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Study on Macrozoobenthos Community in the Waters of the River Air Perikan Municipality of Pagar Alam South Sumatra

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ABSTRACT

The research entitled " Study on Macrozoobenthos Community in the Waters of the River Air Perikan Pagar Alam Municipality", was conducted from November 2007 until March 2008. The aims of the research: to know about composition, density, diversity index, dominancy index, and similarity index, which based on the different microhabitat types. Sampling was carried out on November 2007. Five sampling stations were determined by survey method and the Purposive Sampling method was used at each sampling point to find stony, gravel, sandy and leaf pack area as a different microhabitat substrate. Twenty one orders (Ephemeroptera, Trichoptera, Diptera, Plecoptera, Collembola, Hemiptera, Odonata, Coleoptera, Lepidoptera, Megaloptera, Hymenoptera, Orthoptera, Decapoda, Plesiopora, Tricladida, Amphipoda, Isopoda, Mesogastropoda, Ctenobranchiata, Eulamellibranchiata, and Rhynchobdellida) which are consisted of 70 families and 151 genera were identified from four types of substrates on each sampling station. According to this research, station 4 has the highest in composition (80 genera), and the lowest one at station 1(33 genera). The highest abundance was 12589 ind./m^2 found in the station 5, and the lowest one was in the station 1 approximately 880 ind./m^2. For the diversity index value, station 3 was the highest (3.1) and the lowest one was station 5 (1.9). The Dominancy index was found in station 5 at the sandy substrates was approximately 0,8 index, which dominated by *Tubifex* sp. There were differences species composition on each station.

Key words : Macrozoobenthos, community, the river Air Perikan.

ABSTRAK

Penelitian yang berjudul "Struktur Komunitas Macrozoobentos di Perairan Sungai Air Perikan Pagar Alam", telah dilakukan untuk mengetahui komposisi, kepadatan, indeks keragaman, indeks dominansi, dan indeks kesamaan, yang didasarkan pada jenis mikrohabitat yang berbeda. Pengambilan sampel dilakukan pada bulan November 2007. Lima stasiun pengambilan sampel ditentukan dengan metode survei dan metode Purposive Sampling digunakan pada masing-masing titik sampling untuk menemukan daerah kumuh, kerikil, berpasir dan daun sebagai substrat microhabitat yang berbeda. Dua puluh satu pesanan (Ephemeroptera, Trichoptera, Diptera, Plecoptera, Collembola, Hemiptera, Odonata, Coleoptera, Lepidoptera, Megaloptera, Hymenoptera, Orthoptera, Decapoda, Plesiopora, Tricladida, Amphipoda, Isopoda, Mesogastropoda, Ctenobranchiata, Eulamellibranchiata, dan Rhynchobdellida) yang terdiri dari 70 famili dan 151 genera diidentifikasi dari empat jenis substrat pada setiap stasiun sampling. Menurut penelitian ini,

stasiun 4 memiliki komposisi tertinggi (80 marga), dan yang terendah di stasiun 1(33 marga). Kepadatan tertinggi adalah 12589 ind./m^2 yang ditemukan di stasiun 5, dan yang terendah ada di stasiun saya kira-kira 880 ind./m^2. Untuk nilai indeks keragaman, stasiun III adalah yang tertinggi (3,1) dan yang terendah adalah stasiun 5 (1,9). Indeks dominasi ditemukan di stasiun 5 pada substrat berpasir sekitar 0,8 indeks, yang didominasi oleh *Tubifex* sp. Ada perbedaan komposisi spesies pada masing-masing stasiun.

Kata kunci: Makrozoobentos, komunitas, sungai air perikan

INTRODUCTION

The Waters of the river Air Perikan is located in Pagar Alam Municipality, is a river capable of supporting the surrounding environment, as a media in improving the economy of the surrounding community in terms of irrigation and water resources. Despite the dry season, the water that has a flow from part of North Pagar Alam Subdistrict to cross the District of South Pagar Alam, is still flowing quite swiftly. This river which geographically has a hilly upland area, and is increasingly gentle downstream, with flow types ranging from high current velocity to low current velocity. The substrate of the river bed found was also varied; stony, pebbly, sandy, and with leaf pack. With the above-mentioned types of microhabitats, it is sufficient to support the varied kinds of freshwater invertebrates, especially macrozoobenthos. Various community activities along the river basin, such as: plantations, rice fields, and settlements, also take part in the formation of river microhabitats that can change the ideal conditions of the river.

Macrozoobenthos is one of the important components in the river ecosystem, which is a component that plays a role in the food chain. In this case, macrozoobenthos has basic properties that facilitate the researcher in conducting studies on macrozoobenthos, such as: 1) ubiquitous (cosmopolitan), so that it can be affected by changing habitats, 2) its relatively long life cycle, 3) having high number of species or diversity, thus easily displaying responses or responses in case of environmental change (Merritt and Cummins, 1996: 87), easy to collect, because of their relatively large size and can be seen with the naked eye.

Several studies on freshwater invertebrate fauna in South Sumatera, especially in river on hilly land have been conducted, among others by: Hanafiah and Purwoko (1998), Hanafiah and Harmida (1999), Permana (2000), Agustina (2001), Kamaliyah (2001), and Adriyanto (2001). All of these studies were conducted on the type of stony, pebbly, leaf pack, and sandy microhabitat. Nevertheless, research on freshwater invertebrate fauna (especially macrozoobenthos), with extensive sampling areas based on river flows, has not been conducted, especially in South Sumatra.

Therefore, the authors are interested in doing research on one of the rivers in Pagar Alam Municipality, the Air Perikan River, with the purpose of research to determine the composition, density, and diversity of macrozoobenthos in the Water River Air Perikan Pagar Alam, on the different type of microhabitat.

MATERIALS AND METHOD

Sampling was conducted in November 2007. Collection of samples were conducted in the waters of the River Air Perikan with an environmental hue as follows: a) public baths; b) around PT. Perkebunan Nusantara; c) Perumnas Nendagung settlement; d) around a swimming pool; and e) Plantations and rice fields around the river mouth of Air Perikan. Bottom substrate types of rivers varied (stony, pebbly, leaf pack, and sandy). After the sample was obtained, the identification process was conducted from December 2007 until March 2008 at the Laboratory of Zoology, Departement of Biology, Faculty of Mathematic and Natural Sciences Sriwijaya University.

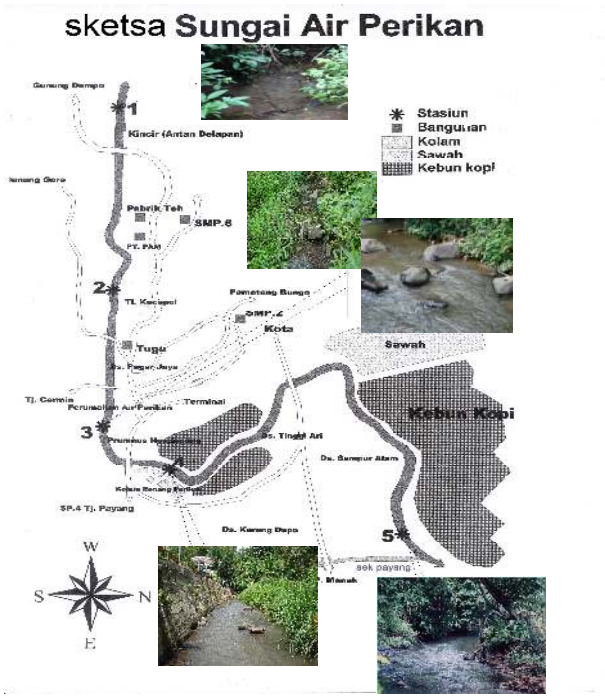

Fig. 1. Scheme of research location

Field Procedures

The samples were taken from several types of microhabitat, namely stony, pebble, sandy, and leaf pack substrates by using hand net with size of face 40 cm x 40 cm. This net was placed vertically on the bottom of the river where the sample was taken, which serves to filter out the drifting zoobenthos. On the face of the mesh frame was taken a substrate in the form of stone, gravel, sand and leaf pack. For the category of stone, the sample was taken only one stone with a diameter of 15 cm - 20 cm (Hanafiah 1996: 9). For the substrate in the form of gravel, sand and leaf pack, the base area of the substrate was set up 25 cm x 25 cm. For gravel and sand substrate, the substrate was dug as deep as 20 cm (Takemon, 1993 in: Hanafiah & Harmida 1999: 7). Furthermore, samples of stony substrates were brushed in a bucket. Concerning with gravel, sandy and leaf pack

substrates, samples were sorted from substrates in a bucket. Then, the water mixed with the sample was filtered using a 250 μm porous sieve and the filtered macrozoobenthos sample was inserted into a sample bottle containing 10% formalin and water, at a ratio of 1: 1, and labeled. As the supporting data was carried out the recording of environmental conditions, such as: water pH, water temperature, current velocity, river depth, and vegetation conditions around the study area.

Laboratory Procedures

After the sample was obtained from the field, it was sorted by its taxon group and identified referring the following identification books: Merrit and Cummins (1996), Dharma (1992), Djajasasmita (1999), Quigley (1980), Pennak (1978) and Needham (1978), using binocular microscope and stereo microscope. Specifically for small insect larvae such as the Chironomidae family, belong to Diptera Order, before identification, the larvae was boiled first with 10% KOH solution for 25 minutes (Wiederholm, 1986). This treatment was done so that the chitine layer can be seen clearly, thus can facilitate the identification process. Samples that have been boiled, placed on the glass object with the ventral position of the body of the larvae facing upwards, then spilled with glycerin, then observed with a stereo microscope with magnification 10 x 10 and 10 x 40, then the identification sample was kept into a sample bottle containing 70% alcohol grouped into genus level.

Data Analysis

Density of Macrozoobenthos

The density of macrozoobenthos was calculated using the formula as follows: (Welch, 1952 dalam Hanafiah & Purwoko 1998 : 10) :

$$N = \frac{10000S}{a}$$

Where: N = Density m^{-2}
S = Number of individuals
a = Surface area of sampling point.

To calculate the relative density of macrozoobenthos, the following formula is used :

$$\text{Relative Density} = \frac{\text{Number of individual each species}}{\text{Total Number of individual of all species}} \text{ x } 100\%$$

The Dominance of Macrozoobenthos

The dominance of macrozoobenthos in different microhabitats can be calculated using the Simpson Dominance Index (1949) formula in Odum (1993: 179) as follows:

$$C = \sum \left[\frac{ni}{N} \right]^2$$

Where: C = Simpson Index
ni = Number of individual per species
N = Total number of individulas

Macrozoobenthos Diversity

The diversity of macrozoobenthos in different microhabitat can be determined by the formula Shannon Wiener (Basmi, 2000) as follows:

$$H = -\sum \left[\frac{ni}{N} \right] \ln \left[\frac{ni}{N} \right]$$

Where: H' = Diversity Index
ni = Number of individual each species
N = Total number of individuals

Similarity Index of Macrozoobenthos Community

The similarity of macrozoobenthos community in different microhabitat can be determined by using Sorensen Index (1948) as follows:

$$S = \frac{2C}{A+B} x100\%$$

RESULTS AND DISCUSSION

Macrozoobenthos Composition

The result of identification of all macrozoobenthos samples at 5 observation stations were obtained 21 orders macrozoobenthos consisting of 70 families and 151 species. The details number of macrozoobenthos species obtained were: 33 species at station 1, 64 species at station 2, 59 species at station 3, 80 species at station 4, and 41 species at station 5 (respectively) (Fig. 1).

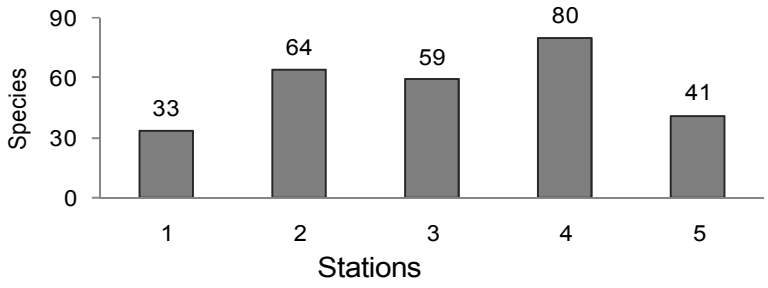

Fig. 1. The total species composition of macrozoobenthos at 5 stations

This is supposed to happen due to station IV located around the water swimming pool and surrounded by the coffee field has a more stable availability of substrates for the survival of most identified macrozoobenthos. This is because the form of a flatter stretch of the river and with the rocks and gravel, which can withstand the strong currents of river water that can change at any time, as a refuge for makrozoobenthos.

The substrate is not only a shelter, the importance of substrate stability in maintaining the presence of macrozoobenthos as mentioned by Minshall in Resh & Rosenberg (1984: 358) is because the substrate as a medium for makrozoobenthos.

Density of Macrozoobenthos

The total density of macrozoobenthos species can be described at each station as shown in Fig. 2. The highest density was occupied by station 5 which has an individual number of 12589 ind./m2. The high value of this density because there were a lot of *Tubifex* sp.

Station V is a station that has been suspected to have accumulated a lot of organic material from the river streams of previous stations as well as from plantations and domestic waste around station V. This can be seen from the dissolved oxygen range between 3.45 - 3.80 (Table 2), which is just Tubifex sp. most abundant because of its tolerance to the low content of dissolved oxygen (Edmonson 1959 in Gustina 2000).

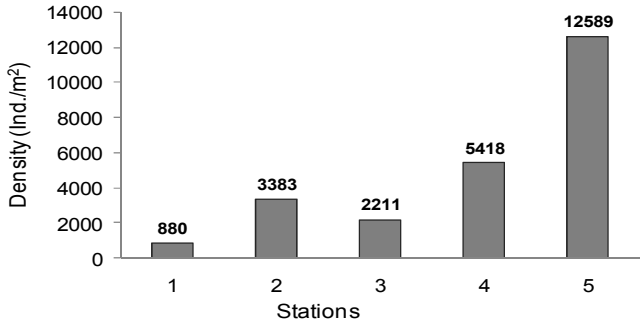

Fig. 2. The total density of macrozoobenthos at 5 stations

Station 1 occupies the lowest total individuality of macrozoobenthos compared to other stations, which is 880 ind./m2. It is suspected to occur due to disruption of the physical condition of the bottom of the river basin caused by the community bathing activity, so that can be found inundated river area. At the river bank there was a vegetation (riparian) that provides a rugged substrate for macrozoobenthos, especially for Diptera which is more favorable to the condition, and was found abundantly (Merritt & Cummins 1996: 484 - 485).

At the next station of stations 2, 3, and 4, it has a more heterogeneous topography which also provides more heterogeneous substrate than station 1. It can be seen from the total abundance value of individual macrozoobenthos, whose respective total abundance values are 3383 ind ./m2, 2211 ind./m2, and 5418 ind./m2, more abundant than station 1.

Despite the input of organic materials from plantations, rice fields and domestic waste, the physical and chemical conditions of water from stations 2, 3, and 4 were still within tolerance for the survival of macrozoobenthos (Table 2). This happens because of mountain topography conditions that cause water can continue to flow from upstream to downstream stations.

DIVERSITY OF MACROZOOBENTHOS

In Fig. 3. The high diversity index of macrozoobenthos was occurred at station 2, station 3, and station 4, which are 3,04; 3,18 and 3,05, respectively. Microhabitat for macrozoobenthos, which is a stony and graveled substrate, is a suitable place for most of the water-insect larvae and other aquatic organisms in the upstream region to undergo the life cycle process (Resh & Rosenberg 1984: 364). Furthermore, Scullion *et al*., (1982) in Hanafiah & Purwoko (1998: 18) explains that stony and pebble substrate found in the upstream of the river, is a heterogeneous substrate, thus making the aquatic insects more diverse. Whereas sandy substrate, is a relatively homogeneous type of microhabitat, and only certain groups of macrozoobenthos can adapt to the substrate, such as *Tubifex* sp. (Brusven & Prather 1974 in Hanafiah & Purwoko 1998: 20).

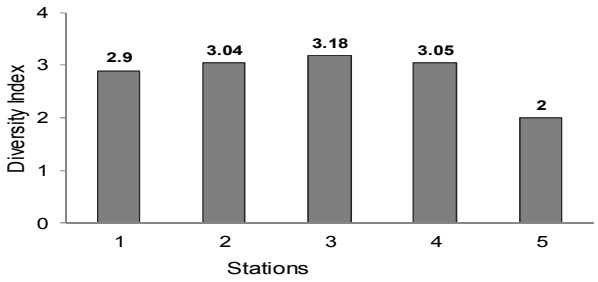

Fig. 3. The Diversity of Macrozoobenthos at 5 stations

Dominance of Macrozoobenthos

In Fig. 4. We can see that the value of total dominance index of macrozoobenthos from station 1 to station 5 is 0.084; 0.090; 0.063; 0.094; and 0.228 (respectively).

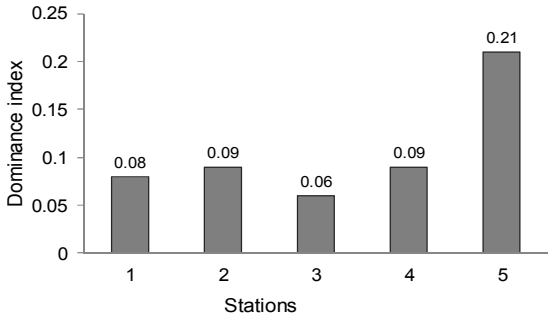

Fig. 4. The Dominance Index of macrozoobenthos at 5 stations

Of the five values are less than 0.5, which means that there was no dominant of the whole station. Although the value of the Dominance Index at station 5 was much higher than other stations, station 5 can still be categorized to have no dominant of macrozoobenthos.in the overall station. A good waters will show a balanced number of individuals in almost all species, otherwise contaminated waters will lead to the spread of unequal numbers of individuals and there will be a tendency of one dominating species (Hartati 1998: 32).

The Similarity between stations

The similarity index is used to determine the degree of distribution of macrozoobenthos between stations. Based on the Sorensen Similarity Index, the percentage of similarity index values between stations as follows:

Table 1. Matrix of the species similarity among stations at the waters of the River Air Perikan.

Stations	1	2	3	4	5
1		35,05 %	30,43 %	28,31 %	27,02 %
2			42,27 %	43,05 %	34,28 %
3				47,48 %	42 %
4					46,28 %
5					

Based on Sorensen Similarity Index, the value of similarity Index was ranging from 27.02% to 47.48%. All values of this similarity Index was less than 50%, indicating that species of macrozoobenthos obtained was relatively different among stations. In other words, each station has a typical species of macrozoobenthos that is relatively not found in other stations.

Despite the values of abiotic factor measurements between stations were not significantly different from one another, but the species of macrozoobenthos which found at each station was not similar. One factor that cause this to happen is due to the different conditions of the natural landscape of the river that affect the formation of the available substrate. In other words that, although the substrate categories are stony, pebbly, sandy and the leaf pack were the similar in each station, but that is different due to the topographic differences of the river from upstream to downstream. As reported by Resh & Rosenberg (1984), that the characteristics of substrate owned by each station have a close relationship to the species of macrozoobenthos in it, and each group of the macrozoobenthos has own adaptation to adjust to the environment.

Physical and chemical parameters of waters

The results of measurements of physical and chemical parameters of waters in the Air Perikan River, generally indicate that river conditions were still within a reasonable range to support macrozoobenthos life. The results of these measurements are shown in Table 2. Current velocity measurements on the Air Perikan River ranging from 5 cm/s up to 50 cm/s, which categorized very slow current to moderate current speeds. The current velocity will affect the bottom substrate of the waters, the species, and the characteristics of the organisms inhabiting in the waters. Ardi (2002: 1) explains that at a weak current velocity, the substrate tends to be muddy, whereas in regions with strong currents the substrate tends to be rocky.

Water temperature obtained from the entire stations ranging from 20 ^{0}C to 28 ^{0}C. This difference might be due to differences in measurement time and differences in the area of canopy cover in each station. Jeffries and Mills (1990: 10) report that the optimum temperature for macrozoobenthos is between 20 ^{o}C – 30 ^{o}C, this means that the temperature range of measurements in the Air Perikan River was still within the tolerance limit for the viability of the macrozoobenthos lifecycle.

The result of measurement of dissolved oxygen content of Air Perikan River ranging from 3.45 ppm to 5.35 ppm. Based on the water quality criteria of the dissolved oxygen content, the Air Perikan River belongs to a mildly to moderate contaminated river (Lee (1978), Riwayati (1994: 13) in Gustina 2000: 17). According to Sastrawijaya (2000: 84) that life in water can survive if the dissolved oxygen content is a minimum of 5 ppm, if less than that value depends on the resilience of orgasnism and the presence of pollutants in the waters.

Measurements of pH values in the Air Perikan River ranging from 6.94 to 7.36. This value indicates a relatively small variation and remains within the normal range for the life of macrozoobenthos living in a waters. According to Cole (1983) in Ward (1992: 346), most of the uncontaminated waters show pH values in the ranging from 6.0 to 9.0.

Table 2. Range of Measurement Result of Physical Chemical Factors in the waters of the River Air Perikan

Abiotic factors / Stations	Current velocity (cm/s)	Water depth (cm)	Water Temp. (^{o}C)	DO (ppm)	pH
1	5 - 30	20 – 70	20 – 23	4,90 – 5,00	7,09 – 7,36
2	10 - 30	7 – 20	23 - 24	4,83 – 5,35	7,03 – 7,10
3	10 - 50	10 – 40	27	4,80 – 5,24	7,15 – 7,16
4	10 - 50	20 – 30	27 - 28	4,54 – 4,85	7,04 – 7,17
5	8 - 50	15 – 30	26	3,45 – 3,80	6,94 – 7,16

CONCLUSIONS

Laboratory identification results obtained 21 orders of macrozoobenthos consisting of 70 families and 151 genera.

The highest number of macrozoobenthos was found in station 4 (80 species), followed by station 2 (64 genera), station 3 (59 genera), station 5 (41 genera) and station 1(33 genera).

Station 5 occupied the highest individual abundance of 12589 ind./m^2. Moreover, the density of macrozoobenthos consisted of 5418 ind./m^2 (station 4); 3383 ind./m^2 (station 2); 2211 ind./m^2 (station 3) and 880 ind./m^2 (station 1) respectively.The dominance index of the largest macrozoobenthos species was found in station 5 which dominated by *Tubifex* sp. While on the other stations no dominant species was found.

The macrozoobenthos species diversity index of the five stations was quite high. With a range of index values ranging from 0.51 to 3.00 (low to moderate level).

All stations have different macrozoobenthos communities, which are shown by the value of similarity index less than 50%.

In this study aquatic insects were found with the greatest number of 86.76% of the total species of macrozoobenthos. Then followed by Gastropods 5.29%, Crustaceae 3.31%, Oligochaeta 1.32%, Turbellaria 1.32%, Hirudinea 1.32%, and Bivalvia 0.66%.

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