INTRODUCTION

Since the dawn of civilization, man has been using the coastal complexes as the dumping sites for disposing off the waste materials among which the domestic sewage contributes a sizeable share. As the open ocean waters are often difficult to study for the assessment of ecological damage, the more viable benthic habitat along with the contained organisms tends to be favored for such researches (Gray, 1980 and Hartley, 1982). Thus a need is increasingly felt everywhere for acquiring more basic data on the structure and function of animal communities in water polluted with domestic sewage and on assessing the degree of variation within these communities over a period of time.

Domestic sewage primarily consists of organic wastes from kitchen, bathrooms and restaurants with variable quantities of suspended solids and dissolved substances containing high concentrations of nutrients. Three main components of sewage likely to affect the faunal community are dissolved nutrients, particulate organic matter and fresh water. Many of the deleterious side effects are caused primarily as a consequence of process of eutrophication and nutrient enrichment. While eutrophication brings about harmful effects on the whole due to the depletion of oxygen, organic enrichment often supports the indiscriminate growth. Hence, the sustenance of these organisms
depend on the degree of organic input and distance from the point of sewage discharge (Pearson and Rosenberg, 1978 and Ansari et al., 1984). The effect of organic input may be classified into two major components: environmental stress and physical disturbance (James and Gibson, 1980). While high degree of environmental stress leads to reduced productivity of the population, the physical disturbance leads to an unpredictable environment favouring colonisation of opportunistic species on the other hand (Gray, 1979).

Generally three zones are recognised in the suspected area of sewage pollution: totally polluted zone, polluted zone and unpolluted zone. Another zone, termed as "enriched zone" (Pearson and Rosenberg, 1976) with increased number of species, abundance, biomass and diversity above the levels encountered than in the unpolluted zone (Dauer and Conner, 1980) is referred to as "transitory zone". The first zone which is near to an effluent source is grossly polluted with eutrophication conditions lacking any macrofauna. At a certain distance, "polluted zone" is generally characterised by groups of tolerant species and beyond which is the "normal zone" unaffected by the disposal. And in the fourth zone (transitory zone) as referred above, the number of individuals, biomass and diversity may be increased well above the levels found in the normal zone due to enhanced nutrient levels.
The intertidal region, a sensitive entity of marine ecosystem between high and low tide water mark forms one of the fascinating transitional zone encompassing both marine and terrestrial habitat. This zone is alternatively exposed to desiccation depending on the tide. The extent of this littoral region depends on the gradient of the seabed governed by topography and depth of the bed, which can either amplitude or compress the tidal movements. The height and angle of the waves have also been found to alter the profile of the beach considerably. While tides are chiefly responsible for the marked periodicities in the occurrence of animal communities, the splash and spray of the waves is responsible for the successful inhabitation of most of the organisms. Thus the organisms living in the intertidal regime are subjected to physical damage due to the instability of the substratum caused by various factors.

However, due to the availability of surplus food and conducive environmental conditions near unpolluted and transitional zones, the intertidal zone is rich with fauna. Unlike the sandy and muddy shores which does not offer a firm substratum for the inhabitation of the organisms, the rocky shores and coral reefs are found to abound with them.

The organisms living in close association with the aquatic sediment are referred to as "Benthos" and their mode of life as "Benthic". They are comprised of bacteria, plants and animals.
drawn from almost all phyla. Though most of these organisms are sedentary in nature, few of them move or crawl within and over the bottom sediment and are generally recognised on the basis of their position in the sediment. Those organisms which live within the interstitial space or burrow into the sediment are termed as 'infauna' and those which crawl or live on the sediment surface as 'epifauna' (Petersen, 1914). Mare (1942) classified these benthic organisms on the basis of their size frequency and it is operationally much useful. In his classification, the benthos are divided into 'microfauna' (1 - 100 μm) comprising bacteria, protophytes and protozoans excluding foraminifera, 'meiofauna' (100 - 1000 μm) comprising small metazoans like nematodes and turbellarians besides foraminifera, and 'macro' or 'megafauna' (above 1000 μm) comprising many macroinvertebrates. But generally the classification of McIntyre (1969) is followed which classifies the metazoans passing through >00 μm, and retained either on a 44 μm or 62 μm mesh as 'meiofauna' and those which are retained on 500 μm as 'macrobenthos' or 'macrofauna'. But these size separations are arbitrary and the classification has no biological meaning except that the relative size fraction is depicted in the terminology.

The macro and meiofauna, be it infauna or epifauna have developed certain physiological characteristics in order to tide over the environmental hazardous like extreme temperature, dessication.
and feeding. Some of them are known to have developed osmoregulation to counter the extreme conditions of salinity and temperature. Their different mode of feeding habits make them possible for the community survival in different environmental biotopes.

It has been well documented that different taxa (polychaetes, bivalves and crustacea) have very different response patterns to disturbance in the substratum (Simon and Dauer, 1977). Also, polychaetes found to be the initial macrobenthic organisms to colonise after a disturbance and also the important taxon to inhabit the stressed region of polluted gradient (Christie and Moldans, 1977 and Pearson and Rosenberg, 1976). Thus, analysis of benthic infauna and epifauna has been considered as a key element of many marine and estuarine monitoring programmes.

REVIEW OF LITERATURE:

Though the study of benthic fauna was started with the pioneering works of Schultze (1853), Bastian (1865) and Clausa (1866), the actual quantification of the benthos was carried out only during the first half of this century by Boysen and Jenson (1919) and Moore (1931). Since then, there had been a sudden spurt in the study of the organisms on different aspects like population density, intra and inter-specific relations, diversity, dispersion and on production in relation to normal and subdued environmental conditions.


The relationship of biotic components with the abiotic parameters which influence their life pattern have been investigated by many workers. Notable among them are Moore (1931), McIntyre (1968), Margrave (1969), Rhoads and Young (1970), Hughes and Thomas (1971), Bloom et al (1972), Smith (1974), Rosenberg (1977), Westerberg (1978), Warwick and Uncles (1980), Raffaelli


Only during the last two decades there had been an increased enthusiasm among the scientists on the study of physical parameters and its relation with the biotic components along the Indian coast. Those studies mainly pertain to the ecological aspects of the benthic fauna in relation to the different environmental parameters which govern their existence. There are many investigative reports on these aspects and few of them are contributed by Ganapathi and Rao (1962), Trevallion et al (1970), Ansell et al (1972, 1978), Dwivedi et al (1973), Achuthankutty and Wafar (1976), Ayyappan Nair (1978), Harkantra (1984), Ansari
et al (1986) and Harkantra and Parulekar (1987). The hydrodynamic changes in the beach in relation to benthos have been studied by La Fonda and Prasada Rao (1956), Veerayya and Varadachari (1975) and Udayavarma and Varadachari (1977).

Investigations of the benthic fauna of Karwar was initiated only during the seventies by Harkantra (1975) and Ansari (1978). Later indepth study of both the inshore and estuarine benthos has been undertaken. While Sudarshana (1985) worked on the meio and macrobenthic communities of Karwar bay, Bhat (1984) made a investigative study on the meio and macro benthic fauna of Kali estuary. Recently the ecology of intertidal macrobenthos of Karwar beach has also been studied by Sujatha (1987).

Besides these studies on the factor fauna interactions, there are number of reports with regard to aquatic pollution by the way of industrial, agricultural and domestic sewage disposal. The domestic sewage disposal and the resultant organic enrichment together with various physico-chemical changes on the benthic fauna have been studied (Reisn, 1957, 1973; Gray and Reiger, 1971; Wade et al, 1972; Buchanan, 1972, Unnithan et al, 1975, Sarma and Ganapathi, 1975; Vijayan et al, 1975; Gray, 1976, 1979, 1980 and 1981; Pearson and Rosenberg, 1976, 1978; McIntyre, 1977; Nichols, 1977; Orth, 1977; Achuthankutty et al, 1978; Zingde et al, 1979; Dauer and Conner, 1980; Blackstock, 1980a; Govindan and Desai,

Realm of study:
As the review of literature reveals, the paucity of study on the benthos along the vast coastline of Indian waters on both the coasts is striking. Most of the hitherto works are confined mostly to the ecology of the interstitial fauna in relation to their abundance, diversity, biomass, production and zonation with scant attention on the community relationship of the organisms and their association to the changing environmental parameters. There has been very few works on the effects of domestic sewage disposal on the macrobenthic community except for few studies confined to either on single species or on a group of organisms (Ansari et al., 1986 and Varshney, 1982).

The main objective of the present study was to find the different aspects of macrobenthic community such as variation in total population density, pattern of distribution, diversity, biomass and production in relation to the altered environmental gradients due to the disposal of sewage.

It is well known that the intertidal region is highly dynamic and ever changing with high fluctuation in the environmental gradients which makes it essential to study these regimes not only geographically but also from time to time. The results
obtained from one intertidal region cannot be applied to the same regime of intertidal zone at another regime, except for considering the general trends. This aspect again gets complicated if the environment is besetted with external stress or anthropogenic activities like dredging, domestic sewage disposal, estuarine incursion, low mixing of water and reclamation of land for various purposes.

This type of an environment is encountered at an intertidal zone of Karwar and has been aptly chosen for the study. In the light of the contrasting results obtained in different stations with the help of few mathematical and statistical analysis - similarity and dispersion indices, diversity, correlation matrix, analysis of variance and stepwise multiple regression, an attempt has been made to unravel the ecology of macrobenthic fauna in relation to changed environmental conditions due to the disposal of domestic sewage.