CHAPTER 1
INTRODUCTION

In recent years mycological research have attracted the attention of many marine ecologists, physiologists and others especially those working on microbial degradation of chemical substances and organic matter within the ecosystem. Marine fungi represent a vast nutritional and ecological array of heterotrophic microorganisms. There are obligatory forms which live and flourish exclusively in the marine environment while many others are facultatively marine and can be found in terrestrial environment also. Fungi transported from terrestrial and fresh water regions are also common in the estuarine and marine environment and can be considered as euryplastic. The filamentous forms of Ascomycetes and Deuteromycetes occur on exposed pilings, plant and other woody materials while yeasts are associated with decaying organic materials. Both filamentous forms and yeasts can be found as epiphytes, saprophytes and also as pathogens. The lower fungi, Phycomycetes are a heterogenous group and many of them are parasites on plants and animals. Fungi are also found in marine sediments and water.

Microbial role in the transformation of matter and regeneration of nutrients has invited the attention of marine researchers to describe the various processes taking place in the marine environment. In most of the cases the studies on bacteria are highlighted and often the role of fungi have
been neglected (Fenchel, 1972; Hanson and Wiebe, 1977). The ecological studies of fungi and their role in marine and marine dominated systems have hardly progressed beyond the descriptive phase with strong emphasis on distributional ecology. The information on marine fungal ecology is so fragmentary that meaningful conclusions regarding the relationships of fungi to either substrate or environmental parameters can rarely be made (Hughes, 1975). This lack of information has apparently led some observers like Fenchel (1972), Hanson and Wiede (1977) and others to comment that fungi are unimportant in marine systems.

As discussed by Jones (1974) the most important and potential function of marine fungi is the decomposition of plant litter. The mycological literature adequately documents the ability of fungi to decompose plant litter in non-marine environments (Stark, 1972; Kirk, 1973; Witkamp, 1974; Jackson, 1975; Kaushik, 1975; Parkinson, 1975; Swift, 1977; Barlocher et al., 1978). Fungi virtually always occur in autochthonous and allochthonous plant litter in marine system. The fungi are well suited for the breakdown of plant material by the formation of hyphae which along with the production of extracellular enzymes enable the effective penetration in to plant cells (Harley, 1971). Relying on direct observations rather than cultural techniques has provided evidences for in situ fungal reproduction on coastal marine plant litter (Kohlmeyer, 1977; Kohlmeyer and Kohlmeyer, 1979). Presently it is known that in coastal
waters all groups of fungi take part in mineralization of dead organic matter and recycling of nutrients. However the precise role of fungi in these processes have hardly been investigated (Raghukumar and Rao, 1986).

1.1 Literature review

The existance of fungi, or what are called moulds by the common man has been recognized almost since the beginning of man's recorded experiences and impressions of nature. Before the invention of microscope itself naturalist's attention was invited by the larger fungi. Thousands of species of fungi are known from the terrestrial habitat and their roles in the nature have been widely recognized. Although a large number of fungi do exist in the marine environment this fact went unnoticed.

**Marine and estuarine mycological studies**

**Filamentous fungi**

The early history of marine mycology starts with the report of Saccardo (1883), Ellis and Everhart (1885) who reported species of *Ophiobolous* on plant remains in marine environments. In the beginning of twentieth century Petersen (1905) made a study of Chytridiaceous forms parasitic on algae. He found that there are true marine fungi which are active in the destruction and disintegration of living autotrophic marine plant. In the successive years, Cotton (1907) and Sutherland (1915a,b,c, 1916) added new
reports of fungi occurring in marine environment.

Major impetus to isolate fungi from marine waters, intertidal soil and benthic sediments were made since 1930 and large number of papers describing these species have been published. Most investigators used standardized isolation techniques such as plating or dilution plate methods or baiting. All these experiments resulted in the isolation of several terrestrial fungi with a few marine or facultative marine species. Elliott (1930) using dilution plate techniques isolated species of ubiquitous terrestrial fungi from the marshy soils of England and recorded lesser number of fungal propagules. In 1937, Sparrow conducted a preliminary investigation of mycoflora of mud samples collected from Buzzard's Bay, Vineyard Sound and the Gulf of Maine, considerably distant from land. He used plating method and recorded many terrestrial forms.

The discovery by Barghoorn and Linder (1944) that fungi showed remarkable adaptations for aquatic mode of life and the potential role of these fungi as wood degraders created much interest among mycologists. They carefully conducted a series of investigations on the various microbiological, chemical and physical factors involved in the decomposition and preservation of submerged plant materials and isolated several fungi specific to the marine environment from wood submerged in the sea.

Johnson and Sparrow (1961) compiled the list of fungi

Higher fungi from sea water were isolated using the aforesaid methods by Höhnk (1959), Roth et al. (1964), Meyers et al. (1967b), Schaumann (1974b), Muntanola Cvetkovic and Ristanovic (1980) and others.

Woody substrates often find their way into the sea. Besides, man deliberately introduces wood in the marine environment in the form of fishing craft and structures such as jetties. Several Ascomycetes and Deuteromycetes produce a vast array of wood degrading enzymes. Kohlmeyer and Kohlmeyer (1979) reviewed the higher lignicolous fungi from wood and other cellulosic materials in their book, "Marine Mycology, the Higher Fungi". Since this review, several publications describing lignicolous fungi have been published
The degradative process of marine fungi involving the production of intra and extracellular enzymes have received considerable study. Meyers and Reynolds (1959a,b,1960,1963), Meyers and Scott (1968), Meyers et al. (1960) were among the first to study the cellulolytic activity of marine lignicolous fungi in detail, which included both Ascomycetes and Deuteromycetes. Meyers (1968) and Jones and Irvine (1972) discussed the degradative role of filamentous marine fungi in the marine environment. Pisano et al. (1964) screened 14 marine fungi for the gelatinase activities and found such activity in the culture filtrates of 13 isolates. The enzyme systems in several marine fungi were examined by Sguros and his co-workers (1970). Rodriguese et al. (1970) studied the dehydrogenase patterns in marine filamentous fungi, while Vembu and Sguros (1972) examined citric acid cycle and glycoxylate by pass in glucose-grown filamentous marine fungi.

Schaumann (1974a) demonstrated in 20 marine fungi, the production of cellulase by applying the viscometric and agar plate methods. He used sodium carboxymethyl cellulose as substrate for the test. The clearing of cellulose-containing agar by 14 marine fungi was also used by
Hennigsson (1976) as a measure of cellulase and xylanase production. Nilsson (1974) employed several methods to assay the enzymatic activities of 36 lignicolous fungi. He found that marine fungi like *Humicola alopallonella* were unable to degrade pure cellulose substrates in culture, but produced characteristic soft-rot patterns. Leightley and Eaton (1977) demonstrated the ability to degrade wood cell wall components of several marine fungi belonging to the genera *Cirrenalia*, *Halosphaeria*, *Humicola*, *Niaculcitalna* and *Zalerion*. They compared them with fresh water and terrestrial fungi and found production of cellulase, xylanase and mannanase in all species tested.

Detailed information on the extracellular enzyme production by marine fungi has been provided by Molitoris and Schaumann (1986) and Schaumann et al. (1986).

Mangrove trees are fascinating study objects for any marine mycologist. The bases of their trunks and pneumatophores are permanently or intermittently submerged in salt water. Terrestrial fungi occupy the upper part of the trees and marine species, the lower part. At the edge of the intertidal area there is an overlap between marine and terrestrial fungi. The majority of manglicolous marine fungi are omnivorous and found mostly on dead and decaying cellulosic substrates. Most of the literature on higher fungi of mangroves were descriptions of new species, new host records, on the geographical distribution, taxonomy etc., but much less in their important role in nutrient cycling etc.
The first account of marine fungi occurring on mangroves was by Cribb and Cribb (1955,1956) in Australia. They were the pioneer mycologists to observe marine fungi in situ on mangroves. Kohlmeyer and Kohlmeyer (1979) reviewed the higher manglicolous fungi. Since this review several publications describing manglicolous fungi have been published (Aleem, 1980; Kohlmeyer, 1980,1984,1985; Kohlmeyer and Schatz, 1985; Kohlmeyer and Vittal, 1986; Koehm and Garrison, 1981; Schatz, 1985; Hyde et al., 1986; Crane and Shearer, 1986; Hyde and Borse, 1986a,b; Hyde and Jones, 1986, 1987, 1988; Jones and Tan, 1987 and Hyde and Mouzouras, 1988). Hyde and Jones (1988) compiled the list of fungi from mangroves.

A few researchers have studied the mycoflora in mangal soil. Stolk (1955) reported two new species from Eastern African mangrove soil. Swart (1958, 1963) examined the culturable mycoflora of mangrove soils of Eastern Africa. He reported Cladosporium, Alternaria, Aspergillus, Penicillium, Phoma, Septonema, Robillarda and Periconia from mangrove soils and noted the absence of Basidiomycotina and the rare occurrence of Ascomycotina and Phycomycotina. Swart (1970) reported a new Penicillium species from Australian mangrove soil. Lee and Baker (1972a,b, 1973) investigated soil microfungi in Hawaiian mangrove swamps. They used plating techniques to isolate fungi from the surface of roots of Rhizophora mangle, from macerated root tissue and from rhizosphere soil.
Newell (1973, 1976) made an extensive study of the microbial colonization on mangrove seedlings. He investigated the mycofloral succession on submerged seedlings of *Rhizophora mangle*. He made direct observation of fungi fruiting at the time of collection and species developing on the seedlings after damp chamber incubation. Newell also applied culture techniques to find species not sporulating on incubated seedlings and reported altogether 84 species of marine fungi.

Mangrove leaf tissue seems to be the most intensively investigated mangrove substratum for understanding the role of fungi in the degradation processes (Fell and Master 1973, 1975, 1980; Fell et al., 1975, 1980, 1984; Cundell et al., 1979; Wannigama et al., 1981 and Findlay et al., 1986).

While the higher marine fungi in the mangroves have attracted considerable interest, little effort has been devoted to the lower fungi. The most detailed studies were those of Ulken (1970, 1972, 1975, 1981, 1983, 1984, 1986), Fell and Master (1980) and Findlay et al. (1986).

**Yeast**

Although yeasts are higher fungi, the marine species are less studied by mold specialists. The confusing nature of yeasts taxonomy is one of the main reasons discouraging investigations on their ecology (Fell, 1976). Fell (1976) and Kohlmeyer and Kohlmeyer (1979) provide up to date reviews of the available information on their taxonomy, distribution
and ecology. Mycological examinations of estuarine and open ocean environments have revealed the occurrence of diverse populations of yeasts of various taxa and physiological groups.

The occurrence of yeasts in the seas has often been reported as incidental during the study of other microorganisms. The discovery of marine yeasts goes back to 1894 when Fischer separated red and white yeast from the Atlantic Ocean. Fischer and Brebeck (1894), Tsiklinsky (1908), Gräf (1909), Issatchenko (1914), Hunter (1920), Nadson and Burgwitz (1931), ZoBell and Feltham (1934) and ZoBell (1946) were the early investigators who reported the occurrence of yeasts along with moulds and bacteria in the sea. Since then many researchers have reported the occurrence of yeasts and yeast like fungi in the pelagic environment, on shrimp, in the fish gut, gut contents of marine mammals and birds and on decomposing algae (Kriss et al., 1952; Phaff et al., 1952; Kriss and Novozhilova, 1954; Kriss 1959; Johnson and Sparrow, 1961; van Uden and ZoBell, 1962; Siepmann and Hohnk, 1962; Shinano, 1962; Capriotti, 1962; van Uden and Castelo Branco, 1963 and Kawakita and van Uden, 1965).

van Uden and Fell (1968) and Ahearn et al. (1968) emphasized the widespread occurrence of yeasts in oceans and estuaries. Goto et al. (1974) and Vaatamen (1976) studied the distribution of yeasts in Pacific Ocean and Northern Baltic Sea respectively. While investigating the distribution of yeasts of the North Sea, Meyers et al. (1967a)
observed that certain yeast populations showed noteworthy concentration in association with various stages of development of the dinoflagellate, Noctiluca miliaris. Kriss et al. (1967) concluding the work carried out as a part of Russian Oceanic research in Indian Ocean and other regions reviewed their efforts in describing marine yeasts. Fell (1967) studied the distribution of yeasts in the Indian Ocean and discussed the relationship to hydrographic and biological conditions. Morris (1968) presented an excellent review of the various isolation techniques of marine yeasts and also discussed their possible use as indicators of water masses, fish populations, pollution etc.

The majority of the yeasts in marine habitats are probably general saprophytes with few exceptions as pathogens. Some of the yeast species are pollution indicators. Candida tropicalis, C.krusei and C.parapsilosis are usually found in estuarine regions and rarely occur in oceans (van Uden and Fell, 1968; Fell, 1976).

Sechadri and Sieburth (1971) evaluated various yeast media while quantitatively estimating yeasts on sea weeds. Gunkel et al. (1984) found the increase of yeast population during the degradation of Desmarestia viridis in model sea water microecosystems.

Fell et al. (1960) were the first researchers to study the distribution of yeasts in benthic environment. They obtained a total of 179 yeast isolates from 45 sampling
stations in the course of a qualitative yeast survey in Biscayne Bay, Florida. Fell and van Uden (1963) used coring device to study the marine yeasts. Yeast population were found confined to upper 2 cm of sediment at water depths of 540m.

The first major discussion about the yeasts found in estuaries and other inshore regions was by van Uden (1967). Kriss et al. (1952), Roth et al. (1962), van Uden and Castelo Branco (1963) and Fell (1965) found denser yeast populations in littoral zones than in adjacent open seas. The estuaries of the rivers Tagus, Sado and Guadiana, in Portugal were studied for yeast populations by Taysi and van Uden (1964) and van Uden (1967). Qualitative studies of yeasts in the Miami river were attempted by Capriotti (1962). Suehiro (1963) found a maximum of 2000 viable yeast units per gram of intertidal mud at two stations from the coast of Kyushu, Japan. Meyers et al. (1971) counted very high concentrations of viable cells in sediments of Spartina alterniflora marshes at the Louisiana coast. Ahearn (1973) studied the effect of environmental stress on aquatic yeast populations. Volz et al. (1974) found that the frequency of isolation and number of yeasts species were greater in sands and sediments than in a few invertebrates that they studied in Bahamas.

In the following years further literature were added to the study on marine yeasts. Yamagata and Fujita (1977), in Uragami sea and basin of the Ota river; Cheng and Lin (1977)

_Candida albicans_ is the most facultatively common and versatile marine yeast, frequently reported as a pathogen causing candidiasis in marine animals. The studies on yeasts with special reference to _C. albicans_ were made by several authors. Crow et al. (1977) isolated and studied the atypical strains of _C. albicans_ from the North Sea and found that such atypical isolates are likely to be misidentified by normal taxonomic procedures. Buck and Bubucis (1978) described a membrane filter procedure for the enumeration of _C. albicans_ in natural waters. Buck (1980, 1983, 1986) examined the occurrence of _C. albicans_ in relation to fecal matter of dolphins and sea gulls. Bossart (1982) and Dunn et al. (1984) reported candidiasis in dolphins and pinnipeds.

The isolation and identification of _C. albicans_ from polluted aquatic environments are facilitated by the inclusion of a selective medium to detect the reduction of 2,3,5-triphenyl tetrazolium chloride (Cooke and Schlitzer, 1981). They observed that _C. albicans_ occurred commonly in low numbers in sewage effluents, rivers and streams. The
distribution of this yeast as a pollution indicator organism has been studied by Robertson and Tobin (1983) and Ekundayo (1983). Safer and Ghannous (1983) observed morphological alterations in *C. albicans* by sea water.

In situ exposure of *C. albicans* to three streams containing acid mine drainage was accomplished using membrane diffusion chamber by DePasquale et al. (1984). *C. albicans* was extremely tolerant of the acid stress as reflected by average decreases in survivors of less than two logs during a three day exposure period.

Yeasts are found to be associated with oil pollution. They are known for the production of single cell protein (SCO - single cell oil, current usage) from hydrocarbons which are useful for combating oil pollution. Turner and Ahearn (1970) reported increase in population of hydrocarbonoclastic yeasts in a fresh water stream after the incidental discharge of waste oil from an asphalt refinery into the stream. Yeast population increased within the five day period following the spill from an initial $30-200$ c.f.u./ml to $10^2-10^5$ c.f.u./ml. Ahearn et al. (1971a) studied the effect of oil on Louisiana marshland yeast populations. Ahearn et al. (1971b) also studied the Louisiana crude oil and its distillates being the sole source of carbon for the growth of yeasts isolated from various marine habitats. *Debaryomyces hansenii, Candida parapsilosis* and *Rhodotorula glutinis* were the predominant species assimilating the carbon from the above source. Meyers and Ahearn (1972) investigated biodegradative
processes of oil in the *Spartina* ecosystem, with particular emphasis on the ecological role of yeasts and filamentous fungi. The selective effect of oil in developing yeast population in estuarine marshland was noted by Ahearn and Meyers (1972). After few months of periodic controlled enrichment of the field plots with crude oil, the dominant species were found to be hydrocarbonoclastic strains of *Trichosporon* and *Pichia*. Ahearn and Meyers (1976) presented an excellent review of research work on fungal degradation of oil in the marine environment.

Crow *et al.* (1980) studied on the hydrocarbon utilizing yeasts *Candida maltosa* and *C. lipolytica*. Both were capable of reducing recoverable amounts of branched chain and aromatic hydrocarbons in a mixture of naphthalene, tetradecane, hexadecane and pristane. Fedorak *et al.* (1984) isolated 74 yeasts from marine water and sediment samples from the strait of Juan de Fuca and Northern Puget Sound. When these yeasts were grown in the presence of Prudhoe Bay crude oil only three yeasts were able to degrade some or all the n-alkanes. Gruettner and Jenson (1984) recorded the physiological composition of the microbial community involved in oil degradation in Kalundborg Fjord, a Danish marine area. Ahearn and Crow (1986) reviewed and dealt in detail, the metabolism of alkanes and alkene by fungi including yeasts.

Nutritional evaluation of marine yeasts in raising aquaculture and rearing the bio-feeds is attaining accelerated momentum. Recent investigations have indicated
the importance of marine yeasts as feed in aquaculture (Al-Hajj et al., 1983; Aujero et al., 1984; Higashiuhara et al., 1984; La Ferla and Zaccone, 1985 and Al Hinty and James, 1986).

Marine and Estuarine Mycological Studies in India

Filamentous fungi

The marine habitats in India have received hardly any attention in the field of mycology as compared with other branches of marine science. There have been only a few records of fungi from the marine habitats of India and they were mostly terrestrial forms transported to estuaries, mangroves and intertidal beaches. A little work has been done on obligate marine fungi from Indian waters.

The publication of Becker and Kohlmeyer (1958) on the presence of soft rotting fungi on small fishing crafts was one of the first marine mycological studies in India. The only species named was Halosphaeria quadricornuta. Later a few more lignicolous fungi have been reported by Kohlmeyer (1959). Almida (1963) made a preliminary investigation of microorganisms on timber in Indian coastal waters. In his report he listed Aspergillus sp., Cladosporium sp., Halosphaeria quadricornuta and a number of bacteria. Kohlmeyer et al. (1967) reported three more lignicolous fungi from India. Jones (1968) reported Humicola sp. and Cirrenalia macrocephala belonging to Deuteromycotina and Lulworthia floridana, L. purpurea and H. quadricornuta belonging to Ascomycotina. He could not find any
successional pattern of fungi and the number of fungi recorded was low due to the very rapid deterioration of the wood by the animal borers and bacteria.

While studying the problem of timber destroying organisms along the Indian Coasts Nair (1970) recorded five species of wood infesting fungi from the Cochin backwater, viz. Gnomonia longirostris, Halosphaeria quadricornuta, Torpedospora radiata, Corrollospora pulchella and Lulworthia sp.. They were all obligatory marine fungi with cellulolytic properties. He felt that there was apparently a softening of the timber by such hydrolytic processes which enhances the activities of the timber destroying organisms.

Raghukumar (1973) studied the lignicolous marine fungi in and around Madras, east coast of India during 1967-1971. He recorded twelve Ascomycetes and six Fungi Imperfecti from drift wood and wood submerged in the sea. Patil and Borse (1982) reported two species of Halosarpheia, viz. H. fibrosa and H. ratnagiriensis sp. nov., from Maharashtra, west coast of India. The former species was a new record for India and the later was a few species to science.

In the course of marine mycological survey of the coast of Maharashtra, Borse (1985) collected a Basidiomycetes fungus Mia vibrissa from a dead and decaying intertidal wood. Six more Ascomycetes were collected from the same area, some of which were found to be rare and not previously reported from India (Borse, 1987).
More recently while studying the distribution of lignicolous marine fungi in the Vellar estuary, east coast of India, Ravikumar and Purushothaman (1988a,b) recorded *Cirrenalia tropicails*, a hypomycete and *Corollospora intermedia*, an Ascomycete which were new records for India.

Pawar and Thirumalachar (1966) were the first Indian mycologists to study the ecology of higher fungi in soils of marine environments. While studying the intertidal beach and marshy soils of Bombay they found a low number of fungal propagules for marine soils. They compared the growth of pure cultures of marine and terrestrial isolates of the same species of soil fungi and concluded that most of the marine isolates grew better on sea water agar than on a distilled water medium, whereas the terrestrial isolates of the same species showed the reverse reaction. They maintain that the only differentiation between marine and terrestrial fungi is that the former is better adapted to grow and tolerate saline conditions. Later Subramanian and Raghukumar (1974) conducted similar studies in soils of marine and brackish environments in and around Madras. They isolated eighty six species of fungi, most of them were common terrestrial forms. Upadhyay et al. (1978) studied the ecology of microfungi in a coastal sand belt near Kanyakumari (Cape Comorin) with special reference to soil microenvironment. *Aspergilli* and *Penicillia* were the commonest components of beach and sand dunes.
Freitz et al. (1979) studied the microfungi from coastal waters of Bombay and Goa. Fungi with different physiological activities were isolated from immersed timber panels, sediments, mangrove vegetation and algae from the brackish water in Bombay and Goa. Patil and Borse (1983a) reported three arenicolous fungi viz. Arenariomyces trifurcatus, Corollospora lacera and C. maritima from the foam samples, collected from sandy beaches in Maharashtra.

The marine fungi in relation to their physiological activities were also studied by a few authors. Desai and Betrabet (1971) studied the cellulolytic activity of fungal isolates from Bombay waters. Nair and Lokabharathi (1977) observed the degradation of hydrocarbons by a Fusarium sp. isolated from tar balls accumulated in Goa beaches. Nair et al. (1977) studied the distribution and activity of L-asparaginase producing fungi in the marine environment of Porto Novo, east coast of India. Araujo et al. (1981) screened marine fungi for their phosphorus solubilizing ability. Namboori et al. (1980) investigated the fungal transformation of Pregneolone and Progesterone with the marine fungus Cladosporium herbarum. Ranu Gupta and Ravindran (1988) determined the ultimate compressive stress of preservative treated wood samples exposed to fungal attack. All the fungal isolates were cellulolytic lignicolous forms from decaying fishing craft.

The fungal population and ecology of Indian mangrove swamps are also very poorly investigated. The earlier papers
dealt with the descriptions of single species isolated from mangrove soils; Rai and Tewari (1963) on Preussia isolates, Pawar et al. (1963) on a Monosporium and Pawar et al. (1967) on Phoma spp.. Additional investigations on Indian mangal soils were conducted by Pawar and Thirumalchar (1966), Padhye et al. (1967), Rai et al. (1969), Venkatesan and Ramamurthy (1971), Rai and Chowdhery (1975, 1976) and Chowdhery (1979).

The relationships between salinity and cellulolytic activity of mangrove fungi were studied by Rai and Chowdhery (1976) and Garg (1982). They found that the cellulose degrading activity decreased with increase in the salinity except in a few species.

Chowdhery and Rai (1980) described five species of aquatic oomycetes which were new records from Indian mangroves.

Matondkar et al. (1980a, b) studied the seasonal variations in the microflora of mangrove swamps of Goa and for various exoenzyme activities. Matondkar (1980) while studying the role of heterotrophic microorganisms in mangrove ecosystem found the dominance of Monilia, Mucor, Syncephalastrum, Aspergillus and Trichothecium. Sheilla De Velho and Joe D'Souza (1982) isolated a total of 52 fungal cultures from the mangrove swamps of Chapora, Mandovi, Sal and Zuari estuaries of Goa and screened for pectinase activity.
Chowdhery et al. (1982) investigated the Sunderban mangrove swamps, West Bengal and isolated a good number of fungi from rhizosphere, rhizoplane and non-rhizosphere zones of mangroves. Highest number of fungi were isolated from rhizosphere zone. Ascomycetes were frequent in rhizoplane and Zygomycetes in rhizosphere; while Basidiomycetes were absent. They observed the active growth of many terrestrial species in mangrove swamps by direct microscopic method. Garg (1983) observed the frequent occurrence of Aspergilli and Penicilli in Sunderban mangrove mud while studying the vertical distribution of mycoflora through direct and dilution plate methods.

Recently more reports on manglicolous marine fungi were published from Maharashtra. Most of the species were new records to India from mangrove habitat (Patil and Borse, 1983b, 1985; Borse, 1984, 1987a,b,c,d). A recent work related to the ecology of fungi in mangrove swamps was conducted by Misra (1986). By using soil plate techniques he isolated twenty fungal species belonging to 12 genera with the dominance of Aspergilli and Penicillia from the mangrove muds of Andaman-Nicobar islands. Prabhakaran et al. (1987) investigated a mangrove swamp of Cochin backwater and recorded thirty one fungal species from the mud and twenty seven from decaying leaves, stems and roots of Avicennia officinalis and Acanthus illicifolius. The dominant fungal genus was Aspergillus followed by Penicillium, Fusarium and Trichoderma.
Yeasts

In India it was Bhat and Kachwalla (1955), who made the first attempt to investigate the marine yeasts. They collected sea water samples off the coast of Bombay and collected over 80 isolates by the enrichment culture methodology. In the same year Bhat et al. (1955) studied the different aspects of the nutrition of marine yeasts and their growth. After a decade Sechadri et al. (1986) further added to the yeast studies by their work in the marine and estuarine waters of Porto Novo. Patel (1975) found that actively growing algae contain lesser number of yeasts per gram of algae than yeasts found per ml of surrounding sea water. Godinho et al. (1978a,b) developed techniques to isolate hydrocarbon assimilating yeasts from the marine environment and conducted nutritional studies on hydrocarbon degrading yeasts of marine origin.

Glenda D'Souza and Joe D'Souza (1979), Emilia Da Costa and Joe D'Souza (1979a,b) Nelson D'Souza and Joe D'Souza (1979a,b) and Naik et al. (1982a,b) isolated a good number of yeasts from Goan estuaries including mangroves and studied various physiological activities of the isolates.

1.2 Need to take up fungal studies in the Cochin backwater

Cochin backwater, a tropical estuary has a detritus dominated food chain. The estuarine system is highly productive due to the supply of detritus from both autochthonous and allochthonous sources (Qasim, 1970; Qasim
and Sankaranarayanan, 1972). The role of fungi is important in detritus dominated ecosystems. A lot of allochthonous materials is added up into the backwater by mangroves and other macrophytes bordering the backwater. It is established that in marine coastal systems macrophytes form the major producers and are the basic source of energy that supply to the animals of commercial and sport fisheries (Mann, 1976). Herbivores consume about 5% of the macrophyte material (Fenchel, 1972; Odum et al., 1973). All the remaining material must be converted to microbial biomass prior to utilization by the primary consumers (Hargrave, 1976; Yingst, 1976; Heinle et al., 1977 and Tenore, 1977). Most animals of the ecosystem including many economically important ones such as prawns and detritus feeding fish cannot assimilate fresh macrophyte vegetation. Fungi and bacteria decompose the vegetation and make them assimilable for detritivores. Their activities bring an enrichment of nitrogen in detritus, reflected by a low carbon to nitrogen ratio of the detritus in comparison to fresh undecomposed detritus. This is highly suitable for the nutrition of detritus feeders. Cochin backwater is well known for its traditional farm fishery which is directly linked to the constant availability of nutrients, where fungi must be playing an important role.

Presently Cochin backwater is exposed to various hazards of industrialization. Sewage and Oil pollution are common and the estuary often shows the symptoms of eutrophication. Many microbial populations especially yeasts are good pollution
indicators. Thus the quality of the water can be determined based on the distribution of yeasts. It is found that yeasts like Candida tropicalis, C. krusei and C. parapsilosis rarely occur in oceans but are usually found in estuarine regions where pollution is common (Fell, 1976). Candida species convert hydrocarbons into single cell protein (Meyers and Ahearn, 1972). They are resistant than bacteria to UV rays, fluctuations in osmotic pressure and salinity. The studies on the role of hydrocarbonoclastic yeasts are called for as the above conditions prevail in the Cochin backwater along with traces of oil pollution.

Virtually no work has been done on the mycopopulations of the backwater system except one or two occasional investigations (Jones, 1968; Nair, 1970). Work on general systematics of higher fungi from Indian waters are meagre. The importance of microbial taxonomy and ecology have been increasingly recognized in recent years in view of their significant role in the cycling of nutrients, in ecosystem productivity, in combating pollution, because of their potential in biotechnological applications etc..

Systematics of filamentous fungi can more easily be studied as they are mainly based on cultural and morphological characteristics. Taxonomy of yeasts is much more difficult and require examination of cultural, morphological, physiological and biochemical characteristics.
In the present study yeasts were therefore given greater importance especially with respect to their systematics besides the studies on ecology, biochemical activity etc., taken along with filamentous fungi. Throughout, the two groups are treated separately so as to see more clearly their distinctive features. In brief the broad objectives of this work are:

1. A general survey of the mycoflora (both filamentous and yeasts) present in the water, mud and decaying mangrove vegetation to ascertain the kind of mycoflora that is found in the Cochin backwater,

2. To record their occurrence and also their abundance in different sites in backwater,

3. To take up a detailed study of the taxonomy and systematics of estuarine yeasts,

4. To examine general ecology and distribution and

5. To contribute to the understanding of their possible role in the biogeochemical cycling in the backwater system.