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Study of Biodiversity of fresh water zooplankton in Barali Lake, Hurda, District Bhilwara Rajasthan (India)

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Abstract

The present work fulfilled its task as a direction finder in a diversified subject area, embodying both theoretical and applied knowledge. It contributed to a more informed evaluation and response to environment problems in water quality, pollution control and environmental concerns; comprising a logical scientific approach to which there is no known competitor. In the present study the main focus on the objectives like quarterly variation in physio-chemical properties of water, Primary Productivity in terms of Biomass and Chlorophyll content, variations in Composition and Density of zooplankton population and correlation between BOD & COD with zooplankton Population of BARALI LAKE, Hurda. The zooplankton found on the water body and float with the water current but they plays important part in transferring the energy from one to another trophic level, they act as a food alternative for many aquatic creatures. They are main vital part of eutrophication. Zooplankton are found as tremendous Bio indicator to estimate the contamination of water body. The biodiversity of zooplankton are found very high in the potentiality as bio indicator their diversity and density depends on certain environmental factors like temperature, pH, pollution, stratification etc. and also on some biological factors like predation, food restrictions and competition for survival. There are four main classes of zooplankton viz. Rotifera, Ostracoda, Cladocera and Copepoda. The zooplankton community especially rotifers changes with respect to change in biotic and abiotic factors like temperature, pH, turbidity, BOD, COD, Alkalinity, TDS, dissolved oxygen, Total hardness etc.

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Water is the most imperative compound that enormously influences life. Quality of water is habitually described as per its physicochemical and biological characteristics. The plankton describes the water quality and its ecological status. The plankton abundance with special reference to physio- chemical factors and revealed that abundance of different groups of zooplankton the optimal temperature is required in different seasons. The physio chemical components like Dissolved oxygen, pH and transparency shows negative co realtion with rotifers cladocerans[7]. The water cannot be used for drinking purposes if the physiochemical parameters under the permissible limit of world health organization. The Occurrence of plankton in the water body can be identified by the co-ordination of ecological components and biotic components. The trophic status of the Lake is determined by the changes occur inside the community of plankton there. Zoopanktonic species such as Brachinous, Moina and Cyclops were found in abundant can be responsible for the degradation of quality of water body[9]. As the eutrophication is the process of increasing nutrient richness of the water body and in terms of lakes this process is found naturally as well as due to human interference in the environment. When there is a disturbance in surrounding environment the zooplankton show rapid change in their population such as eutrophication[10].

Collection of zooplanktons:

The collection of zooplanktons is added with the percolation of water with net, water is collected in bottles. The mesh size selected should be suitable and time taking the sample should be suitable. There are three leading approaches of zooplankton collection:

a. Bottles / water samplers :

The method of bottles is mainly used to collect smaller micro-organisms or micro zooplanktons. The bottles collect the sample of 5 to 20 liter from the sampling sites.

The bottles should be taken after getting it sterile preferably. Some of the important note which should be considered during the collection of sample are:- to reduce the reaction by planktons there should be minimum disturbance in water body, bottle should be of suitable size and sterile. The sample is allowed to settle, centrifuge or fine filtration so that concentrated sample of micro zooplanktons will be achieved. This method is easy to operate and the depth of sampling is accurately being known. The disadvantage id this that the filtered amount of sample is less. Macro zooplanktons or bigger zooplanktons are not collected by this means[13]. So it is not preferable for qualitative and quantitative analysis.

b. Nets :

Net is the method of collecting zooplanktons very commonly. Water filtered amount is much higher and is appropriate for qualitative and quantitative analysis. These nets are available of different types and different sizes. Two types of nets are found open and closed nets out of which open types are used for horizontal study and closed are used for oblique or vertical study.

These nets are conical in shape and having a ring, collecting bucket and cone for filtering of the organisms. Net material should be made up of bolting silk, synthetic material or nylon. Bucket for the collection should be strong enough and should be easily removable from the net. Net material should be durable and of fixed in pore size. As the material puts effects on zooplanktons types. So it should be square in shape and uniform aperture. Fine mesh size net helps to collect smaller organisms micro zooplanktons, larvae and eggs in planktonic forms while granular net helps to gather bigger planktons macro zooplanktons and fishes.

For collecting zooplanktons for productivity of water body study and taxonomic study the mesh size of 0.25 mm is preferable. Quality and quantity of collected zooplanktons depends on the mesh length, mouth area of net, type of mesh, speed of pulling and time of collection.

The collection of zooplanktons can be made vertical oblique or horizontal hauls. Horizontal collection is made up of of towing water speed for 5 to 10 minutes. This speed should be like, for better filtration the amount of water entering through mouth should be maximum. If the towing speed goes much higher than the water is diverted outside and effective filtration got reduced. This can results in damage of net also. The net should be sunken in water.

According to light the zooplanktons moves vertically. They appear less in day time on upper layers of water body. Before dawn, after dusk or night is the right suitable time for zooplanktons to get collected. The nets should be in desired position of collection during the water current. On surface and sub surface layers of water body the horizontal collection is done mostly.

The depth of sampling is done through vertical method and the depth may not be known accurately. Net moves from uo to down and sample is collected from down to up direction in a column. Out of so many types of net, Commonly used net is HT net which is heron tranter net. Having mouth area of 0.25 mm, filtering cone of square frame, mesh size of 2mm and used for oblique and horizontal studies both. At particular depth these net get closed after collection. The net should be washed after each collection. So that the planktonic material remained attached in net should be transferred to bucket so that contamination of samples is prevented. It also helps to prevent clogging. If the net gets torn then planktons will run away escaping and loss of sample occurs so it should be checked regularly.

Plankton Net

After each collection the sample is transferred to half liter capacity beaker which

is previously cleaned and dried. Large impurities like debris should be removed. The zooplankton collection particularly from deeper strata it results in expensive, expertise and proper gear. Records of sampling, volume of sample, time of collection, environmental conditions and other information should be written in the field on worksheet, before it is taken to the laboratory for further investigations and fixation. Some of the observations like abundance, composition and coloration are made in field before fixation[14].

Fixation :

For effective analysis of sample fixation is necessary. Poorly fixed or preserved samples will make the subsequent analysis. If the sample is improperly fixed, ruptured than whitish precipitate will be seen. As early as possible the sample should be fixed. At least within five minutes of collection the fixation to be done so that animal tissue damage by autolysis or bacterial action should be avoid.

Selection of fixative is done on the basis that it should be cheap and also it should kill the animals quickly. It should be non-poisonous and non-corrosive in nature. Most commonly use fixative and preservative is formaldehyde (formalin) 4to 5 %. It is cheapest of other fixatives and helps to fix and store the zooplanktons for so many years. Osmotic effects are reduced by diluting the concentrated formalin with fresh water or by sampling water. One part of 4-5 % formalin is added in 9 part of fresh or sampling water for the dilution. Fixative pH should be around 8.0 buffered formalin can be used. Buffering can be done through borax or hexa methylene tetra amine. After fixation body of zooplanktons becomes hard and brittle. To resist the bacteria and moulds some of the additives are added to fixatives like propylene glycerol and propylene phenoxetal for specimen flexibility.

Preservation :

For minimum ten days the fixation is allowed. Then preservation can be done. After completion of fixation the sample zooplanktons are transferred to air tight containers and stored with adequate quantity of preservatives. Buffered formalin of 4-5 % is most widely used preservative. Other are ethanol of 70%, isopropanol of 40%. In the transfer of sample care should be taken as to minimize the loss of any part of zooplankton caused. Addition of glycerine is done to stop the shrinkage of specimen, material drying and zooplanktons colors are retained through it. The zooplankton samples are usually kept in well ventilated rooms at temp. below 25ºC. the details of zooplankton collection and time, fixative preservative more are written on slip fixed on the bottle prior to the study.

Analysis of the samples:

The physiochemical analysis of parameters was done by APHA techniques and analysis of zooplanktons and water consist of measurement of standing stock (biomass), listing of texa and species[3].

1. Biomass :

In the zooplankton sample the amount of living matter or live weight denotes its

biomass. These values are essential to evaluate the secondary productivity and potentials of fishery in that particular area. Before the biomass measurement is done the fish larvae, siphonophores, salps, medusa, ctenophores are separated from the sample which are larger zooplanktons[2]. Total biomass will be of bigger plus rest of zooplanktons. Estimation of biomass can be done by following methods:-

a. Volumetric method (settling and displacement volume).
b. Gravimetric (Ash free, wet, dry weight) method.
c. Chemical method.

a. Volumetric method :

This method is easy to done in field or in laboratory. In this method the total of zooplankton volume is calculated by displacement volume method. First the sample of zooplankton is filtered with the help of dry, clean and netting material. Its mesh size should be same or smaller than the mesh size of collecting sample net. The water in the middle of the organisms interstitially is detached by the blotting paper. The zooplankton after filtration is shifted to recognize volume of 4 % buffered formalin in a measuring cylinder. The volume of fixatives displaced by zooplanktons in measuring jar is recorded to know the displacement volume. Before determining the settled volume the planktons remain settle for at least 24 hours.

b. Gravimetric method:

The measurement of zooplankton weight should not be completed in laboratory preferably. It is done by filtering the zooplanktons. The water in the middle of the organisms interstitially is detached by the blotting paper. Not too much of pressure should be made on the blotting, to reduce the damage of delicate organisms or specimen.

Aluminum foil or filter paper's weight is done firstly than the zooplankton weight is taken on it. The grams are a unit to express the weight. As the values of dry weight indicate the organic content of planktons the method is dependable. Dry weight is determined by drying the sample at 60 degree centigrade in electric oven. Only some amount of sample is dried for the analysis of weight as remaining is used to analyze the identification and listing of their species. Values of weight are denoted in milligrams and till weighing the sample is kept in the desiccator[4].

c. Chemical method:

In this kind of method dry frozen of live zooplanktons is done. The distilled water is used to rinse the samples before its analysis. The chemical constituents such as nitrogen, carbon, phosphorus are measured also with bio chemical analysis like carbohydrates, proteins and lipids. Occasionally at higher trophic levels the bio-chemical values of specific texa and species are carry out to calculate the food energy transfer. The calorific content of the plankton can be used as an index of zooplankton biomass[6].

Counting :

The next step to study of the analysis is to list and count the sample specimens. Two types of sorting is primarily known. Primary and secondary. In primary sorting the sample

is separated in 30-40 taxonomic groups then on secondary stage the found significant groups of organisms are separated into their corresponding families or genera in the next. In fresh water the biodiversity of zooplanktons groups is less commonly found texa of zooplanktons are protozoa, Cladocera, Rotifer, Copepod and Ostracoda etc. The biodiversity of zooplankton are found very high in the potentiality as bio indicator.[4] So many zooplanktons of particular group is seen under the microscope then the tally mark is made on the sheet. All the specimens are counted in record form of the sub sample. Multiple counting is made for studying the sample simultaneously. Later according to amount of subsamples examined helps to compute the number of specimens for the whole sample.

The system of image analysis is used for the quick counting of collective species and taxa. Examples of fresh water in addition to marine water of identical group are generally take place in marine biology and Limnology.

Species identification:

Group of organisms capable of interbreeding are defined as species. Accurate identification of species depends on some of the characteristics like seasonal variability, distributional pattern, and community structure of zooplanktons the the ecosystem. Initially the common species can be identified with the help of given examples list. This work needs patience, adequate published works and knowledge.

The apparatus mandatory for the species identification are dissecting microscope, glass slides of fine quality, forceps of stainless steel, dissecting needles, coverslips, pipettes, chemical reagents etc. Various steps are required for the identification process like cleaning of specimen, staining, dissection and slide preparation. Very common and plentiful forms of zooplanktons in an given area are recognized live under the dissecting microscope mixed with drop of distilled water. Narcotization is done to regulate the movement of specimens.

Data Calculation:
Qualitative and quantitative analysis of zooplankton:

The method for standardization is Sedwick- rafter cell method and Lackeys drop method were used for the analysis of zooplankton on the basis of qualitative and quantitative aspects. Sedgwick-rafter cell comes with the dimensions of 50milimiter * 20milimeter * 1milimeter to count six strips. The sedgewick rafter cell holds 100 cubic milimilters of liquid 1 mm deep over an area of 50 * 20 mm.[8].

Sedgewick rafter cell

For lackeys drop method usually drop water is taken on the slide and coverslip is placed over it. This cover slip is studied by placing strips over one another to calculate all

the organisms in one drop. For each drop 20 strips are studied. The Zooplankton are identified with the help of standard literature up to generic level by using standard keys of Adoni *et al.*[1], Edmondson[5]. Qualitative and quantitative analysis of the organism is carried out by Sedgwick rafter cell as per the standard methods APHA[3]. So The zooplankton up to taxonomic values identified by the help of self-made keys and standard keys of identification up to generic level of all the groups of protozoa, Rotifera, Cladocera and Copepoda. The identification keys were of Prescott[11]. Sample solution is taken around 1ml in Sedgwick rafter cell and glass cover slip is placed over it. All the zooplankton Groups Rotifers, micro crustaceans, Protozoans etc. were identified under microscope. Microscope of 5 * 10 * 40 * objectives and 10 * eyepiece is used for the analysis of zooplanktons qualitatively. Total number of chambers is 1000 on the rafter cell. So the numbers of zooplanktons per cell are multiplied thousand to get total in one liter.

Total no of individuals identified in the sample by Sedgwick-rafter cell method are now putted in the tables and diversity index are calculated by following method:-

Shannon and weaver index

$$\mathbf{I = - \Sigma\ D^* \log D}$$

Where :-

D = diversity= ni/N

I = Shannon Weaver index

ni = Number of entities in the species.

N = Total number of organisms (density).

Ni = Proportion on i^{th} species in the sample.

The value of index shows the diversity of individuals if
it will be between 0-1.5 least diversity
between 1.5 to 2.5 moderate diversity
2.5 or more higher diversity of organisms is considered.

5.11 Seasonal occurrence of zooplankton in barali lake

Zooplankton species	Rainy			Winter			Spring			Summer		
Rotifera	D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N	
Brachionus forficula	0.13445378	-0.87142698	-0.11716665	0.173077	-0.76176	-0.13184	0.19858156	-0.7020 61081	-0.1394 16385	0.148 14815	-0.8293	-0.12286
Filinia longisseta	0.11764706	-0.92941893	-0.1093434	0.144231	-0.84094	-0.12129	0.10638297	-0.9731 27854	-0.1035 2424	0.140 74074	-0.85158	-0.11985
Keratella tropica	0.20168067	-0.69533572	-0.14023578	0.173077	-0.76176	-0.13184	0.12765957 4	-0.8939 46608	-0.1141 20844	0.155 55556	-0.80811	-0.12571

Monostyla bulla	0.17647059	-0.75332767	-0.13294018	0.11538 5	-0.93785	-0.10821	0.10638297 9	-0.973127854	-0.10352424	0.11851852	-0.92621	-0.10977
Philidinac-itrine	0.15966387	-0.79679336	-0.12721911	0.17307 7	-0.76176	-0.13184	0.22695035 5	-0.644069134	-0.146171718	0.17777778	-0.75012	-0.13336
Philodin-asp	0.13445378	-0.87142698	-0.11716665	0.14423 1	-0.84094	-0.12129	0.10638297 9	-0.973127854	-0.10352424	0.11851852	-0.92621	-0.10977
Rotaria vulgaris	0.07563025	-1.12130445	-0.08480454	0.07692 3	-1.11394	-0.08569	0.12765957 4	-0.893946608	-0.114120844	0.14074074	-0.85158	-0.11985
Total			-0.82887631			-0.83201			-0.82440251			-0.84117
Cladocera	D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N	
Ceriodap-hnia reticulate	0.19047619	-0.7201593	-0.1371732	0.25	-0.60206	-0.15051	0.25862069	-0.587336735	-0.151897431	0.2688172	-0.57054	-0.15337
Daphnia carinata	0.17857143	-0.74818803	-0.133605	-	-	-	0.27586206 9	-0.559308011	-0.154291865	0.16129032	-0.79239	-0.12781
Daphnia lumholtzi	0.23809524	-0.62324929	-0.14839269	0.26785 7	-0.5721	-0.15324	-	-	-	0.20430108	-0.68973	-0.14091
Diaphano-smasp	0.16666667	-0.77815125	-0.12969188	0.21428 6	-0.66901	-0.14336	0.24137931	-0.617299958	-0.149003438	0.19354839	-0.71321	-0.13804
Scapholeberis sp	0.22619048	-0.64552569	-0.14601176	0.26785 7	-0.5721	-0.15324	0.22413793 1	-0.649484641	-0.145574144	0.17204301	-0.76436	-0.1315

Total			-0.6948 7453			-0.6 003 5			-0.6007 66878			-0.69 163
Copepode	D=Ni/ N	Log Ni/N		D=Ni/ N	Log Ni/N		D=Ni/ N	Log Ni/N		D=Ni/ N	Log Ni/N	
Diaphor-esis all diaptomus raoi	0.1076 9231	-0.9678 1532	-0.1042 2626	0.15 625	-0.8 06 18	-0.1 259 7	0.138 88888 9	-0.8573 32496	-0.1190 73958	0.154 47154	-0.81 115	-0.12 53
Diatomus	0.1846 1538	-0.7337 3211	-0.1354 5824	0.21 875	-0.6 60 05	-0.1 443 9	0.138 88888 9	-0.8573 32496	-0.1190 73958	0.130 0813	-0.88 579	-0.11 522
Mesocy-clopus hylanius	0.1230 7692	-0.9098 2337	-0.1119 7826	0.25	-0.6 02 06	-0.1 505 1	0.104 16666 7	-0.9822 71233	-0.1023 1992	0.154 47154	-0.81 115	-0.12 53
Mesocyc-lopus strenuous	0.1230 7692	-0.9098 2337	-0.1119 7826	-	-	-	0.111 11111 1	-0.9542 42509	-0.1060 26945	0.081 30081	-1.08 991	-0.08 861
Neodiap-tomus	0.1153 8462	-0.9378 5209	-0.1082 137	0.06 25	-1.2 04 12	-0.0 752 6	0.125	-0.9030 89987	-0.1128 86248	0.113 82114	-0.94 378	-0.10 742
Neodiap-tomus schmac-keri	0.1230 7692	-0.9098 2337	-0.1119 7826	0.07 812 5	-1.1 07 21	-0.0 865	-	-	-	-	-	-
Phyllodia-ptomus annae	0.1076 9231	-0.9678 1532	-0.1042 2626	0.15 625	-0.8 06 18	-0.1 259 7	0.104 16666 7	-0.9822 71233	-0.1023 1992	0.113 82114	-0.94 378	-0.10 742
Rhine diaptomus indicus	0.1153 8462	-0.9378 5209	-0.1082 137	0.07 812 5	-1.1 07 21	-0.0 865	0.138 88888 9	-0.8573 32496	-0.1190 73958	0.130 0813	-0.88 579	-0.11 522
Spico diap-tomusc hilospinus		-	-	-	-	-	0.138 88888 9	-0.8573 32496	-0.1190 73958	0.121 95122	-0.91 381	-0.11 144

Total			-0.89627295			-0.79509			-0.899848865			-0.89594
Ostracoda	D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N	
Centro Cypris sp	0.21538462	-0.66678532	-0.1436153	0.2	-0.69897	-0.13979	0.14705882 4	-0.832508913	-0.122427781	0.26666667	-0.57403	-0.15308
Cypris sp	0.24615385	-0.60879337	-0.14985683	0.4	-0.39794	-0.15918	0.26470588 2	-0.577236408	-0.152797873	0.21333333	-0.67094	-0.14313
Hetero Cypris sp	0.30769231	-0.51188336	-0.15750257	-	-	-	0.44117647 1	-0.355387658	-0.156788673	0.25333333	-0.59631	-0.15106
Ostracoda sp	0.23076923	-0.6368221	-0.14695895	0.4	-0.39794	-0.15918	0.14705882 4	-0.832508913	-0.122427781	0.26666667	-0.57403	-0.15308
Total			-0.59793365			-0.45815			-0.554442108			-0.60035
Protozoan	D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N		D=Ni/N	Log Ni/N	
Amoeba proteus	0.04393064	-1.35723251	-0.05962409	0.055846	-1.253	-0.06998	0.04807692 3	-1.318063335	-0.06336843	0.04367607	-1.35976	-0.05939
Amoeba verrucosa	0.05549133	-1.25577487	-0.06968462	0.055236	-1.28103	-0.06707	0.04487179 5	-1.348026558	-0.06048837 1	0.04549591	-1.34203	-0.06106
Arcella gibboosa	0.04855491	-1.31376682	-0.06378983	0.04886 6	-1.311	-0.06406	0.04807692 3	-1.318063335	-0.06336843	0.03457689	-1.46121	-0.05052

Ceratium hirudinella	-	-	-	0.01396 2	-1.85506	-0.0259	0.04487179 5	-1.348026558	-0.060488371	0.03639672	-1.43894	-0.05237
Chlamy-domonas	0.03699422	-1.43186613	-0.05297077	0.048866	-1.311	-0.06406	0.01282051 3	-1.892094603	-0.024257623	0.03457689	-1.46121	-0.05052
Clathulina elegans	0.03468208	-1.45989485	-0.05063219	-	-	-	-	-	-	0.04549591	-1.34203	-0.06106
Coleps hirtus	0.03236994	-1.48985808	-0.04822662	0.048866	-1.311	-0.06406	0.02564102 6	-1.591064607	-0.040796528	-	-	-
Coleps inermis	0.03236994	-1.48985808	-0.04822662	0.048866	-1.311	-0.06406	0.00320512 8	-2.494154594	-0.007994085	0.04367607	-1.35976	-0.05939
Colpoda aspera	0.03699422	-1.43186613	-0.05297077	0.034904	-1.45712	-0.05086	0.04487179 5	-1.348026558	-0.060488371	0.03457689	-1.46121	-0.05052
Colpoda inflate	0.00346821	-2.45989485	-0.00853143	0.026178	-1.58206	-0.04142	0.02884615 4	-1.539912085	-0.044420541	-	-	-
Cyclidium glaucoma	0.03468208	-1.45989485	-0.05063219	0.031414	-1.50288	-0.04721	0.01602564 1	-1.795184459	-0.028768984	0.04549591	-1.34203	-0.06106
Difflugia lobostoma	0.06011561	-1.22101276	-0.07340192	0.048866	-1.311	-0.06406	0.04487179 5	-1.348026558	-0.060488371	0.03821656	-1.41775	-0.05418
Difflugia pyriformis	0.05549133	-1.25577487	-0.06968462	-	-	-	0.03205128 2	-1.494154594	-0.047888957	0.05277525	-1.27757	-0.06742
Dileptus anser	0.02312139	-1.63598611	-0.03782627	0.034904	-1.45712	-0.05086	0.04487179 5	-1.348026558	-0.060488371	0.02911738	-1.53585	-0.04472

Euglena spirogyra	0.03699422	-1.43186613	-0.05297077	0.055846	-1.253	-0.00698	0.04807692 3	-1.318063335	-0.06336843	0.04367607	-1.35976	-0.05939
Euglen-acus	0.05780347	-1.2380461	-0.07156336	0.055846	-1.253	-0.00698	0.06730769 2	-1.171935299	-0.07888 0261	0.04549591	-1.34203	-0.06106
Frontonia bursaria	0.03699422	-1.43186613	-0.05297077	0.03490 4	-1.457 12	-0.00506	0.05128205 1	-1.290034611	-0.06615 5621	0.02911738	-1.53585	-0.04472
Parame-cium Aurelia	0.05549133	-1.25577487	-0.06968462	0.048866	-1.311	-0.00640 6	0.02884615 4	-1.539912085	-0.04442 0541	0.02911738	-1.53585	-0.04472
Parame-cium bursaria	0.03468208	-1.45989485	-0.05063219	0.02617 8	-1.582 06	-0.00414 2	0.01602564 1	-1.795184 59	-0.02876 8984	0.05732484	-1.24166	-0.07118
Parameci-um caudatum	0.03699422	-1.43186613	-0.05297077	0.048866	-1.311	-0.00640 6	0.04487179 5	-1.348026558	-0.06048 8371	0.03821656	-1.41775	-0.05418
Prodon discolor	0.03236994	-1.48985808	-0.04822662	0.03490 4	-1.457 12	-0.00506	0.04807692 3	-1.318063335	-0.06336843	0.05277525	-1.27757	-0.06742
Prodon edentates	0.03699422	-1.43186613	-0.05297077	0.02617 8	-1.582 06	-0.00414 2	0.04807692 3	-1.318063335	-0.06336843	0.03821656	-1.41775	-0.05418
Trachelo-monas	0.04855491	-1.31376682	-0.06378983	0.069808	-1.156 09	-0.0807	0.06730769 2	-1.171935299	-0.07888 0261	0.04367607	-1.35976	-0.05939
Vorticella campanula	0.03236994	-1.48985808	-0.04822662	0.05235 6	-1.281 03	-0.00670 7	0.06089743 6	-1.215400993	-0.07401 4804	0.04549591	-1.34203	-0.06106

Vorticella microst-oma	0.0369 9422	-1.4318 6613	-0.0529 7077	0.05 235 6	-1.2 81 03	-0.0 670 7	0.080 12820 5	-1.0962 14585	-0.0878 37707	0.045 49591	-1.34 203	-0.06 106
Vorticella sps.	0.0554 9133	-1.2557 7487	-0.0696 8462	-	-	-	-	-	-	0.047 31574	-1.32 499	-0.06 269
Total			**-1.3728 6365**			**-1.3 410 7**			**-1.3328 57885**			**-1.37 326**
			-4.3908 2109			-4.0 266 8			-4.2123 18246			-4.40 236

5.13 Biodiversity indexes (Barali) of zooplankton in different seasons in the study area.

	Rainy	Winter	Spring	Summer
Rotifera				
Brachionus forficula	-0.11716665	-0.13184	-0.139416385	-0.12286
Filinia longisseta	-0.1093434	-0.12129	-0.10352424	-0.11985
Keratella tropica	-0.14023578	-0.13184	-0.114120844	-0.12571
Monostyla bulla	-0.13294018	-0.10821	-0.10352424	-0.10977
Philidinacitrine	-0.12721911	-0.13184	-0.146171718	-0.13336
Philodinasp	-0.11716665	-0.12129	-0.10352424	-0.10977
Rotaria vulgaris	-0.08480454	-0.08569	-0.114120844	-0.11985
Total	-0.82887631	-0.83201	-0.82440251	-0.84117
Cladocera				
Ceriodaphnia reticulate	-0.1371732	-0.15051	-0.151897431	-0.15337
Daphnia carinata	-0.133605	-	-0.154291865	-0.12781
Daphnia lumholtzi	-0.14839269	-0.15324	-	-0.14091
Diaphanosmasp	-0.12969188	-0.14336	-0.149003438	-0.13804
Scapholeberis sp	-0.14601176	-0.15324	-0.145574144	-0.1315
Total	-0.69487453	-0.60035	-0.600766878	-0.69163
Copepode				
Diaphoresis all diaptomus raoi	-0.10422626	-0.12597	-0.119073958	-0.1253

Diatomus	-0.13545824	-0.14439	-0.119073958	-0.11522
Mesocyclopus hylanius	-0.11197826	-0.15051	-0.10231992	-0.1253
Mesocyclopus strenuous	-0.11197826	-	-0.106026945	-0.08861
Neodiaptomus	-0.1082137	-0.07526	-0.112886248	-0.10742
Neodiaptomus schmackeri	-0.11197826	-0.0865	-	-
Phyllodiaptomus annae	-0.10422626	-0.12597	-0.10231992	-0.10742
Rhine diaptomus indicus	-0.1082137	-0.0865	-0.119073958	-0.11522
Spico diaptomuschilospinus	-	-	-0.119073958	-0.11144
Total	-0.89627295	-0.79509	-0.899848865	-0.89594
Ostracoda				
Centro Cypris sp	-0.1436153	-0.13979	-0.122427781	-0.15308
Cypris sp	-0.14985683	-0.15918	-0.152797873	-0.14313
Hetero Cypris sp	-0.15750257	-	-0.156788673	-0.15106
Ostracoda sp	-0.14695895	-0.15918	-0.122427781	-0.15308
Total	-0.59793365	-0.45815	-0.554442108	-0.60035
Protozoan				
Amoeba proteus	-0.05962409	-0.06998	-0.06336843	-0.05939
Amoeba verrucosa	-0.06968462	-0.06707	-0.060488371	-0.06106
Arcella gibboosa	-0.06378983	-0.06406	-0.06336843	-0.05052
Ceratium hirudinella	-	-0.0259	-0.060488371	-0.05237
Chlamydomonas	-0.05297077	-0.06406	-0.024257623	-0.05052
Clathulina elegans	-0.05063219	-	-	-0.06106
Coleps hirtus	-0.04822662	-0.06406	-0.040796528	-
Coleps inermis	-0.04822662	-0.06406	-0.007994085	-0.05939
Colpoda aspera	-0.05297077	-0.05086	-0.060488371	-0.05052
Colpoda inflate	-0.00853143	-0.04142	-0.044420541	-
Cyclidium glaucoma	-0.05063219	-0.04721	-0.028768984	-0.06106
Difflugia lobostoma	-0.07340192	-0.06406	-0.060488371	-0.05418
Difflugia pyriformis	-0.06968462	-	-0.04788957	-0.06742
Dileptus anser	-0.03782627	-0.05086	-0.060488371	-0.04472
Euglena spirogyra	-0.05297077	-0.06998	-0.06336843	-0.05939
Euglenacus	-0.07156336	-0.06998	-0.078880261	-0.06106
Frontonia bursaria	-0.05297077	-0.05086	-0.066155621	-0.04472
Paramecium Aurelia	-0.06968462	-0.06406	-0.044420541	-0.04472
Paramecium bursaria	-0.05063219	-0.04142	-0.028768984	-0.07118
Paramecium caudatum	-0.05297077	-0.06406	-0.060488371	-0.05418

Prodon discolor	-0.04822662	-0.05086	-0.06336843	-0.06742
Prodon edentates	-0.05297077	-0.04142	-0.06336843	-0.05418
Trachelomonas	-0.06378983	-0.0807	-0.078880261	-0.05939
Vorticella campanula	-0.04822662	-0.06707	-0.074014804	-0.06106
Vorticella microstoma	-0.05297077	-0.06707	-0.087837707	-0.06106
Vorticella sps.	-0.06968462	-	-	-0.06269
Total	**-1.37286365**	**-1.34107**	**-1.332857885**	-1.37326
	-4.39082109	-4.02668	-4.212318246	-4.40236

Zooplankton diversity throughout the study period is shown in table. The highest diversity value was in summer season while the lowest in winter season in both the lakes which were dominated by Rotifera. As per the result the Shannon weaver diversity index stated that the Rotifera was recorded (0.82) to (0.84).[12]

Table show that might be due to thermal and nutritional condition the Cladocera among all the other zooplankton found to be dominant in Barali (0.694). Cladocera species also showed higher Shannon diversity index value (0.691) in summer in Barali.

The Shannon weaver diversity index stated that the inclusive diversity index was highest in summer in was recorded (4.40).

The higher Shannon and weaver index was shown by the species of Copepoda (0.899) in s Barali Lake. The present study concluded the dominance of Rotifera and Cladocera, Copepoda indicating the eutrophication of lake suitable for fish culture in Barali Lake. The values of Shannon Weaver index for zooplankton were mostly indicating that there was impact of pollution in Lake.

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