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Zooplankton Community Structure Based on Different Depths at the Kambang River Estuary, Pesisir Selatan Regency West Sumatra

Struktur Komunitas Zooplankton Berdasarkan Kedalaman di Muara Sungai Kambang Kabupaten Pesisir Selatan Sumatera Barat

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Abstract

This research was conducted in March 2022 at the estuary of the Kambang River, Pesisir Selatan Regency, West Sumatra. This study aims to analyze the structure of the zooplankton community based on depth. The method used is a survey method by determining the sampling location by purposive sampling and zooplankton sampling points by stratified sampling. Sampling of zooplankton utilizing a water pump and filtered using plankton net no. 25, then brought to the laboratory to be identified and the community structure calculated. Sampling was accompanied by water quality pH, temperature, salinity, brightness, current velocity and DO measurements. Four zooplankton species were found in the Kambang River Estuary: Aetideus *armatus, Macrosetella* sp., *Oithona* sp., and *Cyclops* sp. The average value of zooplankton abundance during the day ranged from 1,938.61 - 2,492.50 ind/L, and in the afternoon 1,938.61 - 2,769.45 ind/L, the diversity index during the day was 1.28 - 1.55 and in the afternoon 1.28 - 1.36, the index of uniformity during the day was 0.72 - 0.98 and in the afternoon 0.86 - 0.98, while the index of dominance during the day was 0.40 - 0.53 and in the afternoon 0.40 - 0.52. The one-way ANOVA test results obtained an average value of 0.010 during the day and 0.029 in the afternoon, meaning there was a significant difference in zooplankton abundance between research depths.

Keywords: Depth, Estuary, Community Structure, Zooplankton

Abstrak

Penelitian ini telah dilaksanakan pada bulan Maret 2022 di Muara Sungai Kambang Kabupaten Pesisir Selatan, Sumatera Barat. Penelitian ini bertujuan untuk menganalisis struktur komunitas zooplankton berdasarkan kedalaman. Metode yang digunakan adalah metode survei dengan penentuan lokasi pengambilan sampel secara *purposive sampling* dan titik pengambilan sampel zooplankton secara *stratified sampling*. Pengambilan sampel zooplankton menggunakan mesin air dan disaring menggunakan Plankton net no. 25, kemudian dibawa ke laboratorium untuk diidentifikasi serta dihitung struktur komunitasnya. Pengambilan sampel disertai dengan pengukuran kualitas perairan yang terdiri dari pH, suhu, salinitas, kecerahan, kecepatan arus dan DO. Ditemukan 4 spesies zooplankton di Muara Sungai Kambang yaitu *Aetideus armatus*, *Macrosetella* sp., *Oithona* sp. dan *Cyclops* sp. Nilai rata – rata kelimpahan zooplankton pada siang hari berkisar antara 1.938,61 - 2.492,50 ind/L dan pada sore hari 1.938,61 – 2.769,45 ind/L, indeks keanekaragaman pada siang hari 1,28 – 1,55 dan pada sore hari 1,28 – 1,36, indeks keseragaman pada siang hari 0,72 – 0,98 dan pada sore hari 0,86 – 0,98, sedangkan indeks dominasi pada

siang hari 0,40 – 0,53 dan pada sore hari 0,40 – 0,52. Hasil uji *one way Anova* didapatkan nilai rata-rata pada siang hari 0,010 dan sore hari 0,029, artinya adanya perbedaan kelimpahan zooplankton yang signifikan antar kedalaman penelitian.

Kata kunci: Muara, Kedalaman, Struktur Komunitas, Zooplankton

1. Introduction

The river estuary is one of the ecosystems where interactions occur between the organisms in it and the quality of the water itself. Water is necessary for living things, including plankton, benthos and nekton. All activities around the estuary flow will significantly influence the quality of river waters; these activities impact waters and can affect the quality of the aquatic environment, especially in reducing the rate of marine ecosystems (Asyiawati & Akliyah, 2011). This condition certainly affects higher-level organisms such as fish, so the importance of the role of Zooplankton in a body of water.

Zooplankton is diverse animal plankton comprising various larvae representing almost all animal phyla (Nybakken, 1988). Zooplankton can be found in freshwater, brackish estuaries, open sea waters, and even oceans. According to (Nontji, 2008), Zooplankton that live in estuary waters are included in the marine plankton group (haliplankton). The role of Zooplankton as the first consumer that connects phytoplankton with small and large carnivores can affect the food chain in the aquatic ecosystem. The presence of Zooplankton in a body of water can be used to determine the level of productivity of a body of water (Odum, 1998).

These organisms are found at all water depths because they have the power to move. However, weak Zooplankton can rise up and down and have rhythmic vertical movements every day, where Zooplankton moves towards the bottom during the day and to the surface at night. The movement is intended to avoid intense light from the sun during the day and search for food at night (Malida, 2009; Mahipe et al., 2017). The 4-6 m stratum is adequate for zooplankton life during the day (Izmiarti & Setiawati, 2015). While in the afternoon towards night, zooplanktons are found on average in surface waters up to 15 m depth (Tambaru et al., 2014).

Zooplankton can be found in almost all aquatic habitats with different abundance and distribution. Abundance and distribution depend on the conditions of an aquatic environment (Moniharapon et al., 2014). The distribution and diversity of zooplankton depend on the availability of food, environmental diversity, the pressure of predatory fish or predators, water temperature, dissolved oxygen, wind gusts that trigger water movement and interactions between other biotic and abiotic factors (Rifsaldi et al., 2020). The critical role of zooplankton in waters both as food providers for higher trophic levels and controllers for phytoplankton communities makes fluctuations, and high input of organic matter in waters can affect zooplankton life both in abundance and condition (Widyarini et al., 2017).

The Kambang River estuary is located in Lengayang District, Pesisir Selatan Regency, West Sumatra. This river is the largest estuary in the Lengayang Subdistrict. Along the mouth of this river is the growth and development of the Nipah (*Nypa fruticans*) population. Around this estuary are activities such as fishing boat ports, fish landing bases (PPI), and community activities that are directly related to these waters. The condition of activities caused by human activities along the estuary will affect the quality of these waters and the abundance of zooplankton in these waters.

So, it is necessary to conduct research related to the structure of the zooplankton community based on different depths and times in the Kambang River Estuary, Pesisir Selatan Regency, West Sumatra.

2. Material and Method

2.1. Time and Place

This research was conducted in March 2022 at the Kambang River Estuary, Pesisir Selatan Regency, West Sumatra (Figure 1).

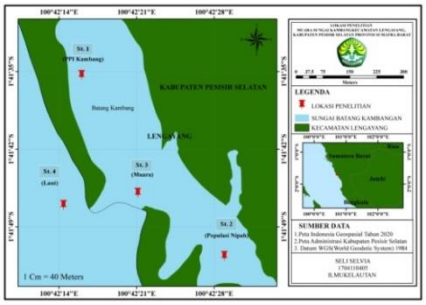

Figure 1. Research location map

2.2. Methods

The method used was the survey method. Data were obtained through observations and measurements in the field. Zooplankton samples were taken to the laboratory to identify and calculate abundance and community structure. The study was conducted at four stations where each station was sampled with three depth strata, namely 0 m (surface waters), 3 m and 5 m. The sampling was conducted at 11 a.m. and 5 p.m. Sampling at 11:00 a.m., and 5:00 p.m. Zooplankton sampling for surface waters was taken using a bucket and a water pump at 3 m and 5 m depth.

Zooplankton samples were brought to the laboratory for analysis. The method used to count the number of zooplankton is the field of view method, with 12 fields of view, then observed using a microscope with a magnification of 100x and identified using Davis (1955); Yamaji (1976) identification books. Water quality measurements were taken in the field. Measurements were pH, temperature, salinity, brightness, current speed and DO.

3. Result and Discussion

3.1. Observation of Water Quality

The results of the average measurement of water quality at each research station during the day and evening as supporting data to determine the variation of the parameters studied in general at each station during the day and evening can be seen in Table 1.

Table 1. Average measurement results of water quality in the afternoon and daytime

Water Quality Parameters	Unit	Station							
		I		II		III		IV	
		daytime	Afternoon	daytime	Afternoon	daytime	Afternoon	daytime	Afternoon
pH	-	7	7,2	7,3	7,3	7,4	7,5	8	8
Temperature	°C	27	27	28	28	28	28	30	30
Salinity	ppt	5	7	6	5	25	25	29	30
Brightness	cm	49	45	75	76	80	75	125	110
Current	m/s	0,46	0,45	0,40	0,42	0,47	0,45	0,45	0,47
DO (surface)	mg/L	5,6	6	6,5	6	7,5	6,5	8	8
DO (3 m)	mg/L	5	5,5	6	5,5	6,2	6,2	7	8
DO (5 m)	mg/L	4,5	5	5	5	6	6	6,8	7,5

Based on Table 1, it can be seen from the average measurement of water quality during the day that the pH of the water ranges from 7-8. These waters are alkaline, which indicates that the waters are ideal for zooplankton growth. Water temperature ranges from 27-30 ° C. This temperature condition is classified in the excellent category for marine biota, according to Tambaru et al. (2014). The salinity of the waters ranged from 5 - 29‰; this indicates that the more towards the sea, the higher the salinity of the waters. Water brightness ranges from 49 - 125 cm. The brightness of these waters is classified as low for marine life but still supports the life of aquatic organisms. The speed of the water current is low, ranging from 0.40 - 0.47 m/sec. The lowest dissolved oxygen concentration is found at station I (4.5-5.6 mg/L), while the highest dissolved oxygen concentration is found at station IV (6.8 - 8 mg/L); this is thought to be due to the lack of human activity in this area, so it does not have a direct influence on dissolved oxygen content.

In the afternoon, it can be seen that the pH of the water ranges from 7.2 - 8. These waters tend to be alkaline, which indicates that the waters are pretty ideal for zooplankton growth. The water temperature ranges from 27 - 30°C, and this temperature condition is classified in the excellent category for marine biota. Tambaru et al. (2014) state that salinity waters range from 5-30 ‰. This indicates that the more towards the sea, the higher the salinity of these waters. Water brightness ranges from 45-110 cm. The brightness of these waters is classified as low for marine biota but still supports the life of aquatic organisms. The speed of the water current is relatively low, ranging from 0.42-0.47 m/sec. The lowest dissolved oxygen concentration is found at station I (5-6 mg/L), while the highest is at station IV (7.5-8 mg/L). This is thought to be due to the lack of human activity in this area, so it does not directly influence dissolved oxygen content.

3.2. Classification of Zooplankton

The results of zooplankton identification found several zooplankton species in the Kambang River Estuary. The classification of zooplankton can be seen in Table 2.

Table 2. Zooplankton classification

Class	Order	Family	Species
Hexanauplia	Calanoida	Aetideidae	*Aetideus armatus*
	Harpacticoida	Miracidae	*Macrosetella* sp
	Eucopepoda	Cyclopidae	*Oithona* sp
	Cyclopoida	Cyclopidae	*Cyclops* sp

Based on Table 2, it can be seen that the zooplankton found consisted of 4 species, all of which came from the hexanauplia class.

3.3. Distribution of Zooplankton Species in the Kambang River Estuary

The distribution of zooplankton species found at all depths and stations during the day can be seen in Table 3 and the afternoon can be seen in Table 4.

Table 3. Distribution of zooplankton species at each depth during the daytime

	Station	I			II			III			IV		
	Depth (m)	0	3	5	0	3	5	0	3	5	0	3	5
Species	*Aetideus armatus*	-	-	-	-	-	-	-	-	-	-	+	+
	Macrosetella sp.	-	-	-	-	-	-	-	+	+	-	-	-
	Oithona sp.	+	+	+	+	+	+	+	-	-	+	+	+
	Cyclops sp.	+	+	+	+	+	+	+	+	+	+	+	+
	Total	2	2	2	2	2	2	2	2	2	2	3	3

Description: + = Found; -= Not found; 0 = surface layer;3 = Depth of 3 meters; 5 = Depth of 5 meters

Table 4. Distribution of Zooplankton species at each depth in the afternoon

	Station	I			II			III			IV		
	Depth (m)	0	3	5	0	3	5	0	3	5	0	3	5
Species	*Aetideus armatus*	-	-	-	-	+	+	+	+	-	+	-	-
	Macrosetella sp.	-	-	-	-	-	-	-	+	-	-	+	-
	Oithona sp.	+	+	+	+	-	-	+	-	+	+	+	+
	Cyclops sp.	+	+	+	+	+	+	+	+	+	+	+	+
	Total	2	2	2	2	2	2	3	3	2	3	3	2

Based on the results of observations and identification found in research at the Kambang River Estuary based on depth strata in the afternoon and evening, four zooplankton species were found from the Hexanauplia class, namely: *Aetideus armatus, Macrosetella* sp., *Oithona* sp. and *Cyclops* sp. which is where the Hexanauplia class is the most holoplankton obtained in a water body indicating the potential for natural food for meroplankton (Mulyadi and Radjab *in* Nurrachmi et al. 2021). These types of zooplankton were found at each research station, but not all types were found at the same depth due to the passive movement of zooplankton. The most zooplankton found during the day were found at a depth of 5 m (Table 3), while zooplankton found in the afternoon were found in surface waters at a depth of 3 m (Table 4).

As seen in Table 3 and Table 4, *Cyclops* sp. is a type of zooplankton found at all stations and depths both day and evening. This is because the zooplankton type *Cyclops* sp. is cosmopolite and lives along waters covered by plants, and there is running water and can live on the surface to the bottom of the water (Agustin & Sri, 2017). At the same time, *Aetideus armatus* and *Macrosetella* sp. species are only found at an average depth of 3 m and 5 m at each station both day and evening.

The distribution of zooplankton species varied based on the surface layer, 3 meters depth and 5 meters depth. Abiotic factors, namely light intensity, strongly influence species' differences at each depth (Susanti et al., 2012). Zooplankton will respond differently to light, and zooplankton usually maintains their position at depths with a specific light intensity. Sunlight affects the vertical distribution of zooplankton because zooplankton can move or move up and down, but the movement is prolonged (Setiawati, 2017). Differences in zooplankton species found at different depths are also influenced by temperature, DO and pH. Biotic factors not observed in this study are thought also to affect zooplankton distribution, such as predators, food availability and zooplankton life cycle.

3.4. Zooplankton Abundance

The results of the calculation of zooplankton abundance in the Kambang River Estuary found different abundances between depths and stations. More details of zooplankton abundance during the day can be seen in Table 5. Table 5 shows that the average value of zooplankton abundance in the Kambang River Estuary during the day has different abundance values at each depth and station. The average value of abundance ranges from 1,938.61 - 2,492.50 ind/L.

The abundance of zooplankton in the afternoon at the Kambang River Estuary shows differences between depths and stations in Table 6. Table 6 shows that the average value of zooplankton abundance in the Kambang River Estuary in the afternoon has different abundance values at each depth and station.

The abundance of zooplankton in the Kambang River Estuary during the day was higher at a depth of 5 meters (Figure 2). In the afternoon, the highest abundance was in the surface layer (Figure 3). This is thought to be caused by various environmental factors, such as brightness because zooplankton move vertically away from sunlight during the day. Zooplankton abundance is also strongly influenced by migration. Migration can occur

due to population density but can also be caused by physical environmental conditions, such as changes in temperature and currents (Susanti, 2010).

Table 5. Zooplankton abundance at each depth during the daytime

Station	Depth (m)	Number of Individuals	Total Individuals	Abundance (Ind/L)	Mean Abundance (Ind/L) ± Std.Dev
	Lp	2		1.661,67	
I	3	2	7	1.661,67	1.938,61 ± 479,68
	5	3		2.492,50	
	Lp	2		1.661,67	
II	3	2	7	1.661,67	1.938,61 ± 479,68
	5	3		2.492,50	
	Lp	2		1.661,67	
III	3	3	8	2.492,50	2.215,56 ± 479,68
	5	3		2.492,50	
	Lp	2		1.661,67	
IV	3	3	9	2.492,50	2.492,50 ± 830,83
	5	4		3.323,34	

Table 6. Zooplankton abundance at each depth in the afternoon

Station	Depth	Number of Individuals	Total Individuals	Abundance (Ind/L)	Mean Abundance (Ind/L) ± Std.Dev
	Lp	2		1.661,67	
I	3 m	3	7	2.492,50	1.938,61 ± 479,68
	5 m	2		1.661,67	
	Lp	2		1.661,67	
II	3 m	3	7	2.492,50	1.938,61 ± 479,68
	5 m	2		1.661,67	
	Lp	4		3.323,34	
III	3 m	4	10	3.323,34	2.769,45 ± 959,36
	5 m	2		1.661,67	
	Lp	3		2.492,50	
IV	3 m	4	9	3.323,34	2.492,50 ± 830,83
	5 m	2		1.661,67	

Sufficient light in the water can increase the photosynthesis of phytoplankton, which is the food of zooplankton (Elijonnahdi et al., 2012). Depth also affects the nutrients that fall into the body of water. The contribution of many nutrients to the waters will trigger plankton growth (Kusmeri & Rosanti, 2015). Susanti (2012) stated that the distribution of plankton in the water is not the same at different water depths. It is influenced by environmental conditions such as temperature, pH, DO, and light intensity differences. These environmental factors fluctuate every time, resulting in fluctuations in the presence of plankton.

Zooplankton abundance depends on the condition of an aquatic environment (Moniharapon et al., 2014). The highest abundance was found at station III, around the mouth of the Kambang River Estuary. Sutomo in Widjaja et al. (2012) states that the mouth of the river has many nutrients that are carried by river currents and carried towards the sea so that they can be utilized by plankton, Arinandi & Praseno *in* Prasetyati (2004) which states that the addition of nutrients from river water will cause good growth for phytoplankton, where this situation will benefit the growth of zooplankton.

The results of the ANOVA test during the day obtained a significant value of 0.010 where ($p < 0.05$), which indicates the abundance between depths is significantly different (Appendix 9) and further conducted LSD (Least Significant Difference) to determine the average depth that is different between the depth of observation. The results of the LSD further test (Appendix 9) showed that the abundance between the surface layer and a depth of 5 m and between depths of 3 m and 5 m showed an asterisk (*) with a significant value ($p < 0.05$) which means there is a significant difference (significantly different).

The results of the ANOVA test in the afternoon obtained a significant value of 0.029 where ($p < 0.05$), which indicates the abundance between depths is significantly different (Appendix 10) and further conducted LSD (Least Significant Difference) to determine the average depth that is different between the depth of observation. The results of the LSD further test (Appendix 10) showed that the abundance between 3 m and 5 m showed an asterisk (*) with a significant value ($p < 0.05$), which means there is a significant difference (significantly different).

3.5. Zooplankton Diversity, Uniformity and Dominance in the Kambang River Estuary

Based on the data analysis obtained, the calculation of the index value of diversity, uniformity and dominance of zooplankton species during the day can be seen in Table 7.

Table 7. Zooplankton biological index at each depth during daytime

Station	Depth	Biological Index					
		Diversity Index (H') / and mean value (H')		Index of Uniformity (E) / and mean value (E)		Dominance Index (D) / and mean value (D)	
	Lp	1,00		1,00		0,50	
I	3 m	1,00	1,28	1,00	0,86	0,50	0,52
	5 m	1,83		0,58		0,55	
	Lp	1,00		1,00		0,50	
II	3 m	1,00	1,28	1,00	0,86	0,50	0,52
	5 m	1,83		0,58		0,55	
	Lp	1,00		1,00		0,50	
III	3 m	1,83	1,55	0,58	0,72	0,55	0,53
	5 m	1,83		0,58		0,55	
	Lp	1,00		1,00		0,50	
IV	3 m	1,58	1,36	1,00	0,98	0,33	0,40
	5 m	1,50		0,95		0,37	

Based on Table 7, the zooplankton biological index during the day obtained has different average values at each research station. The biological index value consists of the diversity index, uniformity index and dominance index. Here, the average value of the diversity index (H') ranges from 1.28 - 1.55, the uniformity index value (E) ranges from 0.72 - 0.98, and the dominance index value (D) ranges from 0.40 - 0.53.

The average value of different biological indices is obtained, where the highest diversity index value is at station III with an average value of 1.55, and the lowest is at stations I and II with an average value of 1.28, the highest uniformity index value is at station IV with an average value of 0.98 and the lowest is at stations I and II with an average value of 0.72. The highest dominance index value is at station III, with an average value of 0.53, and the lowest is at station 4, with an average value of 0.40.

Table 8. Zooplankton biological index at each depth in the afternoon

Station	Depth	Biological Index					
		Diversity Index (H') / and mean value (H')		Index of Uniformity (E) / and mean value (E)		Dominance Index (D) / and mean value (D)	
	Lp	1,00		1,00		0,50	0,52
I	3 m	1,83	1,28	0,58	0,86	0,55	
	5 m	1,00		1,00		0,50	
	Lp	1,00		1,00		0,50	
II	3 m	1,83	1,28	0,58	0,86	0,55	0,52
	5 m	1,00		1,00		0,50	
	Lp	1,50		0,95		0,37	
III	3 m	1,50	1,33	0,95	0,96	0,37	0,41
	5 m	1,00		1,00		0,50	
	Lp	1,58		1,00		0,33	
IV	3 m	1,50	1,36	0,95	0,98	0,37	0,40
	5 m	1,00		1,00		0,50	

Based on Table 8, the zooplankton biological index in the afternoon obtained has different average values at each research station. The average value of the diversity index ranges from 1.28-1.36, the uniformity index value ranges from 0.86-0.98, and the dominance index value ranges from 0.40-0.52. the average value of different biological indices is obtained, where the highest diversity index value is at station IV with an average value of 1.36, and the lowest is at stations I and II with an average value of 1.28, the highest uniformity index value is at station IV with an average value of 0.98 and the lowest is at stations I and II with an average value of 0.86. The highest dominance index value is at stations 1 and 2, with an average value of 0.52, and the lowest is at station 4, with an average value of 0.40.

The diversity index (H') of zooplankton in the Kambang River Estuary averaged between 1.28 - 1.55 (Table 7 and Table 8). This value shows that the diversity of zooplankton species in the Kambang River Estuary is included in the category of moderate species diversity (H'), and the condition of the waters is lightly polluted. This is by Febrianda (2019), which states that the range of diversity index values $1 \leq H' \leq 3$ means that the waters are experiencing moderate pressure or disturbance or the diversity of organisms present is moderate. Species diversity shows the balance of the ecosystem; the higher the species diversity, the more balanced the ecosystem. Conversely, the lower the species diversity, it indicates that the aquatic ecosystem is under pressure and its condition is declining. This means that the Kambang River Estuary is experiencing moderate pressure or disturbance or a moderate organism community structure (Kasry et al., 2012).

The uniformity index (E) of zooplankton in the Kambang River Estuary ranged from 0.72 - 0.98 (Table 7 and Table 8). This value shows that the uniformity (E) of zooplankton species in the Kambang River Estuary is

balanced, and there is no competition for either place or particular food. According to Basmi (2000), a uniformity index close to 1 (> 0.5) means that the uniformity between species is relatively the same and has an inconspicuous difference. Munthe et al. (2012); Alfin (2014) also explained that a uniformity index close to zero tends to show an unstable community, while if it is close to one, then the distribution tends to be even, and the number of individuals between species is the same.

The dominance index (D) of zooplankton in the Kambang River Estuary ranged from 0.40 - 0.53 (Table 7 and Table 8). Based on this value, it shows that there are no zooplankton species in the Kambang River Estuary that dominate at each research station. According to Triawan & Arisandi (2020), the dominance index value range is $0 < D \leq 0.5$, indicating that no genus dominates another genus in a water body. Pakpahan (2013) suggests that changes in the dominance of plankton species are influenced by environmental factors such as temperature changes, pH variations, and nutrient content in waters, light penetration and biological conditions.

According to Amri *et al*. 2020, if a community has a high H' and E value, the D value tends to be low, indicating a stable community condition. On the other hand, if the H' and E values are low, then the D value is high, indicating the dominance of a species over other species, and a large enough dominance will lead to unstable or depressed community conditions. Thus, it means that the balance of the zooplankton community in the Kambang River Estuary shows a relatively good condition.

4. Conclusions

From The measurement results of quality parameters at each water station in the afternoon and evening are still within the range that supports zooplankton growth. The abundance of zooplankton during the day was highest at a depth of 5 meters, where three species of zooplankton were found, and the lowest at the surface layer, where two species of zooplankton were found, while the abundance of zooplankton in the afternoon was highest at the surface layer where three species of zooplankton were found and the lowest at a depth of 5 m where two species of zooplankton were found. The diversity index during the day was highest in the 5-meter depth and lowest in the surface layer, while in the afternoon, it was highest in the 3-meter depth and lowest in the surface layer and 5-meter depth. The uniformity index during the day was highest in the surface layer and lowest in the 5-meter depth, while in the afternoon, it was highest in the surface layer and the 5-meter depth and lowest in the 3-meter depth. The Dominance Index during the day was highest in the 5-meter depth and lowest in the surface layer, while in the afternoon, it was highest in the 3-meter depth and lowest in the surface layer.

5. Suggestion

Further research is needed to measure light illumination using a Lux meter and analyze the abundance and structure of the zooplankton community at a depth of 6 m to the bottom of the water to determine the distribution of zooplankton to the bottom of the Kambang River Estuary.

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