I INTRODUCTION
The mangrove ecosystem comprises a group of floristically diverse trees and shrubs which characterize the intertidal vegetation of many tropical and sub-tropical area. Mangroves are one among the several specialized marine ecosystems in which the productivity at different trophic levels and energy flow assume unusual importance as it has direct influence in enriching the inshore environment (Heald and Odum, 1962).

The mangrove ecosystem is one of the most productive in the world and plays an important part in the ecology of near-shore waters. Mangrove swamps comprising of foliage as a major organic material, support a detrital type of food chain in the tropical marine environment (Odum and Heald, 1975).

Mangrove swamp forests are complex ecosystems that occur along intertidal accretive shores in the tropics dominated by estuarine trees, they draw many of their physical, chemical and biological characteristics from the sea, inflowing fresh water, and upland forests. Mangrove swamps serve as ecotones between land and sea, and elements from each are stratified both horizontally and vertically between the forest canopy and subsurface soil (Gerald and Walsh, 1974).

In recent years there is steady increase in awareness of mangrove's ecological significance and benefits to mankind. Many aspects to this ecosystem are still unknown like the distribution of antagonistic actinomycetes. Limited investigations are being made in India on ecology, phyto-geography, microbiology, forestry etc. of mangrove ecosystem.
Mangrove fauna and flora have been extensively reviewed by (Macnae, 1968). Schuster (1952) discussed breakdown and modification of the substratum by bacteria, fungi, actinomycetes and myxomycetes. He mentioned the occurrence of the bacteria *Clostridum* sp. and *Azobacter* sp. and the algae *Nostoc* sp. and *Anabena* sp. in mangrove swamp and speculated that those organisms are important in nitrogen fixation.

Some observations on the distribution, ecology and the environmental features of the mangroves from 2 major estuarine systems of Goa, have been reported by Untawale *et al.* (1973). Dwivedi *et al.* (1973) studied the ecology of mangrove swamps of the Mandovi estuary, Goa. The structure and production in a detrital rich estuarine mangrove swamp in Kollur estuary near Coondapoor (Karnataka) along the Central West Coast of India was studied by Untawale *et al.* (1977). The distribution of trace elements in the Pichavaram mangroves was done by Ramdhas *et al.* (1975).

Venkatesan and Ramamurthy (1971) conducted marine microbiological studies of mangrove swamps of killai backwaters and reported the presence of physiologically active groups of bacteria. Natarajan *et al.* (1979) studied the distribution of *V. parahaemolyticus* and allied vibrios in backwater and mangrove biotopes at Portonovo.

Antimicrobial properties of alcoholic extracts from *Rhizophora mangle* was studied by Rojas Hernandez and Coto-Perez (1978).

Matondkar *et al.* (1981) studied seasonal variation of microflora from mangrove swamps of Goa situated along the Mandovi Zuari estuary. Studies were conducted on heterotrophic bacterial flora by the same authors in
1981. Microorganisms degrading phenolic compounds was studied by Gomes and Mavinkurve (1982) in the mangrove swamps of Goa. Humnadkar and Agate (1985) isolated 21 bacterial species from mud and water collected from mangroves of Sindhu drug and Malvan area in Konkan, Maharashtra. Chandrika et al. (1985) encountered green sulphur bacteria responsible for detritus decomposition from mangrove mud in Karuthedum near Cochin. The distribution of heterotrophic bacteria of mangrove ecosystem in the area of Cochin was studied by Surendran (1985). Rhizosphere microflora of Acanthus ilicifolius was studied by Mini Raman (1986). Sulfate reducing bacteria from mangrove swamps of Goa, was studied by Saxena et al. (1988). Composition and biological activity of actinomycetes in the mangrove rhizosphere was discussed by Zhen Zhicheng et al. (1989).


Cribb and Cribb (1956) in Australia were the first mycologists to collect marine fungi from mangroves and Swart (1958) did the first comprehensive studies on fungi of soil in east African mangrove vegetation.

Reports on marine actinomycetes are few and still fewer are the studies on actinomycetes in mangroves. Most of the studies have been concentrated on detecting antagonistic actinomycetes producing antibiotics which inhibit root pathogens. Studies on the types of actinomycetes found
in the root region revealed that they are similar to those from the root free soil, usually *Streptomyces* and *Nocardia* species predominate. The physiological activities of actinomycetes from rhizosphere and non-rhizosphere soil of several plants have been compared by Abraham and Herr, (1964).

Matondkar *et al.* (1981) reported that the actinomycetes and yeasts are known to play an important role in mangrove ecosystems where the plant litter decomposition occurs.

Weyland (1986) reported that the mangroves exhibited the highest density of actinomycetes among the areas investigated by him, also within their high salinity regions.

As mangrove ecosystem is an unexplored area for antagonistic compounds from actinomycetes, the present study "Microbial production of antibiotics from mangrove ecosystem" was undertaken not only to examine the occurrence, distribution and seasonal variations of microflora in mangrove sediment but also to compare their quantities with other soil organisms and to correlate their quantity to the various sediment physico-chemical factors. The richness of sediments harbouring the antagonistic actinomycetes also in certain groups of streptomycetes has been well indicated in this study. The study has also facilitated objective screening of the antagonists encountered, so as to select the most potent among them for use in fish disease control which now plague commercial aquaculture. Very encouraging results in this regard were obtained which are reported here.

The study was taken up for a period of one year from January to December 1991. Samplings were done from four fixed mangrove ecosystem...
viz. Station I - Mangalavana, Station II - Narakkal, Station III - Puthuvyppu, Station IV - Light house area of Puthuvyppu.

Thesis is presented in 6 Chapters, Chapter I - INTRODUCTION to the topic of study, extensive literature on the subject is summarised and correlated with particular reference to the importance of actinomycetes to bring an awareness of the present status of our knowledge in the subject and the review also clearly states that much work has not been done in the mangrove ecosystem related to antibiotic production from actinomycetes.

Chapter II is on MATERIAL AND METHODS for sample collection, isolation of microflora, maintenance of isolated actinomycete cultures, characterisation of actinomycetes, to study the antagonistic effect of actinomycetes and extraction of crude antibiotics. In addition, regular samples of water and sediments were collected to study some important physico-chemical parameters and to find out their possible relationship if any with the microflora of the mangrove ecosystem.

In Chapter III - RESULTS of the present investigation are presented under seven parts. Results of microbial flora encountered during the period of study are given in Part 1. Under which the distribution of total microbes (bacteria, fungi and actinomycetes) between the microbes and inter-relationship of microflora are given in Part 1.A, 1.B, 1.C, 1.D and 1.E respectively. Part 2 deals with the results of the physico-chemical parameters studied viz., Temperature in Part 2.A, pH in Part 2.B, Salinity in Part 2.C, Dissolved oxygen in Part 2.D and the results of Organic carbon content estimated during the period of study is given in Part 2.E. Results of statistical
analysis of ANOVA are given for each parameter studied at the end of every part of the results to find out the level of significance between stations and seasons. Results of correlation study are also given under each part. Distribution of actinomycetes screened and isolated are in Part 3.A and Part 3.B respectively. Results of sodium chloride tolerance of isolated actinomycetes are given in Part 4. Under Part 5 results of identification of actinomycetes are given in detail. Strain description of 52 identified actinomycetes are given in Part 5.A. Results of Generic composition, Sporophore morphology, Spore morphology, Sporophore and Spore morphology and Pigment production are given in Part 5.B, Part 5.C, Part 5.D, Part 5.E and Part 5.F respectively. Results of antagonistic property of the isolated actinomycetes are given in Part 6. Which are presented in 5 sub parts viz. Part 6.A deals with the results of antibacterial activity, Part 6.B deals with results of antifungal activity, Part 6.C gives the results of antibacterial and antifungal activity and Part 6.D deals with the results of antagonistic nature of the isolated actinomycetes against each test organism and in Part 6.E. Antibiogram of 104 isolated actinomycetes are given in Part 6.F. Part 7 deals with the results of antagonistic activity of the crude antibiotic extracts from selected actinomycete cultures, isolated during the period of study. Part 8 deals with the results of invitro evaluation of pH on solvent in testing the anti-microbial activity of selected isolates.

All data collected and the results of the work done on the above aspects are given either in the form of graphic intensity charts or tables for effective presentation of the results.
Chapter IV - DISCUSSION. All major and minor findings are compared with the previous results obtained by various authors. The properties of these organisms have profound effect on our ideas about the classification, ecology and physiology of this group.

SUMMARY of the results of investigation is presented in the final section of the thesis — in Chapter V which is followed by a detailed list of references (Chapter VI) on the subject.

**ACTINOMYCETES**

The actinomycetes have recently come to occupy an eminent place because they are important producers of antibiotics, vitamins and enzymes (Waksman, 1957). They are a group of very useful micro-organisms from the points of view of their role in natural cycles of matter. Investigations for their isolation and biological activities, in virgin areas, would reveal their significance further (Ali and Roymon, 1984).

Alexander (1978) stated that the true bacteria are distinctly different from the filamentous fungi and many morphological characters separate the two broad types. There is however a transitional group i.e. a connecting link between the simple bacteria and the fungi, a group with boundaries overlapping its more primitive and its more developed neighbours. These are the actinomycetes. Among the procaryotes, a mycelial growth habit is confined to Gram-positive bacteria being characteristic of the organism known as actinomycetes.

Micro-organisms in the order actinomycetales are characterised by being filamentous and branched. This is normally exhibited in some degree
by all the species. None produce endospores of the type found in true bacteria, but many produce mould like spores or conidia. The branched cellular growth (mycelium), together with the specialized methods of sporulation, relates these organisms to the moulds; thus Actinomycetales are referred to as the mould like bacteria. On the bacterial side, they are related to the Gram-positive nonspore formers (Pelczar et al., 1977).

The actinomycetes form an extensive and widely distributed group of micro-organisms. Like the bacteria and the moulds, they occur in nature both as saprophytes and as parasites of plants and animals (Waksman, 1919).

Sieburth (1979) stated that the actinomycetes are highly diverse group of Gram-positive bacteria, which sometimes have acid fast branching filaments, with colonies that range from typical bacterial colonies to colonies having a well-defined coherent mycelium, with specialized structures and spores. The saprophytic actinomycetes have an aerobic metabolism and do not accumulate acids from carbohydrate substrates, whereas the parasite forms are usually micro-aerophilic and convert 50% of their substrate carbon to acid.

OCCURRENCE AND DISTRIBUTION OF ACTINOMYCETES

Actinomycetes are among the most widely distributed groups of microorganisms in nature. Very few natural substrates are free from them. In some of the substrates as in soils, in lake water and in lake bottoms, in composts, they lead a normal existence. In other substrates, as in sea water and in dust, they are only in transitory state. They are found abundantly in all soils throughout the world especially under dry alkaline conditions,
form a large part of the microbial population of the soil. They also occur on plant residues and in various food stuffs, such as fruits, vegetables, milk and milk products and cacao (Waksman, 1950). And they are almost absent in peatbogs and in the sea (Waksman, 1957).

The soil represents an ideal natural substrate for the development of actinomycetes. They are found so abundantly there, where they are represented by many genera and species. It has been suggested that their major function in the soils is the decomposition of plant and animal residues. In general, a close correlation has been obtained between the abundance of actinomycetes and the amount and extent of decomposition of available organic matter in the soil (Waksman, 1950).

Actinomycetes are present in surface soil and also in the lower horizons to considerable depths. In abundance, they are only second to the bacteria, and the viable counts of the two are sometimes almost equal. In the environments of high pH, a large proportion of the total community consists of actinomycetes (Alexander, 1978).


The first survey for actinomycete in marine sediments was conducted by Grien and Meyers (1958). The first study to enumerate actinomycetes in fresh sediment samples and to examine off-shore samples was conducted
in the North Sea and in the open Atlantic Ocean by Weyland (1969).

Waksman (1967) stated that actinomycetes belonging to 4 or 5 genera are associated with vegetative matter and sediments in the sea and apparently take an active part in the benthic microflora.

Isolations from marine areas are reported from coastal or shelf regions. Only a few surveys give some knowledge about the occurrence in oceanic sites Zobell (1946), Weyland (1969), Walker and Colwell (1975).

Strains of Nocardia and Streptomyces were obtained from cordage and fishnets by Freitas and Bhat (1954). Occurrence of actinomycetes in the marine environment is briefly reviewed by Sieburth (1979).

Very little work has been done on marine actinomycetes. Since the environmental conditions of the sea are extremely different from terrestrial conditions, it is felt that marine actinomycetes have different characteristics when compared with their terrestrial counterparts, and might produce different types of antibiotics (Elliah and Reddy, 1987). In addition to antibiotics production, some are useful for the chemical transformation of steroids.

The streptomycetes group of micro-organisms are widely distributed in the water masses. The water mass contains relatively small amounts of streptomycetes; the sediments however, are often rich in them. Mass development of streptomycetes in sediments has a reason for the formation of earthy odours of the water in some areas (Rodina, 1972).
ISOLATION OF ACTINOMYCETES

Of new, biologically active compounds, the ability of these microorganisms to produce useful antibiotics and to carry out other transformations of commercial interest has focussed attention on factors bearing on their isolation. It would be desirable, therefore to be able to isolate soil inhabiting actinomycetes with a minimum interference from associated bacteria and fungi.

Actinomycetes being filamentous, branching bacteria with a fungal type morphology, are part of the microbial flora of most natural substrates. Numerous methods have been advocated to facilitate the isolation of actinomycetes (El Nakeeb and Lechevalier, 1963).

Methods for the preferential isolation of actinomycetes from soils was suggested by Poter et al. (1960). Lingappa (1961) suggested several different media for isolation of actinomycetes from soil. Most of them contain carbon and nitrogen sources which are utilised by bacteria and moulds as well as by actinomycetes and therefore are not selective for the latter.

Many investigations involving the selective isolation of streptomycetes from soil have been carried out. A brief survey of the literature revealed a total of 21 recommended media. The most frequently used carbon and nitrogen sources were glucose and asparagine (by 13 workers) and glycerol (by 11 workers), potassium nitrate, peptone, casein and starch were employed with moderate frequency. The best media, allowing good development of streptomycetes while supressing bacterial growth, were those containing starch or glycerol as the carbon source with casein, arginine or nitrate
as nitrogen source (Kuster and Williams, 1964).

Shinobu et al. (1958) on testing a large number of strains, found that glycerol and starch (together with glucose) were used as carbon sources by all. Of all the nitrogen sources tested, nitrate turned out as the best inorganic source. Similar results were obtained by Pridham and Gottlieb (1948) who found that all streptomycetes tested were able to utilize starch, glycerol and glucose.

El Nakeeb and Lechevalier (1963) used calcium carbonate, sodium propionate, phenol treatment, centrifugation method and found that calcium carbonate treatment was most effective, as it not only gave highest total counts of actinomycetes, but also the lowest relative numbers of bacteria and fungi.

Hopwood (1960) stated that the pattern of development of the substrate mycelium is markedly influenced by the composition of the medium. Lingappa (1961) reported that chitin-mineral medium was excellent for isolation and estimation of total number of actinomycetes from soil, for growth and maintenance of cultures. Rodina (1972) has suggested 20 media with different combinations for the growth of streptomycetes. Dekleva et al. (1985) developed a defined medium for *S. peucetius* and methods for reproducible laboratory analysis of its growth and anthracycline production. Two species of *streptomycetes* isolated from rhizosphere soil were described and cultured on seven different media (Nair and Nair, 1986). A simple synthetic medium for the production of the peptide antibiotic thiostrepton by *S. azureus* was found by Charry et al. (1989).
TAXONOMY OF ACTINOMYCETES

As everywhere in biology, the most difficult and complicated, but at the same time most important aspect of the study of organisms is the identification of species (Krasilnikov, 1960).

Many authors have attempted to classify members of this group of organisms and the same is also reviewed by many authors. Shirling and Gottlieb (1966) were the one who initiated to standardize the methods for characterization of these organism. Methods for characterization of streptomycetes is reported in detail in (ISP) International Streptomycete Project (1966) by the same authors in the year 1966 and descriptions for each species is given in detail by Shirling and Gottlieb (1968a, 1968b, 1969 and 1972). Morphological, cultural and physiological were the main characters given in ISP for the identification of streptomycetes. Evaluation of criteria used in the ISP co-operative description of type strains of Streptomyces and Streptoverticillium species was done by Szabo and Marton (1976).

The anatomy of individual colonies of S. coelicolor was studied at various developmental stages in situ by means of surface impressions and thin sections by Wildermuth (1970). Alkalophilic actinomycetes strains were examined by Miyashita et al. (1984) to determine their taxonomic position.

Spore Morphology Studies

Kriss et al. (1945) were probably the first to do electron microscopy of streptomycete spores. Their finding of smooth spores was followed by those of Carvajal (1946) and Bringman (1951), who also examined smooth spores on the cultures they studied. Flaig (1958) described spiny spores on certain species
and also found hairy spores and warty spores on other species. Baldacci and Grien (1955) observed smooth, spiny and hairy spores but failed to mention warty spores. The concept of smooth, warty, spiny and hairy spore surfaces was sufficiently established by Cross and Maclver (1966) and Shirling and Gottlieb (1966) listed these as one of the criteria to be used in characterizing species. Trenser et al. (1966) also stated that spore surface may be characterized according to 4 types, smooth, warty, spiny and hairy. From the studies of Dietz and Mathew (1962, 1968 and 1971) it was shown that, in addition to the 4 recognized spore surface type, a fifth type was designated namely "rugose".


Electron microscopy of cytoplasmic structure in facultative and anaerobic Actinomycete was studied by Overman and Leopine (1963). Williams and Davies (1967) used SEM for the examination of Actinomycetes.

Studies on cell wall - as an aid for identification of actinomycetes

Cell wall composition has been widely accepted as an aid in the identification of genera. Four cell wall types are accepted. Cell-wall compositions of 51 strains of Actinomyces, Nocardia, Streptomyces, Micromonospora, Mycobacterium and Propionibacterium have been investigated by Cummins and Harris (1958). The carbohydrate composition of the cell walls of some lysozyme
resistant streptomycetes was determined by Sohler et al. (1958). Rapid differentiation between Nocardia and Streptomycetes by paper chromatography of whole-cell hydrolysates was done by Becker (1964). Cell-wall preparations were made from more than 140 strains of aerobic actinomycetes. All cell-wall preparations contained as major constituents glucosamine, muramic acid, alanine and glutamic acid. Becker (1965). A rapid method for characterization of actinomycetes by cell wall composition was done by Boone and Pine (1968). De Weese et al. (1968) found that quantitative data on the amino acid composition of cell walls can provide definitive identification of some of the species and differentiation of Actinomyces from other members of the Actinomycetales and from morphologically similar genera such as Corynebacterium and Propionibacterium. Staneck and Roberts (1974) used a simplified approach for the identification of aerobic actinomycetes by thin-layer chromatography. The micro-morphology, ultrastructure and cell-wall composition of Streptosporangium corrugation, isolated from beach sand was studied by Williams and Sharples (1976). Meyer (1976) presented the results of a study designed to determine a suitable taxonomic niche for A. dassonvillei. A battery of morphological, physiological and biochemical tests, including paper chromatographic analysis of whole cell hydrolysates was used to study aerobic actinomycetes by Berd (1973). A Nocardioform isolated from soil was studied, on the basis of cell wall composition and physiological characteristics, this organism was placed in the genus Nocardiopsis Shearer (1983). Lechevalier et al. (1986) proposed two new genera Amycolata and Amycolatopsis to accommodate nocardioform actinomycetes having type IV cell-wall composition and lacking mycolic acids. Report on cell-wall chemistry and morphology of the genus Streptalloteichus was stated by Tomita et al. (1987).
Carbon utilisation of actinomycetes

The utilisation of carbohydrates and of other carbon sources has been recommended by many authors as an aid to species differentiation. The ability of different species of actinomycetes to utilize various sources of carbon and nitrogen was considered as an important criterion in the taxonomy.

Carbon utilisation was studied by many authors, Gottlieb (1961), Lacey (1971), Mayer (1976), Iwaski et al. (1981), Diab and Gounaim (1982), Miyashita et al. (1984), Nair and Nair (1986) and Tomita et al. (1987).

New species of actinomycetes

A single mesophilic species of a new genus belonging to the family Streptomycetaceae of the order Actinomycetales was described and named as Waksmania (W. rosea, type sp.) by Lechevalier and Lechevalier (1957). A new genus of Actinomycetales Micropolyspora gen. nov was proposed by Lechevalier and Scolotorovsky (1961). Two aerobic mesophilic species of new genus belonging to the family Actinoplanaceae were described under the name Microellobosporia (M. cinerea type species) by Cross et al. (1963). Actinomyces humiferus was proposed by Gledhill and Casida (1969) and the details of occurrence and characterization was studied. A new species S. spinoverrucosus isolated from the air during a study of the distribution of aerobic Actinomycetales strains in the atmosphere of Kuwait was described by Diab and Gounaim (1982). The type strain of a new nocardioform genus Saccharothrix was described by Labeda et al. (1984).

PATHOGENECITY OF ACTINOMYCETES

The actinomycetes commonly isolated from soil and less commonly from fresh water, which are pathogenic to man and animals exist in atleast four families.
Mycobacterium marinus has been isolated from spontaneous tubercular lesions from fish dying in sea water aquaria by Aronson (1926).

GENETICS OF ACTINOMYCETES

The first important contact between genetics and microbes occurred in 1941, when Beadle and Tatum succeeded in isolating a series of biochemical mutants from the fungus Neurospora. In 1944, bacterial genetic transfer known as transformation revealed that it is mediated by free deoxyribonucleic acid (DNA). The chemical nature of hereditary material was thus discovered.

Studies on genetics of actinomycete was reviewed by Bradley (1966).

Genetic recombination in S. fradiae by protoplast fusion and cell regeneration was studied by Baltz (1978). DNA were extracted from strains of A. viscosus and A. naeslundii and were compared by DNA-DNA hybridisation (Coykendall and Munzenmaier 1979). Polar lipid composition in the classification of Nocardia and related bacteria was studied by Minnikin (1977). Genetic mapping studies with a number of bld mutants and their classification using various criteria was reported by Merrick (1976). The isolation of 3 kinds of rifampicin resistant mutants of S. coelicolor and the identification of probable RNA polymerase mutants among them was studied by Chater (1974). Gordon et al. (1974) reported some of the characteristic of 27 mislabeled strains and demonstrated their close relationship to the type strain of N. autotrophica. The cultural conditions for preparing stable protoplasts of streptomycetes and for reverting them to the filamentous state at a high frequency on the surface of synthetic agar plates was reported by Okanishi (1974).
Fernandez et al. (1989) studied the diversity among 43 isolates of the genus Frankia by determining levels of DNA relatedness and DNA base compositions. The S. rimosus gene has been cloned into E. coli and expressed under control of ph or hpp promoters Reynes (1988). Chung et al. (1985) made a molecular approach to examine the genetic relatedness of 19 Frankia isolates by measuring the extent of DNA-DNA homology and the fidelity of hybrid-duplex molecules. DNA restriction patterns and DNA-DNA solution hybridisation studies of Frankia isolates from Myrica pensylvanica (Bayberry) was made by Bloom (1989). Ibrahim and Abdul-Hajj (1989) reported unique microbial transformation product of 5-hydroxy-flavone, isolation and elucidation of its structure by Spectroscopic techniques. Crameri et al. (1983) reported the restriction fragment analysis of the total chromosomal DNAs of actinomycete strains by one dimensional agarose gel electrophoresis which generate a reproducible and unique fingerprint for each organism. Biosynthesis of anthracyclines by analysis of mutants of streptomyces sp. Strain C 5 blocked in claunomycin was studied by Bartel et al. (1990).

**ACTIVITY AND FUNCTION OF ACTINOMYCETES**

Development of actinomycete colonies in selective synthetic media is very slow when compared to most fungi and bacteria, characteristic suggestive of their inability to be effective competitors and of the lack of prominence when the nutrient level is high and the pressure of competition is great. The feeble competitive powers may explain their relative scarcity during the initial stages of plant residue decomposition. When nutrients
become limiting and the pressure of the more effective competitors diminish, the actinomycete become more prominent.

The Order Actinomycetales has received special attention because many strains have the capacity to synthesize toxic metabolites. As many as three fourths of the streptomycete isolates may produce the antimicrobial agents known as antibiotics. The antibiotic substances produced in culture by actinomycetes inhibit the growth or cause the elimination of populations of bacteria, yeast and fungi of many taxonomic categories. Percentage of actinomycetes producing antibiotics varies with the soil and season of year and some test organisms are sensitive to compounds produced by many and some are inhibited by metabolites excreted by only actinomycetes. Despite the great industrial and therapeutic value of these chemical, there is still no clear picture of the significance of compounds in natural process. In addition to production of antimicrobial metabolites, many species of streptomycetes liberate extracellular enzymes which lyse bacteria. The possession of enzymes of this type may be important in the microbiological equilibrium in the environment.

The activities of the actinomycetes in soil transformations still are not clearly defined. Because microscopic examination reveals few actinomycetes in the mycelial stage and since the present evidence indicates that the high plate counts are largely the result of conidial persistence, it seems that the actinomycetes have a lesser biochemical importance than the bacteria and fungi. Nevertheless, there is evidence for the microorganisms participating in the decomposition of resistant components of
plant and animal tissue, formation of humus and transformation of organic matter at high temperature (Alexander (1978). Streptomyces are important in the recycling of carbon in polymeric macromolecules Brookes and Mc Grath (1986). Rodina (1972) reported that Streptomycetes also break down proteins, urea, amino acids, and simpler nitrogenous substances. In water masses they effect the decomposition of organic plant and animal remains and the liberation of ammonia from complex proteins.

Chandramohan et al. (1972) stated that marine actinomycetes take an active role in the deterioration of cellulosic substances in the marine environment. Pelczar and Reid (1977) reported that Nocardia, Streptomyces and Micromonospora are responsible for the characteristic musty or earthy odour of a freshly plough field. Evidence for activity against the lignin fraction of straw was produced for a range of actinomycete strains by Ball et al. (1989).

**Vitamin and Enzyme production**

Vitamin B$_{12}$, the pernicious anemic factor has been recovered from waste products from the production of some of the antibiotics by Streptomycetes cultures and is found in appreciable amounts in activated sludge Frazier (1958).

Much work has been done on the production of protease by Streptomyces sp. Chahal and Nanda (1976), but only few reports are about pectinase Sata Masayakti et al. (1980) and cellulase (Desai and Betrabet, 1972) production by some members of this group of micro-organism. L. asparaginase production by S. griseus was studied by DeJong (1972). Extra cellular enzyme
activities during lignocellulose degradation by *Streptomyces* sp. was reported by Ramachandra (1987). Wachinger et al. (1989) surveyed the distribution of cellulase activities and cellulase system associated with mycelia among 160 new streptomycetes isolates.

**ANTIBIOTIC PRODUCTION**

Antibiotic substances are produced by many microorganisms in various ecological conditions. Producers of biologically active substances can be found among representatives of marine microflora, inhabitants of rivers and lakes, antibiotics are produced by decaying plant and animal remains, by growing plants and live animals, etc. But the major part of microorganisms that can produce antibiotics inhabit the soil (Egorov 1985).

The observation that one micro-organism could inhibit the growth of another had been made fairly frequently towards the end of the nineteenth century and it had even been demonstrated that such an interaction might be mediated by the release from one organism of a metabolite which was toxic to the other. Only after the discovery and development of penicillin that a truly wide ranging search for antibiotics was initiated.

The search for chemotherapeutic agents from microbes has resulted in the discovery of an amazing number of antibiotic substances, the majority of which have proved in tests on laboratory animals to be too toxic for them to be of any practical clinical use.

Penicillin was found out in 1928, by Fleming from a stray fungal (*Penicillium notatum*) contaminant preventing the growth of *Staphylococci*, is a historical fact known to many.
In 1932 Raistrick turned his attention to Fleming's confirming that an interesting antibiotic was liberated into the medium but he was unable to isolate the active substance.

In 1938-39 Florey and Chain included *P. notatum* in a study of naturally occurring antibacterial substances. Their work at Oxford was encouraging and by 1941 a quantity of material, so active that it was considered to be pure penicillin, had been isolated and used for clinical trials.

Waksman and his team considered that one of the ecological factors involved in the fierce competition of micro-organisms living in the soil might be antibiotic production. They discovered many organisms producing compounds with antibiotic activity, none of these compounds proved to have any medical potential until 5 years and some 10,000 isolates later, streptomycin was isolated from a strain of *S. griseus* cultured from heavily manured soil (Riviere, 1977).

Grein and Meyers (1958) isolated 166 isolates of actinomycetes obtained from sea water and found that 70% of these were active against both Gram-positive and Gram-negative bacteria. Krassilinilov (1962) tested 326 microbial isolates obtained from oceans throughout the world at a depth of 0 to 3500 m. Isolates exhibited a very large antibacterial spectrum. Bamm et al. (1966) isolated 2 streptomycetes from Bombay waters and the cultures were found to elaborate antibacterial substances. Wood (1967)
recorded a number of actinomycetes from estuarine sources and some have been found to produce antibiotics.

Yagi et al. (1971) reported that the addition of elemental sulfur to the fermentation medium of *S. sioyaensis* caused marked stimulation of siomycin production. The stimulation appeared to be the result of the utilisation of thiosulfate, which accumulates as an oxidation product of elemental sulphur.

In a survey of Sagami Bay, 136 strains of actinomycetes were obtained from 37 samples, of which 27% had antimicrobial activity and 17% inhibited a sarcoma cell. The saline tolerance of representative isolates were also tested (Okazaki and Okami, 1972).

*S. flavohelwanesis*, Strain AS-H-23, isolated from the Egyptian soil of Helwan, showed strong proteolytic activities and an antimicrobial agent AS-H-23A, highly active against Gram-positive bacteria (Abdullah and Fathy, 1976). Vanaja Kumar (1991) screened 386 isolates from various tissues of 5 different molluscs from Portonovo coastal region, out of which 290 strains (75.1%) exhibited antagonistic properties. It is reported that, of all the animals examined *T. telescopium* was found to be the best source for antagonistic actinomycetes.

*S. coeliocolor* was found to produce a third secondary metabolite by Rudd and Hopwood (1980) in addition to the antibiotics methylenomycin A and actinothoradin. It was a red pigmented, highly non polar compound with antibiotic activity against certain Gram-positive bacteria. Production
of new aminoglycoside antibiotics the sannamycin complex from \textit{S. sannanensis} isolated from soil sample was studied by Iwasaki \textit{et al.} (1981). A novel antibiotic producing \textit{Actinomadura kijaniata} sp. nov. was reported by Horan and Brodsky (1982). An antibiotic related to production of the red antibiotic, Undecyl prodigiosin, by \textit{S. coeliocolor} A 3(2) was studied by DNA cloning and biochemical analysis (Feitelson 1985). \(\beta\)-lactam antibiotic from \textit{Streptomyces} JA 13 was studied by Daginawala and Wadher (1985).

Effects of metals on \textit{S. coeliocolor} growth and actinorhodin production was studied by Abbas and Edwards (1990). Vilches \textit{et al.} (1990) stated the influence of different nutritional compounds on oleandomycin biosynthesis by \textit{S. antibioticus}, resulting in the design of a chemically defined medium for the production of the antibiotic. Kapurimycins, new antitumour antibiotics produced by \textit{Streptomyces} was studied by Yoshida (1990). Imai (1990) isolated and studied the structure of a new phenoxazine antibiotic. Exfoliazone produced by \textit{S. exfoliatus}. A new antitumour substance produced by \textit{Streptomyces} (isolated from a soil sample collected in Seto, Aichi Prefecture, Japan) was reported by Kojiri (1991). Detection, isolation and structural elucidation of 2 new angucyclinones exhibiting biological activity was studied by Grabley \textit{et al.} (1991). The producing organism \textit{Streptomyces} sp. was isolated from soil sample collected near Ajantha (India). Henkel and Zeeck (1991) reported structure and absolute configuration of Napthomevalin, a new dihydro-napthoquinone antibiotic from \textit{Streptomyces} sp. (isolated from soil sample collected in Strathgordon, Australia). Fermentation, isolation and structural determination of a cyclic
hexadepsipeptide compound from *Streptomyces* sp. was studied by Hensens et al. (1991), the organism was isolated from rhizosphere soil sample obtained from Japanese Garden. Hydantocidin, a new compound with potent selective herbicidal activity, was found in submerged culture of *S. hygroscopicus* by Nakajima et al. (1991).