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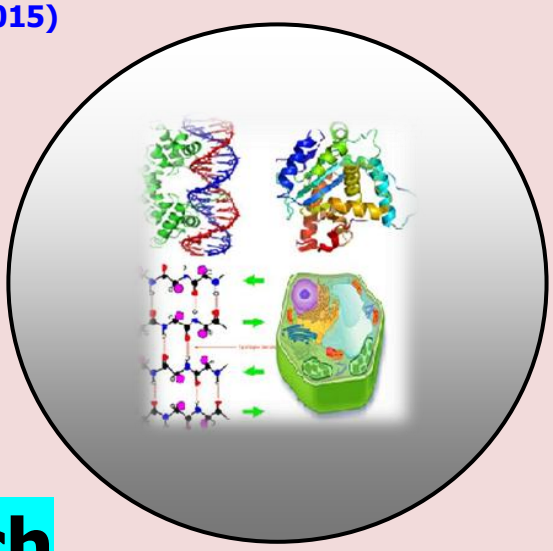

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Dr. Harshita Jaiswal
http:// www.sasjournals.com
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jbiolchemres@gmail.com

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Diversity of Aquatic Fungi from Ganga River at Kanpur

Harshita Jaiswal and Vijay Tewari*
Department of Botany, Shri Jai Narain Degree College (KKC), Lucknow, U.P., India
***Department of Botany, D.G.P.G. College, Kanpur, U.P., India**

ABSTRACT

Ganga river water was assessed at three sampling stations during study period from January 2009 to December 2009. The present investigation was carried out on diversity of aquatic fungi from Ganga river water at Kanpur. During the study, the fungal taxa belonging to class Hyphomycetes, Ascomycetes, Oomycetes and Zygomycetes were isolated and identified. From the station I (Bithoor ghat) and II (Ganga barrage ghat) which were less polluted, 31 and 32 fungi were recorded. However in highly polluted station III (Jajmau), 33 fungi were recorded. The more no. of fungal flora were occurred in station-III, may be due to the polluted nature of water and sewage, human/animal excreta bathing cremation of human body and industrial discharge. Comparatively less fungal flora in station no I and II may be due to the less polluted nature of the water.
Key words: Aquatic Fungi, River Ganga Water and Polluted Nature.

INTRODUCTION

Ganga is known for its variance in biological fabric within short distances and totality of fungal infestation. Results of investigations emphasize importance of fungi of Ganga waters in self-purification and public health hazards. The occurrence of fungal spores and hyphae in Ganga waters indicates that they are capable of utilizing the nutrients from the polluted waters. Fungi the decomposers of any ecosystem have been reported to degrade various compounds present in waste, polluted waters and sediments for their food requirements. It was as scavenger organisms which appear to be aiding in stream purification (Harshita Jaiswal, 2013).

Fungi are ubiquitous, achlorophyllous and heterotrophic organisms, which are directly influenced by environmental factors. They cosmopolitan in occurrence and are found in rivers, oceans and occur commonly on decomposing organic matter. Excessive levels of nutrients and other chemicals lead to irreversible changes in aquatic life (Dudgeon *et al*., 2006). Heterotrophic organisms are usually present in natural water in direct proportion to the physico-chemical nature of the aquatic environment (Prasad *et al*., 2009). Fungi play an important biological process in an aquatic ecosystem. Aquatic fungi contribute significantly in aquatic ecosystem as decomposers of animal and

plant remains (Johnson, 1956 and Sparrow, 1968). Aquatic fungi contribute to the energy flow and productivity of ecosystems by their active role in the utilization and bio deterioration of organic materials (Hunter, 1975 and Khulbe, 2001). These fungi also possess the ability to parasitize aquatic plants and animals including fishes under certain conditions (Khulbe, 2001). Aquatic fungal diversity has been carried out in all over the world by (Robertson, 1980; Dick, 1990 and Loniewska *et al*., 2007). In the Indian context, aquatic fungi from various water habitats were studied by different investigators including (Manoharachary 1991); (Sridhar *et al*.,1992); (Kumar and Saha, 1992); (Sati, 1997); (Sati *et al.,* 2002); (Prasad *et al*., 2009); (Paliwal and Sati, 2009). In Maharashtra, these fungi were studied by (Borse and Patil 2006); (Borse and Patil, 2007); (Patil, 2009); (Pawara, 2009); (Wagh *et al.*, 2009); (Nemade *et al.,* 2009); (Patil *et al.,* 2010) and (Patil *et al.,* 2011). In which some investigations have been conducted on the occurrence of aquatic fungi with special reference to polluted streams by Khalil (1985) and Ezzat (1989). Cooke and Bartsch (1960) studied on streams in Ohio, indicated a correlation between the degree of pollution and occurrence of the fungi. The occurrence of several aquatic hyphomycete species in heavily polluted streams has been reported (Sridhar *et al.,* 2000); (Krauss *et al.,* 2001 and Pascoal *et al.,* 2003, 2005). El-Hissy *et al.* (2001) has been given for studying the biodiversity and the occurrence of zoosporic fungi in polluted water especially at sites polluted by heavy metals (Kshirsagar and Gunale, 2011). 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).

In Kanpur river Ganga takes entry at Bithoor and passing along several ghats, it exist at Jajmau covering a distance about 22 km., the flora and fauna of different region of river Ganga at Kanpur is of different categories according to a degree of pollution at various ghats therefore, for a study purpose a stretch of about 24 km. of river Ganga is selected for the upper stream near Bithoor middle stream to Ganga barrage and to the downstream at Jajmau. Analysis of the water samples collected from upper, middle and down streams of river Ganga from tannery area to Jajmau automobile, Transport Bridge revealed that almost all the major characteristics were little beyond permissible limit. The water as such could not be used both drinking and bathing purpose. It could only be used for irrigation of fields but after treatment.

MATERIAL AND METHODS

Water samples were collected monthly intervals from selected stations Bithoor, Ganga barrage and Jajmau during January 2009- December 2009 in sterilized glass bottles from different station situated in and around Kanpur.

The water samples for fungal diversity analysis were collected in the morning hours from composted leaves and other plant debris which were in river water. The samples so collected were brought back to the laboratory within a few hours after collection and each was baited separately.

To study the distribution and occurrence of aquatic fungi of Ganga river water and organic waste material's like twigs, decaying aquatic plant parts were collected from sampling site. 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, and woody materials were collected from the river. The materials were broken into small pieces and incubated on wet blotters in petri-plates. The materials along with petri-plates were kept in the incubator under laboratory condition (22+ 2ºC temperature) for about 8 days. In baiting method, sterilized hemp seed 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 hemp seed and paper pieces of blotter paper were added. The plated materials were kept for incubation under laboratory conditions (22+2ºC temperature) for about 7 to 8 days, at the end of the incubation period the colonized fungi were found on the incubated materials, (J.K. Mishra, 1986).

The forms were identified with the help of various standard references, monographs and keys provided, manual by Khulbe (2001), Coker, 1923; Mathews, 1931; Karling, 1942; Johnson, 1956; Sparrow, 1960; Seymour, 1970; and Dick, 1973.

RESULTS AND DISCUSSION

The three different sampling collection stations (Bithoor, Ganga barrage and Jajmau) were selected in the river based on the extent of pollution and anthropogenic activities. From all the three sampling station a total no. of 33 fungal species from 19 genera belonging class Hyphomycetes-8, Zygomycetes-1, Oomycetes-8, Ascomycetes-2 were isolated and identified from the Ganga river at Kanpur where as present study revealed that difference in the occurrence and distribution of aquatic fungi in periodically proved to depend on physico-chemical parameters of the water and also on seasonal variations from river ganga in Kanpur. Sampling station I, II and III differ in physico-chemical characteristics, station I and II (Bithoor and Ganga barrage) were less polluted than station III (Jajmau ghat, 2009). At the station I- 31 and station II-32 fungal species were recorded which were less polluted station. Whereas at and at station III-33 fungi were recorded this is highly polluted station from the Ganga river of Kanpur (Table 1, 2 & 3). The data obtained during the present study reveals the maximum no. of fungal species were recorded in sampling station III while minimum no. in sampling station I. Physico-chemical characteristics greatly influence to the diversity of fungi.

The occurrence of fungal spores and hyphae in Ganga waters indicate that they are capable of utilizing the nutrients from the polluted waters. Cooke and Matsuura (1969) reported an increase of 5-200 folds in the fungal and yeast populations within a year of operation of the stabilization pond, speaking thereby of the milieu of pond as a favorable habitat. In water ecosystem fungi occupy the same functional status as bacteria, bringing about effective degradation of phosphate and ammonia through domestic water. Fungi posses twin capability to reduce BOD as well. Presence of fungi and yeasts in the water receiving organic enrichment is of pivotal importance in self-purification of water and cannot be simply ignored as casual contaminants (Cooke, 1963). Aquatic fungi were observed at sampling station I with 31 species in close approximation of 32 species at sampling station II and 33 species at sampling station III from the Year 2009. Exemplifying variance in fungi of Ganga river, Species of genera *Achlya, Aphanomyces, Dictyuchus, Leptomitus, Pythiopsis, Saprolegnia, Thraustotheca, Alternaria, Aspergillus, Penicillium, Cladosporium, Curvularia, Fusarium, Mucor, Chaetomium, Trichosphaeria, Trichoderma, Pythium* and *Memnoniella* (Table-1, 2 & 3)

Occurrence, distribution and seasonal fluctuation of aquatic fungi inhabiting 3 sampling station of water having temperature range of 13-32 ^{o} C in different months of a year have been studied, during course 33 species were collected.

Aquatic Mycoflora at different Sampling Stations (TABLE)

Table 1. Sampling Stations I.

No	Name of Mycoflora	Month											
		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1	*Achlya americana*	+	-	-	-	-	-	-	-	-	+	+	+
2	*A. dubia*	+	+	-	-	-	-	-	-	-	+	+	+
3	*Aphanomyces laevis*	-	+	+	-	-	-	-	-	-	-	-	+
4	*Dictyuchus monosporus*	+	+	+	-	-	-	-	-	-	+	+	+
5	*D. sterile*	+	+	-	-	-	-	-	-	-	-	+	+
6	*Leptomitus lacteus*	+	+	+	-	-	-	-	-	-	-	+	+
7	*Pythiopsis intermedia*	-	+	+	-	-	-	-	-	-	-	+	-
8	*Saprolegnia ecentrica*	+	+	-	-	-	-	-	-	+	+	+	+
9	*S. diclina*	-	-	+	-	-	-	-	-	-	-	+	+
10	*S. ferax*	+	+	+	-	-	-	-	-	+	-	+	+
11	*S. rhaetica*	-	+	-	-	-	-	-	-	-	-	-	+
12	*Thraustotheca clavata*	+	-	+	-	-	-	-	-	-	+	-	-
13	*Alternaria alternata*	-	+	-	-	-	+	-	+	+	+	-	-
14	*Aspergillus clavatus*	+	-	-	-	+	-	+	+	+	-	-	+
15	*A. nidulans*	+	+	-	-	-	-	-	-	-	+	+	+
16	*A. niger*	+	+	+	+	+	+	+	+	+	+	-	+
17	*A. flavus*	-	+	+	+	-	+	+	+	+	+	+	-
18	*A. fumigatus*	-	-	+	-	+	+	+	+	+	+	-	-
19	*Penicillium funiculosum*	+	-	-	-	+	+	-	+	+	-	-	-
20	*P. citrinum*	+	+	+	+	+	+	+	+	+	+	+	+
21	*Cladosporium herbarum*	+	+	+	+	+	-	-	-	-	-	-	+
22	*Curvularia lunata*	+	+	-	-	-	-	-	-	-	+	+	+
23	*Fusarium moniliforme*	+	-	+	-	-	-	-	-	+	+	+	+
24	*F. oxysporum*	+	+	+	-	-	-	-	-	+	+	+	+
25	*F. semitectum*	+	+	+	-	-	-	-	-	-	+	+	+
26	*Mucor hiemalis*	+	+	+	+	+	+	+	+	-	+	-	+
27	*Chaetomium globosum*	-	-	-	-	-	-	-	-	-	-	+	-
28	*Trichosphaeria pilosa*	-	+	-	-	-	-	-	-	-	-	-	-
29	*Trichoderma aueroviride*	-	-	+	+	-	-	-	-	-	-	-	-
30	*Pythium indigoferae*	+	+	-	-	-	-	-	-	-	-	-	+
31	*Memnoniella echineta*	-	+	+	-	-	-	+	+	-	-	-	-

Table 2. Sampling Stations II.

No	Name of Mycoflora	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*Achlya americana*	+	+	-	-	-	-	-	-	-	+	+	+
2	*A. dubia*	+	+	+	-	-	-	-	-	-	+	+	+
3	*Aphanomyces laevis*	+	-	-	-	-	-	-	-	-	-	+	+
4	*Dictyuchus monosporus*	+	+	+	-	-	-	-	-	-	+	+	+
5	*D. sterile*	+	-	-	-	-	-	-	-	-	+	+	+
6	*Leptomitus lacteus*	-	-	+	-	-	-	-	-	-	+	+	+
7	*Pythiopsis intermedia*	+	+	-	-	-	-	-	-	-	-	-	-
8	*Saprolegnia ecentrica*	+	+	+	-	-	-	-	-	+	+	+	+
9	*S. diclina*	+	-	+	-	-	-	-	-	-	+	+	+
10	*S. ferax*	+	+	+	-	-	-	-	-	+	+	+	+
11	*S. rhaetica*	-	-	+	-	-	-	-	-	-	+	+	+
12	*Thraustotheca clavata*	+	+	-	-	-	-	-	-	-	-	-	+
13	*Alternaria alternata*	-	+	+	-	-	+	+	+	-	+	-	-
14	*Aspergillus clavatus*	+	-	-	+	+	-	-	-	+	+	-	-
15	*A. nidulans*	-	+	-	-	+	-	-	-	-	+	+	+
16	*A. niger*	+	-	-	+	+	+	-	-	+	+	-	+
17	*A. flavus*	-	+	+	+	-	-	+	+	-	+	+	-
18	*A. fumigatus*	+	+	-	-	+	+	-	-	+	-	-	+
19	*A. terreus*	+	-	-	-	-	+	-	-	-	+	-	-
20	*Penicillium funiculosum*	+	+	+	-	+	+	-	+	+	-	-	-
21	*P. pinophilum*	-	+	-	-	-	-	+	-	-	-	-	-
22	*Cladosporium herbarum*	+	+	-	+	+	-	-	-	+	-	-	+
23	*Curvularia lunata*	+	+	-	-	+	-	-	-	-	+	+	+
24	*Fusarium moniliforme*	-	-	-	+	+	-	-	-	+	+	+	+
25	*F. oxysporum*	+	-	-	-	-	-	-	-	+	-	+	+
26	*F. semitectum*	-	+	+	-	-	-	-	-	-	-	+	+
27	*Mucor hiemalis*	+	+	+	+	+	+	+	+	-	+	-	+
28	*Chaetomium globosum*	-	+	-	-	-	-	-	-	-	-	+	-
29	*Trichosphaeria pilosa*	-	+	-	+	-	-	-	-	-	-	-	-
30	*Trichoderma aueroviride*	-	-	+	-	-	-	-	-	+	-	-	-
31	*Pythium indigoferae*	-	+	-	-	-	-	+	-	-	-	-	-
32	*Memnoniella echineta*	-	-	+	-	-	+	+	+	-	-	-	+

Table 3. Sampling Stations III.

No	Name of Mycoflora	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*Achlya americana*	+	+	-	-	-	-	-	-	-	+	+	-
2	*A. dubia*	+	+	-	-	-	-	-	-	-	+	-	+
3	*Aphanomyces laevis*	-	+	+	-	-	-	-	-	-	-	-	-
4	*Dictyuchus monosporus*	-	+	+	-	-	-	-	-	-	+	+	+
5	*D. sterile*	+	+	+	-	-	-	-	-	-	+	+	+
6	*Leptomitus lacteus*	+	+	-	-	-	-	-	-	-	+	-	-
7	*Pythiopsis intermedia*	+	+	-	-	-	-	-	-	-	-	+	-
8	*Saprolegnia ecentrica*	+	+	-	-	-	-	-	-	+	+	+	+
9	*S. diclina*	+	-	+	-	-	-	-	-	-	+	-	+
10	*S. ferax*	+	+	+	-	-	-	-	-	-	-	+	+
11	*S. rhaetica*	-	+	-	-	-	-	-	-	-	+	+	+
12	*Thraustotheca clavata*	+	-	-	-	-	-	-	-	-	-	-	+
13	*Alternaria alternata*	-	+	+	-	-	+	-	-	+	+	-	-
14	*Aspergillus clavatus*	-	+	-	-	+	-	+	+	+	-	-	-
15	*A. nidulans*	+	+	-	-	-	+	-	-	-	+	+	+
16	*A. niger*	+	+	-	-	+	-	+	+	-	+	-	+
17	*A. flavus*	-	+	-	+	-	+	+	+	-	-	+	-
18	*A. fumigatus*	-	-	+	-	-	-	-	+	+	+	-	-
19	*A. terreus*	+	+	+	-	-	+	-	-	-	+	-	-
20	*Penicillium funiculosum*	+	-	-	-	+	+	-	+	+	-	-	-
21	*P. citrinum*	+	+	-	+	+	+	-	+	+	+	-	-
22	*P. pinophilum*	-	-	+	-	-	-	-	-	+	+	-	-
23	*Cladosporium herbarum*	+	+	-	+	+	-	-	+	-	-	-	+
24	*Curvularia lunata*	+	+	-	-	-	-	-	+	-	+	+	+
25	*Fusarium moniliforme*	+	-	-	-	-	+	-	-	+	+	+	+
26	*F. oxysporum*	+	-	-	+	+	-	-	-	+	+	+	+
27	*F. semitectum*	+	+	-	-	-	-	+	-	-	+	+	+
28	*Mucor hiemalis*	-	-	+	+	+	+	-	+	-	+	-	+
29	*Chaetomium globosum*	-	+	-	-	-	-	-	-	-	-	+	-
30	*Trichosphaeria pilosa*	+	-	-	-	-	+	-	-	-	-	-	-
31	*Trichoderma aueroviride*	-	-	+	-	+	-	-	-	-	+	-	-
32	*Pythium indigoferae*	+	+	-	-	-	-	-	-	-	-	+	-
33	*Memnoniella echineta*	-	+	+	-	-	-	+	+	-	-	-	+

Present: (+), Absent: (-)

Maximum occurrence was found in November to February whereas gradual decrease with the increase in water temperature was recorded minimum occurrence was found in April to July. Based on temperature range of different species obtained; they were grouped into low temperature and high temperature species. Water temperature is of outmost importance in assessment of lentic water quality. Temperature directly affects natural flora and fauna. Temperature increases in summer and gradually reduces in winter and rains. Sudden fluctuation of temperature reflects the whole ecosystem of river and sometimes causes death of organisms.

Low temperature species in water: in this group these species were isolated, when the temperature of the water ranged below 20 ^{o} C. such species are *Achlya americana, A. dubia, Aphanomyces laevis, Dictyuchus monosporus, D. sterile, Leptomitus lacteus, Saprolegnia ecentrica, S. ferax, S. diclina, S. rhaetica, Thraustotheca clavata, Aspergillus clavatus, A. nidulans, A. niger, Penicillium funiculosum, P. citrinum, Cladosporium herbarum, Curvularia lunata, Fusarium moniliforme, F. oxysporum, F. semitectum, Mucor hiemalis* and *Pythium indigoferae*.

Higher temperature species in water: most of the species isolated during the present course could be assigned to this group because of their occurrence at wide range of temperature i.e. above 30 ^{o} C. These are *Alternaria alternata, Aspergillus nidulans, A. niger, A. flavus, A. fumigatus, A. terreus, Penicillium funiculosum, P. citrinum, P. pinophilum, Chaetomium globosum, Fusarium moniliforme, Mucor hiemalis, Trichosphaeria pilosa* and *Pythium indigoferae*. During the present investigation occurrence of aquatic fungi was found to be highest in the month of October to February and gradual decrease was observed cooler to warmer months. This finding agrees with the observations of other Indian workers (Dayal & Tondon, 1962 and Srivastava, 1976 b).

During the study different species have been assigned to two groups on the basis of temperature range viz. low temperature and high temperature species. Low and high temperature species, group of the present study contains out of the total number of genera isolated the members of Oomycetes, Zygomycetes, Ascomycetes and rest of Deuteromycetes. Which were isolated at water temperature below 20^{o} C an above 30 ^{o} C. Srivastava (1967 b) and Khulbe & Bhargava (1977) have also isolated the species of the genus from Indian workers and have placed them under low temperature group. Other species recorded and assigned by them to low temperature group have either not been isolated from the present habitat or have been isolated even at higher temperature than what is considered for low temperature species in the present case.

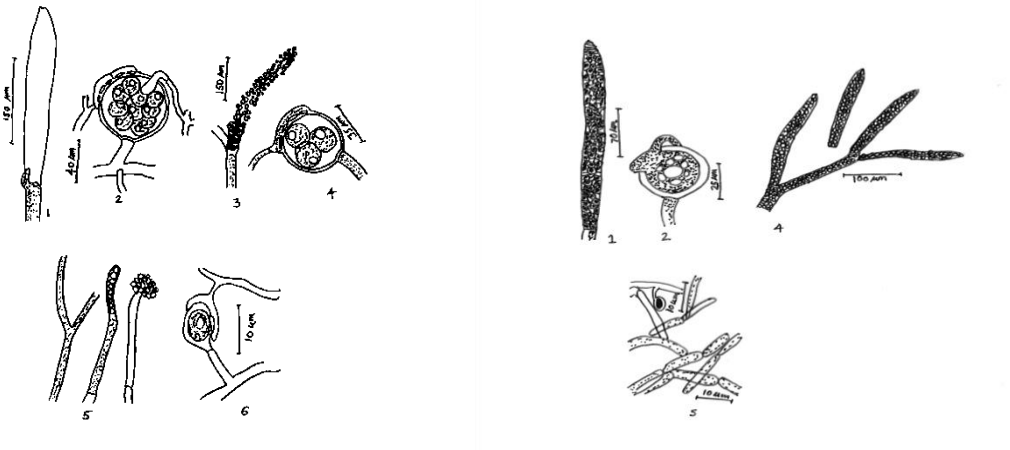
Achlya americana and *A. dubia* were isolated by Srivastava (1967 b) in October to May, October to April and October to December respectively and were placed with low temperature species, whereas Dayal and Tondon (1962) who have isolated *A. americana* from October to December did not classify it on temperature basis. In the present observations it was found that *A. americana* and *A. dubia* occur during October to March.

In present observation it was found that *Aphanomyces laevis* occur during October, November to February and March. *Leptomitus lacteus* occur during October to March. *Leptomitus lacteus* is found in wastewater such as sewage waste.

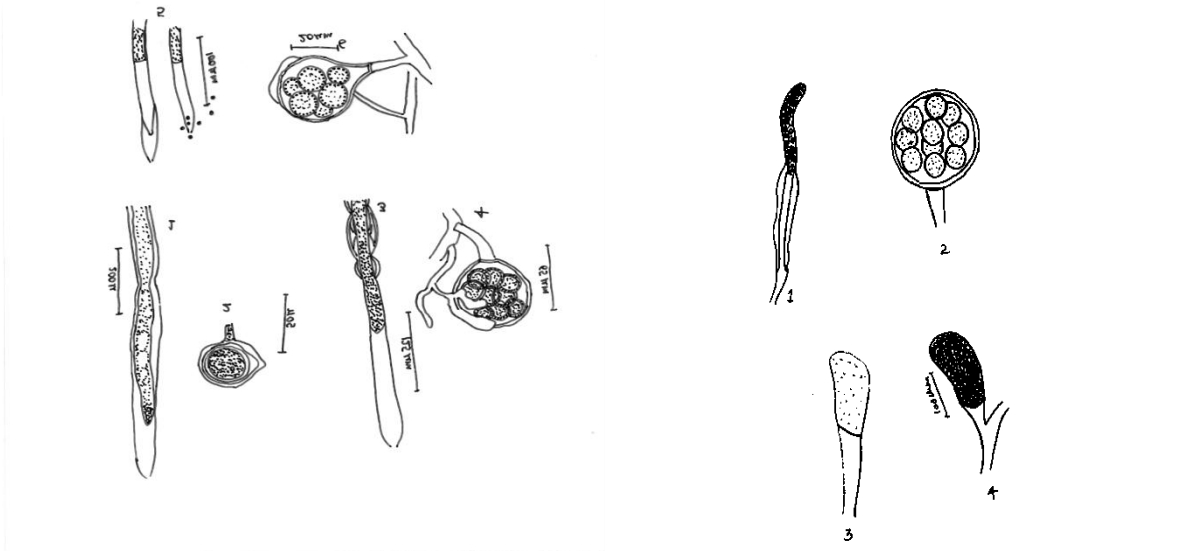
The magazine "Science" has reported research being conducted in the application of *Leptomitus lacteus* for wastewater treatment and sewage management. It is able to denitrify at a faster rate than bacteria and is resistant to inhibitory chemicals. The fungus is an environment friendly alternative to conventional bacterial based nitrogen removal system. *Leptomitus lacteus* has numerous distinct advantages over bacteria. It completes denitrification in a single step as opposed to bacteria, which goes through a two-step nitrification process. Fungi offer greater resistance to bacteria than chemical inhibitors and industrial effluents found in wastewater. It is also resistant to metal waste (Riethmuller *et al*., 2006). *Thraustotheca clavata* occur during October to December, January and February. *Alternaria*, *Aspergillus*, *Penicillium, Mucor* and *Fusarium* species occur throughout the year. During the observation *Trichosphaeria pilosa* occur during January to June.

Cladosporium species occur September, December to May. *Curvularia* species occur August, October to May. *Chaetomium* species occur during October, November to February and June. *Trichoderma* species occur during September, October and January to May. *Pythium* species occur during November to February, whereas Srivastava (1967 b) isolated it from September to March. *Memnoniella* species occur during December to August (Jaiswal, 2013).

Aquatic Mycoflora at different Sampling Stations (Figure)

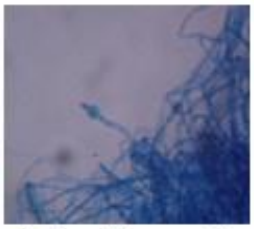


Figs. 1 and 2 *Achlya americana,* 3 and 4 *Achlya dubia,* 5 and 6 *Aphanomyces laevis*
Figs. 1 and 2 *Dictyuchus monosporus,* 4 *Dictyuchus sterile,* 5 *Leptomitus lecte*



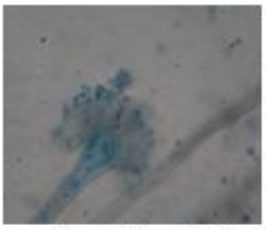
Figs. 1-2 *Saprolegnia ecentrica,* 3-4 *Saprolegnia ferax,* 5-6 *Saprolegnia diclina*
Figs. 1-2 *Saprolegnia rhaetica,* 3 *Thraustotheca clavata*

Alternaria alternata

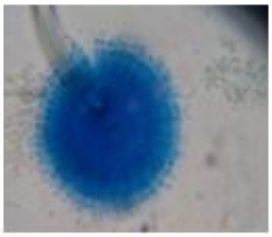


Pythiopsis intermedia

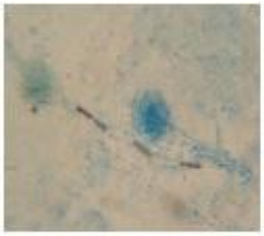
Aspergillus clavatus



Aspergillus nidulans

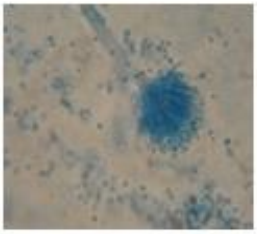


Aspergillus niger

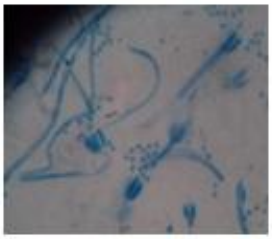


Aspergillus flavus

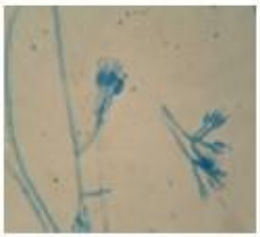
Aspergillus terreus



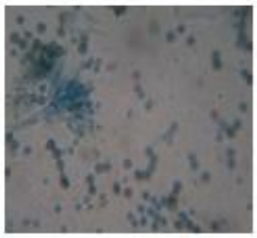
A. fumigates



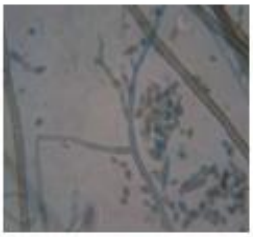
Penicillium funiculosum



Penicillium citrinum



Penicillium pinophilum



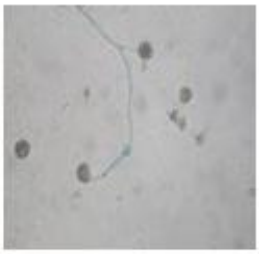
Cladosporium herbarum

Curvularia lunata

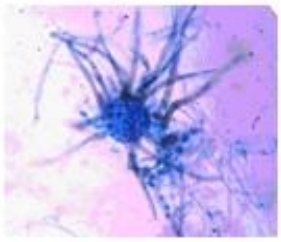
Fusarium moniliforme

Fusarium oxysporum

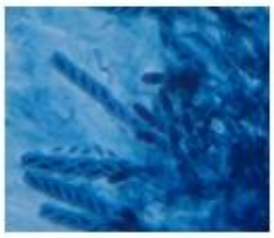
Fusarium semitectum



Mucor hiemalis



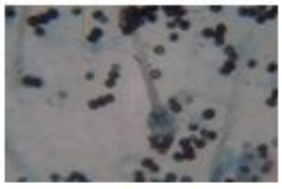
Chaetomium globosum



Trichosphaeria pilosa

Trichoderma aueroviride

Pythium indigoferae



Memnoniella echineta

CONCLUSION

A total of 33 fungal species belonging to class Hyphomycetes, Ascomycetes, Oomycetes and Zygomycetes were isolated and identified from Ganga river. From the station I (Bithoor ghat) and II (Ganga barrage ghat) less polluted, 31 and 32 fungi were recorded. Whereas highly polluted station III (Jajmau), 33 fungi were recorded respectively. The more no. of fungal flora were occurred in station-III, may be due to the polluted nature of water and sewage, human/animal excreta bathing cremation of human body and industrial discharge. In Jajmau there is a cluster of industrial units mainly tanneries, so discharge of industrial water. Station I and II less number of fungal taxa occurred. This was may be due to the less polluted nature of the water and bathing agricultural washouts, human body cremation, sewage and religious material discharge. Bathing is religious in the bank of Ganga River, because Bithoor has religious and historical importance. Water pollution due to industries is negligible in Bithoor ghat. Human body cremation is regular practice in Bithoor. Burn and unburnt body ashes etc. add pollution load to the water. Boat navigation and fishing also add pollution to the water. Bathing and fishing are regular practice at Ganga barrage station. With regard to fungi from river Ganga, it was found that some species were more sensitive to pollutants than the others. *Aspergillus niger*, *Aspergillus terreus and Thraustotheca* sp. were the most tolerant species and could be regarded as pollution tolerant fungus and may be used as a biological indicator for water pollution by pollutants.

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Corresponding author: Dr. Harshita Jaiswal Department of Botany, Shri Jai Narain Degree College (KKC), Lucknow, U.P., India
Email: hjaiswal12@gmail.com