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Importance of Plankton Communities for Water Quality and Nutrition in the White Shrimp (*Litopenaeus vanname*) Ponds

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ABSTRACT

This study investigated the dietary selectivity of the white shrimp, *Litopenaeus vannamei*, through analyzing the phytoplankton and zooplankton communities in both three ponds water and shrimp gut content. Results revealed significant differences in species composition between the two environments. A total of 155 phytoplankton species were identified in shrimp ponds, though their relative abundances varied spatially and temporally, impacting shrimp growth and potentially linked to mortality events associated with blooms of specific species like *Cyclotella glomerata*, *Oscillatoria limnetica*, *Gomphosphaeria aponina*, *Nitzschia longisima*, and *Prorocentrum micans*. Cyanophyta and diatoms (average abundance about 72 %) were the most frequent phytoplankton found within shrimp guts *(Cyclotella glomerata, Cymbella* sp.*, Navicula erifuga, Nitzschia obtusa*, *N. palea*, *Pleurosigma elongatum*, *Oscillatoria limnetica* and *Prorocentrum micans*) which revealed a high PPI index value referring to high selectivity of shrimp to these species. 10 zooplankton taxa were identified with a high dominance of rotifera, representing more than 50% of the total recorded zooplankton in pond water and absence record in gut contents. These findings suggest that *L. vannamei* exhibits selective feeding behavior, preferentially ingesting certain diatom species. The high abundance of *Cyclotella glomerata* and *Prorocentrum micans* in both environments indicates their potential importance as food sources for the shrimp.

INTRODUCTION

Shrimps are the second most lucrative group in the world's fish and fish products trade. Both aquaculture and capture fishing have increased shrimp production in recent years, and shrimp consumption is steadily increasing **(FAO, 2018)**. Premium proteins, minimal fat content, and fatty acids (FA) with chemopreventive qualities make these products healthy **(López-Saiz *et al*., 2013)**.

Relatively little research has been done to look at how naturally existing food sources affect the growth and development of this commercially significant species, despite the fact that a great deal of ecological and biological research has produced a thorough understanding of its biology. Natural foods can drastically lower the expenses and dangers of synthetic feeds and are known to be essential for prawn nutrition in culture settings **(Martinez-Cordova *et al*., 1998; Cuzon *et al*., 2004)**. Since *Litopenaeus vannemei* is more efficient at using plant-based proteins, feed costs are generally reduced **(Gaxiola *et al*., 2006)**. According to **Muller-Feuga (2000)**, microalgae constitute a substantial amount of the natural output in the different aquatic systems and are crucial for raising aquatic creatures. These microalgae are also essential to the dynamics of all shrimp pond systems, including pH, alkalinity, ammonia, dissolved oxygen, and water quality. To supplement the nutrients that shrimp naturally produce, commercial pond production for aquaculture of shrimp necessitates the use of artificial feeding.

Although it is commonly known that shrimp larvae actively consume microalgae and that they are crucial to their nutrition during that life stage, it is unknown if juveniles and adults also actively consume microalgae. Research has indicated that penaeids may benefit more from the consumption of diatoms and other microalgae linked to detritus than from the debris itself **(Gleason, 1986; Stoner & Zimmerman, 1988; Dall *et al*., 1990)**.

In order to preserve the water's purity and to give phytoplankton and zooplankton species a high-quality food source for other consumers, it is beneficial for ponds and other waters to support these species. Moreover, it is imperative to clarify trends of species dominance and the likely factors governing the community structure. The purpose of this study was to provide insights into the importance of phytoplankton and zooplankton species as food sources for *Litopenaeus vannamei* aquaculture, and highlight the shrimp's preference and selectivity for different phytoplankton and zooplankton species. This information can be used to optimize feeding practices and to enhance productivity through the progressive use of these species as dietary supplements.

MATERIALS AND METHODS

Shrimp and experimental management

On 27 July, 2021, the 41600, 41600 and 35000 larvae of *Litopenaeus vannemei* at 15 days age were obtained and kept in three cement ponds with an area (1333, 1032 and 946m^2) for about 4 months (till 7 December, 2021). Before the feeding study began, they were given a commercial meal (2g of protein) to help them get used to the experimental conditions. The shrimp's original body weight was 0.8± 0.2g. Each pond was regularly aerated by two air stones. Six days a week, twice a day, the prawns were manually fed **(Hassaan *et al.*, 2019)**. The ambient temperature during the experiment is displayed in Table (1). By counting dead and moribund shrimp at the pool's edges or on the filters on the effluent gates, the survival rate of the shrimp during rearing was calculated (Table 1).

Throughout the trial period, some water physicochemical data were recorded using various instruments. This included mercury thermometers, an Orion pH meter, and a Jenway 970 dissolved oxygen meter (Table 1).

Plankton sampling and monitoring

After installation of shrimps in the ponds, water samples for optical microscope analysis were collected. The samples were collected from Lake Qarun infront of the suction pump of the farm as a reference station and from the three shrimp farm ponds. The entire pool was represented by one sample. As a result, water sampling was performed in the early hours of the morning (between 6 and 8 am, local time). During the period from August 22 to December 7, sampling was planned almost every week. Samples for phytoplankton communities (about 500ml) were collected by 1.5L Ruttner Sampler and were then transferred to glass cylinder of 500ml capacity and Lugols Iodine Solution was added **(APHA, 2005)**. The phytoplankton abundance (cells L^{-1}) was carried out using the inverted microscope, with phase contrast-Zeiss Axiovert **(Utermöhl, 1958)** magnification power 40 and 100x. Identification of the phytoplankton to genus or species level was performed when possible, according to **Hendey (1964)**, **Bourrelly (1968)**, **Krammer and Lange-Bertalot (1986, 1988, 1991)** and **Taylor *et al.* (2007)**.

Water samples for zooplankton analysis were collected using Nansen Bottles. 50L of water was collected on weekly basis and was filtered by 55µm mesh size plankton nets for systematic analyses of zooplankton. Zooplankton count was performed using a bioresearch microscope. Replicate 1 cc sub-sample was taken and the individuals of each species were separately counted, and expressed as organisms m^{-3}.

Processing of gut samples

The *L. vannamei* samples were taken from three prawn ponds used for culture. Following collection, the shrimps were kept in ice trays while their stomachs were taken out, put into separate 25ml glass vials and preserved in 10% buffered formalin. Following the digestive system's dissection and the recording of various intestinal components, the stomach contents were then examined in a lab. To learn more about this species' eating and feeding behaviors, the content was viewed under a light microscope. The food items were identified up to the species level wherever possible. After identification, Phytoplankton Preference index (PPI) was calculated for each phytoplankton species according to: PPI= (number of stomachs with a specific phytoplankton species/the number of total non-empty stomachs from phytoplankton) ×100. Three groups of phytoplankton preferences can be distinguished by the values of PPI: A particular phytoplankton species is prevalent and serves as the primary food if PP is greater than 50%. A certain phytoplankton species is secondary if 50%> PP>10%. The specific phytoplankton species is inadvertently consumed if PP is less than 10%.

RESULTS AND DISCUSSION

1. Water quality

Mean water temperature and salinity during the experimental period were determined. The values of the water quality variables (dissolved oxygen, temperature, pH, salinity, and nitrogen compounds) in the treatments were within the ranges recommended for the farming of marine shrimp in an intensive system (Table 1) **(Van Wyk, 1999; Samocha, 2019)**.

2. Composition and abundance of planktons

2.1 Phytoplankton

In the cultivated shrimp pools, a total of one hundred fifty five phytoplankton species belonging to ten classes were recorded. The most dominant and frequent classes were Bacillariophyceae, Cyanophyceae, Chlorophyceae and Dinophyceae. The dominance of Bacillariophyceae was slightly different through the ponds and lake, it ranged between 29% & 37% of total phytoplankton. Both Cyanophyceae and Dinophyceae showed a notable spatial variation of abundance while Chlorophyceae maintained a relatively small proportion in all locations with a slight increase in pond 2 (Fig. 1). Diatoms are more effective than cyanobacteria at promoting growth, according to **Boyd (1989)**. While cyanobacteria predominate in ponds with lower salinities in temperate waters, diatoms are the main phytoplankton group in brackish waters, according to **Boyd (1989)**, which is why most shrimp farm managers want a high ratio of diatoms in a phytoplankton community.

In the current study, weekly monitoring of three shrimp pools revealed notable variations in the dominant phytoplankton species, which followed a complex pattern of increasing and declining phases. In the ponds under study, the most prevalent phytoplankton species were *Cyclotella glomerata*, *C. ocellata*, *Nitzschia longisima* and *Prorocentrum micans*. However, these diatom species are considered as cosmopolitan species surviving through a wide range of nutrient levels though they prefer mesotrophic environments. While, the dinoflagellates seemed to prefer higher light levels with less turbidity and fewer nutrients. In consequence, the absence of cyanophyta bloom denies the symptoms of heavy eutrophication. In coastal waters, however, centric diatoms have been deemed the most desirable phytoplankton **(Ryther & Officer, 1981)** due to their significance as food items for higher consumers **(Boyd, 1990)**.

Table 1. Growth performance and feed utilization of the shrimp with measured water parameters

		PL (age)	Feeding %	% survival	IN Shrimp	BW (g)	Daily feed (Kg)	p H	^{0}C	PSU (Salinity)	TDS Mg/L	DO Mg/L	Cond. mS/cm	Notice
Pond 1	Week 1	15	0		41600	0.8	0	7.4	32	34.4	34	4.7	54	
		16	6		41600		2 kg/p	7.39	32	34.5				
		20	5	98	40768	1	2 kg/p	7.4	32	35				
		23	5				2 kg/p	7.5	33	34				
	Week 2	27	5				2 kg/p	7.44	32	33.5				
		30	5				2 kg/p	7.53	32	34.5				
		34	5				2 kg/p	7.5	31	34				
	Week 3	35	5				2 kg/p	7.5	33	35				
		37	5				2 kg/p	7.5	32	35.5				
		41	5	80	33280	2.5	4kg/ p	7.6	31	36				
	Week 4	55	5	75	31200	5	8 kg	7.79	29	36.5	24	4.7	47	
		58	5				8 kg	8.18	29	37	27	4.7	55	
		60		0	0	0	0	7.79	30	36.5	28	4.7		shrimp moulting process. Do not feed
	Week 5							8.18	29	37	26	4.1		
		61	5				8 kg	6.99	31	37.1	28	4.7	56	
		65	5				8 kg	8.2	28	35.5	29	4.1	50	
	Week 6	70	5				8 kg	8.4	31	35	26	4.5	52	
		72	8	60	24960	6	12	7.61	27	34.7	26	4.6	52	
		76	8				12	8.8	26	35.2	25	4.6	50	
		90	8				12	8.4	28	36.7	30	4.9	56	
		93	8				12	8.5	28	35.1	27	4.3	54	
	Week 7	97	8				12	8.6	29					
		100	8				12	8.5	28					
		104	8				12	8.51	27					

		107	8				12	8.4	27	35	27	4.5	52	
		111	8				12	8.45	28					
	Week 8	114	5	20	8320	20	8	8.41	28					
		118	5				8	7.9	28	35.5				
		121	5				8	8.1	28					
		128	5				8	8.33	27					
		135	5				8	8.41	29	36.5	27	4.2	55	
		136				25.2								shrimp fishing
Pond 2	Week 1	15	0		41600	0.8		7.53	27	34.3	36	4.7		
		16	6		41600			8.39	26	37.1	28	4.7	56	
		20	5	90	37440	1	2	8.1	27	37.5	28	4.3		
	Week 3	30	5	85	35360	1.8	3	8.3	28	38		4.1		
		34	5					8.33	28	37.3		4.5		
		32	5					8.37	27	37.9		4.3		
		37	5					8.5	28	37.6		4.2		
		41	5	80	33280	3	5	8.5	29	38		4.2		
	Week 4	58	5	78	29203	5	7.3	8.38	29	38.1	29	4.8	56	
		61	5					8.5	29	40	27	4.7	55	no. dead shrimp
		64	5					8.18	29	37	28	4.7		
	Week 5	69	5					7.46	27	37	27	4.6	56	
		71	8	70	29120	6	13.9	8.18	29	37	28	4.7		
		74	8					7.53	27	34.3	27	4.7	52	
	Week 6	84	8					8.37	26	36.3	27	4.5		
		88	8	40	16640	15	14.9	8.5	29	36.8	27	3.5	57	
	Week 7	112	3	30	12480	20	7.5	8.9	29	37	28	3.8	56	
		116	3				8	8.3						
		119	3				8	8.2						
	Week 8	134	3				8	8.5						
		137	3	10	4160		8	8.3						
		140	3				8	9.06	19	32.3	25	4.8	84	

		144				30								shrimp fishing
Pond 3	Week 1				35000			7.4	30	37	28	4.6		
		16	6		35000		2 kg/p	7.5	30	37.1	28	4.7		
		20	5	90	31500	1	2 kg/p	7.4	31	37.5				
	Week 2	23	5				2 kg/p	7.4	32	38	29	4.9	57	
		41	5	50	17500	2.5	4kg/ p	7.8						
	Week 3	55	5			3	8 kg	7.9						
		58	5				8 kg	8.1	35	36.1	27	4.7	57	
		61	5				8 kg	8.4	32	34.6	26	4.9		
		65	5				8 kg	7.59	31	34.5	26	4.7		
	Week 4	70	5				8 kg	8.85	29	37	28	3.8	56	
		72	12	30	10500	5	6.5	8.5	28	36.1	27	4.6	50	
		76	8				6.5	7.61	27	34.7	26	4.6		
		107	8				6.5	8.5	29	36.8	27	3.5	57	
	Week 5	114	5	20	7000	13	4	8.4		38				
		118	5				4	8.4		37.5				
		121	5				4	8.5	27	375	27	4.5	53	
	Week 6	128	5				4	8.42		38				
		135	5				4	8.38		38.1				
	Week 7	144	5						19	33	25	4.8	94	
		151				15								shrimp fishing

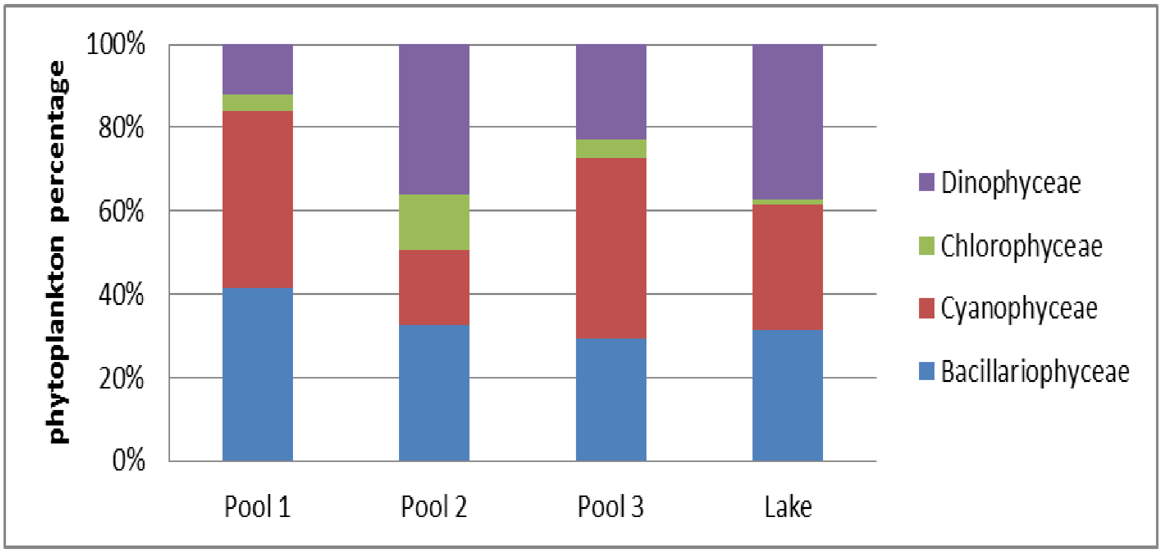

Fig. 1. The recorded phytoplankton classes composition percentage in Qarun Lake and three cultivated shrimp pools

The frequencies of the above phytoplankton species in the studied cultivated ponds scarcely affected phytoplankton species diversity, with an average value on all ponds and the lake of 3.36, varying from 1.69 to 5.24 (Fig. 2). The three studied ponds favored an irregular abundance of some species during late weeks, showing that the ponds present low species number, diversity and low evenness. Hence, this system may support in some period highly diverse algal communities less likely to collapse than blooms dominated by one species **(Smith, 1985)**. During this period, the trophic condition can support the eutrophic species as Cyanophyta species which favor the high N/P ratio in water.

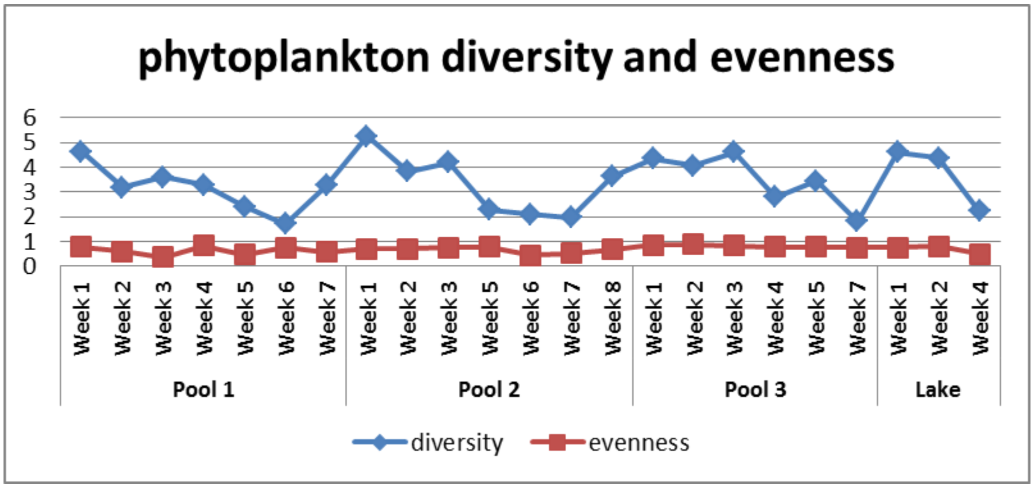

Fig. 2. The recorded phytoplankton evenness and diversity in Qarun Lake and three cultivated shrimp pools

Phytoplankton abundance in Pond 1 ranged from 151.25 to 2084.7 × 10^5 cells/L, in Pond 2 from 313.87 to 2146.5 × 10^5 cells/L, while Pond 3 exhibited the lowest abundance with ranges from 74.03 × 10^5 cells/L to 422.56 × 10^5 cells/L (Fig. 3). The initial mortality episodes were accompanied by a decline in cell abundance. After a subsequent surge, another decline was observed, marking the onset of the chronic mortality period. Diatoms and Cyanophyta were generally responsible for the high densities in Ponds 1 and 2, with species blooms such as *Cyclotella glomerata* and *Oscillatoria limnetica*, reaching values over 1276 × 10^5 cells/L and 715 × 10^5 cells/L, respectively.

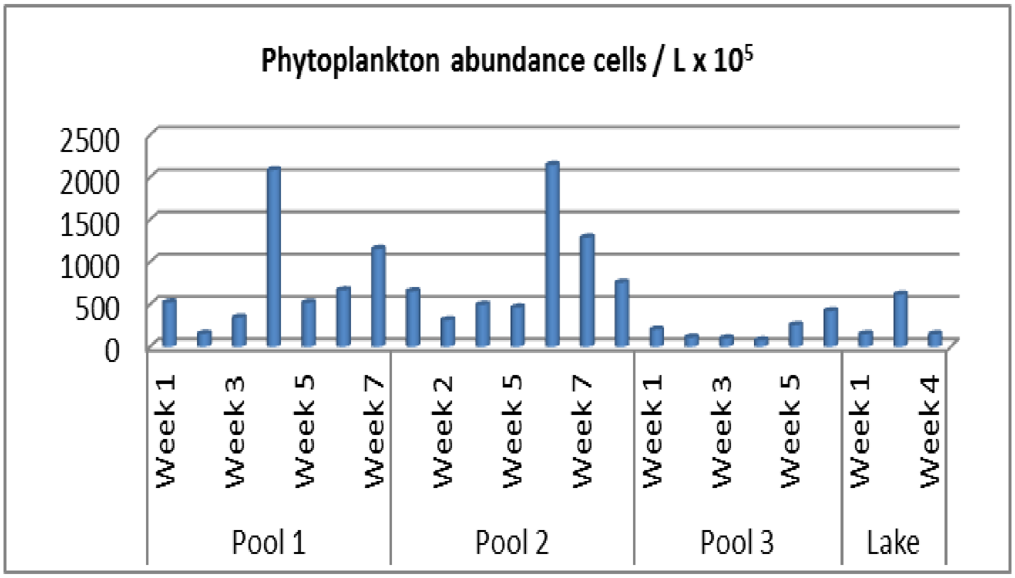

Fig. 3. The total recorded phytoplankton abundances in Qarun Lake and three cultivated shrimp pools

Other algae species with high densities were *Gomphosphaeria aponina*, *Nitzschia longisima* and *Prorocentrum micans*. However, blooms of *Prorocentrum micans* dominate Ponds 2 and 3 during week 7 and are responsible for most phytoplankton densities. Because these phytoplankton populations are present, less water exchange is required, which undoubtedly lowers shrimp production costs. According to other investigations, the cultivated organisms were not harmed by the diminution or even the suppression of water exchange.

2.2 Zooplankton

In the study, a total of 10 zooplankton taxa were identified, including 1 protozoan, 3 rotifers, 1 copepod, and 5 other forms (Table 2 & Fig. 4). Rotifera was the most dominant group, representing more than 50% of the total recorded zooplankton density in the studied samples. *Brachionus plicatilis* represented mostly more than 50%. It constituted 45.46% of total zooplankton number at the reference station. The percentages of the zooplankton density in the shrimp farm ponds P#1, P#2, and P#3 were very high than the reference station (88.96, 82.65, 54.21%, and 1.13%, respectively). The highest shrimp yield correlated with the highest *B. plicatilis* density. **de Andrade *et al.* (2021)** found that the addition of the rotifer *B. plicatilis* as supplemental feed during the nursery phase of shrimp improved the final weight and yield. It led to better performance variables, indicating the benefit of these organisms as a natural food source for *Litopenaeus vannemei* post larvae. *B. plicatilis* may also have an antibacterial effect, as microalgae commonly used with rotifer feeds produce metabolites that can potentially be converted into bioactive antibacterial compounds **(Farisa *et al*., 2019; Sahandi *et al*., 2020)**.

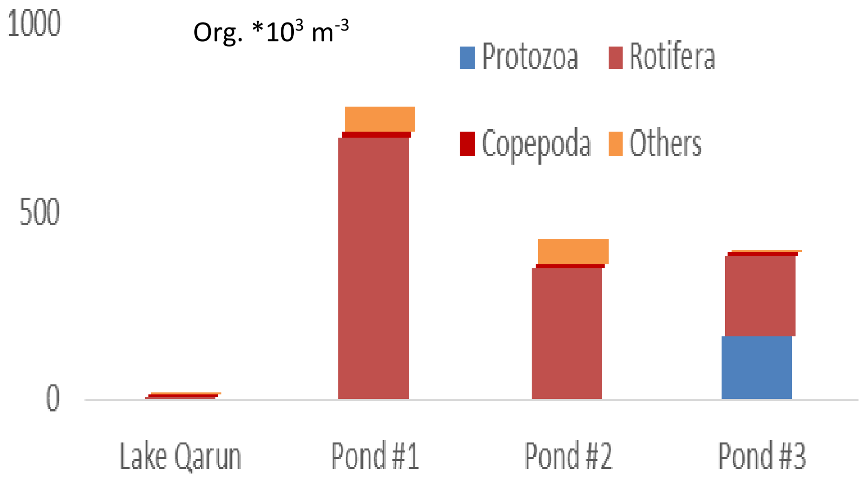

Fig. 4. Zooplankton density (org. *10^3 m^{-3}) at the reference station and in the shrimp farm ponds during the study

The weekly change in zooplankton density is more or less similar in the three ponds with high density in the first pond, especially after six weeks of shrimp culture (08 of September). Molt status in shrimp is a critical factor in aquaculture. It has been reported that during this period, energy for sustainment comes only from endogenous material **(Sahandi *et al.*, 2020)**. The maximal feeding activity was during intermolt. Therefore, the lowest zooplankton density was recorded pre and post molt (Fig. 5).

Table 2. Frequency of the recorded zooplankton taxa at the reference station and in the shrimp farm ponds during the study

	Lake water	Pond #1	Pond #2	Pond #3
Protozoa				
Euoplots sp.	0.00%	0.00%	0.00%	41.79%
Rotifera				
Brachionus plicatilis	45.46%	88.96%	82.65%	54.21%
Keratella cochlearis	0.00%	0.06%	0.00%	0.00%
Lecane luna	0.00%	0.09%	0.00%	0.00%
Copepoda				
Nauplius larvae	9.09%	0.67%	0.62%	1.49%
Calanoid copepodites	9.09%	0.95%	1.12%	0.60%
Acartia latisetosa	9.09%	1.01%	0.45%	0.12%
Other forms				
Cirripid larvae	18.18%	7.28%	13.14%	1.43%
Zoae larvae	0.00%	0.03%	0.00%	0.12%
Polychaete larvae	4.55%	0.31%	1.85%	0.06%
Veliger larvae	0.00%	0.00%	0.06%	0.00%
Nematoda	4.55%	0.64%	0.11%	0.18%
Total zooplankton number (org. m^{-3})	18,335.5	778,758.1	424,555	398,856
% To total zooplankton number	1.13%	48.06%	26.20%	24.61%
Production of shrimp (g/m^3)	-	72.02	58.14	31.71

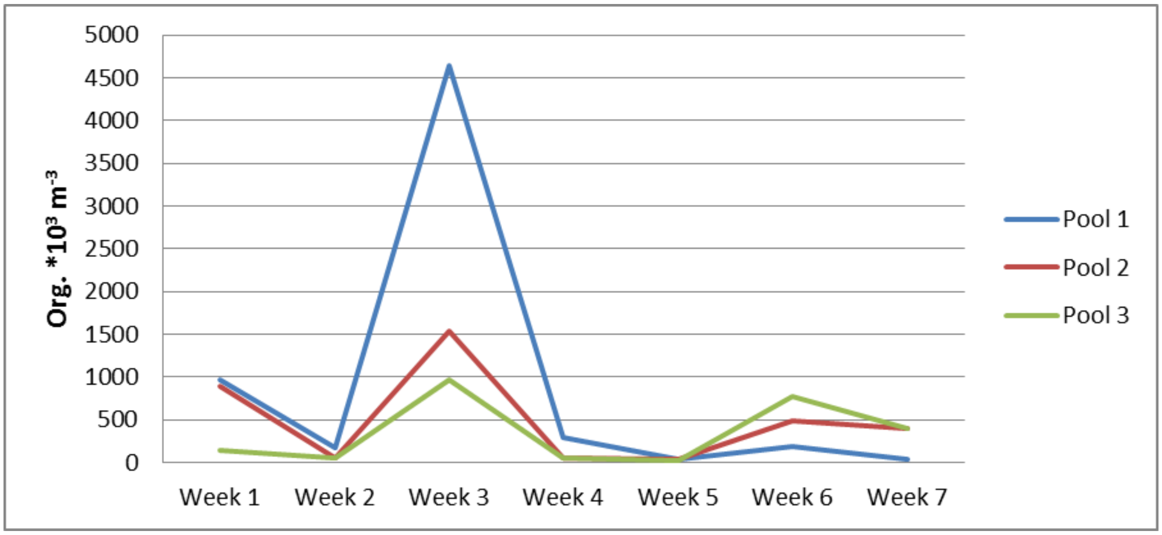

Fig. 5. Weekly changes in total zooplankton counts (org. x10^3 m^{-3}) in the shrimp ponds during the study

3. Composition of food items in shrimp gut

The feeding habit of *Litopenaeus vannemei* is demonstrated by a variety of food items detected in its stomach. The intestine of *L. vannemei* contains a variety of food items, including mud, phytoplankton, decomposing organic waste, and other materials. Zooplankton was definitely absent from shrimp gut content reflecting an herbivorous feeding habit. Knowing how microalgae function in *L. vannamei*'s diet could help with better culture management of this species by revealing the kinds of microorganisms that these shrimps prefer to use in culture systems. The phytoplankton species observed in the gut belong to sex classes, Bacillariophyta, Cyanophyta, Dinophyta, Chlorophyta, Euglinophyta and Crysophyta. The last two mentioned groups were rarely observed in the gut contents contributing less than 1% of total phytoplankton in only three samples. In spite of the high abundance of all these groups in pool water, the clear dominance (average abundance 48.4 %) of Cyanophyta in most gut samples were observed, which reflects the evidence of shrimp "selectivity" for food. The most observed Cyanophyta species in the gut contents were *Lyngbya limnetica, L. majuscule, Oscillatoria fermosa, O. limnetica* and *Spirulina major*. However, this dominance might potentially be more strongly linked to low aquatic brightness than to the increase of nutrients **(Scheffer *et al.*, 1997)**. Cyanobacteria dominance is another stable-state of a phytoplankton community in shallow aquatic systems, according to data from a few lakes linked to mathematical models.

The second dominance rank was occupied by Bacillariophyta which represents an average of 24.4% of total phytoplankton, followed by Dinophyta with an average abundance of 19.1% (Fig. 6). However, this preference of shrimp to these species was also revealed through the PPI index values, as listed in details in Table (3).

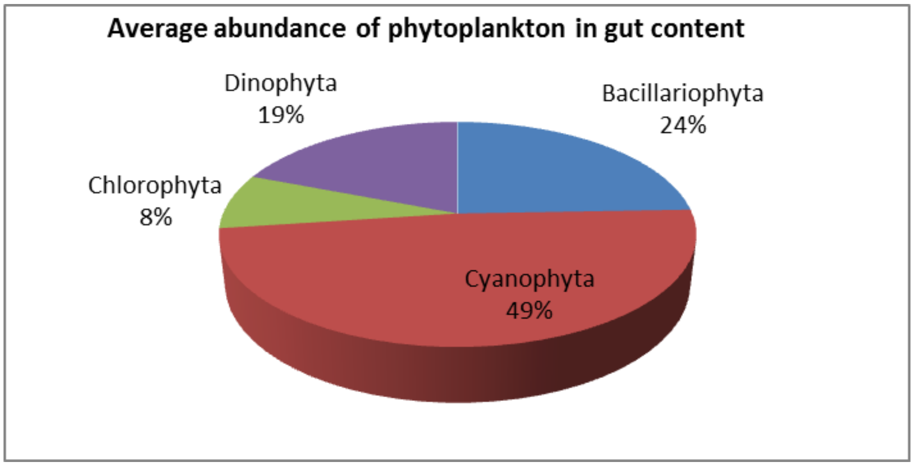

Fig. 6. The recorded phytoplankton average abundance in gut content of shrimp

Table 3. Phytoplankton Preference index (PPI) for recorded phytoplankton species in the gut of *Litopenaeus vannamei* in cultivated pools

	Phytoplankton species	PPI%			
		Pool1	**Pool2**	**Pool3**	**Average**
1	*Achnanthidium minutissimum* (Kützing) Czarnecki	18.18	18.75	0	12.31
2	*Achnanthes* sp.	0	6.25	0	2.083
3	*Amphora coffeaeformis* (C.Agardh) Kützing	0	0	6.667	2.222
4	*Amphora spectabilis* W.Gregory	18.18	0	0	6.061
5	*Amphora* sp.	0	18.75	13.33	10.69
6	*Amphora veneta* Kützing	0	6.25	6.667	4.306
7	*Anabaena circinalis* Rabenhorst ex Bornet & Flahault	0	6.25	0	2.083
8	*Chaetoceros* sp.	18.18	0	0	6.061
9	*Chlorella vulgaris* Beijerinck	18.18	25	33.33	25.51
10	*Closterium gracile* Brébisson ex Ralfs	0	6.25	0	2.083
11	*Coscinodiscus radiatus* Ehrenberg	0	12.5	6.667	6.389
12	***Cyclotella glomerata* Bachmann**	27.27	75	46.67	49.65
13	*Cyclotella ocellata* [*Pantocsekiella ocellata* (Pantocsek) K.T.Kiss & Ács	18.18	6.25	0	8.144
14	*Cyclotella striata* (Kützing) Grunow	18.18	6.25	0	8.144
15	*Cymbella microcephala* Grunow	0	6.25	0	2.083

16	***Cymbella* sp.**	45.45	75	46.67	55.71
17	*Craticula* sp.	0	0	26.67	8.889
18	*Dinobryon* sp.	0	25	0	8.333
19	*Euglena acus* (O.F.Müller) Ehrenberg	0	6.25	0	2.083
20	*Euglina* sp.	0	6.25	0	2.083
21	*Eutreptiella* sp.	9.091	0	0	3.03
22	*Fragilaria construens* (Ehrenberg) Grunow (ab)	9.091	6.25	13.33	9.558
23	*Fragilaria ulna* *[Ulnaria ulna* (Nitzsch) Compère	9.091	0	0	3.03
24	*Gomphonema parvulum* (Kützing) Kützing	9.091	0	0	3.03
25	*Gunardia* sp.	0	6.25	0	2.083
26	*Gonyaulax spinifera* (Claparède & Lachmann) Diesing	0	0	6.667	2.222
27	*Gyrosigma attenuatum* (Kützing) Rabenhorst	0	6.25	26.67	10.97
28	***Lyngbya limnetica* *[Planktolyngbya limnetica* (Lemmermann) Komárková-Legnerová & Cronberg**	0	50	53.33	34.44
29	*Lyngbya majuscula* Harvey ex Gomont	36.36	43.75	13.33	31.15
30	*Lyngbya* sp.	9.091	0	6.667	5.253
31	*Navicula digitoradiata* (W.Gregory) Ralfs	0	6.25	0	2.083
32	*Navicula erifuga* Lange-Bertalot	27.27	43.75	40	37.01
33	*Navicula harderii* Hustedt	0	0	6.667	2.222
34	*Navicula huefleri* v. leptocephali	0	6.25	0	2.083
35	*Navicula recens* (Lange-Bertalot) Lange-Bertalot	0	6.25	0	2.083
36	*Navicula* sp.	0	43.75	20	21.25
37	*Navicula* sp.	0	0	6.667	2.222
38	*Nitzschia closterium* (Ehrenberg) W.Smith	9.091	25	0	11.36
39	*Nitzschia filiformis* (W.Smith) Van Heurck	18.18	31.25	13.33	20.92
40	*Nitzschia obtusa* W.Smith	27.27	18.75	0	15.34
41	*Nitzschia palea* (Kützing) W.Smith	18.18	31.25	46.67	32.03
42	*Nitzschia prolongata var. hoehnkii* (Hustedt) Lange-Bertalot	18.18	0	6.667	8.283
43	*Nitzschia* sp.	0	0	6.667	2.222

44	*Noctiluca scintillans* (Macartney) Kofoid & Swezy	0	6.25	6.667	4.306
45	*Oocystis borgei* J.W.Snow	9.091	6.25	0	5.114
46	***Oscillatoria fermosa***	18.18	56.25	40	38.14
47	*Oscillatoria limnetica* [*Pseudanabaena limnetica* (Lemmermann) Komárek	27.27	62.5	13.33	34.37
48	*Oscillatoria lutea* C. Agardh	0	0	6.667	2.222
49	*Oscillatoria tenuis* C.Agardh ex Gomont	0	18.75	0	6.25
50	*Phacus* sp.	18.18	0	13.33	10.51
51	*phormedium* sp.	0	18.75	33.33	17.36
52	*Pinularia* sp.	9.091	0	0	3.03
53	***Pleurosigma elongatum* W.Smith**	36.36	50	0	28.79
54	*Pleurosigma diverse-striatum* F. Meister	0	6.25	0	2.083
55	*Prorocentrum balticum* (Lohmann) Loeblich III	45.45	37.5	46.67	43.21
56	*Prorocentrum compressum* *Tryblionella compressa* (Bailey) Poulin	0	0	26.67	8.889
57	*Prorocentrum gracile* F.Schütt	9.091	0	0	3.03
58	*Prorocentrum lima* (Ehrenberg) F.Stein	27.27	18.75	6.667	17.56
59	***Prorocentrum micans* Ehrenberg**	72.73	56.25	93.33	74.1
60	*Spirulina* sp.	18.18	18.75	0	12.31
61	*Spirulina major* Kützing ex Gomont	0	12.5	20	10.83
62	*Spirogyra* sp.	0	6.25	0	2.083
63	*Scenedismus* sp.	0	6.25	0	2.083

****Bolded species represent highest PPI***

Cyclotella glomerata, *Cymbella* sp., *Navicula erifuga*, *Nitzschia obtusa*, *N. palea*, and *Pleurosigma elongatum* were the most frequent diatoms found in the shrimp gut. Among the Dinophyta, *Prorocentrum micans* was the most frequently recorded species, appearing in 74% of the gut samples. It dominated some samples, especially in the gut contents of shrimp from Pond 3, where it made up to 76% of the total phytoplankton.

Cyclotella glomerata, *Oscillatoria limnetica*, and *Prorocentrum micans* were not only dominant in the pond water samples but also in the shrimp gut. These species are nutritionally valuable to shrimp, as they are rich in fatty acids such as palmitic acid, palmitoleic acid, stearidonic acid, eicosapentaenoic acid, and docosahexaenoic acid. Even though the abundance of *Spirolina major*, *Nitzschia obtusa*, *N. palea*, and *Pleurosigma* *elongatum* in the water was relatively low, their high concentrations in the gut samples suggest a nutritional selectivity by *Litopenaeus vannamei*.

Diatoms store a significant amount of nutrients due to their large surface area to volume ratio, large vacuole size, and high production rates **(Raven & Beardall, 2016)**. This allows them to thrive even in nutrient-poor conditions. Moreover, their small size enables them to flourish in environments with less mixing, making them an ideal food source for shrimp.

CONCLUSION

This study examined the composition and abundance of plankton communities, including both phytoplankton and zooplankton, within shrimp ponds and their potential impact on shrimp growth and survival. A diverse array of phytoplankton species was observed, with *Bacillariophyceae*, *Cyanophyceae*, *Chlorophyceae*, and *Dinophyceae* being the most dominant groups. While diatoms are generally considered beneficial for shrimp growth, their dominance varied across different ponds. Cyanobacteria, although potentially problematic in some cases, were also observed in significant numbers.

The study revealed notable spatial and temporal variations in phytoplankton abundance and composition. Blooms of certain species, such as *Cyclotella glomerata*, *Oscillatoria limnetica*, and *Prorocentrum micans*, were observed in some ponds, potentially affecting water quality and shrimp health.

Zooplankton communities were predominantly composed of rotifers, especially *Brachionus plicatilis*, which is considered a valuable food source for shrimp larvae. Zooplankton abundance fluctuated throughout the shrimp culture cycle, with peak densities observed during periods of active shrimp feeding.

Analysis of shrimp gut contents revealed a preference for certain phytoplankton species, suggesting a selective feeding behavior. Cyanobacteria were the most dominant group found in shrimp guts, likely reflecting their abundance in the water column or selective ingestion by the shrimp. The dominance of cyanobacteria may also be linked to low water clarity, which can promote their growth.

In conclusion, the study highlights the complex interactions between plankton communities, water quality, and shrimp growth, with shrimp exhibiting a selective feeding behavior, preferentially ingesting certain phytoplankton species.

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