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Plankton Density and Diversity in *Litopenaeus vannamei* Culture Ponds of Haryana

Khushbu Sharma, Rachna Gulati, Karuna Bamel, Sushma Singh, Poonam Devi

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ABSTRACT

Present paper deals with the study of plankton density and diversity in *Litopenaeus vannamei* ponds in eleven districts of Haryana and their correlations with physico-chemical characteristics of water. The present study showed significant positive correlations with Dissolved Oxygen (0.874), pH (0.813), Ammonia (0.656), Alkalinity (0.635), Nitrate (0.635), Biochemical Oxygen Demand (0.634), and negative correlation with Hardness (-812), Turbidity (-0.805), Nitrite (-0.777), Temperature (-0.722), Total Dissolved Solid (-0.622), and Salinity (-0.608). Forty species of phytoplankton belong to seven classes Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Trebouxiphyceae, Zygenematophyceae, Euglenophyceae, and twenty-five species of Zooplanktons belonging to six classes viz. Tintinnida, Copepoda, Cladocera, Rotifera, Decapoda, and Meroplankton were recorded. The highest plankton density was recorded from *Litopenaeus vannamei* culture ponds of Hisar (126,000/m^3), and the minimum at Kaithal (50,000/m^3). For phytoplankton, Simpson and Shannon-Weiner index for the phytoplankton varied between 3.4-3.2 and 0.964-0.948 per individual. The Simpson and Shannon-Weiner species diversity index for the Zooplankton varied between 0.942- 0.911 and 2.93- 2.65 per individual that indicating high plankton diversity and density in *Litopenaeus vannamei* ponds of Haryana.

Keywords Diversity, Haryana, *Litopenaeus vannamei,* Physico-chemical, Plankton.

INTRODUCTION

Aquaculture has grown quickly over three decades and has become a significant global economic activity. The demand for cheap protein sources has been the main force propelling the aquaculture business ahead (Welcomme and Bartley 2021). Shrimp farming is a key aquaculture industry that is garnering significant investment both globally and in India due to its higher economic returns (Lakra and Krishnani 2022). Furthermore, of all cultivable shrimp species, *Litopenaeus vannamei* alone contributes more than 80% of global output and the culture of this species is nearly outcompeting the usage of other cultivable shrimp species for production (Khushbu *et al.* 2022a). The profitability of shrimp farming is mainly dependent

Khushbu Sharma[1]*, Rachna Gulati[2], Karuna Bamel[3], Sushma Singh[4], Poonam Devi[5]

[1,3,4,5] Department of Zoology and Aquaculture, [2]Aquatic Animal Health Management

Chaudhary Charan Singh Haryana Agriculture University, Hisar 125004, Haryana
Email: Khushbu181997@gmail.com
*Corresponding author

on feed input costs, which may be decreased to a larger extent by increasing pond organic productivity, particularly plankton productivity, which includes phytoplankton and zooplankton assemblages (Cheng *et al.* 2020). The phytoplankton in the shrimp culture system would also help to maintain the water quality parameters necessary for better survival by assimilating the accumulated nutrients through feed in the pond water as well as in the sediments, producing enough dissolved oxygen through photosynthesis for the culture species as well as for the microbes to decompose the organic matter, and serving as natural food (Tharik *et al.* 2021). If the culture pond has high biomass of these phytoplanktonic assemblages, it will favor the multiplication of herbivorous zooplankton, particularly copepods, which will form a very good protein-rich live food organism (50-75 % protein on a dry weight basis) for the larval and juvenile shrimps in the ponds (Gamboa - Delgado 2022). On the other hand, the blooming of harmful phytoplankton species in shrimp culture ponds, particularly dinoflagellate species is known to cause stress to phytoplankton and zooplankton feeding (Khushbu *et al.* 2022b). The blooming of toxic algae is also known to impair shrimp eating, and growth and increase shrimp illness susceptibility (Turner *et al*. 2021). Plankton diversity varies from place to place and from pond to pond in the same site with similar biological circumstances (Bambang *et al.* 2021). As a result, managing water quality parameters to achieve optimal plankton growth in shrimp ponds is critical. With this view in mind, the present study was planned to observe the plankton density and diversity of *Litopenaeus vannamei* pond in Haryana.

MATERIALS AND METHODS

The study was carried out in eleven districts (Hisar, Fatehabad, Sirsa, Jind, Jhajjar, Faridabad, Rohtak, Bhiwani, Gurugram, Kaithal, and Dadri) of Haryana (Fig 1) in relation to plankton diversity, density and water parameters such as pH, temperature, salinity, alkalinity, hardness, total dissolved solids (TDS), Dissolved oxygen (DO), Turbidity, Biochemical Oxygen Demand (BOD), Nutrients (Ammonia-N, Nitrate-N, Nitrite-N).

Water sample analysis : Surface water samples were collected in clean plastic bottles from the different areas of the pond. Temperature and pH were measured by using a laboratory thermometer and pH meter, respectively. Biochemical Oxygen Demand (BOD)

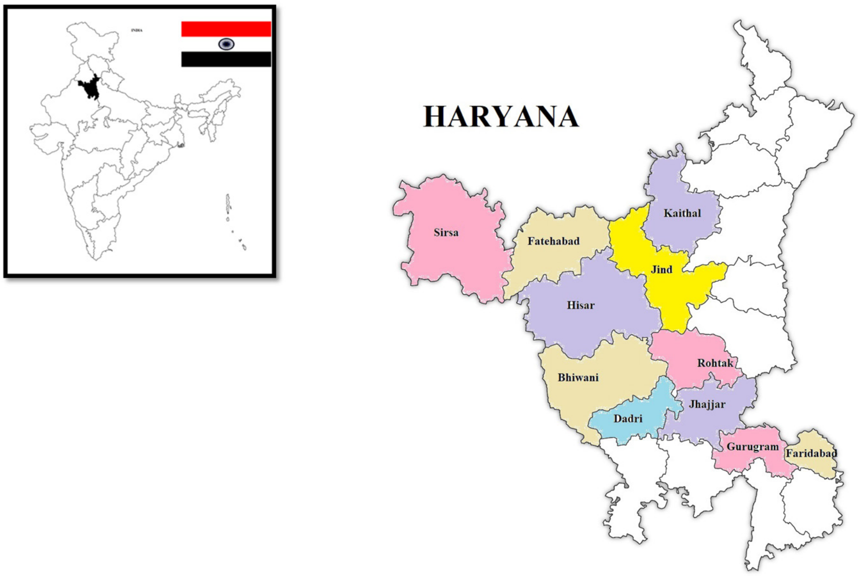

Fig. 1. Sampling sites in Haryana.

was calculated using Ramadhas and Santhanam's methodology (1996), Total dissolved solids (TDS), Salinity by the microprocessor, Dissolved oxygen by Winkler method, and Turbidity by using the Secchi disk. The other water parameters like Hardness and Alkalinity were measured by using the standard titration method (APHA 2017). The water samples were filtered using filter paper and analyzed for Nitrite, Nitrate, and Ammonia using API kits.

Plankton analysis: A hand plankton net constructed of bolting silk (mesh size 30 and aperture size 41) was used to gather plankton samples from the surface water. The plankton samples were collected by filtering 50 liters of surface water with hand plankton net (Santhanam *et al.* 1994). The obtained samples were stored in 5% formalin at the sample collecting location for further laboratory examination. The species composition and density of the obtained plankton samples were determined in the laboratory. A standardized light Microscope at 10 and 40X (Model Magnus MX21iLED) was used to examine the composition and density. The plankton sample was prepared to a known volume, and a sub-sample of 1 ml was obtained in a Sedgwick-Rafter counting cell, which was then moved to a microscope equipped with a counting stage, as described by Dutta (2005). The phytoplankton and zooplankton densities were represented as cells per liter and numbers per m3, respectively. Two counts were performed on each plankton sample, and the average was recorded. The quantitative measurement of phytoplankton and zooplankton was carried out using Santhanam and Srinivasan (1994). The keys of Kasturirangan (1963), Newell and Newell (1988), and Santhanam *et al.* (1993) were used to identify various phytoplankton and zooplankton species.

Species diversity: Species diversity was calculated using Dominance, Simpson dominance, Shannon-Weiner's function, Margalef index, and Berger parker index.

RESULTS

The plankton density was found to vary between 50000-126,000/m^3. The highest plankton density was recorded at Hisar (126000) followed by Fatehabad (118000), Jhajjar (110000), Bhiwani (104000), Rohtak (86000), Faridabad (86000) Sirsa (80000) Dadri (70000), Jind (64000), Gurugram (60000) and the minimum at Kaithal (50000). The plankton density showed significant positive correlation with DO (0.874), pH (0.813), Ammonia (0.656), Alkalinity (0.635) and Nitrate (0.635), BOD (0.634), and negative correlation with Hardness (-812), Turbidity (-0.805), Nitrite (-0.777), Temperature (-0.722), TDS (-0.622), and Salinity (-0.608) (Table 1).

Table 1. Correlation between plankton density with hydrological parameters at different districts.

Water parameters Pd (Plankton density)	Pd	pH	Temp	DO	Hardness	Salinity	Alkalinity	Ammonia	Turbidity	TDS	BOD	Nitrite	Nitrate
pH	0.813**												
Temp	-0.722**	-0.836**											
DO	0.874**	0.703**	-0.863**										
Hardness	-0.812**	-0.603*	0.350^{NS}	-0.551^{NS}									
Salinity	-0.608*	-0.877**	0.924**	-0.679*	0.256^{NS}								
Alkalinity	0.635*	0.913**	-0.864**	0.653*	-0.396^{NS}	-0.936**							
Ammonia	0.656*	0.665*	-0.579*	0.630*	-0.703**	-0.534^{NS}	0.705**						
Turbidity	-0.805**	0.934**	-0.784**	0.673*	-0.647*	-0.868**	0.894**	0.737**					
TDS	-0.622*	-0.842**	0.651*	-0.505^{NS}	0.574*	0.738**	-0.827**	-0.860**	-0.877**				
BOD	0.634*	0.786**	-0.822**	0.726**	-0.488^{NS}	-0.774**	0.835**	0.887**	0.775**	-0.885**			
Nitrite	-0.777**	-0.670*	0.655*	-0.778**	0.654*	0.539^{NS}	-0.641*	-0.916**	-0.702**	0.793**	-0.867**		
Nitrate	0.635*	0.669*	-0.546^{NS}	0.583*	-0.680*	-0.520^{NS}	0.671*	0.979**	0.728**	-0.892**	0.892**	-0.924**	

*Correlation is significant at the 0.05 level. **. Correlation is significant at the 0.01 level.

Table 2. Phytoplankton diversity of shrimp pond at different districts of Haryana.

Class	Plankton	Number of phytoplankton per district										
		Hisar	Fatehabad	Bhiwani	Rohtak	Jind	Kaithal	Fardidabad	Gurugram	Dadri	Jahjjhar	Sirsa
Bacillariophyceae	*Navicula* sp.	45	60	27	11	39	33	47	30	5	25	9
	Pinnularis microstauron	63	15	23	23	0	4	44	17	4	24	0
	Bacillaria sp.	48	15	43	9	51	37	19	15	6	18	11
	Chaetoceros peruvianus	27	25	51	4	9	11	1	34	5	15	9
	Coscinodiscus eccentricus	39	26	10	16	5	9	8	33	23	34	23
	Diploneis sp.	51	2	0	5	3	0	9	39	25	27	19
	Gyrosigma balticum	7	5	21	33	0	4	7	23	22	39	33
	Nitzschia closterium	0	4	0	0	5	9	11	43	14	18	4
	Thalassiothrix sp.	4	13	25	32	27	19	32	25	45	51	37
	Diatoma sp.	29	1	15	2	4	1	12	36	9	33	5
	Asteromphalus sp.	23	0	12	1	3	1	10	29	5	25	3
Chlorophyceae	*Actinotaenium cucurbitinum*	10	44	22	39	39	40	26	7	35	4	33
	Pediastrum tetras	2	38	11	5	24	35	22	5	14	11	22
	Scendesmus bijunga	1	12	5	33	10	17	7	5	5	5	7
	Kirchneriella lunaris	0	10	0	8	7	9	3	2	2	2	5
	Volvox sp.	8	9	0	7	6	8	5	0	4	2	5
	Oedogonium sp.	0	0	0	0	0	0	1	0	0	0	0
	Anabaena sp.	1	28	18	25	10	17	9	8	35	17	9
	Aphanizomenon flosaquae	1	0	0	0	1	0	0	1	17	4	8
	Cylindrospermopsis raciborskii	8	34	27	32	25	25	7	5	9	24	20
	Microcystis sp.	22	31	8	26	4	22	1	2	18	36	27
	Oscillatoria limosa	53	50	54	48	25	11	13	3	0	42	38
	Spirulina sp.	38	26	26	25	15	11	9	7	27	15	12
	Nostoc sp.	0	0	0	0	1	1	3	5	1	0	0
Dynophyceae	*Ceratium extensum*	24	14	9	12	5	7	1	6	8	23	34
	Pyrophacus horologicum	20	17	27	14	15	10	2	9	25	11	9
	Procentrum sp.	25	26	26	25	15	11	9	7	27	15	12
	Dinophysis caudata	28	40	22	35	18	10	5	25	20	45	12
	Peridinium sp.	28	25	32	32	14	9	4	42	24	30	0
Trebouxiophyceae	*Botryococcus* sp.	22	31	8	26	4	22	1	2	18	36	27
	Chlorella sp.	53	50	54	48	25	11	13	3	0	42	38
	Nephrocytium agardhianum	18	9	25	0	22	0	8	3	21	44	42
	Oocystis sp.	22	31	8	26	4	22	1	2	18	36	27
	Micoactinum sp.	0	12	0	28	10	0	21	12	0	0	0
Zygnematophyceae	*Closterium* sp.	53	50	54	48	25	11	13	3	0	42	38
	Cosmarium depressum	38	26	26	25	15	11	9	7	27	15	12
	Gonatozygon sp.	53	50	54	48	25	11	13	3	0	42	38
	Sphaerozosma sp.	38	26	26	25	15	11	9	7	27	15	12
	Zygnema sp.	11	17	27	14	15	10	2	9	25	11	9
Euglenophyceae	*Phacus* sp.	12	10	5	4	25	12	13	0	0	15	0
	Total	925	822	801	794	565	492	430	514	570	893	649

Phytoplankton composition

In the present study, a total of 40 species of phytoplankton from the classes Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Trebouxiphyceae, Zygenematophyceae, and Euglenophyceae were recorded from the eleven districts of Haryana (Table 1). Irrespective of districts, Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Trebouxiphyceae, Zygenematophyceae and Euglenophyceae constituted 34, 10, 17, 15, 5, 18, and 1% of phytoplankton (Fig. 2). Bacillariophyceae was the most dominant class with eleven species and consisted of *Navicula* sp., *Pinnularis microstauro, Bacillaria*

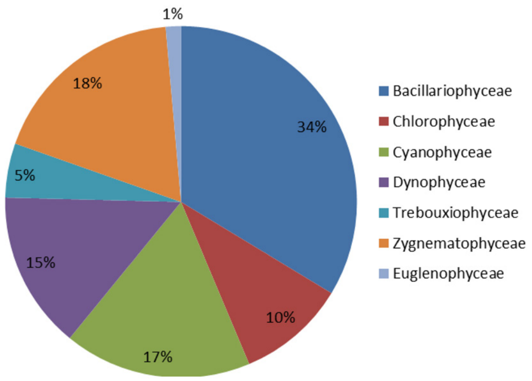

Fig. 2. The percentage composition of phytoplankton of shrimp ponds.

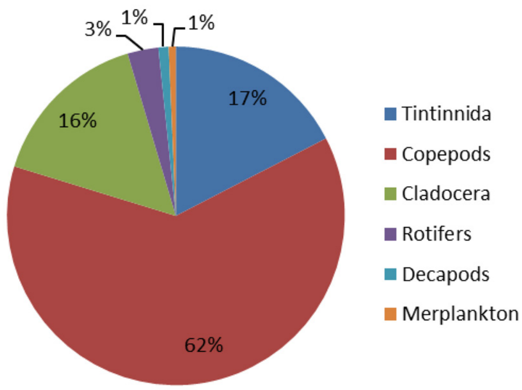

Fig. 3. The percentage composition of Zooplankton of shrimp ponds.

sp., *Chaetoceros peruvianus, Coscinodiscus eccentricus, Diploneis* sp., *Gyrosigma balticum, Nitzschia closterium*, *Thalassiothrix* sp., *Diatoma* sp. and *Asteromphalus* sp. Cyanophyceae was the second most dominant class and represented *Cylindrospermopsis raciborskii, Microcystis* sp., *Oscillatoria limosa, Spirulina* sp., and *Nostoc* sp. Chlorophyceae, Dinophyceae, Trebouxiphyceae, Zygenematophyceae, and Euglenophyceae were represented by 5, 5, 6, and 1 species respectively. The maximum number of phytoplankton species was recorded at Hisar (927) followed by Jhajjar (893), Fatehabad (882), Bhiwani (801), Rohtak (794), Sirsa (649), Dadri (570), Jind (565), and Gurugram (514), Kaithal (492) and minimum at Faridabad (430) (Table 2). The common phytoplankton species observed in all the districts are shown in Fig. 3 (Plates I-XLI). Simpson and Shannon-Weiner index for the phytoplankton varied between 3.42-3.28 and 0.9642-0.9488 per individual (Table 3). Higher the value of the Simpson and Shannon index indicates high diversity that was recorded at Jhajjar (0.9642 and 3.429). The maximum species evenness was recorded at Jhajjar (0.8341) and the minimum at Gurugram (0.6595). Berger- Parker index expressed the proportional importance of the most abundant type of species and Margate's diversity index is a species richness index According to Margalef and Berger-Parker diversity index, maximum species were recorded at Gurugram and Faridabad (6.727 and 0.1093) (Table 3).

Zooplankton composition

The total of 25 species of zooplankton from the classes Tintinnida, Copepods, Cladocera, Decapoda, Rotifera, and Meroplanktonic with percent composition (Fig. 4) 17, 62, 16, 3, 1 and 1 were recorded from eleven districts of Haryana (Table 4). Tintinnida, Copepods, Cladocera, Decapoda, Rotifera, and Meroplanktonic had 3, 11, 6, 3, 1, and 1 species respective-

Table 3. Different diversity index of phytoplankton species of shrimp pond in Haryana.

	Districts										
Diversity index	Hisar	Fatehabad	Bhiwani	Rohtak	Jind	Kaithal	Fardidabad	Gurugram	Dadri	Jahjjhar	Sirsa
Taxa_S	36	36	32	35	37	35	39	37	33	37	34
Individuals	927	902	801	794	565	492	430	514	570	893	649
Simpson_1-D	0.9586	0.9595	0.9576	0.9605	0.9572	0.9574	0.9502	0.9488	0.9577	0.9642	0.9581
Simpson_1-D	0.9586	0.9595	0.9576	0.9605	0.9572	0.9574	0.9502	0.9488	0.9577	0.9642	0.9581
Shannon_H	3.304	3.356	3.29	3.341	3.326	3.324	3.271	3.195	3.28	3.429	3.309
Evenness_e^H/S	0.7562	0.7967	0.8387	0.8069	0.7519	0.7931	0.6757	0.6595	0.8052	0.8341	0.805
Margalef	5.123	5.144	4.637	5.092	5.681	5.485	6.267	5.767	5.043	5.298	5.096
Berger-Parker	0.06796	0.08869	0.06742	0.06045	0.09027	0.0813	0.1093	0.08366	0.07895	0.05711	0.06471

Table 4. Zooplankton diversity of shrimp pond at different districts of Haryana.

		Number of zooplankton per dDistrict										
		Districts										
Class	Zooplankton	Hisar	Fatehabad	Bhiwani	Rohtak	Jind	Kaithal	Fardidabad	Gurugram	Dadri	Jahjjhar	Sirsa
Tintinnida	*Codonellopsis ostenfeldi*	30	49	25	41	47	27	0	15	45	43	39
	Favella philippinensis	24	44	21	49	37	39	21	34	40	42	23
	Tintinnopsis butschlii	17	35	44	43	44	23	15	33	44	44	0
Copepoda	*Acartia danae*	18	42	46	49	11	18	0	42	47	47	43
	Acrocalanus gracilis	15	41	46	49	19	43	15	35	48	48	51
	Paracalanus parvus	34	25	45	44	1	51	25	27	45	51	9
	Undinula sp .	33	29	42	38	8	45	26	39	54	49	5
	Coryceaus danae	42	38	48	36	20	30	23	23	53	44	34
	Eucyclops sp.	35	49	45	44	32	35	33	18	42	43	33
	Cyclops scutifer	27	38	39	51	22	22	14	43	35	48	11
	Nauplius sp.	39	19	35	45	9	45	2	51	27	49	3
	Microsetella norvegica	23	33	45	33	7	21	5	7	39	54	0
	Microsetella rosea	18	42	47	40	4	15	3	7	23	42	9
	Euterpina acutifrons	43	50	46	51	11	51	4	0	48	49	5
Cladocera	*Diphnosoma* sp.	51	42	42	44	9	15	11	5	43	38	35
	Daphnia similis	25	37	45	42	32	25	13	4	51	51	0
	Moina macrocopa	1	14	4	0	35	0	14	7	9	0	22
	Moina micrura	15	11	7	10	5	5	24	2	3	0	9
	Daphnia longspina	13	19	5	6	2	3	3	1	9	3	3
	Daphnia magna	13	1	17	2	5	0	1	2	1	0	1
Rotifers	*Bracnhionus roundiformis*	0	8	9	0	4	0	2	0	1	0	2
	Brachionus ruben	2	20	7	0	11	12	18	4	9	0	8
	Branchinus calyciflorus	15	2	5	0	0	0	9	7	4	15	9
Decapoda	*Lucifer faxoni*	0	1	3	5	0	21	5	4	5	11	5
Meroplankton	*Gastropod veligers*	1	0	5	2	0	0	11	5	5	2	11
	Total	534	689	723	724	375	546	297	415	730	773	370

ly. Copepod was most dominant with eleven species and consisted of *Acartia danae, Acrocalanus gracilis, Paracalanus parvus, Undinula* sp., *Coryceaus danae, Eucyclops* sp., *Cyclops scutifer, Nauplius* sp., *Microsetella norvegica, Microsetella rosea,* and *Euterpina acutifrons* (Table 3). Cladocera was the second most dominant class and represented by *Diphnosoma* sp., *Daphnia similis, Moina macrocopa, Daphnia micrura, Daphnia longspina,* and *Daphnia magnum.* The highest number of zooplankton species was recorded at Jhajjhar (773) followed by Dadri (730), Rohtak (724), Bhiwani (723), Fatehabad (689), Kaithal (546), Hisar (534) Gurugram (415), Jind (375), Sirsa (370) and minimum at Faridabad (297) district. The common species of zooplankton are given in Fig. 3 (Plate XLII-LXVI). The Simpson and Shannon-Weiner species diversity index for the Zooplankton varied between 0.942- 0.911 and 2.93- 2.65 individuals. The maximum species Evenness was recorded at Jhajjar (0.876) and the minimum at Gurugram (0.662). According to Margalef and Berger-Parker index maximum species, diversity was recorded at Bhiwani and Sirsa (3.512 and 0.1541) (Table 5).

DISCUSSION

The abundance of phytoplankton in shrimp ponds is of great importance for successful and sustainable aquaculture practices (Saraswathy *et al.* 2013). The phytoplankton populations are also considered one of the important wealth of the water bodies (Khushbu *et al.* 2022b). As discussed earlier, the plankton density fluctuates with changes in the Physico-chemical parameters of water. In the present study, plankton density was found to vary between 50,000-126,000/ m^3 in shrimp ponds of Haryana. Therefore plankton analysis could be an excellent bioindicator of the water quality of shrimp ponds. As reported in earlier studies, the optimum pH for plankton growth is 7-8.5 similarly recorded in this study, low pH prevents the

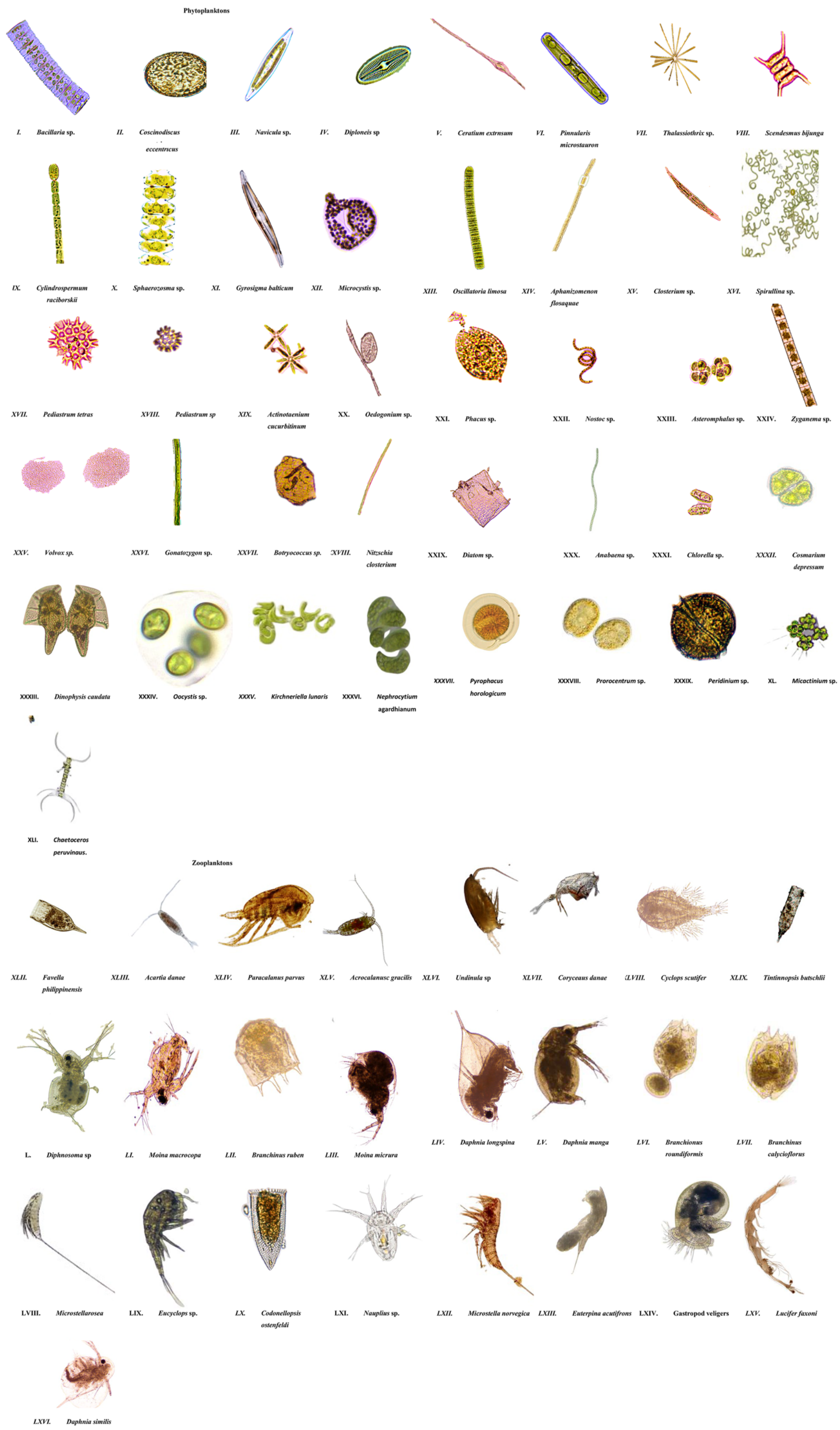

Fig. 4. Different species of phytoplankton and zooplankton.

Table 5. Different diversity index of phytoplankton species of shrimp pond in Haryana.

Diversity index	Hisar	Fatehabad	Bhiwani	Rohtak	Jind	Kaithal	Fardidabad	Gurugram	Dadri	Jahjjhar	Sirsa
Taxa_S	22	23	24	20	21	19	23	22	24	19	21
Individuals	504	640	698	683	328	519	297	400	685	730	331
Simpson_1-D	0.9385	0.943	0.9422	0.9369	0.9205	0.9324	0.9355	0.9182	0.939	0.9377	0.9118
Shannon_H	2.886	2.935	2.938	2.811	2.721	2.788	2.876	2.679	2.886	2.813	2.652
Evenness_e^H/S	0.8143	0.818	0.7863	0.8316	0.7234	0.8554	0.7713	0.6624	0.7468	0.8764	0.6753
Margalef	3.375	3.405	3.512	2.911	3.452	2.879	3.864	3.505	3.523	2.73	3.447
Berger-Parker	0.1012	0.07813	0.06877	0.07467	0.1341	0.09827	0.1111	0.12750	07883.	7397	0.541

absorption of nutrients by plankton and makes them vulnerable to disease (Gärtner *et al.* 2021). The pH and alkalinity is directly proportional to each other hence plankton grow more rapidly at high alkalinity, these result was in accordance with the earlier result represented by Palupi *et al.* (2022). The other water parameter Ammonia, Nitrate, and BOD, all these parameters greatly depend on the input of the organic matter of nutrient-rich feed material given to the shrimps (Nesapriyam *et al.* 2022). Higher TDS, Ammonia, and BOD mean higher nutrient that ultimately favors the growth of plankton. Turbidity and Nitrite also depend on organic input but excess organic matter increases turbidity and nitrite concentration which negatively impacts plankton growth (Rabaey *et al.* 2021). Water temperature, salinity, and hardness influence the distribution of aquatic species in all aquatic habitats. Surface water temperatures varied from 24.5 to 32°C in all districts of Haryana in the current research. In this study plankton density negatively correlated with them because at their high value, the mixing of nutrient become less and leads to nutrient deficiency in water that is responsible for a decline in plankton growth, a similar result reported by Richards (2021). In this study, Bacillariophyceae was the most dominant class recorded with 11 species that are beneficial to shrimp. Because of their high nutritional content, Bacillariophyceae and Chlorophyceae, Trebouxiphyceae, and Zygenematophyceae are excellent natural foods for vannamei shrimp. Microalgae with b-carotene and chlorophyll concentration boost the antioxidant pigment astaxanthin in shrimp tissue, resulting in increased shrimp development. According to earlier research, the most prominent kinds of phytoplankton in marine waters are Bacillariophyceae. Previous studies also discovered Diatom is dominant in vannamei production in Bangladesh (Katmoko *et al.* 2021). Furthermore, diatoms are a type of phytoplankton that is useful to the growth of vannamei shrimp because they aid in the formation of the carapace. Meanwhile, the Cyanophyceae, Dinophyceae, and Euglenophyceae genera may create poisons that are detrimental to aquatic species, making them highly hazardous to cultured organisms. In this study high population of population of plankton was recorded. Oscillatoria is the most prevalent genus identified in the Cyanophyceae class. Oscillatoria is a form of blue-green algae (BGA) found in brackish water. Oscillatoria is a diazotrophic category of Cyanobacteria that can fix nitrogen gas (N_2) from the air, allowing this organism to exist in environments with low nitrogen levels as long as there is phosphorus (Katmoko *et al.* 2021). In the present study, the maximum numbers of phytoplankton species recorded were 925 at Hisar and Zooplankton species 773 at Jhajjar. Among zooplankton, copepods were the most dominant class due to their high reproductive potential and adaptation to the marine environment. Predation of zooplankton by shrimp may transfer a significant proportion of the nutrients from the natural biota to the shrimp (Zaghloul *et al.* 2020).

CONCLUSION

Bacillariophyceae and copepods were found dominant in *L.vannamei* ponds that could serve as bio-indicators and natural food for shrimp. Plankton abundance and composition in culture ponds appeared to be an important source of food and nutrition for shrimp post larvae, at least for the earlier period when the ponds are stocked, therefore managing plankton abundance before stocking larvae in the aquaculture pond is important and may reduce the feed cost if well maintain a population of plankton fluctuates along with the physicochemical factors. As a result, managing water quality parameters to achieve optimal plankton growth in shrimp ponds is necessary for the optimum growth of shrimp.

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