Appendix
Fungal Spore Calendar for The Year 1997 of Bangalore

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Abstract

Allergy due to fungi has been well established over past several decades. People are almost always exposed to varying concentration of fungal spores at home, at work, or outdoors, which may result in the sensitization of atopic individuals. This is particularly true in Bangalore as fungal spores outnumber pollen grains by a varying ratio of 1:27. In this respect a study of concentration of fungal spores has been carried out in Bangalore during the calendar year of 1997. Rotorod Sampler (model 40) was used for the present study. Analysis of the number of fungal spores shows that the spore counts were maximum during October. The spores of Alternaria, Cladosporium, Aspergillus-Penicillium, Curvularia, Cercospora and Helminthosporium were found all through the year even though their peak varied from month to month. The seasonal variations in the incidence of dominant spores have been presented in the form of calendar to be utilised by allergy patients and medical practitioners.

Keywords: Rotorod Sampler, Fungal spores, Fungal spore calendar, Allergy

INTRODUCTION

Investigations carried out in various parts of the world have proved beyond doubt that fungal spores play an important role in the etiology of respiratory allergic disorders. These spores are widespread and are quite common in the atmosphere. Like pollen, fungal spores are also clinically very significant allergens for both Type I and Type III hypersensitivity. A fungal spore calendar of an area is of great help to the clinicians, which is a prerequisite for immunological treatment. Fungal spore calendars should be compiled and updated very year. The annual spore calendar gives a picture of the change in trends of the peak and concentrations over the years.

Bangalore is one of the fastest growing cities in the Southeastern part of Karnataka state of India. The past studies on the airspora of Bangalore by Agashe et al (1980) who have emphasized on the importance of continuous monitoring of Bangalore atmosphere, provides the importance of pollen and fungal spores monitoring in relation to allergy. Survey of airborne fungal spores at Bangalore, therefore was initiated.

MATERIALS AND METHODS

Air sampling was carried out for a period of one year from January 1997 to December 1997 using a Rotorod sampler (fig 1). The Rotorod sampler (model 40) is a volumetric, rotation impaction device capable of quantitatively sampling airborne particles in the size range 1-100 μm, at sampling rates up to 120 litres per minute (L/Min). The sampler consists of constant speed motor and aerodynamically designed collectors rods, which
are rotated by the sampler motor. The retracting head holds two 'I' rods within the protective housing when the sampler is idle. When the sampler is activated the rods extend to a position perpendicular to the head. Rods are inserted in the pivot blocks and fastened with small thumbscrews.

This was the first time that a Rotorod sampler was used for aerobiological survey in Bangalore. The sampler was installed on the roof of Central Observatory building, Bangalore. Silicon grease was applied to approximately 25mm of the leading edge of the collector rods. This was applied on the rod that moves in the direction of motion, when the sampler is activated. A duty cycle of 10% (1 minute on, 9 minutes off) was used for sampling. The fungal spore counts were expressed as number per m³ air.

**RESULTS**

The aerobiological studies conducted in Bangalore indicated the richness of airborne fungal spores and their qualitative and quantitative features. A total of 70 genera representing three major groups i.e. Ascomycotina, Basidiomycotina and Deuteromycotina were recognised for 1 year. The Deuteromycotina constituted the largest fraction accounting for 71% of the catch. It was represented by numerous genera and the more common among them being *Cladosporium, Alternaria, Aspergillus Penicillium, Nigrospora, Helminthosporium, Cercospora and Curvularia.* The Basidiomycotina (16%) formed the second most predominant group comprising of Basidiospores, Smut spores and Uredospores. The Ascomycotina (12%) ranked the third major group, which included Ascospores like *Chaetomium, Didymosphaeria, Leptosphaeria, Pleospora, Paraphaeosphaeria, Pringsheimia and Sporormia.*

During one year period, a total of 50,919 spores/ m³ were recorded. The predominant spore types recorded during the year were *Cladosporium, Alternaria, Aspergillus-Penicillium, Nigrospora, Curvularia, Basidiospores, Ascospores and Smut spores accounted to 84.34% of the total catch. Their percentage contribution against total is shown in fig 2.

The incidence and concentration of fungal spores varied from month to month during the study period as shown in fig. 3. The Highest monthly concentration was recorded in October with a total of 7698 spores/m³ and the lowest was recorded in the month of August with 2639 spores/m³. The spores of *Cladosporium, Alternaria, Cercospora, Helminthosporium, Aspergillus-Penicillium and smut spores were found throughout the year even though their peak varied.*
Fig. 2. Percentage contribution of predominant fungal types during 1997.

Fig. 3 Monthly variation in the presence of fungal spores for 1997.
from month to month. The seasonal variations in the incidence of dominant spores have been presented in the form of a calendar to be utilized by allergy patients and medical practitioners (Fig 4).

**DISCUSSION**

The results of this study suggest that atmosphere of Bangalore is never free of fungal spores and forms an important biopollutant of the atmosphere.

![Calendar of fungal spores](image)

**Fig. 4.** Airborne fungal spore calendar of Bangalore for the year 1997.

<table>
<thead>
<tr>
<th>Spores</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<th>Oct</th>
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<tbody>
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<td>Alternaria</td>
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<td>Basidiosporus</td>
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<td>Cladosporia</td>
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<td>Cercospora</td>
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<td>Curcularia</td>
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<td>Helminthosporia</td>
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<tr>
<td>Nigrospora</td>
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<tr>
<td>Smut spores</td>
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</tbody>
</table>

**MONTHS**

- **A = 1** - 49 Fungal spores
- **B = 50** - 99 Fungal spores
- **C = 100** - 499 Fungal spores
- **D = 500** - 999 Fungal spores
- **E = 1000** - 4999 Fungal spores
Airborne fungal spores exhibited monthly variations though no distinct seasons could be demarcated. However, there was a general trend of increasing variety and concentration from October to December, relatively high numbers were also encountered during April to July. Bhat & Rajasab (1991) also reported large numbers of fungal spores during September to March in Gulbarga; Agarwal et al (1969) during July to September and November to December in Mysore; Singh et al (1987) from July to October in Dehradun, Satheesh et al (1997) during November to December in Kodalkanall. But during August and September, very low incidences of spores were noticed and this variation could be accounted for heavy rainfall.

The spores of Cladosporium were dominant and represented nearly 45.22% of the total fungal spora. Its overall dominance is probably explained by its saprophytic habit and ability to grow in a variety of substrates together with the capacity to produce enormous number of spores which are adapted to passive dispersal (Ingold, 1971). The dominance of Cladosporium spores in the air have been reported by many researchers in India and Abroad (Tilak, 1982; Agashe et al, 1983; Hawke and Meadows, 1989) whereas alternaria has been the predominant genus at some sites (Singh and Babu, 1983; Kumar 1984).

The incidence and concentration of fungal spores varied from month to month during the study period as shown in fig. 4. The peak season for Cladosporium occurred at April and July. The spores of Ascomycetes, Basidiomycetes, Smuts, Alternaria, Curvularia showed peak incidence during October to December, whereas Aspergillus-Penicillium established their peak in April. The major types showed an increase during monsoons associated with high relative humidity and maximum rainfall. Thus the various factors associated with relative humidity, wind speed, rainfall and temperature played their role on effecting sporulation and subsequent dispersal of airborne particles.

Similar fungal spore calendars have been prepared for various other centers in India (Nair et al., 1986, Bhat and Rajasab, 1988; Satheesh et al., 1994). However, perhaps this is the first time fungal spore calendar for Bangalore city is reported here. It has been noted that the quantitative nature of the fungal spores may be the same in most of the places however, they differed in concentration and seasonal occurrence. This variation could be attributed to the difference in climate and the development of host plants, which will vary from place to place and year to year.

In conclusion Fungal calendars should be compiled and updated very year. The annual fungal spore calendars give a picture of the change in trends of the peak and concentrations over the years. Allergy practitioners should keep a close watch of fungal spore calendar, which will help in selecting antigenic extracts of fungal aerollerens for skin testing to assess allergenicity. This will help in a better correlation of allergy symptoms of patients with atmospheric fungal spores and proper diagnosis.

ACKNOWLEDGEMENTS

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REFERENCES


APPENDIX - II

AEROALLERGENS AND HUMAN HEALTH - AEROBIOLOGICAL STUDIES - MEDICAL UNIT
(Project financed by the Ministry of Environment & Forestry, Govt of India)
Lake Side Medical Center & Hospital
33/4 Manees Avenue Road, Bangalore 560 042

STUDY INSTRUMENTS OR QUESTIONNAIRE - ADULT:

<table>
<thead>
<tr>
<th>Race of survey:</th>
<th>Date:</th>
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</tbody>
</table>

**PERSONAL DATA:**

Name     :  
Address  :  

Age     :  years  
Height  :  Cms.  
Weight  :  kg  
Religion:  
Occupation:  
Habitat :  

0. Duration of stay in Bangalore:  years  
1. State of origin:  
2. Distance from home to working place:  kms  
3. Conveyance used:  
4. Education:  
5. Economic status:  

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Cough</td>
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<tr>
<td>Breathlessness</td>
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<td>Migraine</td>
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<tr>
<td>Conjunctivitis</td>
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<tr>
<td>Urticaria</td>
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<td>Fever</td>
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<td>Wheeze</td>
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</table>

A. COUGH:

1. Nature:  
   - Dry  
   - Productive  
2. Sputum:  
   - White  
   - Yellow  
   - Yellowish green  
   - Brownish  
   - Blood mixed  
3. Whether associated with:  
   - Fever  
   - Rhinitis  
   - Breathinglessness  
   - Conjunctivitis  
   - Urticaria  
4. Whether headache has to get up at night:  
   - Almost awake  
   - Frequently 2-3 times in night  
   - Occasionally  
   - No  
5. Characteristic:  
   - Seasonal  
   - Perinatal  
   - Irregular  
6. Worst months:  
   - Jan  
   - Feb  
   - Mar  
   - Apr  
   - May  
   - June  
   - July  
   - Aug  
   - Sept  
   - Oct  
   - Nov  
   - Dec  
7. Time on onset:  
   - A.M.  
   - P.M.  
8. Number of symptoms:  
   - A.M.  
   - P.M.
B. BREATHELESSNESS

1. Nature: Tightness in chest with difficulty in breathing /wheezey /without wheeze /asthma - attack.
2. After exercise: Normal /can run for short distance /limited activity to walking
3. Whether any particular activity precipitates the attack - Y/N.
If yes specify ..........................................................

4. Whether associated: Fever /cough /rhinitis /conjunctivitis /urticaria

5. Nocturnal dyspnoea: Almost awake all night / frequently 2-3 times / occasionally /never.

6. Nocturnal wheezing: yes /No

7. Characteristics: Seasonal /Perinatal /Irregular

8. Worst month: □ Jan □ Feb □ Mar □ Apr □ May □ June □ July □ Aug □ Sept □ Oct □ Nov □ Dec

          P.M. : 1 2 3 4 5 6 7 8 9 10 11 12

C. RHINITIS

1. Nature: Running nose /itching nose / sneezing / stuffy or blocked nose / headache / itchy throat / ears

2. Discharge: Watery /sneezing /purulent

3. Whether associated: Fever /cough /dyspnoea / conjunctivitis / urticaria

4. Frequency: Occasional /frequent

5. Sneezing: Few /multiple / none

6. When you have cold does it go to your chest: Never /usually / always.

7. Characteristics: Seasonal / Perinatal / Irregular

8. Worst month: □ Jan □ Feb □ Mar □ Apr □ May □ June □ July □ Aug □ Sept □ Oct □ Nov □ Dec

          of symptoms : P.M. : 1 2 3 4 5 6 7 8 9 10 11 12

D. CONJUNCTIVITIS

1. Nature: Watering /redness / irritation / swelling of lids

2. Whether associated: Fever /breathlessness /rhinitis / cough / urticaria / none

3. Characteristics: Seasonal / Perinatal / Irregular

8. Worst month: □ Jan □ Feb □ Mar □ Apr □ May □ June □ July □ Aug □ Sept □ Oct □ Nov □ Dec

          of symptoms : P.M. : 1 2 3 4 5 6 7 8 9 10 11 12

E. URTICARIA

1. Site:

2. Duration:

3. Characteristics: Chronic / Intermitant

4. Type: Itching / non-itching

5. Whether associated with: Cough / breathlessness / fever / rhinitis / conjunctivitis / none

OTHER ILLNESS

1. Bronchitis □ Yes □ No

2. Tuberculosis □ Yes □ No
3. Diabetes Mellitus □ Yes □ No
4. Hypertension □ Yes □ No
5. IHD □ Yes □ No
6. Any other illness □ Yes □ No

PAST HISTORY OF
1. Allergic disorders - rhinitis / dermatitis / atopic / sinusitis / nasal polyps / GI disorders / adverse reaction to food or drugs
2. Injury to airways in early childhood

HABITS:
1. Smoking: □ Never □ Occasional □ Habitual □ Ex-smoker
2. No. of cigarettes/day: ...........................................
3. Duration of smoking _______ yrs
4. Alcohol: Occasional □ Never □ Habitual
5. Type of smoke □ manufactured cigg. □ Hand rolled cigg □ Chukka □ Bidis □ Pipe □ Cigar □ Combination □ Others
6. Age when started smoking: ................................ years
7. Age when left smoking: ................................ years
8. Reason for stopping smoking: □ Doctors advice □ Health reason □ Family reason □ Social □ Economic □ Self motivation □ Others
9. Are you a passive smoker □ Y □ N If yes, for how many years ________________

FAMILY HISTORY
1. Household
2. Total numbers
3. Family [H/O] asthma / rhinitis / diabetes / hypertension / other allergic disorders / other diseases

PREVIOUS MEDICATIONS
Allopathic Y/N Duration

Other systems
Details

RESIDENCE
Area: Urban □ Rural
Type - Kucha □ Pucca □ Apartment □ Flat □ Roof □ Thatched □ Asbestos □ Concrete □ Tiled
Ventilation - Good □ Satisfactory □ Poor
Surrounding area - Dew □ Dry
Sanitary conditions - Satisfactory □ Unsatisfactory
Pests pests - Y/N. Specify ________________________________

FOR HOUSEWIFE:
1. Cooking fuel used: Firewood □ Coal □ Cow dung □ Kerosene oil □ Gobages □ Gas □ Electricity □ Others
2. Time spent in kitchen __________ days/week
PRECIPITATING FACTORS:
Allergic inhalants: Pollen / house dust / carpet dust / cotton dust / wheat dust / danders - cat or dog or horse or cow or buffalo / feather - chicken or pigeon / fumes / perfumes / A.C. / outdoors / closed room
Ingestants: Foods / drugs / chemicals
Physical agents: Physical exertion / cold / heat / rain
Psychological factors: Emotional upset / anger episodes / frustrations / anxiety / depression / others
Others: For children / normal / over cared / neglected / irritable

OCCUPATIONAL/INDUSTRIAL:
* Employment at industry - regular / casual
  No. of years with the present job ..........................................
  No. of hours spent ______ hours/day
* Nature of work - office work / chemical / stores
  Inside factory / other - specify ...........................................................
* Job conditions - exposed to dust/ fumes/ smoke/ irritant/ chemical/ gasses/ excessive heat or cold/ A.C.

MANUFACTURING PROCESSING
Condition to which you are exposed
* Do you feel your symptom are associated with work - ☐ Yes ☐ No
* Do your symptom increase when you enter the work place - ☐ Yes ☐ No
  If yes, whether immediately / after few hours
* Are there any specific area where your symptoms aggravate - ☐ Yes ☐ No
* Did your problem start when you changed to fresh job - ☐ Yes ☐ No
* Do you suspect anything at work in causing your problem ☐ Yes ☐ No
  Specify ...........................................................................................
* Does your problem get better when you are -
  away from work place ☐ Yes ☐ No
  during holidays ☐ Yes ☐ No
  After working hours ☐ Yes ☐ No

ON EXAMINATION:

INVESTIGATION:
Blood:

Urine:

Stock:

Xray chest PA

Spirometry

<table>
<thead>
<tr>
<th>REACTIVITY</th>
<th>SPIROMETER READING</th>
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<tr>
<td>FeV1</td>
<td>Age _______ Height_______</td>
<td>Age _______ Height_______</td>
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<tr>
<td>PEF</td>
<td>FeV1 _______________</td>
<td>FeV1 _______________</td>
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<td>PD 2 0 Ht</td>
<td>FVC _______________</td>
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Skin test (Prick)  Antigen  Positivity

Peak flow reading: Before: ___________________________ After inhalation of bronchodilator ___________________________