Journal of Aquaculture and Fish Health Vol. 13(2) - June 2024
P-ISSN: 2301-7309 / E-ISSN: 2528-0864
doi : 10.20473/jafh.v13i2.52715

Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems

Munjayana[1], Julie Ekasari[1], Heny Budi Utari[2], Wiyoto[3*], Apriana Vinasyiam[1,4], and Ahmad Shofy Mubarak[5]

[1]Department of Aquaculture, Faculty of Fisheries and Marine Sciences, IPB University (Bogor Agricultural University) Jalan Lingkar Kampus IPB Darmaga, Bogor, West Java 16680, Indonesia
[2]Free Market Technical Service Shrimp and Laboratory Service, Shrimp Feed Marketing, Jakarta 12190, Indonesia
[3]Technology and Management of Applied Aquaculture, College of Vocational Studies, IPB University (Bogor Agricultural University) Kampus IPB Cilibende, Jalan Kumbang No 14, Bogor, West Java 16151, Indonesia
[4]Aquaculture and Fisheries Chair Group, Wageningen University and Research, AH Wageningen 6700, the Netherlands
[5]Department of Marine Science, Faculty of Fisheries and Marine, Airlangga University, Kampus C Jl. Mulyorejo Surabaya, East Java 60115, Indonesia

*Correspondence :
wiyoto@apps.ipb.ac.id

Received : 2023-12-24
Accepted : 2024-05-09

Keywords :
Diatoms, Plankton, Salinity, Total organic matter, Water quality

Abstract

Plankton plays an important role in shrimp cultivation in ponds, both as an indicator of water quality and as a natural food source for shrimp that are raised. The purpose of this study was to measure the relationship between the dynamics of the plankton community, the concentration of total organic matter, and water salinity with the abundance of plankton in intensive shrimp farming systems. The study was conducted on six units of ponds located in Cirebon district, West Java, Indonesia. The ponds were lined with HDPE on each side and plastic mulch at the bottom. Post larvae of shrimp were stocked at an average density of 110 shrimp.m^{-2} and maintained for 98 days. Water quality samples were collected for daily measurement. Data were analyzed descriptively and then analyzed using Pearson's correlation test and regression. The results of this study showed that during the shrimp rearing period, 65 species of plankton were identified, consisting of Chlorophyta 20%, Cyanophyta 15.38%, Diatoms 26.15%, Euglenophyta 6.15%, Dinoflagellates 4.62%, Protozoa 10.77%, and Ciliates 16.92% with an average density ranging from 7.56x10^{5}-19.99x10^{5} cells.mL^{-1}. *Chlorella* sp. (Chlorophyta) and *Oscillatoria* sp. (Cyanophyta) were found to be the dominating species in all ponds. Total phytoplankton density tended to be higher during the first 54 days of culture. The results of the correlation and regression tests showed that the composition of plankton, the concentration of total organic matter, and the salinity of the water affected the abundance of plankton in the pond.

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

INTRODUCTION

Pacific whiteleg shrimp is a fishery commodity with high economic value. The increasing demand for Pacific whiteleg shrimp from both the local and global markets has powered an increase in aquaculture production through intensification which is characterized by high shrimp density and the use of artificial feed. The existence and dependence on natural feed in intensive systems are very limited, causing the input of artificial feed to increase (Ekasari, 2009; Emerenciano *et al*., 2022).On the other hand, the intensive system applied to the shrimp farming process faces several problems such as poor water quality and low feed efficiency resulting in large amounts of waste material being produced (Avnimelech, 2006; Wiyoto *et al*., 2021).

Phytoplankton and zooplankton can be used as indicators of aquatic environmental conditions because of their sensitivity to changes in water quality such as low dissolved oxygen concentrations, high organic matter, toxic contamination, poor feed quality, and predation (Casé *et al*., 2008; Fernandes *et al*., 2019). In general, at feeding rates of less than 300 $kg.ha^{-1}.day^{-1}$, phytoplankton activity is important in water quality control (Hargreaves, 2013). In addition, plankton also plays an important role as an additional source of feed for the shrimp being raised. Although its contribution as feed is not large in intensive shrimp farming, the role of plankton as additional feed remains (Chang *et al*., 2020; Silva *et al*., 2021). The abundance and composition of plankton can be an indicator of the nutrient conversion process that occurs in a shrimp cultivation system and can be used as a complementary indicator in monitoring water quality (Casé *et al*., 2008).

Organic matter is a collection of complex organic compounds that have been decomposed by decomposing organisms, either in the form of humus resulting from humification or inorganic compounds from mineralization, and is an important source of nutrients for aquatic organisms (Michael-Kordatou *et al*., 2015; Wang *et al*., 2016; Artifon *et al*., 2019). The mineralization process of organic matter containing nitrogen will produce ammonia that could harm aquaculture organisms because it is toxic even at low concentrations and it reduces the quality of water in aquaculture (Ekasari, 2009; Rurangwa and Verdegem, 2015; Jasmin *et al*., 2020). As much as 75% of oxygen consumption in water is due to the respiration process of algae, bacteria, and detritus, including the organic matter decomposition process (Boyd, 2019; Wiyoto *et al*., 2021). Nutrients produced by the decomposition of organic matter by bacteria will be quickly absorbed and stored in algal cells, which can affect the abundance and composition of these microalgae (Hargreaves, 2013).

In the process of shrimp farming in ponds, various parameters will interact with each other in the water and can affect the biological process of both shrimp as the cultivated organism and plankton as one of the natural sources of shrimp feed. One of the water quality parameters that also affect plankton is salinity. Mo *et al*. (2021) stated that the number of plankton types formed was influenced by salinity. Different groups of plankton can adapt to a certain range of salinity (Chakraborty *et al*., 2011). This study aimed to measure the magnitude of the relationship between plankton community composition dynamics, total organic matter, and salinity in intensive shrimp farming systems.

METHODOLOGY

Ethical Approval

In this study, animals were not handled directly. This study focused only on the observations of plankton and water quality parameters. All experimental and rearing procedures involving animals were

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

conducted under the National Accreditation for Animal Welfare as outlined in the Republic of Indonesia's SNI 7311:2009.

Place and Time

The location of the research pond was in Playangan Village, Gebang District, Cirebon Regency, West Java for one cultivation cycle (98 days) starting from December 2017 to May 2018.

Research Materials

The equipment used in this research is 500 mL bottle sample, microscope (Olympus CX23, Japan), Neubauer hemocytometer (Assistent, Germany), and refractometer (Atago 2473 MASTER-S10M, Japan.

Research Design

All shrimp ponds use high-density polyethylene (HDPE) on the walls, while the bottom is covered with plastic mulch. Each pond was also equipped with 8-10 units of paddle wheel aerators (30,000 shrimp HP-1) to supply oxygen and mix the pond water. The water level in each pond ranged from 120-130 cm. The sludge formed by the decomposition of feed waste and various detritus accumulated in the center of the pond was removed periodically through the central drain just before feeding from the age of 20 days of rearing until before harvest. Approximately 8-10% of the total water volume was added every week to replace water lost due to sludge disposal, evaporation, and seepage.

The study was conducted on 6 shrimp ponds coded A2, A4, A6, A7, A8, and A9 (Figure 1) with an area ranging from 2,000-4,000 m2 and an average initial shrimp stocking density of 110 shrimp m-2. Shrimp postlarva (PL8) was obtained from a commercial hatchery. Feeding was done four times a day with commercial feed with a protein content of 28-30% given at 3-5% of body weight. Water samples were collected directly from the pond on-site at a depth of ±20 cm above the pond bottom at a certain point in the feeding area around the feeding try bridge using 100 mL plastic bottles every week. The water samples were immediately carried to the pond laboratory after collection and 10 mL of water samples from each observation pond was set aside separately from the total water sample for plankton observation, while the rest was immediately used for the analysis of organic matter content and salinity (Sepian *et al*., 2022).

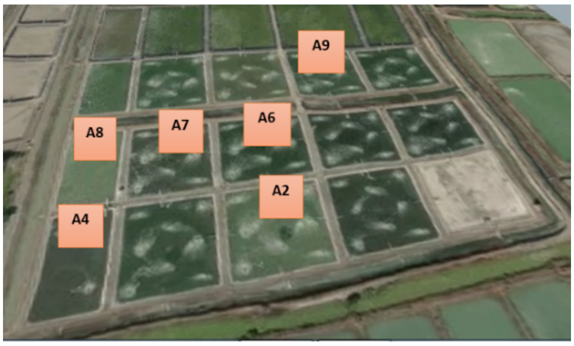

Figure 1. Map of observation shrimp pond location (A2, A4, A6, A7, A8, A9).

Work Procedure

The samples that had been set aside for plankton observations were then stored in a refrigerator before being analyzed. Quantitative and qualitative analysis of plankton was carried out using a microscope at a total magnification of 100x and 400x on the sub-sample of water that was dripped on a Neubauer hemocytometer using a dropper and the numbers calculated based on the cell

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

counting technique: the number of each type of plankton observed on one grid was multiplied by 10,000 (cells.mL^{-1}) (Sepian *et al.*, 2022). The total organic matter analysis was carried out by the titrimetric method using $KMnO_4$ (APHA, 2002), while salinity was measured once a day at 06.00 Western Indonesian Meantime using a refractometer (Table 1).

Table 1. Observational parameters measured, method, and time of measurement in each shrimp pond plot for 98 days of observation.

Parameter	Method	Frequency
Plankton (density, genus, and composition)	Sepian *et al.* (2022)	Every week
Total organic mater	APHA (2002)	Every week
Salinity	Refractometer	Everyday

Data Analysis

All data including plankton, TOM, and salinity were processed with Microsoft Excel 2010 and presented descriptively in the form of tables and graphs. To discover whether there is a relationship between the plankton density formed and the composition of the plankton community, organic matter, and salinity, the data were analyzed further by Pearson's correlation test and regression using the Minitab 16.0 software.

RESULTS AND DISCUSSIONS

Plankton Density and Community Composition

Based on the average value of total plankton density obtained from the 6 ponds, the highest plankton density was 19.99 x 10^5 cells.mL^{-1} in pond A8, while the lowest density was in pond A9 with an average of 7.56 x 10^5 cells.mL^{-1} (Figure 2). The highest plankton density occurred during the rearing period of 21-33 days and continued to decrease with increasing rearing age. Total plankton abundance is related to the frequency of fermented product additions which decreased with increasing rearing age and the intensity of rain which fell quite often in the middle of the rearing period. The addition of fermented products serves as fertilizer to support the growth of plankton in shrimp-rearing ponds.

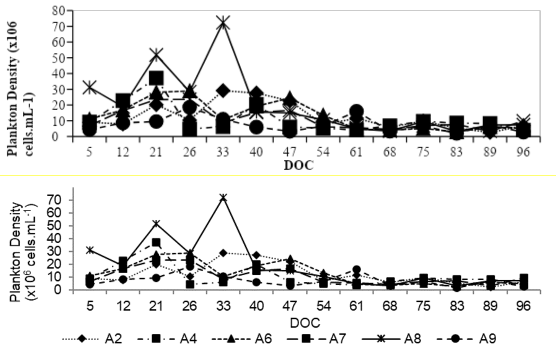

Figure 2. Total plankton abundance based on days of shrimp culture in 6 unit observed pond (A2= shrimp pond number 2; A4= shrimp pond number 4; A6= shrimp pond number 6; A7= shrimp pond number 7; A8= shrimp pond number 8; A9= shrimp pond number 9).

The percentage density of the Chlorophyta group was almost the same in all rearing ponds with a range between 60 and 74%, followed by the Cyanophyta group with an average of 14-23%, and Diatoms with an average of 5-19%. The highest density of the protozoa group was found in pond A9 with an average

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

percentage of 3.54±0.08%, while the Euglenophyta, Dinoflagellate, and Ciliata groups were almost the same in all ponds with a percentage of less than 2% (Table 2).

Table 2. Proportion (%) of plankton based on days of shrimp culture in 6 unit observed ponds (mean ± standard deviation, n = 14).

	A2	A4	A6	A7	A8	A9
Chlorophyta	62.15±0.25[a]	65.03±0.2[a]	63.72±0.21[a]	60.06±0.19[a]	74.22±0.11[a]	64.56±0.21[a]
Cyanophyta	23.61±0.2[a]	18.09±0.14[a]	14.16±0.09[a]	21.77±0.15[a]	15.23±0.11[a]	19.23±0.18[a]
Diatom	11.46±0.11[a]	14.01±0.2[a]	19.17±0.2[a]	15.59±0.19[a]	15.66±0.05[a]	11.30±0.13[a]
Euglenophyta	0.39±0.01[a]	0.18±0.01[a]	0.46±0.01[a]	0.37±0.01[a]	0.82±0.01[a]	0.21±0.01[a]
Dinoflagellata	0.53±0.01[a]	0.63±0.01[a]	1.68±0.03[a]	0.88±0.02[a]	0.97±0.03[a]	0.14±0.01[a]
Protozoa	0.52±0.01[a]	1.09±0.02[a]	1.43±0.03[a]	0.70±0.01[a]	2.36±0.04[a]	3.54±0.08[a]
Ciliata	0.44±0.01[a]	0.27±0.01[a]	0.23±0.01[a]	0.74±0.02[a]	1.10±0.02[a]	0.92±0.02[a]

Overall, there were 65 species of plankton identified, consisting of 20% Chlorophyta, 15.38% Cyanophyta, 26.15% Diatoms, 6.15% Euglenophyta, 4.62% Dinoflagellates, 10.77% Protozoa, and 16.92% Ciliates (Table 3). Based on the observation results, the composition of the plankton community formed was quite high even though it had only reached the genus level. The Diatom group is the group with the largest number of members, consisting of 17 species, while the Dinoflagellate group is the smallest group with 3 species. This proves that Diatoms have high diversity in estuary waters (Casé *et al*., 2008; Chakraborty *et al*., 2011; Afonina and Tashlykova, 2018).

Table 3. Plankton genera identified in the six observation pond units were grouped based on the phylum.

Chlorophyta	**Cyanophyta**	**Diatom**	**Euglenophyta**	**Dinoflagelata**	**Protozoa**	**Ciliata**
Chlamydomonas	*Anabaena*	*Amphiprora*	*Astasia*	*Gymnodinium*	*Chilomonas*	*Askenasia*
Chlorella	*Aphanocapsa*	*Amphora*	*Trachelomonas*	*Protoperidinium*	*Amoeba*	*Acanthometra*
Chlorococcum	*Aphanothece*	*Cerataulina*	*Strombomonas*	*Gyrodinium*	*Chroomonas*	*Balantidium*
Cosmarium	*Chroococcus*	*Chaetoceros*	*Euglena*		*Cryptomonas*	*Euplotes*
Cosmocladium	*Gloeocapsa*	*Chrysococcus*			*Petalomonas*	*Favella*
Dictyosphaerium	*Gomphosphaeria*	*Chrysocromulina*			*Pelagomonas*	*Frontonia*
Dunaliella	*Merismopedia*	*Coscinodiscus*			*Pleotia*	*Halteria*
Gloeocystis	*Microcystis*	*Cromulina*				*Tintinnopsis*
Gloeotilopsis	*Nostoc*	*Cyclotella*				*Mesodinium*
Mesotaenium	*Oscillatoria*	*Diatoma*				*Coleps*
Oocystis		*Melosira*				*Strombidium*
Radiosphaeria		*Navicula*				
Tetraselmis		*Nitzschia*				
		Odontella				
		Pinnularia				
		Pleurosigma				
		Thalassiosira				
13*	10*	17*	4*	3*	7*	11*
20.00%**	15.38%**	26.15%**	6.15%**	4.62%**	10.77%**	16.92%**

Note:

- Result showed in genus each phylum
- * Number of genus each phylum
- ** Percentage of phylum

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

The plankton community formed in each pond was varied in numbers, from 3 species to 23 species. Similar to the dynamics of the total abundance of plankton in each pond, the number of types of plankton that grew in each pond also demonstrated a downward trend after 54 days of rearing until before harvest. Regular disposal of sludge through the central drain to prevent the accumulation of organic matter in the water will cause the nutrient concentration to decrease, affecting the composition of plankton species in the water. Burford (1997) stated that nutrient concentration plays an important role in the dynamics of plankton community composition.

The highest number of plankton species was found in pond A6 with a total of 23 species of plankton consisting of 6 species each from the Chlorophyta, Cyanophyta, and Diatom groups, while Euglenophyta and Dinoflagellates each contributed 1 species and the protozoan group 3 species (Figure 3). The dynamics of changes in the number of plankton species compositions which were quite stable occurred in the plankton community in pond A9 with a range of 5-15 plankton species observed. Boyd (2019) stated that the composition of phytoplankton species differs from one water to another and will always change over time even in the same waters. Casé *et al*. (2008) also stated that an irregular blooming of one plankton species in a pond indicates that the system working in the pond waters is imbalanced.

The most common types of plankton found in the observation ponds were *Chlorella* sp. from the Chlorophyta group which experienced blooms in almost all observation ponds and *Oscillatoria* sp. from the Cyanophyta group. The dominance of the Diatom group in the early maintenance period occurred in all observation ponds except for the A8 pond, then it began to shift to the Chlorophyta group in the middle to the end of the rearing period (Figure 3). In this study, the plankton dominance began to shift with the increasing concentration of organic matter (Figure 4). Casé *et al*. (2008) stated that the dominance of diatoms has the potential to shift to BGA when there is an increased concentration of P in the water. The dominance of the Cyanophyta group was also recorded several times in the middle to the end of the rearing period (Figure 3). According to Yusoff *et al*. (2002), the dominance of Cyanophyta has a longer period than that of the Diatoms because the increase in nutrient concentration along with the age of the shrimp rearing will benefit the Cyanophyta.

Boyd (2019) stated that the blooming of the Cyanophyta plankton group or blue-green algae (BGA) is most strongly avoided by shrimp farmers because BGA will form foam that will cover the water surface, disrupting sunlight penetration and oxygen assimilation. This will affect the growth of other types of plankton and cause crashes or shifts in the plankton population growing in the ponds. When there is a shift in the composition of the plankton community, dissolved oxygen (DO) will decrease to 0 mg.L^{-1} and this will continue until a new plankton community is formed. According to standard operating procedures (SOP) applied to ponds based on experience and existing conditions, the standard proportion of plankton classes in shrimp cultivation should consist of > 80% Chlorophyta and Diatom groups, < 20% Cyanophyta, and < 5% Dinoflagellates. In this study, the proportion of planktonic Chlorophyta and diatoms tended to always dominate during the rearing period, and although the number of harmful plankton species composition exceeded the recommended SOP, the abundance was low with the proportion ranging from 1-2% of the total plankton abundance for Dinoflagellates, Euglenophyta, and Ciliates, so it did not have a direct effect on water quality.

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

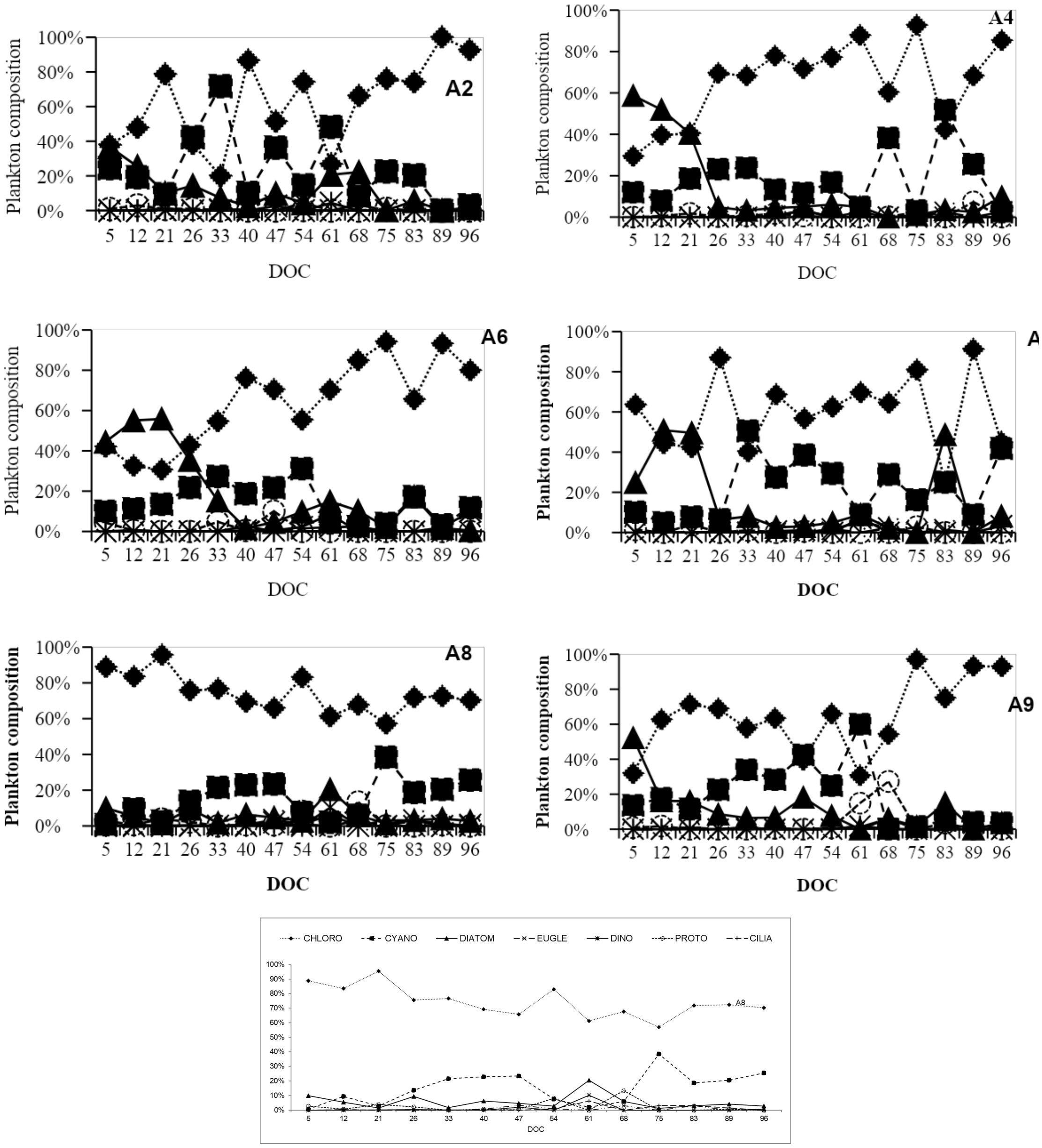

Figure 3. The dynamics of composition plankton community in 6 units observed shrimp ponds during 98 days of culture (A2= shrimp pond number 2; A4= shrimp pond number 4; A6= shrimp pond number 6; A7= shrimp pond number 7; A8= shrimp pond number 8; A9= shrimp pond number 9). Note: Chloro = Chlorophyta; Cyano = Cyanophyta; Dino = Dinoflagellata; Proto = Protozoa; Cilia = Ciliata; Eugle = Euglenophyta.

Total Organic Matter

The concentration of total organic matter (TOM) in the observation pond was quite stable during the rearing period. The pattern of total organic matter concentration in the observation pond tended to increase with increasing shrimp rearing age in the ponds but was still within the tolerable range for Pacific whiteleg shrimp with an average concentration ranging from 97-105 $mg.L^{-1}$ $KMnO_4$ (Figure 4).

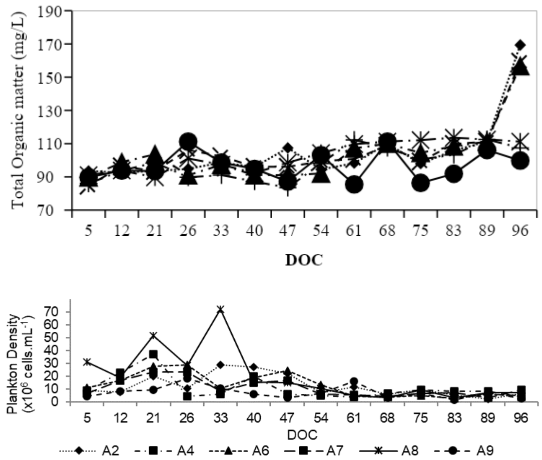

Figure 4. Total organic matter concentration based on days of culture in 6 unit observed ponds (A2= shrimp pond number 2; A4= shrimp pond number 4; A6= shrimp pond number 6; A7= shrimp pond number 7; A8= shrimp pond number 8; A9= shrimp pond number 9).

The regular sediment removal through the central drain at every feeding time and a fairly high percentage of water input (8-10% per week) contributed to the reduced concentration of organic matter in the water. The application of a cultivation pattern with an efficient use feed is also one of the factors that cause the controllable concentration of TOM during the rearing period. Artificial feed used during rearing is the main source of organic matter in intensive shrimp ponds, accounting for 78% of total N and 51% of total P (Briggs and Fvnge-Smith, 1994). The increase in TOM at the end of the rearing period was thought to be related to the amount of leftover feed and shrimp metabolic products which also increased with the age of rearing.

Salinity

The salinity in the rearing medium tended to decrease in the middle of the rearing period (DOC 33-68) and increased slowly at the end of the rearing period (DOC 78-96). This was due to the high level of rainfall in the middle of the maintenance period which tended to decrease at the end of the maintenance period. The salinity range during the rearing period was between 13 and 28 $g.L^{-1}$, with the highest average in pond A9. The dynamics of the water salinity in each observation pond during the maintenance period can be seen in Figure 5.

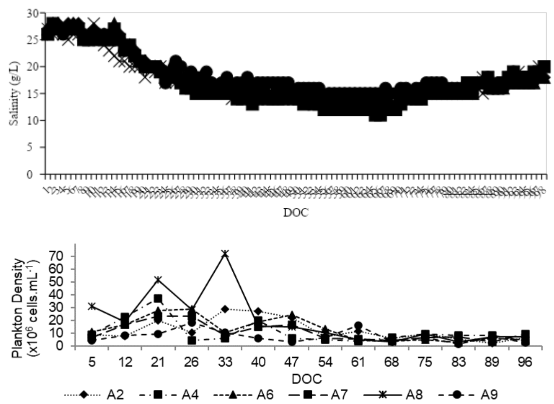

Figure 5. The dynamics of water salinity of 6 unit ponds during 98 days of culture (A2= shrimp pond number 2; A4= shrimp pond number 4; A6= shrimp pond number

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

6; A7= shrimp pond number 7; A8= shrimp pond number 8; A9= shrimp pond number 9).

The salinity level shifting demonstrated a pattern related to the dominant plankton groups. Diatoms dominated at the beginning of the rearing period with the highest salinity levels during the observation period (24-28 $g.L^{-1}$). This follows what has been reported by Chakraborty *et al*. (2011) that waters with low to high salinity are more dominated by plankton from the Diatom and Dinoflagellate groups. After 2 weeks of rearing, salinity levels decreased significantly due to the heavy rainfall which was followed by a shift of dominance in the plankton group.

The abundance of *Chlorella* sp. from the Chlorophyta group in the observation pond began to dominate after the salinity of the waters fell within the range of 14-17 $g.L^{-1}$ as Boyd's (2019) statement that Chlorophyta will dominate in waters with low salinity levels up to 0 $g.L^{-1}$. In this study, the water salinity tended to be in the moderate range with the highest level at 28 $g.L^{-1}$. The higher the salinity level in the waters, the lower the diversity of plankton species that grow (Chakraborty *et al.*, 2011). This is caused by osmotic stress at the cellular level, ion uptake and reduction, and the plankton's cellular ion ratio at salinity level variations.

Relationship between Plankton and Water Conditions

Based on the test results, the correlation between plankton community composition, total organic matter, and salinity was not significant (P > 0.05), so it could be concluded that the observed factors were not interrelated; or, in other words, they are independent. To see the magnitude of the influence of plankton community composition, total organic matter, and salinity on the abundance of plankton, a regression test was carried out. The test results showed that the three variables were able to explain 93% of the factors (R^2 = 0.93) that significantly affected the abundance of plankton in the shrimp cultivation system in the pond with a p-value of 0.041 (sig $p<0.05$), while the remaining 7% was influenced by other factors. The equation formed from the regression test was Y (abundance) = 188 + 2.34a (composition) - 0.875b (TOM) - 6.38c (salinity).

The results of the regression analysis showed a positive correlation between the diversity of the composition of the plankton community and the abundance of the plankton that grew. This was the opinion of Smith (1985) who stated that the potential for population shifts which resulted in a decrease in plankton density would decrease with the high level of diversity in the composition of the algal community. On the other hand, the total organic matter concentration and salinity were negatively correlated with the abundance of plankton. The negative correlation that appeared in the equation obtained in this study is contrary to the results of several previous studies that stated that high concentrations of organic matter would stimulate the growth of plankton in the water (Case *et al*., 2008; Shaari *et al*., 2011). This is thought to be related to the cultivation pattern and system applied such as regular mud removal, the entry of rainwater, and a fairly high percentage of water replacement. According to Funge-Smith and Briggs (1998), the removal of sediments accumulated at the bottom of the pond during the cultivation period shows great potential to reduce the load of organic matter in the cultivation system; therefore, in this study, the concentration of organic matter and abundance of plankton was kept under control. The negative correlation with salinity is thought to be related to the tolerance limit of each species to osmotic stress due to differences in ionic pressure in waters with

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

different salinities (Chakraborty *et al*., 2011; Shaari *et al*., 2011).

CONCLUSION

The composition of plankton species had a greater influence than the concentration of organic matter and salinity on the abundance of plankton in the waters. The composition of plankton, the concentration of total organic matter, and the salinity of the water affected the abundance of plankton in the pond.

CONFLICT OF INTEREST

The conflict of interest contains a declaration that there is no conflict of interest among all authors upon writing and publishing the manuscript.

AUTHOR CONTRIBUTION

The author's contribution contains an explanation of the contribution each author provides to the study/experiment.

ACKNOWLEDGMENT

The author would like to thank the Education Fund Management Institute (Lembaga Pengelola Dana Pendidikan, LPDP) that provided the scholarship and research funds, all staff of the Technology Research and Development Division of Animal Health Service, and the shrimp feed marketing department of PT. Central Protein Prima and Mr. H. Tarmadi as the owners of the pond and all the pond staff.

REFERENCES

Afonina, E.Y. and Tashlykova, N.A., 2018. Plankton community and the relationship with the environment in saline lakes of Onon-Torey plain, Northeastern Mongolia. *Saudi Journal of Biological Sciences*, *25*(2), pp.399–408. https://doi.org/10.1016/j.sjbs.2017.01.003

APHA (American Public Health Association), 2002. Standard Method for the Examination of Water and Waste. Vol. 21. p.1288.

Artifon, V., Zanardi-Lamardo, E. and Fillmann, G., 2019. Aquatic organic matter: Classification and interaction with organic microcontaminants. *Science of the Total Environment*, *649*, pp.1620–1635. https://doi.org/10.1016/j.scitotenv.2018.08.385

Avnimelech, Y., 2006. Bio-filters: the need for a new comprehensive approach. *Aquacultural Engineering*, *34*(3), pp.172–178. https://doi.org/10.1016/j.aquaeng.2005.04.001

Boyd, C.E., 2019. Water quality: an introduction. Springer Nature. p.440. https://doi.org/10.1007/978-3-030-23335-8

Briggs, M.R.P. and Fvnge-Smith, S.J., 1994. A nutrient budget of some intensive marine shrimp ponds in Thailand. *Aquaculture Research*, 25(8), pp.789–811. https://doi.org/10.1111/j.1365-2109.1994.tb00744.x

Burford, M., 1997. Phytoplankton dynamics in shrimp ponds. *Aquaculture Research*, *28*(5), pp.351–360. https://doi.org/10.1046/j.1365-2109.1997.00865.x

Casé, M., Leça, E.E., Leitão, S.N., Sant'Anna, E.E., Schwamborn, R. and Junior, A.T.M., 2008. Plankton community as an indicator of water quality in tropical shrimp culture ponds. *Marine Pollution Bulletin*, *56*(7), pp.1343–1352. https://doi.org/10.1016/j.marpolbul.2008.02.008.

Chakraborty, P., Acharyya, T., Babu, P.V.R. and Bandyopadhyay, D., 2011. Impact of salinity and pH on phytoplankton communities in a tropical freshwater system: An investigation with pigment analysis by HPLC. *Journal of Environmental Monitoring*, *13*(3), pp.614–620.

https://doi.org/10.1039/C0EM00333F

Chang, Z.Q., Neori, A., He, Y.Y., Li, J.T., Qiao, L., Preston, S.I., Liu, P. and Li, J., 2020. Development and current state of seawater shrimp farming, with an emphasis on integrated multi-trophic pond aquaculture farms, in China–a review. *Reviews in Aquaculture*, *12*(4), pp.2544–2558. https://doi.org/10.1111/raq.12457

Ekasari, J., 2009. Bioflocs technology: theory and application in intensive aquaculture system. *Jurnal Akuakultur Indonesia*, *8*(2), pp.117–126. https://doi.org/10.19027/jai.8.117-126

Emerenciano, M.G.C., Rombenso, A.N., Vieira, F.d.N., Martins, M.A., Coman, G.J., Truong, H.H., Noble, T.H. and Simon, C.J., 2022. Intensification of Penaeid Shrimp Culture: An Applied Review of Advances in Production Systems, Nutrition and Breeding. *Animals*, *12*(3), 236. https://doi.org/10.3390/ani12030236

Fernandes, V., Sabu, E.A., Shivaramu, M.S., Gonsalves, M.J.B.D. and Sreepada, R.A., 2019. Dynamics and succession of plankton communities with changing nutrient levels in tropical culture ponds of whiteleg shrimp. *Aquaculture Environment Interactions*, *11*, pp.639–655. https://doi.org/10.3354/aei00341

Funge-Smith, S.J. and Briggs, M.R.P., 1998. Nutrient budgets in intensive shrimp ponds: implications for sustainability. *Aquaculture*, *164*(1-4), pp.117–133. https://doi.org/10.1016/S0044-8486(98)00181-1

Hargreaves, J.A., 2013. Biofloc production systems for aquaculture. Southern Regional Aquaculture Center Stoneville, MS.

Jasmin, M.Y., Syukri, F., Kamarudin, M.S. and Karim, M., 2020. Potential of bioremediation in treating aquaculture sludge: Review article. *Aquaculture*, *519*, 734905. https://doi.org/10.1016/j.aquaculture.2019.734905

Michael-Kordatou, I., Michael, C., Duan, X., He, X., Dionysiou, D.D., Mills, M.A. and Fatta-Kassinos, D., 2015. Dissolved effluent organic matter: characteristics and potential implications in wastewater treatment and reuse applications. *Water Research*, *77*, pp.213–248. https://doi.org/10.1016/j.watres.2015.03.011

Mo, Y., Peng, F., Gao, X., Xiao, P., Logares, R., Jeppesen, E., Ren, K., Xue, Y. and Yang, J., 2021. Low shifts in salinity determined assembly processes and network stability of microeukaryotic plankton communities in a subtropical urban reservoir. *Microbiome*, *9*, 128. https://doi.org/10.1186/s40168-021-01079-w

Rurangwa, E. and Verdegem, M.C.J., 2015. Microorganisms in recirculating aquaculture systems and their management. *Reviews in Aquaculture*, *7*(2), pp.117–130. https://doi.org/10.1111/raq.12057

Sepian, N.R.A., Yasin, N.H.M. and Ramesh, N., 2022. Immobilization method to separate microalgae biomass for fatty acid methyl ester production. *Chemical Engineering & Technology*, *45*(8), pp.1474–1481. https://doi.org/10.1002/ceat.202100462

Shaari, A.L., Surif, M., Latiff, F.A., Omar, W.M.W. and Ahmad, M.N., 2011. Monitoring of water quality and microalgae species composition of Penaeus monodon ponds in Pulau Pinang, Malaysia. *Tropical Life Sciences Research*, *22*(1), pp.51-69. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3819091/

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.

Silva, D.A., de Lima, P.C.M., da Silva, A.E.M., Filho, P.R.C.O., da Silva, S.M.B.C., Gálvez, A.O. and Brito, L.O., 2021. Effects of adding rotifers on the water quality, plankton composition and growth of Pacific white shrimp, Litopenaeus vannamei juvenile, when cultured with biofloc technology. *Aquaculture Research*, *52*(9), pp.4380–4393. https://doi.org/10.1111/are.15276

Wang, Z., Zhang, L., Zhao, J. and Xing, B., 2016. Environmental processes and toxicity of metallic nanoparticles in aquatic systems as affected by natural organic matter. *Environmental Science: Nano*, *3*(2), pp.240–255. https://doi.org/10.1039/c5en00230c

Wiyoto, Sukenda, Harris, E., Nirmala, K. and Djokosetiyanto, D., 2021. Pacific whiteleg shrimp (*Litopenaeus vannamei*) behaviour, oxygen consumption and sediment oxygen demand at different sediment redox potential. *Aquaculture, Aquarium, Conservation & Legislation*, *14*(6), pp.3510–3516. http://www.bioflux.com.ro/docs/2021.3510-3516.pdf

Yusoff, F.M., Zubaidah, M.S., Matias, H.B. and Kwan, T.S., 2002. Phytoplankton succession in intensive marine shrimp culture ponds treated with a commercial bacterial product. *Aquaculture Research*, *33*(4), pp.269–278. https://doi.org/10.1046/j.1355-557x.2002.00671.x

Cite this document as Munjayana, Ekasari, J., Utari, H.B., Wiyoto, Vinasyiam, A. and Mubarak, A.S., 2024. Relationship Between The Dynamics of Plankton Community Abundance, Total Organic Matter, and Salinity in Intensive Shrimp Farming Systems. *Journal of Aquaculture and Fish Health*, *13*(2), pp.186-197.