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Seasonal variation of zooplankton population in relation to physicochemical parameters in Valkulam pond, Agasteeswaram, Kanyakumari

P Mathana and S Thiraviaraj

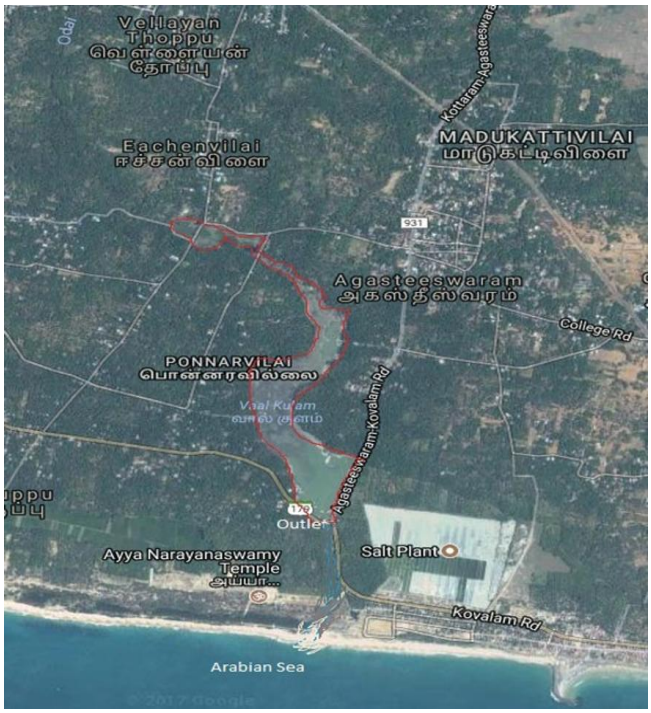
Abstract
Physicochemical parameters play a vital role to determine the occurrence of zooplankton population. Present study was conducted to assess the relationship between physicochemical parameters and zooplankton population of Valkulam pond. Results showed an increased concentration in physicochemical parameters has an adverse impact on the density of zooplankton in monsoon, where maximum disturbances were recorded. High population of zooplankton was recorded from late postmonsoon to early premonsoon.

Keywords: Zooplankton, physicochemical parameters, seasons and Valkulam

1. Introduction
Water is the key substance for the survival of all organisms in this globe. Quality of water in terms of physicochemical and biological characteristics in the pond offers most favourable conditions for the existence of zooplankton which constitute essential components of the food chain (Ahmad *et al.* 1989 and Islam *et al.* 2007) [1, 12]. Ecologically zooplankton is one of the most important biotic components influencing all functional aspects of an aquatic ecosystem such as food chains, food webs, energy flow and cycling of matter (Gonzalves *et al.* 1946 and Radhakrishnan *et al.* 2009) [10, 21]. Plankton assemblages are closely linked to seasonal changes in temperature, nutrient and light availability. Zooplanktons respond rapidly to changes in the aquatic environment and their population may be used as a tool for biomonitoring the status of aquatic bodies (Ferdous *et al.* 2009) [8]. All lives from microorganisms to human beings faces serious problem of present day because of water resources have reached to a point of crisis due to unplanned urbanization, industrialization and other manmade activities. A number of studies have been carried out on ecological condition of freshwater bodies in various parts of India but the ecological studies of freshwater body is very scanty in coastal Kanyakumari particularly Agasteeswaram. So the present study deals with the influence of physicochemical parameters on zooplankton population in Valkulam pond, Agasteeswaram, Kanyakumari.

2. Material and Methods
Valkulam Pond is located near Agasteeswaram at Kanyakumari District. The pond leads narrow extends in the south north direction, resembling a tail and hence the name Valkulam. This pond is situated 500m away from the Agasteeswaram and 2km away from the Kanyakumari. The pond covers an area is about 25.86.5 hect. Pond water is used for irrigation of 70 acre agricultural area and aquaculture. The villagers used this pond for bathing, washing and domestic activities. Pond supplies drinking water to 4 Panchayath such as Kovalam, Agasteeswaram, Kanyakumari and Thamaraikulam. Outlet of this pond meets the Arabean Sea at Kovalam after covering a distance of 0.5 km.
Sample was collected fortnightly between 7:00 to 9:00 a.m. from the depth of 2 to 3 m during October 2015 – September 2016, representing three seasons (Postmonsoon = October–January; Premonsoon= February–May and Monsoon = June–September). Physicochemical parameters like temperature, dissolved oxygen, pH, alkalinity, calcium, sulphate, phosphates, sodium and nitrates were estimated by using standard methods (Wetzel *et al.* 1991 and APHA, 2005) [29, 2]. For zooplankton analysis, one liter of sample was collected and filtered through plankton net of bolting silk No.25 (mesh size 64 micrometer). All the filtered content was transferred to 100 ml glass container, added 4% formalin and few drops of glycerin.

Supernatant plankton free water was removed and sedimentary zooplankton was counted by Sedgewick-Rafter cell method. The zooplankton species were identified with the help of standard works (Ward *et al.* 1959 and Battish, 1992) [28, 3]. Karl Pearson's correlation coefficient was used to determine relationship between the physicochemical parameters and zooplankton.



Map Showing the Valkulam Pond (Study area)

3. Result and Discussion

Table 1 represents the physicochemical parameters and zooplankton populations of the study area. Temperature plays a vital role in vertical distribution of zooplankton (Islam *et al.*, 2007) [12]. The recommended temperature for freshwater bodies ranges from 20^0C to 33^0C. In the present study, temperature recorded in between 27-30^0C. Maximum water temperature was recorded in premonsoon (30.75±1.29) and it was minimum (27.75±1.29) in monsoon (Fig: 1). Increase in temperature may be due to shallowness of the pond in which sunlight penetration would be the maximum. It enhanced the rate of decomposition by which water is enriched with nutrient. This reflects high productivity of planktons. Low temperature might be due to monsoonal rain, cloudy sky and influx of high amount of water to the pond. It lowers the growth of zooplankton population. Present finding was confirmed by Siddique *et al.* (1980) [27] from primary production studies in a freshwater pond.

Dissolved oxygen (DO) is one of the most important parameters that reflect the physical and biological processes prevailed in water (Fakruzzaman *et al*, 1996 and Gautam, 1990) [7, 9]. A maximum of 4 mg/lit of dissolved oxygen was recommended for healthy growth of planktons and fish. In the present study, dissolved oxygen content varied from 4.22±1.05mg/lit to 5.35±0.87 mg/lit. Narrow fluctuation and reasonably good DO was recorded in postmonsoon and early premonsoon. It indicates the prevalence of higher zooplankton population and also favoured for the production of fishes in pond. Above finding was supported by Okpokwasili, (1996); Chindah, (2003) and Rahman *et al.* (2008) [19, 4, 22].

Table 1: Seasonal variation of physicochemical parameters and Planktonic Populations.

Parameters	Postmonsoon	Premonsoon	Monsoon
	Mean±SD	Mean±SD	Mean±SD
Temperature	29.75±1.78	30.75±1.29	27.75±1.29
Oxygen	4.22±1.05	4.91±0.58	5.35±0.87
pH	7.3±0.18	7.48±0.28	7.4±0.1
Alkalinity	71.5±1.12	71±1.58	72±0.71
Calcium	66.25±1.08	63.5±1.11	75±1.23
Posphates	0.48±0.05	0.41±0.05	0.66±0.04
Sulphates	0.6±0.12	0.525±0.10	0.55±0.11
Sodium	6.48±0.57	6.34±0.37	7.91±0.38
Nitrates	0.03±0.001	0.03±0.01	0.03±0.001
Rotifera	25±2.73	21.25±4.32	12.75±0.82
Copepoda	17±1.63	23.25±5.7	12.25±1.47
Cladocera	14.75±1.92	15.75±3.11	12±1.87
Protozoa	12.25±1.47	16.25±2.17	7.5±1.80
Ostracoda	7.75±1.08	8.5±1.12	6.75±1.92

pH is the measure of acidity or alkalinity and the concentration of hydrogen ions in water. pH has no direct adverse effect on health. However the value of pH hastens the scale formation in water heating apparatus and also reduces germicidal potential of chloride. Aquatic animals thrive well in water that has the pH value in the range of 7.3-9.0 (ELC, 2005) [6]. In this study, pH in the pond was slightly alkaline in early premonsoon (7.48±0.28), low in the postmonsoon (7.3±0.18) and fall within the above said range and hence, it supports zooplankton growth. This pH correlated the rise of temperature with increase in zooplankton population and also the production of freshwater fishes. The present finding was supported by Salam *et al.* (2000) and Ntengwe, (2005) [24, 18].

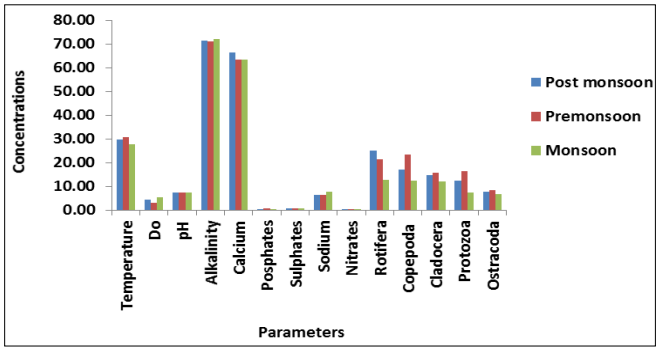


Fig 1: Seasonal variation of physicochemical parameters and Planktonic Populations.

Alkalinity values of 20-200 mg/l are common in fresh water ecosystems. Alkalinity is important for fish and aquatic life because buffers against rapid pH changes. High alkalinity (72±0.71mg/l) was reported in monsoon and it was minimum (71±1.58mg/l) in premonsoon. Result obtained in this study is within the permissible limit. Presence of alkalinity might be due to high rate of decomposition where high rate of CO_2 was released. This CO_2 react with the water to form HCO^{-3} and thereby increasing the alkalinity which helps to maintain buffering capacity of water and favours zooplankton production. Present result was confirmed by Chowdhury *et al.* (2004); Huisman *et al.* (2005) and Manjare *et al.* (2010) [5, 11, 17].

In the present study, concentration of calcium was maximum (75±1.23 mg/l) in monsoon and it was low (63.5±1.11) in premonsoon. Similar finding was reported from Haraz River, Iran (Jafari *et al.* 2011) [13]. Maximum concentration of

phosphates was recorded (0.66±0.04mg/l) in monsoon and minimum (0.41±0.05mg/1) in premonsoon. Concentration of sodium was high (7.91±0.38mg/l) in monsoon and it was low (6.34±0.37 mg/l) in premonsoon. Nitrogen is essential for organisms as an important constituent of proteins, including genetic material. Maximum concentration of nitrates and sulphates were observed in monsoon, when the pond was received high amount of debris from the watershed and agricultural runoff which in turn disfavors zooplankton production. Nitrate and phosphate content present in water bodies showed direct relationship with growth of zooplankton. Similar findings were reported from Ganga River (Rani *et al.* 2011) and Rapti River (Kushwaha *et al.* 2014) [23, 16].

3.1 Zooplankton population

Zooplankton population was low in monsoon and high in late postmonsoon to early premonsoon. A total of 29 zooplankton (table: 2) species belonged to five groups namely Rotifera (12 sp), Copepoda (8 sp), Cladocera (3 sp), Protozoa (4 sp), Ostracoda (2 sp).

3.1.1 Copepoda

Copepoda was the dominant group out of total zooplankton population. *Nauplii, Microcyclops varicans, Eucyclops serrulatus, Paracyclops fimbriatus, Calanus finmarchicus, Eucalanus bungii, Diaptomas denticornis* and *Mysis* were observed in the genera copepoda. Occurrence of copepods was high in early premonsoon, whereas low in monsoon. Copepods made positive correlation with temperature (r = 0.719) and Ca (r = 0.345) while made negative correlation with oxygen, alkalinity and nitrogen (table: 3). Positive correlation with temperature coincides with the investigation of Koli *et al.* (2012) [15] in Tulsi Reservoir, Maharastra.

3.1.2 Rotifera

Rotifera represented by 12 species and it was high in February and low in July. Commonly occurring rotifers were *Brachionus caudatus, B. falcatus, B. calyciflorus, B. forficula, B. angularis, Filinia longiseta, Polyarthraremata, Hexathra Sp., Keratella tropica, Synchaeta sp., Asplanchna sp.,* and *Anuraeopsis sp*. Rotifer population was positively correlated with temperature (r = 0.565) and calcium (r = 0.504). On the contrary, this population were negatively correlated with oxygen (r = - 0.535). Similar observation was also made by Sharma (2009) [26] in Loktak Lake, Manipur. He showed that transparency and oxygen was favour for rotifer population.

3.1.3 Cladocera

In the present study, Cladocera group were represented by 3 species. The population was high in early premonsoon but low monsoon. This group was dominated by *Daphnia sp., Cerio daphnia sp., Bosmina sp., Cladocerans*. They showed positive correlation with temperature, pH and phosphate and negative correlation with oxygen. Positive correlation with phosphate had also been reported by Poongodi *et al.* (2009) [20].

3.1.4 Protozoa

Members of the Protozoa were *Amoeba sp.,* and *Paramecium sp*. The two species were available throughout the year. High density was found in February and low in September. This group set up positive correlation with sulphates and sodium, and negative correlation with oxygen. Positive correlation with calcium was also suggested by Kedar *et al.* (2008) [14] in Rishi Lake.

Table 2: Zooplankton population in the Valkulam pond.

Type of planktons	October	November	December	January	February	March	April	May	June	July	August	September	Total
Copepoda													
Nauplii	15	20	22	35	50	43	38	27	28	32	20	25	355
M. varicans	18	16	20	38	47	40	35	22	25	28	23	26	338
E. serrulatus	13	15	16	25	40	34	28	19	22	21	20	22	275
P. fimbriatus	12	13	15	20	35	30	30	13	18	15	18	16	235
C.finmarchicus	19	17	24	36	47	39	33	14	19	16	19	18	301
Eucalanus bungii	10	12	14	29	39	34	31	12	14	12	10	11	228
D. denticornis	9	7	10	15	19	20	18	10	9	8	9	10	144
Mysis	4	3	2	6	7	5	4	1	0	0	1	2	35
Rotifera													
B.caudatus	12	10	14	16	19	20	12	9	8	7	0	0	127
B. falcatus	9	10	5	14	18	15	10	4	6	3	2	1	97
B. calyciflorus	6	9	7	11	14	12	9	5	2	2	1	0	78
B. forficula	7	8	4	10	13	10	8	7	5	3	2	4	81
B. angularis	6	7	9	10	13	9	7	5	8	6	4	2	86
Filinia longiseta	5	4	6	9	10	8	4	2	1	0	0	1	50
Polyarthra remata	3	4	5	7	9	7	5	3	0	0	1	1	45
Hexathra Sp.,	4	2	5	6	7	4		2	1	0	2	1	34
Keratella tropica	2	3	3	4	6	4	3	1	2	2	1	2	33
Synchaeta sp.,	3	2	3	5	7	4	3	2	0	1	2	1	33
Asplanchna sp.,	1	2	1	5	6	3	2	1	1	0	1	0	23
Anuraeopsis sp.,	2	1	3	6	8	4	2	2	0	1	1	0	30
Cladocera													
Daphnia sp.,	20	18	21	32	38	44	34	25	15	16	18	20	301
Ceriodaphnia sp.,	11	14	10	15	26	38	30	20	14	13	10	9	210
Bosmina sp.,	10	12	13	16	28	34	30	19	13	10	8	5	198
Ostracoda													
Cypris sp.,	15	14	18	21	25	36	32	20	12	10	0	8	211
Cyprinotus sp.,	18	15	14	20	26	34	30	17	11	7	3	2	197
Protozoa													
Amoeba sp.,	1	2	0	1	2	2	0	0	1	1	0	1	11
Paramecium sp.,	1	2	1	1	2	1	0	1	0	1	2	2	14
Total	236	242	265	413	561	534	438	263	235	215	178	190	3770

Table 3: Correlation intermatrix between physicochemical parameters and Zooplankton population.

Parameters	Temperature	Do	pH	Alkalinity	Calcium	Posphates	Sulphates	Sodium	Nitrates	Rotifera	Copepoda	Cladocera	Protozoa
Temperature													
Oxygen	-0.771												
pH	0.206	-0.171											
Alkalinity	0.120	0.092	0.380										
Calcium	0.296	0.066	-0.441	0.000									
Posphates	0.242	-0.590	0.033	-0.239	-0.333								
Sulphates	0.148	-0.236	-0.271	0.139	0.300	-0.050							
Sodium	-0.461	0.454	-0.253	-0.015	-0.293	-0.369	0.205						
Nitrates	0.000	-0.014	0.442	0.450	-0.356	0.019	-0.128	0.072					
Rotifera	0.565	-0.535	-0.100	-0.077	0.504	0.311	0.343	-0.525	-0.420				
Copepoda	0.719	-0.679	-0.171	-0.061	0.345	0.222	0.284	-0.279	-0.374	0.786			
Cladocera	0.760	-0.792	0.129	-0.196	0.067	0.479	-0.004	-0.506	-0.158	0.734	0.867		
Protozoa	0.021	-0.012	-0.448	-0.307	0.182	-0.168	0.320	0.305	-0.158	0.332	0.214	0.067	
Ostracoda	0.603	-0.757	0.182	-0.197	0.065	0.589	0.015	-0.678	-0.390	0.790	0.744	0.931	-0.037

3.1.5 Ostracoda

Cypris sp., and *Cyprinotus sp.,* was the representative of ostracoda group which was high in premonsoon and very poor in postmonsoon. This group demonstrates positive correlation with temperature, pH and negative correlation with sodium. Positive correlation with alkalinity was found by Shah and Pandit (2013) [25] in Wular Lake.

3.2 Total zooplankton abundance and physicochemical parameters

Zooplankton population was found in increasing trend during late postmonsoon to early premonsoon whereas, reverse trend was seen during late premonsoon. Physicochemical parameters prevailed during this period was favouring the productionof zooplankton and also it can be utilized for aquaculture purposes.

4. Conclusion

Selected Valkulam pond in our place is highly useful for domestic, agriculture and fishing and for creating natural environment. Present study concluded that the pond has high zooplanktonic population and sediments are not so much abundant because the selected pond is periodically desilted by local people. The selected study area is suitable for inland aquaculture and proper water quality management measures are adopted.

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