

Seasonal variation and distribution of fungi in two freshwater ponds of Andhra Pradesh, India

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MS received 28 April 1980; revised 9 April 1981

Abstract. Seasonal variation and distribution of fungi from two freshwater ponds were studied for a period of one year employing 'sector analysis' method, baiting and plating techniques. A marked seasonal variation in mycoflora of the two pond waters has been found. Many species of aquatic fungi (Mastigomycotina) were obtained by baiting boiled hemp seeds, maize grains and grass leaves and also by sector analysis. Extra-aquatic fungi were isolated by plating organic detritus on PSA + strepto-penicillin medium. Fungi have been divided into monsoon, winter, summer and constant types based on their occurrence and periodicity. In all 36 species of fungi belonging to 23 genera were isolated from the two ponds. Pond A, which was slightly acidic (pH 5.8-6.2), supported many species of fungi than pond B, whose pH ranged between 7.6 and 8.2. *Achlya*, followed by *Pythium* and *Allomyces*, formed the dominant genera.

Keywords. Distribution; phenology; Saprolegniaceae; indweller; extra-aquatic fungi.

1. Introduction

The importance of mycological studies of aquatic habitats has been emphasized by Sparrow (1968) and Park (1972). There are quite a few reports on aquatic fungi from various countries (Alabi 1971; Cooke 1963; Hughes 1962; Hunter 1975; Lund 1934; Perrott 1960; Willoughby 1962). However, aquatic fungi received only a meagre attention from Indian workers (Dayal and Tandon 1962, 1963; Dayal and Thakur 1966; Srivastava 1967). Therefore, an attempt has been made in the present investigation to study the phenology and distribution patterns of fungi in two freshwater ponds of Andhra Pradesh (India).

2. Materials and methods

Water samples were collected from two freshwater ponds of Hyderabad at 4-weekly intervals, starting from May 1971 to May 1972 and the ponds were designated as pond-A and pond-B.

Pond-A is located in the vicinity of Vikarabad on Anantagiri hills and is 80 km away from Hyderabad city. It is a permanent pond measuring 0.0005 km² with a maximum depth of 4.5 m, supporting aquatic Angiosperms (pH range 5.8 to 6.2).

Pond-B is situated in the Osmania University campus with an area of 0.007 km² and its depth is about 1 m. The pond supported only *Typha angustata* Bory and *Chaus* and *Ipoemea* sp. during the period of collection (pH range 7.6 to 8.2).

The ponds received an average rainfall of 460 mm during 1971-72. The average elevation of Hyderabad district is about 416.6 m above sea level with summits here and there raising to 833 m. There are three marked seasons, viz. monsoon (June to September), winter (October to January) and summer (February to May), with a maximum of 42° C air temperature during summer and a minimum of 10-15° C during winter.

Water samples were collected in sterile pyrex bottles under aseptic conditions and the percentage occurrence of fungi was estimated by the 'sector analysis method' of Willoughby (1962). In addition, the baiting technique of Butler (1907), using boiled hemp seeds, maize grains, grass blades and fresh mango fruit, was also employed. Organic detritus from the two water samples was plated on acidified potato sucrose agar + strepto-penicillin medium for isolating extra-aquatic fungi.

Fungi have been identified with the help of the keys provided by Ellis (1971), Johnson (1956), Middleton (1943) and Sparrow (1960).

3. Results

Monthly changes in rainfall, relative humidity, water temperature and pH are presented in table 1. Saprolegniaceae appeared to be the most dominant group, followed by Deuteromycotina (table 2). In pond-A, ascomycetes were fewer than Peronosporales and Mucorales. Members of Mastigomycotina were more or less dominant in all the months of monsoon and winter compared to the summer months. The lowest number of fungi was recorded during summer months; however, members of Deuteromycotina formed the most predominant group during this season.

A variety of fungi and many fungal species were found during winter than in monsoon and summer. According to their occurrence and distribution the fungi recorded in the present study can be divided into the following four categories: monsoon, winter, summer and constant species (table 3). The number of fungi was more in pond-A, which had an acid pH range than pond-B. More fungi could be isolated by baiting boiled hemp seeds, maize grains and grass blades than by other methods. Fungi representing *Alternaria*, *Cladosporium*, *Curvularia*, *Fusarium*, Mucorales, *Phoma* and *Pseudoeurotium* were isolated by plating organic detritus and also by the sector analysis method.

4. Discussion

Monthly fluctuations in mycoflora of two pond waters were identical in monsoon and winter; the fungal population showed sudden blooms when there was sufficient

Table 1. Showing the data of rainfall, relative humidity, water temperature and pH in two ponds.

	May	June	July	Aug.	Sept.	Oct.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May																	
Factor	A B	A B	A B	A B	A B	A B	A B	A B	A B	A B	A B	A B	A B	A B																	
Rainfall in mm	18.6	10.0	94.9	84.9	39.2	36.0	126	124	186	180	76	68	76	68	2.1	1.0	1.0	0	0	0	1.0	1.2	0	0	12	10	8.6	8.6			
% Relative humidity	31.0	28.0	76.0	64.0	72.0	62.0	77	63	76	66	79	78	79	76	62	60	69	60	60	75	70	62	60	32	28	40	40	42	42		
Water temperature in °C	30.0	27.0	28.0	27.0	26.0	26.0	27	26	26	26	24	25	25	23	20	18	20	18	18	18	18	19	23	25	27	28	28	27	29	29	
pH	6.2	8.0	6.0	7.8	5.8	7.8	8.0	6.2	8.2	8.0	6.2	6.2	7.8	5.8	7.8	6.0	7.8	6.0	7.8	5.8	7.8	5.8	7.6	6.0	7.8	6.0	7.8	6.1	7.6	6.1	7.8

A = Pond 'A' ; B = Pond 'B'

Table 2. Percentage occurrence of particular groups of fungi in the two pond waters*.

Particular groups of fungi	1971					1972								
	May	June	July	Aug.	Sept.	Oct.	Dece.	Nov.	Dece.	Jan.	Feb.	Mar.	Apr.	May
	Pond-A													
Saprolegniales	35.0	37.5	75.0	35.0	22.5	15.0	32.5	47.5	22.5	45.0	5.0	5.0	7.5	20.0
Peronosporales	—	—	2.5	—	2.5	—	—	2.5	2.5	2.5	—	—	—	—
Mucorales	—	5.0	5.0	5.0	—	—	—	—	—	—	2.5	—	—	2.5
Ascomycetes	—	5.0	—	—	—	—	—	—	—	—	—	—	2.5	2.5
Penicillia	—	—	—	—	—	12.5	2.5	2.5	—	—	5.0	—	—	—
Other fungi (Deuteromycotina)	2.5	12.5	5.0	10.0	—	10.0	2.5	7.5	—	2.5	7.5	2.5	2.5	—
(Sectors without any fungal growth)	62.5	40.0	12.5	50.0	70.0	62.5	62.5	40.0	75.0	50.0	80.0	92.5	87.5	75.0
	Pond-B													
Saprolegniales	10.0	5.0	17.5	25.0	27.5	—	10.0	2.5	5.0	2.5	2.5	—	2.5	—
Peronosporales	—	—	2.5	—	2.5	—	—	2.5	—	—	—	—	—	2.5
Mucorales	—	—	5.0	—	—	—	—	—	—	—	—	—	—	—
Ascomycetes	7.5	5.0	5.0	2.5	5.0	—	—	—	—	2.5	—	—	—	—
Penicillia	—	—	—	—	—	10.0	2.5	—	—	—	—	—	—	—
Other fungi (Deuteromycotina)	2.5	10.0	7.5	10.0	15.0	10.0	7.5	7.5	5.0	5.0	—	5.0	5.0	—
Blank (Sectors without any fungal growth)	80.0	80.0	62.5	62.5	50.0	80.0	80.0	87.5	90.0	90.0	97.5	95.0	92.5	92.5

— = absent

* = Data based on sector analysis method

Table 3. Distribution of fungi in two freshwater ponds.

Fungi	Pond-A	Pond-B	Isolation method/ observation*
Monsoon species (June to September)			
<i>Achlya debaryana</i> Humphrey	+	-	1, 2, 3
<i>A. proliferoides</i> Coker	+	-	1, 2, 3
<i>Achlya</i> sp. (zoosporangial form)	+	+	1, 2, 3
<i>Allomyces anomalous</i> Emerson	+	+	2, 3, 4
<i>Pythium aphanidermatum</i> (Edson) Fitz.	+	+	1, 2, 3, 4
<i>P. elongatum</i> Matthews	+	-	2, 3, 4
<i>Pythium</i> sp.	+	+	4
<i>Rozella</i> sp.	+	-	2, 3, 4
Winter species (October to January)			
<i>Acaulopage macrospora</i> Drechsler	+	+	3
<i>Achlya orion</i> Coker and Couch	+	-	2, 3
<i>Achlya</i> sp. (Forming oospores)	+	+	1, 2, 3
** <i>Blastocladia globosa</i> var. <i>bhargavii</i> var. nov.	+	-	5
<i>Eletherascus lectardii</i> (Nicot) Arx	+	-	3
<i>Fusariella obstipa</i> (pollack) Hughes	+	-	6, 9
<i>Gonapodya prolifera</i> (Cornu) Fischer	+	-	5
Mucorales member (?)	+	+	1, 6
<i>Myzocyttium megastomum</i> de wildeman	+	-	7
<i>Nectria</i> sp. (conidial state)	+	-	3
<i>Olpidiopsis achlyae</i> McLarty	+	-	8
<i>Pythium middletoni</i> Sparrow	+	-	1, 2, 3, 4
<i>Pythiogeton ramosum</i> Minden	+	+	3
Summer species (February to May)			
<i>Fusarium aqueducium</i> Lagerh	+	-	1, 2, 3, 6, 9
<i>Phoma fimeti</i> Brunn	+	+	1, 6
<i>Pseudoeurotium multisporum</i> (Saito and Minoura) Stolk	+	+	1, 6
<i>Pythiella</i> sp.	+	-	7
Constant species (all the 12 months)			
<i>Achlya klebisiana</i> Pieters	+	+	1, 2, 3
<i>A. recurva</i> Cornu	+	+	1, 2, 3
<i>Alternaria tenuissima</i> (Fr.) Wilt.	+	+	1, 6
<i>Allomyces arbusculus</i> Butler	+	+	2, 3, 4
<i>Aphanomyces laevis</i> de Bary	+	+	1, 2, 3
<i>Cladosporium oxysporum</i> Berk. and Curt.	+	+	1, 6
<i>Curvularia lunata</i> (Walker) Boed.	+	+	1, 6
<i>Fusarium equiseti</i> (Corda) Sacc.	+	+	1, 6, 9
<i>Penicillium lilacinum</i> Thom	+	+	1, 6
<i>Pythium carolinianum</i> Matthews	+	+	1, 2, 3, 4, 6
<i>P. echinulatum</i> Mathews	+	-	2, 4

+ = present; - = absent

*1 = Sector analysis method

2 = Boiled hemp seed baiting

3 = Boiled maize grain baiting

4 = Boiled grass blade baiting

5 = Raw mango fruit baiting

6 = Plating organic detritus on PSA

7 = Found as parasites on Algae

8 = Found as parasites on *Achlya* spp.

9 = Growing on submerged leaf litter

** to be described elsewhere.

precipitation (rainfall) during June–September. However, the mycoflora dwindled during summer months. In temperate countries, spring and autumn are found to be favourable seasons for water molds (Hunter 1975; Perrott 1960; Roberts 1963). However, in tropical and sub-tropical countries like India, maximum numbers of fungi have been observed either in monsoon or winter (Dayal and Tandon 1962, 1963; Srivastava 1967) and the least during summer. Similar results have been obtained in the present study also. The winter peaks in the present work may be due to the presence of more oxygen, low temperatures, high nutrient status and large amounts of oxidizable organic matter. During winter, sexual forms of Mastigimycotina were dominant while zoosporangial forms were more frequent in their occurrence during monsoon months. The monsoon peaks are probably due to the availability of more oxygenated water, high rainfall and surface run-off along with the nutrients. The fall in fungal species during summer could be attributed to high water temperatures and low nutrient status.

It has been observed by Lund (1934), Hughes (1962) and Hunter (1975) that species representing *Achlya*, *Saprolegnia* and other Phycomycetous genera with eccentric oospores are abundant in tropics, while centric and subcentric oospore-bearing species are confined to temperates; and the present study also confirms the same. In Europe, *Saprolegnia* forms the most dominant member of the Saprolegniaceae recovered from freshwaters compared to *Achlya* (Dick 1976). Willoughby (1962) also suggested that *Saprolegnia* was the predominant genus followed by *Achlya* and others. It appears from the present work that *Achlya* forms the most dominant genus of Saprolegniaceae while *Saprolegnia* is absent in the freshwaters, confirming the earlier statements of Alabi (1971) and Dick (1976) that *Saprolegnia* may be largely absent from warm temperate and tropical climates.

Allomyces is considered as a warm temperate fungus but its occurrence in colder regions suggests that other factors may be more important (Dick 1976). Emerson (1941) isolated some species of *Allomyces* from waters and humid soils. In the present study, *Allomyces anomalus* and *A. arbusculus* have been isolated from two freshwater ponds. It could be concluded that *Allomyces* might be occurring naturally in waters and humid soils, perhaps shifting from one habitat to the other depending on certain factors, which have yet to be understood.

Species of *Achlya*, *Pythium*, *Aphanomyces*, *Pythiogeton*, *Allomyces*, *Gonapodya*, *Pythiella*, *Blastoclada* and *Acaulopage* were the common water fungi recorded in the present study. Fungi which are not specific to aquatic habitats like *Pseudo-eurotium*, *Nectria*, *Penicillium*, *Phoma*, *Curvularia*, *Alternaria*, *Cladosporium* and *Fusarium* have been isolated and this could be due to the leaching from surrounding land or litter. Earlier such fungi were recorded from aquatic habitats (Cooke 1963; Willoughby 1962).

Hunter (1975) and Roberts (1963) have designated the aquatic mycoflora as winter, summer and constant species based on their monthly frequency of isolation. Alabi (1971) added one more, the rainy season category. The fungi isolated in the present study have been classified as monsoon, winter, summer and constant species. Dick (1971) distinguished the aquatic fungi as 'inhabitants', 'aliens' and 'active aliens' in lentic environments; while Park (1972) classified them as 'indwellers, versatiles or transients and immigrants'. It could be concluded from the present study that species of *Achlya*, *Acaulopage*, *Aphanomyces*, *Blastoclada*, *Myzocyium* and *Pythium* are indwellers as they spend their entire life cycle

in water ; *Allomyces* might be transient between aquatic and terrestrial ecosystems. Species of *Alternaria*, *Cladosporium*, *Curvularia*, *Fusarium*, *Phoma*, *Pseudoeurotium* and others, arriving from non-aquatic habitats, could be regarded as 'immigrants'. The aquatic mycoflora appears to be favoured by a pH range between 5.8 and 6.2 coupled with low temperatures.

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