Diversity of Aquatic Fungi in Relation to Environmental Conditions in Tunga River (South India)

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Abstract: The present investigation was carried out on studying the impact of environmental conditions on diversity of aquatic fungi. Tunga river water was assessed for the physico-chemical factors of the water with respect to seasonal variations with reference to aquatic and aero-aquatic fungal diversity. Tunga river water was assessed at 6 different study stations with study period from April, 2007 to March, 2009. During the study, 12 aquatic fungal species and 14 aero-aquatic species, a total of 26 fungal species belonging to class *chytridiomycetes*, *oomycetes*, *phycomycetes Ascomycetes*, *Zygomycetes* and *Deuteromycetes* were isolated and identified. Maximum fungal distribution was recorded during the monsoon period followed by pre-monsoon periods in all the four stations. But comparatively less percentage of fungal incidences was recorded during post monsoon period. The present investigation revealed that the difference in the percent of occurrence, distribution of aquatic fungi and aero aquatic in periodically proved to depend on the physico-chemical factors of the water and also on seasonal variations. [Researcher. 2009;1(6):54-62]. (ISSN: 1553-9865)

Key words: Tunga river, aquatic fungi, physiochemical factors, aero aquatic fungi.

1. Introduction

Ecology of aquatic fungi has not attained the degree of prominence as the ecology of soil fungi. The qualitative composition of the fungal population in water is now becoming fairly well known. Heterotrophic organisms are usually present in natural water in direct proportion to the physico-chemical nature of aquatic environment. A wide variety of aquatic fungi such as *chytridiomycetes*, *Saprolegniales* and *Peronosporales* are found in fresh water. Till 1942, available information was mainly concerned to "oosporic phycomycetes" or "water molds" which till then were regarded as true water fungal flora. In 1942, Ingold reported a distinctive and abundant flora of conidial fungi as aquatic hypomycetes. Another assemblage of aquatic hypomycetes was recognized as aero aquatic fungi with the mycelium in submerged decaying leaves (Glen-Bott, 1951). The fungi encountered in fresh water are divided into two principal groups, The Hydro fungi which require the presence of water to complete their life cycle and geo-fungi or typical soil fungi which were not specially adopted to aquatic existence, but they might be found in water because of adequate supply of nutrients, these were regarded as "Facultative aquatic fungi" (Cooke 1963).

The aquatic fungi play a key role in the decomposition of leaf litter in aquatic environments (Barlocher, 1992; Gessner, Chauvet & Dobson, 1999). Fungal activity on leaves is affected by several environmental factors, such as dissolved nutrients in water (Suberkropp & Chauvet, 1995; Gulis & Suberkropp, 2003), temperature (Chauvet & Suberkropp, 1998), turbulence (Webster, 1975) and pH (Dangles et al., 2004). Generally, low to moderate nutrient concentrations stimulate fungal activity (Gulis et al., 2006). Number of species of aquatic hyphomycetes was lower in a side arm of the Rhone River than in the main channel, and this difference was attributed to lower water velocity and dissolved O_2 in the side arm (Chergui,1988).

Fresh water bodies receives various category of waste materials, many of them are organic in nature. These organic wastes are easily degraded by microbes like fungi and bacteria, naturally present in river water. Hunter (1975) studied the water molds and their role in the degradation of wastes in the river great use and its tributaries. The various wastes accumulated in the water bodies creates several problems and are responsible to kill aquatic fungi, which are useful for the bio-degradation process. Thompstone and Dix (1985) identified 25 isolates of *Achlya* and *Saprolegnia sp*. Singh (1982) studied the

distribution, occurrence and cellulose decomposition of the five species of aquatic hypomycetes. The study of aquatic fungi have been carried out in all over the world by Coker (1923), Dick (1990), Johnson (1956), Scott (1961), Middleton (1943), Seymour (1970), and Robertson (1980). The studies of aquatic fungi in Indian was carried out by Sati (1997), Paliwal and Sati (2009), Bhargava (1946), Dayal (1968), Khulbe (1977), Mer et al. (1980), Manoharachary (1991), and Mishra and Dwivedi (1987). The present investigation was carried out on diversity, distribution and periodical variation of aquatic fungi and aero aquatic fungi in Tunga River, Shimoga district, Karnataka, South India.

2. Materials and Methods

Study site Shimoga - a South west region of India, is located between 13° 27' and 14° 39' North latitude and 74° 38' and 76° 4' East longitude. Shimoga is located almost at the central part of Karnataka state in the Malnad region bounded by Sahyadri ghats on the east direction. The eastern part of the district comes under the semi-Malnad zone with plain topography and occasional chains of hills covered with semi-deciduous vegetation. Shimoga is a true picture of nature's bounty-landscapes dotted with waterfalls. Hence, climatically major parts of this study area represent a temperate zone and monsoon pattern of rain fall with dry summer and winter. The Tunga river of South India selected for the present study originates in the Western Ghats on a hill known as *Varaha Parvata* at a place called *Gangamoola*. From here, the river flows through two districts in Karnataka -Chikmagalur District and Shimoga District. It is 147 km long and merges with the Bhadra River at Koodli, a small town near Shimoga City, Karnataka.

Initially, physico-chemical characteristics of Tunga river water was studied, water samples were collected from each of the identified sampling stations at monthly intervals for a period of one year during April 2007 to March 2009 from Tunga river in sterilized plastic bottles periodically. The detailed information of the sampling stations selected for the study purpose are given in Table 1.

To study the distribution and occurrence of aquatic fungi of Tunga river water and organic waste material's like twigs, decaying aquatic plant parts were collected from lake. Water was collected in 2 litres plastic cans and decaying plant materials were collected in polythene bags of 1kg capacity from the identified stations at monthly intervals.

Isolation of fungi was carried out by following isolation techniques *viz.*, Incubation and baiting techniques in the laboratory. In incubation method, decaying leaf litter, aquatic plant parts, woody materials were collected from the river. The materials were broken into small pieces and incubated on wet blotters in petriplates, The materials along with petri-plates were kept in the incubator under laboratory condition (22$\pm$ 2ºC temperature) for about 8 days. In baiting method, sterilized broken pulses and pieces of blotter papers were used as fungal baits. The known quantity of water was taken in the sterilized petri-plates, and then broken pulses and paper pieces of blotter paper were added. The plated materials were kept for incubation under laboratory conditions (22$\pm$2ºC temperature) for about 7 to 8 days, at the end of the incubation period the colonized fungi were found on the incubated materials.

The isolates were purified by single hypha culture method. Culturing of few aquatic and Extra-aquatic was done in the laboratory on cornmeal and potato dextrose agar media for pure culturing. Identification and characterization of fungi were made with the help of aquatic fungi manual by Khulbe (2001) with support of various standard monographs (Coker, 1923; Johnson, 1956; Scott, 1961; Dick, 1990 and Barnett.H.L, 1962).The physico-chemical properties (pH, water temperature, and total organic matter) of water analyzed by following standard methods of APHA (1989). Calculations of total and individual fungal occurrence were made at the end. All calculations were made in terms of percentage by following simple formula.

$$\frac{\text{Number of samples in which fungi appeared}}{\text{Total number of samples plated}} \times 100$$

The individual fungal occurrence of each fungal species was calculated by using following simple formula.

$$\frac{\text{Individual fungal species appeared in the samples}}{\text{Total number of colonies of fungi that grew from sample}} \times 100$$

3. Results

The six different sample collection stations (station-I, station-II, station-III, station-IV, station-V, station-VI) were selected in the river based on the extent of pollution and Anthropogenic activities. From all the six sampling station, a total of 26 aquatic and aero-aquatic fungal species were isolated and identified, about 12 species of aquatic fungi belonging to 7 genera of class *chytridiomycetes and oomycetes* were encountered, which includes: *Achlya debaryana, A. Orion, A. prolifera, A. recurva, Allomyces arbuscular, A. anamalus, Aphonomyces laevis, Pythium elongatum, P. debarianum*

,Saprolegnia ferax, S. parasitica and S. terrestries. The two yearly average percentage of aquatic fungi distribution of individual fungi has summarized in the table 2. And about 14 species of aero-aquatic fungi belonging to 8 genera of aquatic *phycomycetes, Ascomycetes, Zygomycetes and Deuteromycetes* were isolated. Which includes, *Alternaria alternata, Aspergillus flavus, A. fumigatus, A. niger, Chaetomium globosum, Cladosporium cladosporides, Fusarium oxysporum, F. solani, F.equisiti, F. semitectum, P. citrinum, Rhizopus nigricans, Trichoderma viride and T. harzianum.* The two yearly average percentage of aero aquatic fungi distribution can be depicted from Table 4.

Table 1. Sampling stations selected for the present study

Sl. No	Sampling Stations	Location
01	S_1	Thirthahalli, Near new Bridge (Shimoga District), South India.
02	S_2	Mandagadde, Near Bird wild life Sanctuary (Shimoga District), South India.
03	S_3	Sakarebile, (Shimoga District), South India.
04	S_4	Gajanur,Near dam site upstream stream (Shimoga District) , South India.
05	S_5	Shimoga,Near old Bridge (Shimoga city) , South India.
06	S_6	Koodli, Near Nandi temple(Shimoga District)), South India. (Before confluence point)

Table 2. Seasonal average values of occurrence of Aquatic fungi in different stations of Tunga River from Apr 2007 to March 2009.

Sl No	**Species of Fungi**	**Station-I**			**Station-II**			**Station-III**		
		PM	**M**	**PO-M**	**PM**	**M**	**PO-M**	**PM**	**M**	**PO-M**
1.	***Achlya debaryana***	31.5	43.0	30.4	30.2	28.5	20.6	29.5	29.2	26.2
2.	***Achlya orion***	27.3	31.6	19.8	13.4	19.0	11.2	16.5	16.9	15.0
3.	***Achlya prolifera***	7.9	11.5	8.9	6.0	8.9	3.5	6.2	7.3	4.5
4.	***Achlya recurva***	4.6	7.8	5.0	3.7	6.0	2.5	3.7	5.9	2.0
5.	***Allomyces arbuscula***	16.5	18.9	17.5	11.6	12.5	13.5	12.5	10.9	13.8
6.	***Allomyces anomalus***	13.7	19.3	12.0	8.5	11.5	14.5	9.2	10.0	9.5
7.	***Aphanomyces laevis***	13.2	20.5	12.5	11.5	13.5	11.0	12.3	14.0	10.5
8.	***Pythium elongatum***	27.6	30.0	23.2	24.2	26.5	14.5	22.6	25.3	13.5
9.	***Pythium debarianum***	32.0	40.0	31.5	19.4	20.5	19.0	17.0	16.6	18.5
10	***Saprolegnia ferax***	24.0	28.3	22.5	15.5	19.0	13.4	13.0	16.2	11.6
11	***Saprolegnia parasitica***	16.2	20.5	18.6	11.5	12.8	10.0	11.5	14.6	8.9
12	***Saprolegnia terristries***	12.5	14.8	9.7	11.5	13.0	8.8	10.8	12.0	8.5
Sl. No	**Species of Fungi**	**Station-IV**			**Station-V**			**Station-VI**		
		PM	**M**	**PO-M**	**PM**	**M**	**PO-M**	**PM**	**M**	**PO-M**
1.	***Achlya debaryana***	19.5	24.0	19.5	18.2	23	17.5	24.5	28.0	19.5
2.	***Achlya orion***	14.0	16.5	12.3	13.5	15.0	12.3	16.3	19.2	16.3
3.	***Achlya prolifera***	5.0	6.0	3.5	4.9	4.5	3.0	4.0	4.9	3.2
4.	***Achlya recurva***	3.0	4.5	1.5	2.5	3.5	2.0	3.0	3.5	2.9
5.	***Allomyces arbuscula***	10.5	10.7	11.2	12.0	10.0	11.1	13.0	16.8	12.0
6.	***Allomyces anomalus***	14.3	14.5	11.5	13.8	14.0	12.2	13.5	13.8	12.0

7.	***Aphanomyces laevis***	13.3	13.8	10.0	12.2	12.6	9.3	11.0	12.0	9.0
8.	***Pythium elongatum***	21.0	24.3	12.0	20.0	21.0	11.0	23.5	25.6	14.5
9.	***Pythium debarianum***	15.5	16.0	17.5	14.8	15.7	15.0	14.0	15.2	14.6
10	***Saprolegnia ferax***	12.5	14.5	10.6	11.5	13.5	9.8	11.0	12.5	8.0
11	***Saprolegnia parasitica***	10.5	13.6	7.0	9.2	12.0	7.3	11.5	11.0	9.5
12	***Saprolegnia terristries***	8.0	8.5	7.0	7.0	7.5	6.0	8.6	9.1	6.5

PM-Pre Monsoon; M- Monsoon; PO-M-Post Monsoon.

Table 3. Percent occurrence of different of Aquatic fungi in different stations of Tunga river from Apr 2007 to March 2009.

Sl. No	**Species of Fungi**	**Station-I (%)**			**Station-II (%)**			**Station-III (%)**		
Study period		**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**
1.	***Achlya debaryana***	35.0	45.0	40	20.0	27.2	23.6	20.2	24.0	22.1
2.	***Achlya orion***	29.3	30.6	29.9	20.9	29.2	25.0	16.5	20.2	18.35
3.	***Achlya prolifera***	7.9	11.5	9.7	14.0	22.0	18	7.2	8.3	7.75
4.	***Achlya recurva***	6.5	8.6	7.55	5.8	10.2	8.0	3.0	6.9	4.95
5.	***Allomyces arbuscula***	18.5	20.4	19.4	3.5	6.8	5.15	12.5	14.8	13.65
6.	***Allomyces anomalus***	14.7	20.4	17.5	10.9	12.5	11.7	10.2	13.5	11.8
7.	***Aphanomyces laevis***	14.4	21.5	17.9	7.4	11.5	9.4	13.3	17.0	15.15
8.	***Pythium elongatum***	27.5	31.5	22.5	12.2	14.4	13.3	22.6	19.3	20.9
9.	***Pythium debarianum***	32.0	40.0	36.0	23.0	24.5	23.75	20.6	21.05	18.0
10	***Saprolegnia ferax***	24.0	28.3	26.15	14.9	20.2	17.5	12.0	15.2	13.6
11	***Saprolegnia parasitica***	17.2	20.5	18.85	12.4	16.4	14.4	93.8	12.6	11.2
12	***Saprolegnia terristries***	11.5	14.3	12.9	17.4	20.2	18.8	8.0	10.5	10.25
Sl. No	**Species of Fungi**	**Station-IV(%)**			**Station-V (%)**			**Station-VI (%)**		
Study period		**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**
1.	***Achlya debaryana***	22.2	25.0	23.6	21.1	24.0	22.5	26.3	27.6	26.9
2.	***Achlya orion***	14.5	18.2	16.3	12.1	16.1	14.1	18.3	20.0	19.1
3.	***Achlya prolifera***	7.0	7.5	7.2	7.2	6.3	6.75	7.25	9.1	8.15
4.	***Achlya recurva***	5.0	3.8	4.4	4.5	3.2	3.8	8.0	8.5	8.25
5.	***Allomyces arbuscula***	11.5	12.8	12.1	10.5	11.5	11.0	13.0	16.0	14.5
6.	***Allomyces anomalus***	9.2	12.1	10.6	7.2	11.1	9.16	14.3	14.7	14.5
7.	***Aphanomyces laevis***	12.9	16.0	14.4	9.7	15.0	12.3	10.8	12.5	11.6
8.	***Pythium elongatum***	21.6	20.0	20.8	18.3	19.0	18.65	25.8	27.2	26.5
9.	***Pythium debarianum***	21.0	19.5	17.3	20.0	18.65	22.0	26.8	26.8	24.4
10	***Saprolegnia ferax***	11.0	14.2	12.6	9.1	13.2	11.15	13.6	16.8	15.2
11	***Saprolegnia parasitica***	8.5	11.5	10.0	6.5	9.0	7.75	13.5	14.5	14.0
12	***Saprolegnia terristries***	8.0	9.5	8.5	6.0	5.5	5.7	10.6	11.2	10.9

Table 4. Percent occurrence of different of Aero- Aquatic fungi in different stations of Tunga river from Apr 2007 to March 2009.

Sl. No	**Species of Fungi**	**Station-I (%)**			**Station-II (%)**			**Station-III (%)**		
Study period		**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**
1.	***Alternaria alternata***	18.0	16.5	17.2	10.0	9.2	9.6	10.0	8.6	9.3
2.	***Aspergillus flavus***	39.5	36.	37.9	19.6	2.6	21.1	20.5	23.3	21.9
3.	***Aspergillus fumigatus***	34.0	32.5	33.2	20.3	21.4	20.8	17.0	16.7	16.7
4.	***Aspergillus niger***	38.6	39.5	39.0	25.0	22.5	23.5	21.5	22.4	21.9
5.	***Chaetomium globosum***	13.0	12.6	11.8	8.5	5.7	7.1	7.6	7.0	7.3
6.	***Cladosporium cladosporides***	17.8	13.5	15.6	5.7	5.0	5.3	4.5	4.9	4.7
7.	***Fusarium eqiusiti***	26.6	23.7	21.1	20.3	18.4	19.3	18.6	16.5	17.5
8.	***Fusarium oxysporum***	30.6	31.4	31.0	22.3	21.5	21.9	19.3	18.8	19.5
9.	***Fusarium semitctum***	32.3	30.5	31.4	27.3	22.6	24.9	19.0	20.3	19.6
10	***Fusarium solani***	28.6	26.5	27.5	19.0	16.2	17.6	18.0	15.4	16.7
11	***Penicillium citrinum***	16.8	15.0	15.9	10.6	12.0	11.0	10.0	11.5	10.7
12	***Rhizopus nigricans***	17.5	14.6	16.5	10.8	7.5	9.5	11.0	9.5	8.0
13	***Trichoderma viride***	15.5	14.0	14.7	8.16	8.5	8.3	7.3	6.5	6.9
14	***Trichoderma harzianum***	15.5	18.6	17.0	8.5	6.8	7.6	8.5	6.2	7.3

Sl. No	Species of Fungi	Station-IV(%)			Station-V (%)			Station-VI (%)		
Study period		07-08	08-09	Avg	07-08	08-09	Avg	07-08	08-09	Avg
1.	*Alternaria alternata*	9.6	8.2	8.9	7.3	8.5	7.7	13.0	14.7	13.8
2.	*Aspergillus flavus*	19.3	22.0	20.6	18.9	21.0	19.9	23.5	22.7	23.1
3.	*Aspergillus fumigatus*	16.2	17.3	16.7	15.2	17.0	16.1	18.3	20.8	19.5
4.	*Aspergillus niger*	20.5	21.3	20.9	19.2	20.3	19.8	19.4	26.0	22.7
5.	*Chaetomium globosum*	6.2	7.1	6.6	5.2	7.3	6.2	10.1	9.8	9.9
6.	*Cladosporium cladosporides*	4.3	5.0	4.6	4.1	4.5	4.3	6.8	7.1	6.9
7.	*Fusarium eqiusiti*	16.6	17.0	16.8	15.0	14.5	14.5	19.1	16.5	17.8
8.	*Fusarium oxysporum*	18.2	18.5	18.3	17.2	19.3	18.2	24.0	22.6	23.3
9.	*Fusarium semitctum*	17.0	19.5	18.2	16.0	20.5	18.2	22.3	18.0	20.1
10	*Fusarium solani*	17.0	14.4	15.7	16.0	19.0	17.5	19.5	17.5	18.5
11	*Penicillium citrinum*	9.8	10	9.9	8.9	10.1	8.5	13.8	14.5	14.1
12	*Rhizopus nigricans*	10.1	11.2	10.6	9.4	10.3	9.8	13.5	11.6	12.5
13	*Trichoderma viride*	6.2	8.5	7.3	6.0	7.1	6.5	9.3	10.5	9.7
14	*Trichoderma harzianum*	7.3	5.2	6.3	6.8	8.1	7.4	11.0	8.5	9.7

Table 5. Seasonal average values of occurrence of Aero-Aquatic fungi in different stations of Tunga River from Apr 2007 to March 2009.

Sl. No	Species of Fungi	Station-I			Station-II			Station-III		
		PM	M	PO-M	PM	M	PO-M	PM	M	PO-M
1.	*Alternaria alternata*	35.4	39.2	18.6	26.3	29.2	12.6	21.4	23.5	14.6
2.	*Aspergillus flavus*	36.2	38.3	21.0	20.5	21.2	15.4	19.6	20.3	13.3
3.	*Aspergillus fumigatus*	37.8	39.3	28.2	24.4	26.5	14.3	20.9	22.3	13.2
4.	*Aspergillus niger*	39.9	43.2	30.0	21.2	27.6	18.0	19.2	22.3	15.0
5.	*Chaetomium globosum*	14.5	18.0	11.5	9.5	14.0	8.0	8.5	13.0	7.3
6.	*Cladosporium cladosporides*	20.1	22.4	14.0	12.5	14.5	9.0	11.4	15.3	6.5
7.	*Fusarium eqiusiti*	27.6	33.8	22.5	23.5	25.6	18.6	21.6	22.5	16.8
8.	*Fusarium oxysporum*	38.0	40.0	22.7	22.6	28.4	20.2	23.8	25.6	18.0
9.	*Fusarium semitctum*	31.6	37.4	22.5	20.6	23.1	18.9	21.5	23.8	10.7
10	*Fusarium solani*	29.8	33.5	18.6	10.5	14.6	10.5	12.5	13.0	7.5
11	*Penicillium citrinum*	20.0	23.0	15.5	13.4	15.5	6.8	11.8	13.4	12.0
12	*Rhizopus nigricans*	19.5	23.0	16.2	12.6	15.5	9.5	11.6	14.7	8.8
13	*Trichoderma viride*	14.5	18.5	13.5	7.5	10.0	6.5	6.0	12.5	4.6
14	*Trichoderma harzianum*	18.6	20.2	14.5	11.0	13.5	7.5	8.5	12.0	9.13
Sl. No	Species of Fungi	Station-IV			Station-V			Station-VI		
		PM	M	PO-M	PM	M	PO-M	PM	M	PO-M
1.	*Alternaria alternata*	20.4	22.0	13.0	19.0	21.0	12.0	26.3	27.4	19.6
2.	*Aspergillus flavus*	18.0	19.5	12.0	17.2	18.0	11.0	22.5	31.4	19.5
3.	*Aspergillus fumigatus*	19.0	21.8	12.5	18.3	22.0	11.3	20.7	22.0	13.6
4.	*Aspergillus niger*	18.5	21.4	13.2	16.5	20.0	10.2	23.2	26.4	20.5
5.	*Chaetomium globosum*	7.2	9.3	6.0	6.5	8.5	5.0	9.5	14.5	6.5
6.	*Cladosporium cladosporides*	10.5	14.0	5.8	9.3	12.0	4.0	12.0	15.5	8.0
7.	*Fusarium eqiusiti*	20.8	19.0	15.8	19.5	18.0	16.0	18.4	23.5	117
8.	*Fusarium oxysporum*	22.5	24.3	17.0	20.5	22.0	16.9	20.5	25.5	18.4
9.	*Fusarium semitctum*	19.2	19.8	8.2	17.0	18.5	6.7	20.2	23.0	15.8
10	*Fusarium solani*	9.8	11.6	10.0	7.0	10.0	6.8	13.4	18.6	10.6
11	*Penicillium citrinum*	10.5	12.2	11.1	9.8	10.7	7.9	14.5	15.0	12.7
12	*Rhizopus nigricans*	10.3	13.0	7.0	9.1	12.3	6.8	13.4	14.5	13.2
13	*Trichoderma viride*	5.3	9.8	3.0	4.7	6.8	3.4	6.2	5.8	4.0
14	*Trichoderma harzianum*	12.2	12.6	9.9	10.1	11.3	7.2	9.8	10.3	8.9

PM-Pre Monsoon; M- Monsoon; PO-M-Post Monsoon.

Table 6. Average values physico-chemical parameters of Tunga river for the year Apr 2007 to March 2009.

Sl. No	Physico-Chemical Parameters	Station-I			Station-II			Station-III		
Study period		**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**
1.	Air Temp. (^{0}C)	30.5	29.8	30.15	32.3	31.2	31.7	31.5	30.5	31
2.	Water Temp. (^{0}C)	25.0	23.0	24.0	24.6	24.8	24.7	25.0	26.0	25.5
3.	pH	7.6	7.1	703	7.59	7.7	7.6	7.6	7.8	7.7
4.	Electrical Conductivity	123	121	122.0	122.7	124.0	123.3	123.0	122.3	122.6
5.	Total Hardness (mg/l)	35.6	32.3	33.95	30.0	31.5	30.75	39.6	37.2	38.4
6.	Carbonates (mg/l)	0.10	0.12	0.11	0.12	0.11	0.11	0..16	0.15	0.155
7.	Bio-carbonates (mg/l)	1.8	1.6	1.7	2.0	1.5	1.7	1.8	1.6	1.7
8.	B.O.D (mg/l)	2.90	2.50	2.7	2.69	2.74	2.7	2.79	2.63	2.7
9.	D.O. (mg/l)	7.81	8.01	7.9	7.74	8.0	7.8	7.72	7.68	7.7
10	C.O.D (mg/l)	9.3	9.4	9.3	9.48	10.1	9.79	10.02	9.59	9.7
11	Sulphate (mg/l)	19.2	17.2	18.2	16.3	15.2	15.75	21.3	18.2	19.7
12	Chloride (mg/l)	18.7	17.5	18.1	18.0	18.3	18.1	24.2	22.8	23.5
13	Phosphate (mg/l)	0.13	0.11	0.12	0.08	0.10	0.09	0.16	0.14	0.15
14	Sodium (mg/l)	2.65	2.33	2.49	2.08	2.05	2.06	2.58	2.56	2.5
15	Potassium (mg/l)	1.13	1.10	1.1	0.8	1.10	0.95	1.35	1.33	1.34
16	Calcium (mg/l)	16.5	15.8	16.15	13.7	14.3	14	18.32	18.6	18.46
17	Magnesium (mg/l)	3.8	2.7	3.25	3.9	3.5	3.7	4.52	4.59	4.55
18	Total Dissolved solids	113.7	110.2	111.9	112.0	111.0	111.5	118.23	120.20	119.2
Sl. No	**Physico-Chemical Parameters**	**Station-IV**			**Station-V**			**Station-VI**		
Study period		**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**	**07-08**	**08-09**	**Avg**
1.	Air Temp. (^{0}C)	32.0	32.5	32.3	34.0	34.2	34.1	34.5	33.2	33.8
2.	Water Temp. (^{0}C)	26.12	26.7	26.4	26.61	26.8	26.7	26.4	26.5	26.45
3.	pH	7.98	7.8	7.8	8.0	8.2	8.1	7.9	7.8	7.85
4.	Electrical Conductivity	124.12	125.0	124.5	127.0	128.0	127.5	126.89	127.0	126.94
5.	Total Hardness (mg/l)	36.8	37.0	36.9	41.2	42.0	41.6	39.45	40.0	39.72
6.	Carbonates (mg/l)	0.17	0.18	0.17	0.19	0.20	0.195	0.18	0.17	0.175
7.	Bio-carbonates (mg/l)	1.9	2.0	1.9	2.4	2.3	2.35	2.39	2.35	2.37
8.	B.O.D (mg/l)	3.19	3.3	3.2	4.64	4.7	4.67	3.80	3.83	3.81
9.	D.O. (mg/l)	7.74	7.62	7.6	5.25	5.5	5.35	7.5	7.7	7.6
10	C.O.D (mg/l)	10.60	9.2	9.9	13.45	13.62	13.53	13.26	13.30	13.28
11	Sulphate (mg/l)	22.0	22.8	22.4	24.85	23.89	24.3	23.75	24.0	23.87
12	Chloride (mg/l)	24.31	24.8	24.5	26.91	26.70	26.8	24.0	24.5	24.3
13	Phosphate (mg/l)	0.17	0.18	0.17	0.21	0.22	0.215	0.14	0.15	0.145
14	Sodium (mg/l)	2.89	2.96	2.92	3.0	3.15	3.7	2.30	2.32	2.31
15	Potassium (mg/l)	0.9	0.11	0.10	1.42	1.47	1.44	1.80	1.82	1.81
16	Calcium (mg/l)	19.7	21.3	20.5	23.0	23.6	23.3	21.0	22.14	21.5
17	Magnesium (mg/l)	5.0	5.2	5.1	5.46	5.47	5.465	4.62	4.7	4.66
18	Total Dissolved solids	122.5	123.0	122.7	125.47	126.0	125.8	123.4	124..0	123.7

Table 7. Seasonal average values physico-chemical parameters of Tunga river for the year Apr 2007 to March 2009.

Sl. No	Physico-Chemical Parameters	Station-I			Station-II			Station-III		
		PM	M	PO-M	PM	M	PO-M	PM	M	PO-M
1.	Air Temp. (^{0}C)	34.02	27.69	29.22	35.0	26.50	29.0	34.72	27.53	30.0
2.	Water Temp. (^{0}C)	26.22	22.92	25.12	26.12	24.62	25.0	26.39	23.13	25.08
3.	pH	7.89	7.42	7.81	7.94	7.35	7.81	8.1	7.56	7.82
4.	Electrical Conductivity	124.57	118.0	119.18	126.12	118.8	122.6	127.7	130.59	124.5
5.	Total Hardness (mg/l)	44.12	22.23	28.0	46.12	22.1	23.5	45.18	24.59	33.5
6.	Carbonates (mg/l)	0.11	0.06	0.009	0.18	0.08	0.12	0.195	0.008	0.15
7.	Bio-carbonates (mg/l)	1.9	1.3	1.7	2.45	1.4	1.7	2.65	1.6	1.92
8.	B.O.D (mg/l)	2.88	2.37	2.6	3.58	2.39	2.84	3.68	2.59	3.15
9.	D.O. (mg/l)	7.18	8.82	7.8	7.09	870	7.79	7.19	10.0	7.80
10	C.O.D (mg/l)	9.71	8.65	9.1	11.48	9.52	9.82	12.84	10.12	10.1
11	Sulphate (mg/l)	20.22	13.32	17.3	24.09	14.54	18.0	24.9	18.26	21.6
12	Chloride (mg/l)	23.78	17.47	18.4	23.05	19.60	18.75	25.12	18.59	22.68
13	Phosphate (mg/l)	0.15	0.09	0.07	0.17	0.15	0.13	0.23	0.10	0.16
14	Sodium (mg/l)	2.69	1.56	1.9	2.95	1.86	2.52	3.47	2.12	2.71
15	Potassium (mg/l)	1.14	0.6	0.8	1.35	0.8	1.01	1.49	0.9	1.35
16	Calcium (mg/l)	15.41	10.25	13.2	15.5	12.85	15.4	19.41	17.85	18.74
17	Magnesium (mg/l)	3.57	2.50	2.7	4.14	3.58	3.82	5.11	4.0	4.71
18	Total Dissolved solids	117.3	109.3	113.0	118.12	112.1	114.5	120.8	113.56	120.50
Sl. No	**Physico-Chemical Parameters**	**Station-IV**			**Station-V**			**Station-VI**		
		PM	M	PO-M	PM	M	PO-M	PM	M	PO-M
1.	Air Temp. (^{0}C)	35.17	26.50	30.50	36.42	26.95	31.33	36.4	24.6	31.23
2.	Water Temp. (^{0}C)	25.45	24.0	25.2	26.8	23.56	26.34	26.90	23.0	26.0
3.	pH	8.35	7.6	7.96	8.3	7.7	7.90	8.7	7.2	8.0
4.	Electrical Conductivity	127.8	121.6	125.6	128.8	122	126.71	130.0	123.56	125.63
5.	Total Hardness (mg/l)	45.8	28.0	37.85	46.0	27.0	35.42	48.0	29.8	36.0
6.	Carbonates (mg/l)	0.19	0.007	0.18	0.23	0.009	0.16	0.25	0.1	0.16
7.	Bio-carbonates (mg/l)	2.73	1.7	2.0	2.8	1.8	2.3	3.0	1.9	2.39
8.	B.O.D (mg/l)	3.8	2.64	2.85	5.1	3.52	4.12	5.18	3.0	3.85
9.	D.O. (mg/l)	6.03	9.8	7.89	4.23	8.04	6.0	4.0	8.56	7.8
10	C.O.D (mg/l)	14.0	10.2	9.94	14.38	11.8	13.0	15.7	11.22	13.67
11	Sulphate (mg/l)	26.5	18.33	22.32	27.0	22.3	25.0	29.9	21.34	24.0
12	Chloride (mg/l)	27.3	20.18	24.38	28.7	24.5	26.4	29.6	22.22	26.0
13	Phosphate (mg/l)	0.23	0.11	0.14	0.24	0.14	0.2	0.28	0.13	0.2
14	Sodium (mg/l)	3.58	2.0	2.81	4.0	2.63	2.89	4.12	2.20	2.3
15	Potassium (mg/l)	0.26	0.11	0.16	1.8	1.45	1.64	2.8	1.0	2.1
16	Calcium (mg/l)	22.0	17.9	19.67	23.5	21.4	22.56	27.6	21.56	24.18
17	Magnesium (mg/l)	5.25	4.12	4.80	5.8	4.5	5.64	6.0	4.3	5.68
18	Total Dissolved solids	123.05	117.86	120.5	124.50	120.36	123.0	130.45	120.0	123.45

PM-Pre Monsoon; M- Monsoon; PO-M-Post Monsoon.

4. Discussion

The data obtained from the analysis regarding distribution of aquatic fungi and aero aquatic fungi of all the six stations reveals that, maximum percentage of fungal distribution was recorded in the station –I, when compared to other five stations (station-II, station III, station –IV, station V, station VI).

The higher fungal incidence that occurred in station-I was observed, may be due to unpolluted nature of water and less anthropogenic activities was encountered at this station. Whereas, the lowest percent distribution of aquatic and aero aquatic fungi was recorded in the station-V. This was may be due to the polluted nature of the water and increased anthropogenic activities at this station (Table 2 and 4). Seasonal variation in relation with aquatic and aero aquatic fungi distribution in all the six stations was studied and recorded in the Table 3 and 5. The data obtained during the present investigation reveals the maximum fungal distribution was recorded during the monsoon period followed by pre-monsoon periods in all the six stations. But, comparatively less

percentage of fungal incidences was recorded during post monsoon period (Table 3 and 5). The occurrence of maximum percentage of aquatic and extra aquatic fungi during monsoon period is probably due to low temperature, high organic load and low pH of the water (Table 6 and 7).

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