General Introduction

Chapter - 1

GENERAL INTRODUCTION

There are more than 600 species of freshwater fungi and a greater number are known from temperate, as compared to tropical regions. These include 300 ascomycetes, 300 mitosporic fungi and a number of chytrids and oomycetes (Goh and Hyde, 1996). Three main groups can be considered, they are 1) The Ingoldian fungi which occur on decaying leaves in streams and lakes and which are probably the most well studied. They have been documented in many countries around the world, although the tropics have received less attention, 2) The aquatic ascomycetes and hyphomycetes occurring on submerged woody material have received less attention. Studies on these fungi in temperate regions are mainly based in North America, Chesapeake Bay (Shearer, 1993a) and 3) The chytrids and oomycetes, including those that cause diseases are well-documented (Laidlaw, 1985; Fuller and Jaworski, 1987; Barr, 1988; Bruning, 1991; Powell, 1993). These fungi generally lack the ability to degrade cellulose and are important in degrading noncellulosic entities entering the freshwater ecosystem (e.g. dead insects, keratin and pollen grains).

Although there were some earlier reports on aquatic hyphomycetes, it was the remarkable work by Ingold (1942, 1967, 1975, 1976) which gave new dimensions to research on these fungi. These fungi also named the 'Ingoldian fungi' after Ingold (Webster and Descals, 1981) have been reported from various parts of the world. Their geographical distribution extends from the arctic to the equator (Barlocher, 1992), although certain species are found to be dominant in temperate and others in tropical latitudes. As this is an ecotaxonomic group of fungi, the research on this group has also been centered mainly on the ecological and taxonomic aspects.

The ecological work on these fungi was reported by pioneers like Nilsson (1964) and Tubaki (1957, I960). New avenues were opened when quantitative techniques for the analysis of conidial numbers were developed (Iqbal and Webster, 1973, 1977). The conidial numbers have been shown to fluctuate with seasonal and temporal changes and the amount of plant material present in water. Research work on the ecology of these fungi has been done from Australia (Thomas *et al.,* 1989), Austria (Regelsberger *et al.,* 1987), Canada (Barlochcr *et al.,* 1977; Michaelides and Kendrick, 1978), England (Iqbal and Webster, 1973b, 1977; Chamier and Dixon, 1982; Sanders and Anderson, 1979; Shearer and Webster, 1985). France (Eggeschwiler and Barlocher, 1983; Merce, 1987; Chauvet, 1991; Gessner *et al.*, 1993), Germany (Eggenschwiler and Barlocher, 1983), Hungary (Gonczol, 1975, 1987, 1989), India (Manocharachary and Madhusudan, 1983; Sridhar and Kaveriappa, 1984, 1988, 1989; Merce and Sati, 1989; Chaiidiashekar *et al.,* 1990), Italy (Del Frate and Caretta, I983), Japan (Suzuki and Ninura, 1960, 1961; Tubaki, 1960), Morocco (Cherigui, 1990), Pakistan (Iqbal *et al.,* 1979, 1980; Iqbal and Khan, 1982; Iqbal *et al.,* 1995;

Marvanova, 1979), Sweden (Nilsson, 1964; Barlocher and Petersen, 1988), Switzerland (Barlocher and Rosset, 1981; Eggenschwiler and Barlocher, 1983) and United States (Triska, 1970; Suberkropp, 1984, 1991; Metvalli and Shearer, 1989).

Detailed ecological reviews have been studied by Nilsson (1964), Webster and Descals (1979), Suberkropp (1991) and Barlocher (1992).

The decomposed and processed leaves contribute much to the energy budget, food web and finally to the productivity of aquatic ecosystem. Submerged leaves play a key role in supplying energy to aquatic communities but the most of this energy is not directly available to animals. Conidial fungi of submerged leaves and convert substantial fractions in to their own. The progeny content of leaves has been doubled due to the growth of this group of fungi. It is also observed that a number of chemicals including sugars are leaked in water during decomposition. This kind of release may enhance nutrient status of water body. Dry weight losses were also reported in aquatic litter due to fungal activity. There are no fungal inoculation studied available in water bodies. Fungal inoculation is as essentially to assess the nutrient status of water body (Monoharachary, 2008).

The conventional techniques to study the aquatic hyphomycetes were direct examination of decaying plant material submerged in water and natural foam present in streams. Ecological studies of freshwater hyphomycetes have been based on a single technique in the past. Hyphomycetcs on decaying leaves (Iqbal *et al.,* 1979; Chamier *et al.*, 1984) or in foam samples (Gonczol, 1971, 1975, 1987; Iqbal and Bhatty, 1979; Barlocher, 1987) have been described. Later on techniques like membrane filtration of water, and use of leaf baits of known species were employed in the ecological studies on these fungi. Membrane filtration technique has been employed to determine the seasonal periodicity of these fungi based on spore concentrations in water (Iqbal and Webster, 1973b, 1977; Barlocher and Rosset, 1981; Thomas *et al.,* 1989) or by introducing leaf baits of selected leaf species (Barlocher and Kendrick, 1974; Suberkropp and Klug, 1976; Chamier and Dixon, 1982; Suberkropp, 1984; Gonczol, 1989; Iqbal, 1996). Recently artificial foam trap has been used to detect conidia of species which are very low in concentration in water and are otherwise undetectable (Iqbal, 1993, 1995). The sampling techniques in ecological studies when used singly generate results that are biased in different directions (Regelsberger *et al.,* 1987).

A combination of two or more techniques have been used to describe freshwater hyphomycetes communities. Shearer and Webster (1985a) have used *data obtained from random leaf sampling and leaf pack baiting to describe the* longitudinal and temporal communities of freshwater hyphomycetes in the River Teign, England, Bareen and Iqbal (1997) have used all possible techniques at a given site and the cumulative information obtained from all techniques was used to define communities of freshwater hyphomycetes. The species composition of the communities can be efficiently characterized by the data generated by using all techniques simultaneously (Iqbal, 1995).

Agricultural runoff and urban activities can increase the inputs of Nitrogen (N) and Phosphorous (P), leading to stream eutrophication and thus substantially affecting the structure and functions of the benthic communities (Menendez, 2012).

Many aquatic hyphomycetes form tetraradiate conidia (four diverging arms, Plate 5a-f); some have sigmoid conidia (long, wormlike, generally curved in more than one plane); a minority have spores of a more conventional shape. This suggests parallel evolution; today, it is commonly accepted that the tetraradiate and, to a lesser extent, the sigmoid shape facilitate conidial attachment to leaves and other substrates (Webster, 1959; Read *et al.*, 1995).

Studies on aquatic hyphomycetes have been increasing due to the evidence of their importance on the energy flow of woodland streams (Baldy *et al.*, 1995; Gulis and Suberkropp, 2004; Methvin and Suberkropp, 2003). In general, these studies have been taxonomical, which are few and have been conducted mainly in temperate streams (Sridhar *et al.*, 1992; Crusius and Piccolo, 2003) or ecological which are more numerous but also mainly reported for temperate streams. The importance of aquatic hyphomycetes on degradation and decomposition of organic matter (allocthonous material) and the utilization by invertebrates (mainly shredders) as a food resource has been well established (Barlocher and Kendrick, 1981; Barlocher, 1992; Gessner and Chauvet, 1997; Baldy and Gessner, 1997; Gulis and Suberkropp, 2004).

Aquatic hyphomycetes constitute polyphyletic mitosporic group with mainly ascomycetes and a few basidiomycete. Depending on the conidial state, about 30 species have been connected with telomorphs (Marvanova, 1997; Webster, 1992).

Aquatic hypomyceetes are freshwater borne fungi that apparently in adaptations to living conditions in running water produce branched or sigmoid conidia easily trapped on under water substrates. Most of these fungi belong to the aquatic hyphomycetes. They have been described from many different geographical locations (Webster and Descales, 1981).

There are numerous aspects to their ecological function (Barlocher, 2005; Suberkropp, 1998): aquatic hyphomycetes affect autotrophs (by releasing inorganic nutrients), other heterotrophic microorganisms (competing for or sharing organic nutrients) and invertebrates (improving leaf palatability to shredders; releasing fine particulates consumed by collectors). Several field studies have examined aquatic hyphomycete diversity and leaf decomposition in streams from different geographic areas e.g., tropics (Chauvet, 1991), temperate climate (Hieber and Gessner, 2002) and under different environmental conditions. e.g., nutrient load (Gulis and Suberkropp, 2004; Pascoal and Cassio, 2004), riparian vegetation (Barlocher and Graca, 2002) and heavy metal pollution.