THE ABUNDANCE OF ZOOPLANKTON AS SECONDARY PRODUCER AT AWUR BAY IN THE NORTHERN CENTRAL JAVA SEA

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ABSTRACT

The diversity of zooplankton (as Secondary Producer) were observed at seagrass, mangrove and coral reef area at Awur Bay, in Jepara Waters. The observation were made from August, 13 to September, 10, 2000, at four daily intervals : at 09.00 A.M., 12.00 noon, 3.00 P.M. and 6.00 PM.

The zooplankton abundance at the seagrass area are 3373–6497 individuals/m² with an average of 3,329 individuals/m², at the mangrove area 4132–5970 individuals/m² with an average of 5,177 individuals/m², and at the coral reef area 3061–4079 with average of 3,399 individuals/m². The zooplankton diversity at the seagrass area are 2.1594–2.2917, with an average of 2.2289, at the mangrove area 2.0925–2.4962 with an average of 2.3130 and at the coral reef area 1.9227–2.1181 with an average of 2.0306. On the basis of the zooplankton abundance and diversity at seagrass, mangrove and coral reef area of the Awur Bay, the averages at the Jepara Waters can be regarded as an indicator of marine productivity. The three locations observed displays a direct interrelation as the habitat of zooplankton.

Keywords: zooplankton, seagrass, mangrove, coral reef, Awur Bay - Jepara.

I. INTRODUCTION

The typology of coastal ecosystem in Indonesia were diversified. Kartawinata & Soemadisahdjo (1976); Nontji (1987); Rokhmin Dahuri et. al. (1996) state that there are several ecosystems and resources in the coastal region with high productivity. In addition, Rokhmin Dahuri et. al. (1996), remarked that the three elements of the natural ecosystem in coastal region such as seagrass beds, coral reef and mangrove, known as nursery areas, provide shelter and food for relatively diverse fish communities (Robertson, 1980; Bell & Hamerlin-Vivien, 1982; Endrawati, 1992; Zainuri, 1993; 1994; 1996; Zainuri & Endrawati, 1999).

The secondary producer were denoted as heterotroph biotas which transfer the organic compound from one trophic level to another (Pipkin et al., 1987). While Bougis (1974), Newell & Newell (1977) and Onori & Ikeda (1992) stated that the zooplankton or plankton animal consist of heterotrophs biota which graze on primary producers and do not have the ability to synthesize with organic matter from the environment (phagotrophic). Zooplankton as secondary producer and primary consumer in the food web plays an important link between phytoplankton and nektom (Odum, 1971). This is likely to influence the productivity of the area.

The objective of the present study was to determine the abundance and diversity of zooplankton as secondary producer at the seagrass bed, mangrove and coral reef of the Awur Bay, Jepara waters.
II. MATERIAL AND METHODS

The Jepara Waters is located at 110° 37' E, 6° 38' S. This area consists of several types of ecosystem, three of which are dominant, namely seagrass bed, mangrove and coral reef. The seagrass beds cover the area along the coastal line of the Awur Bay while the mangrove area is located at Bandengan Waters. The coral reefs area is covers the area from Kartini beach to Panjang island. These three locations were chosen as the study sites, as shown in Figure 1.

Sampling was conducted three times, on August 13 and 27, and September 10, 2000, with the samples collected at 08.00, 12.00, 15.00 and 18.00. Twenty five liters of sea water from 3 locations were filtered using a 45 μm mesh size plankton net. The samples were preserved in 4% formalin. They were identified according to Bougis (1974); Newell & Newell (1977); Pipkin et al. (1977) Todd & Laverack (1991); Omori & Ikeda (1992).

Water quality (Temperature, Salinity, Dissolved Oxygen and Current) measurements were taken simultaneously.

The zooplankton abundance and diversity were calculated using the Shannon Weaver Index (Digby & Kempton, 1987; Omori & Ikeda, 1992):

\[
H = - \sum \frac{n_i}{N} \ln \frac{n_i}{N}
\]

where:

- \(H\) = Shannon Weaver Index
- \(s\) = The total number of species
- \(n_i\) = The total number of individual species
- \(N\) = The total number of individuals

III. RESULT

The species of zooplankton present and their abundances in the samples are summarized in Table 1, 2 and 3 (Figure 2). The observations yields a total of 22 zooplankton species, with the following details: 22 species were found in the seagrass beds, 19 species in the mangrove area and 15 species in the coral reefs. Four species, Centropages sp., Acartia sp., Oithona sp and Cirripedia dominated between 8–27 % respectively of the total zooplankton collected. This was followed by Poly-chaeta, Mollusc larvae and Calanus sp., the relative abundance of which is between 3–21.5 %.

The abundance of zooplankton collected at the seagrass bed area is between 3373-6497 individuals/m², with an average of 5329 individuals/m² (Table 1), while the abundance of zooplankton collected at the mangrove area is between 4132–5970 individuals/m², with an average of 5177 individuals/m² (Table 2). The lowest zooplankton abundance was shown in the coral reef area, ranging between 3061-4079 individuals/m², with an average of 3599 individuals/m³ (Table 3).

With reference to sampling, the zooplankton abundance collected at 09.00 ranged between 3096-6497 individuals/m³, while the zooplankton abundance collected at 12.00 ranged between 3173–6913 individuals/m³ and the zooplankton abundance collected at 15.00 ranged between 3212–6014 individuals/m³. The sample of zooplankton abundance collected on 18.00 showed a range between 3061–5660 individuals/m³.

The diversity of zooplankton collected at the seagrass beds is between 2.1594–2.2917, with an average of 2.2289 (Table 1), in the mangrove area 2.0925–2.4962, with an average of 2.0513 (Table 2), in the coral reef area 1.9227–2.1181, with an average of 2.0306 (Table 3).

The measure of water quality, as well as temperature, salinity, dissolved oxygen, and current velocity is presented in table 4.
Figure 1. The Study Site (110° 37' E, 6° 38' S), A (Seagrass Beds), B (Mangrove) and C (Coral Reefs)
Table 1. Zooplankton Abundance (individuals/m³) and Diversity in Seagrass Bed (A), Jepara Waters, collected at August, 13 and 27; and September, 10, 2000 (Abs. = Absolut; Rel. = Relatif = %).

<table>
<thead>
<tr>
<th>No</th>
<th>Taxons</th>
<th>August, 13, 2000</th>
<th>August, 27, 2000</th>
<th>September, 10, 2000</th>
<th>Average</th>
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<td></td>
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<td>09.00 12.00 15.00 18.00</td>
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<td>09.00 12.00 15.00 18.00</td>
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<td>732 990 885 469</td>
<td>827 16</td>
</tr>
<tr>
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<td>529 584 569 423</td>
<td>462 607 526 358</td>
<td>544 10</td>
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<tr>
<td>3</td>
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<td>118 113 120 93</td>
<td>159 3</td>
</tr>
<tr>
<td>4</td>
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<tr>
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<td>95 120 77 68</td>
<td>83 124 71 37</td>
<td>90 2</td>
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<td>188 106 156 134</td>
<td>165 110 144 114</td>
<td>155 3</td>
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<td>0 1</td>
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<td>494 724 510 351</td>
<td>559 10</td>
</tr>
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<td>0 20</td>
</tr>
<tr>
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<td>81 88 83 57</td>
<td>79 92 76 49</td>
<td>78 1</td>
</tr>
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<td>4 5 0 0</td>
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<td>1571 1458 1465 1213</td>
<td>1374 1165 1357 1025</td>
<td>1471 28</td>
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<td>118 150 70 67</td>
<td>109 2</td>
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<td>17</td>
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<td>543 10</td>
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<td>2 0 0 0</td>
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<td>2.2204 2.2175 2.1754 2.1984</td>
<td>2.2043 2.2435 2.1594 2.1764</td>
<td>2.2289</td>
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</tbody>
</table>
Table 1. Zooplankton Abundance (individuals / m³) and Diversity in Seagrass Bed (A), Jepara Waters, collected at August, 13 and 27; and September, 10, 2000 (Abs. = Absolut; Rel. = Relatif = %).

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<thead>
<tr>
<th>No</th>
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<th>August, 27, 2000</th>
<th>September, 10, 2000</th>
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<th>Average</th>
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<td>1</td>
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<td>837 952 956 555</td>
<td>732 990 885 469</td>
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<tr>
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<td>Meridia lucens</td>
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<td>135 109 130 110</td>
<td>118 113 120 93</td>
<td>159 3</td>
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<tr>
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<td>Calanus sp.</td>
<td>368 598 435 352</td>
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<td>461 9</td>
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<td>95 120 77 68</td>
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<td>1571 1458 1465 1213</td>
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<td>109 2</td>
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<td>17</td>
<td>Mollusca (Larvae)</td>
<td>627 654 583 469</td>
<td>549 680 540 396</td>
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<td>543 10</td>
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<td>Branchyura (Larvae)</td>
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<td>2.2043 2.2433 2.1594 2.1764</td>
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</tbody>
</table>

The Abundance of Zooplankton as Secondary Producer at Awur Bay in The Northern Central Java Sea
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<tr>
<th>No</th>
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<td>Cirripedia (Nauplius)</td>
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<td>Mellusca (Larvae)</td>
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<td>20</td>
<td>Laophonte sp.</td>
<td>27 17 20 12</td>
<td>24 18 19 10</td>
<td>21 18 17 9</td>
<td>18 0</td>
</tr>
<tr>
<td>21</td>
<td>Obesa sp.</td>
<td>12 8 5 6</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>3 0</td>
</tr>
<tr>
<td>22</td>
<td>Capitella sp.</td>
<td>8 7 3 3</td>
<td>7 7 3 3</td>
<td>1 3 3 2</td>
<td>4 0</td>
</tr>
</tbody>
</table>

Total Kind: 22 | 21 | 19 | 18 | 17 | 16 | 16 | 15 | 15 | 21
Total Individu: 6497 | 6913 | 6014 | 4849 | 5524 | 5910 | 5338 | 4013 | 4818 | 5773 | 4925 | 3373 | 5729 | 100

Diversity Index: 2.2917 | 2.2289 | 2.2103 | 2.2455 | 2.2204 | 2.2175 | 2.1754 | 2.1984 | 2.2043 | 2.2435 | 2.1594 | 2.1764 | 2.2289
Figure 2. The relative abundance of zooplankton in Seagrass Beds, Mangrove and Coral Reefs in the Jepara Waters.
Table 4. The water quality range measured at three study sites of the Jepara waters on August 13 and 27; and September, 10, 2000.

<table>
<thead>
<tr>
<th>No</th>
<th>Parameters</th>
<th>August, 13, 2000</th>
<th>August, 27, 2000</th>
<th>September 10, 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temperature (°C)</td>
<td>31 – 32</td>
<td>29 – 32</td>
<td>30 – 32</td>
</tr>
<tr>
<td>2</td>
<td>Salinity (‰)</td>
<td>29 – 32</td>
<td>29 – 34</td>
<td>28 – 34</td>
</tr>
<tr>
<td>3</td>
<td>Dissolved Oxygen (ppm)</td>
<td>5,1 – 7,6</td>
<td>5,5 – 7,8</td>
<td>5,5 – 6,9</td>
</tr>
<tr>
<td>4</td>
<td>Current Direction</td>
<td>Southeast</td>
<td>Southeast</td>
<td>Southeast</td>
</tr>
<tr>
<td>5</td>
<td>Current Intensity (cm/second)</td>
<td>20 – 30</td>
<td>15 – 28</td>
<td>20 – 30</td>
</tr>
</tbody>
</table>

III. DISCUSSION

The domination of Centropages sp., Acartia sp., Oithona sp., Cirripedia, Polychaeta, Mollusc larvae and Calanus sp. shows that the environmental resource of the three locations observed (seagrass beds, mangrove and coral reefs), support their life cycle. In general, the determination of productivity on the basis of the zooplankton abundance could not eliminate the life cycle and type of zooplankton itself. Two criteria of zooplankton based on the life cycle which is holoplankton and meroplankton, were illustrated by the dominant species. Centropages sp., Acartia sp., Oithona sp and Calanus sp represent the existence of species which are known as secondary producers, while the presence of Cirripedia, Polychaeta and Mollusc larvae show the presence of the primary consumer, which will develop adult biota, benefiting the presence of food at three locations of study. Stated by Odum (1971) and Bakus (1990), on the basis of trophic level criteria, the zooplankton was the important chain at the second level trophic of the food chain or food pyramid of marine productivity. Zainuri & Endrawati (1999) found the same phenomena, which depicted a mass balance trophic flow model at the same location.

The zooplankton abundance in the three locations studied showed a range which is not so much different from each other, although the figures were very low in the coral reef area compared to those in the seagrass bed and mangrove areas. The high abundance of zooplankton in the seagrass bed and mangrove areas were possibly due to the stock of organic and inorganic matters of the study sites. The seagrass bed of Jepara waters was found at Awur Bay, which is known as the final resting place of sediment deposit brought by the current and trapped by the seagrass. The high density of this deposit will influence the organic and inorganic matters dissolved in the water, which at the end will support, direct and indirectly, the zooplankton growth. The same phenomena were studied by Endrawati (1992), Zainuri (1993, 1998), Endrawati & Zainuri (1996, 1997), which proved the existence of the dissolved material and their relation to the secondary productivity. The same phenomena were also found at the mangrove area. Known as a productive area, the abundance of zooplankton of this region was directly related to the existence of organic matter. State by Sasekumar et. al (1992), the prevailing view of mangrove-offshore interactions is that mangrove export large quantities of detritus to estuarine and near shore waters. The
lower quantity of zooplankton at the coral reef area possibly due to the diminution of coral reef population and bleaching, especially at Panjang island. Sumich (1990) and Kasiyan Rominohtarto & Sri Juwana (1998) stated that the zooplankton abundance of coral reef related directly to the quantity of biota (primary producer) symbion of the coral reef. The diminution of the biota symbion on coral reef surface will of also influence the quantity of zooplankton.

The abundance of zooplankton observed were based on e daily cycle (light intensity); the result of this observation, proved the relationship between the phytoplankton as primary producer and zooplankton as secondary producer (Odum, 1971). The three study sites observed showed the same phenomena as well as their diversity. The diversity of zooplankton showed a direct inter-relation of the three locations observed as a habitat. This condition has been underlined by Rokhmin Dahuri et. al. (1998), who found that seagrass bed, mangrove and coral reef, are the productive area of the coast water, which related directly, especially in the tropical region.

IV. CONCLUSION

The zooplankton abundance at the seagrass area was 3373–6497 individuals/m³, with an average of 5329 individuals/m³, at the mangrove area 4132–5970 individuals/m³, with an average of 5177 individuals/m³ and at the coral reef area 3061–4079 individuals/m³, with an average of 3599 individuals/m³.

The zooplankton diversity at the seagrass area was 2.1594–2.2917, with an average of 2.2289; in the mangrove area 2.0925–2.4962, with an average of 2.5130 and in the coral reef area 1.9227–2.1181 with an average of 2.0306. The zooplankton abundance and diversity can be utilized as the indicator of marine productivity and at the same time can display a direct inter-relation between the three locations observed as a habitat of zooplankton.

ACKNOWLEDGEMENTS

This study was funded by a grant (No. 121/J07/PJJ/KP/2000, April, 10, 2000) from the Routine DIK of Diponegoro University.

REFERENCES


