



Taxonomical study and Diversity of Rotifers in Chikkadevarayana canal of Cauvery river, Karnataka, India

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Abstract

The study was undertaken to assess the diversity and taxonomical observations of rotifers in Chikkadevaraya canal (CDC). The investigation revealed that 27 species belonging to 15 genera and 9 families coming under 3 orders and 2 classes, were observed, photographed and also identified up to species level and are reported for the first time in this region. Among 22 genera of rotifers, the maximum of 11 species belonged to family Brachionidae followed by 5 species from family Lecanidae, 2 species of Euchlanidae, Collurellidae, Notommatidae and Philodinidae respectively. One species each from family Trichocercidae, Testudinellidae and Filinidae. The genus Brachionus, Keratella and Euchlanis was found in all the five sampling points. Euchlanis dialata was abundant while Macrotrachela quadricornifera was found to be least. Species abundance was higher at Gandehosahalli followed by Darsaguppe, Kannalu, Edmuri and lowest in Pandavapura sampling stations. Shannon's diversity was also found to be highest at Gandehosahalli (2.63) while low in Pandavapura (1.78). The samples of water were used to conduct physico-chemical parameters like temperature, electrical conductivity, pH, dissolved oxygen, total alkalinity, total hardness, chlorides, total solids, total dissolved solids, total suspended solids, sulphate, phosphate and nitrate etc. Statistical interpretations of data were presented based on correlation analysis. The population of rotifers were positively correlated with pH, total alkalinity, hardness and negatively correlated with total suspended solids and total solids of water samples.

Keywords: Rotifer diversity, taxonomy, brachionidae, *E. dialata*, dissolved oxygen, CDC.

Introduction

Fish growth and its diversity in an aquatic ecosystem depend on zooplankton abundance of that water body. Since zooplankton are motile, their vertical and horizontal distribution varies with time. They are important source of food for fishes, especially larvae of carps because they are the major source of protein, which is required for the development of organs specially the gonad of fishes¹². Rotifers are a diverse assemblage of pseudocoelomate, primary bilaterally symmetrical organisms. The taxon traditionally includes three groups (freshwater Monogononta, Bdelloidea and marine epizoic Seisonacea) and is closely related to, amongst others, the parasitic Acanthocephala³. About 500 species of rotifers have been described from Indian water bodies and around 1700 species of rotifers were described from different regions of world^{4,5}. Rotifers have been recognized as a critical component of freshwater ecosystems⁶. The inadequate taxonomic and molecular knowledge on the phylum, identification difficulties related to phenotypic plasticity and cryptic speciation of reliable biogeographical studies, especially in developing countries⁷.

The Indian literature shows a paucity of works on the faunal diversity of phylum Rotifera from aquatic biotopes of conservation areas of Northeastern India region⁹⁻¹¹. Although taxonomic studies of Indian rotifers began more than a century ago, information on rotifer biodiversity in Indian waters is still

incomplete. The present study helps to identify the diversity of rotifers with an account on the taxonomical character. The results obtained are discussed in light of available literature.

Material and Methods

Study Area: A preliminary survey of the Chikkadevaraya canal was done using the Toposheet 57 D/11 and 57 D/15. Chikkadevaraya canal is a major canal of the KRS dam. It spans a length of 130 km, irrigating about 25949 acres agricultural land in three taluks besides being a source of drinking water for Darasaguppe, Kannalu, Gandehosahalli, Harakere, Mandyakoppal, Ballekere and a few other villages. Canal water is utilized for different domestic purposes like, washing of utensils, clothes, cattle, heavy vehicles, etc.

The present study was undertaken in Chikkadevaraya canal during November 2012 to October 2013. For determination of physico-chemical properties of Chikkadevarayana canal the water samples were collected from each of the five sampling stations Edmuri, Darasaguppe, Kannalu, Pandavapura and Gandehosahalli. Physico-chemical parameters were estimated using standard methods¹².

Plankton samples were collected every month from different sampling sites (during November 2012 to October 2013) using plankton net made up of bolting nylon cloth (mesh size 25µm)

by sieving 10 liters of water sample. This is then reduced to 100 ml and to this 2 ml of 4% formalin was added. The preserved samples were used for their taxonomic study and numerical estimation. Lackey's drop method was employed for estimating zooplanktons. The identification was made using standard keys and monographs¹³⁻²¹. The data were subjected to a software program PAST²² which generates diversity indices with the help of course manual fisheries statistics the correlation co-efficient r_{12} ²³.

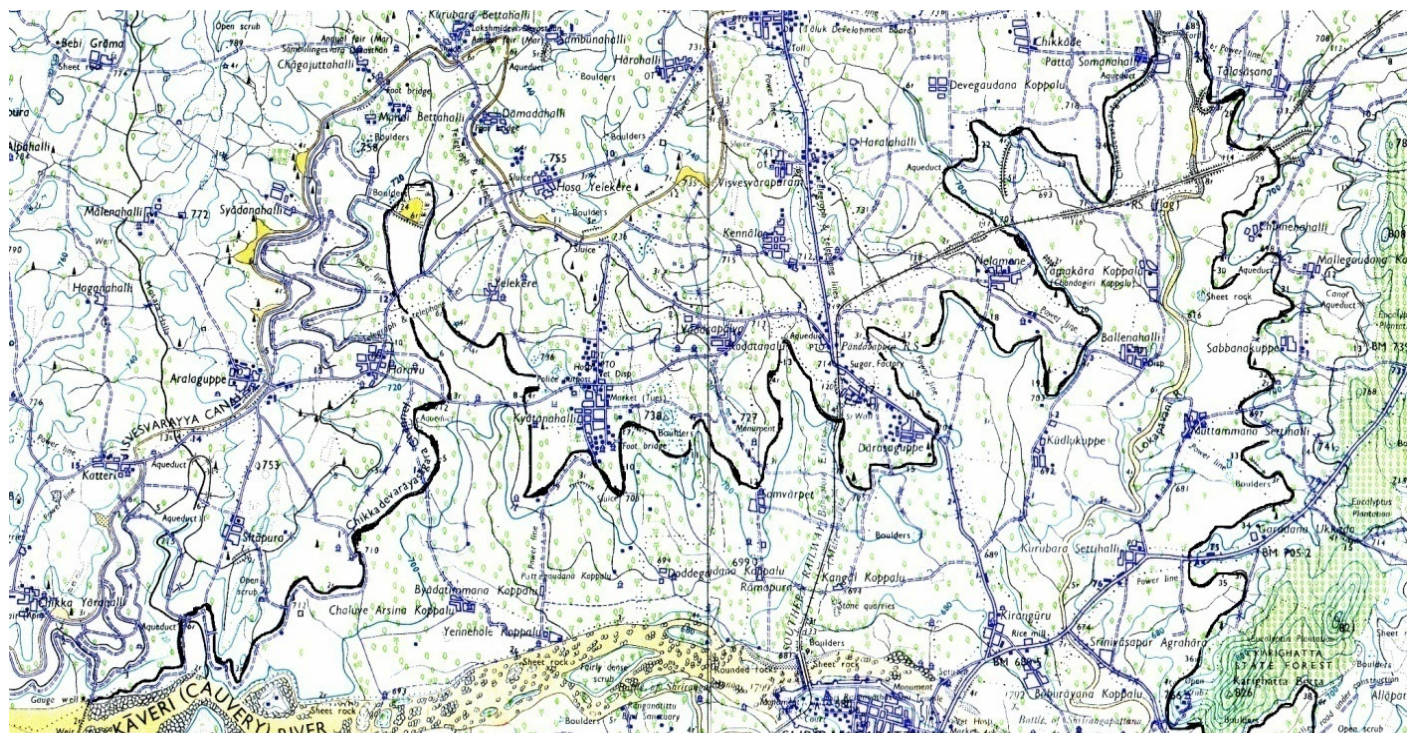
Results and Discussion

The phylum rotifers consist of microscopic, pseudocoelomate animals and they are commonly known as wheel animalcules have a length of 0.4 -2.5 mm. A rotifer has a transparent cylinder shaped body, lined by a thin cuticle. In majority of rotifers cuticle form a lorica. Lorica has an arched dorsal plate and a flat ventral plate connected by a flexible cuticular membrane, the sulci. The body is divided into head, trunk, neck and foot. In some species of rotifers the head has a corona with cilia, which absorb water and food into the mouth. The food is ground by the trophy, it lies just beneath the mouth in the throat.

Trophy found in all rotifers and they are important organs of the rotifers. The whole body is semi-flexible, extensible and it has cuticle which is transparent. Presence of cuticle indicates that the rotifers are the close relatives of arthropoda and roundworms. The last part of the body is foot; it ends with toe which is having a cement gland. Cement glands helps the rotifers to attach with other objects in water.

Systematic and taxonomical characters of rotifer community in Chikkadevarayana canal: Rotifera, Class: Monogononta, Order: Ploimida, Family: Brachionidae, *Brachionus ruben*, Lorica oval, smooth and anterior dorsal margin with six saw-tooth spines, medians longest. Anterior ventral margin markedly elevated toward the center, notched medially. Foot opening with a rectangular aperture dorsally and a larger oval aperture ventrally (figure-3).

Brachionus forficula, Lorica has four occipital spines. Posterior spines stippled and inside it has swellings, in the occipital spine region *B. forficula* resembles like *B. aculeatus*. But there are markable differences in posterior spines and shape of the body (figure- 4).



- Site 1: Edmuri- 12° 24.83'78" N 76° 35.69'06" E;
- Site 2: Darasaguppe- 12° 27.09'24"N 76° 41.64'82"E;
- Site 3: Kennala- 12° 27.88'06"N 76° 40.68'64"E;
- Site 4: Pandavapura 12° 27.22'82"N 76° 40.90'65"E
- Site 5: Gendehosahalli 12°23'11"N 76°48'41"E

- Five sites were selected for this investigation, following are the sites:
- I. Edmuri- 12° 24.83'78" N 76° 35.69'06" E
 - II. Darasaguppe- 12° 27.09'24"N 76° 41.64'82"E
 - III. Kannalu- 12° 27.88'06"N 76° 40.68'64"E
 - IV. Pandavapura – 12° 27.22'82"N 76° 40.90'65"E
 - V. Gandehosahalli- 12°23'11"N 76°48'41"E

Figure-1A
 Study Map

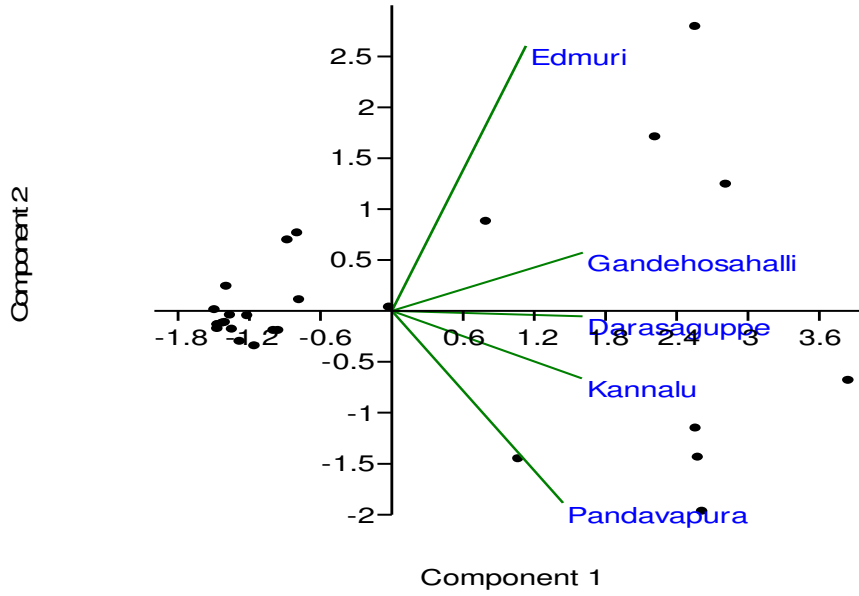


Figure-1B

Biplot of principal components derived from five sampling sites of Chikkadevarayana canal

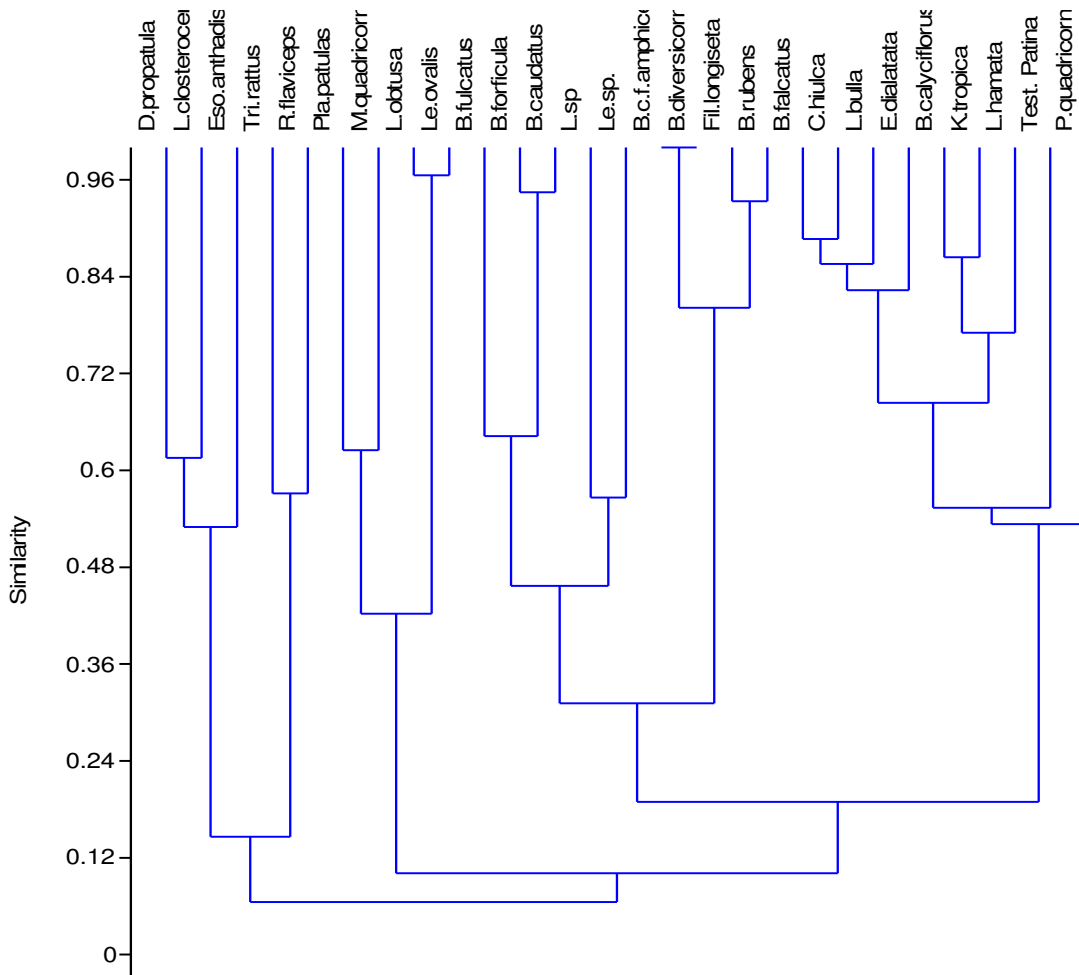


Figure-2

Cluster analysis using simple linkage method for five sampling units in Chikkadevarayana canal

Brachionus calciflorus, It shows smooth lorica and it is flexible. The base of anterior margin is broad and rounded. Laterals are slightly shorter than the median spines but posterior spines were absent. This species shows polymorphic forms with posterior spines in all forms (figure-5).

Brachionus famphiceros: Pointed anterior spines and they are equal in length. It shows characteristics of well developed antero-median and postero-median spines. Rectangular shape of lorica was observed. Medians may be slightly longer than laterals. Anterior ventral margin extended toward the center, notched medially. Posterior spines are long and pointed; broad-based, 1.5-2.0 times longer than the anterior median spines (figure-6).

Brachionus falcatus: Posterior spines were bent inwards and touch each other at their tips. Long medians and they are curved outward. Anterior dorsal margin has six spines, which are equal in length (figure-7).

Brachionus fulcatus: Anterior and posterior spines are present and they are well developed. Total length is 330µm; anterior width 80 µm; posterior spines 150 µm; anterior occipital spine 18.75-20 and it has maximum width of 115 µm; (figure-8).

Brachionus diversicornis: Lorica is elongated and it has four occipital spines which is different from other *Brachionus* species, lateral spines are longer than the median spines. It shows long foot, toe with claws (figure-9).

Brachionus caudatus: Intermediate and lateral spines are slightly developed or absent, Polymorphic in nature, posterior spines stout and anterior dorsal margin has two short spines (figure-10).

Keratella trophica: Lorica is flat and compressed dorso-ventrally; the dorsal surface of lorica consists of three median polygons. It bears two posterior spines on the lorica with the left spine shorter than the exuberant right one the anterior dorsal margin has six spines, medians are long, stout and curved. Lateral normally longer than the intermediate one. Lorica contains two unequal posterior spines. Left spine is always shorter than right (figure-11).

Playtyias quadricornis: Body is rounded in shape with lorica is dorso-ventrally flattened. Two stout spines are present in occipital margin. It shows equal length of posterior spines and at the end antenna like structure is present (figure-12).

Platyonus patulas: Medians are shorter than the posterior lateral spines; six spines are present in the occipital margin, of which ventral four spines are shorter than the medians (figure-13).

Family: Lecanidae: *Lecane hamata*: Lorica oval, anterior dorsal margin concave, ventral margin with 'V' shaped sinus and with triangular cusps between edges of lorica and the sinus.

Toe slender, parallel sided and tapers into an acute point (figure-14).

Lecane bulla: Lorica elongate and ovate. Anterior dorsal margin V shaped, Ventral margin with deep rounded sinus. Second foot segment nearly triangular. Toe long and enlarged in the middle and ends in acute claws (figure-15).

Lecane obusta: Distinctive signs are presence of shell, its front edge straight, matching on the sides with small spines; posterior segment of the small, round, going beyond the edge of the shell; fingers in the second half of its length and well expressed (figure-16).

Lecane closterocera: Shell is almost flat. Abdominal disc more dorsal. The front edges of both blades on shallow hollows in the middle of the lateral edge moderately protruding. The first pair of legs is very small. Finger extended at the base and ends pointing (figure-17).

Lecane sp.: Lorica is separated into dorsal and ventral parts, which is connected by a soft sulcus and it is dorso-ventrally flattened. Mouth opening is not funnel shaped. Foot extends through an opening in the ventral plate having one or two long toes with partially fused toes. (figure-18).

Family: Collurellidae: *Lepadella ovalis*: It is common in freshwater habitats. The outline of the lorica varies from circular to broadly ovate; its width is less than the length. The ventral plate is flat and dorsal plate is slightly convex. A stippled collar is present on the dorsal plate and is sometimes discernible on the ventral plate. The dorsal sinus is U-shaped and the ventral sinus is large and deep. The foot groove is parallel sided and the edges of the groove project below the surface of the ventral plate. The toes are short and pointed (figure-19).

Lepadella sp.: Dorso-ventrally flattened lorica which is more or less rigid and it is divided into dorsal and ventral plates. Mouth opening is not funnel shaped in the bucal cavity. Foot extends through an opening in the ventral plate carrying one or two long toes, in some partially fused toes (figure-20).

Family: Euchlanidae: *Euchlanis dialatata*: Lorica is transverse with longitudinal sulci, dorsal plate is 'U' shape. Mastax with four club shaped teeth. Foot is slightly slender, toes are like blade and fusiform (figure-21).

Dipleuchlanis propatula: Lorica is oval in shape, dorsal plate is smaller and concave and both the plates have shallow sinuses at anterior margin. Toes are slightly long; sides are parallel and pointed (figure-22).

Family: Notammatidae: *Cephalodella hiulca*: Body transparent, head and trunk separated by constriction, abdomen cylindrical and narrow posteriorly, toes are pointed and curved (figure-23).

Eosphora anthadis: The trophi is very small (33-35 μm) and slightly different from the virgate type. The spherical rami are characteristic, and have an interior denticulate membrane which probably has a pumping function. The manubria have a nearly triangular lamella on the anterior end; the end of the fulcrum has a rough surface for attachment of the mastax muscles. The gastric glands are very big like foot glands. The foot is wrinkled and has paired toes with separate claws (figure-24).

Family: Trichocercidae: *Trichocerca rattus*: Lateral margins are pointed with the spiny outgrowth. Foot segment with air triangular spines, dorsum stiff, stippled with usual plates. Toes are slender, long and pointed (figure-25).

Order: Flosulariceae: **Family: Filinidae:** *Filinia longeseta*: Body is transparent, oval in shape, ventral side contains

posterior spines, spines were not bulged. The body is divisible into head portion, trunk and foot is absent (figure-26).

Family: Testudinellidae: *Testudinella patina*: Lorica is nearly stippled and slightly circular. Anterior dorsal margin with blunt tooth like projection. Foot is opened on ventral side and it is away from the posterior end (figure-27).

Class: Bdelloidea, Order: Bdelloida, Family: Philodinidae: *Macrotrachela quadricornifera*: Body stout, cuticle thin and transparent. Corona with two discs. Trophy ramate, eyes absent. Foot with three toes, elongated posterior point (figure-28).

Rotaria flaviceps: Body transparent with soft cuticle. Corona with two ciliary discs. Mastax ramate, segmented foot with four elongated toes (figure-29).



Figure-3

Brachionus rubens



Figure-4

Brachionus forficula



Figure-5

Brachionus calciflorus



Figure-6

Brachionus f amphiceros



Figure-7

Brachionus f falcatus



Figure-8

Brachionus fulcatus



Figure-9

Brachionus diversicornis



Figure-10

Brachionus caudatus



Figure-11

Keratella trophica

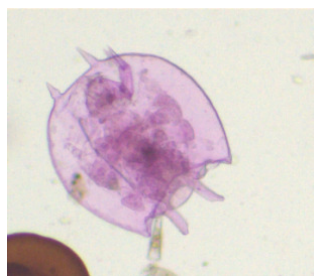


Figure-12

Playtyias quadricornis



Figure-13

Platyonus patulas



Figure-14

Lecane hamata



Figure-15
Lecane bulla



Figure-16
Lecane obusta



Figure-17
Lecane closterocera



Figure-18
Lecane sp



Figure-19
Lepadella ovalis



Figure-20
Lepadella sp



Figure-21
Euchalanis dialatata



Figure-22
Dipleuchlanis propatula



Figure-23
Cephalodella hiulca



Figure-24
Eosphora anthadis



Figure-25
Trichocerca rattus

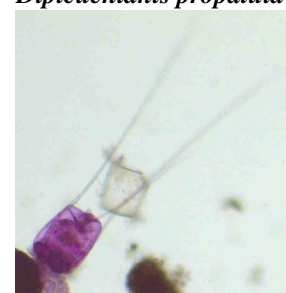


Figure-26
Filinia longeseta

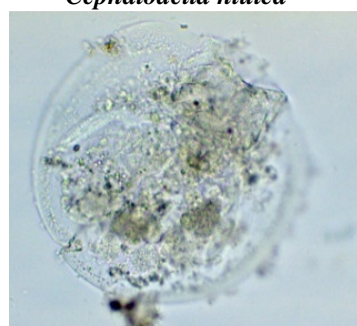


Figure-27
Testudinella patina



Figure-28
Macrotrachela quadricornifera



Figure-29
Rotaria flaviceps

During the investigation 27 species belonging to 15 genera and 9 families coming under 3 orders and 2 classes, Among 15 genera of rotifers, the maximum of 11 species belonged to family Brachionidae. The genus Brachionus, Keratella and Euchlanis was found in all the five sampling points. *E. dialata* was abundant while *Macrotrachela quadricornifera* was found to be least. Species abundance was higher at Gandehosahalli followed by Darsaguppe > Kannalu > Edmuri and Pandavapura

sampling stations. Species diversity of rotifers in different sampling station of Chikkadevaraya canal is given in table-1. The species richness (Marglef index) of rotifers of Gandehosahalli had the highest value of richness (2.69) and lowest value at Pandavapura (1.26). Shannon's diversity was also found to be highest at Gandehosahalli (2.63) while low in Pandavapura (1.78). The species diversity of rotifers was highest in more eutrophic areas²⁵. Dominance of rotifer species

increased in Pandavapura while it decreased in Gandeohahalli. Evenness index ranges between 0.73 and 0.88. Species evenness means even distribution of the individuals among the different species, it is the ratio of species diversity (H) to the maximum species diversity (H. sub. max). Values range from 0 to 1, where 1 is the maximum species diversity in which all species in the community would have an equal number of individuals²⁶. In the present study *Brachionus* species were numerically abundant and they are most commonly available in tropical water²⁷⁻³⁰.

Correlation among physico-chemical factor and rotifer are given in table-2. Rotifer showed a significant positive correlation with physico parameters of pH (0.530), total alkalinity (0.696), hardness (0.964) and negative correlation with TS (-0.617), TSS (-0.874). With special reference to zooplankton it was observed that rotifers showed significant positive correlation with total alkalinity and hardness in Almatti Reservoir of Bijapur, Karnataka State, India³¹. pH showed positive correlation with

temperature (0.670). TS correlated positively with electrical conductivity (0.616) and TDS were also positively correlated with electrical conductivity (0.646) and TS (0.963). DO was positively correlated with pH (0.780), The present observation was in accordance with the results of physico-chemical parameters of surface water of River Gomti in Uttar Pradesh³². Total alkalinity showed positive correlation with temperature (0.652). Chlorides showed positive significant correlation with total alkalinity (0.921) and negatively with chloride (-0.547), total hardness was positively correlated to total alkalinity (0.856) and chloride (0.636) and negatively correlated with TSS (-0.763). Total alkalinity (0.710) is positively correlated with sulphate, chlorides (0.897) and TDS (0.640) and negative correlation with DO (-0.715). A significant positive correlation between phosphate and temperature (0.900), total alkalinity (0.759), chlorides (0.751) and sulphate (0.598) was registered respectively. Nitrate was positively correlated with total dissolved solids (0.669), total alkalinity (0.853), total hardness (0.594), sulphate (0.860) and phosphate (0.665).

Table-1
Rotifer diversity indices of Chikkdevarayana canal

	Edmuri	Darasaguppe	Kannalu	Pandavapura	Gandeohahalli
Taxa_S	11	13	12	8	18
Individuals	261	508	372	261	560
Dominance_D	0.1474	0.0925	0.1016	0.1913	0.08173
Simpson_1-D	0.8526	0.9075	0.8984	0.8087	0.9183
Shannon_H	2.089	2.444	2.353	1.784	2.627
Evenness_e^H/S	0.7342	0.8864	0.8768	0.7439	0.7682
Margalef	1.797	1.926	1.858	1.258	2.686

Table-2
Correlation coefficient values among certain physico-chemical parameters and rotifers at Chikkadevaraya canal

	Temp °C	pH	EC mS/cm	TS mg/L	TDS mg/L	TSS mg/L	DO mg/L	TA mg/L	Chlorides mg/L	TH mg/L	Sulphate mg/L	Phosphate mg/L	Nitrate mg/L	Rotifers
Temp °C	1.000													
pH	0.670	1.000												
EC mS/cm	0.297	0.200	1.000											
TS mg/L	0.073	-0.456	0.616	1.000										
TDS mg/L	0.197	-0.424	0.646	0.963	1.000									
TSS mg/L	-0.157	-0.427	0.450	0.880	0.718	1.000								
DO mg/L	0.366	0.780	0.510	-0.045	-0.150	0.147	1.000							
TA mg/L	0.652	0.229	0.231	-0.002	0.262	-0.466	-0.238	1.000						
Chlorides mg/L	0.513	-0.097	0.022	0.128	0.375	-0.329	-0.547	0.921	1.000					
TH mg/L	0.479	0.472	0.169	-0.409	-0.165	-0.763	-0.019	0.856	0.636	1.000				
Sulphate mg/L	0.219	-0.491	0.097	0.446	0.640	0.022	-0.715	0.710	0.897	0.325	1.000			
Phosphate mg/L	0.900	0.286	0.319	0.364	0.520	0.020	0.016	0.759	0.751	0.406	0.598	1.000		
Nitrate mg/L	0.400	-0.150	0.513	0.446	0.669	-0.030	-0.331	0.853	0.842	0.594	0.860	0.665	1.000	
Rotifers	0.337	0.530	0.034	-0.617	-0.406	-0.874	0.040	0.696	0.449	0.964	0.110	0.185	0.376	1

EC=Electrical Conductivity, TS= Total Solids, TDS= Total Dissolved Solids, TSS= Total Suspended Solids, DO= Dissolved Oxygen, TA= Total Alkalinity, TH= Total Hardness (all the values are expressed in mg/L except pH, temperature and EC)

It is evident from the PCA as represented in figure-1, that relative distance between the two sampling stations indicates the similarity between them and respective coordinates. Similarly, closer the two rotifer species, the more similar are their respective abundance in sampling stations. In order to understand the association of communities, similarity values we followed the Bray and Curtis an ordination of the upland forest communities³³. It was observed that the study shows both positive and negative correlations with respect to water quality. Only values above 90% were accounted to study the distribution of species in the canal (figure-4). The occurrence of *Lecane obtusa*, *Lepadella ovalis*, *Brachionus calyciflorus f amphiceros* and *Brachionus diversicornis*. Showed similarity of occurrence reaching above 90 %. These species have the capacity of close co-existence in the canal ecosystem. The lowest similarity of taxa was between *Trichocera rattus* and *Rotaria flaviceps*.

The finding of the present study indicate that high rotifer species density could be explained by eutrophic effect. *Lecane bulla*, *B. calyciflorus*, *Lepedella species* and *Keratella sps* were predominant at all the five sampling sites. The above mentioned species are the indicators of eutrophic water^{29,34}. Some of the species recorded in Chikkadevarayana canal are indicators of eutrophication. Studies on the rotifer associations with diverse aquatic macrophytes observed in the canal. Understanding rotifer distribution may serve as a model for other lotic and terrestrial organisms valuable for aquatic biodiversity and sustaining ecologically important species by emphasizing the importance of niche, distribution and abiotic environmental factors. Abundance and community structure of rotifers and its role in productivity of an aquatic ecosystem needs further research in the study area.

Conclusion

The species recorded in the study area are the indicators of water quality, the rotifer associations with the diverse aquatic macrophytes was observed in the present study area. Understanding rotifer distribution may serve as a model for other lotic and terrestrial habitat and sustaining ecologically important species by emphasizing the importance of niche, distribution and abiotic environmental factors.

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