Research Article

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STUDY AND SURVEY OF FUNGAL DIVERSITY OF BORRA CAVES SITUATED IN ANDHRA PRADESH, INDIA

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ABSTRACT

As there is increasing interest in cave microbiology, the present study deals with study of fungal diversity and distribution in Borra cave situated in north of Vishakhapatnam in the Ananthgiri Hill Ranges of Eastern Ghats of India. It falls in the State of Andhra Pradesh. It is beautiful cave where the average temperature reported is 16°C. The sample taken from cave were guano deposits, soil and water. The period of study was during rainy and winter season. The samples were serially diluted and were inoculated in PDA media. A total of 65 fungal species were reported from Guano deposits and 53 from water, out of which maximum number of species belongs to Anamorphic fungi. The percentage frequency and distribution were also recorded. These isolated species will help in pursuing further studies like in biodegradation potency, etc.

Keywords: PDA, Guano deposit and Serial dilution method.

INTRODUCTION

Caves provide a niche to several kinds of microorganisms. Nowadays cave ecosystem is attracting microbiologists to study the microbial diversity present inside the cave. These includes Bacteria, fungi, actinomycetes etc ¹. Fungi are an important microflora found in well diversified ecological condition including cave. The science of cave microbiology has similarly mirrored the meteoric rise of microbiology as a science with a new insight suggesting that cave microorganisms may be involved in processes as varied as speleothem deposition to cavern enlargement^{2,3}. There are many important roles of cave microorganisms. Microorganisms play a crucial role in maintaining the delicate ecological balance of the earth. They help in recycling of organic matters ⁴. Certain specific species of fungi and bacteria are the engines of the process of decomposition, essential for natural recycling, helping to guarantee life on earth. In nature biodegradation is mainly carried out by thermophilic bacteria, actinomycetes and fungi in anaerobic microenvironment. This will help in promoting organic farming and managing waste. The current paper deals with the study of fungal diversity from Borra cave situated in Andhra Pradesh, so that scientists can explore those microorganisms for many purpose. As the temperature in Borra cave is recorded average of 16°C we can get those microorganisms which can degrade wastes in mesophilic condition also and in rapid pace.

DESCRIPTION OF CAVE

The Borra Caves, are located on the East Coast of India, in the Ananthagiri hills of the Araku Valley with hill ranges elevation varying from 800 m (2,624.7 ft) to 1,300 m (4,265.1 ft) of the Visakhapatnam district in Andhra Pradesh. The fauna observed in the caves are predominantly bats, as well as the golden gecko. They feed on fruits and leaves and their guano is decomposed in rapid pace by microorganisms. Speleothem carbonates (considered as inorganic precipitates) found in the caves have

been subject to scientific studies. Soil and water is also present, water especially during rainy.

METHODOLOGY

Samples were collected from the Cave during rainy and winter season in the month of August, September, October, November and December. Guano deposits and water, separately were collected aseptically in polythene bag and sterile bottle respectively. The isolation of microscopic fungi was done using potato dextrose agar media. The samples were serially diluted by method of serial dilution. Dilution of 10⁻³, 10⁻⁴, 10⁻⁵ were taken. The petri plates were kept for incubation in incubator for 28°C ± 2°C. After incubation fungal colonies were counted and identified. Identification of fungi was done by analyzing both morphological and microscopic characters and further by help of available literature.

RESULTS AND DISCUSSIONS

From Guano deposits

A total of 65 species belonging to 23 genera and two sterile mycelia were isolated. Among them Anamorphic fungi dominated over the member of Ascomycotina and Zygomycotina. Out of total isolates 8 species (6 genera) belong to Zygomycotina, 4 species (4 genera) belong to Ascomycotina and 53 species (13 genera) belong to *Deuteromycotina*. (Table 1).

In the cave *Aspergillus* taxa were found dominant. The genus *Aspergillus* were represented by 17 species, *Penicillium* was represented by 8 species, *Curvularia* by 4 species, *Fusarium* and *Cladosporium* by 3 species, *Alternaria*, *Dreschlera*, *Rhizodpus*, *Trichoderma* by 2 species and other represented by one species. *Choanephora cucurbitarum*, *Alternaria spl*, *Alternaria alternate*, *Aspergillus awamoori*, *Aspergillus flavus*, *Aspergillus fumigates*, *Aspergillus niger*, *Aspergillus luchensis*, *Aspergillus sclerotium*, *Cladosporium cladosporides*, *Curvularia lunata*, *Penicillium brevicompactum*, *Penicillium citrinum*,

Phanerochaete chrysosporium, *Trichoderma atroviridae*, *Trichoderma viridae* and *mycelium sterilia* has shown 100% frequency. It has been also noticed that maximum species were

observed to be isolated during month of August (48 species), followed by September (47 species), November (41 species) and least in October and December (34 species).

Table 1: Distribution from Guano deposits

Name Of Fungi	August	September	October	November	December
Zygomycotina	Colony number	Colony number	Colony number	Colony number	Colony number
<i>Absidia corymbifera</i>	1	2			
<i>Choanephora cucurbitarum</i>	1	2	1	2	5
<i>Circinella simplex</i>	1				
<i>Cunninghamella elegans</i>	2	1			
<i>Mucor hemalis</i>	1		1	2	
<i>Mucor racemosum</i>	2	1			
<i>Rhizopus oryzae</i>	1				
<i>Rhizopus stolonifer</i>		1			
Ascomycotina					
<i>Chaetomium globosum</i>	1	2		2	
<i>Emericella nidulans</i>		1	1	1	2
<i>Talaromyces flavus</i>	1		5		1
<i>Thielavia basicola</i>	2			4	
Anamorphic fungi					
<i>Acremonium persicinum</i>			1	2	1
<i>Acremonium strictum</i>	2	2	3	1	
<i>Alternaria alternata</i>	2	5	6	4	4
<i>Alternaria crassa</i>	1	2	1		2
<i>Alternaria radicina</i>	2		2		1
<i>Alternaria sp1</i>	3	2	2	2	1
<i>Aspergillus albus</i>	1	1	1	4	4
<i>Aspergillus astus</i>			2	2	
<i>Aspergillus aureus</i>		1			2
<i>Aspergillus awamoori</i>	3	4	4	5	6
<i>Aspergillus flavus</i>	1	2	2	3	4
<i>Aspergillus fumigatus</i>	4	2	2	7	8
<i>Aspergillus japonicas</i>	1	2			
<i>Aspergillus luchensis</i>	4	2	1	4	4
<i>Aspergillus nidulans</i>		1		4	
<i>Aspergillus niger</i>	4	2	2	5	6
<i>Aspergillus niveus</i>	2	1			3
<i>Aspergillus ochraceous</i>	2	1			
<i>Aspergillus parasiticus</i>	2		1	2	
<i>Aspergillus phoenisis</i>	1	1			
<i>Aspergillus sclerotium</i>	1	1	2	2	3
<i>Aspergillus stellatus</i>		1		1	
<i>Aspergillus versicolor</i>			2		
<i>Aspergillus sp I</i>	2			2	
<i>Aureobasidium pullulans</i>	1			2	1
<i>Cladosporium cladosporides</i>	6	12	6	4	4
<i>Cladosporium oxysporium</i>	10	5	2		
<i>Cladosporium-sphaerospermum</i>	6	6			
<i>Cladosporium herbarum</i>	1	1			
<i>Curvularia clavata</i>	1			2	1
<i>Curvularia geniculata</i>		2			
<i>Curvularia pallescens</i>	1		1	1	
<i>Curvularia lunata</i>	1	1	2	5	3
<i>Drechslera bicolor</i>	1			2	3
<i>Drechslera tetramer</i>		1			
<i>Fusarium oxysporum</i>	2	3			3
<i>Fusarium moniliform</i>	2	1	1	2	2
<i>Fusarium caucasicum</i>	1				
<i>Monilia sp</i>	1	1	1		
<i>Nigrospora oryzae</i>		2	2	3	
<i>Penicillium brevicompactum</i>	2	2	2	3	4
<i>Penicillium citrinum</i>	3	3	1	1	2
<i>Penicillium crysogenum</i>		2			1
<i>Penicillium digitatum</i>	2				1
<i>Penicillium oxalicum</i>		2		3	
<i>Penicillium purpogenum</i>			1	2	
<i>Penicillium rubrum</i>		2		1	4

<i>Penicillium rugulosum</i>		2		1	2
<i>Periconia sp</i>		1		2	
<i>Phanerochaete chrysosporium</i>	2	2	2	4	3
<i>Trichoderma viridae</i>	2	5	5	3	4
<i>Trichoderma atroviridae</i>	1	2	1	4	4
Mycelia sterilia					
<i>Mycelia sterilia (White)</i>	1	2	1	3	1
<i>Mycelia sterilia (Orange)</i>				2

Figure 1: Dominant fungal group

Figure 2: Maximum species monthwise

From Water

A total of 53 species belonging to 26 genera and two sterile mycelia were isolated. Among them Anamorphic fungi dominated over the member of Ascomycotina and Zygomycotina and Basidiomycotina. Out of total isolates 5 species (5 genera) belong to Zygomycotina, 4 species (4 genera) belong to Ascomycotina, 2 species (2 genera) belong to Basidiomycotina and 40 species (14 genera) belong to Deuteromycotina and 2 species from *Mycelia sterilia*. (Table 2).

In the cave *Aspergillus* taxa were found dominant. The genus *Aspergillus* were represented by 11 species, *Penicillium* was

represented by 6 species, *Curvularia* by 3 species, *Fusarium* and *Cladosporium* and *Drehsclera* by 3 species, *Alternaria*, and *Trichoderma* by 2 species and other represented by one species. *Syncephalastrum racemosum*, *Mucor varians*, *Alternaria radicina*, *Aspergillus awamoori*, *Aspergillus carneus*, *Aspergillus luchensis*, *Aspergillus niger*, *Aspergillus nidulans*, *Drehsclera Tetramer*, *Fusarium chlamydosporum*, *Fusarium moniliform*, *Penicillium citrinum*, *Penicillium brevicompactum*, *Phanerochaete chrysosporium*, *Trichoderma atroviridae* and *Mycelia sterilia (White)* has shown 100% frequency. Maximum species were observed to be isolated during month of August (35 species), followed by November (34 species), September (33 species) and least in October and December (31 species).

Table 2: Distribution from cave water

Name Of Fungi	August Colony number	September Colony number	October Colony number	November Colony number	December Colony number
Zygomycotina	1	2	1	2	5
<i>Choanephora cucurbitarum</i>					
<i>Cunninghamella echinulata</i>				4	
<i>Mucor varians</i>	2	1	1	1	2
<i>Rhizopus oryzae</i>	1				
<i>Syncephalastrum racemosum</i>	1	1	1	3	4
Ascomycotina					
<i>Hypocreales sp</i>				2	1
<i>Thielavia terricola</i>	2	1	1		
<i>Talaromyces flavus</i>	1		5		1
<i>Thielavia basicola</i>	2			4	
Basidiomycotina					
<i>Alysidium resinae</i>			1		1
<i>Sporotrichum</i>				1	
Anamorphic fungi					
<i>Acremonium fusidioides</i>		2	1		2
<i>A. raphani</i>	2		2		1
<i>Alternaria radicina</i>	3	2	2	2	1
<i>Aspergillus awamoori</i>	3	4	4	5	6
<i>Aspergillus. carneus</i>	1	2	2	3	4
<i>Aspergillus clavatus</i>			2	3	3

<i>Aspergillus fumigatus</i>	1	2			
<i>Aspergillus luchensis</i>	2	2	1	2	4
<i>Aspergillus nidulans</i>	1	1	2	4	2
<i>Aspergillus niger</i>	4	2	2	3	2
<i>Aspergillus neoniveus</i>	2	1			3
<i>Aspergillus ochraceous</i>	2	1			
<i>A. sclerotiorum</i>				2	
<i>A. sulphureus</i>	1	1		1	1
<i>Basidiospora alba</i>				3	4
<i>Cladosporium oxysporium</i>	12	5	2		
<i>Cladosporium-sphaerospermum</i>	8	6			
<i>Cladosporium herbarum</i>	4	4	2		
<i>Curvularia clavata</i>	1			2	1
<i>Curvularia bicolor</i>		2			
<i>C. oryzae</i>	1		1	1	
<i>Drechslera rostrata</i>	1		1	5	4
<i>Drechslera specifer</i>			1	2	3
<i>Drechslera tetramer</i>	1	1	2	2	5
<i>Fusarium chlamydosporum</i>	2	3	2	1	3
<i>Fusarium moniliform</i>	2	1	1	2	2
<i>Fusarium caucasicum</i>	1				
<i>Monilia sp</i>	1		1		
<i>Penicillium brevicompactum</i>	1	2	2	2	4
<i>Penicillium citrinum</i>	3	2	1	1	2
<i>Penicillium crysogenum</i>		2			1
<i>Penicillium digitatum</i>	2				1
<i>P. italicum</i>		2		3	
<i>Penicillium rubrum</i>			1	2	
<i>Phoma exigua</i>		2			4
<i>Pithomyces chartarum</i>		2			2
<i>Periconia sp</i>		1		2	
<i>Phanerochaete chrysosporium</i>	2	1	2	1	3
<i>Trichoderma harzian</i>				3	4
<i>Trichoderma atroviridae</i>	1	2	1	4	4
Mycelia sterilia					
<i>Mycelia sterilia (White)</i>	1	1	1	2	1
<i>Mycelia sterilia (Orange)</i>		2	1	2

Figure 3: Dominant fungal group

Figure 4: Month wise distribution

The survey in the paper shows that guano deposits has shown maximum number of fungal species as compared to water, this indicates that may be it is due to partially digested guano which is rapidly decomposed by microorganisms. Similar result is concluded by karkun and her coworkers, they have got maximum number of species in bat guano. During their survey they got 54 species of fungi in Mandeepkhol cave. Novakova⁵ also studied diversity of fungi from Domica cave system where

they have isolated total of 195 fungal taxa from various cave substrates. Similarly, diversity of thermophilous soil microfungi in forest and cave ecosystems of Taiwan has also been studied by Hsu and coworkers⁶. Karkun^{7, 8} studied the degradation potency of organic materials especially cellulose and pectin by the isolates of Mandeepkhol cave. Prabhakar and his coworker isolated fungi and studied their antifungal studies⁹.

Figure 5: Fungal pictures

CONCLUSION

The results revealed that the maximum isolation were from bat guano, which clearly indicates that it is mostly preferred by fungal species and hence can be potent degrader also. Water also contains varied fungal species. These fungal species can be used and studied for further investigation and molecular works for various purpose like biodegradation or remediation etc.

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