Cochin backwater system exhibits a unique ecological complex having marine, estuarine and fresh water environments at different zones and a large number of organisms inhabit in these environments. Comprehensive studies covering the combined effects of hydrobiology and nutrient dynamics on trophic structure in this ecosystem is scarce. Present investigation was an attempt to evaluate the implications of the hydrobiology and nutrient dynamics on the trophic relationship and community structure in the Cochin backwaters. An integrated approach relating biological as well as physicochemical aspects of this unique backwater system with respect to seasons was employed.

Seasonal samplings of water, sediments primary producers, secondary producers and fish landings were made from fifteen stations in Cochin backwater system during January 2009 (POM 08), April 2009 (PRE 09), August 2009 (MON 09), January 2010 (POM 09) and April 2010 (PRE 10). Water samples (both surface and bottom layers) were collected using Niskin Sampler and surface sediment samples were taken using Van Veen Grab. Water samples for general hydrography and nutrient analysis was subsampled into high density polyethylene bottles, kept on ice bags, transported to laboratory and analysed without delay. Hydrographic parameters such as pH, dissolved oxygen, BOD, carbon dioxide, temperature, salinity, alkalinity, chlorophyll pigments, productivity, depth and transparency were determined by standard procedures. Nutrients like
nitrite-N, nitrate-N, ammonia-N, phosphate, silicate, iron were also estimated in the water samples by spectrophotometric methods. General sedimentary parameters like pH, redox potential, texture, total organic carbon, total nitrogen, and total sulphur were estimated to assess the general geochemical setting of the sedimentary study area. Fractionation of nitrogen and phosphorous in sediments was also carried out to evaluate the enrichment of these nutrients in the estuarine environment. Primary productivity of the study area was investigated by various tools like phytoplankton (qualitative and quantitative), chlorophyll pigments, light and dark DO bottle method. While secondary production was evaluated by zooplankton abundance and tertiary production by fish landings, gut content analysis and proximate composition. Statistical methods were employed to establish the spatiotemporal variation; interrelationships existed among various estimated parameters and trophic interactions (ANOVA, Pearson correlation and PRIMER).

Values of pH in both surface and bottom waters remained slightly alkaline at all the stations. Higher values for pH might be due to the influence of seawater ingression or increased photosynthetic activity. Discharge of floating sediments carried by land runoff as well as dredging operations in Cochin estuary resulted in wide fluctuations in transparency of water column. Higher concentration of dissolved oxygen recorded during monsoon could be due to the cumulative effect of high wind velocity joined with heavy rainfall and the resultant freshwater mixing. The combined effects of higher biological production coupled with sinking of organic matter, discharge of untreated effluents, wastes from aquaculture fields and agricultural fields into the backwater system have contributed to the increased BOD levels. In the present investigation, no vertical
stratification for salinity was observed and fresh water conditions were prevalent during the monsoon and the estimated higher values during post monsoon season could be due to increased rate of evaporation and sea water ingestion. Among nutrients, ammonia displayed a non-uniform distribution throughout the entire study period which indicated an exogenic input in the estuary. The increased nitrate level was due to fresh water inflow, organic decomposition and terrestrial run-off during the monsoon season. The lower contents of nitrite during the premonsoon season were due to less freshwater input, higher salinity, higher pH and also uptake by phytoplankton. The higher phosphate content in the water column could be attributed to regeneration and release of total phosphorus from sediment into the water column by turbulent mixing. Silicate exhibited significant negative correlation with salinity, suggesting its input through land runoff.

Texture analysis provided an insight into the grain size of the sediments in the study area. Higher concentration for organic carbon reported at some stations could be attributed to the settling of the terrigenous organic matter derived from land runoff. During monsoon value observed could be attributed to the dilution effects associated with high river discharge. The average TOC/ TS values indicated the periodic anoxia nature of the system where, the sediments undergo sulphate reduction below an oxygenated water column. Fractionation of nitrogen and phosphorous in sediments were carried out to evaluate their various forms and enrichment character. The lower values for C/P and N/P ratio indicated enrichment of phosphorous in sediments of estuarine system. Phosphorus fractions were analyzed to quantify the different fractions of phosphorus in the estuarine sediments in order to assess the processes leading to the
fractional distribution of phosphorus, its bioavailability and influence on trophic status. The contribution of labile phosphorus to total P pool was higher indicating that sedimentary P can act as a source for this nutrient to water column.

Biochemical composition of sedimentary organic matter in the study region showed a dominance of lipids followed by proteins and carbohydrates. Higher concentrations of lipids and proteins in sediments reflected the productive nature of the system. The dominance of lipids and protein over carbohydrates indicated the nutritional status of organic matter in the sediments of the study region. PRT/CHO and LPD/CHO ratios were useful to evaluate the quality and quantity of organic matter in the estuarine sediments. Estimated PRT/CHO ratios having values <1 indicated the presence of aged or less degradable organic matter (refractory organic matter). Lower values of LPD/CHO ratio might be attributed to the higher concentration of carbohydrates derived from allochthonous sources. The higher chlorophyll content in the sediments of the study area pointed towards the higher primary production, settling of the pigments to sediment and their preservation due to anoxic conditions. Biochemical composition of sediment also revealed the fact that the trophic state of the study area can be included under meso-oligotrophic condition. The average values of C/N indicated a mixed origin of organic matter i.e., autochthonous as well as terrestrial input. The higher tannin and lignin content in the estuarine sediments could be attributed to the input of terrestrial higher plant debris associated with land runoff.

The present study revealed the fact that phytoplankton diversity was more pronounced during premonsoon season, but maximum density was observed during postmonsoon season due to stable hydrographical
conditions and less predation. *Skeletonema costatum*, *Cyclotella meneghiniana* etc are present which are euryhaline. Phytoplanktons are classified as abundant, rare, common, few according to biomass. Community composition and community diversity profiles revealed the seasonal and spatial variation of phytoplankton in the study area. Among the various diversity indices Shannon Weiner index was satisfactory with regard to changes in index value with the variation in pollution intensity. Biotic diversity index revealed higher level of environmental stress which will tend to lower biotic diversity.

The results of the present study revealed that production of phytoplankton in the estuary exceeds several times than zooplankton. Increase in nitrogen and phosphorous in the system is a direct response of human interference. The present investigation recorded higher phytoplankton production which may lead to eutrophication. The insignificant correlation between nutrients and primary production pointed out the fact that inspite of the higher concentration of available nutrients in the water column; the productivity was restricted by factors like transparency and meteorological parameters. The phytoplankton distributions, species composition and dominance are closely associated with the prevailing hydrographic condition and nutrients. The standing crop of phytoplankton showed seasonal variation and spatial variation in CBW. Highest peak was observed during POM 09. During this peak Bacillariophyceae (diatoms) were dominant which could well thrive in widely varying hydrographical conditions both phytoplankton growth and primary production and showed fluctuations according to seasons. Similarity between stations was studied with the help of Bray Curtis similarity index and community coefficient (using only the presence and
absence of species). In general, higher diversity was followed by lower level of species evenness or equitability in distribution. The results could be included that the existing conditions were favourable for pollution tolerant phytoplankton species. An inverse relationship between species richness and evenness component of diversity which is mathematically expected can be observed in this study. It can be concluded that the components of diversity viz., richness and evenness are necessary to furnish adequate explanation of species diversity. The highly significant negative correlation existing among different groups of phytoplankton explained the presence of a particular group inhibiting the existence and growth of another set of phytoplankton due to inter/intra specific competition or predation prevailing in the ecological niche.

In the present investigation, copepods were present throughout year in the plankton samples and formed the dominant component of the crustacean holoplankton. Copepods like *Acartia centura*, *Acartia spinicauda*, *Acartia bowmani*, *Acartia southwelli*, *Acartia pacifica* and *Acartia plumosa* were present during all seasons except monsoon. The zooplankton distribution in the back waters suggests that the salinity is the major limiting factor controlling their abundance. All groups showed remarkable seasonal distribution with respect to changes in salinity and other environmental factors. It was found that population density of zooplankton in the estuary was no way limited by primary production, which throughout the year far exceeds the consumption by zooplankton.

Fish stock assessment was made from seven fish landing centres in the study area. Monthly data were collected for seasonal comparison for fishes captured from the estuary. It was observed that 16 species of major food fishes and 5 crustacean species were identified which were found to
be valued and marketed in the local markets. The decline in the fish production was observed during the investigation. The proximate composition of the commercially important fish species from CBW were studied to assess their nutritional values in order to achieve the knowledge of the risk and benefits associated with the indiscriminate consumption of these species. This study would help us for taking necessary steps which should be taken to increase the production and proper management of natural habitat of the species. Differences in biochemical composition of fish may also occur within the same species depending upon the fishing ground, fishing season, age and sex of the individual and reproductive status. The estimation of proximate composition was carried out in the present investigation which revealed seasonal variation. The main causes are spawning cycle and food supplies and are the main factors responsible for this variation. Proper understanding about the biochemical constituents of fish has become a prime need for the nutritionists and dieticians.

The integrated approach involving hydrobiology, nutrient dynamics and productivity and trophic level interactions will be useful to implement corrective measures to restore the health of Cochin backwater system and implementation of sustainable management practices. The present study would serve as a reference for the future investigations in this ecosystem.
LIST OF PUBLICATIONS


8. **Radhika,R.,** Ranjitha Raveendran , Sujatha. C.H., 2011. Role of women in the improvement of Aquatic resources in and around Cochin - an Overview. Presented in the UGC Sponsored seminar, conducted by Department of Economics, Cochin University of Science and Technology,


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