CHAPTER I

INTRODUCTION AND HISTORICAL ACCOUNT

1. INTRODUCTION

Man has made rapid strides in all walks of life with the advances in science. He has utilised science and modern technology for his comfort, pleasure and betterment of living standards. The increasing demand for products coupled with the pressing need to supply them at a faster rate has resulted into increased mass production and industrialisation of these products. This has resulted into increasingly larger quantities of inevitable undisposable waste matter, which has undeniably caused pollution of atmosphere - land, water and air, by disturbing the equilibrium of natural products, environment and organisms including mankind.

Different kinds of paper has become an important necessity of present day life, more so in the urban populace. Paper finds use in writing, communication, documentation, education, decoration, wrapping, packing, advertising, etc. This demand is complied by setting up new factories for paper production. In this context, many paper and pulp mills sprang up and the existed ones expanded their production capacity, in the recent years. The disproportionate rates of waste matter produced and its decomposition consequently

led to pollution of the natural outlets viz. the nearby lands, water streams and rivers.

Irrigation of agricultural lands by using industrial wastes is an old practice. The objective is to cultivate the nearby land with a hope to yield additional income from the crops produced. The real benefit however, comes in an indirect way. Cultivation renders the soil microflora more active as waste decomposition agents. Uncultivated land loses this benefit and serves merely as a substratum for disposal of waste water.

It is observed that nature always tries to develop the organisms suited for any changed environment. Fungi, like any other microorganism adapt to their racial existence. It was therefore thought worthwhile to survey the fungal flora of polluted areas in the vicinity of some paper mills, with a hope to select the most efficient fungal decomposers and study their possible role in the degradation of pollutants.

The art of paper making in India dates back to the era of Muslim invasion. It developed in the northern provinces of Kashmir and Punjab and later on spread to other parts of the country. The first paper mill was set up near Calcutta in 1832 A.D. by a Christian missionary. Half a century later, many mills were established, especially during 1881 - 1894. Titaghar Paper Mill (1854) began at

Titaghar. Upper India Paper Mills Co. Ltd. (1881) began in Lucknow. In Maharashtra Deccan Paper Mills Co. Ltd. (1887) was started at Hadapsar (Mundhwa) near Poona. These are some of the big establishments which sprang up during this period. In the recent years, numerous paper and pulp factories have been established in different parts of India.

Today, Maharashtra also has a number of paper and pulp mills. The industrial effluents from these mills have already polluted the nearby areas to a significant extent and have posed a hazard to the inhabitant flora and fauna. Some factories store the effluent in tanks and use it for irrigation purposes with very little or at times no treatment. The effluent is partly degraded by the microflora in the storage tanks and partly by the soil microflora.

Cellulose degradation study merits a special significance in the biological treatment of effluents because cellulose is one of the important components of paper and pulp industry. Cellulose is a complex organic compound. It forms a good source of carbon, but it is utilized only by the small group of organisms which produce cellulose degrading enzymes. The cellulolytic enzymes are produced only in the presence of cellulosic substrate. Enzymatic hydrolysis breaks down cellulose into smaller units of glucose and makes it available for the other organisms. The complete knowledge of the occurrence of such cellulolytic forms in

the effluent of paper and pulp factory and the neighbouring soil is important in manipulating the biological degradation of wastes.

The present research aims at studying the mycoflora from the various storage tanks, water streams and nearby soils irrigated by these effluents. The method of study is based on isolation of these fungi in pure cultures and studying their morphology and taxonomy. The knowledge of mycoflora growing in storage tanks is quite inadequate. The role of these mycoflora in the quantitative and qualitative degradation of cellulose is ill understood. Hence, in the present study, the naturally occurring cellulolytic fungi have been selected for their morphology, physiology and determination of cellulolytic activity in qualitative and quantitative terms.

Further addition to the existent knowledge in this field will be of immense help in the after-treatment of paper and pulp industry effluents.

2. NATURE OF PAPER AND PULP MILL WASTES

In paper production an important stage of the pulping process is separation of cellulose from other constituents of wood. Cellulose is utilised to make paper, while other constituents along with the utilised pulping chemicals are rejected as wastes. The main constituents of the waste are

wood sugars, lignin and cellulose escaped in the process of removal of knots and larger particles from the pulp.

In the sulphite process, wood chips are heated under pressure with bisulphite solution of calcium and SO_2. The liquid is converted to water soluble lignosulphonic acids during digestion and a certain amount of carbohydrate is dissolved while the cellulose remains in solid state which is made free from the dissolved material by washing with water.

The most important wastes from the manufacture of pulp are the liquors from the digesters, in which the fibres produced from raw materials are refined. Wastes are also produced in processes like sawing of logs, barking, chip formation, washing, knot removing etc.

Waste water from the sulphite pulp mill contains waste from cooking process, digester liquor, water from washing and screening of the digested pulp etc. The mixed waste water contains more than half of the organic material originally present in the wood. The waste water is acidic as it contains small amounts of sulphuric acid which has a specific toxic effect on fish at a aconcentration of about 0.5 mg/L (Nillest, 1973). The waste water also contains dissolved organic substances like sugars.

An alkaline pulp is produced when soda and sulphate processes are used for pulping. Soda process produces soft paper. The pulp from the sulphate process is known as 'kraft'.

The wastes from the paper mill contain principally the fibres which are not retained in the sheets. The water is filtered and the recovered fibres are returned for recycling. The remaining waste is known as whole water, which still contains varying amounts of fibres, dyes, loading materials, etc.

3. HISTORICAL ACCOUNT

i) EFFECTS OF THE WASTE WATER

Cellulose is the major component in the paper industry. Cellulose undergoes various processes in paper making, as described earlier. These processes require a large amount of water. The average intake of water in a paper industry is 20,000 gal. per ton of paper produced (Isabell, 1968).

The waste water from the industry is generally left in the nearby fresh water streams or rivers. Hughes (1971) noticed that water soluble materials extracted during paper making processes may escape in the effluents causing slime accumulation. He suggested that the slime can be controlled by biodegradation processes. Kelso *et al.* (1977) have studied the pulp and paper mill effluent in a fresh water environment

in Canada. They studied the effect of effluent on fresh water ecosystem. Hendry et al. (1982) have also studied the effects of pulp and paper waste on microbiological water quality of a river. They reported that a large number of fecal indicator bacteria and other coliforms are discharged from the paper mill. Pseudomonas aeruginosa (82/100 ml), E. coli (200/100 ml) and fungus Leptomites were observed.

The effect of effluent on the soil has also been studied. Among the Indian workers Gosh (1966) has given the chemical analysis of paper industry waste and has studied the use of paper mill waste for the betterment of acid soils. Patra and Behera (1974) studied the effect of a paper mill waste on mineralization of the soil nitrogen whereas Rajanan and Oblisami (1979) studied its effect on soil and the crop plants. Rajanan and Oblisami observed that the combined effluent samples were alkaline and contained large amounts of suspended and dissolved solids. It was also observed that the undiluted effluents drastically affected the germination of rice, blackgram and tomato seeds, growth as well as the vigour index of the seedling. Though the undiluted effluent inhibited growth, the diluted effluent (25 - 50%), however, enhanced growth. Rice tolerated the pollutant effect much better than black gram and tomato. Nitrogen, phosphorus and potassium in the soil treated with the diluted effluent were found to be more than those treated with normal water, indicating the possibility of recycling of these effluents for agricultural use.

Dolar et al. (1972) studied the effect of paper mill waste on the yield of the crop and on mineral nutrition.

ii) TREATMENT OF THE EFFLUENT

The problem of treatment of paper industry effluent has been studied by workers in India and abroad. Most of them have given chemical treatment to the effluent except Kutney et al. (1982), who have studied the biological detoxification of resin in the kraft pulp mill effluent by transforming acids into a number of non-toxic hydroxylated derivatives by Mortierella isabellina.

Butler (1964) and Wenzel (1965), have surveyed the waste water treatment problems. Wenzel worked on the problem with respect to chemical treatment with Mg, Na and ammonium bases. Pearl (1968) reported that reutilization of the waste water is one of the useful methods to control paper-industry pollution. Greathouse (1950) studied the microbial degradation of cellulose.

Among the Indian workers Murty et al. (1965), Dhaneshwar et al. (1970), Saxena et al. (1975) and Sastry et al. (1977) studied the characteristics of the waste from the paper and pulp factories. Saxena et al. have given the physico-chemical and settling properties of the waste. Bhatia et al. (1978) have worked on the chemical treatment of the waste.

iii) MICROFLORA OF THE EFFLUENT

It has been observed that the waste water from the paper and pulp industry is rich in microflora. Microorganisms in the paper and pulp factory were studied as early as 1933 by Sanborn J.R. Following the work of Sanborn, Höhnl (1956) noticed development of a red growth in the effluent. The red growth was from Fusarium, Mucor, and other related sewage fungi. Streptococcus developed only when pH rose to 6.4 (usual pH range being 5.2 to 5.8).

Brewer (1958, 1959) and Eveleigh and Brewer (1963, 1964a) studied slime accumulation in pulp and paper mills. They could isolate a large number of thermophilic and thermotolerant fungi and bacteria. Eveleigh & Brewer (1964b) also studied the nutritional requirements of such microflora.

Brewer (1958, 1959) observed that the white water from the factory stimulated the growth in slimes and noticed the occurrence of Phialophora fastigata while studying the slime accumulation (1959). Wang (1965) has given a list of fungi occurring in pulp and paper industry in New York. Churchland & Mc Claren (1971) studied the effect of kraft pulp mill effluents on marine fungus Zalerion maritimum, whereas Judd & Boeser (1975) studied the ecology of a river polluted by treated pulp mill effluent.

Indian workers like Sreenivasan et al. (1977) have given an account of biological indicators of pollution in a river polluted by paper mill waste. Rajanan & Oblisami (1979) observed that the effluent contained very low population of bacteria and fungi whereas actinomycetes and phytoplantons were absent. However, he found high populations of bacteria, fungi and actinomycetes in the effluent treated soil. In contrast to the observations of Rajanan and Oblisami, Hendry et al. (1982) observed a large number of fecal indicator bacteria and other coliforms discharged from the paper mill.

It was observed after considering the previous literature, that the results are contrasting to each other and very little work has been done in India, and hence the present work was undertaken.