

# Seasonal Variation Of The Surface Water Quality And Its Ecological Relationship With Zooplankton Community Structure Of Muttukadu Backwater, Tamil Nadu.

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**Abstract:** A study pertaining to the seasonal variation in physicochemical characteristics and its ecological relationship with zooplankton community structure of muttukadu backwater was carried out for a period of one year between October 2017 and September 2018. Samples were collected from different salinities such as backwater and marine coastal waters at three different locations viz., station 1 and 3 from brackish region and station 2 from lagoon region. Physicochemical parameters such as atmospheric temperature, surface water temperature, salinity, dissolved oxygen, chlorophyll-a, turbidity, alkalinity, hardness and inorganic nutrients. The environmental condition in the coastal waters was almost similar to the estuarine region except the salinity. A total of 41 different taxonomic groups of zooplankton were identified under 10 different orders namely, Amphipoda (2), Anomopoda (2) Calanoida (14) Canuelloida (1) Cyclopoida (4) Copelata (1) Harpacticoida (7) Myodocopida (1) Plioma (4) and Tanaidacea (1) Others (4). The density of zooplankton was very high during pre-monsoon and monsoon at the brackish and coastal waters due to optimum level of nutrients and the availability of food. On spatial scale, zooplankton density and biomass were found to be relatively higher at the lagoon water mainly attributed to the abundance of *Dioithonargida*, *oithonasimilis* and *Brachionusplicatilis*. In contrast, zooplankton diversity was relatively higher in the coastal waters of the study area 3 than the brackish water and lagoon region.

**Index Terms:** Backwater, Biodiversity, Community structure, Ecosystem, Muttukadu, Physicochemical, Zooplankton.

## 1 INTRODUCTION

The zooplankton diversity responds to changes in aquatic environment. They usually act as primary consumers and constitute an important link between primary producers (phytoplankton) and higher consumers like carnivore fish and others in aquatic food chain [1]. The zooplankton mainly consume primary producer and form the major food source for tertiary consumers. Certain species of zooplanktons are used as bio-indicators of water quality [2]. In aquatic ecosystems, coastal zones are regions of land margins with dynamic interactions among atmospheric, terrestrial and aquatic systems and these interactions result in a high productivity and economically important resources [3]. Coastal lagoons are shallow water bodies serrated from the ocean by a barrier, connected at least intermittently to the ocean by one or more restricted inlets usually oriented parallel to the shore [4]. Since lagoons have limited water exchange capacity they are more susceptible to anthropogenic pollution but the changes in water quality seem to be irreversible at least for a certain period [5]. Furthermore water, quality fluctuates based on its salinity levels. Commonly a function of its contact with either fresh or sea water [6]. Estuaries are complex ecosystems due to its highly dynamic environment [7].

The increased levels of chlorophyll concentration and phytoplankton abundance are considered as an immediate biological response for nutrient enrichment that leads to the elevated primary productivity commonly referred to as eutrophication. The eutrophication state can be inferred based on a trophic state index (TSI) level [8]. By virtue of their rapid growth rate and sensitive reaction to environmental changes they have been considered as effective bio indicators of water quality and environmental contamination [9]. The importance of estuarine environment management has been stressed for a long time, because marine systems are influenced by land based pollution and their discharge into the sea [10]. India has a coastline of about 8000 km which encloses a wide range of coastal ecosystems like estuaries, lagoons, back water, salt marshes, rocky coasts and coral reefs [11]. In the present study, different physicochemical parameters and zooplankton species diversity were monitored in order to identify the physical, chemical, biological aspect of aquatic biodiversity.

## 2 MATERIALS AND METHODS

### 2.1 Study area

The Muttukadu backwater, extends for a distance of 20 km from the bar mouth, is present in the southeast coast, Tamilnadu, India. The backwater covers an area of 0.87 km<sup>2</sup> and is used for fishing and boating activities. The backwater is connected to the sea by a bar mouth, the width of which is variable from a few meters to 200 m in different months. The backwater is normally cut off from the sea during May – September; During October – December, due to inundation by the flood stream from the upper reaches, the sand bar gets eroded and the connection with the sea is restored. The width of the estuary ranges from 800 m to 1050 m. The estuary is shallow, the maximum depth being 2 m, in the middle of the channel, while in most of the areas; it is 1 m or less. Granite stones are found along the banks of the southern side. Due to limited fresh water supply, even during the monsoon, and

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limited flushing, the salinity of the backwater goes up appreciably during summer months. Seasonal variations were observed on Muttukadu Backwater by continuous monitoring of water quality for one year. Three stations (S1–S3) were designated so as to include different environmental conditions as follows (Fig. 1).

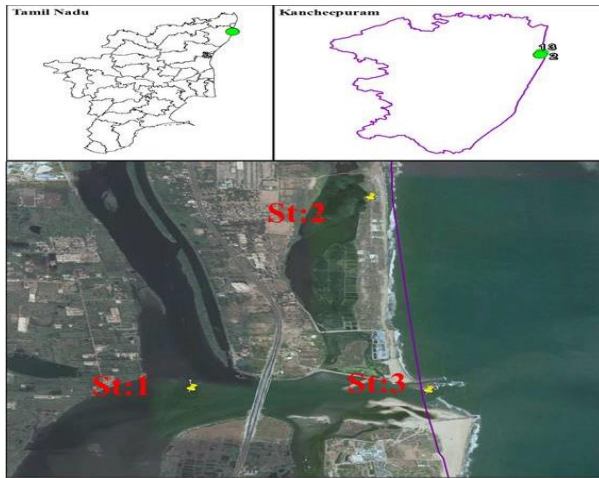


Figure 1. Study area map

Station 1: located near the Tamil Nadu Tourism Boat House 2 km from the bar mouth;

Station 2: located at lagoon area, 5 km from the bar mouth;

Station 3: located near bar mouth.

## 2.2 Sample collection and analysis

Surface water samples were collected monthly in polyethylene bottles from the above named stations during high tide and brought to the laboratory for estimation. All samples were collected from the shallow water body that ranged between 0.7m and 2m depth. The water column depth may reach approximately 2 m in flood periods at S1. S2 is located in the north-eastern part of the Backwater, is a shallow area influenced by a supply of freshwater. S3 faces the Bar mouth of sea, located at 300 meter distance from Central institute of brackish water aquaculture (CIBA) Muttukadu experimental station. Selected physicochemical parameters, including atmospheric temperature, surface water temperature were recorded with the help of a hand held mercury thermometer, the values were noted after two minutes of stabilization. Estimation of dissolved oxygen (DO) was carried out by following Winkler's method [12]. Salinity was measured at sampling sites with the help of hand refractometer (ATAGO, Japan). pH was measured at hand pH meter. Turbidity was determined with Elico CL52D Nephelometer. Water samples for nutrients and chlorophyll-a concentrations were collected in 1000-ml polypropylene bottles. In the laboratory, chemical analysis for nitrate, nitrite, phosphate, ammonium were determined by using a UV-visible (SHIMADZU 1700) spectrophotometer [13]. Chlorophyll a was extracted in 10 ml of 90% acetone for 24 h, in the dark at +4°C and the extract concentration analyzed spectrophotometrically (UV-visible spectrophotometer 1700). Sampling was carried out every month, from October 2017 to September 2018.

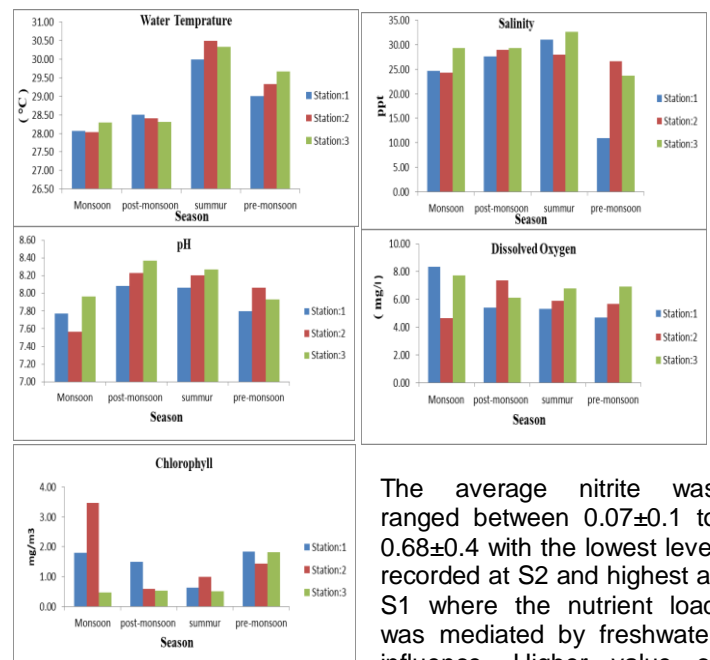
## 2.3 Zooplankton collection and processing

The zooplankton samples were collected by using standard

plankton net with 50 micron mesh and 0.28m<sup>2</sup> mouth areas, attached with a flow meter for measuring the volume of water filtered. All samples were collected before sunrise by horizontal towing behind a fishing boat. Filtered samples were collected in 250 ml plastic container and immediately fixed and preserved using 5% buffered formaldehyde for taxonomic enumeration. Upon reaching to the laboratory, zooplankton samples were identified to the lower possible taxa by following the key prepared by Kasturirangan [14] and Altaff [15] under a stereo-zoom microscope and light microscope at different magnifications.

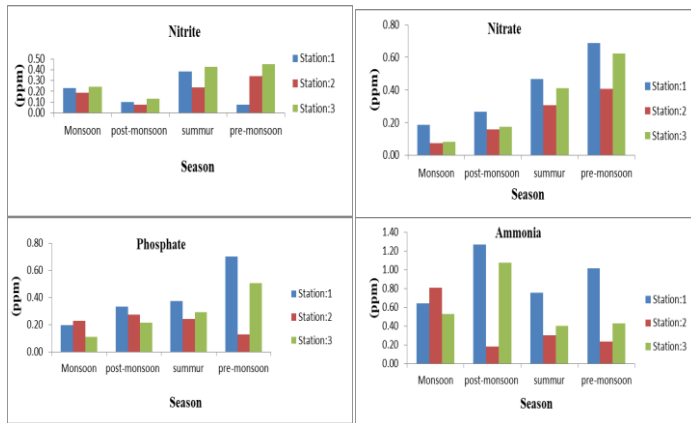
## 3 RESULT

The surface water temperature ranged from 23.8°C to 32°C but not much variation between seasons. The average salinity was found to be 32.66 ± 4.04, at S1, lower salinity (4 ppt) was recorded during pre-monsoon due to direct fresh water influence and during summer season no much variation in the salinity was recorded at S3 (bar mouth). Seasonally no much variation in the pH value was recorded among the stations, while the pH recorded at S2 showed slight variation (7.03 to 8.5) among the seasons. At all the stations, dissolved oxygen ranged between 2.93 to 11.06 mg/l with an average of 8.35 ± 2.4 mg/l. The higher DO level recorded during monsoon season was due to the consequence of fresh water influence.

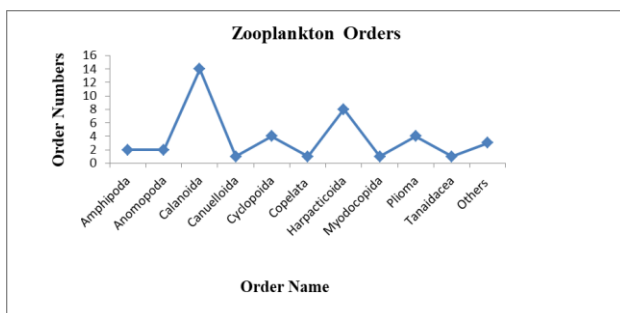


The average nitrite was ranged between 0.07±0.1 to 0.68±0.4 with the lowest level recorded at S2 and highest at S1 where the nutrient load was mediated by freshwater influence. Higher value of ammonia (1.074±1.2) was recorded at S3 during post monsoon attributed to low level of freshwater and increased discharge of sewage and industrial wastes. Phosphate ranged from 0.108±0.1 to 0.7±0.3 and the lowest and highest values recorded at S3 and S1 respectively, during per monsoon season, in addition, high load of phosphate was due to runoff from agriculture and domestic waste. Chlorophyll was recorded between the ranges of 0.45±0.2 to 3.47±4.4 mg/m<sup>3</sup>, the lowest recorded at S3 during pre-monsoon and the highest was recorded at S2 where the parameters like temperature, salinity and pH was found to be optimum. The lowest turbidity value (1.33±0.5) was recorded at S2 during pre-monsoon and the highest value (14±3) was recorded at S1 during summer

season.



A total of 41 zooplankton taxa was recorded from the present investigation, which belongs to 10 orders such as Amphipoda-2, Anomopoda-2, Calanoida-14, Canuelloida-1, Cyclopoida-4, Copelata-1, Harpacticoida-8, Mydocopida-1, Plioma-4, Tanaidacea-1, Others-3. OrdeCalanoida was found to be overall dominant followed by Harpacticoida, Cyclopoida and Plioma, respectively. During monsoon season, normal level of plankton distribution and abundance was recorded at all stations, while during post monsoon season lowest level of plankton diversity was recorded at S2 due to the dominance of copepod nauplii and might be due to the sampling time and water fluctuation compared to that of other stations. During summer season no variation in the plankton diversity was found among the stations and during premonsoon season variety of zooplankton was recorded compared to that of the other seasons. Same species of rotifers and cladocerans were dominant during this season in low slain freshwater and brackish water habitat. Species richness was found in the month of September (*Dioithona rigida* (sample/ml-82)) and July (*Barchionus plicatilis* (sample/ml-92)) may be due to hydrographic influence and nutrient enrichment.



## 4 DISCUSSION

The Physicochemical characteristics of water play a significant role in determining the species composition, abundance and productivity of the native population of aquatic organisms [16]. Physicochemical variation of the back water and estuarine environment from different locations in Muttukadu back water was studied to assess the presence and dominance of zooplankton species which plays an important role in the functioning of fresh water ecosystem. The physicochemical parameters of the present study showed slight variation since the seasonal variations of the environment in the estuarine ecosystem are mainly controlled by the rainfall during

monsoon season [17]. In our study, it is found that the water quality also depends on the place of collection hence the variation was seen on the three different stations among which S1 and S3 are somewhat similar except salinity. Based on which the zooplankton diversity was assessed and so different environmental factors play an important roles in the developmental and abundance of zooplankton [18]. The surface water temperature was found to be high during summer and low during monsoon season. The temperature depended upon the climate of the estuary. Among the different seasons and different stations, during pre monsoon season and at station S1 the salinity was found to be low because of the rainfall and the adayar river mixes with the S1 region. The pH level during the pre monsoon season and monsoon season was found to be low; the reason may be of the influence of the fresh water. A similar seasonal pattern was recorded previously by Srinivasan and Natesan., [17] in muttukadu backwater; Palpandi [19] in the Vellar estuary; Soundarapandian et al. [20] also recorded a similar seasonal pattern in the Uppanar backwaters. During the monsoon season in the S2, chlorophyll-a was found to be high and the DO was found to be low. It is found that they are negatively correlated with each other which was similarly reported by Satpathy et al., [21]. The DO is also one of the indicators for organic matter decompositions within water and for the degree of eutrophication's [22]. Furthermore, hydro-dynamics such as vertical mixing is another key cause for DO variability, as it accelerates the diffusive O<sub>2</sub> exchanges of oxygen-rich surface water and oxygen-poor bottom water [23]. Inorganic nutrients such as Nitrate, Nitrite, Ammonia and phosphate was estimated among which was ammonia was found to be high during post monsoon season in which between the different stations S1 was recorded with high level of ammonia during all seasons except monsoon. The reason for high ammonia level will be of no rainfall, water fluctuation and influx of domestic wastes. Following the ammonia, nitrate is high in level during pre monsoon season at S1. Among all the stations studied, mostly S1 was found to be high in inorganic nutrients. Qualitative analysis of zooplankton diversity at different location and different environment condition yielded 41 species from the Muttukadu back water. The nutrient and physicochemical parameters study by Dirican et al. [24] reported the prevalence of rotifer species such as *Brachionus* and *Keratella* as indicators of eutrophic condition in aquatic systems. Similarly, in our study, rotifer species was found to be predominant. Totally 10 different order of zooplankton was identified in which most dominant order is calanoida. Calanoida dominated at various stations and were reported as the major food sources for commercial fishes [25].

## 5 CONCLUSION

The present study on Muttukadu backwater summarizes the seasonal fluctuations of physicochemical and zooplankton community. Zooplankton was very high when the optimum level of nutrients and food is available. S1 yielded more zooplankton biomass compared with other stations and pre monsoon yielded more zooplankton biomass among various seasons. In the Among 41 zooplankton identified most dominant species were *Dioithona rigida*, *oithona similis* and *Brachionus plicatilis* in different location and different environment condition. From the study, it is concluded that the physicochemical parameters plays an important role and

controls the zooplankton community.

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