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***Research Article** (Open Access)*

STUDY ON PHYSICO-CHEMICAL CHARACTERISTICS, ZOOPLANKTON DIVERSITY AND POPULATION DENSITY IN THE FRESHWATER PONDS OF SOUTH CHENNAI

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ABSTRACT
Ponds are important inland water bodies that act as small reservoirs of freshwater biodiversity, so it is important to scale up research given their importance to aquatic biodiversity. Studying the different components of water ecosystems is essential to elucidate the diversity and processes that change freshwater ecosystems. Zooplankton communities occupy a dominant position in freshwater ecosystems, playing an essential role in maintaining the ecological balance of the environment they live in. Because of their rapid response to environmental changes, they serve as an ecological indicator of the aquatic environment. The aim of this study was to analyse the physico-chemical characteristics and study the zooplankton diversity and density in three different ponds of south Chennai *i.e.*, Pallikaranai Lotus pond, Nanganallur pond and Tirusulam quarry rock pond. Physico-chemical parameters like pH, electrical conductivity, dissolved oxygen, calcium, magnesium, sulphate, nitrate, chloride, total dissolved solids, total alkalinity, and total hardness were analysed. The diversity showed the presence of rotifers, cladocerans, ostracods, calanoid copepods and cyclopoid copepods in all the three ponds. The population density of zooplanktons in the three different ponds was (i) Pallikaranai Lotus Pond - Rotifers > Cyclopoids > Calanoids > Cladocerans > Ostracods, (ii) Nanganallur Pond – Cyclopoids > Calanoids > Rotifers > Cladocerans > Ostracods, (iii) Tirusulam quarry Rock Pond – Calanoids > Cylopoids > Rotifers > Ostracods > Cladocerans

Keywords: *Zooplankton Diversity, Density, Rotifers, Cladocerans, Copepods, Ostracods*

INTRODUCTION
The massive ecosystem on earth, the aquatic ecosystem is always threatened by rapid changes in the aquatic environment that affect its physicochemical features. The species that dwell there are constantly at risk owing to these changes (Santos-Wisniewski *et al.,* 2006). Zooplankton are small, microscopic creatures that reside in the water column of almost all bodies of water and serve as primary link in the food chain of all aquatic ecosystems. These zooplankton are essential components of freshwater fauna (Rahatgaonkar, 2019). The population of zooplankton are influenced by factors like intensity of light, access to food, level of dissolved oxygen, and predator activity. Moreover, low pH and increased salinity might lower their diversity and density (Horne and Goldman, 1994). The growth of zooplankton is controlled by the necessary abiotic components including water, carbon dioxide, oxygen, calcium, nitrogen, and phosphorus salts, amino acids, and humic acids (Rao *et al.,* 1990, Boyd and Tucker, 1998). They can be used as a tool in monitoring aquatic ecosystems since changes in physico-chemical conditions in aquatic systems result in alterations to the relative composition and richness of life that thrive in the water (Jose *et al.,* 2015; Smitha *et al.,* 2013). Hence the diversity and distribution of the zooplanktons depend on the physicochemical properties of the waterbodies (Harikrishnan and Abdul Azis, 1989, Lampert and Sommer, 1997). Since zooplankton communities are so susceptible to changes in the environment and anthropogenic activities, it may be possible to forecast continual alterations in freshwater ecosystems by studying these communities (Ferrara *et al.,* 2002; Jeppesen *et al.,* 2011; Preston and Rusak, 2010). Many studies have noted that zooplankton can act as an indication of alterations in transfer of energy from one trophic level to next trophic level and the ecological status of freshwater bodies due to changes in nutrient concentration and climatic condition.

Variations in zooplankton abundance, species diversity, and community composition might signal the change or disturbance of the environment (Caroni and Irvine, 2010; Kehayias *et al.,* 2014). Freshwater zooplanktons consists of different groups i.e., Rotifers, Cladocerans, Copepods (Cyclopoids and Calanoids) and Ostracods. Rotifers are minuscule, soft-bodied invertebrates. Cladocerans, the primary consumers feed on microscopic algae and fine particle debris (Dhanasekaran *et al.,* 2017). Copepods make a significant amount of the consumer biomass in aquatic environments and are important primary and secondary consumers in food webs as well as a substantial source of food for small fishes feeding on zooplanktons (Altaff and Chandran, 1995, Aman and Altaff, 2004). Copepods are considered as biological indicators for aquatic ecosystem. Ostracods are bivalve crustaceans, widely distributed in both freshwater and marine habitats are of significant interest since they might be used as indicators of changes in the climate and ecology. They were also discovered in highly contaminated places (Martens *et al.,* 2008, Edmondson, 1959). The present study aims to analyse the physico-chemical characteristics of the three different ponds of south Chennai i.e., Pallikaranai Lotus pond, Nanganallur pond and Tirusulam quarry rock pond. Study the zooplankton diversity and density of the three ponds.

MATERIALS AND METHODS

Water samples for physicochemical analysis and zooplankton sample were collected from three freshwater ponds of south Chennai (i)Pallikaranai Lotus Pond, (ii)Nanganallur Pond and (iii)Tirusulam Quarry Rock Pond.

Physicochemical Analysis of the Pond Water: The surface water samples from each pond was collected in sterile polyethylene bottles. The physicochemical parameters such as pH, turbidity, Dissolved Oxygen, Total dissolved solids, Alkalinity, nitrates, calcium, magnesium, sulphate was analysed with standard procedures of APHA, 1998.

Qualitative and Quantitative Analysis: Zooplankton samples were collected during the early hours of the day using plankton net (30cm diameter) made up of Bolton silk of 50µm mesh size. Samples were collected by towing the plankton net horizontally at a depth of 40cm for about 10mins. The collected plankton samples were immediately transferred to sterile polyethylene bottles and then preserved in 5% neutral formalin. Different species of zooplankton were separated under binocular stereo microscope using a fine needle and brush. The zooplanktons were identified based on morphological details and taxonomic key characters described by Altaf, 2004.

Zooplankton sample was quantitatively analysed and enumerated by Sedgewick Rafter method. The number of zooplankton present in one litre of water sample was calculated using the formula:

$$N = n \times v / V$$

where,

N = Total number of plankton per litre of water filtered
n = Average number of plankton in 1 ml of plankton sample
v = Volume of plankton concentrated (ml) and
V = Volume of total water filtered (litre)

The zooplankton population of each group was expressed in number of individuals per litre.

RESULTS AND DISCUSSION

The physico-chemical analysis of three ponds of south Chennai showed that all the parameters were within the permissible limits. The results of the physico-chemical analysis are depicted in table 1. The plankton distribution and species richness are significantly influenced by physico-chemical factors and the amount of nutrients in the water. Water temperature has a significant impact on all physiological, and biological functions, including nutrition, reproduction, mobility, and dispersion of organisms (Shanthi *et al.,* 2010 and Manickam *et al.,* 2015). Due to the carbonates and bicarbonates that are present, natural water is often alkaline. The usual pH range of water should be 6.2-8.5. Intense photosynthesis by phytoplankton raises water's pH when it absorbs carbon dioxide. In water bodies, free carbon dioxide plays a significant role in the

Table 1: Physicochemical analysis of three ponds of south Chennai

Parameters	Pallikaranai Lotus Pond	Nanganallur Pond	Tirusulam Quarry Rock Pond	Permisible Limit
Surface Water Temperature (ºC)	26	26	27	-
Turbidity (NTU)	0.8	0.7	1.1	5
Electrical Conductivity (Micro mho/cm)	496	373	1047	2100
pH	7.24	7.5	7.49	6.5-8.5
Dissolved Oxygen (mg/L)	6.0	5.5	5.9	3-8
Calcium (mg/L)	56	44	112	200
Magnesium (mg/L)	1.2	2.4	2.88	100
Sulphate (mg/L)	5	30	84	200
Chloride (mg/L)	69	35	170	250
Fluoride (mg/L)	0.5	0.5	0.5	1.5
Free Ammonia (mg/L)	0.27	0.53	0.72	0.5
Nitrate (mg/L)	4	4	4	45
Total Dissolved Solids (mg/L)	347	261	733	2000
Total Alkalinity (mg/L)	152	120	200	600
Total Hardness (mg/L)	145	120	292	600

formation of calcium bicarbonate from calcium carbonate, which alters the pH of pond water by interacting with it to produce carbonic acid (Dey *et al.,* 2021). Natural waterbodies with high alkalinity signify phytoplankton productivity in an aquatic ecosystem. Total alkalinity in a waterbody is produced by sodium, potassium, magnesium, calcium, ammonia and ferrous cations reacting together with carbonate or bicarbonate ions as a result forming mineral ions of carbonate or bicarbonate (Reza and Singh, 2010). Sulphates and calcium of magnesium and chlorides contributes to the total hardness of a freshwater pond. But, in some instances, the sulphates and chlorides of Ferrous, Manganese, and Aluminium are to responsible for the permanent hardness (Dey *et al.,* 2021).

Table 2: Diversity of Zooplankton

Zooplankton	**Pallikaranai Lotus Pond**	**Nanganallur Temple Pond**	**Tirusulam Quarry Rock Pond**
Rotifers	*1. Branchionus falcatus* *2. Branchionus quadridentatus* *3. Branchionus calyciflorus* *4. Ascomorpha ecaudis*	*1. Branchionus falcatus* *2. Branchionus calyciflorus* *3. Branchionus caudatus* *4. Proales decipiens*	*1. Branchionus falcatus* *2. Horaella brehmi*
Cladocerans	*1.Diaphanasoma sarsi* *2. Moina micura* *3. Moina brachiate* *4. Ceriodaphnia cornuta*	*1. Diaphanasoma excisum*	*1. Diaphanasoma sarsi* *2. Dunhevedia crassa crassa*
Ostracods	*1. Eucypris bispinosa* *2. Parastenocypris canaliculata*	*1. Stenocypris major* *2. Cyprinotus nudus*	*1. Parastenocypris canaliculata* *2. Strandesia elongata*
Calanoid Copepods	*1. Allodiaptomus (R.) raoi*	*1. Heliodiaptomus viddus* *2. Sinodiaptomus (R.) indicus*	*1. Heliodiaptomus viddus* *2. Sinodiaptomus (R.) indicus* *3. Neodiaptomus*
Cyclopoid Copepods	*1. Mesocyclops aspericornis*	*1. Mesocyclops aspericornis*	*1. Thermocyclops decipiens*
Total Zooplankton species	**12**	**10**	**10**

One of the most crucial parameters that represents the physical, chemical, and biological characteristics and organic pollution in aquatic ecosystem is the dissolved oxygen (Fakruzzaman and Zaman). The atmospheric air pressure, photosynthetic activity, temperature, salinity, and turbulence all have an impact on the dissolved oxygen level of a waterbody. Oxygen becomes more soluble as the temperature drops (Singh *et al.,* 1990, Dey *et al.,* 2021). The quantity of solid substances, both inorganic and organic dissolved in water is

determined as a total dissolved solid. Hazardous substances resulting in the imbalance of ionic concentrations are caused by natural or anthropogenic activity. Cations and anions are both present in the total dissolved solids in the pond water. As a result, the total dissolved solids analysis indicates the total ions present, but it does not specify their type or degree of interaction (Sudarshan *et al.*, 2019). The TDS amount within permissible limit shows the undisturbed ecological balance of the ponds and stabilizes the life of aquatic fauna. The electrical conductivity is determined by the ionic salts that are dissolved in water and the nutrient profile of a freshwater pond. Although the EC of natural water is low, pollution elevates its level significantly. Electrical conductivity is a good predictor of the quality of the water in general (Trivedy and Goel, 1984 and Kadam, 1990).

The present study has observed diversity of zooplankton species – Rotifers, Cladocerans, Ostracods and Copepods in all the three ponds of south Chennai and the results are presented in Table 2 and Figure 1. Many ecological factors, such as nutrient load and pollution status, affect the composition and dominance of the zooplankton species in each waterbody (Dhanasekaran *et al.*, 2017). Rotifers are found in almost all freshwater bodies and have gained widespread interest as a water quality indicator (Rahatgaonkar, 2019). Four species of rotifers were found in Pallikaranai Lotus pond, four in Nanganallur pond and two species in Tirusulam quarry rock pond. The genus *Branchionus* was observed in all the three ponds which are indicators of eutrophication.

The Cladocera, commonly known as water fleas feed on microscopic algae and the fine particulate matter in the detritus are crucial for energy transfer and food chain (Jayabhaye and Madlapure, 2006). In the present study four species of cladocerans was found in Pallikaranai Lotus pond, one in Nanganallur pond and two in Tirusulam quarry rock pond. The genera *Ceriodaphnia, Moina and Diaphanosoma* are widespread and abundant throughout the world and known to be indicators of eutrophication of the freshwater bodies (Balakrishna *et al.*, 2013). The genus *Diaphanosoma* was observed in all the three ponds. Ostracods are small bivalve crustaceans, sometimes called as the seed shrimp are widespread in all waterbodies. In the present study the 2 species ostracods were found in each of the three freshwater ponds.

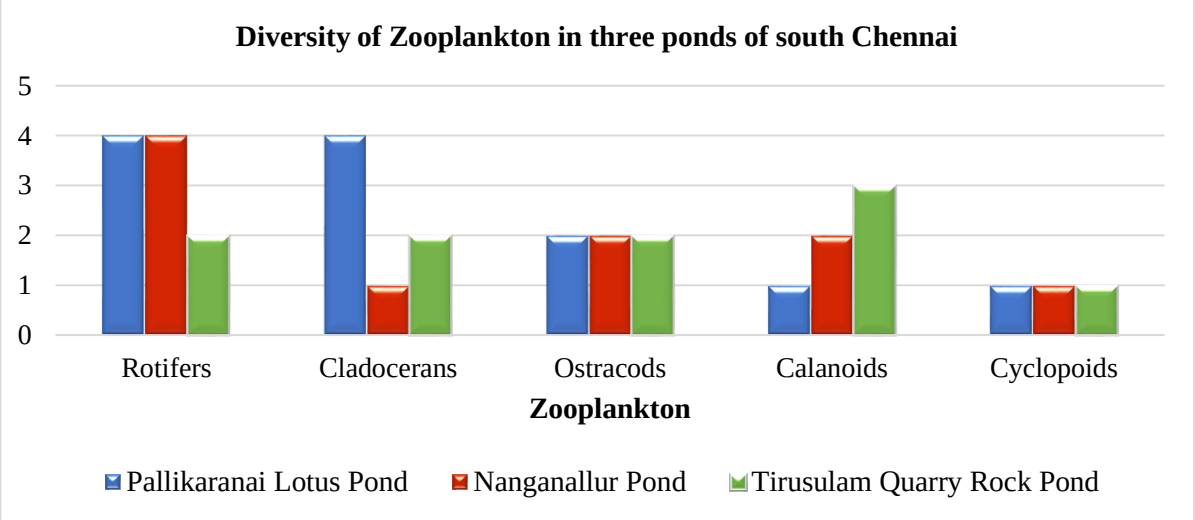

Figure 1: Diversity of Zooplankton in three ponds of south Chennai

The flow of carbon from producers to higher trophic levels in freshwater ecosystem is greatly facilitated by copepods, which are one of the largest providers of animal protein in the world (Rashmi, 2016). Calanoid and Cyclopoid Copepods were found in all three ponds. The Pallikaranai Lotus pond was found to have one species of each calanoid and cyclopoid copepods. The Nanganallur pond comprised of two calanoids and one cyclopoid copepods. While the Tirusulam quarry rock pond was found to have three calanoids and one cyclopoid copepods. The dominance of Calanoid copepods above all the zooplanktons in the Tirusulam

quarry rock pond shows that pond is oligotrophic in nature, while the dominance of Cyclopoid copepods in Nanganallur pond shows the eutrophic nature of the pond (Dhanasekaran, 2017).

The density and percentage composition of zooplankton in the three ponds of south Chennai is shown in Table 3 and Figure 2. In Pallikaranai Lotus Pond density and percentage composition of zooplankton was Rotifers (32.6%) > Cyclopoids (25.3%) > Calanoids (19.1%) > Cladocerans (16.3%) > Ostracods (6.74%), In Nanganallur Pond it was Cyclopoids (35.03%) > Calanoids (18.47%) > Rotifers (19.1%) > Cladocerans (17.83%) > Ostracods (9.55%) and in Tirusulam quarry Rock Pond it was Calanoids (74.3%) > Cylopoids (34%) > Rotifers (30.6%) > Ostracods (11.63%) > Cladocerans (8.14%).

Table 3: Density of zooplanktons in three ponds of south Chennai

Zooplankton	Pallikaranai Lotus pond			Nanganallur pond			Tirusulam quarry rock pond		
	No./L	%	Mean ± SD	No./L	%	Mean ± SD	No./L	%	Mean ± SD
Rotifers	58	32.6%	58.3±7.63	30	19.1%	30.6±2.51	30	17.44%	30.6±4.16
Cladocerans	29	16.3%	29.3±3.20	28	17.83%	28.0±4.0	14	8.14%	14.6±3.7
Ostracods	12	6.74%	12.6±1.52	15	9.55%	15.6±15.0	20	11.63%	20.6±2.51
Calanoids	34	19.1%	34.3±7.76	29	18.47%	29.0±2.64	74	43.02%	74.3±10.0
Cyclopoids	45	25.3%	45±7.21	55	35.03%	55.3±4.5	34	19.77%	34.0±2.64

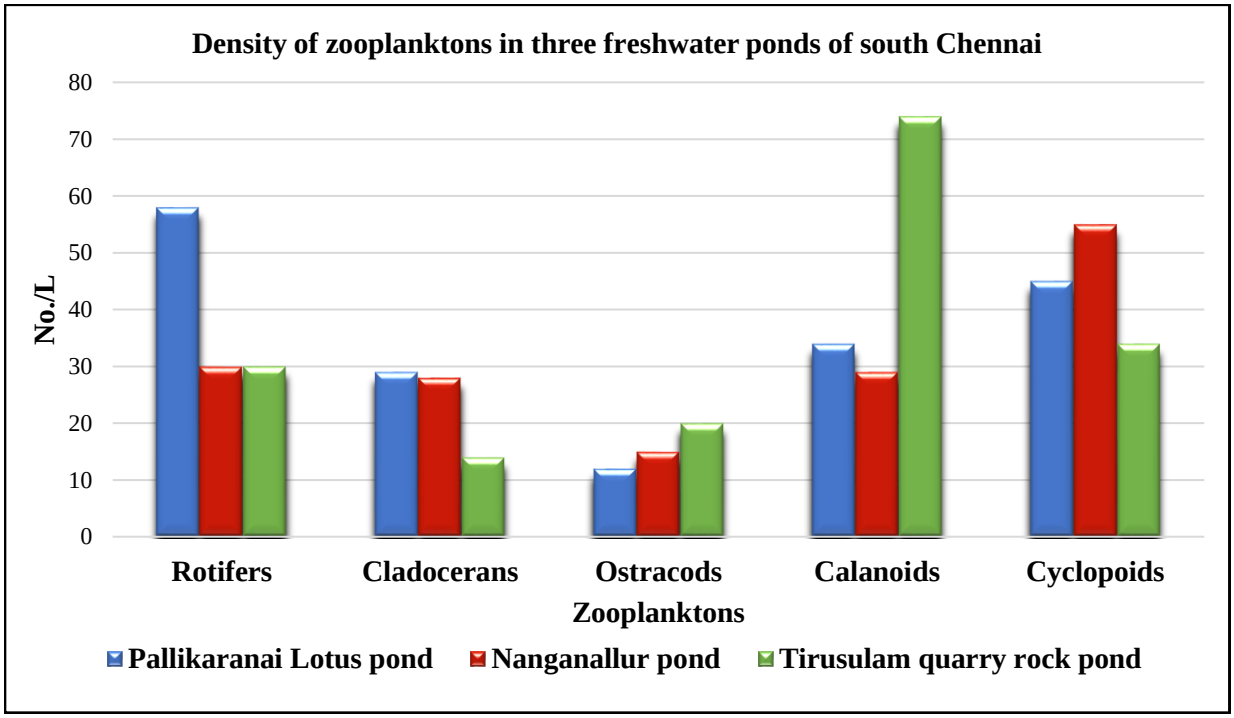

Figure 2: Density of zooplanktons in three freshwater ponds of south Chennai

CONCLUSION

The present study of three ponds of south Chennai indicates the presence of diverse groups of zooplanktons and in overall consensus the human activity around this freshwater bodies could have an impact on the zooplankton production and adaptiveness of the species to the ecological condition in which they live in.

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