CHAPTER 7

Summary and Conclusion

Cochin backwaters situated at the tip of the northern Vembanad lake is a tropical positive estuarine system. The backwaters of Kerala support as much biological productivity and diversity as tropical rain forest and are responsible for the rich fishery potential of Kerala. Backwaters also act as nursery grounds for commercially important prawns and fishes. Recent changes brought about in the estuary like reclamation and consequent shrinkage of the backwaters and the discharge of pollutants have made an adverse impact on the potential of the aquatic ecosystem that used to support high levels of bioproductivity and diversity. Eloor industrial region is described as one of the most vulnerable industrially polluted ‘hot spots’ in the world. There are over 50 large and medium industries and over 2500 small-scale industries in this region. The industries located in Edayar-Eloor area consumes about 189343 cum water per day and discharge about 75% as used water along with large quantity of effluents and pollutants. The major types of these industries are fertilizers, pesticides, chemicals and allied industries, petroleum refining and heavy metal processing, radioactive mineral processing, rubber processing units, animal bone processing units, battery manufacturers, acid manufacturers, pigment and latex producers etc. The northerly connection, Azhikod, is at the mouth of the Periyar river. This connection takes care of half the discharge by the Periyar river. Central estuary also receives effluent discharge along with civic effluents from township. The estuary acts as a sink for the nutrients, flushing out only a portion of the pollution that it receives.

The usefulness of benthos in pollution monitoring programme to ascertain the health of estuarine and marine environments has been known since 1916. The longevity of benthos provides long-term exposure to toxic
substances. They live in close contact with sediments, which enhances their intimacy with many pollutants. These infaunal organisms reflect the situations not only at the time of sampling but also during yesteryears. Among benthos, polychaetes are ideal indicator organisms, since they constitute well over half of the total number of organisms in and on the bottom and thus give a good indication of benthic conditions.

The thesis has been subdivided into seven chapters. The first chapter gives a general introduction about the topic and also highlights the scope and purpose of the study. The second chapter covers the methodology adopted for the collection and analysis of water quality parameters, sediment and the macrobenthic fauna.

Chapter 3 deals with hydrographic features, sediment characteristics and the spatial variation and abundance of macrobenthic fauna in the Cochin estuary. The study was conducted from 56 stations during three season namely pre-monsoon, early monsoon and monsoon in 2005. The study revealed the presence of high concentration of nutrients in industrial region of Eloor. High nitrite value of 1.53 µM was recorded from the industrial region. Nitrate values ranged between 0.64 and 72.0 µM and high average was recorded at the central estuarine and the industrial region. NH₄ value ranged from 0-162.83 µM and high average was reported from the industrial region. High average (3.46 ± 2.18) in PO₄ was also reported from the industrial region during monsoon. High concentration of SPM and DIC was reported from the northern and central estuarine region. High SPM recorded was due to heavy sedimentation and discharge of sewage and industrial effluents. High chlorophyll a was recorded from the industrial and central estuarine region. Disposal of sewage and industrial waste is the major cause for nutrient enrichment resulting in domination of opportunistic algal species. Abundance of nano plankton (*Skeletonema costatum*) which grows quickly under eutrophic conditions has been reported from the estuary by earlier workers. Analysis of
sediment texture showed that the northern region was dominated by high clay fraction throughout the sampling period. Central estuarine region was dominated by an equal proportion of sand and clay fraction during pre-monsoon where as it was dominated by clay during the other two seasons. Dominance of sand was reported from most of the stations in the southern region. High TOC and TN values were reported from the northern and central estuarine region. Altogether 73 species of macrobenthic organisms were identified during the study. Analysis of the macrobenthic community revealed the dominance of isopods from the northern region. High abundance of the isopod species *Cirolana fluviatilis* recorded from this region is a major threat as it might reduce the fish catch from this region as reported earlier in 1994 from Kumbalangi-Perumpadappu area of the Cochin backwaters. Central estuary and industrial region were dominated by indicator organisms and pollution tolerant species which shows that this region is under stress. High abundance of *Villorita cyprinoides* was recorded from the southern region.

Chapter 4 explains the impact of organic enrichment on macrobenthic population in the Cochin estuary and includes the comparison of the present data with the earlier work in this region. This study was conducted to investigate the quality and composition of sediment organic matter and its impact on the macrobenthic population in a tropical estuary. Sediment TOC, TN and Clay were generally positively correlated with each other. TOC: TN ratio suggests that SOM quality is a combination of labile and refractory in the Cochin Estuary. The benthic infaunal communities recorded in the sewage polluted zone of Cochin estuary were characteristic of those generally seen in organically enriched sediments. As sediment organic matter increases above a critical level, changes in physiochemical properties of the sediment, caused by excessive organic matter leads to decreasing faunal densities. Regions receiving such high inputs of sewage have been reported to undergo drastic changes in the composition of benthic fauna, as observed in the present study. This has
resulted in the dominance of more tolerant and opportunistic species of polychaete worms, especially deposit feeders belonging to the family capitellidae, which are reported to be the biological indicators of organic pollution. The long-term changes in the Cochin estuary give an indication as how anthropogenic influences have dominated the natural process and affected the benthic organisms. The former retting yards in the estuary showed ecological recovery, as an increase in species abundance due to reduced activities of retting in the recent years and subsequent reduction in levels of organic carbon in the sediments. This study is a clear indication that proper treatment and disposal of the effluents can bring about a positive change in the environment. Average TOC and TN was high in sewage polluted zone due to larger input of sewage. TOC/TN ratio was high at retting yard zone an indication of refractory organic input in this region in the mode of coconut husk. Thirty five species were identified from S-zone and 42 species from R zone during the present study compared to 45 and 19 species recognized in 1983. Polychaetes with 27 species were the most abundant faunal group (90%) in S zone and was dominated by the highly pollution tolerant capitellids. The dominant species reported was Capitella capitata. Polychaetes were the dominant group in the R-zone and both the zones supported high abundance of deposit feeders. Bray-Curtis similarities were calculated on (root transformed) species abundance data and two major macrobenthic assemblages were identified based on cluster analysis. The results of the present study showed that spionids (the dominant community) in early 80’s was replaced by capitellids in 2005 at the sewage polluted zone. Species richness and diversity estimated based on Margalef, $d'$ and Shannon-Wiener, $H'$ ($\log_e$) indicated low species diversity at S-zone.

Chapter 5 deals with seasonal variability in abundance of macrobenthic species in the estuary. The study was conducted from 9 stations during three seasons (pre-monsoon, monsoon and post-monsoon) in 2003. High salinity was
recorded during the pre-monsoon period and almost fresh water condition prevailed in the entire estuary during monsoon. The estuary is well mixed and homogenous condition prevailed in the estuary during pre-monsoon whereas during monsoon and post-monsoon period a clear stratification occurs in the water column with low saline water at the top and high saline water at the bottom. Low D.O (<1 mg/l) was recorded from the bottom waters at station 1 (Barmouth) during monsoon and post-monsoon season and subsequently low benthic abundance was recorded from this region compared to earlier works. In general high D.O was reported during monsoon. The results revealed that the concentration of nitrite, nitrate, phosphate and silicate exhibited pronounced seasonal variation and also indicated large inputs from industrial units, sewage works and agricultural runoffs. High values of nutrients reported during monsoon season indicated input from terrestrial origin induced by land runoff and industrial discharge. Bottom water indicated higher value of inorganic nutrients than surface especially during the post-monsoon period probably because of the obvious reason of through mixing enabling the release of nutrients from the sediment. High concentration of silicate was reported during monsoon and post-monsoon season due to river water influx. Chlorophyll $a$ concentration was high which indicated that eutrophication was apparent in the estuary. High values were reported during monsoon. Increased grazing of phytoplankton by microzooplankton was reported as one of the reasons for relatively low level of chlorophyll $a$ during pre-monsoon season. The substratum was dominated by sand during pre-monsoon and post-monsoon period whereas during monsoon the substratum was dominated by fine grained sediments. Organic carbon content in the sediment was high during monsoon followed by pre-monsoon and post-monsoon due to high productivity, settling of detritus, decay of vegetation and sewage disposal. Macrobenthic abundance was high during pre-monsoon and monsoon months. Forty seven species belonging to nine taxa were encountered during the study period. In general the
dominance of polychaetes were reported in the present study particularly those belonging to the family capitellidae through out the period, which is a clear indication of pollution stress. High benthic abundance was recorded from station 2, pollution indicator and tolerant species dominated this station. Stations 3 and 4 located nearer to the industrial region of Elloor reported low density and abundance. Abundance of *Villorita cyprinoides* was reported from station 6, 8 and 9.

Chapter 6 deals with Life history and Population Dynamics of *Eriopisa chilkensis* Chilton (Gammaridae-Amphipoda). The life cycle of the gammarid amphipod *Eriopisa chilkensis* from the Cochin estuary, south west coast of India was studied for the first time under laboratory conditions. Amphipods especially gammarids are known as potential live feed in fish culture more so for juveniles and this formed the base of our study. Live samples were collected and maintained in the tanks of the recirculating system of the laboratory for the experimental study and field sampling was conducted for one year (2003-2004) at the mangrove environment of Puduvypin. Females lived on average 1.4 times longer than males. Moulting rate was higher in females and growth rate was higher in males. Males attained sexual maturity earlier than females. Embryonic development time ranged from 8 to 14 days and the different stages of embryonic development were identified. The number of broods produced in the life cycle ranged from 4 to 7. Total number of juveniles from a single brood varied from 35 to 139. The distribution and population dynamics of *Eriopisa chilkensis* was studied in the field and the density varied from 21 to 1583 m$^{-2}$. Maximum population density was observed during November. *E. chilkensis* tolerated a wide range of temperature and salinity of the medium. Gravid females were observed in high numbers during November and December indicating their preference for medium saline conditions. Study on *E. chilkensis* gives a basic knowledge about the life history and ecological aspects for evaluating the potential role of this amphipod as a test species in estuarine areas.
and to further develop assays for pollution at sub-lethal levels using this species.

Developmental activities around the estuarine environment resulted in the degradation of this ecosystem in recent times. Increasing population, urbanization and industrialization has had its share in degrading this fragile ecosystem by large-scale reclamation of land near estuaries, swamps marshes and mangroves for various purposes. Dredging activities in the estuaries for navigation, reducing the river discharges to a very less extent for various reasons, discharging untreated urban sewage and industrial effluents and the aquaculture activities around estuaries are the major threats for sustenance of the unique ecosystem. Major conservation measures that can be taken include:-

To have strict regulatory measures on the reclamation of estuarine areas for all purposes except aquaculture and strict adherence to coastal zone regulations

Prescribed water treatment by Pollution Control Board on urban sewage, industrial effluents, untreated water from aqua farms etc. may be strictly adhered through

Water flow by addition of check dams or release of water from the existing dams into the waterways may be facilitated so as to assure the sustenance of estuaries and adjoining water bodies