REVIEW OF LITERATURE
Until the invention of the microscope, the plankton study was untouched and unknown to science of biology. Many naturalists observed the illuminating sea at night and it was remained unsolved puzzle for centuries. Many workers observed these microscopic organisms in the sea but could not identify them but it was Norwegian scientist, Victor Hensen (1887) who coined the term “Plankton” to these wandering organisms. Later extensive works were carried out by many scientists and could categorize these organisms based on mode of their nutrition as ‘Phytoplankton’ and ‘Zooplankton’. Research on plankton flourished during the later part of the 19th century. Initially, the research work was focused on taxonomy and new species were identified and described in detail. After this preliminary taxonomic splurge, interest began to develop in the quantitative relationships that exist between the various plankton species. This directly led to the modern emphasis in plankton research.

The plankton samples were collected earlier days by using conical bolting cloth net, then Clarke-Bumpus sampler were made use. More advancement in science paved way to continuous plankton sampler devise designed by Alister Hardy. Today, sophisticated technique has been developed to simultaneously collect fine scale of plankton and water sample for analysis of physical, chemical and biological factors in the vertical profile of the water column. A high-resolution electronic probes is first used to define the vertical structure of temperature, salinity, light transmission, phytoplankton fluorescence, oxygen and light intensity. Another milestone in the field of marine science was the construction of four component
physical, biological model (nutrient, phytoplankton, zooplankton and detritus). This component was fabricated for measuring nutrients, chlorophyll distribution, zooplankton and detritus called the coastal zone colour scanner (Ishizaka, 1990).

Regarding the studies on the ecology and seasonal succession of diatom flora of estuarine waters of India lead the way by Iyengar and Venkataraman (1951) in the Cooum estuary of Madras. Whereas the seasonal variations in the total biomass and total organic matter of the plankton in the Vellar estuary was studied by Seshadri (1951). Devasundaram and Roy (1954) have made the preliminary study of the plankton of Chilka Lake for the years 1950-51, further Roy (1954) studied the periodicity of the diatoms of the Chilka Lake. Dutta et al., (1954) and Roy (1954) have worked on the hydrology and seasonal fluctuations of the plankton of the Hooghly estuary. George (1958) observed the plankton of the Cochin backwaters. Rangarajan (1958) for the first time carried out studies on the diurnal tidal cycles in Vellar estuary whereas Seshaiya (1959) worked on the hydrology and biology of this estuary. Mani et al., (1966) studied the phytoplankton bloom and its ecology in the Vellar estuary. Venugopalan (1969) estimated primary production in the estuarine and inshore waters of Porto Novo region.

Phytoplankton plays an important role in determining the productivity of aquatic biotope, for example coastal waters, estuaries, backwaters etc. It is well known fact that, in an aquatic environment especially in estuaries and marine water, phototrophic plants are the basis of all life. The problem of proper assessment of organic production in the coastal waters has assumed
great importance in view of the urgent need to explore all possible food resources for increasing anthropogenic population.


Temporo-spatial variation of phytoplankton community in a coastal aquatic media is mainly controlled by the set of physical and chemical process of an area and the differential growth rate of the algal population is noticed due to the varying local environmental conditions.

Variation of phytoplankton population is mainly governed by environmental factors. Hence, the study of hydrographic factors is also necessary along with the plankton studies. Several workers namely Braarud, 1951 & '59; Jones et al., 1963; Mc Lachlan, 1961; Nordli, 1957 and Smayda 1969 have carried out several investigations on phytoplankton growth rates in relation to changes in salinity profile. Prabhu and Reddy (1987) have studied the impacts of nutrients on plankton in the inshore waters of Mangalore area.

Studies on planktonic diatoms of Indian waters have been carried out by Subrahmanyan (1946, 1958 & 1959), Gonsalves (1947), Venkataraman
(1957 & 1958), Misra (1962), Chennubhotla (1969), Gopalkrishnan (1972), Desikachary (1977) and Nair et al., (1980) in the recent past years. Among the estuaries of west coast of India, very little work has been done; of which there have been little work has been carried out on Zuari estuary of Goa. Some of the investigations carried on primary production are Bhattathiri et al., (1976); Devassy and Goes (1989) and on phytoplankton pigment by Bhargava (1974); Bhargava and Dwivedi (1976); Dehadri and Bhargava (1972); Latasa and Bidigare (1998) and Redekar and Wagh (2000).

An extensive work has been carried out on this fragile community of phytoplankton of different natural waters of west coast of India and most of them were focused in understanding on the ecology of phytoplankton and their importance as fish diet, as indicator of pollution and trophic status of the water body (Subrahmanyan, 1959; Thomas, 1970; Bhargava, 1973; Bhargava and Dwivedi, 1974 & 1976; Battachaarya and Devassy, 1975 and Gopinathan, 1972).

The study of phytoplankton community structure and their seasonal abundance is important in the investigation of higher trophic levels, particularly in view of its influence on the efficiency of carbon and energy transfer between different trophic levels in any given system. Further, knowledge of plankton together with data on water characteristics is useful in assessment of water quality as it provides information on the minute and subtle changes in the environment. The spatial and seasonal distribution of phytoplankton of west coast of India was studied with relation to fisheries by few researchers (Pillai, 1968; Benakappa et al., 1979; Kumar, 1984; Ramesha et al., 1992; Lingadhal et al., 1998) whereas in Uttara Kannada
coast, very limited studies were conducted (Ramamurthy, 1965; Naik and Neelakantan, 1989 and Naik et al., 1989).

Plankton is the main diet for many pelagic fishes like Mackerel, Sardines, etc., whereas the demersal fishes depend indirectly on the plankton population. Ramamurthy (1965) studied the relation between hydrographic parameters and the pelagic fisheries of North Kanara coast. Naik et al. (1989) studied the relationship between plankton and pelagic fisheries (Mackerel and Sardines) in the inshore waters of Karwar.

The measurement of primary production is most important because of the significance with the problems of aquatic ecology and fishery management. The chlorophyll content of the phytoplankton population has been used as an index of productivity as well as measure of the size of the standing crop. Bannister (1974) has evolved an equation for estimating gross daily production directly from the chlorophyll concentration present in the phytoplankton species. The fluctuation of phytoplankton standing crop is mainly governed by the environmental factors. Very limited work on primary productivity and chlorophyll content in the inshore waters of Karwar bay (Arabian Sea) has been carried out by Naik et al., 1989, Naik et al., 2006 but there is no report on productivity and chlorophyll estimation made on the Kali estuary. In the present investigation, an attempt has been made to study the diel variation in phytoplankton population, chlorophyll and carotenoids in the Kali estuary.

Margalef (1958) has given some information, which can be used as a measure to study the diversity of a plankton of a given space and time. Lloyd and Ghelardi (1964) related diversity to the maximum possible value of a given number of species. Heip and Engels (1974) have compared diversity indices from the point of view of the statistical significance of observed difference or similarities and they concluded by recommending the use of the Shannon and Weaver (1963) function together with a new index of evenness or equitability. In all, the brief review of literature indicates that there is no universal agreement on the use of any one index that would help in a relative assessment of community. On the contrary, the indices are of specific utility and the application value varies with respect to experimental design. Naik (1986) has studied the diversity index and the multiple
regressions of the plankton of Kali estuary and inshore waters of Karwar. Various multivariate statistical analyses have been employed to study the interactions between the biotic and abiotic components (Cassie and Michael, 1968; Hughes and Thomas, 1971; Alasdair, 1978 and Penas and Gonzalez, 1983) respectively.

Qasim and Reddy (1967) estimated plant pigments of Cochin backwaters during monsoon months. During 1968-69, Qasim and his co-workers studied the solar radiation and light penetration, organic production, tidal cycle and environmental parameters, salinity and plankton production in Cochin backwaters of Kerala. Shankaranarayan and Qasim (1969) have studied the nutrients of Cochin backwaters in relation to environmental characters. Devassy and Gopinathan (1970) observed the hydrological features of Kerala backwaters during pre-monsoon and monsoon seasons. Qasim et al., (1972) have observed the influence of salinity on the rate of photosynthesis and abundance of some tropical phytoplankton of Cochin backwaters.

Vijaylakshmi and Venugopalan (1973) studied the diurnal variation in the physico-chemical and biological parameters in the Vellar estuary. Krishnamurthy and Purushothaman (1971) studied the diurnal variations in the phytoplankton pigments in the Vellar estuary. Similarly, Bhargava and Dwivedi (1974) also studied the diurnal variations in the phytoplankton pigments in Zuari and Mandovi estuaries of Goa. Devassy and Bhargava (1978) worked on the diurnal variation in phytoplankton community in Mandovi and Zuari estuaries.
The measurement of primary productivity is most important because of its significance to the problems of aquatic ecology and fishery management. The following investigators studied the primary productivity and its variation with respect to the environmental parameters. Devassy et al. (1983), Bandopadhyya et al. (1986), Manian Udainyan et al. (1992) and Verghese (1992) respectively.

The pigments play very important role in trapping up of light energy. The pigments are unique in nature and evolved the phytoplankton species to adopt for suitable environment. The intensity of light goes on decreasing with increase in depth profile, stimulating phytoplankton to occupy a upper photic layer of the euphotic zone. The vertical distribution of phytoplankton depends mainly on pigment present in it. Many scientists worked on the plankton and pigment, some notable ones are Goes (1983), Arces and Salamanca (1984), Jones et al. (1988), Valention et al. (1990) and Gabracy et al. (1990).

Phytoplankton forms a highly nutritive diet easily available for the larval forms. The larvae prefer nutritive and non-spiniferous phytoplankton. The algal culture is one of the most important branches in a hatchery. Earlier pure culture of diatom like Skeletonema costatum was attempted but in the mass production practices of prawn larvae, mixed population of diatoms have been found to be adequate (Shigueno, 1972). Liac and Huang (1972) reported that 3 to 20μ size diatoms were suitable to serve as food for zoea stages of P. monodon and P. japonicus species of prawn. Feeding with Thalassiosira species has been reported to give 90% survival of protozoea of Metapenaeus affinis species has been found effective as food for zoea.
While studying the spawning rate of sardine (*Sardina pilchardus*), Robinson *et al.* (1991) observed that the high abundance and distribution of sardine larvae coincided with the high particulate assemblages.

Studies on diversity index and abundance of micro plankton was studied by Soppana-Boonyapiwat (1987). He has reported that the diversity index was mainly correlated with phosphate and pH while salinity, ammonia and oxygen seemed to be less important, temperature and nitrate had no influence.

A good amount of work has been done on the hydrographic factors of inshore waters of Karwar bay (Arabian Sea) by various workers, the notable ones are, Ramamirtham (1963), Ramamurthy (1965), Annigeri (1968 & '72), Noble (1968), Neelakantan (1981), Kusuma (1983), Sudarshana (1983), Naik (1986), Naik and Neelakantan (1989), Naik *et al.* (1990), Naik *et al.* (2000).

Since there is no comprehensive work carried out on phytoplankton of Kali estuary, in the present investigation, an attempt has been made to study the distribution and abundance of phytoplankton of this biotope (Kali estuary). In addition to this, 24 hours diel variation study on phytoplankton community and its chlorophyll 'a' and carotenoids contents in the Kali estuary was also undertaken to project the clear picture on their distribution in the vertical profile of the water column with respect to various environmental factors.