INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 7, Issue - 5, May – 2021
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.719
Received Date: 29/04/2021 Acceptance Date: 17/05/2021 Publication Date: 31/05/2021

Study of zooplankton community in relation to physico-chemical parameters of three neglected ponds located in Dhanbad, Jharkhand, India

[1]Bushra Naseer [2]Shailendra Kumar Sinha
[1]Ph.D. Research Scholar, [2]Associate Professor & Head,
[1,2]Department of Zoology, Binod Bihari Mahto Koyalanchal University, Dhanbad, Jharkhand, India
Email - [1]bushrannaseer@gmail.com, [2]sinhashailendra66@gmail.com

Abstract: *Studies on the physical and chemical properties of water play a crucial function in determining the water quality, type and level of water pollution existing within a water body. Present endeavor was made to assess the Physico-chemical characteristics of three neglected ponds for a period of February 2019 to January 2020 and their subsequent effects or relationship with the zooplankton community structure. During the study period parameters like- dissolved Oxygen, free Carbon dioxide, total dissolved solids, total suspended solids, Chloride, phosphates, nitrates, etc were analysed along with zooplankton species and a total of Thirty species of zooplankter were recorded from the group of Cladocera, Copepoda, Rotifera, Ostracoda, and Protozoa out of which total zooplankton population was mainly dominated by the rotifers presenting the eutrophication condition of the studied ponds. Pearson's product-moment correlation coefficient or the Karl Pearson's coefficient of correlation was calculated between the physico-chemical parameters and the zooplankton abundance. Results revealed that the physico-chemical parameters have their effect on the zooplankton population dynamics. As per the above results, it was concluded that although at present the selected ponds are in bad condition yet can be made suitable for fish culture practice but only after employing certain developmental management strategies and continuous monitoring thereby improving the physico-chemical parameters of the ponds' water.*

Key Words: *Physico-chemical parameters, fish culture, ponds, zooplankton, Jharkhand, India*

1. INTRODUCTION:

Water is a compound that is the most important and abundant one in the ecosystem. Water makes survival and growth possible, of all the living organisms on the earth. At present the only planet having a large share of approximately 70 % of water is the Earth. Due to expansion of the human population, urbanization, fertilizers application in agriculture and several anthropogenic activities, water has become polluted with different contaminants. Hence it becomes a necessity to check the water quality at a regular basis so that its quality could be maintained at certain standard levels for its proper utilization and in order to avoid any future loss by the polluted or contaminated water. Generally, most of the times, pollutants are found in the environment either in form of sewage, domestic waste, agricultural waste, accidental discharge, industrial waste or many times as compounds used with the intent to protect plants and animals. And the pollution occurs when a certain product added to natural environment triggers and promotes adverse effects on the nature's ability to dispose it off. Various physico-chemical parameters can be measured for the assessment of presence of pollution in the water [1]. The physico-chemical analysis of water is taken as a primary consideration towards assessing the water quality for any of its productive utilization which may include drinking, irrigation purpose, fisheries, and industrial purpose. These analyses are also helpful for understanding various complex processes like interactions between the climatic and the biological processes in water [2].

Change in climate has created an irregularity in seasonal patterns in the past years. The extreme weather phenomena during the last few years have also contributed to the rise in scarcity of water availability and resources of energy [3-4]. Alike other states of India Jharkhand are also largely dependent on the monsoon rainfall for the fulfillment of its demand of water.

As compared to lotic body of water like- the river, ponds are more prone towards pollution due to their stagnant property. Pond contamination occurs in many ways and any type of contamination in the pond water directly or indirectly affects the pond flora and fauna and also the human health if water is aimed for domestic utilization. Fresh water being one of basic needs to the human being and other organisms on the earth, most of the fresh water bodies all over the world are gradually getting polluted, thus deteriorating the portability property of water [5]. Ponds are the source of fresh water, that in a direct or in an indirect manner pose enormous ecological, commercial and socio-economic importance. Pond water provides natural shelters to many aquatic animals, plants, and microorganisms thereby making life possible in it. They are quite rich in biodiversity components like flora and fauna of local of natural and regional significance. Therefore, the ponds hold an important place in biodiversity [6]. In India, the natural ponds are expanded about 0.72 million ha of area. Most of these ponds are found in the villages, places of

INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 7, Issue - 5, May – 2021
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.719
Received Date: 29/04/2021 Acceptance Date: 17/05/2021 Publication Date: 31/05/2021

religious worship including other human inhabitations [7-9]. All of these make them vulnerable to changes day by day, which might probably present a clear picture about the pollution load on them [10].

Zooplankton population in freshwater mainly comprises of the Cladocerans, Copepods, Ostracods, Protozoans, and Rotifers. Zooplankton plays an integral role in the food web of aquatic ecosystem because they are the consumers for primary producers (phytoplankton) thereby forming a major food source for the tertiary producers. Zooplankton has been considered as the basic and principal natural fish food for the young fishes and for some adult fishes that support the fish production in the broader picture [11]. Zooplankton occurrence often responds quick to the environmental changes because of the short generation time (usually days to weeks) of most of the species. Spatial zooplankton distribution in relation to variation in various physical factors has been studied by [12] and [13].

And present study has been taken under consideration for the investigation of prevailing abiotic and biotic conditions in aquatic habitats on monthly basis and the work is aimed to assess the physico-chemical characteristics including the zooplankton population of the pond water to measure the present pollution status and nutrient loads of three neglected ponds located in Dhanbad, Jharkhand. The data thus obtained from the study would help in understanding the existing condition of the pond water and would also be helpful in establishing their conservation strategies along with in parallel their probable utilization to fulfill some of the productive and beneficial purposes especially for pisciculture.

2. MATERIALS AND METHODS:

2.1. STUDY AREA:

Dhanbad is a district in the state of Jharkhand that is well known as the 'Coal Capital' of India. It is located in the coordinates of 23.7998°N and 86.4305°E on an average elevation of 232 m above the sea level.

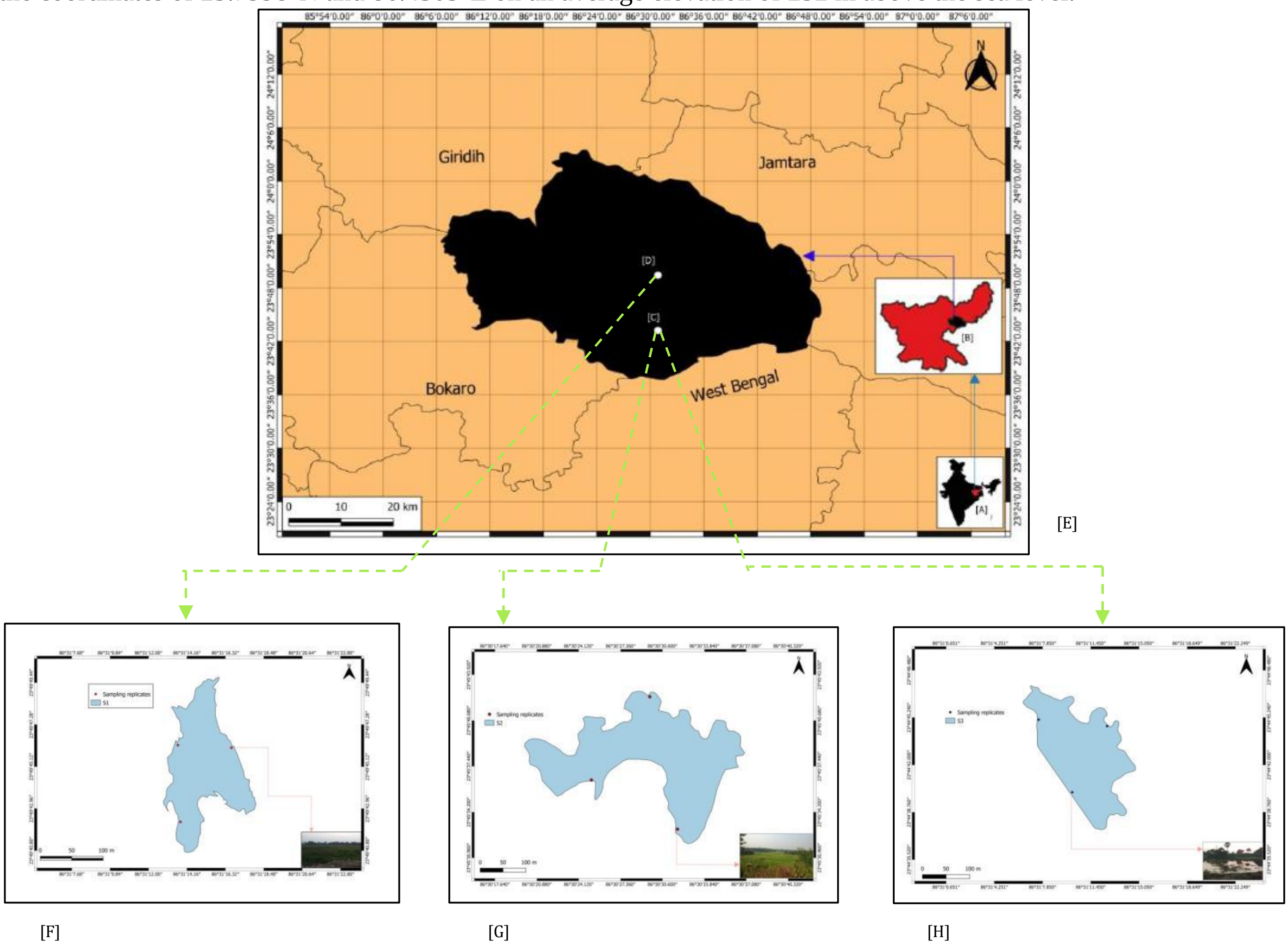


Figure 1. Map showing location of the study area. [A] Location of state Jharkhand in the map of India. [B] Location of district Dhanbad in the map of Jharkhand. [C] Location of block Balliapur in the map of Dhanbad. [D] Location of block Govindpur in the map of Dhanbad. [E] Broader picture of Dhanbad boundary showing locations of different study areas. [F]/[G]/[H] Locations of different study sites (the ponds) with their boundaries and their respective surface pictures that were taken from one of the sampling locations.

INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 7, Issue - 5, May – 2021
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.719
Received Date: 29/04/2021 Acceptance Date: 17/05/2021 Publication Date: 31/05/2021

The study was undertaken at three different ponds which are abandoned since long back and are not being used for any useful purpose. These ponds are located in two blocks of Dhanbad, viz., Balliapur Block and Govindpur Block (Figure 1) and the location map has been drawn using a GIS software, the QGIS 3.16.5 'Hannover'. These are the non coal-mining zone of Dhanbad where at present no coal mining is practiced and out of the three derelict ponds which have been considered to carry out the work, two of them are located in the Balliapur Block and another one is located in the Govindpur Block.

All of the ponds with their respective global location are mentioned in the Table 1.

The Rejali Pond, locally known as Saheb bandh or Rajni Bandh, is perennial fresh water, sewage fed pond situated adjacent to the Govindpur-Balliapur Road line and is conveniently being denoted as S_1. The pond receives dumps from the local market including the sewage waste arising from local residential area. The main sources of replenishment are sewage effluent from locally spread market area through drains and surface run-off from the surrounding areas. The shoreline of Rejali Pond is completely irregular and the pond surface is having a rich growth of the macrophyte as *Eicchornia crassipes* (water hyacinth) covering about 85 % of the surface followed by another macrophyte as *Typha latifolia* (cattail).

Another pond considered to carry out the study is the Kichinn (S_2) Pond being locally called as Kichinn bandh presenting a non-uniform somewhat crescent shape. During the period of study, pond surface remained mainly covered with *E. crassipes*, *T. latifolia*, and *Lemna minor* (duckweed).

The third study site, the Bhokta Pond is also irregular in shape and in this paper it is marked as the S_3. Discharge of sewage water, use of soap and detergents arising from bathing and washing of clothes, dumping of solid waste by the locals are the common anthropogenic disturbances that were recorded at sampling site the S_3. Surface of the pond remained occupied by water mat as *Hydrilla verticillata* (hydrilla) along with other algal blooms like *Spirogyra* (water silk), *Volvox* (green alga), and the duckweed *L. minor*.

Table 1: Geographical description of three neglected ponds chosen for the study.

Sl. No.	Name of Ponds	Denoted as	Geographical Location (Latitude/Longitude)	Sampling Replicates Location	Approximate Surface Area (in ha)
1	Rejali	S_1	23°49'45.45"N / 86°31'15.00"E	23°49'46.15"N / 86°31'16.66"E 23°49'46.18"N / 86°31'13.55"E 23°49'42.17"N / 86°31'13.86"E	~2
2	Kichinn	S_2	23°45'39.15"N / 86°30'29.62"E	23°45'32.83"N / 86°30'31.78"E 23°45'36.78"N / 86°30'25.01"E 23°45'42.21"N / 86°30'29.62"E	~6
3	Bhokta	S_3	23°44'43.14"N / 86°31'10.92"E	23°44'45.10"N / 86°31'07.60"E 23°44'40.07"N / 86°31'10.14"E 23°44'44.73"N / 86°31'12.72"E	~3

3. SAMPLE COLLECTION AND ANALYSIS:

Multiple water samples from the surface were collected from the aforementioned neglected water bodies for the determination and analysis of different physico-chemical parameters. Monthly sampling was undertaken between 09:00 to 11:00 a.m. for a duration of 12 months viz. from February 2019 to January 2020 and the period was divided in seasons as Pre-monsoon (from February to May), Monsoon (from June to September), and Post-monsoon (from October to January). A total of three sample replicates were obtained for each parameter for integrating and recording the final results. All the standard methods [14] were used for the sampling, preserving, transporting, and analysis of water samples.

Water temperature and air temperature were measured in-situ using the centigrade thermometer graduated to 100 ^{0}C. Electrical conductivity, pH, and Total Dissolved Solids (TDS) were determined using Water and Soil Analysis Kit (Labtronics, model LT -62) at the sampling site. Transparency of water column or the Sechhi Disc depth was measured using a device with black and white enamel coated quadrate area called the Secchi Disc having a diameter of 20 cm. Dissolved oxygen (DO), free Carbon dioxide (free CO_2), Total Suspended Solids (TSS), total alkalinity, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Calcium, Magnesium, hardness, nitrate, phosphate, chloride, Sodium and Potassium were analysed by using standard methods [14].

For zooplankton analysis, sample collection was carried out by filtering hundred liters of water through plankton net of mesh size 25µm and the collected samples were allowed for preservation in 50 ml of 5% formalin solution for analysis. Preserved and homogenized samples were then subjected to the laboratory observations using a research microscope (Magnus MLXi- Plus LED Binocular) connected with camera; with various magnifications as

INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 7, Issue - 5, May – 2021
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.719
Received Date: 29/04/2021 Acceptance Date: 17/05/2021 Publication Date: 31/05/2021

10×, 20×, 40×, and 100×. Plankton count was done by applying the Sedgwick-rafter cell method and results were expressed in unit/units per litre (U/L). Zooplankton identification was carried out according to the keys given in [14-18].

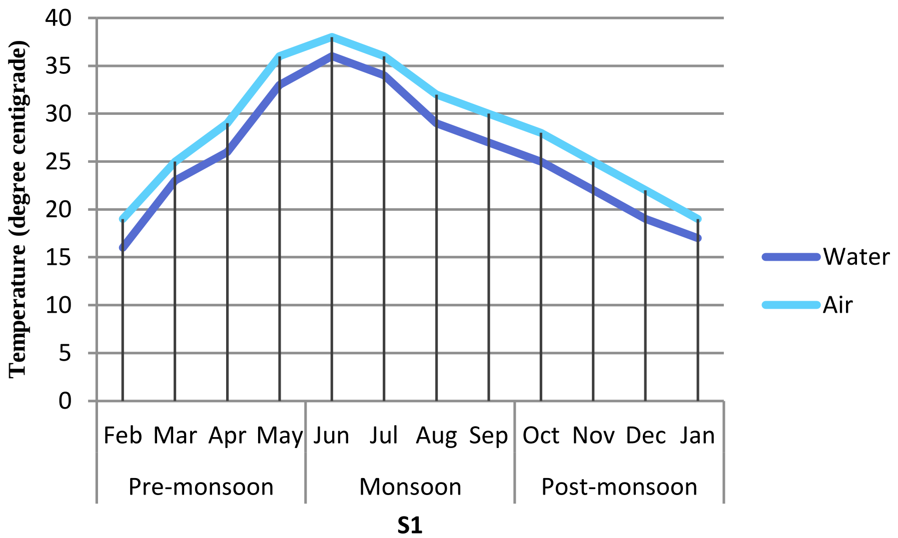
4. RESULTS AND DISCUSSION:

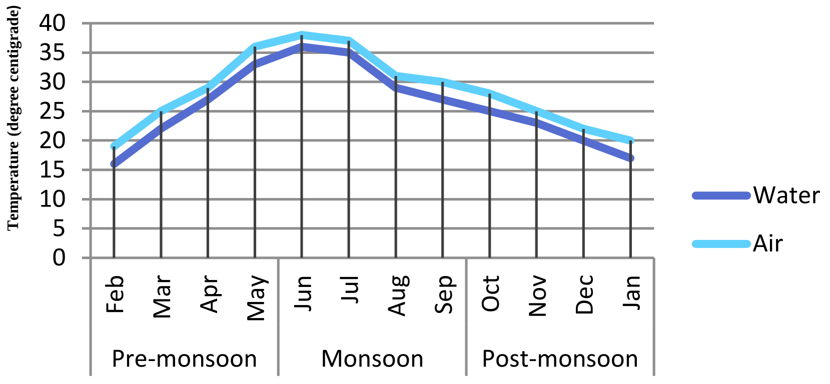
The water quality of a natural pond is generally governed by various physico-chemical and biological parameters. The importance of physico-chemical parameters for assessing the quality of water is well established [19-20]. The variation in physico-chemical parameters of the studied pond water of S_1, S_2, and S_3, are presented in Table 1 and correlation coefficients among physico-chemical characteristics including the zooplankter are mentioned in Table 2. Electrical Conductivity (EC) provides the measurement of the ability of a solution as to how much of the electric current is it allowing to pass through it. EC is influenced by factors like temperature, ionic concentration and their mobility. [21] have found the EC to be a good indicator of the water quality. Concentration of the dissolved solids has been found to be proportional to the ionic strength and it was stated that an increase in EC might also be a result of the leachate infiltration from the surrounding content of the soil in the natural aquatic environment [22]. Some other sources of EC may include abundance in the dissolved salts in the medium (pond water) from rain water and its runoff, also from nearby poor irrigation management system, dissolved minerals and other discharges. During present study maximum EC was recorded in S_1 while the minimum EC was reported in S_2. Transparency ranged between 15-19.5 cm in S_1, 15-21.5 cm in S_2, and 14-19.1 cm in S_3 and the highest reading range was recorded during monsoon season which might be as a result of dilution effects of rain while the lowest reading was recorded during post-monsoon which might be attributed to the occurrence of favourable conditions for production of plankton. Transparency of water is affected by the turbidity, plankton growth, cloudiness, rainfall, including position and visibility of the Sun in the sky.

Water temperature variations have been found in accordance with the air temperature and the trend is presented in Figure 2. Temperature of water was recorded to be the highest during the month of June and being the lowest during February. Increasing water temperature is responsible for increase in the chemical and biological reactions in water body resulting in the reduction of the solubility of gases [22]. During present study period, no significant difference was reported in the water temperature of the water from the studied ponds, viz. S_1, S_2, and S_3 that might have occurred due to the existence of the ponds in almost the same climatic conditions.

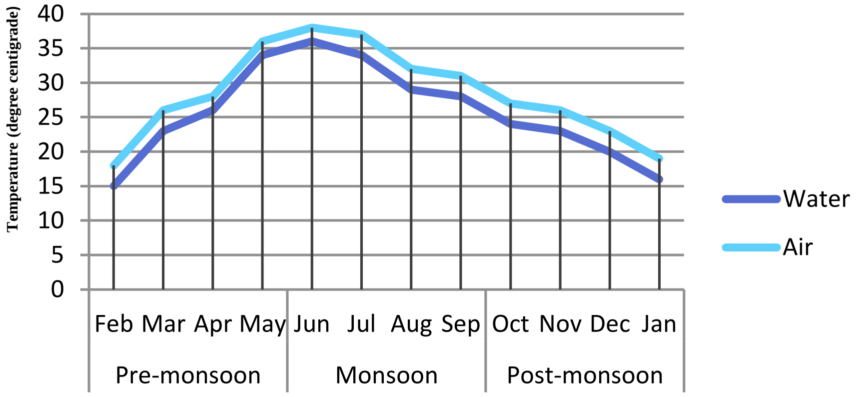
Determination of the water quality standards can also be established by the estimation of Total Dissolved Solids (TDS), and it accounts for many types of solids in dissolved form present in the water which may be of organic or inorganic in origin [23]. During the present period of study, the value of TDS was recorded in the order as $S_1 > S_2 > S_3$ and in all of the three ponds, TDS was maximum during post-monsoon and minimum during pre-monsoon.

Total Suspended Solids (TSS) are those solids that are found to be present in the water and could be entrapped by the help of a filter. The TSS may include materials like silt, sewage, dead and decaying matters of plant or animal origin, and industrial wastes. High values of TSS may pose many problems to the health and life of an aquatic system. Annual average TSS in case of S_1, S_2, and S_3 were recorded as 126.75mg/L, 98.83mg/L, and 103.83 mg/L, respectively.





S2



S3

Figure 2. Monthly and seasonal temperature values showing the temperature trend reported at three study sites (S_1 S_2 & S_3) from February 2019 to January 2020.

Capacity of water which helps it to neutralize a strong acid has been termed as the Total Alkalinity (TA) [24]. Alkalinity increased due to increase in the concentration of nutrient loads in the water during dry months [25], but the alkalinity became decreased in the monsoon season that might have caused due to dilution from rainwater [26]. Maximum TA was reported in S_1 while minimum in S_2, however, the annual mean difference in the total alkalinity of these two pond water were not found to be significantly different.

Furthermore, free carbon dioxide is considered as one of the major factors in the aquatic habitat and is the principal source of carbon path way in the environment. Carbon dioxide concentration in water bodies is contributed and to some extent maintained by the respiratory activity of animals. It is a product from various other living aquatic organisms and is utilized by the phytoplankton and macrophytes for photosynthesis during daytime. As an acidic gas the free carbon becomes more harmful to the aquatic life when the dissolved oxygen concentration is less. Carbon dioxide content was recorded to be the highest in water sample from S_1 while its reading was recorded to be as low as 0mg/L in case of S_2 and S_3.

Table 2: Values (based on monthly variations) of physico-chemical attributes at three abandoned study sites (S_1, S_2, S_3) from February 2019 to January 2020.

Sl. No.	Parameters	S1			S2			S3			Desirable limits for freshwater fish culture
		Range	Annual Mean	S.D.	Range	Annual Mean	S.D.	Range	Annual Mean	S.D.	
1	Electrical Conductivity (µS/cm)	1401-1736	1606.41	108.19	1001-1458	1258.83	146.14	1076-1497	1311.16	128.60	50-1500 [32]
2	Transparency (cm)	15-19.5	17.03	1.69	15-21.5	18.75	2.16	14-19.1	17.40	1.56	
3	TDS (mg/L)	970-1250	1103.25	87.57	725-1150	908.45	127.72	798-1071	920.91	101.14	<500 [33]

4	TSS (mg/L)	105-152	126.75	13.83	65-115	98.83	13.34	88-119	103.83	11.32	
5	Total Alkalinity (mg/L)	260-726	429	146.35	250-652	428.83	137.91	290-750	503.08	143.86	50-30 [33]
6	Free CO_2 (mg/L)	3.1-7.6	5.7	1.38	0-6.9	3.00	2.27	0-6.2	3.77	2.10	5-8 [34]
7	DO (mg/L)	1.5-8.6	4.60	1.88	1.9-8.7	5.30	1.90	1.6-7.8	4.45	2.00	5-15 [33]
8	BOD (mg/L)	4.6-8	6.25	1.29	2.5-6	3.69	1.07	1.7-7.2	5.13	1.88	>10 [33]
9	COD (mg/L)	36-76	56.58	15.64	26-68	41.25	17.30	15-68	48.16	19.26	
10	Hardness (mg/L)	215-300	255.58	25.69	205-367	267.75	41.81	220-360	287.25	46.58	>15 [35]
11	pH	5.9-7.1	6.58	0.30	7.3-8.8	8.32	0.52	7.2-8.1	7.55	0.23	7-9 [33]

An optimum level of dissolved oxygen (DO) concentration is essential to maintain the biological life in water and in order to allow the water system to perform the self-cleaning activity thus making the water bodies healthy. Any chemical and biochemical processes that undergo in a water body largely depend upon the presence of oxygen. On an annual average basis, the ponds in study area showed low DO and S_3 was observed to have the lowest DO concentration (4.45mg/L). High value of dissolved oxygen concentration was recorded in the post-monsoon season at all the study sites that might be because of the decrease in the temperature. Factors affecting oxygen amount dissolved in a reservoir are the water temperature, salinity, water inflow and photosynthesis by plants and algae [27-28]. The determination of Biochemical Oxygen Demand (BOD) is done to find out the amount or concentration of oxygen consumed by the aerobic microorganisms in order to carry out the decomposition of the organic and certain inorganic matter present in some wastewater, polluted water, etc. It is helpful in the assessment of organic pollution load [29]. BOD level was found in order of S_3 (1.7mg/L) < S_2 (2.5mg/L) < S_1 (4.6mg/L), and on the basis of the observed results it can be suggested that the pond water from S_2 and S_3 may be used for some domestic purposes but not water from the pond S_1.

Chemical Oxygen Demand (COD) is the measurement of oxygen consumption for chemical oxidation of the organic matter. COD values can be attributed to the quantity of dissolved oxidisable organic matter and non-biodegradable substance present in it. In the present period of work value of measured COD ranged from 36-76mg/L in S_1, 26-68mg/L in S_2, and 15-68mg/L in S_3. The hardness of water not being a pollution parameter but it indicates the quality of water. Hardness in water is the property that allows it to form precipitate with the soap and scales after reaction with certain ions present in water. Waters is generally categorized according to the extent of hardness as: 0–75mg/L = soft, 75–150mg/L= moderately hard, 150-300mg/L= hard, above 300mg/L= very hard. During present investigation, the hardness of water varied from 215-300mg/L, 205-367mg/L, and 220-360mg/L in S_1, S_2, and S_3 respectively. pH is the parameter in study of a solution that helps to find out the acid–base balance. Corroding ability of water can be determined by the help of estimation of pH. Lower the value of pH, higher would be the corrosiveness of water. pH of water affects solubility of various nutritive and toxic chemicals and so the presence of these substances in an aquatic system affects the organisms living within. Higher pH values indicate that the carbon dioxide was more affected due to changes in the physico-chemical conditions [30]. The pH value ranging between 6.0-8.5 has been discovered to show the medium level of productivity character of a reservoir [31]. Since an annual average value of pH has been measured as 6.58 for S_1, 8.32 in S_2, and 7.55 in case of S_3, the studied ponds' water seem to be of medium productive in nature.

5. DISSOLVED IONS:

Annual mean concentrations of the studied major cations (Sodium, Calcium, Magnesium, and Potassium) and nutrient salts (Phosphate, Nitrate, and Chloride) are given in Figure 3. Sodium is often reported as the major elemental constituent of the salt in water and in general, relatively low Sodium ion level is considered more acceptable. In the studies ponds, Sodium ion concentration was significantly different among the three ponds and its concentration was relatively higher in all the three ponds. Sodium and the Potassium are also two important minerals that are abundantly found in water bodies. Potassium ion is an indispensable plant nutrient that plays various important roles in plants such as protein synthesis, ion absorption & transport, photosynthesis and respiration [36]. Potassium from the pond water was also studied and significant variations in its values were observed among the three ponds. The values of Potassium ion were recorded in the range as 273-625mg/L in S_1, 205-570mg/L in S_2, and 110-527mg/L in S_3.

Hardness in water is mainly due to the existence of Calcium and Magnesium ions in it. Calcium ion is also a vital nutrient for the aquatic organisms, and is usually present in greater abundance in almost all the natural water bodies [37]. During present study, the Calcium ion concentration varied from 52-99mg/L in S_1, 43-100mg/L in S_2, and 39-80mg/L in S_3 that is quite high. Higher Calcium ion levels might have occurred to the leaching activities. The concentration range of Magnesium in the studied ponds has been recorded between 10-35mg/L, 10-31mg/L, and 5-25mg/L in S_1, S_2, and S_3 respectively. Magnesium ion is often related with Calcium ion in all type of water but its amount generally remains lower than that of the calcium [38].

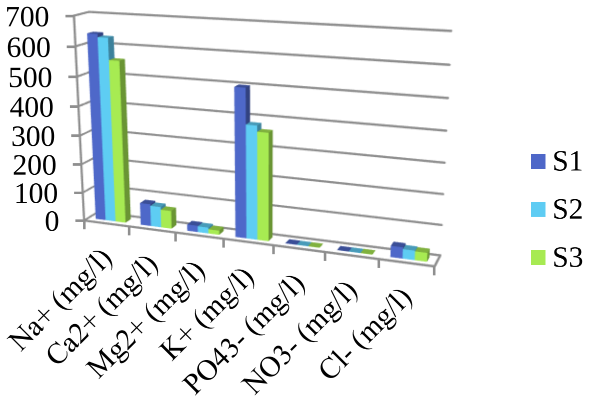


Figure 3. Major ions and their annual mean concentrations at different study sites

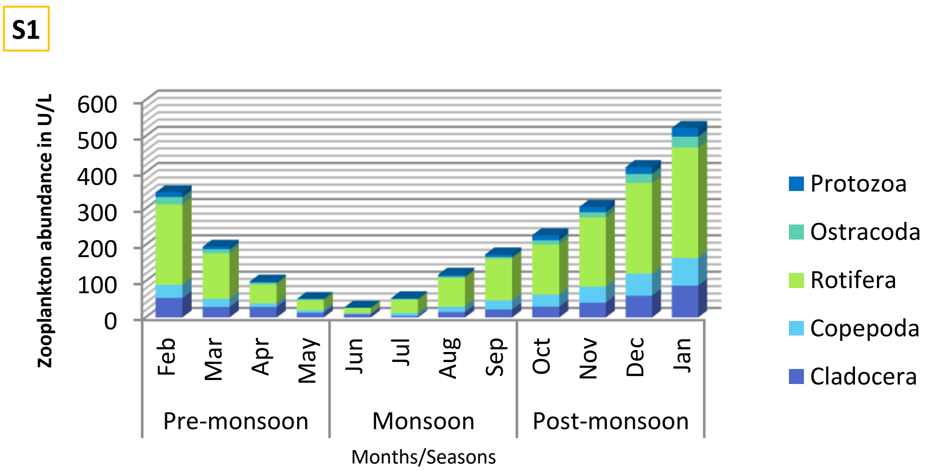
Phosphate plays a role as one of the major macronutrients which is responsible for the biological productivity and thus the eutrophication of the water body. The annual mean concentration of phosphate was more in S_1 (0.69 mg/L) followed by S_3 (0.49 mg/L) and S_2 (0.41 mg/L) and this relatively lower values might have occurred as a result of utilization by the aquatic vegetation. Comparatively higher concentrations of phosphates in S_1 might be because of maximum sewage water effluent that also resulted in a low dissolved oxygen event. During the period under study higher values of phosphate were observed in the post-monsoon season which may be attributed to an elevation in the anthropogenic activities around the pond after post-monsoon season is over which includes the agricultural fertilizers from surrounding catchment areas that enrich the Phosphate in the ponds as a result of surface runoff. Low values of Phosphate during the pre-monsoon months may have resulted due to uptake of phosphate readily by the macrophytes for their luxuriant growth. An annual average concentration of nitrates from the studied ponds was recorded as $S_1 < S_2 < S_3$ which might be ascribed to the maximum human activities at S_3. Higher level of the nitrate ion showed effects of comparatively higher anthropogenic activities including agricultural runoffs [39]. And seasonally, the maximum concentration of nitrate concentration was observed during the post-monsoon.

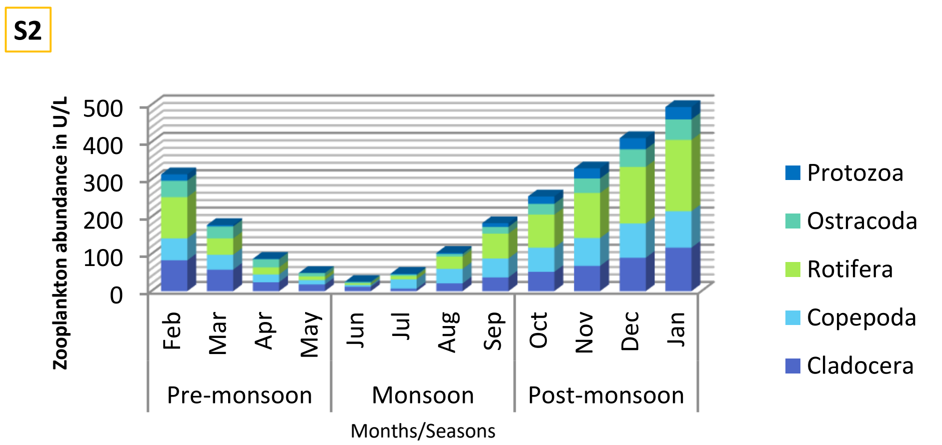
Chloride anion is quite often present in natural waters. In natural freshwater, high Chloride ion concentration is considered as a pollution indicator [40]. Chloride ion concentration is usually higher in the organic wastes and consequently its high concentration in natural water presents a clear picture of pollution from the domestic sewage. The content of chloride in water samples of S_1 varied from 14-65mg/L, S_2 ranged from 12-50mg/L, and S_3 showed a variation of 9-52mg/L. Thus, the overall trend resulting from the study of different physico-chemical parameters in the ponds revealed that the sampling site S_1 is the most degraded in terms of water quality while, the better water quality persists at S_2 and S_3. In terms of management to utilization of the ponds for some prolific purposes, maximum management is required for S_1, less for S_2, and the least for the water in S_3.

6. ZOOPLANKTON COMMUNITY:

Plankter are quite sensitive to change as their species replacement takes place with altering of the prevailing conditions in the aquatic ecosystem and they exhibit present status of different ecological and biological characteristics of the aquatic environment. Zooplankton community has been implied as indicator of pollution and nutrient status of a water body [41-42]. The abundance and occurrence of each genus of zooplankton varied in each pond (Table 3). A total of Thirty species of zooplankter were recorded in the studied ponds being represented by five groups, Cladocera (4 species), Copepoda (4 species), Rotifera (15 species), Ostracoda (2 species), and Protozoa (5 species) from the three ponds. Maximum number of zooplankter was recorded in S_3 (3032 U/L) and the minimum was recorded in S_2 (2476 U/L). The present study revealed that the zooplankton abundance displayed similar trend of distribution seasonally between different study sites while their composition was different at all of the three sites. Highest number of zooplankter was recorded during the post-monsoon months (December-January) as also mentioned by [43] that winter months provide the most favourable conditions for the growth and flourishment of zooplankton species. Furthermore, maximum zooplankton number was recorded during the winter season in the study conducted by [44]. [45] also recorded the maximum number of Rotifers and Cladoceran species during winter. The zooplankter number started declining from March onwards and attains exhaustive ebb during June (Figure 4). And gradually zooplankter showed an increment in the number from August attaining a peak in January (post-monsoon season) which confirms the results of [46] and [47] where zooplankter peak was reported during the month of winter season (January). The zooplankter abundance gradually increased with an increase in the rain and nutrient like organic manure level, as also observed by [48]. This result, however, is in contrast to the findings of [49] where zooplankter maxima occurred during the dry season.

During this complete study period the percentage share of the total zooplankter population was observed as Cladocera (21.60%), Copepoda (20.41%), Rotifera (42.09%), Ostracoda (10.53%), and Protozoa (5.36%). Rotifera group members were found as the most abundant and frequently occurring genera in all the three studied ponds, however, their percentage varied among them (S_1= 61.45% of total zooplankton) and not much specific difference in the percentage of abundance was recorded from S_2 and S_3 (34.32%, and 32.25%, respectively). The second most abundant group members belonged to Cladocera (15.56%) in S_1 and their highest percentage of species occurred in S_3 (24.93%) during present study period. Copepoda were more abundant in S_3 (23.71%) than in S_1 (13.42%) and S_2 (23.50%). The highest abundance of Ostracods was recorded in S_3 (13.32%, 404 U/L) while being the lowest in S_1 (5.25%, 133 U/L). Protozoa were reported as the lowest abundant group, out of total zooplankter and their highest percentage and number were found in S_2 as 5.93% or 147 U/L and the lowest in S_1 as 4.30% or 109 U/L; during the investigation period.





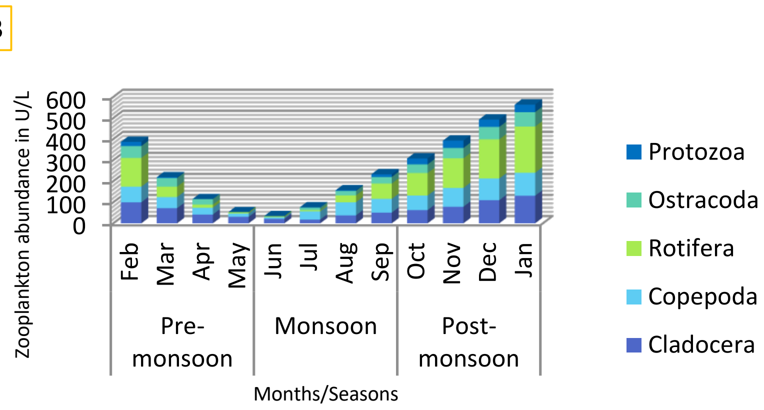


Figure 4. Distribution of various zooplankton groups during different months and seasons at three study sites from February 2019 to January 2020.

Only 15.56%of Cladocera constituted the total zooplankton population in S_1 while it registered comparatively higher in composition as 23.70% and 24.93% of total zooplankton in S_2 and S_3, respectively. This group was represented by common species like *Daphnia* sp., *Moina* sp., *Ceriodaphnia* sp., and *Bosmina* sp. and these species presence has been reported in eutrophic lakes [50-51]. Out of these four reported Cladoceran species only the presence of *Daphnia* sp. was recorded throughout the study and during all the seasons. However, the highest number of *Daphnia* sp. was found in S_3 which might be ascribed to receiving of organic substances by the pond from surrounding areas. Presence of *Daphnia* sp. in the pre-monsoon season during low levels of dissolved oxygen accompanied by high temperature values indicates that this species can thrive well under stress and is an indicator of increasing organic matter in the water body as also reported by [52]. Group of Copepoda was represented by a total of four species as *Cyclops* sp., *Diaptomus* sp., *Mesocyclops* sp., and *Nauplius* sp. over the period of investigation. Copepoda was recorded to be the lowest (340 U/L) in S_1 while the highest and almost the double of S_1 Copepods were recorded in S_3 (719 U/L). *Cyclops* has been the only genus reported to be existing all through the seasons in S_1, S_2, and S_3. Comparatively low Copepoda number in S_1than S_2 and S_3 is an indicator of pollution in it because [11] mentioned Copepoda as the most dominant group found in Lake Nasser, Egypt with good environmental conditions.

Table 3: Occurrence of zooplankton species in S_1, S_2, and S_3 during the study (+ = present / - = absent).

Groups/ Genera	Pre-monsoon												Monsoon												Post-monsoon											
	Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec			Jan		
	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3
Cladocera																																				
Daphnia sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Moina sp.	+	+	+	-	+	+	+	-	+	-	-	+	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bosmina sp.	+	+	+	+	+	+	+	+	+	-	+	+	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ceriodaphnia sp.	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Copepoda																																				
Cyclops sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Diaptomus sp.	+	+	+	-	+	+	-	+	+	-	-	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mesocyclops sp.	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nauplius sp.	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rotifera																																				
Brachionus bidentata	+	+	+	+	+	+	+	+	+	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B. plicatilis	+	+	+	+	+	+	+	+	+	+	+	-	+	-	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B. calyciflorus	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

B. quadridentatus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B. angularis	+	+	+	+	+	+	+	+	+	+	-	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B. tridentatus	+	+	+	+	+	+	+	+	+	+	-	-	+	-	-	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Keratella sp.	+	+	+	+	-	+	+	-	-	-	-	-	-	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Asplanchna sp.	+	+	+	+	+	-	+	+	-	+	+	-	+	-	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Filinia sp.	+	+	+	+	+	-	+	+	-	-	-	-	-	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rotararia sp.	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Monostyla sp.	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	+	-	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tetramastix sp.	+	+	+	+	+	+	+	+	+	+	-	-	+	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Platiyas sp.	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hexarthra sp.	+	+	+	+	+	+	+	-	+	+	-	+	+	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Colurella sp.	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ostracoda																																				
Cypris sp.	+	+	+	+	+	+	+	+	+	+	+	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cypriodopsis sp.	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Protozoa																																				
Paramoecium sp.	+	+	+	+	-	-	+	-	-	-	-	-	-	-	-	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Arcella sp.	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Amoeba sp.	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Stylonchia sp.	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+	-	+	+	+	+	+	+	+	+	+	-
Vorticella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	+	+	+	+	+	+	+	+

Rotifera showed the highest number of species viz. 15 species among the total zooplankter during study and the maximum number of Rotifers (1556 U/L) were recorded in S_1 while the minimum value was found in S_3 (978 U/L). The highest annual seasonal abundance of rotifer was recorded during the post-monsoon and a general lower abundance was recorded during monsoon and low in the pre-monsoon season. Among Rotifers, species that were identified include *Brachionus bidentata*, *B. plicatilis*, *B. calyciflorus*, *B. quadridentatus*, *B. angularis*, *B. tridentatus*, *Keratella* sp., *Asplanchna* sp., *Filinia* sp., *Rotararia* sp., *Monostyla* sp., *Tetramastix* sp., *Platiyas* sp., *Hexarthra* sp., and *Colurella* sp. Rotifers percentage composition at different study sites ranged from 32.25% to 64.15%. The trend of Rotifer species abundance obtained from present work showed that the pond (S_1) is the most eutrophic in nature than the ponds S_2 and S_3. Rotifera species are regarded as the bioindicators of pollution in the body of water [53]. Also many Rotifera species have been identified as the good bioindicators of present trophic state of an aquatic environment. Presence of *Brachionus* species with high density and number is an indication of eutrophication in water body as this particular genus is a pollution tolerant organism [54-55].

Ostracoda occurrence was also recorded during all the three seasons that may be on account of pollution of water [56]. Only two species from the group of Ostracoda were identified during the study which included *Cypris* sp., and *Cypridopsis* sp. Ostracoda abundance from different study sites showed a variation within a range of 5.25% to 13.32% of total identified zooplankton. Such low percentage of Ostracods during study period might have occurred due to less mixing of epibenthic forms from the sediment phase that remains rich in Ostracods. Members of freshwater Ostracoda are of special interest since they act as the biological indicators of environmental changes [57]. The lowest Ostracods were reported in S_1 (133 U/L) which represents the organic pollution in the pond as studied by [58] that in organically polluted waters, Ostracods are usually scarce and sometimes can disappear. Protozoa holds the second position in terms of species (5 spceies) contribution after Rotifera during the present study. In spite of having more number of species its distribution was not recorded to be as much as other zooplankter. And species representing the group of Protozoa included *Paramoecium* sp., *Arcella* sp., *Amoeba* sp., *Stylonchia* sp., and *Vorticella* sp. Out of these five species the least reported species was the *Vorticella* sp. while *Amoeba* was the most reported Protozoan species. Although being low, S_2 exhibited the highest share of Protozoa during study as 5.93% (147 U/L) while lowest was recorded in S_1 as 4.30% (109 U/L) of the total zooplankter in the studied ponds and overall the distribution of Protozoa remained very low throughout at all the ponds. Many species of Protozoa principally inhabit freshwater and marine sediments but none of them are ever abundant [59]. And seasonally, the Protozoan least abundance occurred during pre-monsoon as also supported by [60] where Protozoan number were observed to be the least occurring in dry season. Low Protozoan density might be because of the presence of a lot of aquatic plants and water flow [61].

7. CORRELATION COEFFICIENT:

For the analysis of overall impacts of various physico-chemical parameters on the abundance of zooplankton, correlations were made among the total zooplankton population and the water quality parameters. For this, the calculations of Karl Pearson's correlation coefficients were done and the results are presented in Table 4. The coefficient of correlation of various physico-chemical attributes and total zooplankton showed that there is correlation of varying degrees among them.

Table 4: Statistical relevance (Karl Pearson's Correlation coefficient) among physico-chemical parameters, and zooplankton reported at different study sites during the study period.

	EC	Tr	TW	TDS	TSS	TA	FCO	DO	BOD	COD	Har	pH	Na	Ca	Mg	K	PO	NO	Cl	Cla	Cop	Rot	Ost	Pro	TAZ
EC	1.0000																								
Tr	0.3492	1.0000																							
TW	0.4068	0.6785	1.0000																						
TDS	0.9229	0.2458	0.2458	1.0000																					
TSS	0.7357	0.3598	0.2921	0.8979	1.0000																				
TA	-0.2586	0.1993	0.5950	-0.4109	-0.3868	1.0000																			
FCO	0.1630	0.3723	0.3857	0.0476	0.0951	0.1281	1.0000																		
DO	-0.4361	-0.5172	-0.9205	-0.2484	-0.2692	-0.5848	-0.2103	1.0000																	
BOD	-0.4878	0.1050	0.2226	-0.5762	-0.4890	0.8166	-0.0875	-0.2217	1.0000																
COD	-0.5746	-0.0685	0.1535	-0.6625	-0.5968	0.7973	0.2175	-0.1862	0.7578	1.0000															
Har	-0.0175	-0.2873	0.1316	-0.2477	-0.4554	0.3833	-0.0548	-0.3317	0.3049	0.4041	1.0000														
pH	-0.0661	0.1808	0.0598	0.1586	0.2885	0.1622	-0.4112	-0.0156	0.1813	0.0901	-0.2267	1.0000													
Na	0.2730	0.6273	0.4973	0.1298	0.1310	0.2501	-0.0751	-0.5310	-0.0065	-0.0554	-0.0652	0.3128	1.0000												
Ca	0.6263	0.5011	0.7778	0.4688	0.3864	0.1255	0.1785	-0.7647	-0.3154	-0.3023	0.1988	-0.0081	0.5832	1.0000											
Mg	-0.4645	0.1282	0.0348	-0.6743	-0.6521	0.4672	-0.1108	-0.1318	0.7251	0.4934	0.4501	-0.2295	0.1085	-0.2267	1.0000										
K	0.6791	0.4826	0.3274	0.7438	0.8018	-0.2237	0.0208	-0.3134	-0.4040	-0.5039	-0.4528	0.4062	0.5988	0.4597	-0.5341	1.0000									
PO	0.5498	-0.2895	-0.4536	0.6328	0.4915	-0.7792	-0.0063	0.3243	-0.7415	-0.5701	-0.0607	-0.1242	-0.2077	-0.0414	-0.5577	0.3690	1.0000								
NO	0.5861	0.1882	0.4415	0.4822	0.2954	0.2255	0.3250	-0.5085	-0.0076	0.1749	0.5105	0.0452	-0.0027	0.4165	-0.1336	0.1042	0.2593	1.0000							
Cl	-0.5824	0.2653	0.2697	-0.7287	-0.6074	0.7927	0.1582	-0.2440	0.8301	0.7936	0.1716	0.0355	0.2727	-0.2065	0.7550	-0.3588	-0.8109	-0.1656	1.0000						
Cla	-0.2455	-0.6819	-0.8982	-0.2266	-0.3867	-0.5138	-0.3511	0.7365	-0.1830	-0.1389	0.0949	-0.3800	-0.4622	-0.6657	0.1434	-0.4125	0.4772	-0.3019	-0.2318	1.0000					
Cop	-0.0113	-0.6930	-0.8409	0.0356	-0.1409	-0.6862	-0.3644	0.6474	-0.4601	-0.3701	0.0644	-0.3696	-0.4090	-0.4560	-0.1006	-0.2132	0.6864	-0.2078	-0.5021	0.9411	1.0000				
Rot	-0.2223	-0.7464	-0.9170	-0.1329	-0.2851	-0.6108	-0.3734	0.7655	-0.3609	-0.2269	0.0189	-0.2916	-0.4878	-0.5978	-0.0532	-0.3751	0.5437	-0.2794	-0.3754	0.9541	0.9600	1.0000			
Ost	-0.2357	-0.7669	-0.8977	-0.1921	-0.3549	-0.5478	-0.4327	0.7249	-0.2569	-0.2272	0.1242	-0.3384	-0.4550	-0.5885	0.0783	-0.3892	0.4864	-0.3366	-0.3099	0.9727	0.9574	0.9691	1.0000		
Pro	-0.1458	-0.6658	-0.8600	-0.1165	-0.2990	-0.6367	-0.3263	0.6915	-0.4441	-0.2522	0.0792	-0.3554	-0.3523	-0.4674	-0.0543	-0.3134	0.5944	-0.2390	-0.3978	0.9400	0.9654	0.9690	0.9399	1.0000	
TAZ	-0.1630	-0.7331	-0.9163	-0.0883	-0.2444	-0.6569	-0.3959	0.7584	-0.3778	-0.2983	0.0374	-0.3125	-0.4784	-0.5710	-0.0554	-0.3193	0.5956	-0.2912	-0.4313	0.9677	0.9826	0.9869	0.9815	0.9703	1.0000

S_1

	EC	Tr	TW	TDS	TSS	TA	FCO	DO	BOD	COD	Har	pH	Na	Ca	Mg	K	PO	NO	Cl	Cla	Cop	Rot	Ost	Pro	TAZ
EC	1.0000																								
Tr	-0.1345	1.0000																							
TW	-0.3337	0.6262	1.0000																						
TDS	0.8055	-0.3758	-0.3257	1.0000																					
TSS	0.7868	-0.1322	-0.3506	0.6566	1.0000																				
TA	-0.7055	0.6052	0.6746	-0.8352	-0.6547	1.0000																			
FCO	-0.3470	0.2880	-0.1411	-0.3688	-0.5338	0.2807	1.0000																		
DO	-0.1043	0.3087	-0.0430	-0.4048	-0.0963	0.3852	0.3519	1.0000																	
BOD	-0.3186	0.0393	-0.5474	-0.2683	-0.2174	0.0292	0.6146	0.1929	1.0000																
COD	-0.3653	0.3796	-0.1129	-0.4002	-0.4843	0.3707	0.7257	0.2582	0.6794	1.0000															
Har	0.4892	-0.3463	-0.0792	0.8117	0.3532	-0.6705	-0.4877	-0.4946	-0.3198	-0.4816	1.0000														
pH	0.1538	-0.3094	0.3556	0.2901	0.1819	-0.1758	-0.5906	-0.4308	-0.7378	-0.9037	0.4185	1.0000													
Na	0.6852	0.1500	0.3234	0.6794	0.5020	-0.2778	-0.4611	-0.2585	-0.6955	-0.3897	0.5646	0.3676	1.0000												
Ca	0.0131	0.2290	0.7436	-0.0942	-0.0275	0.2437	-0.4247	-0.2578	-0.8343	-0.5966	0.0824	0.7537	0.4102	1.0000											
Mg	-0.4987	-0.3318	-0.3152	-0.1654	-0.5758	0.0238	0.5109	-0.3303	0.5912	0.4729	-0.0516	-0.2833	-0.4897	-0.4682	1.0000										
K	0.1993	0.0874	0.3136	0.0575	0.1180	0.1496	-0.4521	-0.4401	-0.4509	-0.1406	-0.0026	0.2514	0.4834	0.4376	-0.0862	1.0000									
PO	0.7338	-0.6358	-0.4291	0.8272	0.5702	-0.8299	-0.3589	-0.3387	-0.3474	-0.6549	0.6259	0.5519	0.4276	0.0703	-0.1628	-0.0160	1.0000								
NO	-0.1164	0.3266	-0.1396	-0.5601	-0.0400	0.3178	0.2542	0.8345	0.2668	0.2636	-0.5641	-0.4926	-0.4159	-0.1767	-0.3201	-0.3068	-0.4434	1.0000							
Cl	-0.6727	0.4251	0.2785	-0.7297	-0.6902	0.7858	0.5147	0.2407	0.3878	0.8065	-0.6896	-0.6176	-0.4009	-0.2209	0.4037	0.1372	-0.8615	0.2349	1.0000						
Cla	0.1521	-0.8232	-0.9294	0.2770	0.2242	-0.6353	0.0608	-0.0353	0.4232	-0.0615	0.1283	-0.1248	-0.3827	-0.6212	0.4278	-0.3204	0.4769	0.0104	-0.3198	1.0000					
Cop	0.4309	-0.8424	-0.8263	0.5261	0.4428	-0.8082	-0.1352	-0.1700	0.0996	-0.3754	0.3222	0.1993	-0.0833	-0.3328	0.1924	-0.1782	0.7698	-0.1461	-0.6315	0.9074	1.0000				
Rot	0.2566	-0.8763	-0.8511	0.4205	0.3094	-0.7205	-0.0527	-0.1516	0.2500	-0.2866	0.2621	0.1306	-0.2461	-0.4498	0.3417	-0.2794	0.6722	-0.1555	-0.5154	0.9595	0.9714	1.0000			
Ost	0.1839	-0.8012	-0.9269	0.2543	0.1807	-0.5585	0.0569	0.0546	0.4274	0.0488	0.0544	-0.2257	-0.3659	-0.6856	0.3901	-0.2380	0.4282	0.0565	-0.2020	0.9610	0.8453	0.8964	1.0000		
Pro	0.3258	-0.9163	-0.7655	0.5002	0.3185	-0.7320	-0.1612	-0.1499	0.0783	-0.4059	0.3556	0.2649	-0.1243	-0.3380	0.2372	-0.2396	0.7681	-0.2158	-0.5967	0.8987	0.9659	0.9759	0.8564	1.0000	
TAZ	0.2760	-0.8691	-0.8865	0.4123	0.3143	-0.7226	-0.0350	-0.1094	0.2723	-0.2325	0.2381	0.0596	-0.2485	-0.4943	0.3368	-0.2724	0.6473	-0.1025	-0.4819	0.9758	0.9718	0.9955	0.9272	0.9675	1.0000

S_2

	EC	Tr	TW	TDS	TSS	TA	FCO	DO	BOD	COD	Har	pH	Na	Ca	Mg	K	PO	NO	Cl	Cla	Cop	Rot	Ost	Pro	TAZ
EC	1.0000																								
Tr	-0.2556	1.0000																							
TW	0.3455	0.4356	1.0000																						
TDS	0.7977	-0.3594	0.0468	1.0000																					
TSS	0.5826	0.0539	0.5450	0.7253	1.0000																				
TA	-0.3773	0.3534	0.3305	-0.6440	-0.3617	1.0000																			
FCO	-0.1011	0.0613	0.3093	-0.2577	0.0444	0.1936	1.0000																		
DO	-0.0806	-0.4882	-0.8579	0.2721	-0.1328	-0.6206	-0.1172	1.0000																	
BOD	-0.6995	0.4372	0.1531	-0.7984	-0.4929	0.5337	0.1459	-0.4206	1.0000																
COD	-0.3272	0.1789	0.2829	-0.6258	-0.2731	0.3699	0.1818	-0.4370	0.7335	1.0000															
Har	0.8461	-0.3069	0.3862	0.7538	0.7148	-0.4080	-0.1280	-0.0535	-0.6598	-0.2923	1.0000														
pH	0.6163	-0.2308	-0.0938	0.7557	0.5121	-0.3141	-0.3930	0.2474	-0.8869	-0.7161	0.5807	1.0000													
Na	0.7090	0.2014	0.7638	0.3631	0.5453	0.1387	0.0716	-0.6621	-0.2685	0.0789	0.5816	0.3763	1.0000												
Ca	0.7579	0.0392	0.7003	0.6882	0.9135	-0.2496	0.0320	-0.3470	-0.5217	-0.2215	0.8559	0.5077	0.7483	1.0000											
Mg	-0.4934	0.2771	-0.2276	-0.4757	-0.4788	0.2164	-0.0795	0.0321	0.4488	0.0648	-0.2967	-0.2986	-0.3274	-0.4800	1.0000										
K	0.5671	0.1461	0.5801	0.3397	0.5488	0.1420	0.1449	-0.4593	-0.4600	-0.1318	0.5524	0.5771	0.8748	0.6919	-0.2154	1.0000									
PO	0.4996	-0.7763	-0.5017	0.7170	0.1537	-0.6750	-0.1077	0.6781	-0.7310	-0.5910	0.4237	0.5146	-0.1250	0.1238	-0.3044	-0.0522	1.0000								
NO	-0.5771	0.0848	-0.3659	-0.5335	-0.3719	0.1642	0.2066	0.2163	0.2283	0.3450	-0.6688	-0.1994	-0.3074	-0.5491	-0.0157	-0.1104	-0.2647	1.0000							
Cl	-0.4145	0.5997	0.3005	-0.7249	-0.4916	0.8216	0.2914	-0.5825	0.5836	0.2627	-0.4792	-0.4313	0.0914	-0.3376	0.5275	0.0968	-0.7111	0.1015	1.0000						
Cla	-0.2908	-0.4632	-0.9384	0.0933	-0.4083	-0.3881	-0.4036	0.8253	-0.2175	-0.4409	-0.2243	0.2092	-0.7197	-0.5662	0.3668	-0.5065	0.5556	0.1498	-0.3301	1.0000					
Cop	0.0174	-0.5178	-0.8300	0.4392	-0.0533	-0.6822	-0.3490	0.8806	-0.5595	-0.5949	0.0338	0.4778	-0.4905	-0.2297	0.0109	-0.2593	0.7665	0.1303	-0.6340	0.8795	1.0000				
Rot	-0.0495	-0.6162	-0.8428	0.3626	-0.0985	-0.6265	-0.3179	0.8971	-0.4345	-0.4620	0.0435	0.3650	-0.5527	-0.2940	0.1497	-0.3367	0.7375	0.1188	-0.6246	0.9178	0.9508	1.0000			
Ost	-0.1872	-0.5014	-0.9639	0.1832	-0.3636	-0.4475	-0.3919	0.8699	-0.3397	-0.4666	-0.2381	0.3012	-0.6575	-0.5316	0.1167	-0.4629	0.6407	0.2581	-0.4412	0.9546	0.9286	0.9112	1.0000		
Pro	0.1557	-0.7444	-0.7459	0.5119	-0.0340	-0.6344	-0.2854	0.8372	-0.5471	-0.5766	0.1836	0.4342	-0.4403	-0.1705	0.0185	-0.2939	0.8671	-0.0773	-0.6572	0.8419	0.8995	0.9461	0.8534	1.0000	
TAZ	-0.1025	-0.5642	-0.8974	0.3117	-0.2128	-0.5537	-0.3646	0.8901	-0.4085	-0.5445	-0.0579	0.3540	-0.6195	-0.3891	0.1869	-0.4090	0.7194	0.0947	-0.5218	0.9667	0.9571	0.9771	0.9621	0.9382	1.0000

S_3

Abbreviations: EC: Electrical conductivity, Tr: Transparency, TW: Water temperature, TDS: Total dissolved solids, TSS: Total suspended solids, TA: Total alkalinity, FCO: Free carbon dioxide, DO: Dissolved oxygen, BOD: Biochemical oxygen demand, COD: Chemical oxygen demand, Har: Hardness, pH, Na: Sodium, Ca: Calcium, Mg: Magnesium, K: Potassium, PO: Phosphates, NO: Nitrates, Cl: Chlorides, Cla: Cladocera, Cop: Copepoda, Rot: Rotifera, Ost: Ostracoda, Pro: Protozoa, TAZ: Total abundance of zooplankton

The strong negative correlation coefficient matrices were recorded between temperature of water and total zooplankton abundance in S_1 (r = -0.9163), S_2 (r = -0.8865), and S_3 (r = -0.8974) which resemble the work of [60, 62]. Water transparency was observed to exhibit high negative correlation with the zooplankton abundance which is a good evidence of eutrophication in the ponds (S_1, S_2, and S_3) that is altering the transparency of pond water and holds the potential to affect the zooplankton population dynamics. The abundance of zooplankton also showed an inverse relationship with pH at S_1 (r = -0.3125) confirming the study of [63] and presenting a weak correlation, however, at S_1 and S_3 a direct positive relationship was recorded (r = 0.0596 and r = 0.3540) which are poorly correlated. In the present study the free CO_2 has been reported to be weakly negatively correlated at S_1, S_2, and S_3 (r = -0.3959; r = -0.0350; r = -0.3646). Zooplankton abundance showed a strong direct relationship with DO at S_1 (r = 0.7548), and S_3 (r = 0.8901), similar to the findings of [63-64] while contrasting result was recorded with S_2 (r = -0.1094). As studied by [65] the disappearance of zooplankton took place in the Blue Nile due to increase in concentration of the suspended matter in it while [66] did not find decrement in the zooplankton with increased concentration of the suspended particles. Total alkalinity showed moderate negative relationship with zooplankton abundance at S_1 (r = -0.6569), S_2 (r = -0.7226), and S_3 (r = -0.5537). Hardness has been found to have a weak positive correlation with zooplankton abundance at S_1 (r = 0.0374), and S_2 (r = 0.2381), as supported by the study of [67] while a negative correlation was reported from the S_3 (r = -0.0579). Among the studied ponds electrical conductivity showed very weak positive correlation zooplankton population at S_2 (r = 0.2760) while negative correlation at S_1 (r = -0.1630) and S_2 (r = -0.1025) which can be explained as increase in electrical conductivity decreases concentration of the oxygen dissolved in the medium and thereby the zooplankton population [68]. Although weak but a positive correlation was recorded between TDS and zooplankton abundance in S_2 (r = 0.4123) and in S_3 (r = 0.3117) [9] while in the contrary negative correlation was reported in S_1 (r = -0.0883). In S_1 and S_3 the BOD values were found to have weak negative correlation with zooplankton abundance (r = -0.3778; r = -0.4085) as also reported by [69] whereas in S_2 BOD value showed a positive correlation (r = 0.2723) supporting the work of [68]. COD was recorded to possess a weak but considerable inverse correlation with zooplankton abundance in S_1 (r = -0.2983), S_2 (r = -0.2325), and moderate inverse correlation in S_3 (r = -0.5445); this result is being supported by the work done by [69].

In the present study ions as calcium, potassium and chloride have shown negative correlation with the zooplankton population in the samples from water of all the ponds. These findings corroborate the study of [70]. [71] have also reported the inverse correlation of chloride ion with zooplankton population. Magnesium showed very weak negative correlation with zooplankton in S_1 (r = -0.0554) but weak to moderate positive correlation in case of S_3 (r = 0.1869) and S_1 (r = 0.3368). The zooplankton abundance markedly has been reported to show direct correlation with the phosphate ion at all the studied ponds as S_1 (r = 0.5956), S_2 (r = 0.6473), and S_3 (r = 0.7194) that is moderate to high. Similar findings were made by [72-73] where phosphate displayed a positive correlation with zooplankton population, however, contrary result also exists with work of Joseph and [74] where total zooplankton posed significant and negative correlation with phosphate ion. Sodium ion has shown a negative correlation with the zooplankton abundance in S_1 (r = -0.4784), S_2 (r = -0.2485), and S_3 (r = -0.6195) and present a weak to moderate relationship which is not in confirmation with the study of [70] who mentioned the positive impact of sodium ion on zooplankton population. Nitrates showed very weak but positive correlation with total zooplankton at S_3 (r = 0.0947) similar to the finding of [73] while negative correlation at S_1 (r = -0.2912) and S_2 (r = -0.1025).

8. CONCLUSION / SUMMARY:

Investigation of the surface water chemistry from the Rejali Pond (S_1), the Kichinn Pond (S_2), and the Bhokta Pond (S_3) has given an understanding into the level of contamination in terms of physico-chemical attributes and zooplanktonic community structure. S_1 or the Rejali Pond has been discovered to be the most polluted one that was mainly influenced by disturbances due to high TDS and ions like sodium, potassium, and phosphates with low DO concentration including the high growth of macrophytes (*Eichhornia* and *Lemna*) and rotifers (*Brachionus* and *Keratella*). However, the S_2 and S_3 were comparatively less polluted than S_1; with higher zooplankton occurrence and diversity. Overall, this study has come up with a base line informational data on the prevailing biotic and abiotic conditions of the three forsaken ponds and the result obtained thus shows that these ponds can be managed for the fish culture practice and can be improved for plankton and fish survival.

9. REMEDIES AND MEASURES:

Awareness among local people to maintain the ponds at their optimum quality and purity levels by certain management practices like planting of trees around ponds, although onset of monsoon dilutes pond water pollutants, regular recharging during dry season, sediment removal from pond bottoms along with removal of floating debris from the surface of ponds, diversion of sewage effluents to some managed disposal sites including enforcement of law and policy may be very successful in utilization of the land assets as ponds.

REFERENCES:

1. Gayathri S., Latha N., and Mohan R. M., (2014): Studies on population dynamics and seasonal abundance of zooplankton community in Doddavoderahalli lake, Bangalore. *International Journal of Emerging Trends in Engineering and Development,* 1(4), 50-55.
2. Salve B. S., and Hiware C. J., (2006): Studies on water quality of Wanparkalpa reservoir, Nagapur, Near Parli Vaijinath, Dist Beed, Marathwada region. *Journal of Aqutic Bioiology*, 21 (2), 113- 117.
3. Grant S.B., Saphores J., Feldman D.L., Hamilton A.J., Fletcher T.D., Cook P.L.M., Stewardson M., Sanders B.F., Levin L.A., Ambrose R.F., Deletic A., Brown R., Jiang S.C., Rosso D., Cooper W.J., and Marusic I. (2012): "Taking the "waste" out of "Wastewater" for human water security and ecosystem sustainability". *Science*, 337 (6095), 681–686.
4. Vorosmarty C.J., McIntyre P.B., Gessner M.O., Dudgeon D., Prusevich A., Green P., Glidden S., Bunn S.E.,. Sullivan C.A, Liermann C.R., and Davies P.M., (2010): Global threats to human water security and river biodiversity. *Nature*, 467 (7315), 555–561.
5. Gupta S., Maheto A., Roy P., Datta J.K.., and Saha R.N., (2008): Geochemistry of groundwater Burdwan district, West Bengal India. *Environmental geology*, 53, 1271–1282.
6. Ghanai A.H., Parveen S., and Khan A.A., (2010): Study of some physico- chemical parameters in Medical pond, Aligarh. *The Ekologia*, 10, 89-96.
7. Kamat S., and Sima V., (2000): Hydrobiological studies of two temple ponds in Ponda Taluka, Goa. *Ecology Environment and Conservation*, 6, 361-362.
8. Shiddamallayya N., and Pratima M., (2008): Impact of domestic sewage of fresh water body. *Journal of Environmental Biology*, 29, 303-308.
9. Rajagopal T., Thangamani A. and Archunan G., (2010): Comparison of physico-chemical parameters and phytoplankton species diversity of two perennial ponds in Sattur area, Tamil Nadu. *Journal of Environmental Biology*, 31, 787-794.
10. Raja P., Amarnath A.M., Elangovan R., and Palanivel M., (2008): Evaluation of physical and chemical parameters of river kaveri, Tiruchirappalli, Tamil Nadu, India. *Journal of Environmental Biology*, 29, 765-768.
11. El-Serafy S.S., Mageed A.A., and El-Enany H.R., (2009): Impact of flood water on the distribution of zooplankton in the main chaneel of Lake Nasser, Egypt. *Journal of Egyptian Academic Society for Environmental Development*, 10, 121-141.
12. Epifanio C.E., and Garvine R.W., (2001): Larval transport on the Atlantic continental shelf of North America: A Review. *Estuarine, Coastal and Shelf Science*, 52, 51-77.

13. Kimmel D.G., Roman M.R., and Zhang X., (2006): Spatial and temporal variability in factors affecting mesozooplankton dynamics in Chesapeake Bay: Evidence from biomass size spectra. *Limnology and Oceanogaphy*, 51, 131 – 141.
14. APHA (2005). American Public Health Association, Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, DC.
15. Edmondson, W.T. (1966). *Freshwater Biology*. 2nd Edn., John Wiley and Sons. Inc. New York & London.
16. Needham, J.G. and Needham, P. R. (1962). *"Fresh water biology"*. Holder Day Inc. San. Francisco.
17. Pennak, R.W. (1978). *Freshwater Invertebrates of United States*. 2nd Edn., John Wiley & Sons Inc., New York.
18. Tonapi, G.T. (1980). *"Freshwater Animals of India" An Ecological Approach*. Oxford and IBH Publishing Co., New Delhi, India.
19. Kudesia, V.P. (2000). *Trace and macronutrient elements in drinking water*. Pragathi Prakashan, Meerut.
20. Gaikwad S.R., Ingle K.N., and. Thorat, S.R., (2008): Study of zooplankton pattern and resting egg diversity of recently dried waterbodies in north Maharashtra region. *Journal of Environmental Biology*, 29 : 353-356.
21. Sastry K.V., Rathee P., and Sukla V., (1999): Ground water characteristics of Rohtak and Bahadurgarh. *Environmental Ecology,* 17, 105–108.
22. Murugesan S., Kumar D.S., Rajan S., and Chandrika D., (2004): Comparative study of ground water resources of east and west region of Chennai, Tamilnadu. *Nature Environment and Pollution Technology,* 3(4), 495–499.
23. Jayakumar P., Jothivel N., Thimmappa A., and Paul V.I., (2009): Physicochemical characterization of a lentic water body from Tamilnadu with special reference to its pollution status. *The Ecoscan,* 3(1&2), 59–64.
24. Shinde S.E., Pathan T.S., Raut K.S., More P.R., and Sonawane D.L., (2011): Studies on the physico-chemical parameters and correlation coefficient of Harsool-savangi Dam, District Aurangabad, India. *Middle East Journal of Scientific Research,* 8(3), 544–554.
25. Arasu P.T., Hema S., amd Neelakantan M.A., (2007): Physico-chemical analysis of Tamirabarani river water in south India. *Indian Journal of Scientific Research and Technology,* 1(2), 1–5.
26. Shinde S.E., Pathan T.S., Raut K.S., More P.R., and Sonwane D.L., (2010): Seasonal variations in physico-chemical characteristics of Harsool-Savangi dam, Aurangabad, India. *The Ecoscan,* 4(1), 37–44.
27. George D.G., Marberly S.C., and Hewitt D.P., (2004): The influence of North-Atlantic oscillation on the physics, chemistry and biology of four lakes in the English Lake District. *Freshwater Biology,* 49, 760–774.
28. Abowei J.F.N., (2010): Salinity dissolved oxygen, pH and surface water temperature conditions in Nkoro River, Niger Delta, Nigeria. *Advance Journal of Food Science and Technology,* 2(1), 36–40.
29. Barai S.R., and Kumar S., (2013): Evaluation of the physico-chemical characteristics of river Varuna at Varanasi, India. *Journal of Environmental Biology,* 34, 259–265.
30. Karanth K.R., (1987). Groundwater assessment development and management. Tata McGraw Hill Publishing Company Ltd., New Delhi, 725–726.
31. Kurbatova S. A., (2005): Response of microcosm zooplankton to acidification. *Izv. Akad. Nauk.Ser Biol*., 1, 100-108.
32. Boyd, C. E. (1979). *Water Quality in Warmwater Fish Ponds*. Agriculture Experiment Station, Auburn, Alabama, pp. 359.
33. Boyd, C.E. (1998). *Water Quality for Pond Aquaculture*. Research and Development Series No. 43. International Centre for Aquaculture and Aquatic Environments, Alabama Agricultural Experiment Station, Auburn University, Alabama.
34. Boyd, C.E, and Lichtkoppler, F. (1979). *Water Quality Management in Fish Ponds*. Research and Development Series No. 22, International Centre for Aquaculture (J.C.A.A) Experimental Station Auburn University, Alabama, pp 45-47.
35. Jhingran, V.G. (1992). *Fish and Fisheries of India*. Hindustan Publishing Corporation, New Delhi, India.
36. Mengel, K. (2007). Potassium. In Barker A V and Pilbeam D J (eds). *Hand book of plant nutrition*. Tailor and Francis, New York.pp. 91-120.
37. Ansari K.K., and Prakash S., (2000): Limnological studies on Tulsidas tal of Tarai region of Balrampur in relation to fisheries. *Pollution Research,* 19(4), 651-655.
38. Venkatasubramani R., and Meenambal T., (2007): Study of subsurface water quality in Mattupalayam Taluk of Coimbatore district Tamil Nadu. *Nature Environment and Pollution Technology,* 6, *307- 310.*
39. Kannel P.R., Lee S., Lee Y.S., Kanel S.R., and Pelletier G.J., (2007): Application of automated QUAL2Kw for water quality modeling and management in the Bagmati River, Nepal. *Ecological Modelling*, 202, 503–517.

40. N.J. Prakash, (2004), *Studies on groundwater quality of Magadi taluk, Bangalore rural district, Karnataka*, doctoral diss., Kuvempu University, India, (1–230).
41. Ogbeibu A.E., Ezemonye L.I.N., and Uyigue E., (2001): The crustacean zooplankton of the Ovia River, Southern Nigeria. *Nigerian Journal of Applied Sci*ence, 19, 36-42.
42. Imoobe T.O.T., and Adeyinka M.L., (2010): Zooplankton-based assessment of the trophic state of a tropical forest river. *International Journal of Fisheries and Aquaculture*, 2(2), 64-70.
43. Kumar P., Wanganeo A., Wanganeo R., and Sonaullah F., (2011): Seasonal variations in zooplankton diversity of railway pond, Sasaram, Bihar. *International Journal of Environmental Sciences*, 2, 1007-1016.
44. Bera A., Dutta T.K., Patra B.C., and Sar U.K., (2014): Correlation study on zooplankton availability and physico-chemical parameters of Kangsabati Reservoir, West Bengal, India. International *Research Journal of Environment Sciences*, 3(12), 28-32.
45. Ahmed K.K.U., Ahamed S.U., Hossain M.R.A., Ahmed T., and Barman S., (2003): Quantitative and qualitative assessment of plankton: some ecological aspect and water quality parameters of the river Meghna, Bangladesh. *Bangladesh Journal of Fisheries Research*, 7(2), 131-140.
46. Rahman S.,and Hussain M.A., (2008): A study on the abundance of zooplankton of a culture and a non-culture pond of the Rajshahi University campus. *University journal of zoology, Rajshahi University*, 27, 35-41.
47. Santanu A., Nanda G., Trivedi R.K., Shibam S., Abhrajyoti M., and Susmita J., (2017): A study on plankton diversity of three urban ponds in Kolkata of West Bengal state, India. *International Journal of Advanced Biotechnology Research*, 4, 687-691.
48. Saidu A.K., Agbelege O.O., Ahmed M.T., and Olanrewaju A.N., (2009): Some water quality parameters and zooplankton periodicity of the Baga in-take channel of Lake Chad. *Proceedings of Fisheries Society of Nigeria*, 1, 105–107.
49. Welcomme R.L., (1975): Fisheries ecology of African floodplains. FAO CIFA Technical Paper 3. 51p
50. Hall D.J., (1964): An experimental approach to the dynamics of a natural population of *Daphnia galeata mendotae*. *Ecology*, 45, 94-112.
51. Balakrishna D., Reddy T.R., Reddy K.V., and Samatha D., (2013): Physico-chemical parameters and plankton diversity of Ghanpur lake, Warangal, A.P., India. *International Journal of Zoological Research*, 3, 44-48.
52. Rajashekhar M., Vijaykumar K., and Parveen Z., (2009): Zooplankton diversity of three freshwater lakes with relation to trophic status, Gulbarga district, North-East Karnataka, South India. *International Journal Systems Biology*, 1, 32-37.
53. Arora H.C., (1962): "Studies on Indian Rotifera – Part I". *Journal of the Zoological Society of India*, 14, 33-44.
54. Ahmad U., Parveen S., Khan A.A., Kabir H.A., Mola H.R.A., and Ganai A.H., (2011): Zooplankton population in relation to physico- chemical factors of a sewage fed Pond of Aligarh (UP), India. *Biology and Medicine*, 3, 336-341.
55. Ahmad U., Parveen S., Mola H.R., Kabir H.A., and Ganai A.H., (2012). Zooplankton population in relation to physicochemical parameters of Lal Diggi pond in Aligarh, India. *Journal of Environtal Biology*, 33, 1015-1019.
56. Kiran B.R., Puttaiah E.T., and Kamath D., (2007): Diversity and seasonal fluctuation of zooplankton in Fish Pond of Bhadra fish farm, Karnataka. *Zoos' Print Journal*, 22(12), 2935-2936.
57. Horne D.J., D.J., Holmes J.A., Rodriguez-Lazaro J., and Viehberg F., (2012): *Ostracoda as Proxies for Quaternary Climate Change*. Developments in Quaternary Science 2, 65–84. Elsevier.
58. Poquet J.M., Mezquita F., Rueda J., and Miracle A.R., (2008): Loss of Ostracoda biodiversity in Western Mediterranean wetlands. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 18, 280–296.
59. Fenche, T. and Finlay, B.J. (1995). *Ecology and evolution in anoxic worlds*. Oxford Series in Ecologyand Evolution (Eds R.M. May and P.H. Harvey). Oxford: Oxford University Press.
60. Davies O. A., Abowei J.F.N., and Otene B.B., (2009): Seasonal abundance and distribution of plankton of Minichinda stream, Niger Delta, Nigeria. *American Journal of Scientific Research*, 2, 20-30.
61. K.I.D.K. Sajeev, (1999), Analytical studies on the ecosystem of the Ropar Headworks reservoir, doctoral diss., Punjabi University, Patiala.
62. Islam M.N., Khan T.A., and Bhuiyan A.S., (2000): Ecology and seasonal abundance of some zooplankton of a pond in Rajshahi. *University journal of zoology, Rajshahi University*, 19, 25−32.
63. Alam A.K.M.N., Islam M.A., Mollah M.F.A., and Haq M.S., (1987): Status of zooplankton in newly constructed ponds and their relation to some meteorological and limnological factors. *Bangladesh Journal of Fisheries*, 10(1), 83−88.

64. Veerendra D.N., Thirumala S., Manjunatha H., and Aravinda H.B., (2012): Zooplankton diversity and its relationship with physico– chemical parameters in Mani reservoir of Western Ghats region, Hosanagar Taluk, Shivamoga district, Karnataka, India. *Journal of Urban and Environmental Engineering*, 6(2), 74–77.
65. Moghraby A.I., (1977): A study on diapause of zooplankton in a tropical river, the Blue Nile. *Freshwater Biol*ogy, 7, 207-212.
66. Carvalho M.L., (1983): Efeitos da flutuação do nível d'água sobre a densidade e composição do zooplâncton em um lago de vârzea da Amazônia, Brasil. *Acta Amazonica* , 13(5-6), 715-724.
67. Ratushnyak A.A., Borisovich M.G., Vallev V.S., Ivanov D.V., Andreeva M.G., and Trushin M.V., (2006): The hydrochemical and hydrobiological analysis of the condition of the kuibyshev reservoir littorals (Republic of Tatarstan, Russia). *Ekoloji*, 15, 22-28 .
68. Nigar S., and Rahmatullah M., (2020): Analysis of zooplankton diversity and physicochemical conditions in three perennial ponds of Darbhanga district, Bihar. *International Journal of Advanced Academic Studies*, 2(1), 257-262
69. Santosh V., Archna M., Milin A., Alok V., and Geeta S., (2013): Impact of water quality on zooplankton biodiversity in river Betwa, Madhya Pradesh, India. *Agricultural Ecology and Environment*, 40-57.
70. Subinoy M., Debajyoti K., Smaranya H., Tarakeshwar S., and Apurba G., (2015): Seasonal variation of zooplankton distribution in sewage-fed East Kolkata wetland, West Bengal, India. *Pollution Research*, 34, 477-787.
71. Sharma B.K. and Hussain M., (2001). Abundance and ecology of zooplankton in a tropical floodplain lake, Assam (N.E. India). 7, 397-403.
72. Sinha K.K., and Sinha D.K., (1993): Seasonal trends in physico-chemical factors and zooplankton in a fresh water pond of Munger, Bihar. *Journal of Ecobiology*, 5(4), 299-302.
73. Mustapha M.K., (2010). Seasonal influence of limnological variables on plankton dynamics of a small, shallow, Tropical African reservoir. *Asian Journal of Experimental Biological Sciences*, 1(1), 60-79.
74. Joseph B., and Yamakanamardi S.M., (2011): Monthly changes in the abundance and biomass of zooplankton and water quality parameters in Kukkarahalli lake of Mysore, India. *Journal of Environmental Biology*, 32, 551-557.