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Y. Thanga Kiruba, S. Valarmathi and R. Sivakami

Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 13
Issue: 06

Res. Jr. of Agril. Sci. (2022) 13: 1875–1880

CARAS

Res. Jr. of Agril. Sci. (Nov-Dec 2022)
13(6): 1875–1880

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

www.rjas.org

Full Length Research Article

An Analysis of Plankton Community in Temporary Lentic System Located in Kulumani Village, Tiruchirappalli District, Tamil Nadu, India

Y. Thanga Kiruba[1], S. Valarmathi[2] and R. Sivakami*[3]

Received: 07 Oct 2022 | Revised accepted: 28 Nov 2022 | Published online: 21 Dec 2022

A B S T R A C T

An important component in an aquatic system is plankton which serve as a key group for energy production their growth, abundance and diversity reflect on the density and diversity of other systems organisms in that system. Hence the present study was attempted to analyze the density and diversity of plankters living in a fresh water temporary lentic system located in Kulumani Village, Tiruchirappalli District of Tamil Nadu, India. A total of 44 plankters (25 Phytoplankton and 19 Zooplankton) could be Identified. The phytoplankton belonged to 4 groups and zooplankton to 5 groups. Each group appeared to prefer a certain period of time to recorded their highest group count. Highest diversity was recorded in the hotter periods. This is probably attributed to favorable climatic, physico-chemical variables and nutrient loading.

***Key words*:** Physico-chemical, Temporary water bodies, Plankton community

An important component in the ecological pyramid of a fresh water system is plankton [1]. Planktonic communities in natural aquatic systems serve as a key group for energy production [2]. The growth and abundance of plankton various with season, depth, meteorological and water properties which in turn reflect on the density and diversity of organisms within that system [3-4]. However, today, because of the exploding human population aquatic ecosystems are being affected by several health stressors including sewage, domestic, industrial and agricultural effluents carrying organic matter and highly toxic substances which are significantly depleting biodiversity and even loss of biodiversity [5]. The effects of the above are predicted to be very drastic in the near future. Under these circumstances it was thought worthwhile to assess the planktonic community and diversity in a temporary lentic system located in Kulumani village, Trichirappalli District, Tamil Nadu, India.

MATERIALS AND METHODS

Physico-chemical analyses

Water samples of the system were taken from the surface and stored in separate polyethylene bottles for later analyses in the laboratory. While some physicochemical variables like estimation of dissolved oxygen (DO), hydrogen-ion-concentration (pH), free carbandioxide (free CO_2) and alkanity were analyzed in the field itself, the other variables were done in the laboratory. Duplicate samples were taken and analyzed.

The atmospheric and water temperatures were measured using a centigrade mercury thermometer calibrated to 100°C. Atmospheric temperature was measured in shade, while surface water temperature was analyzed by taking the surface water in a glass container and then measuring it. The water level of the system was measured by using a nylon rope which was graduated with a weight at one end. The measurement was done on every sampling day at a particular spot.

Transparency of the water was measured using a Sechi's disc while total dissolved solids (TDS), free carbondioxide and alkalinity were estimated by following the procedures described by Saxena [6]; dissolved oxygen (DO) was estimated using the unmodified Winkler's method [7] and pH by using digital pH pen (Hanna). Electrical conductivity was measured by using a water analysis kit (Elico). Nutrients like phosphate, silicate, ammoia-nitrogen, nitrite-nitrogen, sulphate, calcium, magnesium, oxidizable organic matter and suspended solids were estimated according to APHA [8]. Nitrate-Nitrogen (NO_3-N) was estimated after Mackereth [9] and chloride by following Strickland and Parsons [10]. Biological Oxygen Demand (BOD) was estimated as per the procedure of Sawer and Bradney [11] and Chemical Oxygen Demand (COD) after Moore *et al*. [12].

Phytoplankton analysis

Surface water samples were collected with the help of a satin net (pore diameter 4.5µm) fitted to an aluminium frame around 8:30 a.m. for a period of one year collection was done

* **R. Sivakami**
✉ drsiva17@gmail.com

[1-3] PG and Research Department of Zoology, Arignar Anna Government Arts College, Musiri, Tiruchirappalli - 621 211, Tamil Nadu, India

on a monthly basis. The counting of algae was done using, Sedgwick-Rafter Counting Cell [13-18]. While phytoplankton population density was estimated by drop method as described by Pearsal *et al*. [19], counting and identification of algae and euglenoids were done by following Pennak [20], Prescott *et al.* [21], Adoni [22], Sridharan [23]. In addition, diversity indices were also calculated following Trivedy *et al*. [24]. Finally, the results obtained in the present study were statistically treated for a meaningful discussion.

Zooplankton analysis

The zooplankton net was of 270 mesh sieve (pore diameter 20-30µm). The zooplankton was fixed immediately with 4% formalin for further microscopic analyses. The counting of zooplankton was done using a Sedgwick-Rafter cell [6] (Saxena, 1987). Identification of plankters was done after Clegg [25]; Edmondson [26], Hutchinson [27]; Michael [28]. After identification of plankters, useful indices of species structure in communities as detailed by Odum [29], Sharma *et al.* [30] were also calculated.

RESULTS AND DISCUSSION

The various physico-chemical variables that were analyzed during the period of study are presented in (Table 1). The water temperature during the period of study ranged between 23 (Nov.) to 27.5 °C (Apr.), while conductivity ranged from 126.4 µmhos/cm (Feb.) to 170 µmhos/cm (Oct.) and turbidity from 16.4 (Jan.) to 22.2 cm (Oct.). pH remained alkaline throughout ranging between 7.2 (Jan.) and 8.3 (Apr.) while Dissolved Oxygen (DO) ranged from 7.6 (Apr.) to 10.6 mg/l (Oct.) and free carbondioxide between 0.28 (Oct.) and 0.41 mg/l(Apr.). Total alkalinity, on the other hand, varied from 120 (Oct.) to 162 mg/l (Apr.) while total hard ness from 84 (Nov) to 129 mg/l (Apr.) and total dissolved solids from 180 (Oct.) to 232 mg/l (April). BOD level were found to range between 1.22 (Oct.) and 1.96 mg/l (April).

With regard to nutrients that were assessed (Table 1), phosphate levels were found to range between 0.28 (Apr.) to and 0.44 mg/l (Oct.) While NO_3-N levels varied from 0.36 (Apr.) to 0.62 mg/l (Oct.) and chloride levels vacillated between 29 (Oct.) to 42 mg/l (Apr.) during the period of study. In the present study, a total of 44 plankters could be identified of which 25 species belonged to phytoplankton and 19 belonged to Zooplankton. The phytoplankton that were recorded in the present study belonged to 4 groups - Cyanophyceae, Chlorophyceeae Bacillariophyceae and Euglenophyceae (Table 2). Cyanophyceae were represented by 7 species each belonging to a different genus. Among the 7 species the most dominant one was *Microcystis aeruginosa* as evident by then individual counts. While each species appeared to prefer a particular period to record their highest counts, in general, the highest group count was noticed in the month of April and their minimum count in September.

Table 1 Physicochemical variables and nutrients analyzed during the period of study

	Unit	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Water temperature	°C	25.2	25.3	26.5	27.5	-	-	-	24.2	24.0	23.6	23.0	24.0	24.63
Conductivity	µs/cm	138.6	126.4	140.2	144	-	-	-	156.2	164.2	170.2	160.4	156.2	139.6
Turbidity	NTU	16.4	18.2	19.6	20.2	-	-	-	17.6	18.6	22.2	18.4	17.6	18.75
pH		7.2	7.6	8.2	8.3	-	-	-	7.8	7.4	7.3	7.3	7.5	7.61
Carbondioxide	mg L^{-1}	8.2	8.0	8.0	7.6	-	-	-	9.2	10.2	10.6	9.4	9.6	8.97
Carbondixide	mg L^{-1}	0.31	0.32	0.34	0.41	-	-	-	0.36	0.35	0.28	0.29	0.30	0.25
BOD	mg L^{-1}	1.62	1.82	1.84	1.96	-	-	-	1.26	1.18	1.22	1.31	1.42	1.44
Total Alkaliny	mg L^{-1}	120	130	140	162	-	-	-	1.30	120	120	126	126	116.1
Total Hardress	mg L^{-1}	102	109	118	11.29	-	-	-	98	90	86	84	86	100.22
T.D.S	mgL^{-1}	210	212	226	232	-	-	-	194	184	180	190	184	202.44
Chloride	mg L^{-1}	37	38	40	42	-	-	-	30	32	29	33	35	35.33
Phosphate	mg L^{-1}	0.39	0.36	0.32	0.28	-	-	-	0.30	0.34	0.44	0.42	0.42	0.30
Nitrate	mg L^{-1}	0.42	0.40	0.38	0.36	-	-	-	0.40	0.56	0.62	0.56	0.44	0.45

Where May – July, Dry Season, - Nil value

Table 2 Phytoplankton identified in the fresh water system

Phytoplankton	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
					Cyanophyceae							
Anabaena aphanizomenan	10	12	40	50	-	-	-	8	10	30	16	17
Nostoc linkia	10	20	60	60	-	-	-	30	10	30	15	18
Oscillatoria formosa	3	6	15	16	-	-	-	10	12	14	7	8
Spirulina major	14	20	22	30	-	-	-	20	10	-	22	30
Lyngbya limnetica	3	4	9	9	-	-	-	-	6	8	5	-
Microcystis aeruginosa	80	90	40	70	-	-	-	30	20	20	50	60
Synechocystic aquatilis	5	6	6	-	-	-	-	-	6	7	7	-
Class Count	125	158	192	235	-	-	-	98	74	109	122	133
					Chlorophyceae							
Pediastrum simplex	3	6	5	4	-	-	-	-	-	-	-	-
Scenedesmus bijugatus	11	16	12	-	-	-	-	-	-	-	7	8
Spirogyra sp	14	18	13	11	-	-	-	6	7	8	10	12
Tetradeon minimum	8	12	-	-	-	-	-	-	-	4	4	7
Ulothrix sp	9	14	8	6	-	-	-	-	-	-	5	6
Zygnema sp	19	27	18	12	-	-	-	7	8	10	12	10
Closterium sp	6	8	8	4	-	-	-	-	-	4	5	8
Pandorina sp.	16	17	14	12	-	-	-	7	8	10	12	10
Cladophora sp.	7	10	11	9	-	-	-	-	-	-	6	8
Class Count	86	128	89	58	-	-	-	23	27	36	64	76
					Bacillariophyceae							
Diatoma sp.	4	8	10	12	-	-	-	12	9	7	5	4
Fragillaria sp.	-	-	-	-	-	-	-	7	6	5	5	-

Gyrosigma acuminatum	-	-	4	6	-	-	-	12	7	3	-	-
Navicula sp.	10	19	24	31	-	-	-	36	23	15	12	12
Pinnularia viridis	3	6	7	13	-	-	-	15	10	4	1	2
Amphora sp.	-	3	4	9	-	-	-	7	4	3	4	7
Class Count	17	36	49	71	-	-	-	89	59	37	27	25
Euglenophyceae												
Phacus longicauda	12	9	-	-	-	-	-	5	6	5	7	9
Euglena viridis	19	14	6	5	-	-	-	10	9	11	14	16
Lepocincilis sp	5	2	8	7	-	-	-	-	1	2	3	4
Class Count	36	25	14	12	-	-	-	15	16	18	24	29
Total phytoplankton count	264	347	344	376	-	-	-	225	176	200	237	263

Where May – July, Dry Season, - Nil value

Table 3 Zooplankton identified during the period of study

Zooplankton	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Protozoa												
Paramecium caudatum	2	4	5	7	-	-	-	2	1	-	-	-
Ceratium furca	1	2	4	6	-	-	-	1	-	-	-	-
Class Count	4	6	9	13	-	-	-	3	1	-	-	-
Rotifera												
Brachionus angularis	17	19	20	14	-	-	-	6	9	10	12	16
Brachionus calyciflorus	10	12	13	14	-	-	-	4	6	8	8	9
Brachionus rubens	6	7	7	9	-	-	-	1	4	5	5	6
Brachionus caudatus	9	11	12	16	-	-	-	-	5	7	8	8
Brachionus quadridentata	2	3	5	6	-	-	-	-	1	2	2	1
Keratella tropica	7	8	9	12	-	-	-	1	4	5	5	7
Asplanchna intermedia	2	5	7	8	-	-	-	1	2	2	-	-
Filinia longiseta	1	3	4	7	-	-	-	-	1	2	-	-
Asplanchna brightwelli	1	2	2	4	-	-	-	-	-	-	-	-
Class count	55	70	79	100	-	-	-	13	32	41	40	47
Cladocera												
Daphnia magna	6	11	14	18	-	-	-	11	9	7	4	3
Moina micrura	-	2	3	4	-	-	-	1	-	-	-	-
Diaphanosoma excisum	3	3	4	4	-	-	-	2	4	4	2	1
Class Count	9	16	21	26	-	-	-	14	13	11	6	4
Copepoda												
Mesocyclops hyalinus	12	16	14	9	-	-	-	8	8	2	6	8
Eucyclops separatus	6	9	5	4	-	-	-	-	-	2	4	7
Thermocydops decipiens	9	14	9	8	-	-	-	8	5	4	4	6
Class Count	27	39	28	21	-	-	-	16	13	8	14	21
Ostracoda												
Cypris subglobosa	6	9	11	7	-	-	-	2	4	4	4	6
Eucypris bispinosa	7	6	9	2	-	-	-	1	2	4	5	5
Class Count	13	15	20	9	-	-	-	3	6	8	9	11
Total Zooplankton Count	108	146	157	169	-	-	-	49	64	68	69	83

Where May – July, Dry Season, - Nil value

A perusal of literature reveals that *M. aeruginosa* has been reported to be the commonest algae and also the dominant one in many tropical systems [31-32]. In the present study, Cyanophycean group count was found to vary from 42.04 to 62.5% of the total phytoplankton count. According to Arumgam [33] Cyanophycean count usually range between 11.3 to 66.3% of the total phytoplankton count in various system in India. As to the abundance of Cyanophyceae, literature reveals that their abundance is usually associated with higher values of temperature free CO_2, hardness BOD and richness of nitrate and phosphate [34-36]. Correlation of Cyanophycean count with the above variable shows a positive correlation suggesting their inter relationship (Table 5).

Chlorophyceae were represented by 9 species belonging to 9 different genera. Among these, the dominant species were *Zygnema*, *Pandorina* and *Spirogyra*. Chlorophycean group count was found to vary between 23 i/L (Aug.) to 128 i/L (Feb.). Thus, as a group they preferred to occur in maximum number in February. In relation to trial phytoplankton count, chlorophyceae varied between 10.22 and 36.88% of total phytoplankton. Literature reveals that *Spirogyra* and *Zygnema* were abundant in the tropical systems that were analyzed by Ghavzan *et al*. [37]. According to Arumugam [33] chlorophycean population form 45.3% of the total phytoplankton population in various systems across India. Thus, the observation noticed in the present study is in live with the record of Arumugam [38].

According to Sharma *et al.* [30] the abundance of Chlorophyceae could be attributed to moderate values of turbidity, pH, DO, nitrate and phosphate while Pearsall [19]. Suggested that chlorophyceae occurred when nitrate and phosphate were moderate with high organic matter. A similar situation was also noticed in the present study as evident from their inter relationships (Table 5). Bacillariophyceae was represented by 6 species belonging to 6 different genera. Of the six species, the most dominant was *Navicula* in terms of their count. The group count varied from 17 i/l to89 i/l with the minimal level recorded in January and the highest in August. In terms of phytoplankton count, Bacillariophyceae count ranged between 6.43 and 39.55%.

Table 4 Plankton diversity indices during the study period

Phytoplankton	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Simpson	0.36	0.47	0.67	0.68	-	-	-	0.24	0.30	0.32	0.33	0.35
Shannon Weiner	2.05	2.26	2.61	2.64	-	-	-	1.22	1.33	1.42	1.64	1.8
Berger parker	0.83	0.90	0.92	1.2	-	-	-	0.3	0.34	0.35	0.46	0.67
Margalelf	2.06	2.25	2.34	2.43	-	-	-	1.72	1.79	1.84	1.91	1.94
Zooplankton												
Simpson	0.44	0.63	0.74	0.78	-	-	-	0.21	0.30	0.36	0.40	0.41
Shannon Weiner	2.56	2.63	2.67	2.81	-	-	-	2.2	2.22	2.31	2.39	2.46
Berger Parker	0.82	0.83	0.86	0.94	-	-	-	0.61	0.64	0.72	0.74	0.79
Margalef	2.03	2.42	2.63	2.76	-	-	-	1.42	1.81	1.92	1.93	1.97

Table 5 Correlation co-efficient among hydrobiological parameters

Parameter	Unit	Cyanophyceae	Chlorophyceae	Bacillakiophyceae	Euglenophyceae	Rotifera	Protozoa	Cladocera	Copeepoda	Ostracoda
Water temperature	°C	-0.24	-0.48	0.72	-0.86	0.64	-0.72	0.96	0.96	0.96
Water current	cm/sec	-0.26	0.38	-0.84	-0.72	0.32	-0.64	-0.76	-0.64	-0.76
Turbidity	NTU	-0.44	-0.24	0.34	-0.64	0.27	-0.44	-0.84	-0.36	-0.84
Conductivity	µs/cm	-0.60	-0.60	0.64	-0.38	0.24	-0.70	0.60	0.24	0.60
pH		0.84	0.98	-0.72	0.64	-0.72	0.80	-0.90	-0.34	-0.90
DO	mgL^{-1}	0.24	0.34	-0.64	0.24	-0.84	-0.64	-0.60	-0.76	-0.60
CO_2	mgL^{-1}	-0.72	-0.64	0.60	-0.42	0.72	-0.92	0.64	0.72	0.64
BOD	mgL^{-1}	-0.32	-0.72	0.72	-0.28	0.98	-0.84	0.42	0.64	0.42
Total alkalinity	mgL^{-1}	+0.48	0.36	0.64	0.72	0.47	0.94	0.60	0.26	0.60
Total hardness	mgL^{-1}	0.16	-0.46	0.72	0.92	0.72	0.74	0.24	0.12	0.24
T.D.S	mgL^{-1}	-0.34	-0.32	0.64	0.38	-0.40	-0.36	0.92	0.76	0.92
CL_2	mgL^{-1}	0.60	0.64	0.28	0.40	0.44	0.24	0.32	0.70	0.32
PO_4	mgL^{-1}	-0.75	0.28	0.72	0.26	0.60	0.24	-0.18	0.42	-0.18
NO_3	mgL^{-1}	-0.84	0.36	0.64	-0.36	0.72	-0.26	-0.72	+0.64	-0.72

Bold – Significant at 1% level

Literature reveals that Kundangar and Zutshi [39] recorded their preference between March to September while Singh [40] reported their preference in August and Rajagopal *et al*. [41] suggested they preferred July. However, Sharma *et al*. [30], reported that they preferred of number to record their highest counts. According to Arumugam [33], Bacillariophyceae in the Indian systems formed 4.6 to 57.9% of the total phytoplankton count. This is well within the range obtained in the present study. According to Hecky and Kitham [42] bacillariophycean count increased when alkalinity, NO_3 and PO_4 levels were high while Hegde and Bharathi [43] recorded high counts when the levels of Ca, SiO_2 and DO levels were high. A correlation a positive correlation showing their interrelationship (Table 5). Euglenophyceae were represented by 3 species each belonging to a different genus. Among the 3 species, *Euglena viridis* dominated. A group count reveals that it varied from 12 i/l (Apr.) to 36 i/l (Jan) thus preferring January to record their highest counts.

Literature reveals that Singh [40] reported their abundance in December while Kastooribai [44] noticed then abundance in January as was observed in the present study. Hegde and Bharathi [43] reported maximum euglenoid population when there was a high level of free CO_2, Oxidizable organic matter and chloride. However, in the present study, there was a negative correlation with free CO_2 and a positive correlation with chloride and DO levels thereby showing Euglenophyceae represented between 3.19 and 13.63% of the total phytoplankton count. According to Arumugam [33], euglenoid percentage varied from 0.003 to 28% in various Indian aquatic systems. Hence the range is well within those suggested by Arumugam [33]. Zooplankters that were recorded in the system belonged to 5 groups (Protozoa, Rotifera, Cladocera, Copepoda and Ostracoda). A total of 19 zooplankters could be identified during the period of study (Table 3). Protozoa was represented by only 2 species. Among these *Paramecium caudatum* dominated in terms of count. While both the species were absent from October to December, the group as a whole recorded its highest count in April. Protozoa as a group represented nil to 7.69% of the total zooplankton count. Sharma *et al*. [30] also recorded their highest counts during February to April and suggested that moderate temperature, DO, alkalinity, pH, nitrate and BOD to have played an important role in their population count.

Rotifera was represented by 9 species belonging to 4 genera. The genus *Brachionus* was represented by 5 species, *Asplanchna* by 2 species and the genera *Keratella* and *Filinia* by a single species each. Among the rotifers, *B. angularis* dominated in terms of count rotiferan population recorded their lowest counts in August and the maximum in April suggesting that they preferred this month the most. In terms of zooplankton percentage, rotifera population varied between 26.53 and 59.17% suggesting that they dominated the zooplanktonic population. A perusal of literature reveals that several workers have recorded rotifers to be the dominant zooplankton group in various aquatic systems in India [36]. In addition, several workers have reported rotifers to record their dominance during the hot season as was noticed in the present study [45-47].

As to variations of rotifers noticed in the present study, Yousuf and Qadri [48] (1981) suggested temperature to be an important factor determing their abundance while Pennak [20] reported that pH affects nortiferan population and Schmid-Araya [49] observed that Ca, Ng and Cl_2 have an effect on rotifer population. Even though Ca and Mg were not analyzed in the present study. Correlation between rotifers and other variables did show a positive relationship indicating their influence on rotiferan population (Table 5). Cladocerans and Copepods were represented by 3 species each with all of them belonging to different genera. While *Daphnia magna* dominated among cladocerans *Mesocyclops hyalinus* dominated among copepods. While cladocerans as a group recorded their lowest counts in December, copepods as a group recorded their lowest counts in October. The highest cladoceran group count was recorded in April while in copepods, the highest group count was noticed in February. A perusal of literature reveals that some works have

recorded maximum cladoceran population to occur in the summer months as was noticed in the present study [50-51] with regard to the peak of copepods, George [52] recorded copepodans to peak in February while Jayanthi recorded their peaks in between December and February and Arumugam noticed its peak in January.

Literature suggests that temperature plays an important role in the abundance of cladocerans [53-54]. Here also a positive correlation was obtained with all the above parameters thus indicating their relationship (Table 5). With regard to copepodan occurrence, many workers have suggested that a positive correlation with temperature and pH [55]. A similar correlation was also observed in the present study (Table 5). Ostracoda was represented by only 2 species each belonging to a different genus. Among the too, *Cypris subglobosa* appeared to dominate. While minimal count was noticed in August, the maximum count was recorded in March. Literature reveals that Kalavathi [56] noticed Ostracods to peak in April-June while Jayanthi [57] suggested their peaks to be between March and June and Sivakami [58] recorded their peaks in February and September. Rajashekhar *et al*. [59] attributed the occurrence of Ostracods to the alkalinity of water while Pennak [20] reported that the nature of the substrate and general type of environment may have little effect on their distribution. In the present study there was a positive correlation with temperature and pH as was suggested by Malavizhi [60].

To analyze species diversity, various types of indices were calculated (Table 4). In general, it appears that species diversity were higher during the hot period than the cool period. This could possibly be attributed to the presence of favourable conditions like temperature, light, pH and nutrient load in the system as suggested by Sharma *et al*. [30].

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