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Variation of zooplankton population with respect to physico-chemical parameter in a Seasonal pond in Birbhum District West Bengal

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Abstract
The fluctuation of zooplankton population was studied in ‘Datta pukur’, a seasonal semi-urban pond in Suri, Birbhum district with respect to physical and chemical parameters during March 2022 to February 2023 covering winter and summer season. Aim of this study was to evaluate suitability of zooplankton richness varied with respect to different physical and chemical parameters in favour of pond aquaculture. The water quality parameters were recorded. Temperature 14ºC to 32º C, total dissolved solids (TDS) 198- 410 ppm, pH, 7,2-7.8, total alkalinity 30-56 mg/L, total hardness, 12-49 mg/L, dissolved oxygen, 3.2-7.2 mg/L, dissolved CO_2 3.15-14.2 mg/L nitrate, 4.2-12.1 mg/L, chloride, 22-48 Mg/L, sulphate, 11-21 mg/L and carbonate, 2.10-3.58 mg/L. 15 species of zooplankton belong to five major type Cladocera, Rotifera, Copepoda, Ostracoda and Protozoa were recorded. Among these cladocerans were found dominant followed by protozoan members. Zooplankton population was found in increasing trend during winter months and the reverse trend was observed during summer months. A maximum of 520 nos/10L zooplankton was observed during winter month and a minimum of 280 nos/10L was during summer month with an overall mean average of 35.6 nos./L . The result indicates the fact that water quality or physico-chemical parameters were favouring zooplankton growth during winter months. This information could be utilized for inland aquaculture practices.

Keywords: Birbhum, aquaculture, zooplankton, physicochemical parameters, seasonal pond

1. Introduction
From very primitive days fishes are captured and consumed by human society as delicious protein food item. At present day demand of fresh water fishes mainly the carps has been increased. But it is experienced that supply of freshwater fish species to meet the demand is not satisfactory [1]. Zooplankton population if increased fish production will be enhanced [2]. Abundance of plankton species in a water body is an Indicator of biological productivity that determines the efficiency of biological carbon pump [3]. Plankton constitutes a source of protein, carbohydrate, amino acids, lipids, fatty acids, minerals and enzymes and therefore essential for fish growth [4]. Hansen [5] studied on copepods that serve as important fish food. Aquaculture can be profitable if proper management of feed and ponds are taken care off [6, 7]. Saha and Manna [8] studied pond primary productivity from assessment of phytoplanktons that directly influence richness of zooplankton species. Abundance and diversity of zooplanktons largely depend upon water quality [9, 10]. Tolerance of zooplankton species to physicochemical parameters has frequently been studied by different authors like Bhuiyan and Nessa [11], Sukumar and Das [12], Shaw and Kelso [13], Sarkar and Chowdhury [14] Patil [15] Dutta and Patra [16], Ahmed [17] to explain the composition of zooplankton communities in different seasons or months in the year. Species richness is known to be related with ecosystem morphometry, particularly surface area and depth of water body that direct or indirectly involved in maintaining physico-chemical environment for desirable growth of species richness [18]. Prasad and Singh [19] studied that zooplankton can disperse easily over short distances. There are earlier studies on the qualitative and quantitative nature of the plankton community revealed species identification, month wise distribution, and population density relationship with physicochemical factors by Prescott [20], Michael [21].

Influence of environmental features, such as temperature, precipitation, and hardness and other water ionic content, hydro period and surface area were better explained with relation to the micro crustacean distribution by Yousuf and Quadri [22] Banik, Debnath and Kar [23]. The biotic and abiotic interactions are considered as pivotal for community organization. Hence, investigation in relation to zooplankton assemblage and fluctuation of physicochemical parameters in unutilized small freshwater ponds are warranted. This is for assessing their potential and suitability in order to utilizing them for inland aquaculture. Therefore, in the present study, zooplankton population was assessed in relation to physico-chemical parameters in a small seasonal pond located at Suri, Birbhum of West Bengal.

2. Materials and Methods

The study was conducted in Datta pukur pond, a seasonal pond in the outskirt of Suri of Birbhum District (23.9103ºN; 87.5356ºE).The pond covers about one hectare. The rain water runoff is the main source of water for this pond. Corporation water let outs and house hold let outs are the other sources of water in the pond. Native commercial fishes such as *Tilapia*, *Cyprinus carpio*, *Anabas*, *Clarias batrachus*, *Channa striatus*, *Channa punctatus* and IMC (*Labeo rohita*, *Catla catla* and *Cirrhinus mrigala*) were living in the pond as uncultured non stocking fishes. The sampling was conducted over a period of twelve months from March, 2022 to February, 2023. The water samples were collected on weekly basis in sterile, wide-mouth, screw capped glass bottle from a depth of 5-10 cm below the water surface in the morning hours between 8-9:15 am. The analysis was carried out at the spot (TDS, pH and temperature) and in laboratory within 3-4 hours (DO_2, DCO_2, chemical parameters) after collection. The water samples were subjected to analyses by adopting standard methods for the examination of water and wastewater as prescribed by APHA (2005).

Water temperature was measured by using a thermo probe at the site of collection and recorded in a Celsius scale. The pH was measured by using portable digital pH meter. Total alkalinity was estimated by titration of the sample against strong H_2SO_4, methyl orange was used as an indicator. Water samples were fixed for the analyses of dissolved oxygen at the site of collection and taken to the laboratory. The concentration of dissolved oxygen present in the water samples was estimated by Winkler's Iodometric method by titrating against sodium thiosulphate. Starch was used as an indicator. The total dissolved solid (TDS) was estimated by digital TDS meter. Total hardness (calcium and magnesium generally in salt form of chlorides, bicarbonate and sulphate) were estimated by EDTA (Ethylene Di-amine Tetra-acetate solution) titrimetric method using ammonium purpurate as an indicator. Nitrate, carbonate and chloride was estimated by 7-point water sample test kit Plankton samples were also collected from the pond on weekly basis. 10L (bucket of 10L size) of pond water was filtered through plankton net (Length to Mouth ratio is 3/1 with mesh size 30) to get average number from 5 different spots of the pond. The planktonic sample was fixed in 4% formalin. The quantitative analysis of zooplanktonic organism was carried out using Sedgwick rafter's plankton counting chamber. Plankton samples were subjected to analyses within 24 hrs of collection. The zooplankton species were identified with the help of standard works (Battish, 1992) [27]. The taxonomic identification was conducted under the light microscope at a magnification of 40 x 10. The physicochemical and zooplankton data obtained were subjected to correlation analysis using Prism5 Statistic software to determine their relationship.

3. Results and Discussion

Observation presented in Table 1 describes the physico-chemical parameters of the target pond water studied. The water temperature of the pond was recorded between 14-23ºC during winter and 26- 32.0ºC during summer months. The higher water temperature observed during summer months was due to greater light intensity and longer day length. The temperature is a physical ecological factor that has direct impact on distribution and survival of the planktons that has been correlated from the finding of plankton abundance and diversity of the pond under study (Fig.1). It also directly affects the amount of oxygen that can be dissolved in water [24]. Water temperature affects the rate of photosynthesis by algae and aquatic plants, the metabolic rate of aquatic organisms, the sensitivity of organisms to toxic wastes, parasites and diseases. In the present study, the water temperature was in increasing trend from winter to summer months. The population of zooplankton was found to increase during winter and the reverse trend was observed during summer months (Table 2). Therefore, rise in water temperature has positively influenced the growth of zooplankton up to certain level (Table 1, 2). It has been suggested that duration and intensity of light were the most important factors controlling the plankton periodicity. The level of dissolved oxygen was found in decreasing trend from winter to summer months with a mean of 4.954 mg/L (Table 1). The lower level of dissolved oxygen recorded may be due to less inflow of rain water and turbulence. This state also suggests presence of less number of photosynthetic algae. Natural aeration remains a major source of oxygen in the ponds. This is due to several factors, but the most significant are atmospheric oxygen diffusion, wind and water current, and the release of oxygen through algal photosynthesis. The interactions of these processes produce a dynamic oxygen concentration that is highly variable on a day-to-day basis and year-round. The lower level of dissolved oxygen present during summer was a limiting factor in distribution and abundance of zooplankton in the pond (Table1, 2). Another physicochemical feature of the pond is the pH. The pH values recorded were in decreasing trend from winter to summer months with an overall mean average of 7.416 and SD 0.219 (Table 1). The aquatic animals thrive well in water that has the pH value in the range of 7.5-9.0. In the present study the pH values obtained during winter were slightly alkaline in nature (7.8-7.6) and fall within the above said range and hence, supports zooplankton growth (Table 1, 2). The pH values recorded during summer were close to neutral (7.4-7.2). Alkalinity is important for fish and aquatic life because it protects or neutralizes or buffers against rapid pH changes [25, 26]. It can also be defined as equivalent calcium carbonate and expresses the buffering capacity. The buffering capacity is primarily dependent on the bicarbonate and carbonate anions and not on the calcium and magnesium cations. The level of total alkalinity was found to stabilize almost in a steady state during winter months and thereafter decreased drastically with an overall mean average of 40.583 mg/L with SD value 7.510(Table 1). The higher alkalinity recorded during winter favours the growth of zooplankton (Table 1, 2) and therefore the pond is suitable for aquaculture during this season. Hardness of water is mainly due to the concentrations of calcium and magnesium ions. The total hardness of the pond water was recorded in decreasing trend and falls between 202-122 mg/L during the study period with an overall mean average of 30.833 mg/L and SD value is 11.059 (Table 1). The total hardness recorded during winter months favours zooplankton growth rather than the hardness during summer months. The state of higher hardness recorded may be due to addition of detergents used for washing. The lower hardness recorded during summer may be due to restricted inflow of rain water. The total hardness recorded reflects on the pH values of the pond water (Table 1). It may exert different ecological and physiological effects depending on the interaction with other factors like temperature, oxygen and ionic compound. Higher TDS and hardness observed during summer months may be due to the increased evaporation of pond water associated with high temperature and decreased freshwater inflows. In the present study both total dissolved solids (TDS) were in decreasing trend (Table 1). The level of total dissolved solid (Fig.2) was found in the range between 300-410 mg/L during winter and 198-300 mg/L during summer with an overall mean average of 271.5 mg/L with SD value 67.14 (Table 1). Lower levels of total solids associated with other parameters does not favour the growth of zooplankton during summer months (Table1). In the present study, free ammonia was recorded in the range of 0.16-0.21mg/L during winter and 0.29-0.38 mg/L during summer with an overall mean average of 0.26 mg/L (Table 1). The nitrate level recorded between 12.1-8.5 mg/L during winter and 7.6-4.2 mg/L during summer with an overall mean average of 7.50 mg/L and SD 2.346 (Table 1). The higher levels of nitrate observed during winter months may be due to inflow of rain water and input of fertilizers or nitrogenous waste. This favors production of zooplankton (Table 1). This state in association with other parameters of positive trends favouring the growth of Different zooplankton species in the pond increases during winter months (Table 1, 2).

Plankton diversity in fresh water body is studied from Battish [27], Khan [28], Bera and Dutta [29], Swadling [30]. In the present study, 15 genera of zooplankton belong to five major groups Cladocera (3 genera), Rotifera (5 genera), Copepod (3 genera), Ostracoda (2 genera) and Protozoa (2 genera) were recorded (Table 2, 3). Among these cladocerans are dominant. Table 4 depicts the correlation type of zooplankton population with various physicochemical parameters. The population of zooplankton recorded was negatively co-related with the fluctuation of temperature and positively correlated with alkalinity, dissolved oxygen, carbon dii oxide, TDS, hardness, pH, nitrate and chloride. Species richness in the productivity of aquatic ecosystem is due to presence of nutrients. In a saturated community, site-specific interactions can limit the number of new species capable of colonizing. Further, the quality and quantities of plankton differ with biological and climatic factors [31]. The total zooplankton population was found in increasing trend during winter months, whereas, the reverse trend was seen during summer months with mean 356 and SD value 72.81 (Table 1). The water body studied in the present investigation was a lentic type with limited quantity and resource hence, high dispersal rate on small spatial scales was recorded during winter months (December-February). The physico-chemical parameters prevailed during winter months were favouring the production of zooplankton. The sudden decrease in zooplankton population during summer months indicates the fact that the prevailed physico-chemical conditions were disfavouring for the growth of zooplankton because of lentic water system (Table 2). This effect may also be due to over predation of zooplankton by higher trophic member that maintains more or less stable size in zooplanktonic population in a water body. Laal [32] studied rotifer population variation in different months of the year. This information can be utilized for aquaculture purposes, since zooplanktons play an integral role in transferring energy to consumer in the aquatic food web.

Table 1: Zooplankton abundance and Physico-chemical parameters studied (month wise)

Months	Temperature (°C)	Average Dissolved O_2 mg/L	dCO_2 mg/L	Average Nitrate mg/L	Total Average Alkalinity mg/L	Total chlorine mg/L	Total hardness mg/L	Mean pH	Average TDS (ppm)	Mean Carbonate mg/L	Total Zooplanktons Unit/litre
March 2022	26	4.40	4.75	7.6	46	32	28	7.4	260	3.12	338
April 2022	29	4.20	4.90	8.7	40	38	20	7.3	235	2.52	322
May 2022	29	3.90	4.80	6.7	42	42	12	7.2	225	2.72	305
June 2022	28	3.40	5.90	5.8	42	46	19	7.2	210	2.42	288
July 2022	30	3.20	4.90	5.1	33	48	22	7.3	200	2.82	280
August 2022	32	4.45	3.15	4.6	30	42	26	7.2	198	2.10	285
Sept. 2022	28	4.90	4.10	4.2	31	37	32	7.2	230	2.18	310
Oct 2022	27	5.40	6.40	6.7	35	34	37	7.4	290	2.45	348
Nov. 2022	23	6.10	9.10	8.5	39	30	42	7.6	320	2.52	406
Dec. 2022	16	6.90	10.90	12.1	42	27	45	7.8	410	2.67	440
Jan 2023	14	7.20	14.20	10.6	56	22	49	7.8	380	2.90	520
Feb 2023	18	5.40	10.40	9.4	51	30	38	7.6	300	3.58	430
Range Average	18.0	4.0	11.05	7.9	26	26	37	0.60	212	1.48	240
Mean	25.00	4.954	6.958	7.50	40.583	35.666	30.833	7.416	271.5	2.66	356
SD	5.657	1.234	3.247	2.346	7.510	7.575	11.059	0.219	67.14	0.390	72.81
Variance	32.908	1.523	10.543	5.505	56.409	57.388	122.305	0.048	4508.91	0.152	5302.5

Table 2: Average Zooplanktons abundance (month wise)

Months	Rotifera	Cladocera	Ostracoda	Copepoda	Protozoa	Total (Unit/10L)	Average density per Liter of water sample
March 2022	49	124	21	36	108	338	33.8
April 2022	35	122	19	40	106	322	32.2
May 2022	40	112	17	38	98	305	30.5
June 2022	32	106	14	34	102	288	28.8
July 2022	28	105	16	31	100	280	28.0
August 2022	28	110	13	28	106	285	28.5
Sept. 2022	30	112	22	36	110	310	31.0

Oct. 2022	34	140	19	39	116	348	34.8
Nov. 2022	54	165	27	45	115	406	40.6
Dec. 2022	39	194	32	51	124	440	44.0
January 2023	60	228	38	58	136	520	52.0
February 2023	64	226	32	47	112	481	48.1
Total count	493	1744	270	483	1333	4323	432.3

Table 3: Correlation between Physico-chemical parameter and Zooplankton density (From March 2022 to February 2023)

Serial No.	Correlation	Correlation Co-efficient(r)	Comment
1	Temperature Vs Zooplankton Density	– 0.965	Strong negative co-relation
2	Dissolved oxygen Vs Zooplankton Density	+ 0.914	Strong Positive co-relation
3	Dissolved CO_2 Vs Zooplankton Density	+ 0.964	Strong Positive co-relation
4	Nitrate Vs Zooplankton Density	+ 0.851	Strong Positive co-relation
5	Total Alkalinity Vs Zooplankton Density	+ 0.748	Strong Positive co-relation
6	Chlorides Vs Zooplankton Density	+ 0.928	Strong Positive co-relation
7	Total Hardness Vs Zooplankton Density	+ 0.864	Strong Positive co-relation
8	pH Vs Zooplankton Density	+ 0.951	Strong Positive co-relation
9	TDS(clearness) Vs Zooplankton Density	+ 0.927	Strong Positive co-relation
10	Total Carbonate Vs Zooplankton Density	+ 0.476	Moderate Positive co-relation

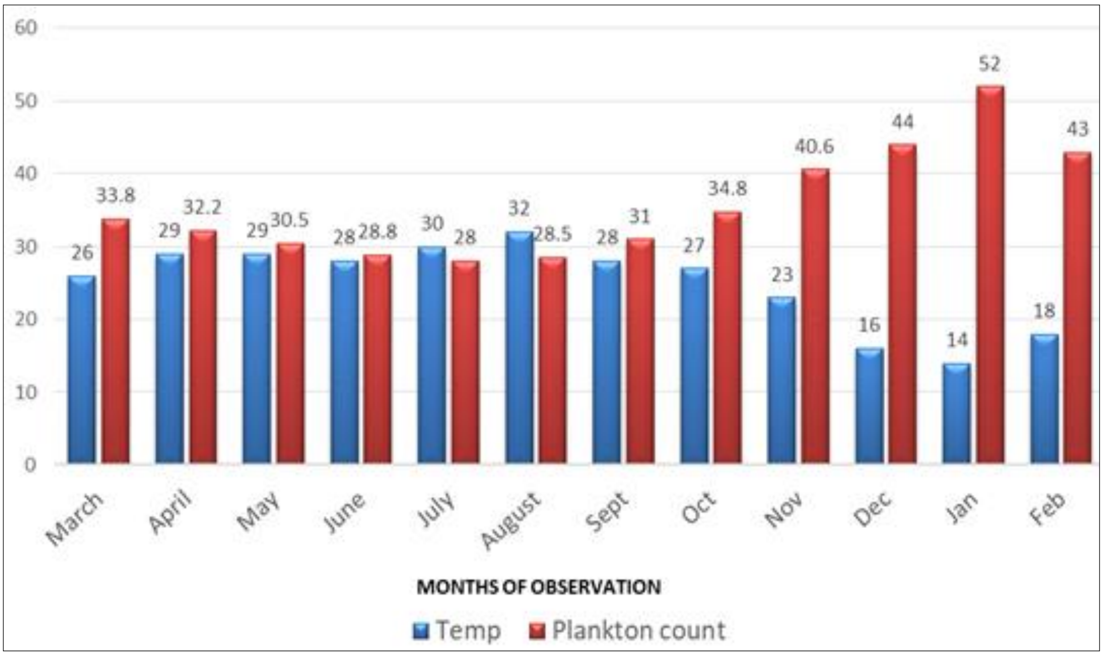

Fig 1: Temperature (ºC) vs Zooplankton density (Unit/L)

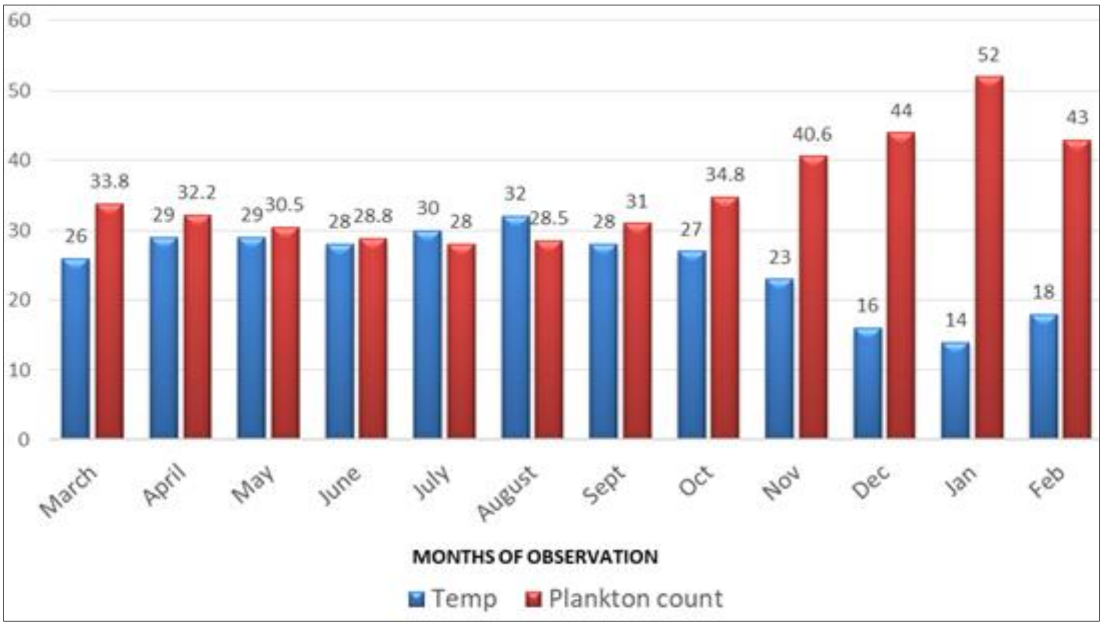

Fig 2: TDS of Water vs Zooplankton Density

4. Conclusion
Among the five selected groups of zooplankton Cladoceran was found to be dominant. Zooplankton density was found to increase during winter months and declines during summer months. Abundance of zooplankton was found directly correlated with both physical and chemical parameters. As they play central role in aquatic food chain and hence fishery development can be synchronized with the zooplankton abundance in ponds and fresh water reservoirs.

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