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The abundance of *Microcystis sp.* on intensive shrimp ponds

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ABSTRACT

Microcytis sp is plankton species that is detrimental in shrimp pond ecosystems. The purpose of this study was to detect the abundance of plankton and the presence of *Microcystis sp.* in the waters of vaname shrimp *(L. vannamei)* aquaculture ponds. The research method used is descriptive quantitative and qualitative with added analysis of dynamic modeling systems. The results showed that pond water quality conditions were still good enough for shrimp farming activities with details of dissolved oxygen 4.01-6.17 mg/L, pH 7.7-7.9, salinity 20‰, temperature 27.05^{0}-28.25^{0}C, nitrate 0.01-0.15 mg/L, phosphate 0.05-0.20 mg/L, brightness 25-35 cm. For the classification of plankton found among them are from the Bacillariophyceae class, there are the genera *Skeletonema* sp., *Cyclotella* sp., *Coscinodiscus* sp., *and Amphipora* sp., from the Chlorophyceae class, there are the genera *Chlorella* sp., *Oocystis* sp., and *Clamydomonas* sp., from the Cyanophyceae class. the genus *Oscillatoria* sp., *Microcystis* sp., and *Anabaenopsis* sp. The plankton diversity index (H') was obtained between 0.01-0.33 and the uniformity index (E) was obtained between 0.10-0.50, meaning that the condition of the pond waters is still quite good and there are minimal indications of pollution. The abundance of *Microcystis* sp. obtained between 0.2x10^4-0.6x10^4 cell/ml. from the results of dynamic modeling analysis it is shown that the abundance of *Microcystis* sp. in pond waters is influenced by the value of the productivity level of the waters and the process of grazing organisms. The results of this study can be concluded that the plankton abundance rate found in ponds ranges from 0.4x10^4-1.9x10^4 cell/ml which consists of 10 genera and 3 classes of plankton. Then *Microcystis* sp. its presence was found in 3 ponds with abundance rate ranging from 0.2x10^4-0.6x10^4 cell/ml.

Introduction

Shrimp cultivation is one of the many cultivation activities carried out in the Pekalongan coastal. Shrimp cultivation can be carried out in various patterns, such as: traditional, semi-intensive and intensive (Ariadi and Wafi, 2020). The water quality dynamics in shrimp ponds always fluctuate throughout the cultivation cycle (Ariadi *et al.*, 2021). Water quality fluctuations are in line with the intensity level of treatment given to the pond ecosystems (Case *et al*, 2008).

The dynamics of quality and treatment intensity carried out in ponds will greatly affect the structure and abundance of plankton (Ariadi *et al.,* 2019). Plankton in pond water ecosystems have an important role as live food and environmental bioindicators (Lyu *et al.,* 2021). The presence of nutrients and temperature are some of the limiting factors that affect the dynamics of plankton dominance in pond waters. The primary productivity rate in pond waters, which is closely related to the plankton abundance, will continue to change, forming character patterns in each cultivation cycle (Zhang *et al.,* 2021).

Plankton several types that are commonly found in vannamei shrimp farming activities in each aquaculture operational cycle are *Microcystis* sp. *Microcystis* sp. is a cyanobacteria that easily blooms and more diverse in pond water ecosystems (Kumar and Sinha, 2014). *Microcystis* sp. has a toxin compound

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called microcystins (Zimba *et al.,* 2006). These microcystins compounds are toxic to shrimp metabolisms. Vaname shrimp is a species of shrimp that is highly resistant to changes in abnormal environmental conditions (Li *et al.*, 2022).

Based on the background above, the purpose of this study was to detect the plankton abundance and the presence of *Microcystis* sp. in the waters of vaname shrimp (*L. vannamei*) aquaculture ponds.

Materials and Methods

Location and time of research

This research was conducted in the shrimp ponds of Siwalan Village on December 2022. The parameters observed in this study included the plankton diversity index, plankton uniformity index, plankton types, and pond water quality parameters. Plankton data collection was carried out in 4 shrimp ponds with the sampling point taking zones being on the surface water, water column and the bottom of the pond.

Data analysis

Data were analyzed descriptively quantitatively and qualitatively using Microsoft Excel and Stella ver.9.0.2 software. Plankton observations were carried out using an Olympus CX23 microscope and Haemocytometer Neubeuer©.

Diversity index

The plankton diversity index is calculated based on the Shannon-Wiener index formula by *Parsons et al,* (1977), as follows :

$$H' = \sum_{i=1}^{s} \text{Pi Log2 Pi}$$

Explanation :
H' : Diversity index
Pi : ni/N
Ni : Number of individual in-i
N : Total number of indviduals

Uniformity i

ndex

The uniformity index is calculated based on the formula introduced by Odum, (1996), as follows :

$$E = H'/H_{max}$$

Explanation :
E : Species uniformity index
H' : Diversity index
H_{max} : Log_7 S
S : Number of species.

Results

Water quality

The water quality value of shrimp aquaculture ponds at the research location is still quite good. The parameters of dissolved oxygen, salinity, temperature, nitrate, phosphate, and brightness are still in accordance with the quality standard values designated for shrimp farming activities. The water quality values for research ponds can be presented in Table 1. Stable water quality parameter values are possible due to the low level of shrimp stocking density and the minimal chemical treatment given (Amorim and Moura, 2021).

Table 1. Water quality in shrimp pond culture.

Ponds	Water Quality Parameters						
	DO (mg/L)	pH	Salinity (gr/L)	Temperature (^{0}C)	Nitrat (mg/L)	Fosfat (mg/L)	Brightness (cm)
A	4.01-5.67	7.7-7.8	20	27.05-27.75	0.03-0.05	0.05-0.08	30-35
B	5.24-5.83	7.7-7.8	20	27.75-28.00	0.01-0.05	0.07-0.13	30-35
C	4.89-6.17	7.8-7.9	20	27.15-28.25	0.06-0.15	0.13-0.20	25-30
D	5.13-6.04	7.7-7.8	20	27.50-27.75	0.03-0.12	0.06-0.11	30-35

Plankton genus

Based on the results of the species identification analysis, the plankton found in the research pond waters consisted of 10 genera from three classes, namely: Bacillariophyceae (4 genera), Chlorophyceae (3 genera), Cyanophyceae (3 genera). The dominance level of the genus in these waters is low. The plankton genus found in the research pond waters can be seen in (Table 2). the plankton dynamics in research ponds is describe as very diverse as very diverse and dynamic. Differences in temperature and environmental conditions of pons water ecosystems will trigger plankton dynamics (Munthe *et al.,* 2012).

Based on the available data, it can be shown that the genus bacillariophyceae, chlorophyceae, and cyanophyceae are very dominant compared to other genus. The plankton predominant condition is caused by the ecosystem conditions of the pond is very dynamic (Ariadi *et al.,* 2022). The pond water characters and the intensity of nutrient fluctuations in pond waters will greatly affect the genus of plankton that grows. Plankton as aquatic microorganisms will easily experience succession if there are dynamically fluctuations in water conditions (Ariadi *et al.*, 2019). Plankton will easily bloom and mass die if the extreme water.

Table 2. The plankton abundance species found in pond waters.

No.	Class	Plankton abundance in shrimp ponds (cell/ml)			
		A	B	C	D
	Bacillariophyceae				
1	*Skeletonema* sp.	10000			
2	*Cyclotella* sp.			40000	30000
3	*Coscinodiscus* sp.				10000
4	*Amphipora* sp.			10000	
	Chlorophyceae				
1	*Chlorella* sp.	80000	20000		
2	*Oocystis* sp.	10000		30000	70000
3	*Clamydomonas* sp.	10000		20000	20000
	Cyanophyceae				
1	*Oscillatoria* sp.	20000	10000		
2	*Microcystis* sp.	20000		30000	60000
3	*Anabaenopsis* sp.		10000		
	Genera	6	3	5	5
	Total (cell/ml)	150000	40000	130000	190000

Diversity index

The plankton diversity index in the study ponds ranged from 0.01-0.33. The highest diversity index value was found in D pond and the lowest in B pond (Figure 1). based on the plankton genus diversity, it can be said that the pond water conditions is still quite good and there are no indications of waste pollution (Munthe *et al.,* 2012). These indications are in accordance with the shrimp culture system conditions at the research location using the traditional plus cultivation system.

The plankton diversity in the shrimp pond will greatly determine the profile of aquatic organisms that grow. The existence of a food chain, especially for higher nekton or shrimp will depend on the presence of primary level organisms, such as plankton and detritus (Amorim *et al.,* 2021). Based on these conditions, the plankton diversity in addition to affecting of water nutriens, also has an impact on the food chain cycle in pond ecosystems. Food chain cycle is natural process can be upgredetable of pond ecosystem (Ariadi, 2020).

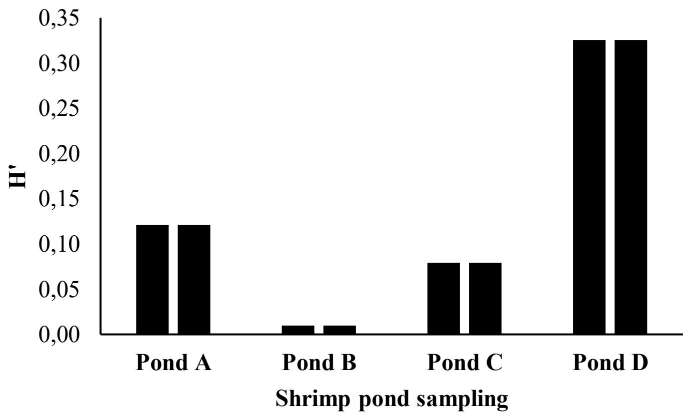

Figure 1. Plankton diversity index in pond waters.

Uniformity index

The plankton uniformity index values in ponds ranged between 0.10-0.50, with the highest uniformity index level found in D pond and the lowest in B pond (Figure 2). The average uniformity index value is ≤4, it can be said that the plankton uniformity index level in the study ponds is low (Munthe *et al.,* 2012). The plankton uniformity index will correlate with water quality dynamics and plankton diversity (Amorim and Moura, 2021). In vannamei shrimp ponds, the level of plankton uniformity will continue to change according to the

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dynamics of water quality (Ariadi *et al.,* 2019). Water quality in shrimp ponds is a important factor (Wafi *et al.,* 2021).

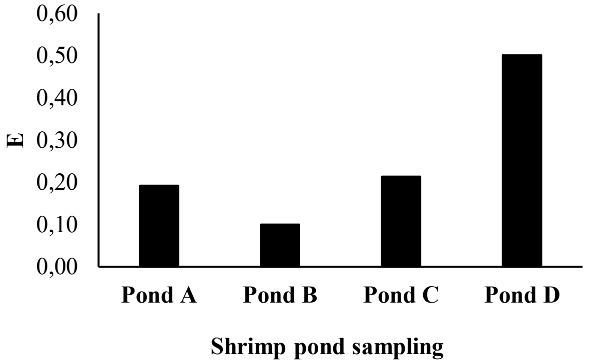

Figure 2. Plankton uniformity index in ponds.

***Microcystis* sp. abundance**

Total abundance of *Microcystis* sp. in research ponds is dynamic. *Microcystis* sp. almost found in every aquaculture pond except B pond (Figure 3). *Microcystis* sp. is a cosmopolitan plankton that blooms easily under nutriet conditions (Masithah, 2011). Shrimp pond ecosystems that have high nutrient levels are very potential to be used as a living habitat for *Microcystis* sp. (Ariadi *et al.,* 2022).

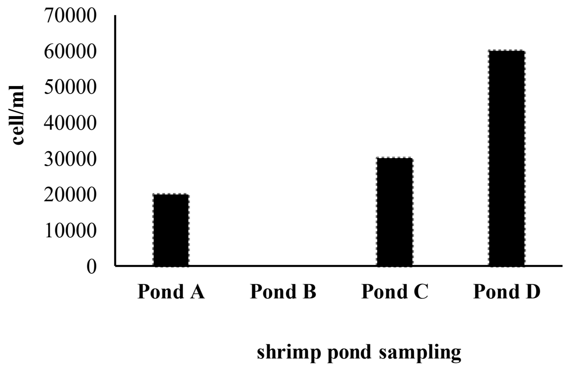

Figure 1. *Microcystis* sp. abundance in shrimp pond waters.

Based on dynamic modeling analysis, the *Microcystis* sp. will continue to increase of aquatic productivity rate on the waters and the grazing process in the pond ecosystem continues to increase. The growth rate of phototrophic organisms in pond feeding tissue is strongly influenced by the grazing process (Calbet *et al.,* 2012). In shrimp ponds, grazing itself will run naturally under normal conditions (Ariadi *et al.,* 2022). The aquatic productivity rate is proportionally influenced by the fertilization process and the feed waste accumulation (Xiong *et al.,* 2020). The results of dynamic modeling correlation can be presented in (Figure 4).

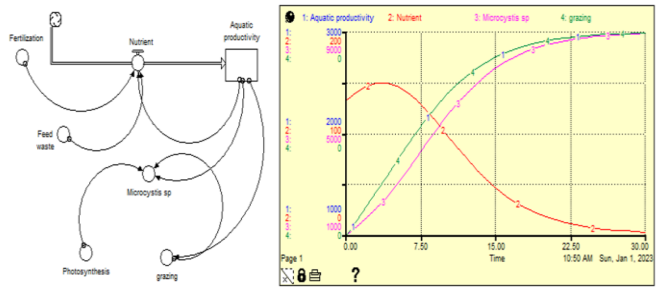

Figure 4. Results of dynamic modeling system analysis about related prediction *Microcystis* sp. abundance in the shrimp pond.

Discussion

The water quality parameter is an important indicator in the operational cycle of shrimp farming (Madusari *et al.,* 2022). Water quality stabilized will make shrimp comfortable and grow well as well as in the opposite condition (Yu *et al.,* 2022). As an aquatic biota, shrimp are very tolerant of fluctuate change in the conditions of the aquatic ecosystem of their habitat. *L. vannamei* is a shrimp species that is physiologically very strong in resisting the environment fluctuations (Ariadi *et al.,* 2019). The water quality condition is also influenced by the level of treatment carried out during the shrimp culture cycle (Wafi and Ariadi, 2022).

The low level of genus dominance in the research ponds is due to the cultivation system used is the traditional plus model so that not much treatment is given to the cultivation ecosystem. Treatment in the cultivation system will greatly determine the plankton existence (De *et al.,* 2020). The nutrient solubility and water quality stability are also other factors that affect to presence of plankton in ponds (Boyd and Davis, 2020). Erratic weather conditions can also cause the plankton dominance in ponds to be unstable over time (Churnside *et al.,* 2020).

From plankton dominance rate in ponds is related for shrimp stocking density (Aliviyanti *et al.,* 2017). The minimum amount of contaminants can be caused by the low stocking density and shrimp biomass in the ponds. The low stocking density will affect the intensity of nutrients in pond waters (Huang *et al.,* 2020). Plankton will be very sensitive to changes in the aquatic environment dynamics.

The low value of the uniformity index illustrates that the existence of plankton communities in pond water ecosystems tends to be unstable. The dynamic ecosystem of pond waters will affect the level of existence of the plankton (Ariadi and Puspitasari, 2021). Plankton will be very sensitive to changes in environment conditions and food chains that exist in pond aquatic ecosystems (McQuatters-Gollop *et al.,* 2019). Seeing the low plankton uniformity index value means that the dominance level of plankton is still quite low.

Microcystis sp. is a very tolerant of growing in high-salinity water (Soedarsono *et al.,* 2013). The status of pond waters that have optimum salinity levels and optimal temperature conditions will allow plankton to grow optimally (Ariadi and Mujtahidah, 2022). *Microcystis* sp. in pond waters has a high level of dominance because of its cosmopolitan nature. In trophic waters several types of plankton such as *Oscillatoria* sp., *Microcystis* sp. and *Anabaena* sp. prone to periodic blooming (Aliviyanti *et al.,* 2017).

Based on the results analysis of the diversity index and uniformity index, it was shown that the waters in the research ponds were still quite good. This status correlates closely with the water quality profile and plankton abundance level in pond waters. The dominance and abundance of plankton will follow by water quality dynamics in the waters (McQuatters-Gollop *et al.,* 2019). The plankton dominance and abundance level is also greatly influenced by aquatic productivity rate (Xiong *et al.,* 2020).

Overall, the study results indicate that the condition of pond waters which is still classified as good is closely related with plankton abundance stabilized. The *Microcystis* sp. appearance with primary productivity rate in each research pond. *Microcystis* sp. is a plankton that tends to be adaptive with water condition changes (Huang *et al.,* 2014). Then indirectly, *Microcystis* sp. abundance will greatly affect the grazing process and the food chain in the pond ecosystem

Conclusion

The results of this study can be concluded that the plankton abundance rate found in ponds ranges from 0.4×10^4-1.9×10^4 cell/ml which consists of 10 genera and 3 classes of plankton. Then *Microcystis* sp. its presence was found in 3 ponds with abundance rate ranging from 0.2×10^4-0.6×10^4 cell/ml.

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