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Analysis of aspects of abundance and diversity of plankton in the waters around the Lantebung mangrove ecotourism area of Makassar City, Indonesia

Andi Puspa Sari Idris[1], Abdullah[1], Patang[2], Jamaluddin[2], Amirah Mustarin [2], Andi Alamsyah[2]
[1] Pangkep State Agricultural Polytechnic, Indonesia
[2]Department of Agricultural Technology, Universitas Negeri Makassar, Indonesia

ABSTRACT
This study aims to determine the aspects of abundance, diversity, uniformity and dominance of plankton in the waters around the Lantebung mangrove ecotourism area, Makassar City. The study used a survey method. Plankton sampling was carried out using a 25-micron plankton net. Each sample bottle was labeled based on the sampling location and analyzed in the laboratory. Plankton sample testing consists of the number, abundance, diversity, uniformity, and dominance of plankton. The plankton data obtained are then processed and analyzed with descriptive analysis. The results of the study showed that the number, abundance, diversity and dominance of plankton at all observation stations were classified as low or small and the highest was in the plankton type *Rhizosolenia* sp. Meanwhile, the highest uniformity of plankton species was at station 1 (ST 1), namely 0.078453, and the lowest was at station 2 (ST 2), namely 0.052748.

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Corresponding Author:
Patang

KEYWORDS: Plankton, abundance, diversity, ecotourism, mangrove

INTRODUCTION

Lantebung Mangrove Ecotourism is one of the ecotourism destinations in the city of Makassar, Indonesia, which is widely visited by people for its beauty and mangrove forest destination. The Lantebung Mangarove Tour is the result of cooperation between the government and the community for planting mangroves with the aim of achieving sustainable mangrove conservation in the area which supports tourism activities. However, by opening it to the public, this area will require more attention regarding the carrying capacity of the area. Therefore, this area is surrounded by mangrove forests and surrounding waters, so it is deemed necessary to conduct a study regarding the condition of plankton in the surrounding waters.

Plankton are aquatic organisms whose presence can be an indicator of changes in the biological quality of river waters (Manalu and Harahap, 2017). Plankton are organisms that live in the sea water column, and their movements follow the current (Lubis et al., 2023). Plankton is an important biological component because it is part of the food cycle chain in aquatic environments (Mulyawati et al. 2019). Plankton are tiny organisms that live floating in the water column and have weak swimming abilities. Plankton can be divided into two large groups, namely phytoplankton and zooplankton (Nybakken, 1998). As primary producers, phytoplankton have the ability to utilize sunlight as a source of energy in their life activities, while zooplankton act as primary consumers by utilizing energy sources produced by primary producers (Tambaru et al., 2014).

Nontji (2008) stated that plankton are creatures (plants or animals) that live floating, drifting, or hovering in water with very limited swimming ability so that they are always carried away by the current. Plankton, both phytoplankton and zooplankton, have an important role in aquatic ecosystems because plankton are food for various other types of animals (Heriyanto, 2012). Phytoplankton are microscopic plankton that are autotrophic or fulfill their life needs by utilizing inorganic nutrients through the process of photosynthesis (Yuliana & Ahmad, 2017). Phytoplankton can be used as an indicator of the category of water fertility or as an indicator of polluted or unpolluted waters (Basmi, 1995).

Fertile phytoplankton are generally found in waters around river mouths or in offshore waters where upwelling occurs (Heriyanto, 2012). Phytoplankton, as primary producers in waters, have an important role as a food source for marine organisms. In addition to being a primary producer, phytoplankton is one of the parameters of the fertility level of a body of water (Syafriani and Apriadi

2017). Phytoplankton also affects the existence of zooplankton, because phytoplankton is a food source for zooplankton (Khuantrairong and Traichaiyaporn, 2008). Saito et al. (2009) explained that the relationship between zooplankton can be seen from the predation process (grazing) on phytoplankton, which then also functions as a link with biota at the trophic level above it, such as fish larvae and juveniles.

In oceanic ecosystems, the predator-prey or top-down relationship between zooplankton and phytoplankton is an important biotic interaction factor that can influence the community structure of both (Abmus et al., 2009). Rahmawati et al. (2021) Primary productivity is input from land in the form of organic nutrients that will trigger phytoplankton growth, especially in coastal areas. In aquatic ecosystems, most of the primary productivity of water is carried out by phytoplankton, and more or less all primary producers in the sea come from phytoplankton (Parson et al. 1984). In addition, zooplankton has a function as secondary productivity as a direct consumer of phytoplankton and is important in the transfer of energy through the food chain. Zooplankton consists of true plankton (holoplankton) and temporary plankton (meroplankton) (Afif et al. 2014).

In line with the development of ecological conditions of a nature reserve conservation area in the future, there will be changes in the composition of biota so that there will be changes in ecological structure and function (Anggara et al., 2017). The abundance, diversity, and dominance of plankton in waters can be used as indicators of whether the waters are still in good condition or have experienced disturbances (Romimohtarto & Juwana 2001). The availability of plankton diversity data can be used to predict the biota that may be associated so that management and protection of conservation areas can be carried out more comprehensively (Colchester 2009).

MATERIALS AND METHODS

This research was conducted from April to June 2024 and was located in the Lantebung ecotourism area of Makassar City, where plankton testing was carried out at 3 stations (ST), namely:

- Station 1 is located in the southern part of the ecotourism area, where facilities such as toilets and tourist spots are available at this station, and currently many new mangroves have been planted as a result of collaboration between students and local residents.
- Station 2 is located in the northern part of the Lantebung mangrove ecotourism area and is the main spot for tourism because the area is larger than the spot area at station 1.
- Station 3 is located on the outside of the Lantebung Mangrove Ecotourism, which is the main road to access tourist spots, and along this station it is very common to see the activities of local residents, especially in the morning and evening when residents who work as fishermen do a lot of activities.

This study used a survey method by taking water samples at the research location. Water samples were filtered using a 25 micron plankton net, then observed in the laboratory using a microscope. Plankton samples were then placed in sample collection bottles and given a preservative in the form of lugol and then taken to the laboratory for analysis. Each sample bottle was labeled based on the sampling location (Dewanti et al., 2018; Rinaldi et al., 2024). Plankton sample testing consists of the number, abundance, diversity, uniformity, and dominance of plankton. The data that has been collected is then processed and analyzed with descriptive analysis.

Number of plankton

Plankton counts were calculated directly under a microscope using a Sedgwick Rafter and a hemocytometer.

Plankton abundance

Plankton abundance is calculated using the formula (APHA 2017), namely:

$$N = n \, x \frac{A}{B} x \, \frac{C}{D} \, x \, \frac{1}{E}$$

Where:
N = Total number of plankton (ind/liter) or (cells/liter)
n = Individual average per number of visual fields
A = Cover glass area
B = Area of one field of view
C = Filtered water volume (ml)
D = Volume of 1 drop under the cover glass (ml)
E = Volume of filtered water (liters)

The range of phytoplankton abundance (ind/L) according to Raymont (1963) is as follows:
Oligotrofik = 0–2000 (Very low fertility)
Mesotrofik = 2000–15000 (Medium fertility)
Eutrofik = >15000 (Fertile Waters)

Where:
E = Uniformity index of species
H' = Species diversity index
H'_{max} = Ln N (N= total number of individuals)
Indicators according to Krebs (1985):
E < 0,4 = Low category
0,4 < E < 0,6 = Medium category
E > 0,6 = High category

Diversity of plankton

Species diversity is calculated by calculating the Shannon–Weiner species diversity index (H') (Puspita, 2017). The formula is as follows:

$$H' = -\sum \text{Pi Ln, where Pi} = \frac{\text{Ni}}{\text{N}}$$

Where:
H' = Diversity Index
Ni = Number of cells of species to-i
N = Total cell count
According to Dewanti et al., (2018), the range of diversity values can be classified as follows:
H' < 1 = Small diversity
1 ≤ H' ≤ 3 = Medium diversity
H' > 3 = High diversity

Uniformity of plankton

Uniformity is calculated using the Shannon-Wiener formula (Odum, 1993) as follows:

$$E = \frac{H'}{Hmaks}$$

Where:
E = Uniformity index
H' = Shannon Wiener diversity index
H_{maks} = L_nS (maximum diversity index)
S = Number of genera discovered

Dominance of plankton

To calculate the plankton dominance index in waters, Simpson's formula (1949) is used as follows:

$$C = \sum \left(\frac{ni}{N}\right)^2$$

Where:
C = Simpson's dominance index
ni = Total number of individuals of type to-i
N = Total individuals of all types
Simpson's dominance indicator (C):
0 < C ≤ 0,5 = Low dominance
0,5 < C ≤ 0,75 = Medium dominance
0,75 < C ≤ 1,00= High dominance
The data obtained were then processed and analyzed using descriptive analysis.

RESULTS AND DISCUSSION

Number of plankton

Makmur et al. (2012) also stated that the phytoplankton population always experiences fluctuations in composition and quantity due to differences in water quality (especially nutrients), also due to grazing by zooplankton and herbivorous fish and accumulation of toxic metabolic waste. Figure 1 shows that the highest number of plankton is in the plankton type *Rhizosolenia* sp.

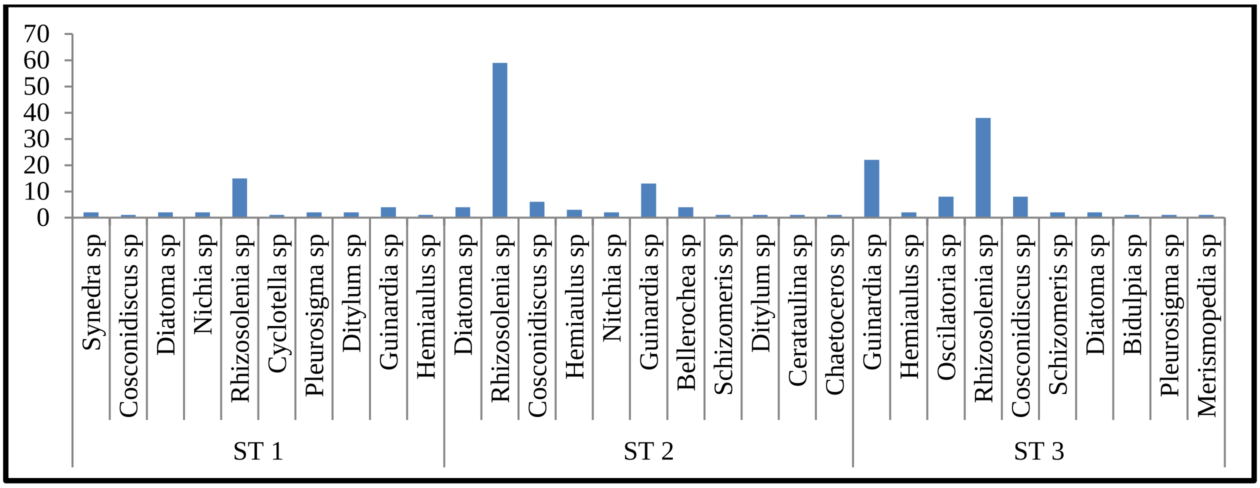

Figure 1. Number of plankton at the research location

Abundance of plankton

Water fertility can be determined from the large amount of phytoplankton abundance. Water productivity can also describe the presence of phytoplankton species as primary producers (Lubis et al., 2023). Its abundance in waters will be influenced by environmental parameters including water quality and physiology (Winarti and Harahap, 2021). Riyantini et al. (2020) explained that the abundance of zooplankton species can be used as a bioindicator to see the level of fertility in waters. Figure 2 shows that the abundance of plankton for all stations (ST) is highest in the plankton type *Rhizosolenia* sp., but overall, the abundance of plankton at all observation stations is classified as low or small (oligotrophic).

The results of Dewanti et al.'s (2018) research, which used principal component analysis (PCA), showed that the parameters that greatly influenced phytoplankton abundance were turbidity, nitrate, phosphate, salinity, pH, and temperature. Abundance values can also be influenced by habitat tendencies and food availability (Subagio et al., 2014). Sulastri et al. (2008) explained that there is a relationship between land use, water quality, and phytoplankton abundance in a body of water. In nearshore waters, the nutrient content is higher because it receives input from river estuaries and from activities on land, whereas in offshore waters, which are in the open sea, the nutrient content is low (Wulandari, 2011).

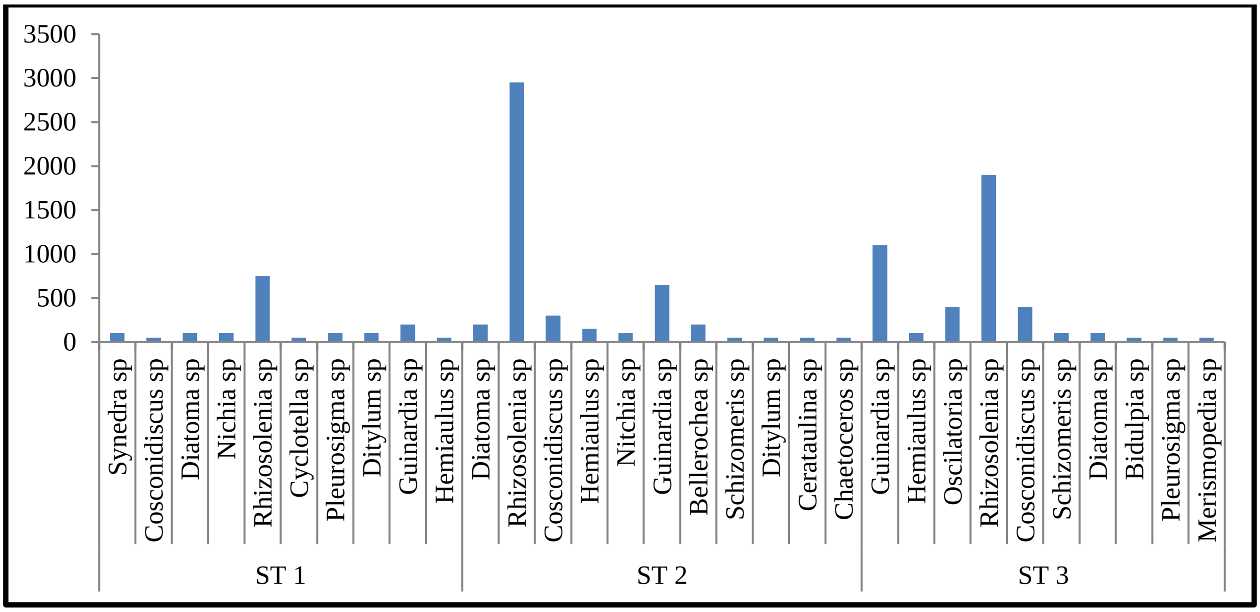

Figure 2. Plankton abundance at the research location

Diversity of plankton

Species diversity is a parameter that is commonly used to determine the condition of a particular community. This parameter characterizes the species richness and balance in a community (Pirzan, 2008). The diversity of plankton species is a mathematical depiction that can describe the structure of life and can facilitate the analysis of information about the types and quantities of plankton (Rahmatullah et al., 2016). Figure 3 shows that the diversity of plankton for all stations (ST) is highest in the plankton type *Rhizosolenia* sp.

According to Deni et al. (2019), the diversity of this species can be influenced by environmental conditions. If the environmental conditions are good, then the diversity of the species is higher (Wijaya et al., 2022). According to Krebs (1998), if the H' value <1, it is stated that the diversity value is small and the stability of the community in the waters is low. Higher phytoplankton diversity indicates that the aquatic ecosystem at the research location is still relatively stable, with the number of phytoplankton species as the main producers being higher than zooplankton as the main direct consumers of phytoplankton (Oktavia et al., 2015). Stable waters with high phytoplankton diversity allow for the presence of more biota at higher trophic levels so that aquatic productivity will also increase (Anggara et al., 2017). According to Veronica et al. (2014), waters with low fertility levels have plankton densities of less than 104 ind/L, moderate fertility is higher than 104 ind/L, and very high fertility is above 107 ind/L. Plankton with densities above 107 ind/L is called blooming.

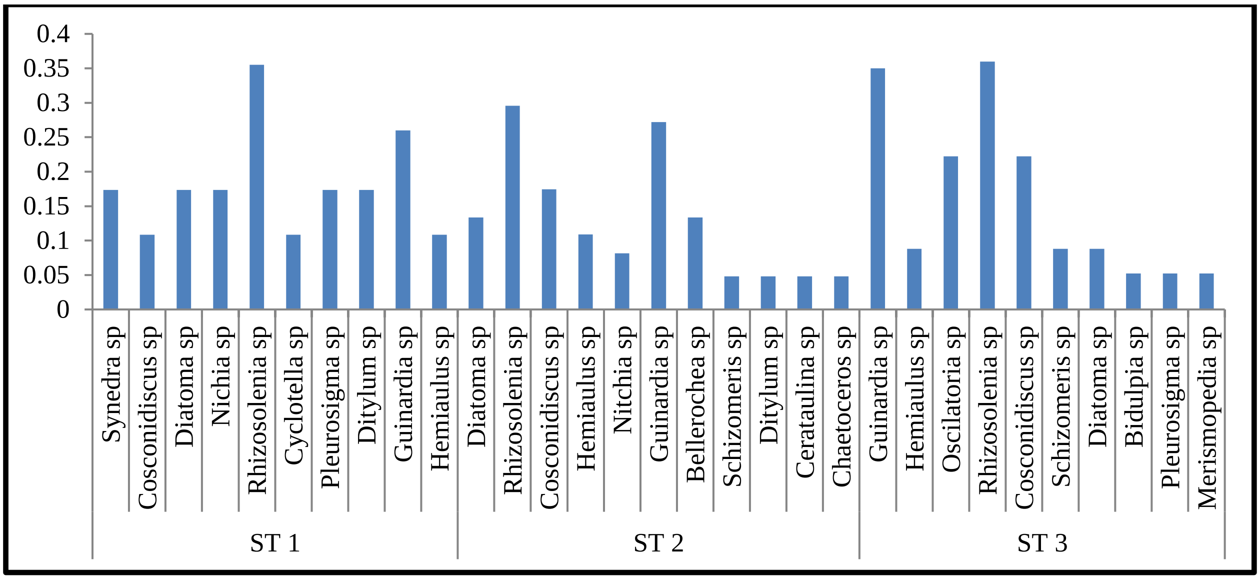

Figure 3. Plankton diversity at the research location

Uniformity of plankton

Figure 4 shows that the highest plankton species uniformity was at station 1 (ST 1), namely 0.078453, and the lowest was at station 2 (ST 2), namely 0.052748. Plankton uniformity in this study was lower than the results of previous studies, such as research in the Siak River Estuary by Amri et al. (2020), where the uniformity index was 0.833–0.976 with a high category, and research in the Kramat Village Estuary, Bangkalan Regency, by Triawan and Arisandi (2020), which obtained a uniformity index of 0.669–0.900 with a high category. The high uniformity index indicates that the distribution of individual species in each location is evenly distributed (Nazar et al., 2024).

According to Heip et al. (1998), 1≤H≤3 indicates moderate species diversity, sufficient water productivity, fairly balanced ecosystem conditions, and moderate ecological pressure. Suwandana et al. (2018) showed that a high uniformity index value indicates that each biota has the opportunity to utilize the nutrients available in the waters simultaneously, although the nutrient content in the waters is limited. To increase productivity, the stability of the aquatic ecosystem is needed, for example, in terms of the availability of food and oxygen so that the supporting components of aquatic biota are maintained (Anggara et al., 2017).

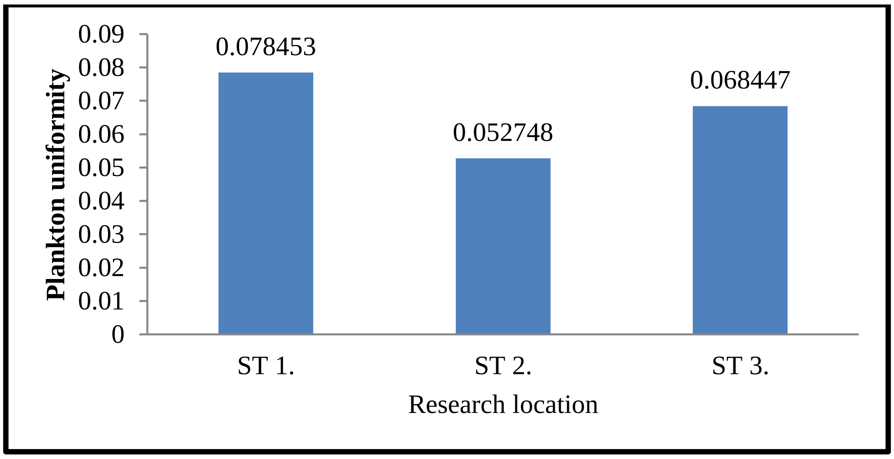

Figure 4. Plankton uniformity at the research location

Dominance of plankton

Plankton dominance index analysis is used to see whether or not a type of plankton dominates a type of plankton population (Rahmatullah et al., 2016). Index values approaching 1 indicate high dominance, and conversely, index values approaching 0 indicate low dominance or no dominant species (Krebs, 1978). Figure 5 shows that the plankton dominance for all stations (ST) is highest in the plankton type Rhizosolenia sp. The highest plankton dominance value in this study was 0.621052632 and was higher than the results of previous studies conducted in the Porong River Estuary, Sidoarjo, by Setyowardani et al. (2021) with a range of 0.14–0.18 and research in the Siak River Estuary by Amri et al. (2020) with a range of 0.08-0.42. The dominance index category at several locations and this research location is categorized as a low dominance index. This shows that at the research location there is no dominant plankton species, this is followed by a high uniformity index value (E) (Mahipe et al., 2017). A dominance index value <0.5 indicates that there are no dominant species in the aquatic environment (Munthe et al., 2012).

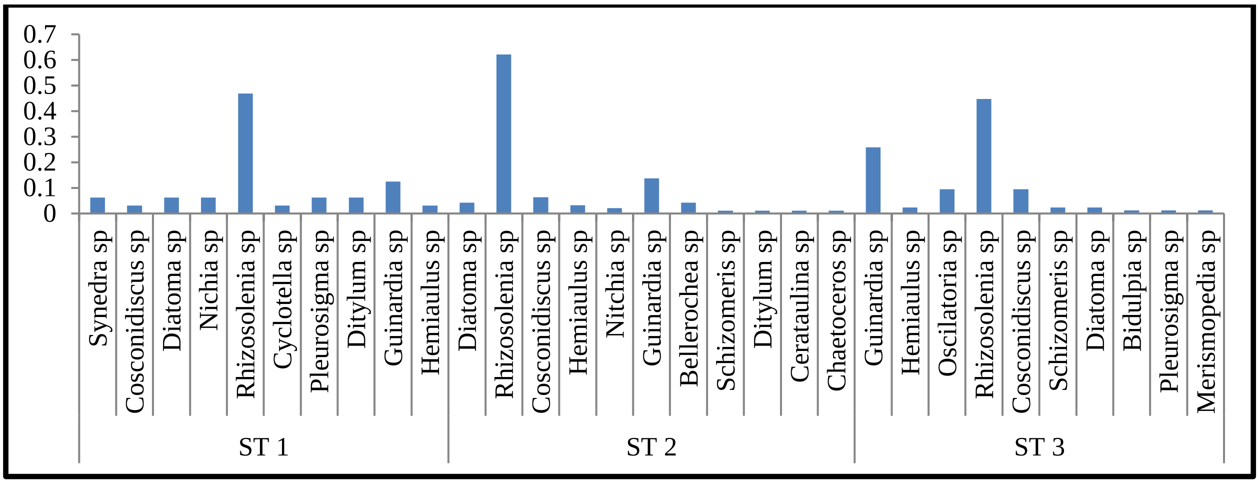

Figure 5. Plankton dominance at the research location

CONCLUSION

The number, abundance, diversity, and dominance of plankton in all observation stations were highest in plankton of the *Rhizosolenia* sp. Plankton abundance in all locations was generally classified as oligotrophic or very low fertility, although there were plankton with abundance above 2500. The plankton diversity index is also relatively small because it is below one. Plankton uniformity is low. The highest plankton type uniformity is at station 1 (ST 1), which is 0.078453, and the lowest is at station 2 (ST 2), which is 0.052748. The level of plankton dominance for all observation stations is generally low.

REFERENCES

1. Abmus, J., Melle, W., Tjostheim, D., & Edwards, M. 2009. Seasonal cycles and long-term trends of plankton in shelf and oceanic habitats of the Norwegian Sea in relation to environmental variables. Deep Sea Research Part II: Topical Studies in Oceanography, 56(21), 1895–1909.
2. Afif, A., Widianingsih., and Hartati, R. 2014. Composition and abundance of plankton in the waters of Gusung Island, Selayar Islands, South Sulawesi. Journal of Marine Research. 3(3):32–331.
3. American Public Health Association (APHA). 2017. Standart Method for the examination of water and wastewater. 23th edition. American Public Health Association. 8–57p.
4. Amri K., Ma'amun, A., Priatna, A., Suman, A., Prianto, E., & Muchlizar. 2020. Spatial Distribution, Abundance and Structure of Zooplankton Community in the Siak River Estuary and the Factors That Influence It. Akuatika Indonesia, 5(1):7–20. https://doi.org /10.24198/jaki.v5i1.26504
5. Anggara, A.P., Kartijono, N.E., and Bodijantoro, P.M.H. 2017. Plankton diversity in the Tlogo Dringo Nature Reserve Area, Dieng Plateau, Central Java. Journal of MIPA. 40(2), 74–79
6. Basmi, J. 1995. Planktonology: Primary Production, Bogor. Faculty of Fisheries. IPB. Bogor. 35 p.
7. Colchester, M. 2009. Saving Nature: Indigenous Peoples of Protected Areas and Biodiversity Conservation. Denpasar: WGCop.
8. Deni, S. R., Fajri, N. El, & Adriman. 2019. Phytopankton Diversity in the Swamp Waters of Sawah Village, North Kampar District, Kampar Regency, Riau Province. Student Online Journal (JOM) in Fisheries and Marine Sciences, *6*(1), 1–11.
9. Dewanti, L. P. P., Putra, I. D. N. N., & Faiqoh, E. 2018. Relationship between abundance and diversity of phytoplankton and abundance and diversity of zooplankton in the Waters of Serangan Island, Bali. Journal of Marine and Aquatic Sciences. 4(2): 324–335. https://doi.org/10.24843/jmas.2018.v4.i02.324-335

10. Heip CHR, Peter MJH & Karline S. 1998. Indice of Diversity and Evennes. Oceanis. 24(4), 61–87
11. Heriyanto, N.M. 2012. Plankton Diversity and Water Quality in Mangrove Forests. Plasma Nutfah Bulletin. 18(1), 38–44. https://www.academia.edu/36187823/Cara_Menghitung_Plankton
12. Khuantrairong, T., & Traichaiyaporn, S. (2008). Diversity and seasonal succession of the phytoplankton community in Doi Tao Lake, Chiang Mai Province, Northern Thailand. The Natural History Journal of Chulalongkorn University, 8(2), 143–156.
13. Krebs, C.J. 1978. Ecology the experimental analysis of distribution and abundance. Harper & Row, New York. 289p
14. Krebs, C.J. 1985. Ecology: The Experimental Analysis of Distribution and Abundance. Third edition. Haeper and Row Publisher, New York.
15. Krebs, C.J. (1998). A review of the Chitty Hypothesis of population regulation.Canadian Journal of Zoology,56, 2463-2480.
16. Lubis, F., Lisdayanti, E., and Najmi, N. 2023. Abundance and Ecology Index of Plankton in Island Seurudong Waters, South Aceh. Habitus Aqua. Journal of Aquatic Resources and Fisheries Management. 4(1):23–33. https://doi.org/10.29244/HAJ.4.1.23
17. Mahipe, F.V., Mantiri, R.O., & Moningkey, R.D. 2017. Zooplankton Community on the Coast of Malalayang Beach, Manado City. Platax Scientific Journal, 5(1):77–84. https://doi: 10.35800/jip.5.1.2017. 15808
18. Makmur, M., Kusnoputranto, H., Moersidik, S. S., & Wisnubroto, D. S. 2012. The effect of organic waste and N/P ratio on phytoplankton abundance in the Cilincing green mussel cultivation area. Journal of Waste Management Technology, 15(2), 51–64
19. Manalu, B. N., & Harahap, A. 2017. The study of quality of the River Pandayangan in his review of the factors of physical-chemical. Budapest International Research and Critics Institute (BIRCI-Journal) Humanities and Social Sciences, 4(1), 1236–1241.
20. Mulyawati, D., Ario, R., and Riniatsih, I. 2019. The Effect of Depth Differences on Phytoplankton and Zooplankton in the Waters of Panjang Island, Jepara. Journal of Marine Research. 8(2):181–188. https://doi.org/10.14710/jmr.v8i2.25101
21. Munthe, Y. V., Aryawati, R., & Isnaini. 2012. Community Structure and Distribution of Phytoplankton in the Sungsang Waters of South Sumatra. Maspari Journal. 4(1), 122–130. https://doi.org/https://doi.org/10.56064/maspari.v4i1.1437
22. Nazar, A., Eva, U., and Umroh. 2024. Correlation of Plankton Diversity with Physicochemical Parameters of Waters in the Selan River Estuary, Central Bangka Regency. Journal of Marine Research. 13(3), 485–492
23. Nontji, A. 2008. Marine Plankton. LIPI Press. Jakarta. 331p.
24. Nybakken, J. W. 1998. Marine biology: an ecological approach (3rd edition). Dalam Eidman, M., Koesoebiono, K., Bengen, D. G., Hutomo, M., & Subarjo, S. (Terj.), Biologi laut: suatu pendekatan ekologis. Jakarta, Indonesia: Gramedia Pustaka Utama. (Original book published 1992).
25. Odum, E.P. 1993. Basics of Ecology Third Edition. Translator Samingan T, Editor Srigando. Gadjah Mada University Press.Yogyakarta. 697p.
26. Oktavia, N., Purnomo, T., & Lisdiana, L. 2015. Plankton Diversity and Water Quality of Surabaya River. Lentera Bio Journal. 4(1), 103–107.
27. Parson, T.R., Takahasi, M., and Hargrave, B. 1984. Biological oceanographic processes. Pergamon Press. New York.
28. Pirzan, A.M. 2008. The relationship between phytoplankton diversity and water quality on Bauluang Island, Takalar Regency, South Sulawesi, Surakarta. Biodiversitas, 9(3): 217–221.
29. Puspita, L. 2017. Structure of Plankton Community in Coastal Waters of Bukit Piatu-Kijang, Bintan Regency. Symbiosis. 6(2), 85–94. http://dx.doi.org/10.33373/sim-bio.v6i2.1144
30. Rahmatullah., Ali, M.S., and Karina, S. 2016. Diversity and dominance of plankton in Kuala Rigaih, Aceh Jaya District. Unsyiah Marine and Fisheries Student Scientific Journal. 1(3), 325–330.
31. Rahmawati, N.O., Hartoko, A., and Latifah, N. 2021. Analysis of Phytoplankton Abundance in Alang-Alang Waters of Karimunjawa National Park. National Marine Journal. 16(2):97–108. http://dx.doi.org/10.15578/jkn.v16i2.9008
32. Raymont, J. E. G. 1963. Plankton and produktivity in the Ocean. Apergamon Press Book. The Macmilan CO. New York.
33. Riyantini, I., Ismail, M. R., & Mulyani, Y. 2020. Zooplankton as bioindicators of water fertility in the mangrove forest of Ciletuh Bay, Sukabumi Regency. Indonesian Aquatics, 5(2), 86–93.
34. Rinaldi., Nopri, Ya., Anis, N., Cut, R.S., Asih, M.M., and Muliari. 2024. Zooplankton diversity as a bioindicator in the waters of the Krueng Pasee River, North Aceh. JAGO TOLIS : Tolis Agrocomplex Journal. 4(1), 77–82. http://dx.doi.org/10.56630/jago.v4i1.539
35. Romimohtarto, K., & Juwana, S. 2001. Marine Biology: The Science of Marine Biology. Jakarta. Djambatan. 483p.

36. Saito, T., Shimizu, I., Seki, J., & Nagasawa, K. 2009. Relationship between zooplankton abundance and the early marine life history of juvenile chum salmon *Oncorhynchus* keta in eastern Hokkaido, Japan. Fisheries Science.75(2), 303–316. https://doi.org/10.1007/s12562-008-0040-6
37. Setyowardani, D., Sa'adah, N., & Wijaya, N.I., 2021. Analysis of water fertility based on phytoplankton abundance in the Porong River Estuary, Sidoarjo. Journal of Tropical Marine Research, 3(1):24–33. https://DOI:10.30649/jrkt.v3i1.54
38. Simpson, E. H., 1949, Measurement of Diversity, Nature Publishing Group. p688.
39. Subagio dan Muliadi A. 2014. Diversity of types and dominance of gastropods in tidal areas (Intertidal Zone) in Sekotong District, West Lombok Regency Based on Habitat. Scientific Journal of IKIP Mataram. 1(2): 155–162
40. Sulastri., Harsono, E., Suryono, T., and Ridwansyah, I. 2008. Relationship of land use, water quality and phytoplankton community of some small Lakes in West Java. Oseanologi dan Limnologi di Indonesia 34(2): 307–332.
41. Suwandana, A. F., Purnomo, P. W., and Rudiyanti, S. 2018. Comparative analysis of phytoplankton and zooplankton and TSI (Trophic Saprobic Index) in pond waters in Tambak Lorok Village, Semarang. Management of Aquatic Resources Journal (MAQUARES). 7(3), 237–245.
42. Syafriani, R., and Apriadi, T. 2017. Phytoplankton diversity in the estuary waters of the Tanjungpinang City Canal Set. Limnotek: tropical inland waters in Indonesia. 24(2):74–82.
43. Tambaru, R., Muhiddin, A. H., & Malida, H. S. 2014. Analysis of Changes in Zooplankton Density Based on Phytoplankton Abundance at Various Times and Depths in the Waters of Badi Island, Pangkep Regency. TORANI: Journal of Marine and Fisheries Sciences, 24(3), 40-48.
44. Triawan, A.C., & Arisandi, A., 2020. Structure of Phytoplankton Community in Estuary and Sea Waters of Kramat Village, Bangkalan District, Bangkalan Regency. Juvenil: Scientific Journal of Marine and Fisheries. 1(1):97-110. https://DOI:10.21107/juvenil.v1i1.6867
45. Veronica, E., Setyo, L., Amin., Soemarno., Arfiati., and Dian. 2014. Effect of water quality on phytoplankton abundance in Hampalam River and Fish Pond of Batanjung Village. Malang. Doctoral Program of Agriculture Science. Faculty of Agriculture. University of Brawijaya
46. Wijaya, N.I., Sari, A.K.A., and Mahmiah. 2022. the effect of phosphate and nitrate concentration on phytoplankton abundance in mangrove waters of Gunung Anyar, Surabaya. Integrated Agricultural Journal. 10(1): 64–77. https://doi.org/10.36084/jpt..v10i1.400
47. Winarti, W., & Harahap, A. 2021. The diversity of makrozoobenthos as bioindicators of water quality of the River Kundur District Labuhanbatu. 1027–1033. Budapest International Research and Critics Institute (BIRCI Journal) Humanities and Social Sciences. 4(1), 1027–1033.
48. Wulandari, D.Y. 2011. Spatial Distribution of Phytoplankton in Bali Strait Waters. Thesis. IPB. Bogor.
49. Yuliana, Y., & Ahmad, F. 2017. Composition of Zooplankton Species and Abundance in Buli Bay Waters, East Halmahera. Agrikan: Journal of Fisheries Agribusiness. 10(2), 44. https://doi.org/10.29239/j.agrikan.10.2.44-50