Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan (2023) 12(2): 223-228

DEPIK
Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan
Journal homepage: www.jurnal.usk.ac.id/depik

The abundance and types of plankton in milkfish ponds at Banyuasin South Sumatera

Mirna Fitrani[1, *], Reni Septiyani[1], Dade Jubaedah[1], Marini Wijayanti[1], Annisa Septimesy[2], Yenni Sri Mulyani[2]

[1]*Aquaculture Study Program, Department of Fisheries, Faculty of Agriculture, Universitas Sriwijaya, Indralaya, Ogan Ilir, Indonesia*
[2]*Pusperi Rawa Indonesia, Palembang, Indonesia*

ARTICLE INFO

Keywords:
bioindicator
milkfish
plankton
tidal lowland
water quality

DOI: 10.13170/depik.12.2.30065

ABSTRACT

Tidal lowland is an area with significant potential for fisheries development, especially in aquaculture. Abundant water supply and land availability provide great opportunities for cultivating aquaculture commodities such as fish, shrimp, and crab. However, effective water quality management poses a significant challenge, necessitating a comprehensive evaluation based on biological, physical, and chemical assessment. Among the crucial parameters influencing water fertility, the presence of plankton stands out. Therefore, this study aimed to investigate water fertility by identifying plankton species, abundance, diversity, dominancy, and water quality in milkfish ponds at Banyuasin, South Sumatra. The results showed that the abundance of phytoplankton and zooplankton ranged from 1030-1791 individual L^{-1} and 103-461 individual L^{-1}, respectively. Furthermore, Bacillariaceae was recorded to be the highest specie, followed by Cyanophyta, Chlorophyta, Protozoa, Rotifer, and Arthropoda. The range diversity index varied between 1 to 2.6, while the density and dominance indices ranged from 0.9 and 1, as well as 0.1 and 0.8, respectively. The classification of the pond's fertility fell within the mesotrophic category, signifying a moderate level. In conclusion, the water quality maintained an optimum range, thereby supporting the growth of plankton and milkfish. Meanwhile, only ammonia was below the optimum range stipulated by PP No. 22 of 2021 suggested.

Introduction

Tidal swamp land is marginal land with considerable potential for the development of agricultural and fishing activities. On this land, fishing activities have great opportunities to be developed and optimized due to the vast potential of land and water in the areas (Fitrani, 2013).

Ponds are a type of habitat used for brackish water aquaculture activities within coastal areas (Ristiyani, 2012). Within the south Sumatra region, particularly Banyuasin, fishpond businesses are scattered among various locals, including tidal swamp areas such as Muara Sungsang and Muara Sugihan Districts. These ponds were traditionally made, and they have relatively the same potential and problems. For example, in the Muara Sungsang, pond farmers have engaged in fish cultivation for a long time. However, their production outcomes have yet to attain optimal levels. The ponds within this district are generally traditional, which implied that the management systems depend entirely on nature (Utami et al., 2014).

The presence of plankton is one of the factors that affect pond productivity. According to Pagoyar and Udayana (2019), environmental feasibility for cultivation can be estimated through quantitative and qualitative measurements of the organisms. The fertility of an aquatic ecosystem is highly dependent on the primary productivity of the water, which is closely related to the availability of plankton. Functioning as a key indicator of pond productivity and serving as natural sustenance for fish, plankton plays a vital role in upholding ecosystem stability. A pond is deemed fertile when it hosts a substantial quantity and quality of primary producers, particularly phytoplankton, which act both as a natural food source and an oxygen producer through the process of photosynthesis (Sihomboing *et*

* Corresponding author.
Email address: fitranimirna@unsri.ac.id

p-ISSN 2089-7790; e-ISSN 2502-6194
Received 4 January 2023; Received in revised form 4 July 2023; Accepted 3 August 2023
Available online 31 August 2023

al., 2015). Radiarta (2013) showed that the abundance of phytoplankton in pond waters serves as a maker for water fertility, and it correlates with the presence of zooplankton.

Materials and Methods

Location and time of research

This study was conducted in traditional milkfish ponds at the Muara Sungsang District, specifically within Banyuasin II, Banyuasin Regency, on December 2021 and February 2022. Samples were collected across 9 stations in three ponds, each of which had initially received fertilizer and commercial feed from the farmer. Plankton was identified at the fisheries basic laboratory, Aquaculture Study Program, Faculty of Agriculture, Universitas Sriwijaya.

Materials and tools

The materials used in this study consisted of pond water samples, 70% alcohol, distilled water, and 4% formalin. The tools employed were a bottle sample, dissolved oxygen, pH meter, plankton net, Secchi disk, refractometer and thermometer, turbidimeter, microscope, as well as a spectrophotometer. For phosphate analysis, the process involved ammonium molybdate, boric acid, sulfuric acid, ascorbic acid, and filter paper, while ammonia analysis employed $MnSO_4$, Clorox, and phenate. Nitrate analysis, on the other hand, utilized brucine, concentrated sulfuric acid, and standard nitrate-N).

Study method

The study employed an observational approach, with sampling conducted using the purposive sampling method. Plankton and water samples obtained from the study site were analyzed descriptively and presented in tables and figures.

Procedure

Collection and Observation of Plankton

Plankton and water samples were collected from different widths and depths within the milkfish ponds. The size of the first, second, and third ponds measured 100×100 m^2 with a depth of 185 cm, 10×6 m^2 with a depth of 160 cm, and 8×4 m^2 with a depth of 85 cm. Each sampling was determined by a diagonal, encompassing inlet, middle, and outlet points that represented all study locations. The fish were sampled twice, namely at the start (7^{th} day after stocking of the fingerlings) and at the end (65^{th} day after stocking fish). This approach aimed to determine the variation of the plankton population during fish rearing. The plankton was retrieved by filtration method, whereby from each station point location was collected into a 10-liter bucket with five repetitions and filtered using a net. The filtered sample was transferred into a bottle and preserved with a 4% formalin solution. Finally, that had been annotated were stored in a cool box, examined under a microscope, and identified using the guidance book by Davis (1955).

Measurement of Water Quality Parameter

Water quality measurements were conducted in the field (*in situ*), encompassing parameters such as temperature, pH, dissolved oxygen, brightness, turbidity, and salinity. Additionally, measurements for nitrate, phosphate, and ammonia were taken, The comprehensive analysis of water quality was performed at the Center for Environmental Health Engineering and Disease Research in Palembang.

Observed Parameters

Plankton Abundance Calculations

Plankton abundance was determined using the formula from APHA (1985) and the Lackey drop micro transect counting method. For this process, a water sample was placed on top of an object glass and covered with a cover glass. Observation and identification were conducted using Davis' plankton identification book and employing a microscope set at 10x and 40x magnification (Davis,1955).

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

Information:

N = Total plankton concentration (ind. L^{-1})
n = The total average number of individual plankton in each field of view (ind).
A = Cover glass area (mm2)
B = Area of one field of view (π x r^2), where r is the radius of the field of view of the objective lens as measured with an ocular micrometer (mm^2).
C = Volume of filtered or collected water (ml)
D = Volume of water under the cover glass (ml)
E = Volume of filtered water (L)

Diversity Index

Diversity indicates the presence of specie in a community within an ecosystem, and it was determined using the following formula outlined by Odum (1971):

Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan
Volume 12, Number 2, Page 223-228

$$H' = -\sum Pi \log Pi$$

Information:
H' = Diversity Index
Pi = Ni/N
ni = Total number of individuals in each species
N = the total number of distinct species (ind).

Uniformity Index

According to Odum (1971), the uniformity index showed the number of types of organisms in an area. The following was used to formulate the uniformity index:

$$e = \frac{H'}{Log\ s}$$

Information:
e = Uniformity index
H' = Diversity index
s = Number of discovered species (ind).

Dominance Index

Dominance refers to the extent to which a particular type of individual holds a position of superiority within a given community. To quantify this phenomenon, the dominance index as proposed by (Odum, 1971 was employed. This index is computed using the following formula:

$$c = \sum(Pi)^2$$

Information:
c = dominance index
Pi = ni/N
ni = Total number of individuals in each species
N = Total number of species (ind)

Estimation of Trophic Status

The following was performed to estimate trophic status using the abundance of phytoplankton and zooplankton, as described by Goldman and Horne (1994), do the following:

a) Oligotrophic waters with low fertility, phytoplankton, and zooplankton abundance of less than 1,000 ind L^{-1} and 1 ind L^{-1}, respectively.
b) Mesotrophic waters with moderate fertility, phytoplankton, and zooplankton abundance ranging from >1,000 to 15,000 ind L^{-1}, as well as 1 to 500 ind L^{-1}, respectively.
c) Eutrophic waters with high fertility, a phytoplankton and zooplankton abundance of more than 15,000 ind L^{-1} and 500 ind L^{-1}.

Results

Plankton Abundance

The average value of the abundance of phytoplankton and zooplankton at the start and the end of the study was presented sequentially in Table 1 and Table 2.

Plankton Genus Composition Found during the Research

The number of plankton compositions tends to decrease from the initial till the end of the study. Meanwhile, the total number of the genus composition is shown in Figures 1, Figures 2, and Figures 3.

Table 1. The average value of phytoplankton abundance (ind. L^{-1})

Ponds	Average of phytoplankton abundance (ind L^{-1})	
	Initial	Final
T_1	1791±126.3	1233±78.4
T_2	1625±820.0	1145±350.0
T_3	1412±134.6	1030±188.0

Table 2. The average value of zooplankton abundance (ind. L^{-1})

Ponds	Average of phytoplankton abundance (ind L^{-1})	
	Initial	Final
T_1	461±43.2	103±55.0
T_2	296±93.2	236±69.9
T_3	338±117.3	269±20.5

Table 3. The average value of the diversity index, uniformity, and dominance of phytoplankton

Index	Phytoplankton					
	Initial			Final		
	T_1	T_2	T_3	T_1	T_2	T_3
H'	2.61	2.33	2.48	2.25	2.16	1
E	0.96	0.95	0.96	0.9	0.67	0.95
C	0.09	0.1	0.38	0.12	0.16	0. 36

Table 4. The average value of the diversity index, uniformity, and dominance of zooplankton

Index	Zooplankton					
	Initial			Final		
	T_1	T_2	T_3	T_1	T_2	T_3
H'	0.93	0.89	1.02	0.44	0.46	1.21
E	0.96	0.97	0.89	0.64	0.51	0.96
C	0.43	0.44	0.4	0.69	0.45	0.31

Information:
H' = Diversity Index e = Uniformity index; c = Dominance index

Plankton Uniformity, Dominance, and Diversity Index

The results of the diversity index, uniformity, and dominance varied between each pond during the study. The average value of each parameter of phytoplankton and zooplankton was presented in Table 3 and Table 4.

Water Quality Data

Table 5 shows data on the average value of water quality obtained at the initial and final of the study.

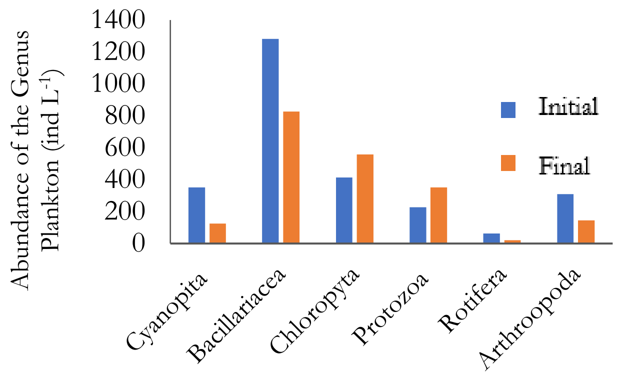

Figure 1. Genus composition of pond plankton 1

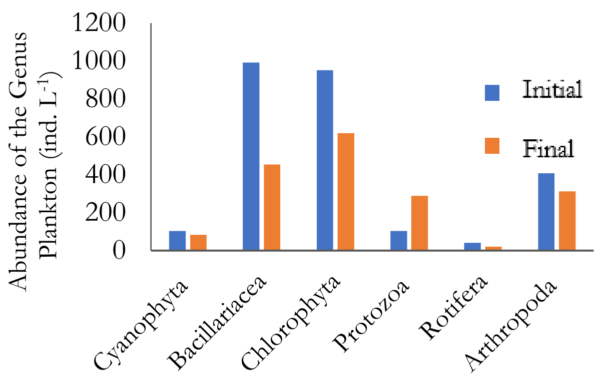

Figure 2. Genus composition of pond plankton 2

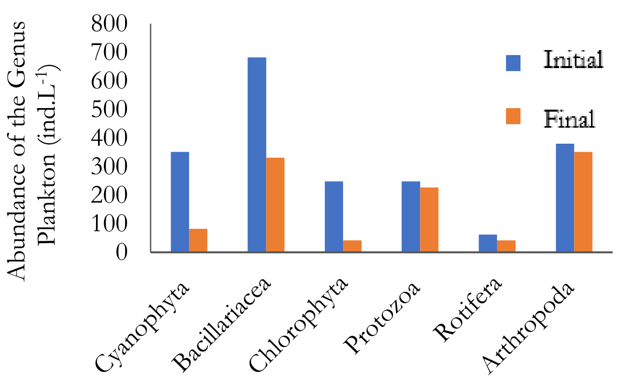

Figure 3. Genus composition of pond plankton 3

Discussion

The average plankton abundance, as presented in Table 1 and Table 2, showed that the value was higher at the initial than at the end of the study. This suggested a gradual decline in pond fertility over time. The heightened nutrient content observed at the study's onset can be attributed to the fertilization treatment administered during the initial pond preparation, before fish stocking. The treatment led to an ample supply of nutrients, thereby fostering a proliferation of plankton. This observation was in line with the report of Harun and Takril (2020), who stated that adding fertilizer increased the abundance and development of various plankton organisms.

Phosphate is a nutrient that plays a crucial role in the formation of an organism's tissue cells and the process of photosynthesis executed by phytoplankton (Paiki and Kalor, 2017). The abundance of phytoplankton and zooplankton recorded at the initial and final stages of the study were included in the category of mesotrophic waters. This category denotes waters possessing a moderate fertility level, characterized by phytoplankton and zooplankton abundance ranging from > 1,000 to 15,000 ind L^{-1} as well as between 1 and 500 ind L^{-1}, respectively. The genus composition of plankton at the beginning and end of the study was presented sequentially in Figures 1, Figures 2, and Figures 3.

Investigation into plankton within Muara Sungsang's milkfish ponds yielded significant findings. The identified plankton types encompassed the genera Bacillariaceae, Cyanophyta, Chlorophyta, Protozoa, Rotifera, and Arthropoda. The highest genus abundance was Bacillariacea, and it was obtained at the initial and end of the study in ponds 1, 2, and 3. The prevalence was attributed to the presence of nutrients that support the growth. This particular genus showed a speedy response to nutrient enrichment and demonstrate adaptability to its habitat, setting it apart from other classes. The highest zooplankton group discovered was the Copepoda subclass, which belongs to the Arthropoda genus. According to Gao *et al.* (2011), copepods stand as the most prolific zooplankton type due to their exceptional adaptability across various aquatic environments, ranging from freshwater to brackish and marine waters.

The average values of the uniformity index, dominance, and diversity of plankton at the beginning and final stages of the study were presented in Tables 3s and 4. The average value of the diversity index (H') of phytoplankton and zooplankton, ranged from 0.44 to 2.61, which means that they have a moderate community structure. The H' value was influenced by the number of plankton that exist in the waters.

Table 5. The average value of water's physical and chemical quality during the study

No	Water Quality Parameters	Unit	Initial			Final		
			T_1	T_2	T_3	T_1	T_2	T_3
1.	Brightness	cm	21	31	35	30	31	38
2.	Water depth	cm	150	120	76	68	84	62
3.	Turbidity	NTU	2.1	1.7	1.9	9.6	4.5	6.1
4.	Dissolved oxygen	mg L^{-1}	4.7	4.2	4.9	4.9	5.1	5.3
5.	pH	-	6	7	7	7	7	6
6.	Salinity	ppt	18	16	19	16	17	16
7.	Temperature	°C	30	30	31	30	31	31
8.	Ammonia	mg L^{-1}	0.2	0.8	0.4	-	-	-
9.	Phosphate	mg L^{-1}	0.3	0.2	0.2	0.1	0.1	0.1
10.	Nitrate	mg L^{-1}	2.8	2.7	2.1	2.1	1.6	1.6

(Helmizuryani *et al.,* 2020). Yuliana and Astriyana (2012) mentioned that a higher number of species accompanied by substantial population results in an elevated H' value. The uniformity index of phytoplankton and zooplankton at the beginning and end of the study was close to 1. This observation implied a well-balanced distribution of species within the community. Furthermore, a high value of uniformity was inversely related to the diversity index (Asiah *et al.,* 2021). The dominance index values for phytoplankton and zooplankton were close to zero at the beginning and final stages, indicating that no species dominated in those waters. The nutrients available in the environment influenced the uniformity index, dominance, and diversity of plankton (Ibrahem and Al-Shawi, 2015). Several studies have shown that nutrient enrichment had a great effect on community composition, density, and diversity of plankton within aquatic environments (Santos *et al.,* 2018; de Melo *et al.,* 2019).

The initial brightness measurements yielded lower values compared to the final observations. Low brightness can be attributed to a higher presence of plankton within the pond. The accumulation of these organisms can hinder incoming light, leading to a reduction in brightness levels. Furthermore, the highest average turbidity value was obtained at the end of the study. According to Yualiana (2014), turbidity in pond waters often originates from suspended materials such as mud, sand, and other microscopic organisms.

The average dissolved oxygen value obtained during the study ranged from 4.2 to 5.3 mg L^{-1}. This value was still good enough for aquatic organisms in the pond. According to WWF Indonesia (2014), the maximum level of dissolved oxygen in milkfish cultivation in ponds fell within the range of 4–8 mg L^{-1}.

The pH measurements conducted at the initial and final stage of the study ranged from 6-7, indicating its suitability in the milkfish ponds. This aligned with the report by Wahyuni *et al.* (2020), that the ideal pH range for successful milkfish cultivation in a pond was 6.5 to 9. The average range of salinity values obtained during the study was 15–20 ppt. According to Sustianti *et al.* (2014), milkfish can grow well at 15–35 ppt. Meanwhile, the temperature value obtained was in the range of 30 – 31 °C, due to sunny weather. WWF Indonesia (2014) stated that a suitable temperature for milkfish was 28–32 °C.

Ammonia values obtained during the study were below the optimum range for fish and plankton growth. According to Class III of water quality standards for fisheries outlined in PP No. 22 of 2021, the maximum limit for ammonia in fishery activities was ≤0.02 mg L^{-1}. In this case, the concentration could potentially lead to variations in plankton assemblage. A study by Caili *et al.* (2023) highlighted the significant impact of ammonia concentration on zooplankton composition within aquatic environments. The average range of phosphate obtained at the initial and end stages of the study were 0.2–0.3 mg L^{-1}, and 0.1 mg L^{-1}, respectively. This aligned with the opinion of Wahyuni *et al.* (2020) that high phosphate results from the influx of domestic, agricultural, industrial, and fishery waste containing this compound. Nitrate yields in this study were between 2.0 and 2.8 mg L^{-1}, and this fell within the suitable range of 0.9–3.5 mg L^{-1} for phytoplankton growth. Finally, traditional ponds required high nitrate concentrations to stimulate the growth of plankton, klekap, and moss, which serve as natural food for fish and shrimp (Utojo, 2015).

Conclusion

The conclusions from this study such as pond fertility, as measured by the abundance of phytoplankton and zooplankton at the initial and final of the season, is classified into mesotrophic waters or waters with moderate fertility. The results of the study of plankton identification in milkfish ponds in Muara Sungsang found plankton types of the Bacillariophyceae, Cynophyceae, Chlorophyceae, Protozoa, Rotifera, and Arthropod classes. The diversity and uniformity index values in the three ponds are evenly distributed, and no plankton species dominate. The water quality is classified as stable, supporting the growth of plankton and milkfish in the pond, except that the ammonia at all stations has exceeded the standard ammonia value. And additional fertilization can be done to maintain and increase the fertility of ponds to ensure natural food sources' availability.

Acknowledgments

We are grateful to the owner of the ponds, Agus Prihanto, Een Karmenda, Eny Sartika, Gracia, and Rupi Sanjaya for kindly help and support in fieldwork.

References

American Public Health Association (APHA). 1985. Standard Method for Examination of Water and Wastewater. American Publik Health, Washington DC.

Asiah, N., Sukendi, S., Harjoyudanto, Y., Junianto, J., and Yustiati. 2021. Water quality analysis based on plankton community structure in Kampar River, Riau Province. Earth and Environmental Science 695: 012005.

Caili, D., Zhao, F., Shang, G., Wang, L., Jeppesen, E., Zhang, L., Zhang, W., and Fang, S. 2003. . Ammonia influences the zooplankton assemblage and beta diversity patterns in complicated urban river ecosystems. Water. 15 :1-14.

Davis, C.C. 1955. The Marine and Fresh-Water Plankton. University Press, Michigan State.

de Melo, T.X.; Dias, J.D.; Simões, N.R.; Bonecker, C.C. 2019. Effects of nutrient enrichment on primary and secondary productivity in a subtropical floodplain system: An experimental approach. Hydrobiologia, 827, 171–181.

Fitrani, M. 2013. Potensi penggunaan lahan pekarangan masyarakat transmigrasi daerah pasang surut untuk budidaya perikanan. Paper presented at Islanda, A., ed. Prosiding Seminar Nasional VII Masyarakat Konservasi Tanah Indonesia, 2013. Palembang: 229-234.

Gao, X., J. Song, X. Li. 2011. Zooplankton spatial and diurnal variations in the Changjiang river estuary before operation of the three gorges dam China. Journal Ocean Limnology, 29(3): 591–602.

Goldman, C.R., A.J. Horne, 1994. Limnology. Mc. Graw Hill Book Co., USA.

Harun, A.M., Takril. 2020. Pengaruh pupuk organik dan anorganik terhadap pertumbuhan ikan bandeng. Journal of Fisheries and Marine Science, 1(2): 2714-6537.

Helmizuryani., Suwignyo, R.A., Hanafiah, Z and Faizal, M. 2020. The abundance and diversity of plankton on peat swamps area Ogan Komering Ilir (OKI) Regency, South Sumatera. IOP Conf. Series: Earth and Environmental Science 584: 1-11.

Ibrahem HF, Al-Shawi IJM. 2015. Potential harmful algae of iraqi coastal marine waters. International Journal of Marine Science, 5:1–6.

Odum, E.P. 1971. Fundamentals of Ecology. London: W.b. Saunders Company, Philadelphia Toronto. ISBN 0-7216-6941-7.

Pagoyar, H., D. Udayana. 2019. Analisis kesuburan tambak di Bontang Kuala Kalimantan Timur. Jurnal Pertanian Terpadu, 7(1): 70-78.

Paiki, K., D.J. Kalor. 2017. Distribusi nitrat dan fosfat terhadap kelimpahan fitoplankton di perairan Pesisir Yapen Timur. Journal of Fisheries and Science, 1(2): 65-71.

Radiarta, I.N. 2013. Hubungan antara distribusi fitoplankton dengan kualitas perairan di Selat Alas, Kabupaten Sumbawa, Nusa Tenggara Barat. Jurnal Mina Laut Indonesia, 13(2): 234-243.

Ristiyani, D. 2012. Evaluasi kesesuaian lahan untuk budidaya perikanan tambak di pesisir Kendal. Jurnal Geo-image, 1(1): 1-7.

Santos, S.A.M.; dos Santos, T.R.; Furtado, M.S.R.; Henry, R.; Ferragut, C. 2018. Periphyton nutrient content, biomass and algal community on artificial substrate: Response to experimental nutrient enrichment and the effect of its interruption in a tropical reservoir. Limnology, 19, 209–218

Sihombing, N.I., S. Hutabarat, B. Sulardiono. 2015. Kajian kesuburan perairan berdasarkan unsur hara dan fitoplankton di sungai Tulung Demak. Journal of Maquares, 4(4): 119-129.

Sustianti, A.F, A. Suryanto, I. Suryanti, 2014. Kajian kualitas air dalam menilai kesesuaian budidaya bandeng (*Chanos chanos* forsskal) di sekitaran PT Kayu Lapis Indonesia Kedal. Diponegoro. Journal of Maquares, 3(2): 1-10.

Utami, R., T. Supriana, R. Ginting, 2014. Analisis faktor-faktor yang mempengaruhi produksi tambak udang sistem ekstensif dan sistem intensif. Forum Agribisnis, 7(1): 49–58.

Utojo, U. 2015. Keragaman plankton dan kondisi perairan tambak intensif dan tradisional di Probolinggo Jawa Timur. Journal Scientific, 32(2): 83-97.

Wahyuni, P.A., M. Firmansyah, N. Fathah, Hastuti. 2020. Studi kualitas air untuk budidaya ikan bandeng (Chanos chanos forsskal) di tambak Kelurahan Samataring Kecamatan Sinjai Timur. Jurnal Agrominansia, 5 (1): 2527-4538.

World Wide Fund for Nature (WWF). 2014. Budidaya Ikan Bandeng (Chanos chanos) pada Tambak Ramah Lingkungan. WWF Indonesia, Jakarta Selatan.

Yuliana and Astriyana 2012 Aquatic Productivity. Jakarta: BumiAksara.

Yuliana, Y. 2014. Keterkaitan antara kelimpahan zooplankton dan fitoplankton dan parameter fisika kimia di perairan Jailolo, Halmahera Barat. Maspara Journal, 6(1): 25-31.

How to cite this paper:
Fitrani, M., R. Septiayani, D. Jubaedah, M. Wijayanti, A. Septimesy, Y.R. Mulyani. 2023. The abundance and types of plankton in milkfish ponds at Banyuasin South Sumatera. Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan, 12(2): 223-228.