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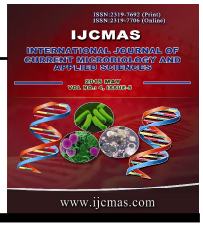

Original Research Article

An analysis of Zooplankton in a Lake, Pudukkottai District, Tamilnadu, India

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A B S T R A C T

Qualitative and quantitative abundance of plankton in a water body are of great importance in imposing sustainable management policies as they vary from location to location and aquatic systems within the same location. Seasonal changes in the pattern of zooplankton community have been driven by a combination of abiotic and biotic factors. Hence the present study was undertaken to assess the zooplankton diversity in a lake situated in the suburb of Pudukkottai District, Tamil Nadu. Results indicate that 40 species belonging to five different groups were recorded during the period of study. Out of the 40 species, two each belonged to Protozoa and Ostracoda, 27 to Rotifera, 5 to Cladocera, 3 to Copepoda and 1 to Anostraca. A percentage composition reveals that rotifera represented 66.03%, cladocerans 12.23%, protozoans 9.56%, copepodans 7.11% and ostracods, 3.51% respectively.

Introduction

Human demands on freshwater ecosystems have risen steeply over the past century leading to large and growing threats to biodiversity around the world (Dudgeon *et al*., 2006). As a result of this global crisis, documenting losses of biodiversity, diagnosing their causes and finding solutions have become a major part of contemporary freshwater ecology (Strayer and Dudgeon, 2010). Further, the qualitative and quantitative abundance of plankton in a water body are of great importance for imposing sustainable management policies as they vary from location to location and aquatic systems within the same location with similar ecological conditions (Boyd, 1982). In addition, in many lakes and reservoirs zooplankton community have been reported to show changes in abundance of specific taxa during the late spring through summer especially in the tropics. Seasonal patterns in zooplankton communities of lakes and reservoirs are recognized as being driven by a combination

of abiotic factors (Moore and Folt, 1993; Benndorf *et al*., 2001), nutrients (Urabe *et al*., 1997) as well as biotic factors like comptetion (Gliwicz and Pijanowska, 1989). Hence the present study was undertaken to study the zooplankton community in a lake situated in the suburb of Tiruchirappalli, Tamil Nadu, India.

Materials and Methods

The aquatic system chosen for the present investigation is a lake situated in Pudukkottai District (Lat. 10° 13', Long. 79° 21') and referred to as Aathivayal Lake. The lake is located at Kottaipattinam, Manalmelkudi Taluk (Periyamadai Phaichal) at an elevation of about 80 MSL and it is conjoined with Vellar river originating from Pudukkottai District. It is mostly perennial.

It has a water spread area of about 1.5 hectares and a depth of about 52 m when full. As the lake is close to East Coast, it is currently used for agriculture, cattle bathing and building constructions. On the other hand, environmental degradation is felt intensely in this area (Jayaram, 2000; Kalavathy *et al*., 2011). Thus this system is prone to more pollution.

The zooplankton net used in the present study was of 270 mesh sieve (pore diameter 20-30 μ). The zooplankton were fixed immediately with 4% formalin for further microscopic analyses. Identification of plankters was done after Clegg (1956), Edmondson (1959), Hutchinson (1967), Michael (1973), Ward and Whipple (1963), Pennak (1978), APHA (1989) and Sridharan (1989). After identification of plankters, useful indices of species structure in communities as detailed by Odum (1971) were also calculated.

Results and Discussion

The zooplankton that were recorded in the lake are presented in tables 1–6. As seen from the tables, the zooplankton that occurred in the pond belonged to five different groups – Protozoa, Rotifera, Ostracoda, Cladacera and Copepoda. On the whole, a total of 40 species were recorded in the lake during the period of study.

The protozoans that occurred during the period of study are presented in table 1. As evident from the table, only two species of protozoans were recorded; of these, only one species *viz*., *Paramecium caudatum* was perennial. The other species (*Difflugia oblongata*) occurred only between December and July recording its highest count in June. *P. caudatum*, on the other hand, recorded the highest count in May. Thus protozoans appeared to prefer May and June as both the species recorded their maximal counts during this period. Comparing both the species reveals that *P. candatum* was dominant over *D. oblongata* in terms of number.

A perusal of literature reveals that Sivakami (1996) recorded maximal protozoan counts from June to September with intermediate peaks between October and November and February to May. In the present study, there was a gradually increasing trend from September to reach the peak in June followed by a decline till August.

A comparison of the protozoan diversity in various water bodies, of India reveals that while Sivakami (1996) recorded the presence of only one protozoan in an aquatic system, she was also able to record the presence of two protozoans in another system. Similarly, Pathak and Mudgal (2004) and Kiran *et al*. (2007) were able to record the presence of two species of

protozoans while Srivastava (2013) was able to record only one species in a water body of North India. Thus, on the whole, it appears that the protozoan diversity in Indian aquatic systems are less. Literature also reveals that the numerical abundance of ciliate protozoans is less and usually depends on trophic state, season and depth of the water column (Pace, 1982; Lewis, 1985; Beaver *et al.*, 1988; Muller, 1989, Sivakami, 1996). In the present study also, there was a positive correlation between water level and protozoans thus reflecting their relationship.

According to Porter *et al.* (1979) protozoans play a key role in zooplankton community by representing an important trophic link while Pace and Orcutt (1981) suggests that protozoans play an important role in nutrient regeneration because of their high rates of phosphorous excretion.

The various zooplankters that represented the group Rotifera are presented in table 2. As evident from the table, a total of 27 species belonging to 16 genera were recorded. Of these, the genus *Brachionus* was represented by 7 species, while the genera like *Filinia, Keretella, Lecane, Rotaria* and *Trichocerca* were all represented by two species each and the remaining genera were represented by a single species.

On the whole, 11 rotifer species were perennial (*A. sieboldi, Brachionus bidentata, B. calyciflorus, B. plicatilis, B. rubens, Filinia longiseta, Keretella cochlearis, Lecane luna, Platyias patulus, Rotaria citrinis* and *Trichocerca longiseta*). Further, two species, *Polyarthra vulgaris* and *Testudinella patina* were noticed only during the second year and were absent during the first year.

Among the perennial species, *L. luna* preferred January to record their highest counts, while *A. sieboldi, B. calyciflorus, B. plicatilis, F. longiseta, K. cochlearis, P. patulus* and *T. longiseta* preferred February to record their highest counts and *B. bidentata, B. rubens* and *R. citrinis* preferred March to record their highest counts.

Within the genus *Brachionus,* three species (*B. angularis, B. caudatus* and *B. diversicornis*) were not perennial. Nevertheless, *B. angularis* preferred January while *B. diversicornis,* February and *B. caudatus,* March, to record their highest counts when present. Among this genus, the species *B. bidentata* was found to be dominant followed by *B. rubens* while the least dominant species was *B. caudatus* in terms of number.

Among the other non-perennial species, *Epiphanes seneta, Kellicottia longispina* and *Testudinella patina* preferred September to record their highest counts while *Cephalodella gibba* preferred October and *K. quadrata,* January to record their maximum counts. On the other hand, *Conochilus arboreus, Filinia terminalis, Lecane angulata, Polyarthra vulgaris* and *Trichocerca capucina* preferred February to show their highest counts while *Notholca acuminata* and *Rotaria rotatoria* preferred March to record their highest counts. The genus *Philodina,* represented by a single species *P. roseola* was found to occur from September to November and April to June in very small numbers.

An overall comparison of the rotifer population reveals that they preferred the period between September to March to record their highest counts even though they were present throughout the year. A closer look further reveals that within this period, the most preferred period appeared to be February/March as 18 of the 27 species that

were recorded registered their maximum counts in these months.

Literature reveals that the genus *Brachionus* is one of the most common rotifer genera that has been recorded in most of the water bodies of India (Sreenivasan, 1974; Rajalakshmi, 1980; Malarvizhi, 1989; Kastooribai, 1991; Sivakami, 1996; Rajasekhar *et al.*, 2010; Singh *et al.*, 2012; Srivastava, 2013). Hence in the present study also, it was quite natural that *Brachionus* was the most common genera in lake.

Studies done by various workers have also revealed that rotifers appear to prefer different months of the year in various water bodies. While Michael (1969), Chourasia and Adoni (1985), Singh *et al*. (2012) and Tidame and Shinde (2012) reported their preference for the summer season, Kastooribai (1991) and Sivakami (1996) reported that they preferred June - August while Jayanthi (1994) and Rajasekhar *et al.* (2010) reported their preference during September and October. These reports are in line with the present observation.

A perusal of literature reveals that Paulose and Maheswari (2008) and Rumana *et al.* (2010) reported that increased temperature results in the increased multiplication of rotifers. The present study also showed a positive correlation with temperature. While Pennak (1978) suggested that changes in pH affect the distribution of rotifers, Chourasia and Adoni (1985) suggested that alkaline pH increased the number of rotifers. The present study also recorded a positive correlation with rotifers.

However, Schmid-Araya (1993) reported that factors related to ionic concentration (Ca, Mg and Cl) have an effect on rotifer density while Rajasekhar *et al.* (2010) reported that rotifers showed a positive correlation with phosphate, dissolved oxygen and primary productivity. This appears to be true in the present study also. In addition, numerous workers have correlated the reproductive rate of rotifers to the quality and abundance of food as different species may respond to a given feeding condition with a different reproductive rate (King, 1967; Dumont, 1977).

Table.1 Protozoan population of Aathivayal Lake (i/l)

S. No.	Protozoa	Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1.	*Difflugia oblongata*	2011-12	120	0	0	0	0	10	20	30	140	250	360	380
		2012-13	210	110	0	0	10	20	40	60	170	280	390	410
2.	*Paramecium caudatum*	2011-12	140	50	60	80	110	220	230	250	360	420	480	340
		2012-13	130	60	80	120	120	220	330	340	380	440	460	250
Total Count		2011-13	**600**	**220**	**140**	**200**	**240**	**470**	**620**	**680**	**1050**	**1390**	**1690**	**1380**
Average		2011-13	**300**	**110**	**70**	**100**	**120**	**235**	**310**	**340**	**525**	**695**	**845**	**690**

Table.2 Rotifer population of Aathivayal Lake (i/l)

S. No.	Rotifera	Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1.	*Asplanchna sieboldi*	2011-12	40	80	160	100	170	210	240	360	160	140	110	40
		2012-13	20	60	140	110	210	220	280	440	380	240	120	60
2.	*Brachionus angularis*	2011-12	0	0	0	0	10	30	150	80	10	0	0	0
		2012-13	0	0	0	0	20	70	160	120	40	0	0	0
3.	*B. bidentata*	2011-12	10	30	120	170	110	220	330	440	450	330	220	100
		2012-13	20	50	80	120	90	130	220	360	460	320	270	190
4.	*B. calyciflorus*	2011-12	10	60	80	160	170	230	360	470	380	290	190	120
		2012-13	10	30	90	190	210	260	340	490	400	310	280	140
5.	*B. caudatus*	2011-12	0	0	0	0	0	0	10	20	80	40	0	0
		2012-13	0	0	0	0	0	0	20	40	140	120	70	0
6.	*B. diversicornis*	2011-12	40	20	10	0	0	20	70	130	90	40	50	50
		2012-13	50	20	20	0	0	10	90	220	150	50	20	0
7.	*B. pilicatilis*	2011-12	10	20	80	40	10	20	80	140	90	80	40	10
		2012-13	20	50	130	90	40	80	140	260	160	140	70	20
8.	*B. rubens*	2011-12	40	90	160	120	150	160	180	230	280	240	180	140
		2012-13	50	60	180	140	160	180	260	290	340	260	200	150
9.	*Cephalodella gibba*	2011-12	10	30	70	110	70	0	0	0	0	0	0	0
		2012-13	30	40	120	100	110	0	0	0	0	0	0	0
10.	*Conochilus arboreus*	2011-12	0	0	0	0	10	40	50	160	130	0	0	0
		2012-13	0	0	0	0	10	30	60	180	130	70	40	0
11.	*Epiphanes seneta*	2011-12	40	160	240	180	0	0	0	0	0	0	10	30
		2012-13	70	140	360	210	0	0	0	0	0	10	30	70
12.	*Filinia longiseta*	2011-12	40	160	240	140	120	220	310	340	260	170	140	40
		2012-13	30	160	300	230	110	270	390	450	370	280	190	50

Continued...

Table.2 continued....

S. No.	*Rotifera*	Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
13.	*F. terminalis*	2011-12	0	0	0	0	0	20	60	110	80	40	10	0
		2012-13	0	0	0	0	0	40	90	120	60	30	20	0
14.	*Kellicottia longispina*	2011-12	20	40	80	70	30	10	0	0	0	0	0	0
		2012-13	10	40	110	80	50	30	10	0	0	0	0	0
15.	*Keretella cochlearis*	2011-12	10	40	80	40	70	110	120	180	140	50	20	10
		2012-13	20	50	120	90	110	170	230	340	230	130	90	60
16.	*K. quatrata*	2011-12	0	0	0	30	60	90	160	90	60	20	0	0
		2012-13	0	0	0	10	40	110	200	140	80	40	0	0
17.	*Lecane luna*	2011-12	10	40	100	70	110	120	230	160	120	120	60	40
		2012-13	10	20	90	40	90	140	280	190	140	110	70	60
18.	*L. angulata*	2011-12	0	0	10	20	130	140	200	260	170	70	0	0
		2012-13	0	0	10	30	160	200	260	310	180	90	0	0
19.	*Notholca acuminata*	2011-12	0	0	0	0	0	10	60	130	240	130	70	40
		2012-13	0	0	0	0	0	10	80	140	260	140	80	20
20.	*Philodina roseola*	2011-12	0	0	10	30	20	0	0	0	0	10	40	20
		2012-13	0	0	20	40	10	0	0	0	0	20	50	10
21.	*Platyias patulus*	2011-12	10	40	120	200	110	190	210	320	260	140	40	30
		2012-13	20	40	160	270	140	240	280	400	370	270	130	40
22.	*Polyarthra vulgaris*	2011-12	0	0	0	0	0	0	0	0	0	0	0	0
		2012-13	0	0	0	10	20	30	40	120	70	40	0	0
23.	*Rotaria citrinis*	2011-12	90	120	180	140	110	230	240	320	410	210	160	0
		2012-13	110	130	170	160	170	240	350	390	570	360	210	0
24.	*Rotaria rotatoria*	2011-12	0	0	0	0	0	10	40	70	130	120	90	0
		2012-13	0	0	0	0	0	10	30	60	180	120	70	0
25.	*Testudinella patina*	2011-12	0	0	0	0	0	0	0	0	0	0	0	0
		2012-13	0	40	120	70	0	0	0	0	0	0	0	0

Continued...

Table-2 continued....

S. No.	Rotifera	Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
26.	*Trichocerca capucina*	2011-12	0	0	0	0	10	40	120	170	80	30	0	0
		2012-13	0	0	0	0	20	60	130	220	140	70	0	0
27.	*T. longiseta*	2011-12	10	30	140	90	20	80	140	160	140	100	40	20
		2012-13	10	40	80	40	10	80	150	260	180	140	80	30
Total Count		2011-12	**20**	**110**	**340**	**200**	**60**	**260**	**540**	**810**	**540**	**340**	**120**	**150**
		2012-13	**870**	**1930**	**4180**	**3800**	**3280**	**4940**	**7450**	**10180**	**8810**	**5830**	**3470**	**1820**
Average		2011-13	**435**	**965**	**2090**	**1900**	**1640**	**2470**	**3725**	**5090**	**4405**	**2915**	**1735**	**910**

Table.3 Cladoceran and Anostracan populations of Aathivayal Lake (i/l)

S. No.	Species	Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Cladocera														
1.	*Bosmina longirostris*	2011-12	0	0	0	0	0	10	30	40	130	220	60	0
		2012-13	0	0	0	0	10	20	80	140	180	310	130	0
2.	*Daphnia carinata*	2011-12	0	0	0	10	30	40	50	120	160	130	40	0
		2012-13	0	0	0	10	20	40	160	230	320	180	60	0
3.	*Daphnia pulex*	2011-12	10	20	30	70	110	120	230	350	360	470	240	120
		2012-13	20	40	40	90	210	260	340	360	480	540	320	130
4.	*Moina brachiata*	2011-12	10	20	10	0	0	0	0	10	20	80	20	0
		2012-13	10	30	10	0	0	0	10	20	40	130	70	0
5.	*Moina micrura*	2011-12	0	0	0	0	10	60	20	130	180	220	140	60
		2012-13	0	0	0	10	20	70	130	160	220	280	120	40
Total Count		2011-13	**50**	**110**	**90**	**190**	**410**	**620**	**1120**	**1560**	**2140**	**2560**	**1280**	**350**
Average		2011-13	**25**	**55**	**45**	**95**	**205**	**310**	**560**	**780**	**1070**	**1280**	**640**	**175**
Anostracan														
1.	*Streptocephalus dichotomus*	2011-12	20	30	140	210	130	0	0	0	0	0	0	10
		2012-13	20	50	140	240	120	0	0	0	0	0	0	20
Total Count		2011-13	**40**	**80**	**280**	**450**	**250**	**0**	**0**	**0**	**0**	**0**	**0**	**30**
Average		2011-13	**20**	**40**	**140**	**225**	**125**	**0**	**0**	**0**	**0**	**0**	**0**	**15**

Table.4 Copepod population of Aathivayal Lake (i/l)

S. No.	Species	Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1.	*Diaptomus castor*	2011-12	40	70	140	120	0	0	0	0	0	0	10	20
		2012-13	70	80	130	110	0	0	0	0	0	0	10	30
2.	*Heliodiaptomus viduus*	2011-12	30	70	180	120	40	20	0	0	0	0	0	0
		2012-13	50	90	210	130	70	20	0	0	0	0	0	0
3.	*Mesocyclops hyalinus*	2011-12	170	220	230	340	150	90	10	40	60	70	120	140
		2012-13	320	330	400	450	220	110	20	30	40	90	180	240
Total Count		2011-13	**680**	**840**	**1290**	**1380**	**480**	**240**	**30**	**70**	**100**	**160**	**310**	**410**
Average		2011-13	**340**	**420**	**645**	**690**	**240**	**120**	**15**	**35**	**50**	**80**	**155**	**205**

Table.5 Ostracodan population of Aathivayal Lake (i/l)

S. No.	Ostracoda	Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1.	*Heterocypris malcolmsonii*	2011-12	30	40	160	90	30	10	0	0	0	0	0	0
		2012-13	20	60	170	110	70	40	0	0	0	0	0	0
2.	*Cypris subglobosa*	2011-12	0	0	0	0	0	0	40	60	170	180	340	300
		2012-13	0	0	0	0	0	20	60	80	190	260	340	240
Total Count		2011-12	**30**	**40**	**160**	**90**	**0**	**0**	**40**	**60**	**170**	**180**	**340**	**300**
		2012-13	**20**	**60**	**170**	**10**	**100**	**70**	**60**	**80**	**190**	**260**	**340**	**140**
Average		2012-13	**25**	**50**	**165**	**100**	**50**	**35**	**50**	**70**	**180**	**220**	**340**	**220**

Table.6 Zooplankton Total Count of Aathivayal Lake (i/l)

S. No.	Zooplankton	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1.	Protozoa	300	160	70	100	120	235	310	340	525	695	645	690
2.	Rotifera	435	965	2090	1900	1640	2470	3725	5090	4405	2915	1735	910
3.	Copepoda	390	420	645	690	240	120	15	35	50	80	155	205
4.	Cladocera	25	55	45	95	205	310	560	780	1070	1280	640	175
5.	Ostracoda	25	50	165	100	50	35	50	70	180	220	340	220
6.	Anostraca	20	40	140	225	125	0	0	0	0	0	0	15
Total		**1195**	**1690**	**3155**	**3110**	**2380**	**3170**	**4660**	**6315**	**6230**	**5190**	**3515**	**2215**

According to Bogdan and Gilbert (1984), rotifers are the dominant members of the zooplankton in most aquatic systems while Goldman and Horne (1983) reported that almost all fish feed on tiny rotifers during their early development and Sharma (1991) opines that of the different rotifers identified so far, rotifers belonging to the genus *Brachionus* are more suitable for feeding fish larvae. Recently, Tidame and Shinde (2012) suggested that rotifers are used as an important aquatic faunal component for biomonitoring.

The various cladereceran species that were noticed in the lake are presented in table 3. As seen from the table, a total of 5 species belonging to 3 genera were recorded. Of these, 2 species each belonged to the genus *Daphnia* and *Monia* and one to the genus *Bosminia*. Among these, only one species, *Daphnia pulex*, was perennial.

As to their most preferred months, *D. carinata* preferred March while the remaining four species (*Bosmina longirostris, Daphnia pulex, Monia brachiata* and *M. micrura*) preferred April to record their highest counts. Thus, it can be seen that their preferred months were March and April within which April appeared to the most preferred month as 4 of the 5 species recorded their maximum counts during this month.

Among the cladocerans, the most dominant species was *D. pulex* followed by *M. micrura* while the least dominant one was *M. brachiata* in terms of their count. A perusal of the total cladoceran count reveals that there was an unimodal peak. In general, there was a steadily increasing trend from July to reach the peak in April followed by a decline.

A perusal of literature reveals that Chourasia and Adoni (1985) reported that they preferred October and April while Khan *et al.* (1986) reported their preference for summer and Haque and Khan (1997) reported their preference for December, May and August. Recently, Rajasekhar *et al.* (2010) suggested that they preferred the rainy season and also the winter season (Tidame and Shinde, 2012). Earlier studies done in Tamil Nadu reveals that they preferred the November to February and to a lesser extent in June. The results of the present study are in line with the

observations of Adoni and Vaishya (1985) and Khan *et al.* (1986).

Prabhavathi and Sreenivasan (1977) reported that ponds which are rich in nutrients like phosphates have an abundance of cladocerans. Sipauba-Tavares *et al.* (2010) also suggested that there was a correlation between nitrate and ammonium during the dry season. This appeared to be true in the present study also.

The group Anostraca (Table 4) was represented by a single species *Streptocephalus dichotomus*. It was not a perennial species. When present, it was recorded between June and October showing the highest count in October.

The copepods that occurred in the lake are presented in table 5. A total of 3 copepods occurred during the period of study of which only one species *viz*., *Mesocyclops hyalinus* was perennial. The other two species, *Diaptomus castor* and *Heliodiaptomus vidvus* occurred only in certain months of the year. *D. castor* occurred only between May and October and *H. vidvus* from July to October. Nevertheless, both of them recorded their highest counts in September. However, *M. hyalinus* recorded its highest count in October. Thus it appears that the most favourable months for copepods were September and October as all the three species recorded their highest counts during this period. Among the copepods, *M. hyalinus* was the dominant species while *D. castor* was the least dominant.

The group Ostracoda was represented only by two species (Table 5). None of the species were perennial; while *Heterocypris malcolmsonii* was found to occur between July and December, *Cypris subglobosa* was found to occur between January and June. Further, while *H. malcolmsonii* preferred September to record their highest counts, *C. subglobosa* preferred May to record their maximum counts.

A perusal of the total ostracod counts reveals that they had a bimodal peak-one occurring in September and the other in May. Of these, the peak that occurred in May was the highest. In general, there was an increasing trend from July to reach the first peak in September which was followed by a decline till December only to increase again to reach the peak in May.

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