AIR-SPORA OF MYSORE

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Received July 6, 1970

(Communicated by Dr. G. Rangaswami, F.A.Sc.)

ABSTRACT

A survey of the air-spora at Mysore was carried out from November 6, 1965 to November 5, 1966, using vertical cylinders as spore trapping devices. Basing on the visual features counts were taken for sixty-one types of which 47 belonged to Fungi, 5 to Algae, 4 to Vascular plants, 4 to Animal parts and one to Lichens. Fungi contributed to 88% of the total air-spora, Cladosporium alone accounting to half the numbers. Vascular plant parts made up 10.6% of the air-spora and the contributions of Animal parts, Algae and Lichens were 1.076, 0.169 and 0.036% respectively. Relatively high incidence of smut spores and Epicoccum conidia is a notable feature of the air-spora of Mysore. There is no spore-free season at Mysore. The highest incidence of air-spora is noticed during the monsoon seasons and the lowest during the hot and dry season. Data on the seasonal periodicities of many spore types were presented for the first time. Data on clumping in the air-borne dispersion units of Cladosporium, Aspergilli, smut spores, Rhizopus, Hyphal fragments, and Alternaria is reported. Cladosporium made up 87.5% of the total fungal colonies on 21 exposures made during May to September 1966. Aspergillus spp. are more common at Mysore than Penicillum spp. Bacterial colonies were estimated to be 14.4% of the total colonies. The usefulness of cylinder traps for aerobiological studies of Alternaria, Cercospora, Helminthosporium, Uredosporas, Pollen, etc., is indicated.

INTRODUCTION

The few aerobiological studies that are conducted in India so far (reviewed recently by Sreeramulu, 1967) have indicated the presence of a rich air-spora and their seasonal variations. Still there are many parts of the country from which similar information is wanted and Mysore State being one of them a survey was undertaken. Vertical cylinders, which were shown to be reasonably efficient in sampling air-spora by Gregory (1951) and Hirst (1959)
were selected as air samplers and methods developed by Ramalingam (1968) were followed for the aerobiological survey conducted from November 6, 1965 to November 5, 1966 in the post-graduate campus (Manasa Gangotri) of the University of Mysore. The results of the survey are reported here.

**Spore Trapping Methods**

Glass cylinders of 4.8 mm. diameter wrapped with an adhesive coated cellophane square were used for spore trapping. The spore traps were exposed on the top of the Botany block, 9.2 m. above the ground level from November 6, 1965 to May 18, 1966 and 1.5 m. above the ground level near the block in an arable area in the rest of the period of survey. The methods followed are the same as those described by Ramalingam (1968). In all, 365 exposures were made for obtaining data by visual count method of which 11 exposures were spoiled or lost. 21 exposures were made for culture studies on different days of May to September 1966.

**Trapping Site**

The trapping site is in the centre of Manasa Gangotri, in the western extreme of the Mysore City, 12° 18' N and 76° 42' E, 750 m. above the mean sea-level. The campus is thinly populated and had a dozen buildings accommodating different faculties. Most of the area is occupied by wild herbs, grasses being the dominant vegetation. A number of avenue trees and ornamental plants are cultivated around the buildings and besides the roads. The campus has some area under mango, sapota and coconut plantations. The area around the campus is under the cultivation of rainfed crops like sorghum, bajra, ragi, horsegram, castor, etc. The millets are grown from May to September and rest of the crops from October to December. The nearest of such fields is 200 m. towards the north of the spore trap.

**Weather**

The place recorded temperature varying from 11 to 37° C, only the months of March and April are relatively hot. Relative humidity showed a great diurnal and seasonal variation. The monsoon period May to November is relatively humid, while the other months are dry, sometimes recording relative humidity as low as 11%. Most of the rainfall is due to south-west monsoon from May to September and the north-east monsoon gave only a few showers during November. Rain was recorded on 72 days during the trapping period and the total amount was 686 mm. The annual
average wind velocity for the trapping period was 10.9 Km. P.H. The monsoon and summer months were particularly windy. This place records an average of 12 hours of sunlight per day of which 7 to 9 hours have bright sunshine.

RESULTS OF VISUAL COUNTS

In addition to the dust articles and smoky spheres more than 80 types of biopollutants of air were identified from the spore trap catches, basing on the visual features. Counts were made under 61 named types and the data are presented as the number of spores caught per one square centimetre of the trap surface per day. Information on the seasonal periodicity, mean number caught in the period of survey, number of days on which records were made and percentage contributions of each of the types is presented in Table I. The seasonal distribution of 17 common air-borne types and that of total air-spora are plotted as 6-day running means at 3-day intervals in Figs. 1, 2 and 3.

Total air-spora.—The data show the absence of a spore-free period at Mysore. Air-spora is relatively abundant during the period July to September and for a short period between November and December (Fig. 1). These periods correspond with the monsoon periods and abundance of vegetation. The period of lowest spore incidence (February, March and April) is the driest and hot period of the year.

Fungal components of the air-spora.—The 47 air-borne fungal types counted contributed to about 88% of the total numbers of the air-spora. The percentage contributions of the classified groups are Myxomycetes 0.045, Phycomycetes 0.915, Ascomycetes 2.095, Basidiomycetes 5.575 and Deuteromycetes 67.690. Hyphal fragments, which were not included in any one of the above groups made up 3.793% of the total.

The highest catches of Cladosporium, the most common element of the air-spora, recorded on many days in July, August, September, November and December coincided with the abundance of drying vegetation in the area.

Fragments of hyphae measuring from 5 to 150 μ in length were one of the chief elements of the air-spora at Mysore. Majority of the hyphae were brown, septate, thick-walled types, hyaline fragments were few and infrequent. On several occasions the fragments of conidiophores were trapped in association with conidia and Cladosporium was the most common of them followed by Aspergillus, Periconia, Curvularia, Penicillium, Alter-
TABLE I

Components of the air-spora at Mysore and their seasonal variations, percentage contributions and other data during the period November 6, 1965 to November 5, 1966

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<tr>
<th>Sl. No.</th>
<th>Biopollutant</th>
<th>Period of occurrence</th>
<th>Peak period</th>
<th>No. of days with catches</th>
<th>Mean catch No./ cm²</th>
<th>Percentage</th>
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Air-Spore of Mysore

TABLE I—(Contd.)

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<th>Seasonal periodicity*</th>
<th>No. of days with catch</th>
<th>Mean No./cm³</th>
<th>Percentage in total air-spora</th>
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* Indicated by numbers corresponding with the months of the year.

naria and Memnoniella. Hyphal fragments showed a distinct seasonal periodicity (Fig. 1) with an average catch of 180/cm² in the dry period and 90/cm² in the monsoon period.

Most of the smut spore catches were identified to the genera Ustilago and Sphacelotheca. Spores of Neovossia were noticed on a few exposures and only a single spore ball of Tolyposporium was encountered in the entire period of the survey. Smut spores showed two seasonal maxima, the one during August to September coinciding with the ripening and harvest of sorghum, and the other during December to February when the grasses in the area are in ripening and drying stages.

Single-celled, black or brightly-coloured spores, usually in chains, resembling those of Aspergillus and Penicillium, were counted under a single group. Even though they were present throughout the year, their numbers during the monsoon season were relatively higher (Fig. 1). Hyaline, angular to roughly circular spores resembling aciospores of rusts were frequent in the months of February and March (Table I). Their seasonal abundance coincided with the period when the aerial infection on the egg plants was noticed in the area.

Vascular plant parts.—In addition to pollen the air-borne vascular plant material trapped and counted separately were epidermal hairs, xylem and fibres and epidermal peels including cuticular fragments. They made up
Fig. 1
Air-Spora of Mysore

Fig. 2
Fig. 3
10.629% of the total air-spora. Pollen alone contributed 4.087%. Counting of pollen was made under specific groups and the data would be reported elsewhere.

The group xylem and fibres, which includes xylem, fibres, sclerenchyma, parenchma and collenchyma, were recorded in great numbers in the months of March, April and May (Fig. 3). Epidermal hairs and epidermal parts were trapped on most days of the trapping period with high catches during the period December to February (Fig. 3). Various kinds of epidermal hairs were caught on the trap surfaces of which the simple, unicellular hairs of graminicolous plants are the most abundant.

**Insect components of the air-spora.**—Insect hairs, eggs, scales and small insects counted from the spore trap catches made up only to 1.076% of the total air-spora. Insect hairs and scales (Fig. 3) were frequently caught in groups during the growing season. Insect eggs were common in November and December. Most of the minute insects caught were mites and their maxima was in August.

**Algal components of the air-spora.**—The five types of algal groups counted made up only to 0.169% of the total air-spora. Coccoid chlorophycean cells were always caught in groups and most of them seem to belong to *Protococcus*. Diatoms were caught on 25 samples, most of them as single cells, often in association with soil particles. Chlorophycean filaments included a few fragments which could be referred to the genus *Spirogyra*. Coccoid cells of *Mxophyceae* were usually caught in groups, while the filaments were in single units. A few of these filaments were identified to the genus *Oscillatoria*.

**Lichen components of the air-spora.**—Soredia of Lichens were counted on 9 exposures and their percentage contribution to total air-spora is 0.036%. Their catches were more frequent in the early monsoon period (Table I).

**Miscellaneous.**—Black smoke spheres were frequent in the period December to March. Their counts were not included for estimating the total air-spora. A few starch grains were also identified in the spore trap catches.

**Clumping in air-borne dispersion units.**—To collect information on this aspect, counts were taken separately for spores and spore units of certain common air-borne fungal types and an analysis of the frequencies has been
made. The data for Cladosporium, Smut spores, 'Aspergilli' and Rhizopus is presented in Table II. 80.8% of hyphal fragments were trapped as individual fragments, 9.0% as groups of 2, 4.0% as groups of 3, 2.2% in groups of 4, 1.4% in groups of 5, 0.6% in groups of 6-10, 0.4% in groups of 11-15 and 0.2% in groups of 16-20. While 86.8% of Alternaria conidia were caught as single spores, 12.8 and 0.8% were caught as two spored and three spored chains respectively.

Table II

Percentage frequencies of air-borne dispersion units of Cladosporium, Smut spores, 'Aspergilli', and Rhizopus type

<table>
<thead>
<tr>
<th>No. of spores per unit</th>
<th>Cladosporium</th>
<th>Smut spores</th>
<th>'Aspergilli'</th>
<th>Rhizopus type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31.6</td>
<td>51.4</td>
<td>54.4</td>
<td>39.7</td>
</tr>
<tr>
<td>2-5</td>
<td>26.3</td>
<td>24.1</td>
<td>27.2</td>
<td>17.6</td>
</tr>
<tr>
<td>6-10</td>
<td>10.9</td>
<td>9.9</td>
<td>6.1</td>
<td>14.4</td>
</tr>
<tr>
<td>11-20</td>
<td>11.5</td>
<td>6.3</td>
<td>3.3</td>
<td>15.5</td>
</tr>
<tr>
<td>21-30</td>
<td>5.5</td>
<td>3.2</td>
<td>1.0</td>
<td>8.6</td>
</tr>
<tr>
<td>31-40</td>
<td>4.3</td>
<td>1.4</td>
<td>1.4</td>
<td>3.5</td>
</tr>
<tr>
<td>41-60</td>
<td>3.7</td>
<td>2.3</td>
<td>2.4</td>
<td>0.5</td>
</tr>
<tr>
<td>61-80</td>
<td>2.4</td>
<td>0.7</td>
<td>2.3</td>
<td>0.2</td>
</tr>
<tr>
<td>81-100</td>
<td>1.1</td>
<td>0.7</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>101-120</td>
<td>0.0</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>121-140</td>
<td>0.6</td>
<td>0</td>
<td>0.4</td>
<td>0</td>
</tr>
<tr>
<td>141-160</td>
<td>0.6</td>
<td>0</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>161-180</td>
<td>0.2</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>181-220</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Results of Colony Counts

From the Petri dish cultures of 21 exposures 9,759 colonies of fungi and one algal colony were identified. The colony counts for the types are as follows: Cladosporium 8,541; Alternaria 272; Curvularia 201, Helminthosporium 51, smut colonies 45, Sphaerospidales 42, Aspergillus 28, Monilia 12,
Air-Spora of Mysore

Torula 7, Memnioniella 6, Penicillium 5, Cordana 2, Fusarium 2, Nigrospora 2, Periconia 2, Verticillium 2, Epicoccum 1, Gloeosporium 1, Humicola 1, Stachybotrys 1, Algal colony 1 and non-saporulating fungi 534. The percentage contributions calculated on the basis of colony counts are Cladosporium 87.5, Alternaria 2.8 and Curvularia 2.1. The rest of the types contributed to less than 1% each. Species of Aspergillus appear to be more frequent at Mysore than those of Penicillium. Five fungi Monilia, Verticillium, Gloeosporium, Humicola and Stachybotrys were identified from the cultures, while they could not be identified and counted separately by visual methods. Reliable data on bacterial counts was obtained only on eight exposures. Of the 8,457 colonies, 1,221 belonged to Bacteria (including Actinomycetes) and their contribution to total air-spora is estimated as 14.4%. This figure is very close to the estimate reported earlier on the basis of a single day's data (Ramalingam, 1968).

Discussion and Conclusions

The air-spora at Mysore is very rich as in many parts of India. Of the 61 biopollutants counted 47 belonged to Fungi, 5 to Algae, 4 to Vascular plants, 4 to animal parts and one to Lichens. Spores of Bryophytes or Pteridophytes were not recorded in this survey. Conidia of Cordana, Dictyarthrinicium and Helicomycetes, Melampsora Uredospores, Aeciospores, Pycnidia, Myxomycete spores, Filaments and Coci of Chlorophycean and Myxophycean members and Diatom cells were new records of biopollutants of air in India.

Fungi accounted to about 88% of the total numbers of air-spora, two-thirds of these numbers were contributed by saprophytic forms like Cladosporium, Aspergilli, Periconia, etc. Many types whose mean catches were insignificant were recorded in relatively great numbers on certain days, like that of Aeciospores 429/cm² on April 4, 1966; Albugo 1,091/cm² on May 29, 1966; Epicoccum 440/cm² on March 21, 22, 23 and 24, 1966; Pyricularia 119/cm² on October 20, 1966; Sclerospora 48/cm² on August 15, 1966 and Insect hairs 631/cm² on September 12, 1966. Such high concentrations might play an important role in plant, human and animal health. Spore trapping should be aimed at detecting and/or forecasting such periods so that effective control measures could be undertaken.

Cladosporium is the chief constituent of the air-spora at Mysore contributing to 49.8% of their total numbers. This is in agreement with the
previous reports from India (Sreeramulu and Seshavataram, 1962; Sreeramulu and Ramalingam, 1966; Bharat and Nandi, 1966) and also from other countries (Gregory and Hirst, 1957; Kramer, Pady, Rogerson and Ouye, 1959; Hyde and Adams, 1960; Meredith, 1962; Rees, 1964; Harvey, 1967). High incidence of smut spores and *Epicoccum* conidia seems to be a notable feature of the air-spora of Mysore. Smut spores were proved to be one of the potential factors of allergenicity in cattle (Ivanov, 1949) and it would be worth while to study their atmospheric incidence in greater detail coupled with clinical studies. The seasonal variations recorded for the different components of the air-spora at Mysore is closely related with the vegetation, weather conditions and the nature of the type, as concluded by Gregory (1961) and Sreeramulu (1967) about the air-spora in general. Seasonal periodicities of several types like xylem and fibres, plant hairs, *Epicoccum*, *Oidium*, and types reported as new air records, were reported for the first time from India in this survey.

Some spore types are more frequently dispersed as groups. Information presented on the clumping of dispersion units of *Cladosporium*, Smut spores *Aspergilli* *Rhizopus*, Hyphal fragments, and *Alternaria* would be valuable in estimating their infection units, dispersal distances, impaction, etc. Larger clumps as well as higher percentage of clumps were recorded in the present survey than those reported by Harvey (1967) from Hirst trap studies at Cardiff.

A comparison of the data of this survey with that of Sreeramulu and Ramalingam (1966) who employed Hirst spore trap, Kalra and Dumbrey (1957) who have used gravity slides, Rajan, Nigam and Shukla (1952) who have used Petriplate exposures and Subba Reddi (1970) who had also employed cylinder traps as in this survey, have led to the following conclusions. Even though the cylinder trap catches are far lower than Hirst trap, they are more significant as compared with Gravity slides and Petri plate exposures. This technique is efficient for sampling relatively large-sized spores like *Alternaria*, Uredospores, *Helminthosporium*, *Cercospora*, pollen, etc., which are dispersed by wind mainly during daytime.

**Acknowledgements**

The author is grateful to Prof. P. H. Gregory, F.R.S., and Prof. T. Sreeramulu for going through the manuscript. He is thankful to the Director,
Reisional Meteorological Centre, for the supply of weather data and to Prof. K. N. Narayan for facilities.

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**EXPLANATION OF FIGURES**

**Fig. 1.** Seasonal periodicities of some predominant fungal types and total air-spores at Mysore during the period November 6, 1965 to November 5, 1966.

**Fig. 2.** Seasonal periodicities of some more common fungal components of air at Mysore during the period November 6, 1965 to November 5, 1966.

**Fig. 3.** Seasonal periodicities of some common vascular plant parts and animal parts at Mysore during the period November 6, 1965 to November 5, 1966.