*Pak. J. Bot.*, 37(3): 519-530, 2005.

# DIFFERENCES IN CONCENTRATIONS OF ALLERGENIC POLLENS AT DIFFERENT HEIGHTS IN DENIZLI, TURKEY

**A. CELIK[1], A. GUVENSEN[2], I. UYSAL[3] AND M. OZTURK[2*]**

[1]*Department of Botany, Faculty of Science and Arts, Pamukkale University Denizli, Turkey*
[2]*Department of Botany, Faculty of Science, Ege University İzmir, Turkey*
[3]*Department of Biology, Faculty of Science, Onsekizmart University, Çanakkale, Turkey*

**Abstract**

An investigation was carried out on the airborne pollen fall in the State of Denizli during the year 2000. Two Durham samplers were placed at different heights above the ground. The averages of pollen counts from 2 samplers were calculated at the end of year. The pollen from 34 flowering plant taxa (20 arboreal +14 non-arboreal) with a total average of 6856 grains/cm$^2$ dominated the atmosphere in this State. Out of these 83.9 % belonged to the arboreal, 16.10 % to the non-arboreal plants and 6.25% were from the family Poaceae. The pollen counts from two heights were different. At higher level (15 m) the total pollen concentration was 7717 per cm$^2$, out of which 6471 per cm$^2$ were of arboreal origin and 1246 per cm$^2$ non-arboreal ones. At the lower level (1.50 m) it was 5995 per cm$^2$, out of which 5033 per cm$^2$ belonged to the arboreal and 962 per cm$^2$ to the non-arboreal group. The maximum number of pollen counts was recorded from the arboreal plants because this area gets enough precipitation for the growth of arboreal species The highest number of pollen in the arboreal plants followed the trend as; Pinaceae (40.92%), Cupressaceae/Taxaceae (14.16%), *Quercus* (9.8%), *Olea europaea* (7.03%) and *Platanus orientalis* (5.69%), and for non-arboreal representatives these were Poaceae (6.25%) Chenopodiaceae/ Amaranthaceae (2.67%), Fabaceae (1.65%) and *Carex* (1.22%). Maximum pollen density was recorded during the spring season and minimum in autumn. During this study period the number of allergic patients treated in the hospitals was 1552 persons, with an outstanding increase during the months of April, March, May and August.

## Introduction

The prevalence and severity of asthma and allergic diseases are increasing all over the world, affecting 5-7% of the population in some of the industrialising countries (Weiss, 1993). It is now a well-known fact that asthma and allergic diseases result from an allergen induced inflammatory process of respiratory mucosa in sensitive persons (Nclerio, 1991; Kay, 1991). A large population is getting affected by these diseases due to aerobiological disorders such as; pollens, spores, dust, insects and different kinds of foods however, the percentage of patients differs from country to country. As such, a lot of work is now being done in the field of aerobiology (Waisel, 1996; Kobzar, 1999; Saar, 2000; Peternel *et al*., 2003; Porsbjerg *et al*., 2003).Turkish investigators too have followed the trend and during the last decade many papers have been published in this connection (Inceoglu *et al*., 1994; Pehlivan, 1995; Pinar *et al*., 1999; Bicakci *et al.* 2002, 2003). A greater attention is being paid now towards the preparation of pollen calendars as the number of allergic patients in the country is increasing at a faster rate. Thus, the aim of this study was to determine pollen density and changes in pollen fall per cm$^2$ on weekly, monthly and annual basis in Denizli one of the fast industrialising States of Turkey. The results of this study are expected to be useful for health centres in the State for establishing a right diagnosis and control of allergic diseases.

[*]Corresponding Author: Prof. Dr. Munir OZTURK, Botany Dept., Sci. Fac., Ege University, Bornova-Izmir, Turkey, E-mail: munirozturk@hotmail.com, Tel: (+90) 0 232- 3884000 / 2434, Fax: (+90) 0 232-3881036

**Study area:** Denizli is spread over an area of 11.868 km$^2$ with a population of about 850 thousand inhabitants. It lies in the West Anatolian part of Turkey between 38°29′-38°52′ N latitudes and 28°38′-30°05′ E longitudes. The altitude varies between 200-2600 m. The area experinces a mediterranean climate of the semi-arid upper cold type (Akman, 1999). Average temperatures vary, being highest (22.3°C - 27.8°C) from 3rd week of May till 2nd week of September and lowest during December (0.8°C). Mean relative humidity varies between 41.3-77.4%. The precipitation in the form of rains (556.3 mm) is very common in spring and winter. Dominant winds are north, north-north-east, west, with an annual average speed of 4.6 km/h. It is included in the Mediterranean phytogeographical division of Turkey and shows a rich plant diversity of both wild and cultivated forms. At higher altitudes forests of *Pinus nigra* subsp. *pallasiana, Pinus brutia, Castanea sativa, Juniperus excelsa, Juniperus oxycedrus* subsp. *oxycedrus, Quercus pubescens, Quercus infectoria* subsp. *boissieri* dominate the area (40%), but at lower level maquis and phrygana are covering large areas and include taxa such as; *Adenocarpus complicatus*, *Arbutus andrachne*, *A. unedo*, *Cercis sliquastrum*, *Cistus creticus*, *Coridothymus capitatus*, *Crataegus monogyna*, *Genista anatolica, Jasminum fruticans, Laurus nobilis, Myrtus communis, Olea europaea* var. *sylvestris*, *Origanum onites*, *Paliurus spina-christii, Phillyrea latifolia*, *Pistacia lentiscus*, *P. terebinthus*, *Quercus coccifera*, *Salvia tomentosa*, *Satureja thymbra, Spartium junceum, Styrax officinalis, Rhus coriaria*, *Ruscus aculeatus* and *Vitex agnus-castus*. The arboreal plant taxa observed commonly in the parks and alongside the roads are; *Berberis* sp., *Buxus sempervirens*, *Cedrus libani*, *Eucalyptus* sp., *Hedera helix*, *Ficus carica*, *Juglans regia*, *Olea europaea*, *Phoenix latifolia*, *Pinus pinea*, *Platanus orientalis*, *Populus nigra*, *Robinia pseudoacacia*, *Sophora japonica*, *Thuja orientalis*, *Ulmus minor* and *Washingtonia filifera*; whereas non-arboreal ones are *Alliaria petiolata*, *Anthemis* sp., *Avena barbata*, *Briza humilis*, *Bromus* sp., *Capsella bursa-pastoris*, *Centaurea solstitialis*, *Chenopodium botrys*, *Chondrilla juncea*, *Cichorium intybus*, *Convolvulus arvensis*, *Crepis sancta*, *Cynosurus echinatus*, *Dactylis glomerata, Daucus carota*, *Galium* sp., *Geranium* sp., *Hordeum bulbosum*, *Inula viscosa*, *Lamium amplexicaule*, *Lapsana communis*, *Lolium perenne*, *Malva sylvestris*, *Mercurialis annua, Miyosotis arvensis*, *Papaver rhoeas*, *Parietaria judaica*, *Plantago* sp., *Poa bulbosa*, *Ranunculus arvensis*, *Rosmarinus officinalis, Rumex acetocella*, *Scabiosa rotate*, *Scandix pecten-veneris*, *Silybum marianum*, *Sinapis alba*, *Trifolium* sp., *Umbilicus horizontalis*, *Urtica dioica, Verbascum* sp., *Vicia* sp., *Taraxacum* sp., *Tordylium apulum* and *Xanthium strumarium*. Olives, pomegranates, figs, apples, grapes, cherries, peaches, apricot, pear, quince, plum, wheat, tobacco, cotton, tomato, pepper, radish, onion and garlic are cultivated widely over an area of 40.50%. The present report describes the dıfferences ın concentratıons of allergenıc pollens at dıfferent heıghts ın Denızlı, Turkey.

## Materials and Methods

Studies were carried out from January to December (2000) in the centre of the Denizli. Durham samplers were fixed on the rooftop of a building (15 m) and at the ground level (1.50 m). The slides smeared with glycerine-jell stained with safranine were changed weekly. Identification was done with the help of B-3000 binocular by using reference slides from 800 taxa, and counting made on 20x20 mm (4 cm$^2$) area of the slide, extrapolated to 1 cm$^2$ according to the methods given by Guvensen & Ozturk (2002, 2003).The record of allergic patients was taken from the hospital and meteorological data obtained from the meteorological station.

## Results

In general pollens from 34 taxa were observed in the atmosphere of Denizli city. Out of these 20 belong to the arboreal plants and 14 to the non-arboreals. At the lower level (1.50 m) dominant arboreal plants were Pinaceae, Cupressaceae/Taxaceae, *Quercus*, *Olea europaea* and *Platanus orientalis*. The dominant non-arboreal plants were Poaceae, Chenopodiaceae/ Amaranthaceae, Fabaceae and *Carex*. The total pollen concentration at this level was 5995 per $cm^2$, out of which 5033 per $cm^2$ belonged to the arboreal and 962 per $cm^2$ to the non-arboreal group (Table 1). At higher level (15 m) dominant arboreal plants were Pinaceae, Cupressaceae/Taxaceae, *Quercus*, *Olea europaea* and *Platanus orientalis* and non-arboreals were Poaceae, Chenopodiaceae/ Amaranthaceae, Fabaceae and *Carex*. The total pollen concentration at this level was 7717 per $cm^2$, out of which 6471 per $cm^2$ were of arboreal origin and 1246 per $cm^2$ non-arboreal ones (Table 1).

The average number of pollens counted from two heights was 6856 pollen/$cm^2$ which includes 5752 arboreal (83.9%) and 1104 non-arboreal (16.10%) taxa (Table 1). The maximum number of pollen counts was recorded from the arboreal plants because this area gets enough precipitation for the growth of arboreal species. The pollen counts from two heights were different. On an average, the highest concentration was that of Pinaceae (40.92%), Cupressaceae/Taxaceae (14.16%), *Quercus* (9.8%), *Olea europaea* (7.03%) and *Platanus orientalis* (5.69%), and for non-arboreal representatives these were Poaceae (6.25%) Chenopodiaceae/ Amaranthaceae (2.67%), Fabaceae (1.65%) and *Carex* (1.22%) (Table 1). The total average of these pollens in the atmosphere was 12258 per $cm^2$, which comes to 89.39% of the total average pollen (Table 2).The total average pollen density in the atmosphere during the study period followed the trend as; May, June, April, March, February, July, August, January, September, October and November. Almost no pollen taxa were recorded in December (Fig. 1, Table 2). The number of pollens in the atmosphere from non-arboreal plants was highest during May, June and July, whereas pollens from arboreal plants dominated during April, May and June (Fig. 2, Table 2). The pollens of herbaceous taxa were not encountered during the months of January and February. Pollens were first recorded in the 2nd week of January. In February, in addition to Cupressaceae/Taxaceae, *Alnus glutinosa,* Pinaceae and *Corylus* pollens were present but the number was very low. Cupressaceae/Taxaceae topped the list during the last week of February. In March, the number of taxa went up to 15 with Cupressaceae/Taxaceae dominating in 1st week, followed by *Salix, Castanea sativa* and *Crateagus* during the last week. In the month of April pollens of 26 taxa in particular *Acer, Castanea sativa,* Pinaceae*, Platanus orientalis, Quercus, Salix* and Poaceae were recorded (Fig. 3). During the 3rd and 4th weeks of this month pollen density was very high. In May pollens from 26 taxa were observed, the highest number belonged to arboreal taxa such as Pinaceae followed by *Olea europaea, Quercus, Platanus orientalis orientalis* and non-arboreal Poaceae. *Crateagus,* Ericaceae, *Juglans regia, Olea europaea,* Pinaceae, *Pistacia, Quercus*, *Ulmus*, Fabaceae, *Parietaria judaica, Plantago*, *Rumex* and *Urtica* were abundant in May. In June the number of taxa determined was 24. *Ligustrum vulgare, Tilia* and *Helianthus annuus* pollens were firstly detected in June and *Carex,* Poaceae, *Rumex*, *Taraxacum* together with *Ligustrum vulgare* reached highest level in this month. *Tilia* pollens were only detected in 1st and 2nd weeks of June. The number went down to 17 taxa during July (Fig. 3). During this month dominating pollens in the atmosphere were Pinaceae, Poaceae, Chenopodiaceae/Amaranthaceae. Pollens of *Ligustrum vulgare, Quercus, Mercurialis annua and Rumex* ended in July. The pollen from non-arboreal taxa reached the highest density in June but number in July decreased. In August only 11 non-arboreal and two arboreal plants were found with a highest

**Table 1. Average total pollen counts of different taxa from two different stations and their percentage values and degree of allergenicity.**

| Plant groups | Allergic degree | TAXA | Lower level (1.50 m) | Higher level (15 m) | Average | % |
|---|---|---|---|---|---|---|
| Arboreal pants | LAP | *Crataegus* | 73 | 73 | 73 | 1.06 |
| | | *Ligustrum vulgare* | 45 | 84 | 64.5 | 0.94 |
| | | *Pistacia* | 27 | 45 | 36 | 0.53 |
| | | *Acer* | 24 | 16 | 20 | 0.29 |
| | | *Ostrya carpinifolia* | 11 | 23 | 17 | 0.25 |
| | | *Tilia* | 4 | 4 | 4 | 0.06 |
| | AP | Pinaceae | 2336 | 3275 | 2805.5 | 40.92 |
| | | Cupressaceae / Taxaceae | 1042 | 900 | 971 | 14.16 |
| | | *Quercus* | 521 | 823 | 672 | 9.8 |
| | | *Olea europaea* | 448 | 516 | 482 | 7.03 |
| | | *Platanus orientalis* | 351 | 429 | 390 | 5.69 |
| | | *Salix* | 42 | 72 | 57 | 0.83 |
| | | *Castanea sativa* | 40 | 67 | 53.5 | 0.78 |
| | | *Populus* | 26 | 24 | 25 | 0.36 |
| | | Ericaceae | 10 | 31 | 20.5 | 0.30 |
| | | *Juglans regia* | 7 | 33 | 20 | 0.29 |
| | | *Phillyrea latifolia* | 13 | 22 | 17.5 | 0.26 |
| | | *Ulmus* | 5 | 18 | 11.5 | 0.17 |
| | | *Alnus glutinosa* | 6 | 9 | 7.5 | 0.11 |
| | | *Corylus* | 2 | 7 | 4.5 | 0.07 |
| | | **Total arboreal pollen** | **5033** | **6471** | **5752** | **83.90** |
| Non-arboreal plants | LAP | Fabaceae | 106 | 121 | 113.5 | 1.65 |
| | | *Carex* | 75 | 92 | 83.5 | 1.22 |
| | | *Taraxacum* | 23 | 75 | 49 | 0.71 |
| | | *Achillea* | 23 | 55 | 39 | 0.57 |
| | | *Inula* | 21 | 28 | 24.5 | 0.36 |
| | | *Helianthus annuus* | 17 | 13 | 15 | 0.22 |
| | AP | Poaceae | 392 | 465 | 428.5 | 6.25 |
| | | Chenopodiaceae/Amaranthaceae | 168 | 198 | 183 | 2.67 |
| | | *Plantago* | 37 | 59 | 48 | 0.70 |
| | | *Mercurialis annua* | 26 | 45 | 35.5 | 0.52 |
| | | *Parietaria judaica* | 22 | 40 | 31 | 0.45 |
| | | *Xanthium strumarium* | 29 | 20 | 24.5 | 0.36 |
| | | *Rumex* | 12 | 22 | 17 | 0.25 |
| | | *Urtica* | 11 | 13 | 12 | 0.17 |
| | | **Total non-arboreal pollen** | **962** | **1246** | **1104** | **16.10** |
| | | **Total** | **5995** | **7717** | **6856** | **100** |

LAP: Low allergenic plants AP: Allergenic plants

**Table 2. Annual pollen distribution (Monthly %) of dominant plant taxa in the atmosphere of Denizli on the basis of averages from two heights (grains/cm$^2$).**

| Taxa | Jan. | Feb. | Mar. | Apr. | May | Jun | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ıpressaceae/ ıxaceae | 190 | 870 | 770 | 45 | 61 | 6 | | | | | | | 1942 |
| *lea europaea* | | | | 20 | 765 | 150 | 14 | 15 | | | | | 964 |
| naceae | | 4 | 3 | 130 | 2715 | 2512 | 211 | 35 | 1 | | | | 5611 |
| *atanus orientalis* | | | | 543 | 234 | 3 | | | | | | | 780 |
| *uercus* | | | 4 | 609 | 670 | 58 | 3 | | | | | | 1344 |
| *ırex* | | | | | 14 | 52 | 50 | 37 | 8 | 6 | | | 167 |
| ıenopodiaceae/ ımaranthaceae | | | | 4 | 34 | 56 | 101 | 113 | 38 | 18 | 2 | | 366 |
| ɔaceae | | | 4 | 41 | 281 | 328 | 153 | 46 | 4 | | | | 857 |
| ıbaceae | | | 4 | 21 | 71 | 57 | 45 | 22 | 7 | | | | 227 |
| **ɔtal** | **190** | **874** | **785** | **1413** | **4845** | **3222** | **577** | **268** | **58** | **24** | **2** | | **12258** |
| **thers** | | **3** | **173** | **373** | **385** | **275** | **120** | 77 | **35** | **13** | | | **1454** |
| **ɔplam ollen grains)** | **190** | **877** | **958** | **1786** | **5230** | **3497** | **697** | **345** | **93** | **37** | **2** | | **13712** |

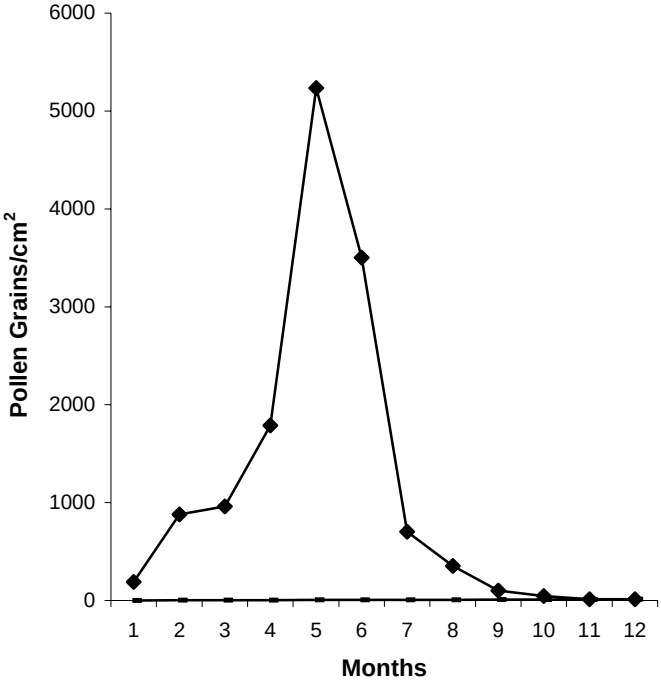


Fig. 1. Monthly average of total airborne pollen in Denizli, Turkey.

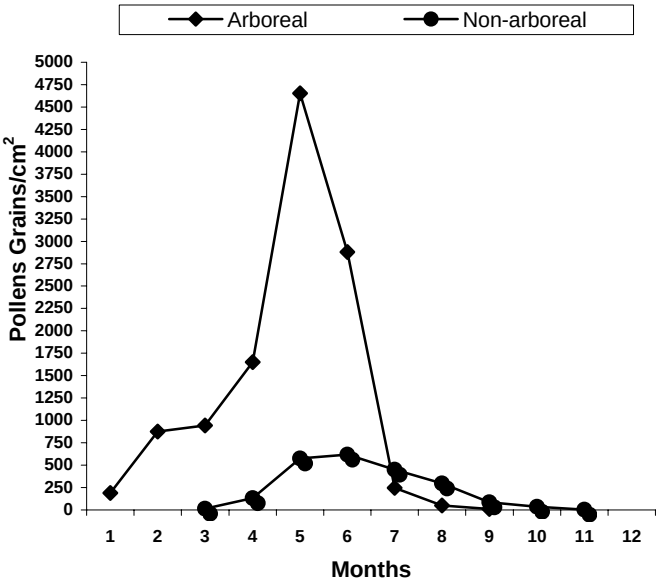


Fig. 2. Monthly average of total airborne pollen of arboreal and of non-arboreal taxa in Denizli, Turkey.

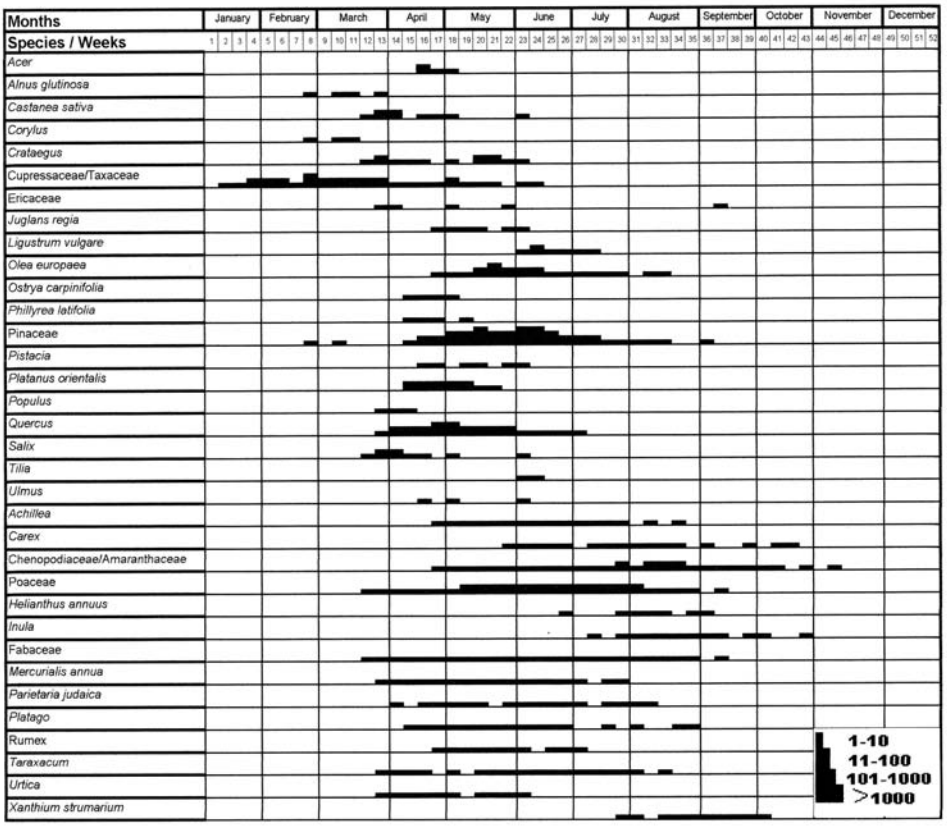


Fig. 3. Average total allergenic pollen counts calendar grains/cm$^2$ of Denizli, Turkey.

number of pollens from Chenopodiaceae/Amaranthaceae. Only pollens of *Olea europaea,* Pinaceae and Ericaceae from the arboreal group were detected in August. In September, 9 taxa of Chenopodiaceae/Amaranthaceae dominated. Only pollens of Pinaceae and Ericaceae from the arboreals were detected in September (Fig. 3).The pollens of arboreal taxa were commonly met with in October and November, with three taxa in October and only pollens of Chenopodiaceae/Amaranthaceae during the 2nd week of November. No pollen was found in December. The longest pollen period on weekly basis in a year followed the trend as: Chenopodiaceae/Amaranthaceae (27 weeks), Fabaceae (25 weeks), Poaceae (25 weeks), Cupressaceae/Taxaceae (22 weeks), Pinaceae (22 weeks), *Taraxacum* (18 weeks), *Mercurialis annua* (17 weeks), *Achillea* (16 weeks), *Carex* (16 weeks), *Olea europaea* (16 weeks), *Quercus* (15 weeks). During July, August and September pollens of non-arboreal plants were more dominating, but in October and November although very little only pollens of herbaceous taxa were found. No pollen from herbaceous taxa was recorded untill 1st week of February and from 3rd week of November. In January, only pollens of Cupressaceae/Taxaceae were detected in 2nd week (Fig. 3).

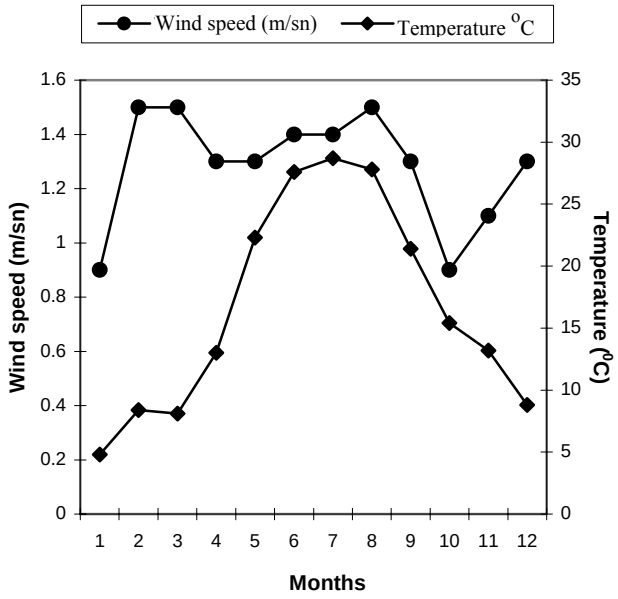


Fig. 4. Annual wind speed data and temperature of Denizli from January to December 2000.

## Discussion

This study revealed that pollen of arboreal taxa was higher in general at both heights as compared to non-arboreals because the former produce more pollen than latter (Table 1). Pollen percentage was lower in November and December because pollination is not common during these months. In the 2nd week of January, pollination in Cupressaceae/ Taxaceae starts and pollen concentration goes up rapidly at higher level. Towards the end of February these taxa are joined by *Alnus glutinosa, Corylus* and Pinaceae thus bringing the pollen concentration of arboreal plants to its highest level. Most of the plants in the area start pollinating in mid-April and May, thus we found *Acer,* Pinaceae, *Platanus orientalis* and *Quercus* together with Poaceae dominating. This is followed by an increase particularly in the concentration of *Olea europaea,* Pinaceae, *Platanus orientalis* and Poaceae pollen during May and June, *Platanus orientalis* and *Quercus* pollen during April (Fig. 3), when wind speed increases (Fig. 4). Pollen distribution showed a good correlation with relative humidity and rise in the temperature during the study period (Figs. 4, 5). Concentration decreased in June and July when most of the species in this area complete their pollination. This is particularly true for arboreal plants during July, but non-arboreal species showed a relatively higher concentation. In July highly dense pollens of Poaceae were observed. In addition, Chenopodiaceae/ Amaranthaceae start pollinating in mid-summer, and as such, July and August showed a dominance of their pollen (Fig. 3) as well. During July relative humidity and percipitation increase once again in parallel with the temperature (Figs. 4, 5) which helps in the pollination of non-arboreal taxa and thereby an increase in the atmospheric pollen density (Fig. 2). In August, temperature and wind velocity (Fig. 4) showed an increase thus producing a positive effect on the pollination. Similar findings have been reported by other researchers (Anderson, 1980; McDonald, 1980).

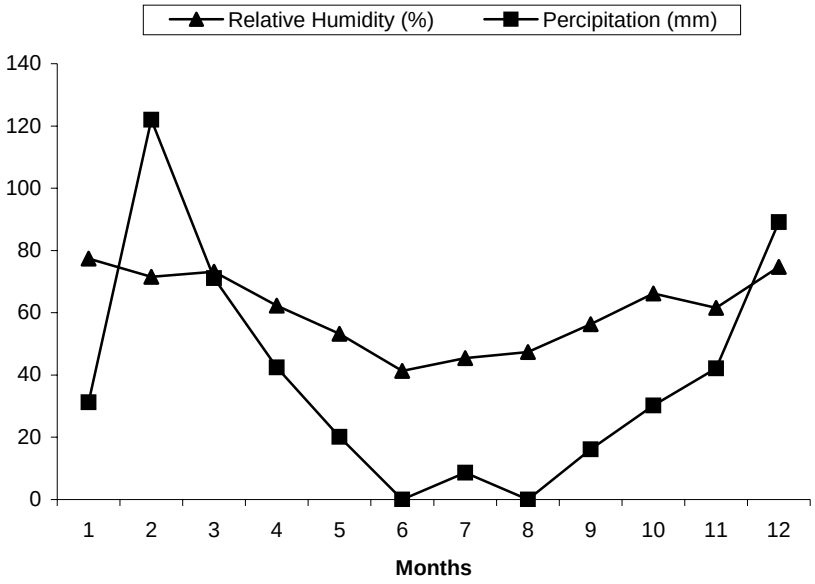


Fig. 5. Annual precipitation and relative humidity data of Denizli, 2000.

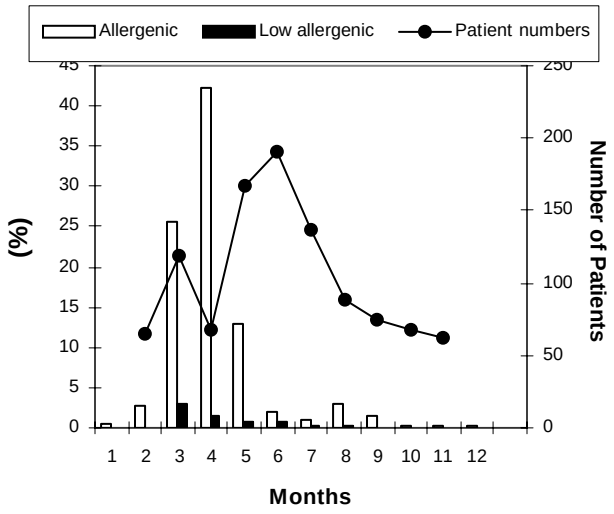


Fig. 6. Monthly variation in the percentage of allergenic/low allergenic species and time course of the number of patients.

Pollen concentration levels of basic plant groups is given in Fig. 1 and Table 1. These figures clearly show that arboreal plant species dominate as compared to the herbs. Although lower than our values similar reports have been published by Gemici *et al*., (1989) from Izmir with a ratio of 58.69%, however our results are very near to those of

Ay (1993), who has given a value of 84.6% for Manisa which is similar to ours. Similar findings have been reported from Balikesir, with a percentage of 70.92% for the arboreals and 24.87% for the non-arboreals (Bicakci & Akyalcin, 2000). They are dominated by Pinaceae, Cupressaceae/Taxaceae, *Platanus orientalis*, *Quercus* sp., Poaceae, Urticaceae, *Plantago* sp., Apiaceae and Chenopodiaceae/Amaranthaceae. In accordance with the ratio of arboreal and non-arboreal taxa in the atmosphere their percentages in the atmosphere of Balikesir is very close to our findings. The pollen density of *Acer* sp., *Plantago* sp., *Populus* sp., *Rumex* sp., and Urticaceae in the atmosphere of Denizli is very low, but arboreal plants are 83.9% and non-arboreals 16.10%, whereas Poaceae is 6.25%.

The investigations undertaken in a neighbouring State Izmir at different heights showed that the percentage of arboreal taxa varied between 81.35-85.68%, non-aboreals 13.75-27% and Poaceae 4.35-6.85%. The dominant woody taxa from the point of view of atmospheric pollen were *Pinus*, Cupressaceae/Taxaceae, *Quercus*, Oleaceae and *Morus*, whereas dominant herbaceous taxa were Poaceae, Chenopodiceae/Amaranthaceae, *Plantago* and *Centaurea. Pinus*, *Quercus*, Oleaceae, Cupressaceae/Taxaceae, *Morus,* Poaceae, Chenopodiceae/Amaranthaceae, Cruciferae and *Plantago* were the taxa with a highest density (Guvensen & Ozturk, 2002, 2003). A comparison of these findings with those of Denizli depicts that the values of both groups are close to each other. They differ from each other only in the number of such taxa as *Platanus orientalis*, Fabaceae and *Carex* which are higher in Denizli. In another neighbouring State Manisa pollen density of woody taxa in the atmosphere was 80.75%, herbaceous ones 7.1% and Poaceae 12.35%. The taxa with highest pollen density in this State were *Pinus, Olea europaea,* Poaceae, Cupressaceae/Taxaceae, *Quercus, Casuarina equisetifolia, Platanus orientalis, Morus,* Chenopodiaceae/Amaranthaceae and *Plantago* (Ay, 1993). Fabaceae and *Carex* were highest in the atmosphere of Denizli as compared to Manisa but arboreal taxa resembled each other.

Sensitivity to pollens in respiratory system allergies is related to differences in macro (i.e: climate) and micro (city or rural area) environmental characteristics of an area (Peternel *et al.*, 2003). The type of pollen allergy is in part related to regional differences. In general the pollen of the Pinaceae are the least allergenic, with a very low positive response whereas Cupressaceae/Taxaceae show higher concentration accompanied by medium to high allergic reaction but the taxa like *Thuja orientalis, Juniperus oxycedrus* and *J. excelsa* show medium to strong allergic reaction (Middleton *et al*., 1988; Bar-Dayan *et al*., 1995). *Quercus* is responsible for pollinosis (Middleton *et al*., 1988) showing medium and high allergic reactions like *Olea europaea* (Aytug *et al*., 1995; Peternel *et al*., 2003). In particular very strong allergic reactions are reported for *Ligustrum* sp., and *O. europaea* (Waisel *et al*., 1996). Chenopodiaceae/Amaranthaceae give a medium to highly effective positive reaction in allergic tests (Kosman *et al*., 1997). *Cynodon dactylon, Dactylis glomerata, Poa pratensis, Phleum ratense, Agrostis* sp., and *Lolium* sp., from Poaceae show high allergic reaction (Porsbjerg *et al*., 2003). *Platanus orientalis* pollens are found in relatively high numbers but show a medium allergic reaction (Middleton *et al.*, 1988).

In Turkey incidence of allergies varies between 15-18% (Bousquet, 2001). The total pollen counts in Denizli follow the trend as May, June, April and March (Fig. 1). Table 1 presents the allergic degree of the pollen in Denizli prepared according to Middleton *et al.*, (1988) and Aytug *et al*., (1995).The table shows that pollens of 23 taxa are highly allergic (AP), 11 taxa are weekly allergic (LAP). The density of pollens of taxa with a

higher allergenic effect in the city atmosphere follow the trend as; May (5017 grains/cm$^2$), June (3202 grains/cm$^2$) and April (1661 grains/cm$^2$). Number of patients on monthly basis in relation to highest allergenic and low allergenic pollen density is given in Fig. 5. According to this, highest patient numbers were recorded in June, May, July and March respectively. Arboreal allergenic pollen counts in Denizli city atmosphere are dense in April, March and May. In particular Cupressaceae/Taxaceae pollens with a high allergic impact are found in March, *Olea europaea,* Pinaceae, *Platanus orientalis, Quercus* and Poaceae taxa in May. These months show an increase in the allergic diseases. In these months, allergic patients also show an increase (Fig. 3; Table 2). In July pollen counts decrease and number of allergic patients also decreases. But in August, Chenopodiaceae/Amaranthaceae and Poaceae are very high (Fig. 3; Table 2) together with other highly allergic non-arboreal plants and allergic patient number again goes up (Fig. 6). As such, inhabitants of Denizli sensitive against the allergic pollen dusts need to be very careful during the months of April, March, May and August. Present calendar will permit a productive and healthy lifestyle for allergic patients as well as control and minimization of symptoms and severity of allergic diseases.

**References**

Akman, Y. 1999. *Climate and Bioclimate (Bioclimatological Methods and Climates in Turkey*). Kariyer Press, Ankara, Turkey, pp. 350.

Anderson, S. 1980. Influence of climatic variation of pollen season severity in wind-pollinated trees and herbs. *Grana*, 19: 45-52.

Ay, G. 1993. Pollen *Calendar of Manisa*. Doctoral Disseration, Ege University Inst. of Sciences, Bornova-Izmir, Turkey, pp. 88.

Aytug, B., F. Yaltırık and A Efe. 1995. *Allergenic pollen producing plants of Turkey*. Proceedings of the National Palynology Congress, Istanbul University, Forest Faculty, 201-212, Istanbul, Turkey.

Bar-Dayan, Y., N. Keynan, Y. Waisel, A.I. Pick and R. Tamir. 1995. *Podocarpus gracilior and Callitris verrucosa*- newly identified allergens that crossreact with *Cupressus sempervirens*. *Clin. Exp. Allergy*, 25: 456-460.

Bicakci, A. and H. Akyalcin. 2000. Analysis of airborne pollen fall in Balıkesir, Turkey, 1996-1997. *Ann Agric Environ. Med.,* 7: 5-10.

Bicakci, A, S. Ergun, S. Tatlidil, H. Malyer, S. Ozyurt, A. Akkaya and N. Sapan. 2002. Airborne pollen grains of Afyon, Turkey. *Acta Botanica Sinica*, 44: 1371-1375.

Bicakci, A., S. Tatlidil, N. Sapan, H. Malyer and Y. Canitez. 2003. Airborne pollens grains in Bursa, Turkey. *Ann. Agric. Environ. Med.,* 10: 31-36.

Bousquet, J. 2001. Epidemiology and genetics. Aria workshop report. *Allergy Clin. Immunol,* 108:153-161.

Gemici, Y., O. Secmen and E. Unal. 1989. İzmir yöresi polinizasyon takvimi. In: Türk Tıp Dernegi (Eds): III. Ulusal Alerjik Hastalıklar Kongresi 20-22 May 1987, 195-210. Cesme-Izmir, Turkey.

Guvensen, A. and M. Ozturk. 2002. Airborne pollen calendar of Buca-Izmir, Turkey. *Aerobiologia*, 18: 1-9.

Guvensen, A. and M. Ozturk. 2003. Airborne pollen calendar of Izmir-Turkey. *Ann. Agric. Environ. Med.,* 10: 37-44.

Inceoglu, O., N.M. Pınar, N. Sakıyan and K. Sorkun. 1994. Airborne pollen concentration in Ankara, Turkey 1990-1993. *Grana*, 33: 158-161.

Kay, A.B. 1991. Asthma and inflammation. *J. Allergy Clin. Immun.*, 87: 893-910.

Kobzar, V.N. 1999. Aeropalynological monitoring in Bishkek, Kyrgyzstan. *Aerobiologia*, 15: 149-153.

Kosman, E., A. Eshel and Y. Waisel. 1997. The 'Travelling Salesman Problem': A new approach for identification of differences among pollen allergens. *Allergy Immun.*, 112: 371- 377.

McDonald, M. 1980. Correlation of air-borne grass pollen levels with meteorological data. *Grana*, 19: 53-56.

Middleton, E., E.R. Charles, F.E. Elliott, N.F. Adkinson and J.W. Yunginger. 1988. *Allergy Principles and Practice*, Toronto.

Nclerio, R.M. 1991. Allergic rhinitis. *N. Engl. J. Med.*, 325: 860-869.

Pehlivan, S. 1995. Türkiye'nin Alerjen Polenleri Atlası. Unal Offset, Ankara.

Peternel, R., J. Culig, B. Mitic, I. Vukusic and Z. Sostar. 2003. Analysis of airborne pollen concentration in Zagreb, Croatia. *Ann. Agric. Environ. Med.*, 10: 107-112.

Pinar, N.M, N. Sakiyan, O. Inceoglu and A. Kaplan. 1999. A one year aeropalynological study at Ankara, Turkey. *Aerobiologia*, 15: 307-310.

Porsbjerg, C., A. Rasmussen and V. Backer. 2003. Airborne pollen in Nuuk, Greenland, and the importance of meteorological parameters. *Aerobiologia*, 19: 29-37.

Saar, M., Z. Gudzinskas, T. Ploompuu, E. Linno, Z. Minkiene and V. Motiekaityte. 2000. Ragweed plants and airborne pollen in the Baltic states. *Aerobiologia*, 16: 101-106.

Waisel, Y., C. Geller-Bernstein, N. Keynan and G. Arad. 1996. Antigenicity of the pollen proteins of various cultivars of *Olea europaea. Allergy*, 51: 819- 825.

Weiss, K.B. 1993. Breathing better or wheezing worse. The changing epidemiology of asthma morbidity and mortality. *Annu. Rev. Publ. Health*, 14: 491-513.

(Received for publication 17 March 2005)