AGROLAND: The Agricultural Sciences Journal
Vol. 9, No. 2 December (2022), 128 - 135
P-ISSN : 2407- 7585 & E-ISSN : 2407- 7593, Published by Tadulako University

Original Research **Open Access**

DIVERSITY AND DOMINANCE OF PLANKTON IN POND WATERS OF SOUTH BANAWA DISTRICT AFTER THE 2018 EARTHQUAKE

Nasmia*[1)]

*[1)]Aquaculture Department, Faculty of Animal Husbandry and Fisheries, Tadulako University, Jl. Soekarno Hatta KM. 9, Palu, Sulawesi Tengah

Correspondence author's: Nasmia
Email : nasmia68@gmail.com

Submit: 7 October 2022, Revised: 22 Desember 2022, Accepted: December 2022
DOI : https://doi.org/10.22487/agroland.v9i2.1445

ABSTRACT

South Banawa District is one of the areas in Donggala Regency which has the best prospects in the pond aquaculture sector because this area has the potential to produce milkfish and shrimp. The earthquake and tsunami of 28 September 2018 damaged most of the ponds in South Banawa District. This study aimed to analyze the composition, diversity, and dominance of plankton in fish and shrimp farming ponds in Lalombi and Tolongano Village. The diversity index (H´) of plankton in the two villages, namely Lalombi, ranges from 0.3040-1.0769 (phytoplankton), 0.4385-0.4610 (zooplankton) and Tolongano, it ranges from 0.2219-1.2318 (phytoplankton), 0-1.3297 (zooplankton). The results of this diversity are included in the low community category, which means that the condition of the plankton community is unstable, so the condition of the community is experiencing environmental disturbances, caused by changes in the structure of the soil texture due to the earthquake and tsunami. The dominance index values ranged from 0.4227-0.9033 for and from 0-0.2778 for Dominance index values close to one mean that under current conditions there is a dominant type of but for the value was close to zero, which means that there was no species dominating the structure of the community. uniformity index values ranged from 0.1562-0.4957 and those for ranged from 0-0.9592.

Keywords*:* Pond, Plankton, Composition, Abundance, Diversity.

INTRODUCTION

Earthquakes, tsunamis, and liquefaction caused environmental damage including damage to ponds that can reduce their productivity. This is in accordance with what was reported by Ndobe et al. (2020), that the earthquake, tsunami and liquefaction that occurred on 28 September 2018 caused most of the irrigation infrastructure and household water sources not to operate until 2019, and some land experienced drought. The degree of damage to the fish farms varied from light or moderate to severely damaged or completely lost. Lalombi and Tolongano are villages in South Banawa District which have ponds for breeding milkfish and vanamei shrimp that have experienced the impact of the earthquake disaster. The villages are strategically located milkfish pond cultivation areas (Indah et al. 2019).

The function of the waters can change due to changes in the structure and quantitative value of plankton. Changes in plankton in pond waters can cause fluctuating changes in the plankton genus. These changes can be caused by factors that come from nature or human activities (Amin and Utojo, 2015). Changes that occur in the environment will affect the presence of plankton either directly or indirectly. The fertility of waters can be evaluated based on the characteristics and abundance of the plankton present, because the plankton reflect the level of production, and act as an ecological parameter that can determine the condition of a water body (Makmur and Fahrur. 2011). A stable pond water environment is characterized by a high diversity of plankton, where the number of individuals of each species is high and evenly distributed. The level of plankton production in waters can be used as an estimate of the potential for shrimp and fish production, as well as whether the condition of the waters is stable or unstable. The presence of plankton can provide other information about water conditions, including serving as an indicator of pollution (Igwe et al., 2019; Krupa et al., 2020).

In aquaculture, the role of plankton is very important as a source of natural food for fish and shrimp. Plankton comprise microscopic organisms that live floating in fresh, marine, and brackish waters, are carried by currents, and are divided into two large groups, namely zooplankton, and phytoplankton (Nontji, 2008). Phytoplankton form one of the most important communities in aquatic ecosystems and are the main primary producers in most waters (Valenzuela-Sanchez et al. 2021), while zooplankton are the main consumers (Kumar et al, 2020). Plankton can be used as a biological indicator to evaluate the quality and fertility of water bodies (Kumar et al., 2020, Samadan et al. 2020). This study aimed to examine the diversity and dominance of plankton in aquaculture ponds in in Lalombi and Tolongano Village, South Banawa District, Central Sulawesi, Indonesia after the earthquake. The results of this study are expected to serve as information to support government programs for sustainable management of aquaculture and to increase fish and shrimp production in South Banawa District.

RESEARCH METHOD

Research Location

The research was carried out in the aquaculture ponds of Lalombi and Tolongano Villages, South Banawa District, Donggala Regency. Plankton analysis was carried out at the Fisheries laboratory and the Integrated Agricultural Laboratory, Tadulako University, Palu.

Tools and Materials

The tools used in this research included a plankton net, bucket, sample bottles, cool box, writing utensils, digital camera, pipette, duct tape, marker, microscope slides, a Sedgwick rafter cell counter, microscope, and identification books. The materials used in this study included plankton samples, distilled water, tissues, and Lugol.

Research Procedure

Samples of plankton in fish and shrimp culture ponds were collected by taking pond water and then filtering it using a plankton net. The collected pond water was then put into a labelled sample bottle and 3 drops of Lugol were added.to preserve the plankton sample so that the plankton sample was not damaged before being analyzed. The plankton samples were then stored in a cool box and brought to the laboratory for analysis. Identification and counting of plankton was carried out under a microscope with a magnification of 100x. The identification of plankton was carried out using an identification guidebook, namely, among others, Prescott, Davis, Sachlan, and also via the internet.

Plankton Analysis

The biological indices of the plankton that were calculated were the diversity/species diversity index, the dominance index, and the uniformity index. These indices were calculated using the following formulae:

- Plankton Diversity Index (Shannon & Weaver, 1963)

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

where:
H' = Diversity index,
ni = Number of the i^{th} taxon,
N = Total number of individuals,
Pi = ni/N (Proportion of the i^{th} species)

- Plankton Uniformity Index (Krebs, 1985)

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

where:
E = Uniformity index,
H' = Diversity index,
H′max = Maximum diversity index

- Plankton Dominance Index (Odum, 1998)

$$C = \sum(ni/N)^2$$

where:
C = Simpson dominance index,
ni = Number of the i^{th} taxon,
N = Total number of individuals

RESULTS AND DISCUSSION

Plankton Composition

The results of plankton observations carried out at two pond locations in South Banawa District, Lalombi and Tolongano Village, are shown in Table 1.

The data in Table 1 show that there were more types of phytoplankton than zooplankton. Plankton is a natural food for larvae of aquatic organisms, where the main producers are phytoplankton while zooplankton is a consumer organism. The composition of phytoplankton in this study was dominated by the phylum *Chlorophyta*, from *Raphidium polymorphum* genus. This is following what was reported by Soetignya et al. (2021), that the class *Chlorophyceae* was found to be the most abundant compared to the others. This is because green algae (*Chlorophyceae*) are the most diverse class of algae with high reproductive ability compared to those found in other algal divisions (Adesalu, 2016). The abundance of phytoplankton was greater than that of zooplankton. Hendrajat and Sahrijanna (2019) found that the total abundance and number of species of phytoplankton should be greater than those of zooplankton because phytoplankton play a very important role as photosynthesizing primary producers and form the basis of the food chain and largely determine the type and abundance of higher trophic levels.

lankton Diversity, Dominance and Uniformity Indices

Plankton is a group of organisms that play an important role in an aquatic ecosystem because plankton serve as food for larval organisms living in the water. The level of plankton production in the water can be used to estimate the stability of biotic communities in water bodies (Wulandari et al. 2018). The species composition, the diversity index (H´), uniformity index (E´), and dominance index (D´) of plankton in aquaculture ponds in Lalombi and Tolongano Villages are shown in Table 2.

The plankton diversity index (H´) in ponds in Lalombi and Tolongano Village ranged from 0.2219-1.2318 for phytoplankton and 0-1.3297 for zooplankton. These results indicate that the diversity of both phytoplankton and zooplankton at the pond locations was in the low category (H´≤ 2) according to Bengen (2000). This means that the condition of the plankton community is unstable and indicates that the community is experiencing environmental disturbances, which could be caused by seasonal factors, waste pollution, or changes in soil texture structure due to the earthquake and tsunami. The results of interviews that have been conducted with pond cultivators revealed that when an earthquake occurs, the pond experiences soil lifting which results in spoilage of the pond which causes mass death of shrimp and fish. Madinawati (2010) reported that the phytoplankton diversity index (H′) obtained in the waters of the lagoon of Harapano Village, South Banawa District before the earthquake ranged from 2.0100– 2.5040 (2.3026 < H′ < 6.9078), which means that the diversity of phytoplankton was classified as moderate. The low diversity index shows the occurrence of an imbalance in the aquatic environment which is characterized by the emergence of certain species that are more dominant over other species in the community.

Table 1. Composition of phytoplankton and zooplankton in traditional ponds in South Banawa District (Lalombi and Tolongano Villages).

Types of Plankton		Pond Observation Location*							
		La1	Lp1	La2	Lp2	Ta1	Tp1	Ta2	Tp2
Phytoplankton									
Phylum Cyanophyta									
1.	*Calothrix*	-	6	-	-	-	-	-	-
2	*Glocotricha cehinulata*	-	14	1	-	-	-	2	-
3.	*Oscillatoria limnosa Ag.*	20	-	-	-	7	-	-	-
4.	*Spirulina spp.*	-	1	-	-	-	1	-	-
5.	*Tolypothrix*	6	-	-	-	-	-	-	-
6.	*Trichodesmium orythrolim*	-	-	2	-	3	-	-	-
Phylum Chlorophyta									
7.	*Actinastrum hantzschii varjavanicum*	7	-	1	-	1	-	-	-
8.	*Oocystus naegelii*	-	7	2	-	-	-	-	-
7.	*Raphidium polymorphum. Kuetz*	305	98	84	56	105	8	92	152
9.	*Scenedesmus quadricauda. Breb*	-	1	-	-	-	-	-	-
10.	*Schroederin setigera. Lemm*	-	12	-	-	-	-	-	-
11.	*Selenastrum* sp.	1	-	-	-	-	-	-	-
Phylum Ochrophyta									
12.	*Guinardia flaccida*	-	1	-	-	-	-	-	-
13.	*Leptrocylindrus dacinus*	-	-	-	-	5	-	11	-
Phylum Foraminifera									
14.	*Globigerina inflate*	-	-	-	1	-	-	-	-
Phylum Rhodophyta									
15.	*Chaetoceras sp.*	-	-	-	-	-	1	-	-
Phylum Diatom									
16.	*Asterionella formosa*	8	9	-	-	-	-	-	-
17.	*Bacteriatrums varians*	-	6	-	-	-	-	-	-
18.	*Bacillaria paradoxa*	-	-	-	-	1	-	-	-
19.	*Nitzschia seriata*	-	-	-	-	2	-	-	-

20.	*Pleurosigma angulatum*	-	-	-	-	2	-	-	-
21.	*Pleurosigma naviculaceum*	-	2	1	-	-	-	-	-
22.	*Thallassiothrix nitzschiodes*	-	-	-	-	4	-	-	-
Phylum Desmidiacae									
23.	*Gonatozygon aculeatum.* Gronbl	-	-	-	-	7	45	-	-
24.	*Spirotacmin condensate.* Breb	1	-	-	-	-	-	-	-
25.	*Triploceras gracile Bail. V. undulatum*	-	1	-	-	-	-	-	-
Phylum Chrysophycae									
26.	*Hymonomonas roseola. Stein*	1	1	-	-	-	-	-	-
27.	*Chysamoeba* radinus. Klebs	-	1	-	-	-	-	-	-
Zooplankton									
Phylum Ciliata									
28.	*Vorticella* sp.	-	1	-	-	-	-	-	-
29.	*Lacrimaria* sp.	-	1	-	-	-	-	-	-
Phylum Rotatoria									
23.	*Rotifer neptunius*	-	1	-	-	-	-	-	-
Phylum Entomostraca									
24.	Nauplius of *Diaptomus gracillis*	-	-	-	5	1	1	-	-
25.	Cyclops fimbriatus	-	-	-	-	1	-	-	-
Phylum Arthropoda									
26.	*Meganyctiphanes norvegica funcilia*	-	-	-	5	-	-	-	-
27.	*Metridia lucens*	-	-	-	-	-	1	-	-
28.	*Parapontella brevicornis*	-	-	-	-	2	-	-	-
Phytoplankton genera		8	14	6	2	10	4	3	1
Zooplankton genera		0	3	0	2	3	2	0	0
Total number of genera		8	17	6	4	13	6	3	1
Total number of individuals		349	163	91	67	141	57	105	152

* La1 : Lalombi 1 sluice gate; Lp1 : Lalombi 1 pond center; La2 : Lalombi 2 sluice gate; Lp2 : Lalombi 2 pond center; Ta1 : Tolongano 1 sluice gate; Tp1 : Tolongano 1 pond center; Ta2 : Tolongano 2 sluice gate; Tp2 : Tolongano 2 pond center

Table 2. Number of species (S), Plankton Diversity (H'), Dominance (D) and Uniformity (E) Indices in aquaculture ponds in Lalombi and Tolongano Villages.

Pond Location (Village)	**Phytoplankton**				**Zooplankton**			
	S	H´	D	E	S	H´	D	E
Lalombi 1	19	1.0769	0.6104	0.3657	3	0.4385	0.0627	0.3991
Lalombi 2	7	0.3040	0.8954	0.1562	2	0.4610	0.2511	0.6651
Tolongano 1	12	1.2318	0.4227	0.4957	4	1.3297	0.2778	0.9592
Tolongano 2	3	0.2219	0.9033	0.2020	0	0	0	0

The dominance index (D) describes the presence or absence of a dominating type/species or group of plankton (Odum, 1971). The phytoplankton dominance index value in aquaculture ponds in Lalombi and Tolongano Villages ranged from 0.4227 to 0.9033, close to the value of one, indicating that certain species dominate the phytoplankton community structure in the pond. The results showed that *Raphidium polymorphum* was the most dominant species of the phylum *Chlorophyta* in the pond waters of Lalombi and Tolongano Villages. The value of the dominance index ranged from 0-0.2778 for zooplankton, which means the value obtained was close to 0. According to Basmi (2000), when the dominance index value is close to 1, this means that the community structure of the observed biota is highly dominated by certain species, while dominance index values close to zero mean that in the observed biota community structure there are no strongly dominant species. The main factors affecting species uniformity and dominance include the destruction of natural habitats due to factors such as chemical pollution and climate change (Ningsih et al., 2020)

The uniformity index (E´) describes the level of balance of the species that make up the community of an ecosystem. Phytoplankton uniformity index values in Lalombi and Tolongano Village ranged from 0.1562 to 0.4957, while zooplankton uniformity ranged from 0-0.9592. These results indicate that, at the pond locations, the uniformity values were low (E´<0.75), except for the Tolongano Village with E' = 0.9592 (E´>0.75). According to the criteria of Lind (1979), if the uniformity index (E) is close to a value of 1, then the presence of plankton species in the waters is relatively even. The low uniformity index value illustrates that the distribution of plankton species in the pond waters is uneven, which means that in the ecosystem there is a tendency for species dominance due to instability of environmental and population factors (Krebs, 1989).

CONCLUSION

Based on the calculation results of the distribution index (H') and uniformity index (E) of plankton in pond waters in Lalombi and Tolongano village, they are in the low category, which ranges from 0.2219-1.2318 (phytoplankton) and 0-1.3297 (zooplankton), while the value of the dominance index of phytoplankton ranged from 0.4227-0.9033 and that of zooplankton ranged from 0-0.2778. These results indicate that the dominance index is close to a value of 1, which means that there is a dominance of phytoplankton species, but for zooplankton it is close to a value of 0, which means there is no dominance of zooplankton.

SUGGESTION

Based on this research, it is necessary to pay special attention to the problem of increasing the human resources of farmers and other actors including pond extension workers in order to improve the productivity of the ponds due to the aftermath of the earthquake to increase fish and shrimp production.

ACKNOWLEDGEMENT

We would like to express our gratitude to the Rector of Tadulako University, The Head of the LPPM and the Dean of the Faculty of Animal Husbandry and Fisheries, The Heads of Lalombi and Tolongano Villages, and the community of pond cultivators who provided good facilities and cooperation for this research.

REFERENCES

Adesalu, T.A. 2016. Diversity of green microalgae in South-Western Lagoon, Nigeria. Journal of Scientific Research and Development, 15(2): 14-19.

Amin, M., dan Utojo. 2015. Diversitas dan distribusi plankton di perairan tambak Kabupaten Tuban Propinsi Jawa Timur. Berkala Perikanan Terubuk, Vol. 43 (2); 60 – 67.

Basmi, H.J. 2000. Planktonologi: Plankton sebagai bioindikator kualitas perairan. Fakultas Perikanan dan Ilmu Kelautan, Institut Pertanian Bogor. P.60

Bengen, D.G. 2000. Sinopsis teknik pengambilan contoh dan analisis biofisik sumberdaya pesisir. Pusat Kajian Sumberdaya Pesisir dan Lautan (PKSPL). IPB

Hendrajat, E.A., and Sahrijanna A. 2019. Plankton condition in tiger shrimp (*Penaeus monodon* Fabricius) pond with different substrates. LIPI. Jurnal Ilmu-Ilmu Hayati. 18(1).

Indah, Antara M., Afandi. 2019. Analysis of income of milkfish pond business in Lalombi Village South Banawa Subdistrict Donggala Regency. J. Pembangunan Agribisnis. 2(1): 32-39.

Igwe, D.O., Igboji P.O., Mbagwu G.I. 2019. Use of plankton as bioindicators in water quality management for sustainable use in fishery production: A review. Elixir Agriculture, 134: 53593-53597.

Krebs, J.C. 1985. Ecology: the experimental analysis of distribution and abundance. Third Edition. Harper Collins, New York.

Krebs, C. J. 1989. Ecological methodology. Harper Collins, Inc. New York. Pp 357-367.

Krupa, K., Romanova S., Berkinbaev G., Yakovleva N., Sadvakasov E. 2020. Zooplankton as indicator of the ecological state of protected aquatic ecosystems (Lake Borovoe, Burabay National Nature Park, Northern Kazakhstan). Water, 12(2580): 1-19.

Kumar, J.Y., Reddy S.J., and Suguna T. 2020. Role of plankton in aquaculture. Int. J. Curr. Microbiol. App. Sci. Vol.9(9): 2848-2851

Lind, O.T., 1979. Handbook of common methods in limnology. C.V. Mosby Company St. Louis, p. 199

Madinawati. 2010. Kelimpahan dan keanekaragaman plankton di perairan Laguna Desa Tolongano Kecamatan Banawa Selatan. Media Litbang Sulteng III (2): 119 – 123.

Makmur, R., dan Fahrur M. 2011. Hubungan antara kualitas air dan plankton di tambak Kabupaten Tanjung Jabung Barat Provinsi Jambi. Prosiding forum inovasi teknologi akuakultur. Balai Riset Perikanan Budidaya Air Payau. Maros. 8 hal.

Ndobe, S., Rusaini, Masyahoro, A., Serdiati, N., Madinawati, Moore, A.M. 2020. Reproductive and morphometric characteristics of climbing perch *Anabas testudineus* in Sigi, Central Sulawesi, Indonesia. AACL Bioflux, Volume 13, Issue 1.

Ningsih, S. W., Setyati, W. A., Taufiq, N. 2020. Tingkat kelimpahan makrozoobenthos di padang lamun perairan Telaga dan Pulau Bengkoang, Karimunjawa. Journal of Marine Research, 9(3), 223–229

Nontji. 2008. Plankton Laut. Jakarta: LIPI Press.

Odum, E.P. 1971. Fundamental Ecology 3rd. W.B. Sanders Company, Philadelphia, 574 pp.

Odum, E. P. 1998. Dasar-dasar ekologi. Edisi Ketiga. Terjemahan T. Samingan. Gadjah Mada University Press. Yogyakarta.

Samadan, G.M., Supyan, Andriani A., Juharni. 2020. Plankton abundance on whiteleg shrimp (*Litopenaeus vannamei*) cultivation with different stocking densities in sand land. Jurnal Ilmu Kelautan Kepulauan, 3(2); 222-229.

Shannon, C. E. & W. Weaver 1963. The Mathematical Theory. Univ of Illinois Press. ISBN 0-486-24061-4.

Soetignya, W.P., Marniati P., Adijaya M., Anzani Y.M. 2021. The diversity of plankton as bioindicators in Kakap River Estuary, West Kalimantan. Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan. Vol. 10(2): 174-179

Valenzuela-Sanchez, C.G., Pasten-Miranda N.M.A., Enriquez-Ocaña L.F., Barraza-Guardado R.H., Valdez Holguin J.E., and Martinez-Cordova L.R. 2021. Phytoplankton composition and abundance as indicators of aquaculture effluents impact in coastal environments of mid Gulf of California. Heliyon. 7: e06203.

Wulandari, A., Putro S.P., Muhammad F. 2018. The diversity of plankton in fish aquaculture water of minapolitan Menayu Village, Muntilan District, Magelang Regency. IOP Journal of Physics: Conf. Series 1217: 012182.