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The study of diversity index on plankton community in Lematang River to determinate the quality of waters as habitat of local fishes

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Abstract. The existence of plankton community in Lematang River is important for supplying diet nutrition to juvenile fishes. Based on study that had been done in Lematang River, there are relationship between the populations of several fishes with plankton diversities. Some activities which disturb the living of plankton are sand and stone mining. This activities have destroyed niche habitat for plankton and fishes. Additionally, other factor that lead to the damage are domestic and industrial wastes or originated from Lahat and areas a longside Lematang River. According to this research, local fishes that could be found in upstream of Lematang River were *Rasbora* sp., *Puntius* sp., and *Hampala* sp. and etc. Diversities index of plankton communities on upstream was higher (more than 3.00) than those that on downstream (less than 3.00). Regulation to prohibit sand and stone mining are necessary to conserve niche habitat of Lematang River for plankton and local fishes.

1. Introduction

Lematang River is aquatic ecosystem serving as lotic habitat for aquatic organisms such as plankton, benthos, nekton and periphyton. Lematang River has approximately 50 up to 15 meters and depth 0.5 up to 30 meters. Plankton are small, floating, weakly swimming plants and animals in freshwater and marine ecosystems while benthos are animals and plants living on sea bottom [1]. Benthos were organisms attached or resting on bottom or living in bottom sediments while nekton were swimming organisms that able to navigate at will to avoid plankton nets, water bottles, etc [2]. Nekton consist of fishes, amphibians, aquatic reptilians, aquatic insects, etc. The periphytons consist of organisms that are attached on a submerged substrate but they do not penetrate in to those substrates. The substrates may be aquatic vegetation and sediment or stones in river currents.

The plankton comprises all those aquatic organisms which drift passively or whose powers of locomotion are insufficient to enable to move contrary to the motion of their inhabited water mass [3]. The plankton drifting along with water currents may be attached on periphery of stones then growing to be periphyton. However as periphyton liberated from their substrates, they become plankton again. The upstream of Lematang River are habitat for plankton, periphytons, benthic animals and nekton. According to their functions, plankton community can be divided in to phytoplankton and zooplankton. Phytoplankton are plankton that less active move in the waters and can carry out photosynthetic process like higher plants. Zooplankton are more active than phytoplankton. On dry seasons water debit is decreased, hence, many plankton would grow and bloom because water quality are better than that on rainy seasons. On rainy seasons, water debitis high and living plankton would disturb and the population
of plankton is decreased. When population of plankton descended, the population of nekton or much of fishes would follow to become descend too. Much of nekton on the lotic ecosystem on the Lematang River suspend their natural foodstuff to plankton existence.

This study will compare the population of plankton in Lematang River in the upstream locations, before Lahat Town up to downstream on after Lahat Town. The purpose of this study is to study the effect of wastes from antropogenic activities from Lahat Town concerning on habitat and populations of plankton communities. According to my survey evidently there are another factor actually influence the quality of plankton habitat on the Lematang River, namely the exploitation of stones from river everyday with trucks.

Everyday much pick trucks carried stones and sands from Lematang River up go to stockpile sites everywhere mainly to Palembang City. On the dry seasons like recently the conditions of rivers were better than rainy season but the exploitation of stones from river to become interfere with population of plankton. The existence of plankton in Lematang River were very important to become fertile for the nursery ground in habitat aquatic for much fishes. The population of periphyton on upstream in Lematang River effect the population of plankton communities. This research would establish that the upstream Lematang River very important to conserve of local fishes. But there are two factors actually disturb grow and developing the population and diversity of plankton in Lematang River. The first was so much the activities of anthropogenic who throw the waste river everyday maybe domestic wastes and industries wastes. The wastes of domestic from drainage of town content of detergent and others. The wastes of industries maybe contents nitrate, phosphates and anothers. We know that plankton communities make up the part of nursery ground. Nursery grounds can be defined generally as habitats could enhanced growth and survival of juveniles or larva of aquatic fauna. The other of means that nursery ground can be consider as habitats that make juveniles of fishes for growing to become normally in aquatic ecosystem.

The importance of plankton as natural diet not only for zooplankton but also for juveniles fishes which their nutrition are abundant on nursery ground niche. That were the reasons why this research necessarily carried out on Lematang River, mainly for local fishes. The other activities that damaged aquatic ecosystem in Lematang River mainly on the downstream were much industries and factories removal the waste to water column of Lematang River. This condition would impede the growth and development of many species of fishes as well as destroy nursery ground which consist of plankton and periphyton in Lematang River. Local fishes in Lematang River are suitable in downstream habitat.

2. Method of research

This research had been made along upstream of Lematang River from Lahat Region up to downstream Lematang River around of Muara Enim Region and Penukal Abab Lematang Ilir (PALI) Region of South Sumatra Province. This survey had done directly and sampling plankton in July 2018. The samples of water from fields had analyzed in laboratory for identifying the chemical parameter. Some parameters like physical and chemical features had been measured in the field or in situ. The physical features directly were measured in the fields like temperature and transparency.

Sample of plankton taken with using plankton net as much as 50 liters and afterwards the plankton precipitate taken in flacon (volume 25 centimetre cubic), and then be given four drops formaldehyde or equivalent with 0.5 centimetre cubic formaldehyde [4, 10]. Furthermore, the sample of plankton inspected under the microscope (model xsz-107bn) observed in 150 X and 400 X magnitude. Identification of plankton species based on [5–7].

Diversity index of communities: 

\[ H = - \sum \pi_i \ln \pi_i; \quad \pi_i = N_i/N \]  

(1)

The symbol \( H \) = Shannon index of general diversity. In here as Diversity Index of Plankton Community (Shannon index); \( \pi_i \) = Importance probability for each species \( = n_i/N \); \( N_i \) = importance value for each species; \( N \) = total importance value [2]. Indices values of diversity can be categorize as follows:

According to [8] that the indices diversity as big as: \( \leq 1 \): can be said that the communities of organism very non stable in the ecosystem because any problems of physical, chemical and biological factors. If indices of diversity as big as \( > 1 \ - \ < 2,0 \): can be estimate that the communities of organism non stable
in the ecosystem by some factors of biological, physical and chemical. When the indices diversity as big as: $>2.0 – 3.0$ mean that the communities of organism adequate stable in the ecosystem. Furthermore, if the indices diversity as big as: $>3.0$ mean that the communities of organism very stable in the ecosystem.

The fishes which caught by fishermen around location during sampling plankton in location recorded and than identified in laboratory. The methods of fishes collection used namely to collect several fishes which were caught by fishermen at each sampling location [9].

3. Results and discussion
Samples which taken from field Lematang River then analyzed in Laboratory of Ecology on Faculty of Mathematics and Natural Sciences Sriwijaya University in July 2018. The results of analysis can be seen in table 1 below:

Table 1. The results of plankton communities analysis in Lematang River from upstream about Lahat Region, South Sumatera.

| No. | Group | Taxon and Species | Sampling location: | Densities: Individu/liter of water |
|-----|-------|------------------|--------------------|----------------------------------|
|     |       |                  | P1     | P2     | P3     | P4     |
| I.  | PHYTOPLANTON |                  |        |        |        |        |
|     | A. Cyanophyceae: |                  |        |        |        |        |
| 1.  | Anabaena catenula |                  | -      | 1      | -      | -      |
| 2.  | Lyngbya limnotica |                  | 2      | 3      | -      | 1      |
| 3.  | Nodularia spumigena |                | -      | 2      | -      | -      |
| 4.  | Oscillatoria limosa |               | 4      | 5      | 15     | -      |
| 5.  | Oscillatoria splendidia |              | -      | 5      | -      | -      |
| 6.  | Oscillatoria tenuis |                | -      | -      | 12     | -      |
| 7.  | Phormidium tenue |                  | 1      | -      | 8      | 3      |
| 8.  | Rivularia sp. |                  | 5      | -      | -      | -      |
|     | B. Chlorophyceae: |                  |        |        |        |        |
| 1.  | Ankistrodesmus falcatus |              | 4      | -      | -      | -      |
| 2.  | Ankistrodesmus spiralis |              | 7      | -      | -      | -      |
| 3.  | Chaetophora elegans |                  | 8      | 7      | -      | -      |
| 4.  | Draparnaldia plumosa |                 | 2      | 5      | -      | 2      |
| 5.  | Microspora tumidula |                  | 5      | -      | -      | -      |
| 6.  | Oedogodium varians |                  | 2      | 2      | -      | -      |
| 7.  | Quadrugula chodattii |                | -      | 3      | -      | -      |
| 8.  | Quadrugula recustris |                | 1      | 1      | -      | -      |
| 9.  | Spirogyra semiornata |               | 11     | -      | -      | -      |
| 10. | Spirogyra varians |                  | 1      | -      | -      | -      |
|     | C. Desmidiaceae:  |                  |        |        |        |        |
| 1.  | Closterium intermedium |              | 1      | -      | -      | -      |
| 2.  | Closterium litterale |                 | -      | -      | 2      | -      |
| 3.  | Closterium striolatum |                | 4      | -      | 1      | -      |
| 4.  | Micrasterias foliacea |                | -      | 6      | -      | -      |
| 5.  | Micrasterias lux |                  | -      | 3      | -      | -      |
|     | D. Diatomae:      |                  |        |        |        |        |
Table 1. The results of plankton communities analysis in Lematang River from upstream about Lahat Region, South Sumatera.

| No. | Group Taxon and Species: | Densities: Individu/liter of water |
|-----|--------------------------|------------------------------------|
|     | Sampling location:       | P1   | P2   | P3   | P4   |
| 1.  | *Amphipleura pellucida*  | -    | 1    | -    | -    |
| 2.  | *Asterionella formosa*   | 4    | 3    | 2    | 1    |
| 3.  | *Caloneis bacillum*      | 2    | -    | -    | -    |
| 4.  | *Cymbella cistura*       | -    | 1    | -    | -    |
| 5.  | *Diatoma elongatum*      | 2    | 3    | -    | 1    |
| 6.  | *Diatoma vulgare*        | -    | 1    | 1    | -    |
| 7.  | *Eunotia arcus*          | -    | -    | -    | 1    |
| 8.  | *Eunotia gracilis*       | -    | -    | -    | 1    |
| 9.  | *Eunotia lunaris*        | -    | -    | -    | 1    |
| 10. | *Fragilaria crotonensis* | 2    | -    | -    | -    |
| 11. | *Gyrosigma attenuatum*   | 2    | -    | -    | -    |
| 12. | *Nitzschia linearis*     | 5    | 2    | 1    | 2    |
| 13. | *Pinnularia borealis*    | -    | 2    | -    | -    |
| 14. | *Surirella robusta*      | -    | 3    | -    | -    |
| 15. | *Stephanodiscus carconensis* | 1 | -    | -    | -    |
| 16. | *Tabellaria fenestrata*  | 16   | 10   | -    | -    |

II. ZOOPLANKTON

A. Flagellata:
   1. *Carteria globosa* 1 - 3 1
   2. *Euglena acus* - - 4 -
   3. *Euglena deses* - - 5 -
   4. *Lepocynclis ovum* - - 1 1
   5. *Monas vivipara* - - - 1
   6. *Thylacoconas compressa* - 1 1 -
   7. *Trachelomonas abrupta* 1 2 - -
   8. *Trachelomonas cervicula* 4 3 - -
   9. *Trachelomonas curta* 1 - 3 -
   10. *Trachelomonas intermedia* - 1 - -
   11. *Trachelomonas oblonga* 1 - - 2
   12. *Trachelomonas volvocina* - 3 - -

B. Rhizopoda:
   1. *Astramoeba radiosa* 1 - 1 -
   2. *Centropyxis aculeata* 1 - - -
   3. *Difflugia urceolata* 1 - - -
   4. *Nebela dentistoma* 1 - - -
   5. *Nebela militaris* 4 - - -

C. Ostracoda:
   1. *Cypridopsis aculeata* 2 - - -

D. Rotifera:
Table 1. The results of plankton communities analysis in Lematang River from upperstream about Lahat Region, South Sumatera.

| No. | Group Taxon and Species: | Densities: Individu/liter of water |
|-----|-------------------------|-----------------------------------|
| P1  | P2  | P3  | P4  |
| 1.  | *Brachionus falcatus*   | 2    | -    | -    |
| 2.  | *Rotaria rotatoria*     | 1    | -    | 1    | -    |

E. Diptera:

| No. | Taxon and Species: | Densities: |
|-----|-------------------|------------|
| 1.  | *Chironomus* sp. (larva) | 1  | 2  | -  | -  |

1. Densities of Plankton: 114 81 61 18
2. Densities of Phytoplankton: 92 69 42 13
3. Densities of Zooplankton: 22 12 19 5
4. Richness of Plankton: 37 27 16 13
5. Richness of Phytoplankton: 23 21 8 9
6. Richness of Zooplankton: 14 6 8 4
7. Diversities Indices of Plankton (H): 3.23 3.08 2.13 2.48
8. Dominant indices (C): 0.055 0.057 0.13 0.13

Data Primer, July, 2018.
P1: Around of Pulau Pinang Village (S: 03° 51'40,2"; E: 103°31'33,1');
P2: Before Lahat Town (S: 03° 51’38,4”; E: 103°31’32,6”);
P3: Around Lahat Town (S: 03° 47’00,6”; E: 103°34’30,0”);
P4: After Lahat Town (S: 03° 45’52,5”; E: 103°39,1’16,2”).

Figure 1. Densities Plankton Communities (individual/lt) In Lematang River, July 2018. 1, Around of Pulau Pinang Village; 2: Before Lahat Town ; 3: Around Lahat Town ; 4: After Lahat Town.

According to table 1 that densities of Plankton Communities apparently as long to downstream as descended maybe because the quality of water column actually had been decline like point out on table 1 above. On the upstream of Lematang River who there no exploitation stone and sand from river, that population of plankton so higer than in sites on downstream of river. When the currents of water flows through Lahat Town, much of domestic wastes enter to column of water, and the colour of water to become more disturbed. This condition appear that the value of transparency of water more lower (table 2) Such as the value of diversities and diversities indices also would lower on the downstream because of wastes enter to column of water in Lematang River. Richness or diversities of species decline from...
upstream up to downstream according to damaged of aquatic environment of River Ecosystem. In the upstream there were 27 up to 37 species of plankton, while in downstream 13 up to 16 species. The results of analysis proved that diet availability such as plankton is more scarce on the downstream. This conditions effects the diversities and population of local fishes as long time to be decreased.

**Figure 2.** Diversities indices of plankton communities (Shannon index) in Lematang River, July 2018 on four locations: 1, Around of Pulau Pinang Village; 2: Before Lahat Town ; 3: Around Lahat Town ; 4: After Lahat Town.

According to value of diversities indices like on tabel 1 and figure 2, apparently that diversity index in upper stream was better or bigger than in sites on downstream. On the site of Lahat Town pathway apparently had diversity index of plankton community more little than in sites of upstream. This data proved that effect of anthropogenic wastes to damaged of habitat of plankton actually happened. This effect would followed to downstream in Lematang River gradually.

**Figure 3.** Richness of plankton communities in Lematang River, July 2018 on four locations: 1, Around of Pulau Pinang Village; 2: Before Lahat Town ; 3: Around Lahat Town ; 4: After Lahat Town.
According to value of diversities indices like on table 1 and figure 3, apparently that richness of plankton communities in Lematang River in upstream was bigger than in sites on downstream. On the site of Lematang River which pathway in Lahat Town apparently had richness of plankton species more little than in sites of upstream. This data proved that effect of anthropogenic wastes to descend quantity of plankton species. This condition effected until to downstream in Lematang River gradually.

Table 2. The results of chemical and physical measurements on four sampling locations on Lematang River.

| Parameter | P1  | P2  | P3  | P4  |
|-----------|-----|-----|-----|-----|
| A. Chemical parameter: |     |     |     |     |
| 1. pH (unite)   | 6.4 | 6.39| 6.32| 6.29|
| 2. DO (mg/liter) | 8.1 | 7.8 | 6.4 | 5.6 |
| 3. CO2 (mg/liter) | 42  | 50  | 60  | 80  |
| 4. Nitrate (NO3) (mg/liter) | 0.01 | 0.02 | 0.03 | 0.05 |
| 5. Phosphate (PO4) (mg/liter) | 0.31 | 0.06 | 0.06 | 0.43 |
| B. Physical parameter: |     |     |     |     |
| 1. Water Temperature (οC) | 25  | 27.5| 29.1| 30.5|
| 2. Current (cm/second) | 63  | 60  | 60  | 56  |
| 3. Transparency (cm)  | 120 | 90  | 70  | 40  |
| 4. River Width (meter) | 240 | 300 | 350 | 400 |

Primary Data: July 2018
Explanation:
P1: Around of Pulau Pinang Village (S: 03° 51’40,2”; E: 103°31’33,1”);
P2: Before Lahat Town (S: 03°51’38,4”; E: 103°31’32,6”);
P3: Around Lahat Town (S: 03°47’00,6”; E: 103°34’30,0”);
P4: After Lahat Town (S: 03°45’52,5”; E: 103°39,1’16,2”).

The acidity of water quality from upstream up to downstream in factually almost same one another, namely 6.29 – 6.40. But dissolved oxygen from upstream up to downstream were depleted a little according to properties of lotic ecosystem, namely 5.6 up to 8.1 where oxygen resources from contact of water surface to atmosphere directly. The depletion of oxygen in the water column on this research because interfere of domestic waster came into water on Lematang River. All of physically and chemically properties in Lematang River in this researches can be shown above in table 2. The depletion of transparency from upstream up to downstream because after pass to Lahat City, there were much organic and inorganic wastes come into Lematang River, with the result that the condition of river tobe turbid.

On the dry seasons like recently the conditions of rivers were very good according to physical and chemical properties like temperature 25 up to 30.5 οC; light penetration up to bottom namely 40 up to 120 cm, pH 6.29 – 6.40, Dissolved Oxygen 5.6 up to 8.1 ppm. When sampling had been doing in field on July 2018, much of nekton like fishes of Rasbora, Puntius and Anematchythus look for nutrition on side of stone under of water. Base to analysis of laboratorium with microscope, species of plankton communities consist of Ankistrodesmus falcatus, Ankistrodesmus spiralis, Chaetophora elegans, Draparnaldia plumose, Mirospora tumidula, Oedogodium varians, Spirogyra semiornata, Clusterium striolatum, Micrasterias foliacea, Asterionella formosa, Diatoma elongatum, Nitzschia linearis, Tabelaria fenestrata, Carteria globosa, Chironomus sp. etc. This condition as long as far from upstream to downstream of Lematang River point out as depletion of densities or population of plankton species. There are some thing problem which accident from upstream to downstream of Lematang River namely exploitation of stone material so very much everyday with truck cars. This accident had been so long time that destroy habitat for organisms like plankton, periphyton, benthic and nekton.
Table 3. The results of identification several species of fishes around of four sampling locations on Lematang River.

| No. | Species                        | Estimation of Population |
|-----|--------------------------------|--------------------------|
| 1   | Anematichthys apogon (Kepras)  | +++          | ++ | +  | -  |
| 2   | Barbodes gonionotus (Tawes)   | +            | -  | +  | -  |
| 3   | Barbonymus schwanefeldii (Lampam) | ++         | ++ | -  | -  |
| 4   | Bagrichthys macracanthurus (ikan layang) | +    | +  | -  | -  |
| 5   | Clarias batrachus (ilele hitam) | +            | +  | +  | +  |
| 6   | Channa striata (gabus)         | +            | +  | -  | -  |
| 7   | Labeobarbus douronensis (Semah) | +           | -  | -  | -  |
| 8   | Labiobarbus festivus (Puyau)   | +            | +  | -  | -  |
| 9   | Hampala macrolepida (Kebarau)  | +            | +  | -  | -  |
| 10  | Kryptopterus limpok (lais)     | +            | +  | -  | -  |
| 11  | Labeo chrysophkedadion (sihitam) | +      | +  | -  | -  |
| 12  | Mastacembelus erythrotaenia (tilan) | +    | +  | -  | -  |
| 13  | Monopterus albus (Belut)       | ++          | ++ | -  | +  |
| 14  | Mystus nemerus (Baung)         | ++          | +  | +  | +  |
| 15  | Mystus nigriceps (Lundu)       | ++          | ++ | +  | +  |
| 16  | Noototerus noptoterus (putak)  | +            | -  | -  | -  |
| 17  | Osteochilus vittatus (Nilem)   | +            | -  | -  | -  |
| 18  | Pangio kuhlii (Langli)         | +++         | +  | -  | -  |
| 19  | Puntius binotatus (Wader)      | +++         | +++ | ++ | +  |
| 20  | Rasbora argyrotaienia (Seluang batang) | +++    | +++ | ++ | +  |
| 21  | Rasbora trilineata (Seluang lidi) | +++      | ++  | +  | +  |
| 22  | Rasbora dusonensis (seluang ekor gunting) | +    | -  | -  | -  |

Richness of Nekton Species (Fishes) : 22 16 8 7

Primary Data: July 2018.
Explanation:
P1: Around of Pulau Pinang Village (S: 03°51′40,2″; E: 103°31′33,1″); P2: Before Lahat Town (S: 03°51′38,4″; E: 103°31′32,6″); P3: Around Lahat Town (S: 03°47′00,6″; E: 103°34′30,0″); P4: After Lahat Town (S: 03°45′52,5″; E: 103°39′16,2″).
- = No Species; + = View, less than 10 individuals; ++ = > 10 up to 20 individuals; +++ = > 20 up to 30 individuals; ++++ = > 30 individuals. The apparatus who used for catching fishes were gill net, fish hook, net lift and scoop net.

4. Conclusion
According to those researches in downstream up to upstream of Lematang River had proved that diversities of plankton communities were 2.48 up to 3.32; densities of plankton were 18 up to 114 individu/liter of waters and the richness of nekton were 13 up to 37 species namely from downstream (20 km from Lahat Town to eastern) up to upstream (30 km from Lahat Town to western).

Conservations to microhabitat in wet land habitat actually very important for living of microorganisms, especially plankton communities to support macroorganisms in aquatic habitat, included local fishes like Anematichthys apogon (Kepras), Barbonymus schwanefeldii (Lampam),
Bagrichthys macracanthus (ikan layang), Labeobarbus douronensis (Semah), Labiobarbus festivus (Puyau), Hampala macrolepidota (Kebarau), Kryptopterus limpopok (Iais), Labeo chrysophekadion (Sihitam), Mastacembelus erythrostigma (tilan), Monopterus albus (Belut), Mystus niger (Baung), Mystus nigriceps (Lundu), Noptoterus noptoterus (Putak), Osteochilus vittatus (Nilem), Pangio kuhlji (Langli), Puntius binotatus (Wader), Rasbora argyraetia (Seluang batang), Rasbora trilineata (Seluang lidi) and Rasbora dusonensis (Seluang ekor gunting).

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