A SURVEY OF AERO-ALLERGENIC POLLEN AND SPORES IN THE URBAN ENVIRONMENT OF BAREILLY (INDIA)*

SUDERSHAN KUMAR

Palynology Laboratory, National Botanical Research Institute, Lucknow 226 001 (India)

Abstract

In all, 7 fungal spore types and 22 pollen taxa apart from grasses have been reported as aero-allergens at Bareilly. The fungal taxa namely *Alternaria*, *Cladosporium*, *Curvularia* and *Helminthosporium* occur throughout the year. For the occurrence of fungal spores there are 3 major seasons namely spring-summer (March-June), rainy (July-October) and winter (November-February). The highest number of spores have been recorded during post rainy season and spring-summer season closely followed to it, while the lowest spore counts have been recorded during winter. Too low temperature coupled with low wind velocity during winter and heavy rains during rainy season have adverse effect on the aerial incidence of fungal spores.

Apart from grasses, 22 aeroallergenic pollen taxa have been recorded in the atmosphere of Bareilly, of which grass pollen are most dominant among all pollen types. In contrary to fungal spores summer-rainy is lean period and so also is November-January for the occurrence of pollen grains in the atmosphere.

The influence of climatic factors on the aerial incidence of pollen indicates that temperature ranging from 10-30°C as the one in spring and also in autumn and a wind speed of 5-10 km/h have a positive effect on high pollen catch, while to high temperature exceeding 40°C or too low temperature below 10°C and heavy rains have an adverse effect on pollen incidence in the atmosphere.

Introduction

Aerobiology in India is just a century old, in 1874 Cunningham examined the air over Calcutta and recorded pollen and spores together with some micro-organisms. After a long gap of inactivity, Mehta (1940, 1952) investigated rust spores in the air at a few places in northern India. The latter part of the present century has witnessed significant advances made in aerobiological studies both in relation to human allergy and plant pathogenicity (Rajan *et al.*, 1952; Kalra & Dumbrey, 1957; Ramalingam, 1971; Mittre & Khandelwal, 1973; Agarwal & Shivpuri, 1974; Tilak, 1974; Tilak & Bhalke, 1978; Gaur, 1978, 1980; Sarna & Govil, 1979; Mandal & Chanda, 1981; A. B. Singh, 1982; Nair & Joshi, 1982; N. I. Singh, 1983; S. Kumar, 1982, 1984).

The prevalence of pollen and spore content is very important to the scientist engaged in various fields of research such as plant pathology, industrial microbiology and medicine. The atmospheric pollen and fungal spores play an important role in the etiology of allergic disorders. The incidence of allergic disorders in India is reported to be quite high (Shivpuri, 1981) but data of aeroallergens of this area are not available, hence the present study has been undertaken.

The present treatise relates to a survey of aeroallergenic pollen and spores in urban environment at Bareilly (79° 24'E long. and 28° 22' lat., 177 m. a. s. l.) situated in the foot-hills of Kumaun in the Gangetic region of northern India. The effect of meteorolo-

*Part of Ph.D. Thesis "Aerobiology of Bareilly with particular reference to pollen grains" of Rohilkhand University (Bareilly), U.P., India.

gical factors on the aerial frequency of various sporomorphs has also been dealt with in the present study.

Material and Method

The air-borne pollen and spores have been trapped at Bareilly by means of the inclined slide method, using an aeroscope rotated by a windvane assembly. The slides coated with thin film of glycerine jelly have been exposed after every 24 hrs in the aeroscope installed at a height of 10 m on the terrace of the Department of Botany, Bareilly College (Rohilkhand University), Bareilly. The exposed area has been covered with glycerine jelly and mounted by a rectangular cover glass (25 × 50 mm) of 12.5 sq cm. The pollen and fungal spores recognised from the exposed slides have been identified with the help of pollen-spore reference index slides of groundflora.

Observations

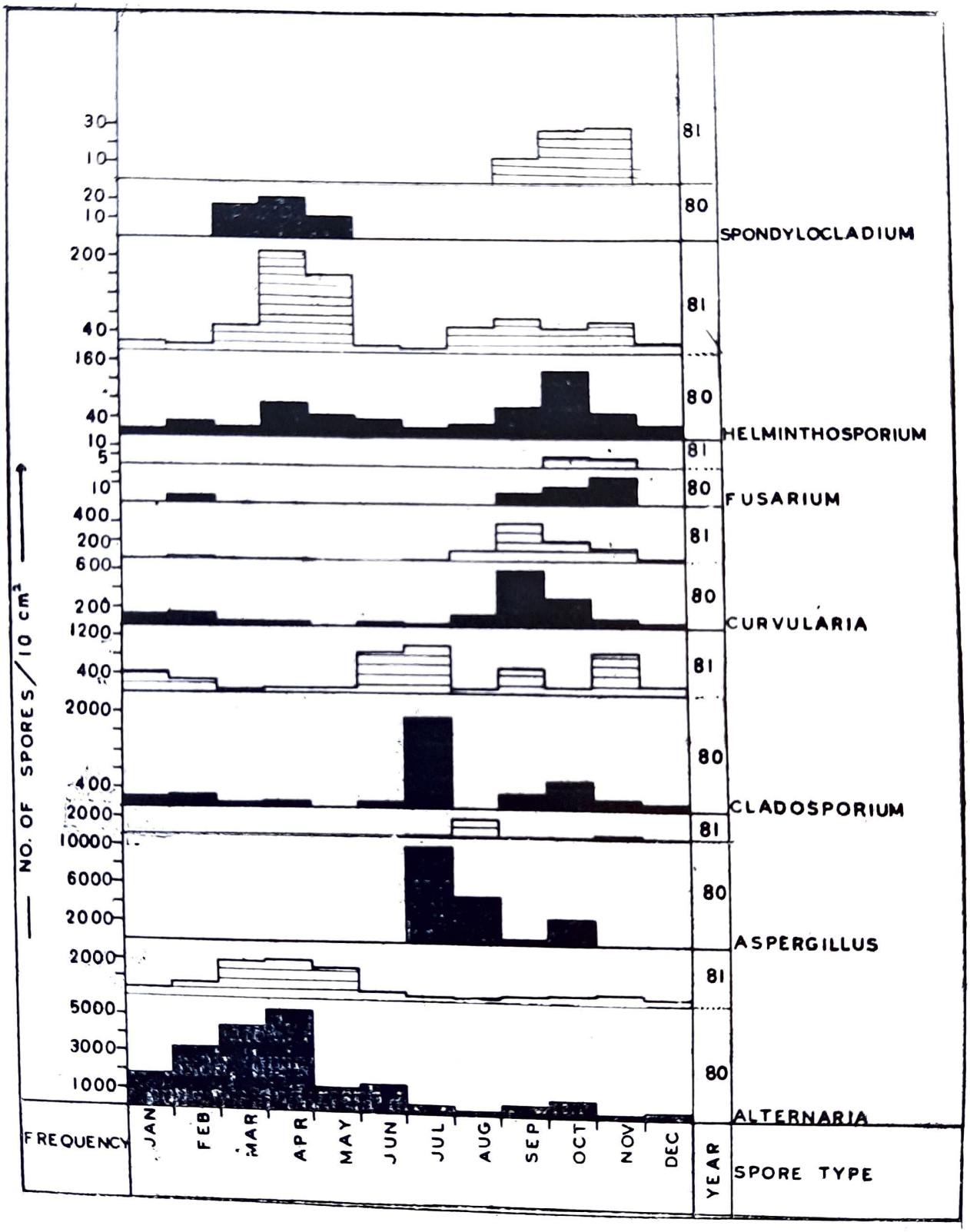
The daily counts per 10 sq. cm of pollen and spores have been made for a period of two years and monthly total has been calculated. Monthly occurrence of various aeroallergens in the atmosphere of Bareilly for the years 1980 and 1981 has been given in the Text-fig. 1 and Text-fig. 2. In all, 7 fungal and 22 pollen aero-allergenic taxa have been observed in the atmosphere. The duration and frequency of occurrence of various aeroallergenic fungal spores and pollen types (Tables 1, 2; Text-figs. 1, 2) are as follows:

Table 1—Aero-allergenic fungal spores in the urban environment of Bareilly during 1980 and 1981

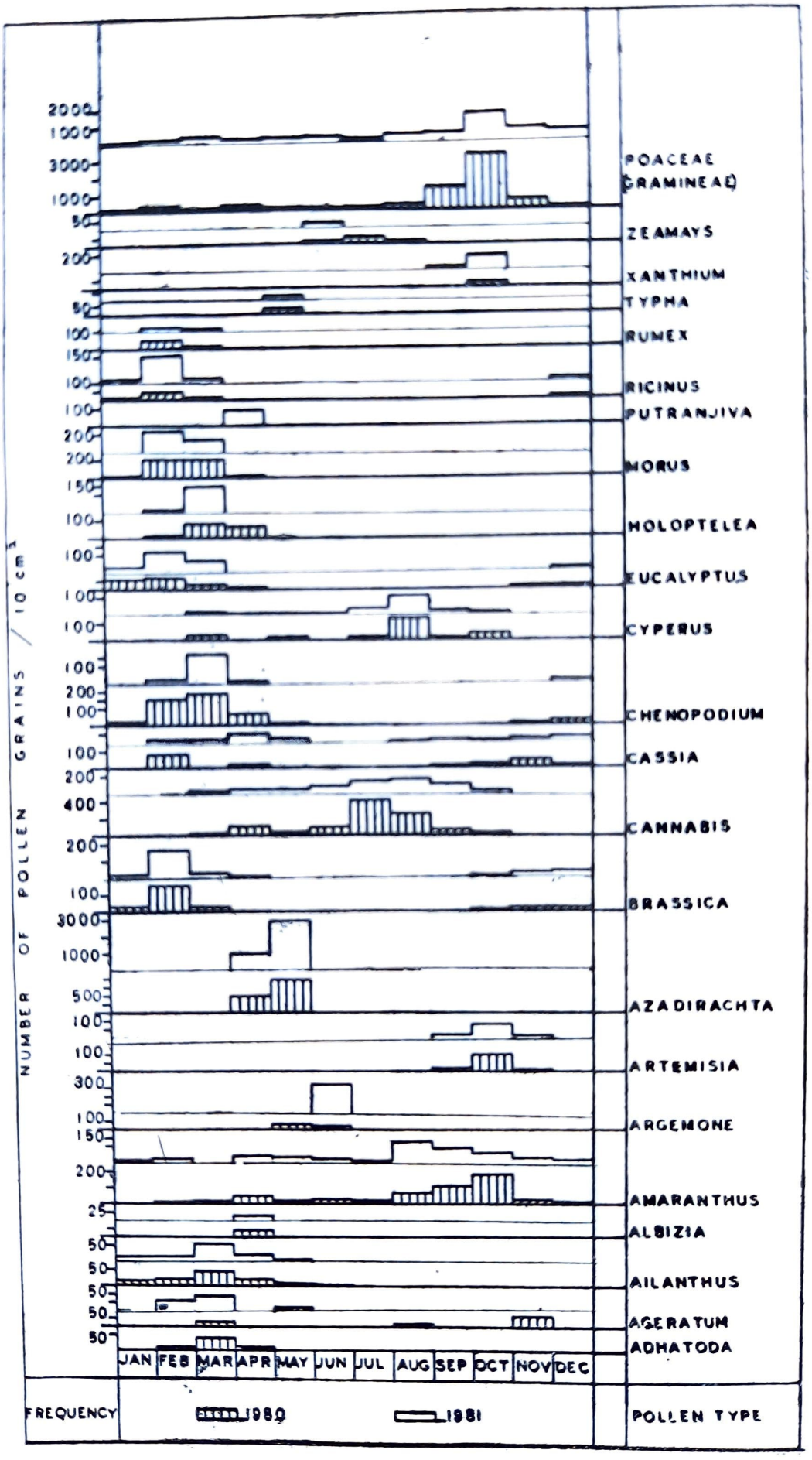
Spore type	Year	Number of spores	Percentage
Alternaria	1980	20242	31.64
	1981	9065	23.63
Aspergillus	1980	14528	22.48
	1981	2367	6.17
Cladosporium	1980	4220	6.53
	1981	4635	12.08
Curvularia	1980	1743	2.70
	1981	1088	2.84
Fusarium	1980	36	0.05
	1981	11	0.03
Helminthosporium	1980	581	0.90
	1981	774	2.01
Spondylocladium	1980	52	0.08
	1981	73	0.19

Table 2 – Annual total of aeroallergenic pollen grains during 1980 and 1981 in the urban environment of Bareilly

Pollen type	Year	Number of pollen grain	Percentage
Adiatoda sp.	80	63	0.36
Ageratum (conyzoides) L.	80	66	0.38
	81	81	0.40
Ailanthus (excelsa) Roxb.	80	81	0.40
	81	108	0.62
Albizia (lebbek) L. Benth.	80	24	0.14
	81	14	0.07
Amaranthus sp.	80	552	3.17
	81	465	2.30
Argemone (mexicana) L.	80	61	0.35
	81	341	1.69
Artemisia sp.	80	144	0.83
	81	125	0.62
Azadirachta (indica) A. Jurr.	80	1432	8.23
	81	3827	19.00
Brassica sp.	80	287	1.65
	81	295	1.46
Cannabis (sativa) (Tourn) L.	80	1021	5.87
	81	581	2.87
Cassia sp.	80	171	1.00
	81	155	0.77
Chenopodium sp.	80	510	2.93
	81	225	1.11
Cyperus sp.	80	301	1.73
	81	222	1.10
Drypetis (Putranjiva) roxburghhii wall.	80	98	0.56
	81	—	—
Eucalyptus sp.	80	213	1.22
	81	268	1.32
Holoptelea (integrifolia) Planch.	80	186	1.07
	81	168	0.83
Morus (alba) L.	80	459	2.64
	81	389	1.97
Ricinus (communis) L.	80	84	0.48
	81	235	1.16
Rumex sp.	80	63	0.36
	81	33	0.16
Typha sp.	80	25	0.14
	81	14	0.07
Xanthium (strumarium) L.	80	28	0-16
	81	185	0.91
Zea mays L.	80	60	0.34
	81	20	0.10
Poaceae (Gramineae)	80	5787	33.28
	81	3617	18.00



Text-fig. 1. Showing the frequency of occurrence of dominant aero-allergenic fungal spores in the urban environment at Bareilly during 1980-1981.



Text-fig. 2. Showing occurrence of aero-allergenic pollen at Bareilly during 1980 and 1981.

Fungal taxa

Alternaria is most dominant among all the air-borne fungal spores and occurs round the year during both the years. The patterns of occurrence of spores indicate that there are two spore seasons commencing from December-August and August-November both in 1980 and 1981, of which the former is longer and comparatively significant. During season December-August, the number of spores increases from December onwards reaching its peak during April in both the years. After April, the number decreases gradually in succeeding months and reaches its minimum in August. In the season August-November, the number of spores increases in subsequent months reaching its peak in October 1980 with steady fall in November. However, in 1981 the peak shifted in November with a steady fall in December.

Aspergillus occurs mainly in the rainy season during both the years. In 1980, the number of spores is maximum in July with a steady fall up to September. The number of spores again increases in October followed by a very low frequency in November. Similarly in 1981 the peak shifts to August with a low frequency in November. The number of spores is comparatively higher in 1980. *Caladosporium* occurs round the year both in 1980 and 1981 with peaks of 1906 and 1006 spores in July of both the years respectively. In other words preceding and succeeding July the numbers show frequent rise and fall without specific pattern. *Curvularia* is confined to all months both in 1980 and 1981 with two spore seasons namely, January-May and June-December for the occurrence of spores. The maximum incidence has been recorded during February and September in both the seasons.

Fusarium occurs during February, September-November of 1980 and October-November of 1981 with comparatively low number during both the years. *Helminthosporium* occurs during all the months both of 1980 and 1981 with maximum of 144 spores in October of 1980 and 214 in April of 1981. There is no specific pattern of rise or decline in number during rest of the months. *Spondylocladium* occurs sporadically during March-May of 1980 and September-November of 1981.

Pollen Type

Adhatoda occurs during the period February to April with highest number of 40 grains in March of 1980 only. *Ageratum conyzoides* L. occurs sporadically in both the years during March, August and November of 1980 and February, March and May of 1981. *Ailanthus excelsa* Roxb. frequency rises from January to March and fall up to June with a maximum of 30 grains only in March in 1980 and 1981. *Albizia lebbek* L. Benth polyads are recorded in the air during April only in both the years. *Amaranthus* grains increase from February onwards and reach the maximum of 184 grains in October and thereafter decrease in November and December of 1981. The number remains more or less 40 grains from January-July, with a sudden rise reaching a maximum of 134 grains in August, followed by a decrease in successive months. *Argemone mexicana* L. occurs during May-June of 1980 and June of 1981. *Artemisia* occurs during September-November in 1980 and 1981 with maximum frequency in October in both the years. *Azadirachta indica* A. Juss. occurs during April-May with maximum number of 972 grains in 1980 and 2902 grains in 1981 during May. *Brassica* occurs during October-March of both the years with a peak period of occurrence during February. *Cannabis sativa* (Tourn) L. occurs during March-October both in 1980 and 1981 with a peak in July of 1980 and August of 1981. *Cassia* occurs during February, April and September-December of 1980

with maximum in February and November. In 1981 the type is found for a comparatively longer period (February-December) with a maximum in April. *Chenopodium* occurs during October-May of 1980 and December-April in 1981 with a maximum number of grains in March during both the years. *Cyperus* occurs during February-October of both the years with a gap in April, and June of 1980. The maximum number of grains occur during August of 1980 and 1981. *Drypetis roxburghii* (Syn. *Putranjiva roxburghii*) is represented by 98 grains during April of 1980 only. *Eucalyptus* occurs during November-April in 1980 and DecemberMarch in 1981 with maximum number of grains in February during both the years. *Holoptelea integrifolia* Planch occurs during the period February to April and is highest in number in March both in 1980 and 1981. *Morus alba L.* occurs during January-April of 1980 and February-March of 1981 with maximum during February of both the years. *Ricinus communis* L. occurs during December-March with maximum number of grains in February during both the years. However, their number is comparatively higher in 1981. *Rumex* occurs during February-March with a maximum in February during both the years. *Typha* is in a comparatively lower frequency with about 15-25 grains only occurring and confined to the month of May only in both the years 1980 and 1981. *Xanthium strumarium* L. occurs during October of 1980 and September-October of 1981 with a comparatively higher incidence in 1981. *Zea mays* L. occurs during June-August in 1980 and only in June of 1981. Grass pollen (Poaceae) constitute the major part among all the air-borne pollen types at Bareilly. The pollen grains occur round the year during both the years with a comparatively lower incidence during January. After July there is a steady rise in incidence reaching the maximum number 2713 grains in 1980 and 1548 grains in 1981 in October of both the years and a gradually low incidence in November and December.

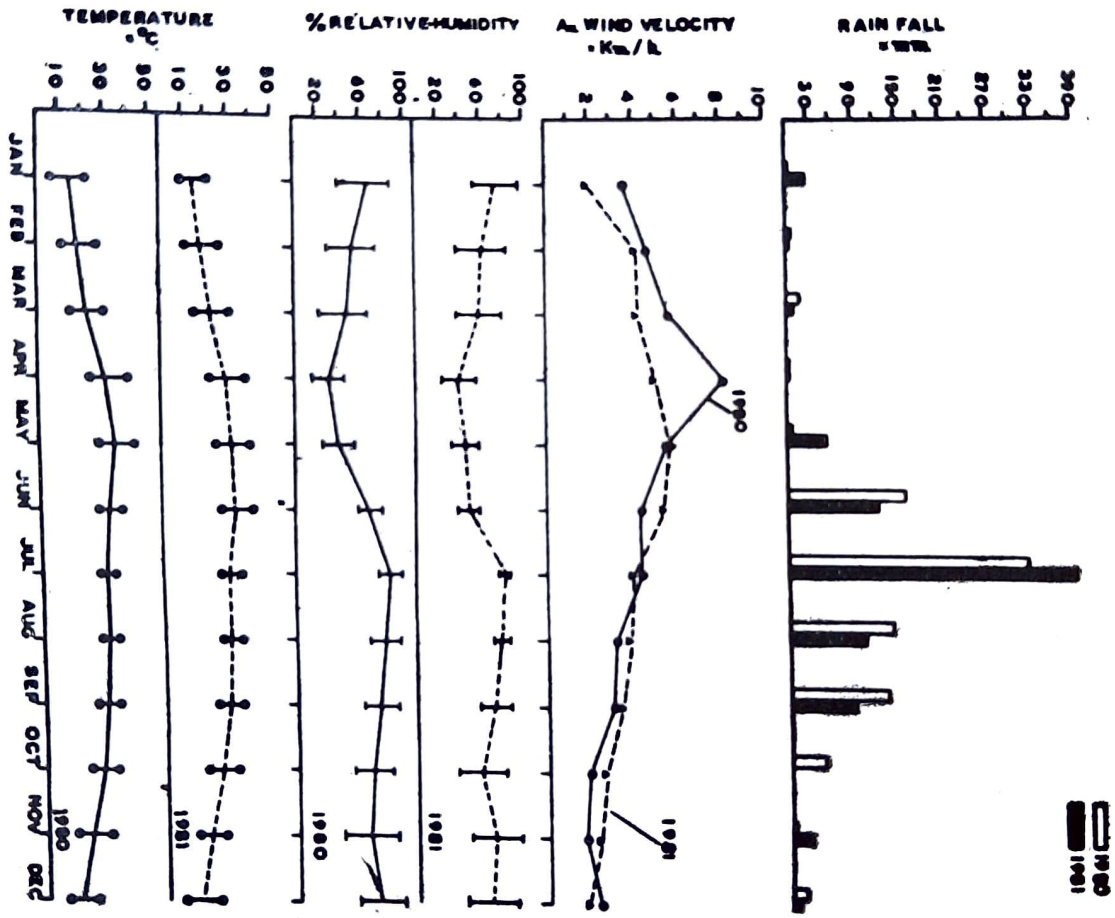
Discussion

An aerobiological survey carried out for a period of two years at Bareilly has shown that pollen grains and fungal spores including algal filaments form the major part of aerial biomass. Of the fungal taxa recorded the genera *Alternaria*, *Aspergillus*, *Cladosporium*, *Curvularia*, *Fusarium* and *Helminthosporium* have already been tested for their allergenicity in India (Shivpuri, 1981). It may be mentioned that fungal taxa namely *Alternaria*, *Aspergillus*, *Fusarium*, *Helminthosporium* and *Spondylocladium* have also been reported as aeroallergen at St. Louis, Missouri area, U. S. A. (Lewis & Imber, 1981).

Influence of climatic factors—On the basis of number of fungal spores in every month it can be seen that there are 3 major seasons namely, spring-summer (March-June), rainy (July-October) and winter (November-February). During post rainy season comparatively higher frequency of spores has been recorded and the spring-summer season closely followed it. Lowest number of spore counts have been recorded during winter season. It may be mentioned that from January onwards the temperature and wind velocity gradually increases and percentage R. H. decreases gradually upto April. Apart from luxuriant vegetational cover these climatic factors account for higher spore incidence during spring-summer season. In May, high temperature coupled with low %-age R. H. lowers the number of spores in the atmosphere. In June, the temperature reached its maximum but its effect is neutralized by sufficient rains. Therefore, in this month higher incidence has been encountered. In July-August the number of atmospheric fungal spores have been found very low, perhaps due to heavy rains. The washing down of spores by heavy rains has already been explained earlier by various workers in India (Ramalingam, 1971; Bhati & Gaur, 1979; Shenoi & Ramalingam, 1981; Gaur & Kasana, 1981, R. Kumar,

1982). However, it may be mentioned that the types namely, *Aspergillus* and *Cladosporium*, have been recorded in considerably high frequency in July of 1980. In September-October the number of spores has been found comparatively higher but not maximum. After, September-October the temperature decreases with the onset of winter season and the number reaches maximum in December.

Thus the total aero-allergenic fungal spores show higher incidence during rainy and summer season, while minimum in winter season, which may be attributed perhaps to the fact that moderately high temperature coupled with increasing wind velocity favour the presence of the airborne inoculum, while heavy rains wash them down in rainy season, but fungal growth during rainy period again accounts for higher incidence during post-rainy period and low temperature, negligible rainfall coupled with low wind velocity reduces them in winter (Text-figs. 1 and 3).



Text-fig. 3. Showing monthly data on various meteorological parameters namely temperature, % relative humidity, average wind velocity and rainfall at Bareilly during 1980 and 1981.

The aero-allergenic spore types namely *Alternaria*, *Cladosporium*, *Curvularia* and *Helminthosporium* occur throughout the year and are, therefore, of significance from the allergenic viewpoint. Apart from climatic factors occurrence of these spore types throughout the year, may be due to their ability to grow and sporulate on a wide variety of substrates and host plants. Further, these spores, although relatively large and multicellular are light due to their low cellular contents and being exogenous possess easy dispersal mechanism from their source of origin, which together enables them to come in the atmosphere more frequently. In the type *Aspergillus* although conidia are small, unicellular and comparatively light, they form in chains and, therefore, usually they come in clusters in the air and may be absent from the atmosphere during summer.

The genera *Fusarium* (September-October) and *Sponaylocladium* (September-November) show shorter duration of occurrence. However, it may be mentioned that in case of *Fusarium* only macroconidia are recorded in the atmosphere and its shorter duration of occurrence may be attributed to its soil-borne nature.

Pollen—Apart from grass pollen, 22 aero-allergenic pollen producing taxa (9 arboreal, 4 shrubby and 9 herbaceous) have been recorded in the atmosphere of Bareilly. Of the types recorded in the atmosphere of Bareilly, the taxa namely, *Amaranthus*, *Artemisia*, *Chenopodium*, *Morus*, *Ricinus* and *Xanthium* are also known to produce aero-allergenic pollen at North-America (Walkington, 1960; Lewis & Imber, 1981; Perlman, 1981).

On the basis of the number of grains in every month it can be seen that 3 major seasons namely, the spring (February-April), summer-rainy (May-September) and autumn-winter (October-January) of pollen occur. Of these summer-rainy months (May-August) are lean period and so also are November-January.

Among the arboreal taxa *Ailanthus* (January-May) with 40-45 grains in March, *Azadirachta* (April-May) with 1000-3000 grains in May, *Eucalyptus* (December-March) with 50-100 grains in February, *Holoptelea* (February-March) with 100 grains in March, *Morus* (February-March) with 200 grains in February and *Ricinus* (December-March) with 50-140 grains in February occur comparatively for longer duration and significant frequency. While the taxa *Albizia* and *Drypetis* (April) show shortest duration and lower frequency among arboreal taxa. It may be mentioned here that all aero-allergenic arboreal taxa have been found to occur in the air during spring season (February-April) which closely coincides with the flowering period of these taxa on the ground. The taxa *Ailanthus*, *Azadirachta* and *Eucalyptus* are entomophilous but their higher frequency and longer duration may be attributed to the fact that these are avenue trees and found growing on the road sides, gardens etc. in Bareilly. Therefore, during their flowering time pollen dropping occurs in the atmosphere due to the strong vibration of air currents.

Among shrubby taxa *Cyperus* (March-April, June-December) with 100-120 grains in August shows longest duration and significant frequency. Next in order are *Argemone* (May-June) with 100-250 grains, *Xanthium* (September-October) with 100-150 grains in October, while the taxa *Adhatoda* (February-March) with 20-40 grains only in March is of less significance. In terms of continuity of incidence and frequency grasses are most significant forming the highest percentage of the total aero-allergenic pollen grains caught from the air. It has not been possible to specify the grass species in any one particular season because of the uniformity in the basic structure of pollen grains of grasses. The autumn season (September-October) with 1000-3000 grains in October may be considered to be the grass pollen period. This situation is in conformity with the flowering of most grasses after the rains in July-August, their wide geographic distribution and very light and prolific pollen. Apart from grasses of 9 herbaceous taxa *Amaranthus* (January-December) with 100-200 grains in October, *Cannabis* (March-September) with 200-400 grains in July-August show longest duration and significant frequency followed by *Brassica* (October-March) with 100-150 grains in February, *Chenopodium* (December-April) with 150-200 grains in March, the taxa namely, *Artemisia* (September-November) with 100 grains in October, *Ageratum* 20-40 grains in March, *Rumex* (February-March) with 40-50 grains in February, *Typha* (May) with 30-40 grains and *Zea mays* (July-August) with 20-40 grains show comparatively shorter duration and lower frequency. The highest number of *Cannabis* pollen in July-August may be perhaps owing to luxuriant growth and abundance of this weed during rainy period and being anenomophilous producing large number of pollen thereby in rainy period. Similarly *Amaranthus* and *Chenopodium* are

abundant weeds in crop fields of winter season and *Brassica* is an oil crop which is grown on a commercial scale in and on the outskirts of the city. The maximum number of grains during February-April followed by a second maximum in September-October and the lower number in winter is recorded abroad and in India (Mittre & Khandelwal, 1973; Gaur, 1978; Singh & Babu, 1980; Jain & Das, 1981; Gaur & Kasana, 1981; Tripathi, 1982).

Influence of climatic factors—The discharge and dispersal of air-borne pollen and spores are greatly influenced by meteorological factors (Reis & Kostic, 1976; Kapyla, 1981; Mercuri *et al.*, 1982). Comparing the incidence of pollen with the climatic factors prevailing at that time it may be found that temperature range from 10-30°C as the one in spring and also autumn helps the flowering of most plants and hence the higher pollen catch during the season. Too high temperatures exceeding 40°C as the one in summer months and too low below 10°C in winter do not help the growth of ground flora and proportionately the number of pollen in the air remains at the minimum. A wind speed of 5-10 km/h has a positive effect on high pollen catch. The rainfall has an immediate effect on air-borne pollen concentration, as heavy rains not only lower the pollen production in a species but also washes them down from the air (Hyde & Williams, 1945; Sreeramulu & Ramalingam, 1964; Ramalingam, 1967). Therefore, during rainy days air-borne pollen are washed down to the ground. Further during rainy season vegetaion, particularly herbaceous growth is solely related to the onset of rain and species in flowering are comparatively lower leading to a low catch of pollen. The optimum % age R. H. for pollen catches ranges from 40-60% and 60-70% in the periods namely, February-April and September-October respectively at Bareilly (Text-figs. 2 and 3).

Acknowledgements

I am highly thankful to Dr P. K. K. Nair, Deputy Director, National Botanical Research Institute, Lucknow and Dr B. N. Pande, Bareilly College, Bareilly for valuable suggestions and guidance. I am also thankful to Dr P. V. Sane, Director, N. B. R. I., Lucknow for encouragement.

References

Agarwal, M. K. & Shivpuri, D. N. (1974). Fungal spores—their role in respiratory allergy. *Adv. Pollen. Spore Res.*, **1** : 78-128.

Bhati, H. S. & Gaur, R. D. (1979). Studies on aerobiology atmospheric fungal spores. *New Phytol*, **82** : 519-527.

Chaubal, P.D. & Deodikar, G. B., (1964). Air borne spores around Poona. *J. Poona Univ.*, **26** : 123-136.

Cunningham, D. D. (1873). *Microscopic Examination of Air*. Govt. of India Publ., Calcutta.

Gaur, R. D., 1978. Aeropalynology of Meerut I. Pollen grains. *J. Indian bot. Soc.*, **57** : 353-365.

Gaur, R. D. (1980). Aeropalynology of Meerut II. Fungal spores. *J. palynol.*, **16** (1 & 2) : 131-139.

Gaur, R. D. & Kasana, M. S. (1981). Studies on aerobiology of Modinagar. *J. Indian bot. Soc.*, **60**: 266-277.

Hyde, H. A. & Williams, D. A. (1945). Studies on the atmospheric pollen. II. Diurnal variation in the incidence of grass pollen. *New Phytol.*, **44** : 83-94.

Jain, A. K. & Das, R. R. (1981). Air pollen survey at Gwalior city. *J. Indian bot.Soc.*, **60** : 344-347.

Kalra, S. L. & Dumbrey, D. G. (1957). Aerobiology of the Army Medical Campus—Poona (Part I). Pollen, spores and mites. *Armed Forces Med. Jl. (India)*, **13** : 3-16.

Kapyla, M. (1981). Diurnal variation of non-arboreal pollen in the air in Finland. *Grana*, **20** : 55-59.

Kumar, R. (1982). Aerospora in a pine forest in India. *Grana*, **21** : 179-181.

Kumar, S. (1982). Phenology of aeroallergen producing plants of Bareilly. *Geobios.*, **9** : 200-204.

Kumar, S. (1934). Aerial pollen flora of Bareilly and at other places in Gangetic region (Northern India)—A comparative study. *J. Palynol.*, **20** : 81-86.

LAKHANPAL, R. N. & NAIR, P. K. K. (1958). Survey of atmospheric pollen at Lucknow. *J. Scient. Ind. Res.*, **17C** : 80-83.

LEWIS, W. H. & IMBER, W. E. (1981). Aeroallergens in the midwestern United States : Pollen and spores hazardous to health. *Proc. IV Int. Palynol. Conf. Lucknow (1976-77)* **3** : 466-474.

MANDAL, S. & CHANDA, S. (1981). Aeroallergens of West Bengal in the context of environmental pollution and respiratory allergy. *Biol. Mem.*, **6** : 1-61.

MEHTA, K. C. (1940). Further studies on cereal rusts in India. *Sci. Monogr. 2nd Counc. Agric. Res.*, **14** : 1-224.

MEHTA, K.C. (1952). Further studies on cereal rusts in India. Part II. *Sci. Monogr. Indian Counc. Agri. Res.*, **18** : 1-368.

MERCURI, L., DE DOMINICIS, V., GRESTI M., SARFATTI, G. & CIAMPOLINI, F. (1982). Airborne pollen concentrations in the atmosphere of Siena and correlation with meteorological data. *Pollen Spores*, **14**(2) : 315-319.

MITTRE, V. & KHANDELWAL, A. (1973). Air-borne pollen grains and fungal spores at Lucknow during 1969-1970. *Palaeobotanist*, **22**(3) : 177-185.

NAIR, P. K. K. & JOSHI, A. P. (1982). *C.S.I R. Report of All India Co-ordinated Project on Aerobiology.*

PERLMEN, F., 1981. Pollen of medical importance in North America. *Proc. IV int. palynol. Conf., Lucknow (1976-77)*, **3** : 475-479.

RAJAN, B. S. V., NIGAM, S. S. & SHUKLA, R. K. (1952). A study of the atmoslheric fungal flora at Kanpur. *Proc. Indian Acad. Sci.*, **15** : 33-37.

RAMALINGAM, A. (1966). A volumetric survey of the atmosoheric pollen over paddy fields at Visakhapatnam in 1960 and 1961. *Palynol. Bull.*, **II & III** : 11-17.

RAMALINGAM, A. Air spora of MYsore. *Proc. Indian Acad. Sci.*, **74** : 227-240.

REISS, N. M. & KOSTIC, S. R. (1976). Pollen season severity and meteorological parameters in Central New Jersey. *J. Allergy Clin. Immunol.*, **57** : 609-614.

SARNA, N. J. & GOVIL, C. M. (1979). Survey of air spora of Jaipur city. *J. Indian bot. Soc.*, **52** : 215-225.

SHENOI, M. M. & RAMALINGAM, A. (1981). A two year study of the precipated microbes at Mysore. *Proc. IVth Int. Palynol. Conf., Lucknow*, **3** : 453-457.

SHIVPURI, D.N. (1981). Clinically important pollen, fungal and insect allergens for Naso-Bronchial allergy patients in India. *Asp. Allerg. & Appl. Immunol.*, **8** & **9** : 19-23.

SINGH, A. B. & BABU, C. R. (1982). Survey of atmospheric pollen allergens in Delhi; Seasonal periodicity. *Ann. Allergy*, **48** : 115-122.

SINGH, N. I. (1981). Atmospheric pollen flora of Shillong. *Indian Aerobiol. Soc., Newsletter*, **3** : 6.

SREERAMULU, T. & RAMALINGAM, A. (1964). Some short period changes in the atmospheric spore content associated with changes in the wather and other conditias. *Proc. Indian Acad. Sci.*, **6**(8) : 154-172.

TILK, S. T.(1974) . Aerobiology in Maharashtra. *M. V. M. Patrika.*, **9** : 125-131.

TILAK, S. T. & BHALKE, S. P. (1978). Aeromycology of Aurangabad. II. *Deuteromycetes. Indian J. Bot.*, **1** : 113-115.

TRIPATHI, R. N. (1982). Pollen flora of Gorakhpur city. *Ph.D. Thesis*. Gorakhpur Univ. Gorakhpur.

WALKINGTON, D. L. (1960). A survey of hay fever plants and important atmospheric allergens in the Phoenix Arizona. metropolitan area. *J. Allergy*, **31** : 25-41.