Ecological Study of Khushalsar Lake, Kashmir: IV. Fungal Community

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ABSTRACT

The present investigation on Khushalsar Lake was taken up to find out different fungal species flourishing there vis-à-vis their relation to the pollution status of the lake. A total of seven fungal genera belonging to two different classes of division Mycotina were isolated. These include *Pencillium* spp., *Cladosporium* spp., *Fusarium* spp., *Botryotrichum* spp. , *Acremonium* spp., *Verticillium* spp., and *Thielaviopsis* spp., Among all the genera recorded *Pencillium* and *Fusarium* formed quantitatively the most dominant genera. However, none of the fungal species isolated belonged to pure aquatic group thus indicating the disturbed environment of the lake.

Keywords:- Khushalsar lake , aquatic fungi , pollution

INTRODUCTION

The records of fungi from Kashmir occur scattered in numerous publications (Berkeley, 1816; Cooke,1870; Murrill,1924; Mundkur, 1944; Wehmeyer,1963,1964; Pandotra,1966; Pandotra and Ganguly,1964,a, b, 1966; Pandrotra and Sastry, 1969 a, b; Pandotra *et al.*, 1968; Puttoo,1971,1972; Puttoo *et al.* 1974; Gupta and Lele,1976; and Qasba and Shah,1979).

The presence of large number of saprotrophs in water indicates the abundance of organic matter (Khulbe and Durgapal, 1994). Unpolluted water has relatively large number of species representing true aquatic fungi (species possessing the flagellated zoospores and gametes), aquatic hyphomycetes and soil fungi. Moderately polluted water may carry cells or spores of these types. However, it has fewer true aquatic fungi and aquatic hyphomycetes but soil fungi are numerous. Heavily polluted water bodies have large number of soil fungi (APHA, 1998). A reduction in number of fungi belonging to class chytridiomycetes and oomycetes tends to occur in polluted waters. It has been noticed that oomycetous forms are in more number to that of chytridiomycetous one, when occurring in polluted situations. The

association between fungal densities and organic loading suggests that fungi may be useful indicators of pollution (Khulbe and Durgapal, 1992, 1994).

Khushalsar Lake has been under strong biotic pressure due to rapid urbanization all along its periphery and has turned into hyper (eu) trophic stage (Pandit and Yousuf, 2003). In past there have been reports of some limnological investigations of the lake (Pandit, 1992, Ali & Pandit, 2005, Shahnaz & Yousuf, 2005 and Punjabi & Yousuf, 2005) but no attention has been paid to study the fungal flora of the lake. Therefore, to form a composite study of various aspects of pollution causing determinants, the present study on presence of fungal community in the lake is an extension of the proposed study.

STUDY AREA

The aim of study was to know the Fungal community of Khushalsar lake which is lying to the North-west of Srinagar between latitudes 34°06 - 34°08N and longitudes 74°47 - 74°49 E at an altitude of 1583.3m a.s.l. The lake receives the water from Dal Lake through Nalla Amair Khan and the water passes to the Anchar. The lake covers an area 68.42 hc. with mean depth 3m and Shoreline 5.32 Km. Four sites were selected in the lake covering the area from Nowshera (inlet) to Saidpora outlet (Fig. 1).

MATERIAL AND METHODS

Samples of water at the depth of 1-10 cms from the water surface were collected in suitable previously cleaned plastic bottles. The inoculation of each collected sample onto the medium was undertaken within hours of collection or at times in some cases the samples were stored in refrigerator at 4°C (for not more than 24 hours) followed by inoculations. Pre-sterilization of glassware was undertaken by soaking for 16-24 hours in soap/ detergent solution and then washed vigorously under a jet of tap water and finally rinsed in distilled water. Subsequently it was dried in an oven at high temperature and sterilized by exposing to the hot dry air (160° - 180° C) for 2-4 hours in a hot air oven. Rose-Bengal agar containing streptomycin was used as the medium. Different organic and inorganic constituents of medium were dissolved in distilled water separately and then finally mixed and the final volume was made with the help of distilled water and solution was heated and continuously stirred to dissolve the agar completely. The prepared medium was subjected for autoclaving at 121° C with 15 p.s.i. for 15-20 minutes (depending upon the volume of the medium). The most frequently used method for the measurement of microbial populations was the Waksman's dilution plate method as detailed by Jhonson and Case (1995). The entire

subsequent process of inoculation and dispensation of medium was done under pre-managed aseptic condition over air laminar flow chamber.

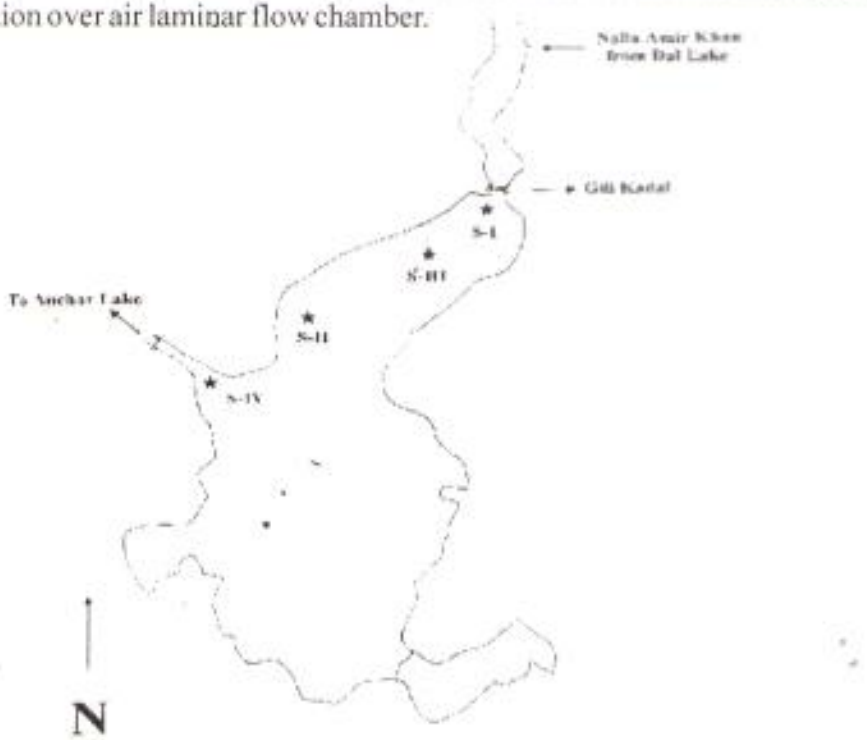

Fig. 1. Outline Map of Lake Khushalsar showing four study sites

RESULTS

The present study was carried out in three different seasons viz. Spring, Summer and Autumn. The quantitative assessment of fungi was made according to Waksman dilution plate method as given by Jhonson and Case (1995) after using Rose-Bengal agar medium. Colony morphology was studied on the basis of key proposed by Jhonson and Case (1995). During the present investigation a comparative assessment in the density of fungal colonies in three different seasons at each site was made. On the basis of colony morphology, it was observed that most of the colonies were circular, entire and convex in appearance, margin and elevation respectively. However, fewer colonies appeared as filamentous, undulate and irregular. Total number of fungal colonies per plate and per ml of inoculums was calculated following standard known procedures. The observation revealed seasonal variation in number and density of fungal colonies. From the present data it became clear that there are appreciable differences between the total number of fungi at different sites in three different seasons. The recorded fungal population showed higher number in summer and lowest in autumn except at site II where maximum number was calculated in spring.

Various fungal colonies were identified mainly on the basis of colour, conidiophore, sporangiophore, mycelia and spore structure after following Khulbe (2001), Gilmannn (1975) and Alexopoulos and Mims(1993).Various genera isolated from different sites in three different seasons are listed in Table 1. The studies as carried out in four different sites of Khushalsar Lake helped only to identify the organisms only up to generic level. These were *Pencillium* spp., *Cladosporium* spp., *Fusarium* spp., *Acremonium spp., Verticillium* spp., *Thielaviopsis* spp. *and Botryotrichum* spp. *which belong to classes* Deuteromycetes and Ascomycetes of division Mycotina respectively.

Table 1 . Season wise percentage occurrence of various fungal species

Species	Spring %	Site	Summer %	Site	Autumn	Site
Pencillium spp.	68.3	I-IV	26.8	I,II	6.6	I,II,IV
Fusarium spp.	5	IV	56.6	I,II,IV	8.3	I,III,IV
Cladosporium spp	26.6	I,IV	21.6	I,IV	0	- - -
Botryotrichum spp.	0	- - -	0	- -	1.6	I
Thielaviopsis spp.	0	- - -	0	- -	5	II
Acremonium spp.	0	- - -	20	I	0	- - -
Verticillium spp.	0	- - -	5	II	0	- - -

In spring season *Pencillium* spp. was found in all the four sites while *Cladosporium* spp. was found at sites I and IV only. In summer season again *Pencillium* spp. was found at I and II sites while *Fusarium* spp. was found at sites I, III and IV. In autumn season *Pencillium* spp. was found at sites I, II and IV while *Fursarium* spp. was found at sites I, III & IV. *Acremonium* spp. *Botryotrichum* spp. and *Thielaviopsis* spp. showed their occurrence only once. *Aceremonium* spp. *and Botryotrichum* spp. were isolated at site I in summer and Autumn respectively. *Thielaviopsis* spp. was isolated once only at site II in Autumn. *Verticillium* spp. was found at site II in summer only.

DISCUSSION

Present investigation was focussed on isolating and recording of 7 fungal genera belonging to two different classes of division Mycotina and their density found at four different sites of Khushalsar lake in three different seasons just to determine about the polluted or unpolluted

status of the lake. The present studies revealed that the higher fungal counts belonging to different genera occur during summer season. This may possibly be due to the increase in organic matter and more feasible temperature range in such season (Khulbe and Durgapal, 1992).

Among all the genera recorded, *Pencillium and Fusarium* were the most dominant genera quantitatively. Contrary to this the maximum number of fungi has been recorded during moderate temperature range by Khulbe and Durgapal (1992) while studying freshwater dynamics of geofungi in polluted freshwater body at Nainital.

During the course of present investigation most of the species isolated, belong to the order Moniliales which normally occur in polluted lake waters. These fungi are also well known common soil flora of ubiquitous distribution and also known as cellulose decomposers (Kellermann and McBeth, 1912). *Pencillium* spp. and *Fusarium* spp. also have strong cellulolytic ability.

Earlier many research workers have reported similar fungi from semi aquatic habitats and have opined that species of *Pencillium, Fusarium, Cladosporium* and many other fungi can tolerate anaerobic conditions and have been able to survive in semi-aquatic habitats for more than 2-3 months. Further, species of *Allomyces, Achlya and Pythium* isolated from pond waters elsewhere were considered to be aquatic fungi while all others which are terrestrial are classified as immigrants and versatile (Park, 1972). The arrival of these non-aquatic fungi was because of surface run-off of soil particles, leaf litter, vegetative debris, dropping of airborne airsporea or presence of perennating structures of the fungi which sporulate and grow at the onset of favourable conditions in the substratum. (Awasthi and Khare, 1990). Similar fungi perhaps could be isolated once a detailed programme on fungal communities in such lake is taken in hand The frequent isolation of *Pencillium, Cladosporium and Fusarium* and many other fungi was because of their constant activity and their adaptability to the semi-aquatic habitats. The fungi *Pencillium, Cladosporium* were isolated during spring while *Pencillium, Fusarium and Cladosporium* were isolated in summer and only *Pencillium and Fusarium* were isolated in Autumn. Such fungi may have originated during their non-aquatic history on the extra aquatic leaf and twig fragments present on the surface of water.

Pencillium and Fusarium may be considered as most tolerable or adaptable species. Species belonging to genera like *Acremonium, Botryotrichum and Thielaviopsis* were isolated only at two occasions and subsequently these did not show the presence further. It can be interpreted that fungi producing resting spores, pigmented spores, ascocarps, sclerotia or other perennating structures are successful colonizers of semi-aquatic habitats and can form dominant fungal flora.

On comparing the total number of fungi (at four sites) in three different seasons the number of fungal colonies showed the maximum number in the summer season for sites I, III & IV. This may be because of the increased organic matter, increased temperature and concentration of Ca^{++} and Mg^{++}. While for site II the fungal population shows reverse trend i.e. maximum number in spring. This may be due to the rich growth of macrophytes *(Lemna, Salvinia)* which extract nutrients from (polluted) water and thus have less fungal colonies due to decrease in nutrient concentration.

Quinn (1984) studied the seasonal occurrence of yeasts and other fungi in freshwater lake in laugh Neagh, Northern Ireland by dilution plate techniques and encountered with a wide range of colonies, of which *Mucor, Aspergillus, Pencillium, Fusarium and Saprolegnia* as well as members of *Sphaeriopsidales* were consistently present and formed the majority of isolates throughout the season. Bhat and Kamili (2004) also reported *Pencillium* species from Dal Lake-a fresh water body of Kashmir. Again in 2004 Pandit and Kamili reported *Pencillium* species from river Jhelum, Kashmir. Singh and Wadhwani (1986) observed that most geo-fungi were also isolated from air and water stagnant ponds and flowing water with abundant aggregations of hydrophytes. Their adaptation to aquatic habitat was assigned to their capability to grow under a wide range of pH and to degrade cellulose. Willoughby (1962) has reported the distribution and occurrence of *Saprolegnia* in Lake Ontario. This take over of Ascomycetes from Chytridiomycetes or to some extent Oomycetes can be related to availability of more organic material which encourages the proliferation of Ascomycetes and other species from Zygomycetes. Many of the species of Ascomycetes and Deuteromycetes thrive well in the organic matter which is in conformity with the present preliminary observations and isolations. Relatively little work has been done on these fungi in the polluted waters but have been studied in polluted waters in England, Germany, Japan.

From the observations it appeared that in general in the Autumn season only a few species thrive and their number also decreased while in spring the fungal diversity was more. From this it can be inferred that different species can thrive at different temperatures and show greater variation in their adaptability that is why some species are present in one season but are lesser in numbers in another season or even absent. Further if detailed studies concerning the life cycle of a particular species or the sporulation and ecological interactions are taken in hand, such an investigation can lead in arriving a decision on determining the inhibitory effect on the other species because these can have competition for the same source of energy.

From the study it can be inferred that the fungal genera isolated were mostly terrestrial although some may be considered aero-fungi but none was found to be purely aquatic fungi. The survival of terrestrial fungi in Khushalsar Lake clearly indicates that the

lake has disturbed environment. While going through the literature available for aquatic fungi, no member recorded in the present study is found to be truly aquatic. Hence it can be concluded that the lake has undergone eutrophication which is confirmed by physico-chemical parameters and other biological communities worked out by other researchers in the same lake who have recorded the hypereutrophic status of the lake in their studies.

Since the studies carried out so far revolve round to the preliminary aspects but it is presumed that there is enough scope for further experimentation to be studied on numerous other parameters which could lead to the ultimate conclusion of the objectives for proposed site.

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