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Research Article

DIVERSITY OF AQUATIC HYPHOMYCETES IN SAGARA TALUK OF SHIMOGA DISTRICT - KARNATAKA

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ABSTRACT
Aquatic Hypomycetes are found abundantly in stagnant water, fast flowing streams and lakes of both temperate and tropical regions. A about 300 species have been reported from all over the world. The present study was carried out the diversity of aquatic Hyphomycetes in Sagara taluk of Shimoga District - Karnataka. The foam samples were collected at different timings from study site and equal parts of F.A.A was added to the samples for further study. Identification of aquatic Hyphomycetes was done based on structure and biometric data of conidiophores and conidia. The fungi were examined under light microscope**.** A total 19 species belonging to 16 genera of aquatic Hyphomycetes were identified. Among them *Flabellospora tetracladia, Tetraploa aristata, Tetracladia, Triscelophorus monosporus Articolospora, Tetracladium marchalianum were* dominating aquatic Hyphomycetes in Sagara taluk.

Key Words*: Diversity, Western Ghats, Hyphomycetes, Foam Analysis, Isolation*

INTRODUCTION
Fungi are a ubiquitous and diverse group of eukaryotic organisms. They exist in diverse forms in a range of habitat, arboreal, fresh water, marine, subterranean and terrestrial. The terrestrial habitats most favored because it provides a wide variety of substrates for fungi. There are about 1.5 million species of which 100,000 are recognized and documented (Hawksworth, 2004). Nearly 30% of known species of fungi are recorded from the tropics. Extensive survey and study of fungi by mycologists have documentation of a sizable floristic data of fungi of India (Bhat and Kendrick, 1993).
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: 1. The In golden 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.
The fungi that have been considered to be truly aquatic are, reproduction is only possible in the water, such as the zoosporic fungi and aquatic Hyphomycetes (also called Ingoldian fungi) and some species of Ascomycota and Basidiomycota (Ingold, 1975).
Aquatic hypomycetes conidia are typically species diagnostic characters that is pure culture is not needed for identification. The pure culture is needed only in some cases for confirmation of identification to species.(Descales,1997). In aquatic hypomycetes the tetra-radiate spore is of such frequent occurrence that it is natural to suppose it has some biological significance in the aquatic environment. The significance may be is pure speculation. Perhaps a spore of this kind settles relatively slowly in water and so stands a good chance of adequate dispersal: Perhaps on the other hand it acts as anchor and readily becomes entraped in a suitable substratum, for the arrest of a spore in a stream may be real problem.
Foam acts as a trap for conidial fungi. The submerged decayed leaves and foam formed below waterfalls and rapid are found colonized by conidial fungi under aerobic conditions. However, the water borne conidial fungi disappear from such habitats as a result of pollution and anaerobic condition (Ingold, 1975).

The aquatic Hyphomycetes are responsible for decomposition of organic matter. The accumulation and gradual release of minerals, for the increase of palatability of substrates utilized by the invertebrates (Bärlocher and Kendrick, 1974) and in the removal of pollutants from water. The main habitats are streams, well aerated waters with moderate turbulence, reservoirs and lakes. The typical substrates are leaves, twigs and branches of deciduous trees, which have fallen into the water submerged macrophytes and eventually healthy roots of riparian trees (Dix and Webster, 1995).

The aquatic ecosystem comprises of variety of biota. Several physico-chemical factors of aquatic ecosystem influence the composition and activity of the fungal community. Fluctuation in temperature, oxygen content, sulphide concentration has been found an important factors for the occurrence and distribution of individual species of water borne conidial fungi in the fresh water stream (Ingold, 1975). Within a stream site differences are closely correlated with altitude or other factors associated with it, which may include differences in water chemistry (Raviraja et al., 1998, Sati and Pratibha, 2009).

The aim of the presented study was to investigate the species composition and density, frequency and abundance of some aquatic Hyphomycetes in Sagara Taluk**.**

MATERIALS AND METHODS

Foam analysis

The study was conducted in the month of 2010 June to December 2010 in Sagara Taluk and its surroundings. Six study stations were randomly selected, and foam samples were collected in each study sites.

Foam was collected from each sampling site in plastic bottles and mixed with 1 ml of formalin-acetic acid–alcohol (FAA) on the spot to fix the fungal conidia present in the foam. The samples were later examined once in a week with a microscope in the laboratory for the presence of conidia.

Fungal characterization was done on the basis of structure of mycelium, conidiophore, shape of conidiophore, arrangement of conidia on conidiophore and also on the basis of spores, shape, size and structure. Identification was done by referring the standard manuals (Dudka, 1974, Ignold, 1975, Matsushima, 1993).

Analysis of physical and chemical parameters

The water samples were collected in black plastic bottles of two liters capacity from study area and analyzed physico-chemical parameters. Eleven parameters were determined in each water sample(Table 1.) according to the generally accepted methods (Greenberg et al. 1992, APHA 1985.).

Data analysis:

The qualitative and quantitative assessment and diversity (Simpson and Shanon, Equitability, Fisher_alpha) of aquatic Hyphomycetes in foam were calculated **(**Zar, 1974**)**

Simpson index: $D' = N(N-1) / \Sigma n(n-1)$

D: Simpson's diversity index
N : Total number of species.
n : Number of individuals.
$\sum$: Sum of all individuals

Shanon index: $H = -\Sigma (p_i \, Ln \, p_i)$
H : Shanon diversity index.
$p_i \sum$: Proportion of individuals of the species in number of individuals of all species.

RESULTS AND DISCUSSION

Results

The hydrochemical analysis: temperature, pH, Iron Fe Mg , Acidity, DO of the water was summarized in Table 1. In all sites shows fungal species described in Table 2. A total of 19 species belonging to 16 genera of aquatic Hyphomycetes were recorded. density, frequency, and abundance of aquatic fungi were summarized in Table 3 and Figure 2 shows graphical representation of density, frequency and abundance.

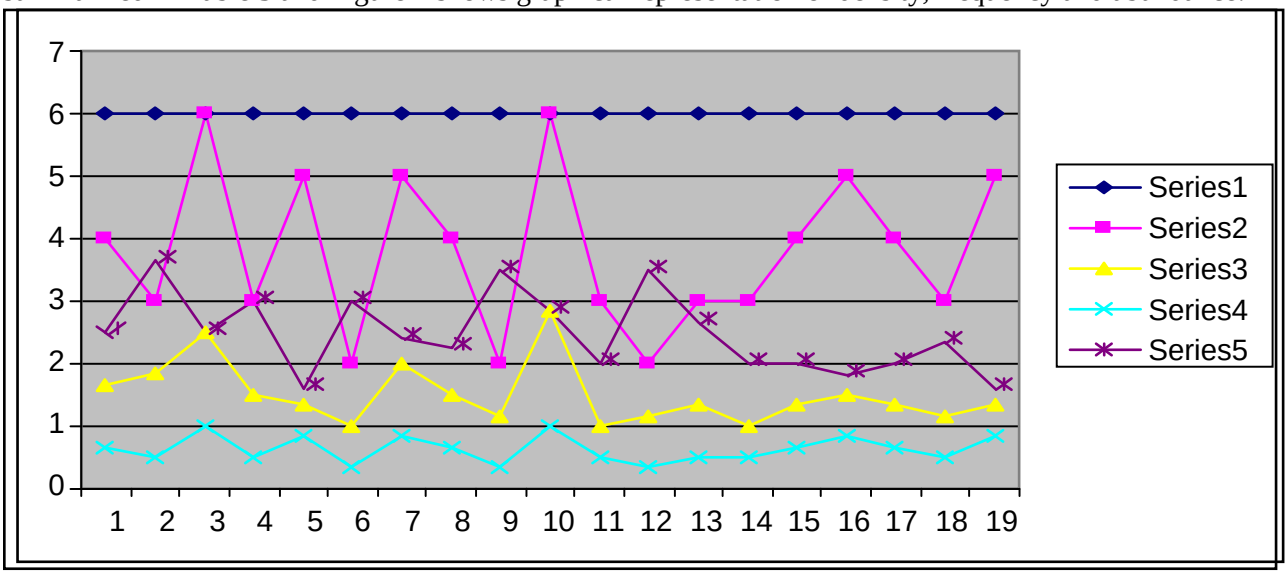

Figure 2. X axis shows number of species occurred, Y axis shows the Series 1: Station, Series 2: Number of species occurred Series 3: Density, Series 4: Frequency, Series 5: Abundance.

The Shanon diversity, Simpson diversity, Equitability, and Fisher alpha are given in Table 4. The most common species were *Articulospora tetracladia* and *Alatospora acuminate.*

The findings shows a diversity of aquatic Hyphomycetes which exhibit low frequency (0.33) exhibit low values of abundance (1.60) and low values of density (1.00) and high values of frequency (1.00), high values of abundance (3.67), and high values of density (2.83). These frequently found fungi could be considered as indicators of the species composition of the lake. Ubiquitous and common species were *Flabellospora tetracladia, Tetraploa aristata, Tetracladia, Triscelophorus monosporus Articolospora* determined the diversity of aquatic Hyphomycetes in the water samples. The total number of species recorded and their frequency, abundance, and density distribution in water samples also contributes to aquatic Hyphomycetes diversity.

Among the study area the physicochemical parameters did not affect the difference in diversity of aquatic Hyphomycetes, but showed slightly varied in density, frequency, and abundance.

Table 1. Physical and chemical parameters in mgl $^{-1}$ of water from Sagara Taluk.

	pH	WT	DO	BOD	Aci	Alk	Ca	Fe	Mg	PO_4	SO_4
Station 1	7.2	22	6.2	0.25	37.2	29	2.5	0.95	2.5	0.23	0.21
Station 2	7.3	22	7.2	0.36	33.62	22	1.9	0.69	1.9	0.14	0.12
Station 3	7.1	20	7.65	0.54	40.32	25	2.2	0.87	2.56	0.29	0.25
Station 4	7.6	22	8.2	0.12	33.96	24.32	2.6	0.59	2.2	0.22	0.11
Station 5	7.54	23	6.87	0.86	34	19.86	2.35	0.99	2.45	0.68	0.52
Station 6	7.1	20	6	1.2	32	25.3	2.41	0.85	2.84	0.75	0.18

Table 2. Fungal species found in the sites F, foam samples Sagara Taluk.

Fungal Species	S-1	S-2	S-3	S-4	S-5	S-6	Technique

Flabellospora verticillata.	+	-	+	+	+	-	F
Flabellospora tetracladia	-	-	+	+	-	+	F
Articulospora grandis	+	+	+	+	+	+	F
Articulospora tetracladia	+	-	-	-	+	+	F
Tricladium attenuatum.	+	+	+	-	+	+	F
Tricladium caudatum	+	+	-	-	-	-	F
Tetracladium marchalianum	-	+	+	+	+	+	F
Tetraploa aristata	-	+	+	+	-	+	F
Triscelophorus monosporus	-	+	-	-	-	+	F
Alataspora acuminata	+	+	+	+	+	+	F
Lunulospora curvula	+	-	+	+	-	-	F
Tetrachaetum elagans	-	-	-	+	+	-	F
Anguillospora longissima	+	+	-	-	-	+	F
Isthmotricladia sp.	+	-	+	+	-	-	F
Clavariopsis aquatica	-	+	-	+	+	+	F
Flagellospora curvula	-	+	+	+	+	+	F
Dactylella aquatica	+		+	+	+	-	F
Helicomyces roseus	+	+	-	-	+	-	F
Tricellula aquatica	+	-	+	+	+	+	F

Table 3. Density, frequency, abundance, of aquatic fungi found in Sagara Taluk (legend: den - density, fre - frequency, abu - abudance).

Fungal Species	**den**	**fre**	**abu**
Alataspora acuminata	2.83	1.00	2.83
Angullispora longissima	1.33	0.50	2.67
Articulospora grandis	2.50	1.00	2.50
Articulospora tetracladia	1.50	0.50	3.00
Clavariopsis aquatica	1.33	0.67	2.00
Dactylella aquatica	1.33	0.67	2.00
Flabellospora tetracladia	1.83	0.50	3.67
Flabellospora verticillata	1.67	0.67	2.50
Flgellospora curvula	1.50	0.83	1.80
Helicomyces roseus	1.17	0.50	2.33
Isthmotricladia sp.	1.00	0.50	2.00
Lunulospora curvula	1.00	0.50	2.00
Tetrachaetum elagans	1.17	0.33	3.50
Tetracladium marchalianum	2.00	0.83	2.40
Tetraploa aristata	1.50	0.67	2.25
Tricladium attenuatum	1.33	0.83	1.60
Tricladium caudatum	1.00	0.33	3.00
Tricellula aquatica	1.33	0.83	1.60
Triscelophorus monosporus	1.17	0.33	3.50

Table 4. Species diversity, Equitability and Fisher alpha, of aquatic species in Sagara Taluk.

Taxa_S	19

Individuals	171
Shannon_H	2.898
Simpson_1-D	0.942
Equitability_J	0.984
Fisher_alpha	5.469

Discussion

This paper deals with the foam analysis technique among these two techniques. The foam analysis is the best way to knowing of the species richness, abundance and density of water. An idea of species richness of water borne fungi may be obtained by natural foams, although the technique is not quantitative, as hypomycetes conidia are trapped with higher efficiency than others (Webster,1959). Foam surveys fulfill as added useful purpose selecting sites and seasons for later isolates of interesting species.

Current findings shows that the aquatic Hyphomycetes which exhibit, high density, frequency and abundance. The aquatic Hyphomycetes could be considered as the indicators of the species composition of the lake.

El-Hissy *et al*., (1982) and El–Hissy and Khalil (1989) reported that zoosporic fungal communities in fresh water habitats are mainly composed of *Saprolegnia, Dictyuchus, Achlya*, and *Pythium*. Present study also reveals the higher abundance, frequency, density, of different aquatic fungi.

High species diversity and conidia were found in streams with a variety of leaf litter and riparian vegetation (Sridhar and Kavariappa, 1989). According to Gulis and Suberkropp (2004) the quality of leaf litter also plays a important role in distribution of species or genotype of aquatic Hyphomycetes. Aquatic Hyphomycetes are predominant microorganisms that colonize leaves in streams, and their activity is affected by a number of environmental variable (Bärlocher, 1992). Colonization of aquatic Hyphomycetes and decomposition of leaf litter and stimulation of aquatic Hyphomycetes have been related to nutrient enrichment (nitrogen and phosphorous) (Rajashekar, 1994**).**

Environmental factors in the streams influence the diversity of the fungal community. Aquatic Hypomycetes diversity varies in the stream or river from its source to its lower reaches (Raviraja *et al*., 1998). The fungal density and conidial numbers change due to the riparian vegetation, altitude, water flow, water chemistry and temperature. Temperature appears to be an important factor affecting the occurrence and distribution aquatic fungi (Suberkropp, 1984). Some species are more common in temperature climates, and other are common in the tropics (Bärlocher, 1992). The effect of temperature on the growth and sporulation of aquatic hyphomycetes has received relatively little attention (Koske and Duncan 1974, Suberkropp, 1984). In temperature climates seasonal shifts in species diversity can occur, with species common in the tropics becoming dominant during the summer and absent during the winter (Suberkropp, 1984; Chauvet, 1991; Chauvet and Suberkropp 1998). I described you temperature. The spatial dynamics of aquatic Hyphomycetes species and suggest water hard ness, altitude, and conductivity were major factors that correlate with the distribution of individual species (Gonozol *et al*., 2003). Aquatic Hyphomycetes diversity and conidial richness were high in the lower reaches of lake. The current investigation study also reveals the findings of Shearer and Webster (1985). The abundance of aquatic Hyphomycetes in acidic pH is not favorable to for the expression of aquatic Hyphomycetes. The aquatic Hyphomycetes express better in neutral pH for their development. Which might lad to trapping of more conidia in the foam. The fungal richness needs neutral pH, and exhibit lower values of density (0.33), abundance (1.60), and density (1.00), and high value of frequency (1.00), abundance (3.67), and density (2.83). The current investigation provides evidence of the diversity of aquatic Hyphomycetes in the Western Ghats water bodies and Sagara taluk.

According to Chauvet (1991), there are some species of aquatic fungi which are characteristic of mountain streams and others characteristic of lowland rivers and streams. In between these groups there

are other species which have affinity to intermediate altitude and some are unaffected by altitudinal variations.

According to Suberkropp (2001), pH or alkalinity of the water appears to affect fungal species richness but its effects have been difficult to interpret due to variations in the nutrient concentrations in the hard water and softwater streams.

The present study may be due to their comparable physico-chemical factors such as pH, temperature, oxygen acidity, alkalinity magnesium, and phosphorous of waters.

The low numbers of aquatic hyphomycetes sampled from the iron content waters. The unusual low pH and high hardness of water is responsible for a lower record of fungi (Rajashekhar, 1994).

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