

Dynamics of cellulolytic fungi in unglazed and glazed papers in Gorakhpur

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Abstract— Cellulolytic fungi degrade objects containing cellulose, such as paper and textiles etc. Therefore, they cause severe damage to these objects, including our cultural heritage. Fungal infestation of unglazed and glazed papers obtained from central libraries of St. Andrew's P.G. College and DDU Gorakhpur University, Gorakhpur, respectively has been investigated and studied. Twenty two fungal species belonging to 12 genera were isolated from these samples of papers, named *Alternaria*, *Aspergillus*, *Chaetomium*, *Cladosporium*, *Cunninghamella*, *Curvularia*, *Helminthosporium*, *Memnoniella*, *Penicillium*, *Scopulariopsis*, *Syncephalastrum* and *Ulocladium*. The microscopical examinations of these cellulolytic fungi provide valuable informations on their structure and damaging effects. Of these fungi, *Aspergillus niger*, *Chaetomium globosum* and *Curvularia lunata* showed the highest frequency and were isolated from all the six samples.

Index Terms— Cellulolytic fungi, Biodeterioration, Glazed and unglazed papers, Xerophilic, Gorakhpur

I. INTRODUCTION

Gorakhpur is located in the North-Eastern Uttar Pradesh of India, in the foot hills of Himalayas. It is characterized by high relative humidity and moderate temperature in most of the months (July to March). Microbial biodegradation of various cultural commodities made of paper, textile, wood and leather commonly occur everywhere in humid, tropical and sub-tropical countries of the world. These countries suffer the most by this calamity due to their hot and humid climate. Cultural heritage made of paper, textile, wood and leather, either movable or immovable, is subjected to biodegradation induced by these microbes. Of all the microorganisms, fungi are the most active ones in this process¹. In India, damage to cultural properties is enormous due to fungal biodeterioration of paper manuscripts and archival materials². A large number of fungi are known to degrade paper³. Xerophilic fungi can infest these articles even under relatively less moist conditions. Fungal deterioration of paper is of great significance in tropical countries like India. A high fungal diversity has been reported in paper from Gorakhpur⁴⁻⁵. The first task in this connection is to identify the fungal species causing this biodegradation. Therefore, the present survey and investigation was done to collect paper samples and to identify various species of fungi causing biodeterioration of paper in libraries in Gorakhpur.

II. MATERIALS AND METHODS

A. Collection of Cellulolytic Fungi: -

Five samples of unglazed and glazed papers from different pages of a book from the Central Library of St. Andrew's (P.G.)

College and a Ph.D. Thesis from Central Library of DDU Gorakhpur University, Gorakhpur, respectively invaded and degraded by fungi were obtained (Fig. 1 – 5). These fungi were examined by Direct Observation and were isolated by direct lifting with inoculation needle and by Standard Blotter Method of Neergaard and Saad⁶ and Agar Plate Method (Czapek Dox Agar of Raper and Thom⁷, and Streptomycin Rose Bengal Agar of Martin⁸). The fungi obtained in mixed culture were purified by streaking on PDA Medium.

B. Identification of Cellulolytic Fungi:-

The semi-permanent mounts of these purified fungi were made in Lactophenol – Cotton blue and fungi were identified by observing under light microscope. The literatures used for identification of these fungi included Ainsworth and Bisby, 1971; Ames, 1961; Booth, 1977; Ellis, 1971, 1976; Gilman, 1957; Kendrick, 1971; Raper and Fennell, 1965 ; Raper, Thom and Fennell, 1968; Rifai, 1969 and Subramanian, 1983⁹⁻¹⁹. Six isolations were done from each of the five samples.

III. OBSERVATIONS

Twenty two species of fungi belonging to 12 genera were isolated from infested unglazed and glazed papers obtained from central libraries of St. Andrew's P.G. College and DDU Gorakhpur University, Gorakhpur, respectively (Table – I). These are *Alternaria alternata* (Fr.) Keissler, *Aspergillus nidulans* (Eidam) Winter, *A. flavus* Link, *A. fumigatus* Fresenius, *A. terreus* Thom, *A. ochraceus* Wilhelm, *A. niger* Van Tiegham, *A. tamari* Kitta, *A. versicolor* (Vuillemin) Tiraboschi, *Chaetomium globosum* Kunze, *C. indicum* Corda, *Cladosporium cladosporioides* (Fres.) de Vries, *C. herbarum* Link ex Fries (Persoon), *Cunninghamella echinulata* Thaxter, *Curvularia lunata* (Walker) Boedijn, *Helminthosporium sp.*, *Memnoniella echinata* (Riv.) Galloway, *Penicillium chrysogenum* Thom, *P. citrinum* Sopp and Thom, *Scopulariopsis brevicaulis* (Bainier) Thom, *Syncephalastrum racemosum* (Cohn) Schroete and *Ulocladium botrytis* Preuss.

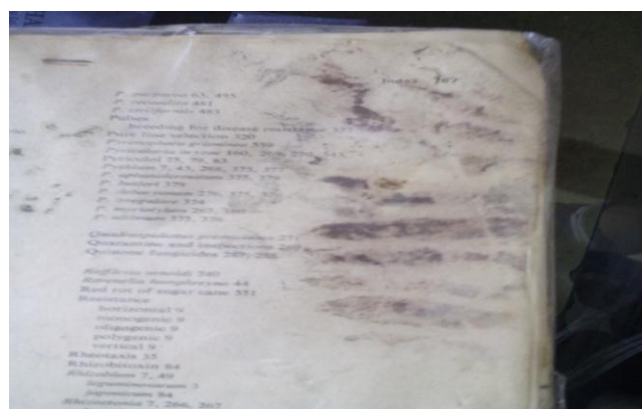


Fig. – 1(A)
Unglazed paper infested by cellulolytic fungi
(from Central Library, St. Andrew's P.G. College,
Gorakhpur)

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Fig. – 1(B) : Close up of infested portion of paper

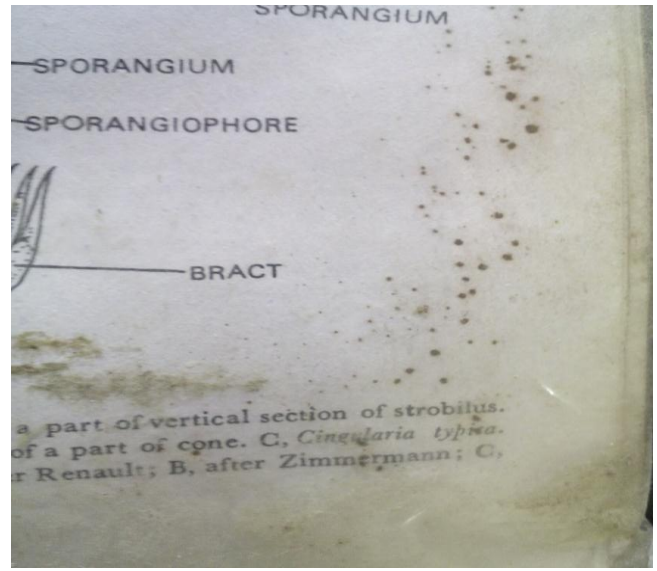


Fig. – 2(B) : Close up of infested portion of paper

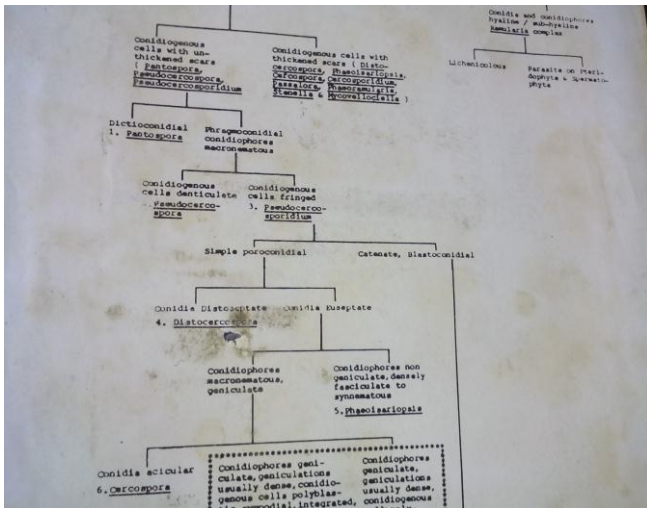


Fig. – 3 : Infested unglazed page of a Ph.D. Thesis (from Central Library, DDU Gorakhpur University)



Fig. – 4(A) Glazed paper of a Thesis infested by cellulolytic fungi (from Central Library, DDU Gorakhpur University)

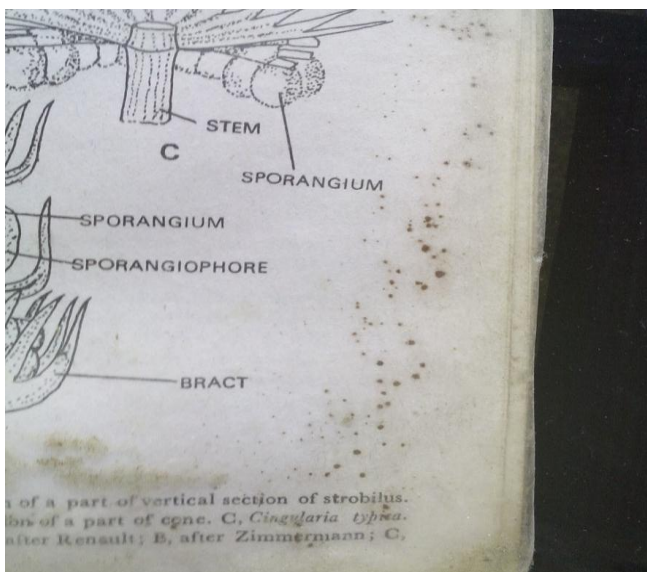


Fig. – 2(A) Unglazed paper infested by cellulolytic fungi (from Central Library, St. Andrew's P.G. College, Gorakhpur)



Fig. – 4(B) : Close up of infested portion of paper



Fig. – 5(A) Glazed paper of a Thesis infested by cellulolytic fungi (from Central Library, DDU Gorakhpur University)



Fig. – 5(B) : Close up of infested portion of paper

TABLE – I
Cellulolytic Fungi and their frequencies isolated and examined from unglazed and glazed papers in Gorakhpur

Sr. No.	Fungus Species	* Frequency in Isolations					
		Ist	IInd	IIIrd	IVth	Vth	VIth
1.	<i>Alternaria alternata</i> (Fr.) Keissler	+	++	-	-	+	+
2.	<i>Aspergillus nidulans</i> (Eidam) Winter	-	+	++	-	++	-
3.	<i>A. flavus</i> Link	+	++	-	+	++	+
4.	<i>A. fumigatus</i> Fresenius	+	++	-	++	+	-
5.	<i>A. terreus</i> Thom	+	++	-	-	+	++
6.	<i>A. ochraceous</i> Wilhelm	+	+	-	-	+	-
7.	<i>A. niger</i> Van Tiegham	+++	+++	+++	+++	+++	+++
8.	<i>A. tamari</i> Kitta	-	-	-	-	-	+
9.	<i>A. versicolor</i> (Vuillemin) Tiraboschi	-	-	-	+	-	-
10.	<i>Chaetomium globosum</i> Kunze	++	+++	+++	+++	++	++
11.	<i>C. indicum</i> Corda	+	-	+	-	++	-
12.	<i>Cladosporium cladosporioides</i> (Fres.) de Vries	++	+	-	+	-	+
13.	<i>C. herbarum</i> Link ex Fries (Persoon)	+	++	+	-	-	+
14.	<i>Cunninghamella echinulata</i> Thaxter	-	-	+	+	-	-
15.	<i>Curvularia lunata</i> (Walker) Boedijn	++	+++	++	+++	+	+
16.	<i>Helminthosporium sp.</i>	-	++	-	-	+	+
17.	<i>Memmoniella echinata</i> (Riv.) Galloway	+	-	++	-	+	+
18.	<i>Penicillium chrysogenum</i> Thom	++	-	+	+	-	++
19.	<i>P. citrinum</i> Sopp and Thom	+	-	+	+	-	+
20.	<i>Scopulariopsis brevicaulis</i> (Bainier) Thom	-	-	+	++	-	-
21.	<i>Syncephalastrum racemosum</i> (Cohn) Schroeter	-	+	+	-	+	-
22.	<i>Ulocladium botrytis</i> Preuss.	-	+	++	-	+	-

*
- = Absence of fungus species
+ = Slight Growth
++ = Moderate Growth
+++ = Abundant Growth

TABLE – II

Fungi Observed/Isolated by all the four techniques (DO, SBM, CDA & SRBA)

Sr. No.	Fungi Observed/Isolated	DO	SBM	CDA	SRBA
1.	<i>Alternaria alternata</i> (Fr.) Keissler	+	+	+	+
2.	<i>Aspergillus nidulans</i> (Eidam) Winter	+	+	+	+
3.	<i>A. flavus</i> Link	+	+	+	+
4.	<i>A. fumigatus</i> Fresenius	+	+	+	+
5.	<i>A. terreus</i> Thom	+	+	+	+
6.	<i>A. ochraceus</i> Wilhelm	+	+	+	+
7.	<i>A. niger</i> Van Tiegham	+	+	+	+
8.	<i>Chaetomium globosum</i> Kunze	+	+	+	+
9.	<i>Cladosporium herbarum</i> Link ex Fries (Persoon)	+	+	+	+
10.	<i>Cunninghamella echinulata</i> Thaxter	+	+	+	+
11.	<i>Curvularia lunata</i> (Walker) Boedijn	+	+	+	+
12.	<i>Penicillium citrinum</i> Sopp and Thom	+	+	+	+

DO : Direct Observation
 SBM : Standard Blotter Method
 CDA : Czapek Dox Agar
 SRBA : Streptomycin Rose Bengal Agar

+: Present/Isolated

TABLE – III

Per cent concentration of fungi of different groups isolated from deteriorated paper samples

Fungal Groups	Per cent Concentration
Division - Zygomycotina	2 of 22 = 09.10 %
Division - Ascomycotina	3 of 22 = 13.63 %
Division - Deuteromycotina	17 of 22 = 77.27 %

IV. RESULT AND DISCUSSION

As shown in Table – I, the most frequently occurring fungi which were isolated from all the five samples and six isolates are *Aspergillus niger* Van Tiegham, *Chaetomium globosum* Kunze and *Curvularia lunata* (Walker) Boedijn. Of these three fungi, *A. niger* has the most abundant growth. Other more frequently occurring species is

Aspergillus flavus Linc, which is isolated from five samples/isolates. The other fungal species show moderate to low frequency and are isolated from two to four samples/isolates. *Aspergillus tamari* Kitta and *A. versicolor* (Vuillemin) Tiraboschi show slight growth and lowest frequency, and are isolated from only one sample/isolate.

Table – II shows that 12 out of total 22 isolates were observed and isolated by all the four techniques applied, i.e., Direct Observation, Standard Blotter Method, Czapek Dox

Agar and Streptomycin Rose Bengal Agar.

It is evident from Table – III that most of the fungi invading paper belong to the Division – Deuteromycotina (77.27%). Fungi of Divisions – Ascomycotina and Zygomycotina are less frequent and their per cent concentrations are 13.63% and 9.10%, respectively. Fungi of Division – Deuteromycotina have rapid and frequent growth under favorable environmental conditions such as high relative humidity and moderate to high temperature. Also, they have the highest adaptability and are able to survive even under unfavorable conditions.

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Area of Interest: Antifungal Plant Products / Mycology & Plant Pathology.

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