

# Fungal diversity of freshwater wetlands of Goa, India

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## ABSTRACT

Fungi are ubiquitous organisms. They exist in diverse forms in a range of habitats, arboreal, freshwater, marine, subterranean and terrestrial. Further, continuous variations in the prevailing climatic condition affect the fungi everywhere and this is reflected with recognizable changes in the diversity of fungus flora, from place to place. Continued survey and study by dedicated mycologists have resulted in the documentation of a sizable floristic data on fungi of India (Bhat, 2007). A mixture of very diverse fungi and their spores are found in water courses. The chief fungi of freshwaters are Chytridiomycetes and Oomycetes. A number of them are parasites on freshwater planktons. The investigation of the taxonomy and diversity of the fungi (Hypomycetes) occurring in the fresh water wetlands of the eleven tehsils of Goa was carried out for a period of two years during different seasons viz Monsoon, Post Monsoon and Pre Monsoon. In all 19 genera of aquatic Hypomycetes namely *Achyla* sps, *Allatospora* sps, *Dendraspora* Sps, *Gonopodya* sps, *Trichadrum* sps, *Allomyces* Sps., *Aphanomyces* sps., *Articulospora* sps, *Tetrachaetium* sps, *Varicosporium* sps, *Chaetospori* sps, *Dictyuchus* sps, *Anguilospora* sps, *Cylindrocarpon* sps, *Actinospora* sps, *Campylospora* sps. were recorded from eleven freshwater wetlands of south Goa and North Goa during the study period.

**Key words :** Wetlands, Ubiquitous, Hypomycetes.

## Introduction

Fungi are ubiquitous organism. They exist in diverse forms in a range of habitats, arboreal, freshwater, marine, subterranean and terrestrial. Of these, the terrestrial habitat is most favored because it provides a wide variety of substrates for fungi to subsist. Further, continuous variations in the prevailing climatic condition affect the fungi everywhere and this is reflected with recognizable changes in the diversity of fungus flora, from place to place. Eumycophytae are generally aquatic fungi Either parasitic or saprophytic .

Parasitic species parasitize algae or other aquatic phycomycetes and are limited to specific host. Aquatic saprophytes are most frequently encountered on vegetative debris or on the dead remains of fishes and insects. Genera belonging to Order Chytridiales normally occurring on algae, like *Olpidium* on algae. *Rhizophydium* parasitic on

fresh water algae. *Chladochtrium* parasitic on gelatinous material of fresh water algae. Genera belonging to Order Monophleharidales example *Monoblepharis* is found in clear water. Genera belonging to Order Laglidiiales are mostly aquatic or fresh water phycomycetes.

## Significance of fungi to Man

In evolution: Of the estimated 1.5 million species, about 100,000 are recognized and documented in literature. Worldwide in distribution, nearly 30% of an exceedingly large number of taxa, from the tropical habitats in the last 5 decades, is a testimony of 'species-richness' of microfungi in this geographical belt. The under and unexplored habitats in the warmer belt are now presumed as the 'store-house' of most of hitherto unknown fungal taxa, in nature (Bhat, 2007).

Diversity of fungi exhibited in form and structure is often expressed in their function. An exceedingly

large number of molecules with known and unknown biological activity have been discovered and derived from fungi (Bhat, 2007). The fungi are now considered as an economically valuable and biologically sustainable resource that could conveniently be channelized into various useful applications in agriculture, bioremediation, energy, fermentation, food, fuel, industry and medicine (Bhat, 2007).

Continued survey and study by dedicated mycologists have resulted in the documentation of a sizable floristic data on fungi of India (Bhat, 2007). Endowed with diverse physiography, vegetation, ecosystem and habitats, India offers plentiful opportunities for systematic exploration and pragmatic utilization of its untapped biological diversity. Besides others, a variety of habitats in the two megabiodiversity rich forest regions, the Western Ghats in south and eastern Himalayas in north, are considered as prime locations for recovery of more fungi in the future.

There is phenomenal advancement in the uses of fungi. From traditional bread making, consumption of edible mushrooms and alcoholic fermentations, modern uses of fungi encompass production of commercially important acids and enzymes, biologically active and pharmaceutically significant life-saving drugs, industrially useful and non-toxic fungal dyes, nutritive and protein-rich food additives, environment friendly biocontrol agents against crop and human pathogens, compounds useful in biopulping, bioleaching, bioremediation and mycorrhizal biofertilizers (Bhat, 2007). Newer discoveries and inventions of fungi are on the rise with exploration of diverse habitats and follow-up biotechnological investigations.

A mixture of very diverse fungi and their spores are found in water courses. The chief fungi of freshwaters are Chytridiomycetes and Oomycetes. Specially Chytridiales and Saprolegniales. A number of them are parasites on freshwater planktons. There are a few fresh water Ascomycetes known while Hypomycetes are quite good in number. These can be extracted from pond or river or sewage using selective techniques.

## Materials and Methods

The investigation of the taxonomy and diversity of the fungi (Hypomycetes) occurring in the fresh water wetlands of Goa was carried out for a period of two years from Jan 2010 to Jan. 2012. The study of

the taxonomy of fungi from different wetlands of the eleven tehsils of Goa was randomly carried out during different seasons viz Monsoon, Post Monsoon and Pre Monsoon. For this purpose water from various wetlands was collected in separate bottles with wide mouth and having a capacity of 1litre. The following technique was followed for isolating aquatic fungi

### Isolation of aquatic fungi by baiting in the laboratory (Gordon 1984, Aneja 2009)

Water samples, soil, plant and animal debris in sterile bottles were Collected and brought to the laboratory. Sterile petri dishes (5 – 10) were half filled with cool sterilized glass distilled water and few ml of collected water or small amount of soil or debris was put in. Suitable baits (sterilized or boiled seeds of mustards, tomato, filter papers strips etc.) were added to the above petri dishes (one bait / 3 petri dishes). The plates were incubated at 5-20 °C for two to three weeks in dark. (to discourage algal blooms) the water in petri plates was changed frequently (first change after 2 -3 days) with sterile glass distilled water to avoid profusion of bacteria and protozoans. As soon as the growth of fungus was observed on the baits the baits were transferred to a new petri plate containing fresh bait and sterile water. The bait with fungus growth was transferred on an agar medium and the petri plates were incubated at 20 °C.

The baits with fungus growth were observed under low power magnification for identification.

The baits were found to have growth of various aquatic fungi. The genera most frequently observed in fresh water included: Achlya, Allomyces, Saprolegnia, Dictyuchers and Monoblepharis. Which were identified consulting various monographs by using Guide to Aquatic Hypomycetes by C. T. Ingold; Ken drick.

### Precautions

1. Incubate petri dishes in dark to discourage algal blooms.
2. Change the water frequently to avoid anaerobic conditions and for avoiding growth of bacteria and protozoans.
3. Baits in petri plates should be shallowly covered with sterile water.
4. Several baits may be used at a time to have a great diversity of fungi were recorded.

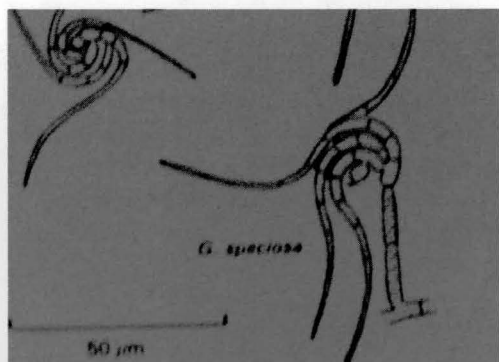
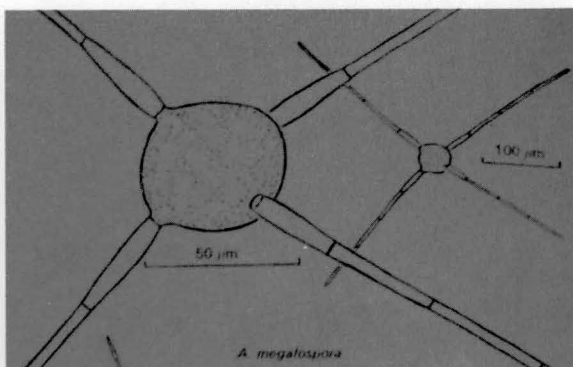
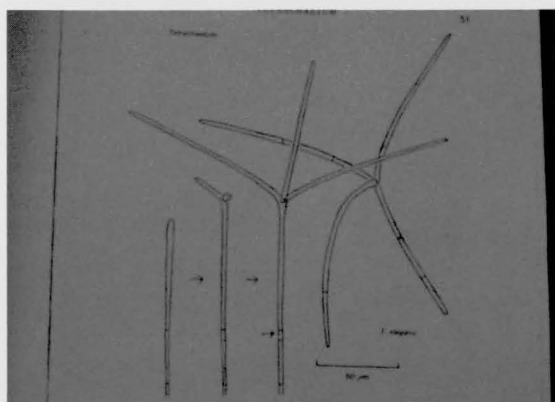
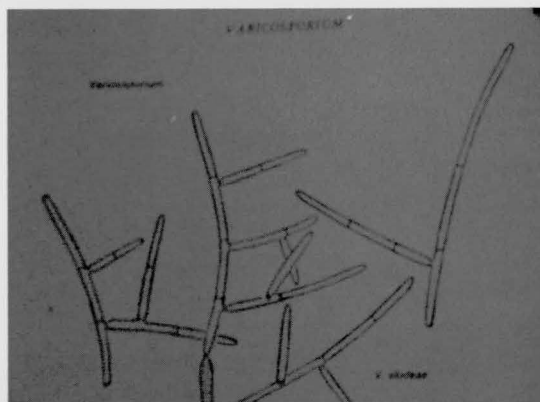
*Gonapodya* sps.*Actinospora* sps.*Tetrachaetium* sps*Varicosporium* sps.

Plate 1 Photographs of Fungi

The observations were recorded in the form of results.

## Results

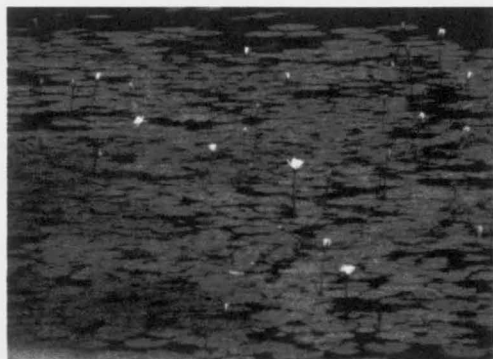
The investigation of the aquatic Hypomycetes occurring in the fresh water wetlands of Goa was carried out from Jan. 2010 to Jan. 2012 as described in the Materials and Methods. The observations are tabulated in the form of tables (Table 1 to 6). In all 19 genera of aquatic Hypomycetes namely *Achyla* sps., *Allatospora* sps., *Dendraspora* sps., *Gonopodya* sps., *Trichadrum* sps., *Allomyces* sps., *Aphanomyces* sps., *Articulospora* sps., *Tetrachaetium* sps., *Varicosporium* sps., *Chaetosporium* sps., *Dictyuchus* sps., *Anguilospora* sps., *Cylindrocarpon* sps., *Actinospora* sps., *Campylospora* sps. were recorded from eleven freshwater wetlands of south Goa and North Goa during the study period.

## Discussion

The observations presented in the results are based on the investigations carried over a period of two years viz. 2010 to 2012 during monsoon, post monsoon and pre monsoon period.

In all nineteen genera of aquatic Hypomycetes were recorded in the wetlands of South & North Goa. Seven genera namely *Achyla* sps., *Allatospora* sps., *Dendraspora* sps., *Allatospora* sps., *Gonopodya* sps., *Trichadium* sps., *Tetrachaetium* sps., *Varicosporium* sps., occurred in all eleven wetlands namely Torshem, Keri, Carmbolim, Mulgao, Sirsai, Shiroda, Curtorim, Xeldem, Velsao, Salauli and Poinguinim of South and North Goa during monsoon, post monsoon and pre monsoon.

Genera namely *Allomyces* sps., *Aphanomyces* sps., *Articulospora* sps., *Tetrachaetium* sps., *Varicosporium* sps., *Chaetosporium* sps., *Dictyuchus* sps., *Anguilospora* sps., *Cylindrocarpon* sps., *Actinospora* sps.,



Wetland from North Goa



Wetland from North Goa



Wetland from South Goa



Wetland from South Goa

## Plate 2 – Photographs of wetlands

Table 1. Showing occurrence of Aquatic Hypomycetes in the wetlands of South Goa during post monsoon.

Sr. No.	Fungus	Year – 2010 - 2012				
		Pernem (Torsem)	Bardez (Shirsai)	Bicholim (Mulgao)	Tiswadi (Carambolim)	Sattari (Keri)
1.	<i>Achyla</i> sps.	+	+	+	-	+
2.	<i>Actinospora</i> sps.	+	+	-	+	-
3.	<i>Angilospora</i> sps.	+	+	-	+	-
4.	<i>Allatospora</i> sps.	+	+	+	+	-
5.	<i>Allomyces</i> sps.	+	+	-	+	-
6.	<i>Aphanomyces</i> sps.	+	+	-	+	-
7.	<i>Articulospora</i> sps.	+	+	-	+	-
8.	<i>Campylospora</i> sps.	+	+	-	+	-
9.	<i>Chaetospermum</i> sps.	+	+	-	+	-
10.	<i>Cylindricarop</i> sps.	+	+	-	+	-
11.	<i>Dendrospora</i> sps.	+	+	+	+	+
12.	<i>Dictyuchus</i> sps.	+	+	-	+	-
13.	<i>Flagellospora</i> sps.	+	+	-	+	+
14.	<i>Gonopodya</i> sps.	-	-	+	-	-
15.	<i>Gyoerffyella</i> sps.	+	+	-	+	-
16.	<i>Lunulospora</i> sps.	+	+	-	+	+
17.	<i>Tetrachaetum</i> sps.	+	+	-	+	-
18.	<i>Tricladurm</i> sps.	+	+	+	+	+
19.	<i>Varicosporium</i> sps.	+	+	-	+	+

M = monsoon = June to Sept. ; = Present; Pre =Pre-monsoon=Feb. to May - = Absent Po=Post monsoon = Oct. to Jan

**Table 2.** Showing occurrence of Aquatic Hypomycetes in the wetlands of South Goa during monsoon.

Sr. No.	Fungus	Year – 2010 - 2012				
		Pernem (Torsem)	Bardez (Shirsai)	Bicholim (Mulgao)	Tiswadi (Carambolim)	Sattari (Keri)
1.	<i>Achyla</i> sps	+	-	+	+	+
2.	<i>Allatospora</i> sps.	+	+	-	+	+
3.	<i>Allomyces</i> sps.	+	-	-	+	-
4.	<i>Dendraspora</i> sps.	-	+	-	-	+
5.	<i>Flagellespora</i> sps.	+	+	-	-	-
6.	<i>Gonopodia</i> sps.	-	-	-	+	-
7.	<i>Tricladium</i> sps.	-	+	-	-	-
8.	<i>Varicosporium</i> sps	+	-	-	-	-

M = monsoon = June to Sept. + = Present

Pre =Pre-monsoon=Feb. to May - = Absent

Po=Post monsoon = Oct. to Jan

**Table 3.** Showing occurrence of Aquatic Hypomycetes in the wetlands of South Goa during Premonsoon.

Sr. No.	Fungus	Year – 2010 - 2012				
		Pernem (Torsem)	Bardez (Shirsai)	Bicholim (Mulgao)	Tiswadi (Carambolim)	Sattari (Keri)
1.	<i>Achyla</i> sps.	+	+	+	+	+
2.	<i>Dendraspora</i> sps.	-	+	+	-	+
3.	<i>Flagellespora</i> sps.	+	+	-	-	+
4.	<i>Lunulospora</i> sps.	+	+	-	+	+
5.	<i>Tricladium</i> sps.	-	+	+	-	+
6.	<i>Tetrachaetum</i> sps.	+	-	-	-	-

M = monsoon = June to Sept. + = Present

Pre =Pre-monsoon=Feb. to May - = Absent

Po=Post monsoon = Oct. to Jan

**Table 4.** Showing occurrence of Aquatic Hypomycetes in the wetlands of North Goa during post monsoon.

Sr. No.	Fungus	Year – 2010 - 2012					
		Murgao (Velsao)	Ponda (Shiroda)	Salcette (Curtorim)	Quepem (Xeldem)	Sangem (Salaulim)	Canacona (Poinganim)
1.	<i>Achyla</i> sps.	+	+	+	+	+	+
2.	<i>Actinospora</i> sps.	-	+	+	-	+	-
3.	<i>Angilospora</i> sps.	-	+	+	-	+	-
4.	<i>Allatospora</i> sps.	+	+	+	-	+	+
5.	<i>Allomyces</i> sps.	-	+	+	-	+	-
6.	<i>Aphanomyces</i> sps.	-	+	+	+	+	-
7.	<i>Articulospora</i> sps.	-	+	+	-	+	-
8.	<i>Campylospora</i> sps.	-	+	+	-	+	-
9.	<i>Chaetospermum</i> sps.	-	+	+	-	+	-
10.	<i>Cylindricarpon</i> sps.	-	+	+	-	+	-
11.	<i>Dendrospora</i> sps.	+	+	+	-	+	+
12.	<i>Dictyuchus</i> sps.	+	+	+	-	+	-
13.	<i>Flgellospora</i> sps.	-	+	+	-	+	-
14.	<i>Gonopodia</i> sps.	+	+	+	-	+	+
15.	<i>Gyoerffyella</i> sps.	-	+	+	-	+	-
16.	<i>Lunulospora</i> sps.	-	+	+	-	+	-
17.	<i>Tetrachaetum</i> sps.	-	+	+	+	+	-
18.	<i>Tricladurm</i> sps.	+	+	+	-	+	+
19.	<i>Varicosporium</i> sps.	-	+	+	-	+	-

M = monsoon = June to Sept. + = Present - = Absent

Pre =Pre-monsoon=Feb. to May Po=Post monsoon = Oct. to Jan

**Table 5.** Showing occurrence of Aquatic Hypomycetes in the wetlands of North Goa during monsoon.

Sr. No.	Fungus	Year – 2010 - 2012					
		Murgao (Velsao)	Ponda (Shiroda)	Salcette (Curtorim)	Quepem (Xeldem)	Sangem (Salaulim)	Canacona (Poinginim)
1.	<i>Achyla</i> sps.	+	+	+	+	+	+
2.	<i>Actinospora</i> sps.	-	+	+	-	+	-
3.	<i>Angilospora</i> sps.	-	+	+	-	+	-
4.	<i>Allatospora</i> sps.	+	+	+	-	+	+
5.	<i>Allomyces</i> sps.	-	+	+	-	+	-
6.	<i>Aphanomyces</i> sps.	-	+	+	+	+	-
7.	<i>Articulospora</i> sps.	-	+	+	-	+	-
8.	<i>Campylospora</i> sps.	-	+	+	-	+	-
9.	<i>Chaetospermum</i> sps.	-	+	+	-	+	-
10.	<i>Cylindricarop</i> sps.	-	+	+	-	+	-
11.	<i>Dendrospora</i> sps.	+	+	+	-	+	+
12.	<i>Dictyuchus</i> sps.	+	+	+	-	+	-
13.	<i>Flgellospora</i> sps.	-	+	+	-	+	-
14.	<i>Gonopodia</i> sps.	+	+	+	-	+	+
15.	<i>Gyoerffyyella</i> sps.	-	+	+	-	+	-
16.	<i>Lunulospora</i> sps.	-	+	+	-	+	-
17.	<i>Tetrachaetum</i> sps.	-	+	+	+	+	-
18.	<i>Tricladurm</i> sps.	+	+	+	-	+	+
19.	<i>Varicosporium</i> sps.	-	+	+	-	+	-

M = monsoon = June to Sept.                      + = Present  
 Pre =Pre-monsoon=Feb. to May                      - = Absent  
 Po=Post monsoon = Oct. to Jan

**Table 6.** Showing occurrence of Aquatic Hypomycetes in the wetlands of North Goa during Pre monsoon.

Sr. No.	Fungus	Year – 2010 - 2012					
		Murgao (Velsao)	Ponda (Shiroda)	Salcette (Curtorim)	Quepem (Xeldem)	Sangem (Salaulim)	Canacona (Poinginim)
1.	<i>Achyla</i> sps.	+	-	+	+	+	+
2.	<i>Actinospora</i> sps.	-	-	+	-	+	-
3.	<i>Angilospora</i> sps.	-	-	+	-	+	-
4.	<i>Allatospora</i> sps.	+	+	+	-	+	+
5.	<i>Allomyces</i> sps.	-	+	+	-	+	-
6.	<i>Aphanomyces</i> sps.	-	+	+	+	+	-
7.	<i>Articulospora</i> sps.	-	+	+	-	+	-
8.	<i>Campylospora</i> sps.	-	+	+	-	+	-
9.	<i>Chaetospermum</i> sps.	-	+	+	-	+	-
10.	<i>Cylindricarop</i> sps.	-	+	+	-	+	-
11.	<i>Dendrospora</i> sps.	+	+	+	-	+	+
12.	<i>Dictyuchus</i> sps.	+	+	+	-	+	-
13.	<i>Flgellospora</i> sps.	-	+	+	-	+	-
14.	<i>Gonopodia</i> sps.	+	+	+	-	+	+
15.	<i>Gyoerffyyella</i> sps.	-	+	+	-	+	-
16.	<i>Lunulospora</i> sps.	-	+	+	-	+	-
17.	<i>Tetrachaetum</i> sps.	-	+	+	+	+	-
18.	<i>Tricladurm</i> sps.	+	+	+	-	+	+
19.	<i>Varicosporium</i> sps.	-	+	+	-	+	-

M = monsoon = June to Sept.                      + = Present  
 Pre =Pre-monsoon=Feb. to May                      - = Absent  
 Po=Post monsoon = Oct. to Jan

*Campylospora* sps. Occurred in the wetlands namely Torshem, Sirsai, Shiroda, Carambolim, Curtorim, Salaulim, Keri, Mulgao, Xeldem, Velsao, Salauli and Poinguinim of both South and North Goa during post monsoon and pre monsoon and didnot occur during monsoons.

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