

Comparative Study of the Distribution and Incidence of Pollen Aeroallergens in Tamil Nadu, India

R SATHEESH**, V ANAND GIDEON, H K P DEVADOSS* and G R RAO[#]

Environmental Resources Research Centre, PB 1230, Thiruvananthapuram 695 005, Kerala

(Received on 19 December 1994; after revision 29 January 1996; Accepted on 8 March 1996)

Using standard aerosampling methods ambient pollen samples were collected at three different centres, representing the diverse geographic regions in Tamil Nadu, namely the hills, plains and coast. The distribution and seasonal incidence of aeroallergenic pollen grains were analysed and the results provided baseline data for the diagnosis and management of respiratory allergy due to the inhalation of pollen grains throughout the year on a broad geographic scale. Special attention was given to anemophilous and exotic taxa which occur in these geographically distinct regions and the pollen of which are known to cause allergic sensitisation. Quantitatively pollen concentration was high at Kodaikanal where as qualitatively pollen diversity was high at Tiruchirapally. The peak season for pollen incidence in general and Poaceae, the most common allergenic pollen all over India, in particular, varied at each centre. The results highlights the influence of pollination characteristics and density of vegetation along with physiography and climate on the incidence and distribution of aeroallergenic pollen grains in the atmosphere.

Key Words : Pollen, Aeroallergens, Tamil Nadu

Introduction

A precise comparative knowledge of pollen concentration in the atmosphere of a given geographical region provides an indispensable tool in the diagnosis and treatment of respiratory allergy [Shivpuri 1964, Nair et al. 1986 and Agashe (Ed) 1994]. Tamil Nadu, the southern most state of India, is

known for its physiographic, climatic and vegetational diversity, exemplified by the hill ranges followed by plains and coastal region in the east. A comparative analysis of aeroallergens of the diverse biogeographic zones of the state is lacking and hence the present account providing information, on the ambient pollen samples of three,

** Address for correspondence

[#] Emeritus Scientist, (CSIR) Nagarjuna University, Nagarjuna Nagar 522510 (AP)

* Dept. of Botany, Madras Christian College, Madras

representative centres namely, Kodaikanal (hills), Tiruchirappalli (plains) and Madras (coast), (see figure 1) which will be of use in allergy diagnosis and therapy.

Materials and Methods

The general information on the physiography, climate and vegetational features of the study

areas are shown in table 1. Airborne pollen grains were sampled by gravity slide method using aeroscopes continuously for a period of one year at 24 hrs intervals. After exposure the slides were mounted with rectangular cover slips (22×50 mm) and the entire mounted area was scanned to obtain counts for 24 hrs and computed on monthly

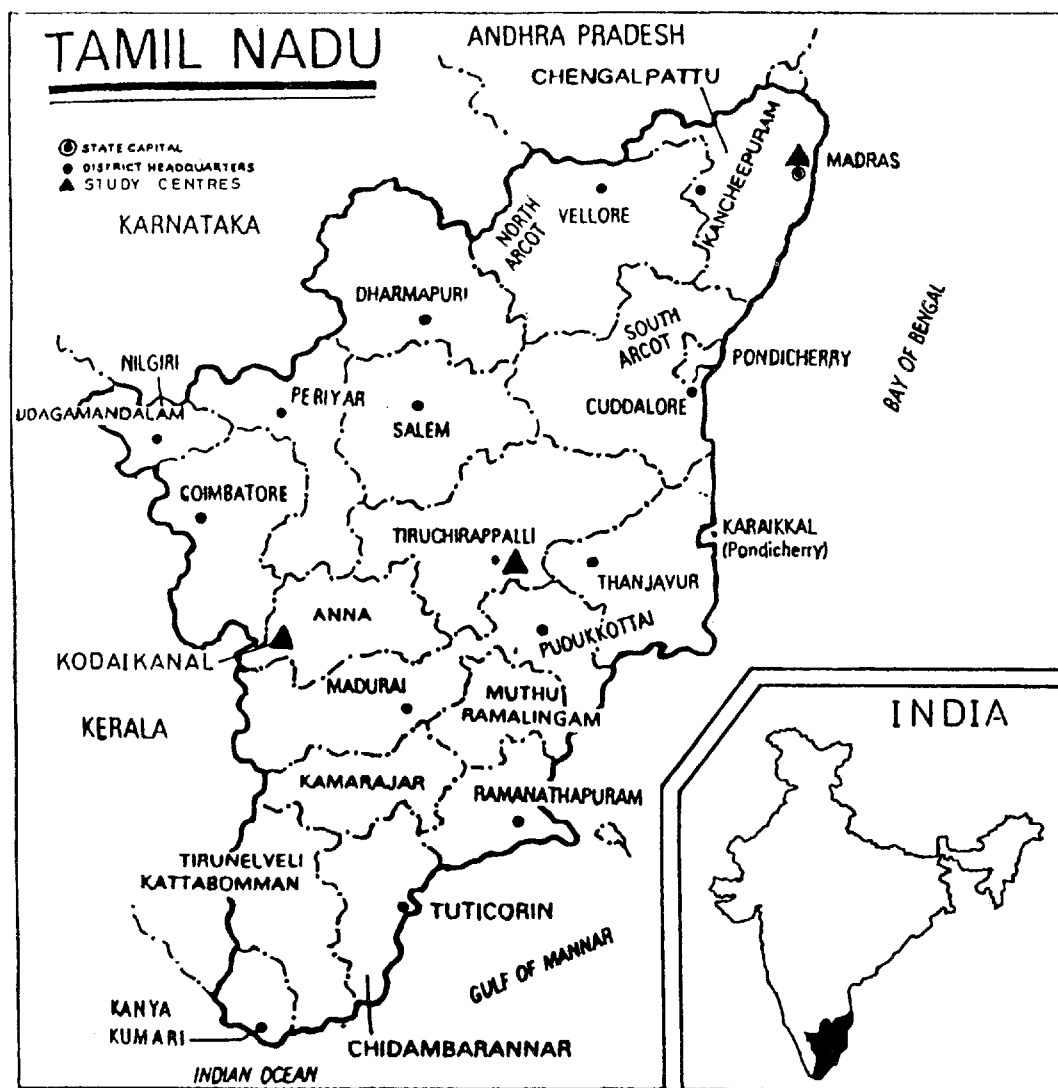


Figure 1 Map showing the locations of study

basis for analysis. The collected pollen grains were identified using reference slides.

Results

Pollen Spectrum

Table 2 gives the list of pollen types identified along with annual count and percentage as occurred in the atmosphere at three centres. Those pollen types which were represented by only a few (< 50) are noted as minor types (see table 3) and the unidentified types are noted as such. Qualitative and quantitative differences in pollen incidence can be noted from the tables. Altogether 45 different pollen types belonging to 40 families, 52 types belonging

to 40 families and 31 types referable to 22 families including both major and minor types were recognised from the atmosphere of Kodaikanal, Tiruchirapally and Madras, respectively. Aeropollen spectra of Tiruchirapally shows maximum diversity (52) followed by Kodaikanal (45) and Madras (31) where as the quantity of pollen incidence during the 12 months period was higher at Kodaikanal (33518) followed by Madras (22122) and Tiruchirapally (8485). The taxa *Cupressus* followed by Poaceae and *Pinus* contributed maximum pollen grains at Kodaikanal where as at Tiruchirapally it was Poaceae, *Prosopis* and *Azadirachta*. In Madras *Syzigium* followed by Poaceae and

Table 1 Physiography, climate and vegetational features of the study areas

Features	Kodaikanal	Tiruchirapally	Madras
Status	(a Hill Station)	(a City)	Metropolitan City
Location			
Latitude	10°12' - 10° 15'N	10°59'E	80°00'E
Longitude	77°26' - 77°33'E	78°44'E	12°55'N
Elevation			
(Above MSL)	2133 M	68.5 M	30 M
Physio-graphy			
	Hills (Westerns Ghats)	Plains	Coastal
Climate			
<input type="checkbox"/> Temperature	Moderate with low annual range irrespective of altitude; Average Temperature: Max. & Min. 22° and 10°C respectively	Maximum and Minimum Temperature 40°C and 22°C respectively.	Highest upto 42°C in May-June and lowest between 20° and 22°C.
<input type="checkbox"/> Rainfall	1450 mm	665 mm	1090 mm
Vegetation			
	Tropical evergreen with sholas and grasslands	Southern tropical thorny vegetation	Tropical dry with evergreen patches

Table 2 Major pollen types identified along with annual counts and other related informations for the three centres in Tamil Nadu

Pollen type	Family	Kodaikanal		Tiruchirapally		Madras	
		No.	%	No.	%	No.	%
1	2	3	4	5	6	7	8
<i>Acalypha indica</i>	Euphorbiaceae	-	-	-	-	101	0.46
<i>Achyranthus aspera</i>	Amaranthaceae	-	-	127	1.50	-	-
<i>Ageratina glandulosum</i>	Asteraceae	360	1.07	-	-	-	-
<i>Ageratum houstonianum</i>	Asteraceae	355	1.06	-	-	-	-
<i>Alnus nepalensis</i>	Betulaceae	419	1.25	-	-	-	-
<i>Amaranthus</i> sp.	Amaranthaceae	98	0.30	102	1.20	590	2.67
<i>Artemisia</i> sp.	Asteraceae	902	2.70	-	-	-	-
<i>Asteraceae</i> sp.	Asteraceae	-	-	221	2.60	-	-
<i>Azadirachta indica</i>	Meliaceae	-	-	354	4.17	117	0.53
<i>Borassus flabellifer</i>	Arecaceae	-	-	63	0.74	179	0.81
<i>Carica papaya</i>	Caricaceae	-	-	53	0.62	-	-
<i>Cassia siamia</i>	Caesalpineaceae	-	-	233	2.75	157	0.71
<i>Casuarinia equisetifolia</i>	Casuarinaceae	-	-	-	-	2512	11.36
<i>Cleome</i> sp.	Capparaceae	-	-	90	1.06	-	-
<i>Cocos nucifera</i>	Asteraceae	-	-	117	1.38	174	0.79
<i>Croton bonplandianus</i>	Euphorbiaceae	-	-	142	1.67	-	-
<i>Cruciferaeae</i> sp.	Cruciferaeae	89	0.27	-	-	-	-
<i>Cryptomeria japonica</i>	Taxodiaceae	446	1.33	-	-	-	-
<i>Cupressus</i> sp.	Cupressaceae	17230	51.41	-	-	-	-
<i>Cyperaceae</i> sp.	Cyperaceae	165	0.49	55	0.65	323	1.46
<i>Delonix regia</i>	Caesalpineaceae	-	-	81	0.96	-	-
<i>Dendriothoe</i> sp.	Loranthaceae	82	0.24	-	-	-	-
<i>Eriocaulon</i> sp.	Eriocaulaceae	94	0.28	-	-	-	-
<i>Eucalyptus tereticornis</i>	Myrtaceae	827	2.47	-	-	202	0.91
<i>Euphorbiaceae</i> sp.	Euphorbiaceae	66	0.20	-	-	-	-
<i>Fabaceae</i> Sp.	Fabaceae	120	0.36	-	-	383	1.73
<i>Fern spores</i>	Pteridophytes	92	0.27	-	-	-	-
<i>Grewia orbiculata</i>	Tiliaceae	-	-	p	-	67	0.30
<i>Hypericum</i> Sp.	Hypericaceae	74	0.22	-	-	-	-
<i>Ilex</i> Sp.	Aquifoliaceae	191	0.57	-	-	-	-
<i>Jacaranda mimosifolia</i>	Bignoniaceae	57	0.17	-	-	-	-
<i>Juncus</i> Sp.	Juncaceae	388	1.16	-	-	-	-

(Table 2 Contd.)

1	2	3	4	5	6	7	8
<i>Lannea coromandelica</i>	Anacardiaceae	-	-	196	2.31	680	3.07
<i>Lauraceae</i> sp.	Lauraceae	121	0.36	-	-	-	-
<i>Meliosoma</i> sp.	Sabiaceae	68	0.20	-	-	-	-
<i>Michelia</i> sp.	Magnoliaceae	55	0.16	-	-	-	-
<i>Mimosaceae</i> (polyad)	Mimosaceae	458	1.37	50	0.59	-	-
<i>Moringa oleifera</i>	Moringaceae	-	-	120	1.41	-	-
<i>Parthenium hysterophorus</i>	Asteraceae	-	-	-	-	856	3.87
<i>Peltophorum petrocarpum</i>	Caesalpineaceae	-	-	76	0.90	607	2.74
<i>Phytolacca octandra</i>	Phytalocaceae	428	1.28	-	-	-	-
<i>Pinus</i> sp.	Pinaceae	3261	9.73	-	-	-	-
<i>Poaceae</i> sp.	Poaceae	4970	14.83	4896	57.70	4682	21.16
<i>Prosopis julifera</i>	Mimosaceae	-	-	634	7.47	-	-
<i>Prunus</i> sp.	Rosaceae	405	1.21	-	-	-	-
<i>Pyrus communis</i>	Rosaceae	626	1.87	-	-	-	-
<i>Quercus</i> sp.	Fagaceae	219	1.87	-	-	-	-
<i>Ricinus communis</i>	Euphorbiaceae	-	-	118	1.39	-	-
<i>Samanea saman</i>	Mimosaceae	-	-	60	0.71	-	-
<i>Schafflera</i> sp.	Araliaceae	57	0.17	-	-	-	-
<i>Schima wallichii</i>	Theaceae 168	0.50	-	-	-	-	-
<i>Sizigium cumini</i>	Myrtaceae	67	0.19	-	-	8666	39.17
<i>Taraxacum officinale</i>	Asteraceae	110	0.33	-	-	-	-
<i>Tephrosia</i> Sp.	Papilionaceae	-	-	66	0.78	-	-
<i>Typha angustata</i>	Typhaceae	-	-	61	0.72	-	-
<i>Ventilago maderaspatana</i>	Rhamnaceae	-	-	-	-	316	1.43
<i>Zizipus oenoplea</i>	Rhamnaceae	-	-	-	-	61	0.28
*Minor Types		369	1.10	513	6.05	301	1.36
Unidentified Types		81	0.24	57	0.67	1148	5.19
Total		33518	100	8485	100	22122	100

*Those types which are represented by < 50 pollen grains annually

Table 3 Minor pollen types identified along with annual counts and other related informations for the three centres in Tamil Nadu

Pollen type	Family	Kodaikanal		Tiruchirapally		Madras	
		No.	%	No.	%	No.	%
<i>Abutilon</i> sp.	Malvaceae	-	-	42	0.50	-	-
<i>Acanthaceae</i> sp.	Acanthaceae	-	-	13	0.15	-	-
<i>Ailanthus excelsa</i>	Simaroubiceae	-	-	12	0.14	-	-
<i>Allophyllus serratus</i>	Spanidaceae	-	-	-	-	48	0.21
<i>Apocynaceae</i> sp.	Apocynaceae	-	-	10	0.11	-	-
<i>Bauhinia purpurea</i>	Caesalpiniaceae	-	-	-	-	3	0.01
<i>Bombacaceae</i> sp.	Bombacaceae	-	-	6	0.07	-	-
<i>Bougainvillea</i> sp.	Nyctaginaceae	-	-	29	0.34	-	-
<i>Calotropis gigantea</i>	Asclepiadaceae	-	-	10	0.11	-	-
<i>Canthium dicoccum</i>	Rubiaceae	-	-	-	-	12	0.05
<i>Casuarina equisetifolia</i>	Casuarinaceae	-	-	16	0.19	-	-
<i>Celosia argentia</i>	Amaranthaceae	-	-	17	0.20	-	-
<i>Clematis</i> sp.	Ranunculaceae	33	0.10	-	-	-	-
<i>Combretum albidum</i>	Combretaceae	-	-	-	-	19	0.10
<i>Convolvulaceae</i> sp.	Convolvulaceae	-	-	14	0.16	-	-
<i>Coriandrum</i> sp.	Umbelliferae	-	-	5	0.06	-	-
<i>Crateva adansoni</i>	Capparaceae	-	-	14	0.16	-	-
<i>Cucurbitaceae</i> sp.	Cucurbitaceae	-	-	8	0.09	-	-
<i>Delonix regia</i>	Caesalpiniaceae	-	-	-	-	3	0.01
<i>Elaeocarpus</i> sp.	Elaeocarpaceae	47	0.14	-	-	-	-
<i>Ericaceae</i> sp.	Ericaceae	31	0.09	-	-	-	-
<i>Eucalyptus</i> sp.	Myrtaceae	-	-	15	0.18	-	-
<i>Euphorbiaceae</i> sp.	Euphorbiaceae	-	-	28	0.33	-	-
<i>Ficus</i> sp.	Moraceae	-	-	4	0.05	-	-
<i>Fuchsia</i> sp.	Onagraceae	25	0.07	-	-	-	-
<i>Gliricidia sepium</i>	Fabaceae	-	-	-	-	13	0.06

(Table 3 Contd.)

Pollen type	Family	Kodaikanal		Tiruchirapally		Madras	
		No.	%	No.	%	No.	%
<i>Gomphrena decumbens</i>	Amaranthaceae	-	-	-	-	15	0.07
<i>Hugonia mystax</i>	Linaceae	-	-	-	-	14	0.06
<i>Labiatae</i> sp.	Labiatae	-	-	19	0.22	-	-
<i>Lantana</i> sp.	Verbenaceae	12	0.04	-	-	-	-
<i>Lawsonia inermis</i>	Luthraceae	-	-	42	0.50	-	-
<i>Leucenia leucocephala</i>	Mimosaceae	-	-	14	0.16	-	-
<i>Lobelia excelsa</i>	Lobeliaceae	24	0.07	-	-	-	-
<i>Mangifera indica</i>	Anacardiaceae	-	-	13	0.15	-	-
<i>Millingtonia hortensis</i>	Bignoniaceae	-	-	14	0.16	-	-
<i>Mimosaceae (Polyad)</i>	Acacia/ Albizia complex	-	-	-	-	49	0.22
<i>Nymphaea</i> sp.	Nymphaeaceae	22	0.07	-	-	-	-
<i>Osbeckia leschaenaultiana</i>	Melastromaceae	40	0.12	-	-	-	-
<i>Phoenix</i> sp.	Arecaceae	-	-	7	0.08	49	0.22
<i>Polyalthia longifolia</i>	Anonaceae	-	-	44	0.52	-	-
<i>Polygonaceae</i> sp.	Polygonaceae	-	-	18	0.21	-	-
<i>Scrophulariaceae</i> sp.	Scrophulariaceae	31	0.09	-	-	-	-
<i>Solanaceae</i> sp.	Solanaceae	38	0.11	25	0.30	-	-
<i>Tamarindas indica</i>	Caesalpinaceae	-	-	37	0.48	-	-
<i>Tectona grandis</i>	Verbenaceae	-	-	9	0.10	-	-
<i>Terminalia catapa</i>	Combretaceae	-	-	17	0.20	-	-
<i>Tinospora cordifolia</i>	Combretaceae	-	-	-	-	2	0.009
<i>Tridax procumbens</i>	Asteraceae	-	-	-	-	25	0.12
<i>Typha angustata</i>	Typhaceae	-	-	-	-	49	0.22
<i>Umbelliferae</i>	Umbelliferae	30	0.09	-	-	-	-
<i>Zantedeschia</i> sp.	Araceae	36	0.11	-	-	-	-
<i>Zizipus</i> sp.	Rhamnaceae	-	-	11	0.13	-	-
Total		369	1.10	513	6.05	301	1.36

Casuarina contributed the highest number of pollen grains to the atmosphere.

Major Pollen Groups

Pollen types were grouped in to various categories like trees, shrubs herbs/weeds and grasses based on their habit and pollination behaviour (table 4). Aeropollen contribution from tree species was predominant at Kodaikanal and Madras amounting to 73.76% and 60.93% respectively, whereas in Tiruchirapally trees contributed only 24.04% of pollen to the total aeropollen. *Cupressus* was the primary contributor followed by *Pinus*, *Eucalyptus* and Rosaceae at Kodaikanal, while at Madras *Sysigium* was the major contributor followed by *Casuarina*, *Lanea* and *Peltophorum*. In all the three centres grass (Poaceae) pollen was recorded in significant numbers and at Tiruchirapally, it even out numbered all other pollen types. The contribution of pollen grains from shrubs was comparatively less in all the Centres.

As expected the wind pollinated plant species (anemophilous) were the chief contributor of pollen to the aerospora with the exception of Madras (table 4) where en-

tomophilous plants outnumbered the anemophilous ones in pollen concentration. However, amphiphilous and entomophilous plants also contributed a substantial number of pollen grains in other centres.

Seasonal Incidence

The daily pollen counts recorded during the study period are computed as monthly total and are given in figure 2. Quantitative differences between the Centres as well as seasonal variation can be observed from the figure. Differences are noted between the centres with respect to pollen incidence in each month. It is found that the pollen concentrations at Kodaikanal was highest during December to May with peak in February. At Tiruchirapally, it was from August to December with peak during November, whereas at Madras it was from May to July with peak in June. An increase in pollen incidence was noticed from October onwards at Kodaikanal and from August onwards at Tiruchirapally. In both the above locations a sharp decline in pollen incidence was recorded from May to July in comparison with other seasons.

Table 4 Differential Pollen Counts at the Three Centres in Tamil Nadu

Location	Habit					Pollination groups			
	Trees	Shrubs	Herbs& Weeds	Grass	Uniden- tified	Animo- philous	Amphi- philous	Entomo- philous	Uniden- tified
Kodaikanal	24722	1242	2503	4970	81	27190	3007	3240	81
%	73.76	3.70	7.47	14.83	0.24	81.12	8.97	9.67	0.24
Tiruchirapalli	2040	474	1018	4896	57	5287	1876	1265	57
%	24.04	5.59	12.00	57.70	0.67	62.31	22.11	14.91	0.67
Madras	13478	472	2342	4682	1148	8219	1352	11403	1148
%	60.93	2.13	10.59	21.16	5.19	37.15	6.11	51.55	5.19

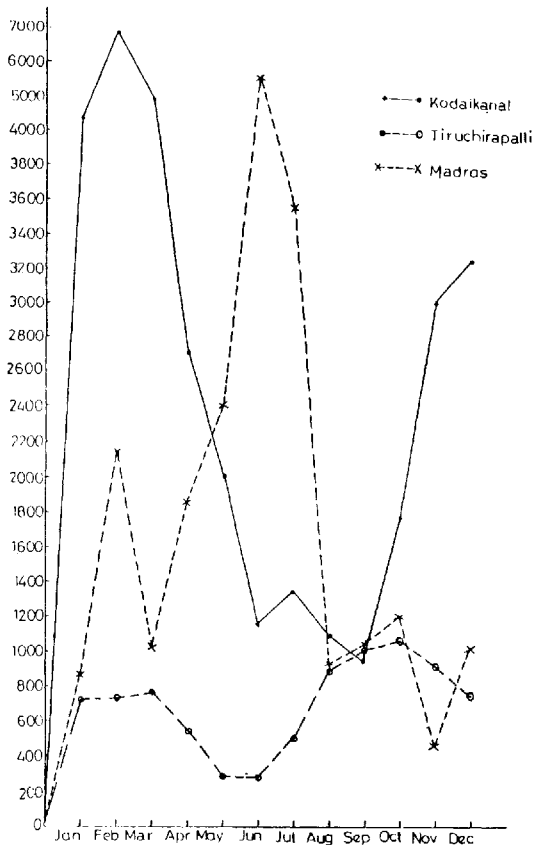


FIG. 2 : SEASONAL INCIDENCE OF POLLEN AT THREE CENTRES IN TAMIL NADU

Figure 2 Seasonal incidence of pollen at three centres in Tamil Nadu

Discussion

About 10-15% of the Indian population suffer from major allergic diseases, pollen grains being among the causative aeroallergens. Although information on airborne pollen grains is available from many centres in northern and peninsular regions of India very few isolated reports are available from Tamil Nadu (Nair 1963, Nair et al. 1986, Sathesh et al. 1992, Singh & Singh 1994). In the present report, centres having diverse phytogeographical, climatic and vegetational features have been covered and compared.

The significant aspect of the result was that the pollen from, grasses were found significant, at all the three centres however, the peak season of incidence varied, i.e., November to January at Kodaikanal, August to November at Tiruchirapalli and October to December at Madras, even though grass pollen was recorded in the air throughout the year at all locations. The contribution of pollen from arboreal plants at Kodaikanal and Madras was high, which may be due to the dominance of trees in both locations particularly around the sampling sites. However, it has been noticed that the pollen diversity in the air was comparatively less in Kodaikanal (45) and Madras (31) than at Tiruchirapalli (52) which at least does not reflect the high biodiversity pattern of Kodaikanal centre, (see tables 2 & 3). A large number of entomophilous and amphiphilous plants contributed pollen to the atmosphere of Tiruchirapalli and Madras than Kodaikanal. The dense shola vegetation though consisted of entomophilous plants reflecting high biodiversity, with a dense canopy which might have provided a closed air system causing difficulties for pollen grains to become airborne. The high humidity, less wind velocity and temperature coupled with the dense and closed canopy could be the major reasons for less representation of pollen types at Kodaikanal whereas at Tiruchirapalli even though most of the plants are entomophilous they are widely distributed and provide an open canopy for free movement of air along with high temperature, wind velocity and less humidity which might have helped the pollen grains to become airborne. The high representation of *Syzigium* pollen grains at Madras could be due to the presence of large number of trees near the sampling site.

In the three centres pollen incidence varied considerably in different seasons both in quality and quantity. No pollen free month was noted in all the three centres. Some pollen types particularly of Poaceae have been reported throughout the year. Seasonal variations in peak incidence of pollen grains were noted among the three centres, may be due to difference in the composition of vegetation, particularly near the sampling site, the climate, altitude, latitude and flowering behaviour of plants as indicated by Akers et al. (1979), Lacey (1981) and others Satheesh et al. 1992.

The comparative analysis of Aeropollen incidence between three zones highlighted the influence of climate, altitude and vegetation for the quality and quantity of aerospora. Kodaikanal is marked by high altitude, humidity, low temperature, etc., with wet-

tropical climate having tropical and exotic trees, shrubs, herbs and grasses. Tiruchirappally lies in the plains with low altitude, high temperature and low humidity having sparse vegetation of scrubby nature with less number of tree population. Madras is represented by a low altitude, coastal ecosystem with high temperature and low humidity and shows well maintained parks, private gardens and protected scrub jungles. The total information provided, helps in the proper diagnosis and management of respiratory patients.

Acknowledgements

The senior author wishes to thank the Council of Scientific and Industrial Research, New Delhi for financial assistance and Dr P K K Nair, Emeritus Scientist (CSIR) and Hony. Director, ERRC for critical evaluation of the manuscript.

References

- Agashe S N 1994 (Ed.) *Recent Trends in Aerobiology, Allergy and Immunology* (New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd) pp. 1-315
- Akers T G, Edmonds R L, Kramer C L, Lighthart B, McManus M C, Schlichting, Jr. H G, Solomon A M and Spendlove J C 1979 Sources and Characteristics of Airborne Materials; in *Aerobiology, the Ecological Systems Approach*, pp. 41-55 Ed. R L Edmonds Hutchinson Dowden and Ross Stroudsburg, Pennsylvania
- Lacey J 1981 The Aerobiology of Conidial Fungi; in *Biology of Conidial Fungi*, 1 373-416 Academic Press. Inc.
- Nair P K K 1963 An analysis of atmospheric pollen, fungal spores and other vegetable matter at vellore, Madras state; *Indian J. Med. Res.* 51 447
- Joshi A P and Gangal S V 1986 *Airborne Pollen, Spores and Other Plant Materials of India - A Survey*. pp. 1-224 (Lucknow: CSIR Centre for Biochemicals and NBRI)
- Satheesh R, Rao G R and Nair P K K 1992 The airborne pollen incidence in relation to season and vegetation at Kodaikanal; *Ind. J. Aerobiol. Special Volume* 37-42
- Shivpuri D N 1964 Aerobiology and its Significance in Allergy; in *Advances in Palynology* pp 120-138 ed. P K K Nair (Lucknow: National Botanical Research Institute)
- Singh A B and Singh A 1994 Pollen Allergy: A global Scenario; in *Recent Trends in Aerobiology, Allergy and Immunology* pp 143-170 ed. S N Agashe (New Delhi: Oxford and IBH Publishing Co. Pvt Ltd)