

## ANALYSIS OF AIRBORNE POLLEN FALL IN BALIKESIR, TURKEY, 1996-1997

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

**Abstract:** In this study, pollen grains were identified by use of Durham sampler in the atmosphere of Balikesir in 1996 and 1997. During these two years, a total of 17,256 pollen grains per cm<sup>2</sup> were recorded. A total of 8,576 pollen grains per cm<sup>2</sup> were identified in 1996 and a total of 8,680 pollen grains per cm<sup>2</sup> in 1997. Pollen fall in the years 1996-1997 comprised grains belonging to 50 taxa and unidentified pollen grains. Of these 50 taxa, 30 belonged to arboreal and 20 to non-arboreal plants. Total pollen grains consisted of 70.92% grains from arboreal plants, 24.87% grains from non-arboreal plants and 4.21% unidentified pollen grains. In the region investigated, *Pinus* spp., Cupressaceae/Taxaceae, Gramineae, *Platanus* spp., *Quercus* spp., *Olea* spp., *Salix* spp., Urticaceae, Moraceae, *Plantago* spp., Chenopodiaceae/Amaranthaceae, *Ailanthus* spp., *Juglans* spp., *Carpinus* spp. and Rosaceae released the greatest amounts of pollens. During the study period, the pollen fall reached its highest level in May.

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**Key words:** Turkey, Balikesir, pollen, pollen calendar.

## INTRODUCTION

Pollen grains cause respiratory system diseases such as allergic asthma and hay fever (pollinosis). These diseases appear mainly during the flowering periods of plants. Determinations of type and falls of pollen grains are helpful for patients suffering from allergic diseases. For this reason, annual pollen calendars have been prepared in many countries [6, 8, 15, 17, 19].

The aim of this study was to determine pollen grains and changes in pollen fall per cm<sup>2</sup> weekly, monthly and annually. The results of this study are expected to be useful for allergists in establishing a right diagnosis.

## MATERIALS AND METHODS

Balikesir is situated at 39° 04' N, 26° 02' E in north-western Turkey at an altitude of 100–150 m above sea level. Balikesir has a Mediterranean, Irano-Turanian vegetation and generally a Mediterranean climate.

Vegetation north of the city is composed of large-leaved woods: *Quercus robur* L., *Q. petraea* (Mattusehka) Liebl., *Fagus orientalis* Lipsky, *Castanea sativa* Miller., *Carpinus betulus* L., *Tilia tomentosa*. In other regions, the most common trees and shrubs are: *Pinus brutia* Ten., *Quercus infectoria* Oliver., *Q. cerris* L., *Pinus nigra* Arn., *Paliurus spina-cristi* Miller., *Ligustrum vulgare* L., *Cedrus libani* A. Richard, *Cupressus sempervirens* L. In this rural area, the major weeds and grasses are Leguminosae, Compositae, Gramineae, Labiatae. On the plain near the metropolitan district grow olives, vegetables and orchards (citrus fruits, figs, vineyards, apples, quinces). The soil there is suitable for sunflower, cotton, tobacco, etc.

In addition to the natural vegetation around Balikesir, the following species are frequently seen in the parks, gardens and streets of the town: *Pinus nigra*, *Pinus brutia*, *Pinus pinea* L., *Cedrus libani*, *Platanus orientalis* L., *Ligustrum vulgare*, *Catalpa bignonioides* Walt., *Buxus sempervirens* L., *Populus* spp., *Acacia* spp., *Fraxinus* spp., *Acer* spp., *Aesculus* spp., *Eleagnus angustifolia* L.,

*Juglans* spp., *Salix* spp., *Tilia* spp., *Forsythia* spp., *Cercis* spp., *Berberis* spp., *Nerium oleander* L., and *Cornus* spp.

In this study, gravimetric method and Durham sampler were used. The Durham sampler was placed on the roof of the office building at a height of 25 m above ground level. Slides placed in the Durham sampler were changed weekly.

Before exposure, the slides were coated with glycerine jelly mixed with basic-fuchsin [4]. The slides were examined weekly by light microscope. The numbers of pollen grains found in the cover-glass area were converted to pollen counts.

## RESULTS

A total of 17,256 pollen grains from 50 taxa, 8,576 in 1996 and 8,680 in 1997, have been identified in the atmosphere of Balıkesir during these two years. Out of 50 taxa, 30 were arboreal while the others were non-arboreal plants. A total of 12,238 pollen grains have been found to be arboreal (70.92%), 4,291 as non-arboreal (24.87%) and 727 as unidentified (4.21%) (Tab. 1).

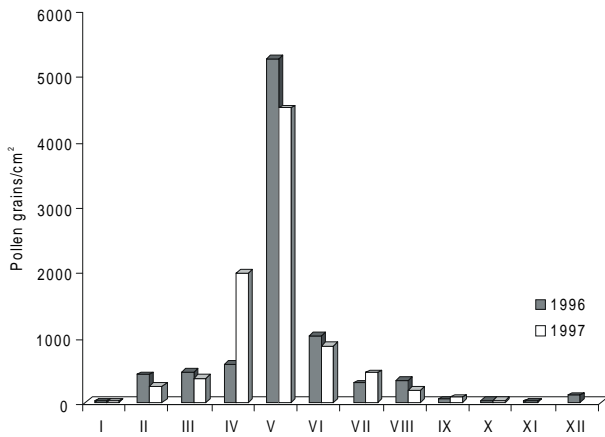
The main pollen producers in the atmosphere of Balıkesir were the following arboreal plants: *Pinus* spp., Cupressaceae/Taxaceae, *Platanus* spp., *Quercus* spp., *Olea* spp., *Salix* spp., Moraceae, *Ailanthus* spp., *Juglans* spp., *Carpinus* spp. and Rosaceae. They form 64.16% of the total pollen fall (Tab. 1). From herbaceous plants, Gramineae, Urticaceae, *Plantago* spp., Compositae, Chenopodiaceae/Amaranthaceae and *Rumex* spp. were found frequently in the atmosphere of Balıkesir making up 21.82% of the total.

Monthly variations of total pollen grains recorded in the atmosphere of Balıkesir during the years 1996–1997 are shown in Figure 1. The seasonal variation of arboreal and non-arboreal pollen fall is given in Figure 2.

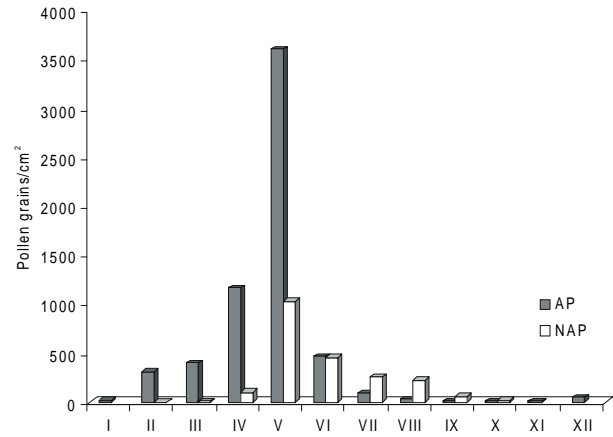
The earliest pollen grains in the atmosphere of Balıkesir were noted in January (Fig. 1). The main arboreal pollen grains were observed in this month. In January, low falls were recorded for Cupressaceae/Taxaceae (0.06%), *Corylus* spp. (0.04%), *Ulmus* spp. (0.03%) and *Alnus* spp. (0.02%) (Tab. 2). Pollen grain falls began to increase in February, March and April, and reached their maximum levels in May (56.6%). *Pinus* spp. (16.2%), Gramineae (7.32%), *Platanus* spp. (6.06%), *Quercus* spp. (5.61%), Cupressaceae/Taxaceae (3.59%), *Salix* spp. (2.03%), Moraceae (1.45%), Urticaceae (1.3%), *Plantago* spp. (1.25%), *Olea* spp. (1.2%), *Juglans* spp. (1.08%), Rosaceae (0.9%), *Carpinus* spp. (0.83%), *Rumex* spp. (0.61%) and Compositae (0.59%) were releasing high amounts of pollen into the atmosphere throughout their pollination period, and formed more than 50% of the total pollen grains in May (Tab. 2). The numbers of pollen grains were also high in June. From July, the pollen grains of weeds became dominant, but the amount of pollens was lower than in springtime. This decrease was correlated with the end of the pollination periods of many arboreal plants which produced and released high amounts

**Table 1.** Annual totals of weekly pollen counts.

|                           | 1996         | 1997         | Total         | %             |
|---------------------------|--------------|--------------|---------------|---------------|
| <b>Arboreal (AP)</b>      |              |              |               |               |
| <i>Pinus</i>              | 1,565        | 2,410        | 3,975         | 23.04         |
| Cupress./Taxa.            | 1,553        | 1,161        | 2,714         | 15.73         |
| <i>Platanus</i>           | 465          | 794          | 1,259         | 7.30          |
| <i>Quercus</i>            | 560          | 608          | 1,168         | 6.77          |
| <i>Olea</i>               | 371          | 114          | 485           | 2.81          |
| <i>Salix</i>              | 203          | 182          | 385           | 2.23          |
| Moraceae                  | 152          | 149          | 301           | 1.74          |
| <i>Ailanthus</i>          | 110          | 106          | 216           | 1.25          |
| <i>Juglans</i>            | 80           | 117          | 197           | 1.14          |
| <i>Carpinus</i>           | 108          | 82           | 190           | 1.10          |
| Rosaceae                  | 86           | 96           | 182           | 1.05          |
| Ericaceae                 | 57           | 59           | 116           | 0.67          |
| <i>Ostrya</i>             | 80           | 34           | 114           | 0.66          |
| <i>Sophora</i>            | 59           | 52           | 111           | 0.64          |
| <i>Castanea</i>           | 70           | 37           | 107           | 0.62          |
| <i>Alnus</i>              | 38           | 64           | 102           | 0.59          |
| <i>Fagus</i>              | 43           | 52           | 95            | 0.55          |
| <i>Fraxinus</i>           | 63           | 26           | 89            | 0.52          |
| <i>Populus</i>            | 17           | 41           | 58            | 0.34          |
| <i>Corylus</i>            | 33           | 19           | 52            | 0.30          |
| <i>Pistacia</i>           | 32           | 15           | 47            | 0.27          |
| <i>Robinia</i>            | 28           | 14           | 42            | 0.24          |
| <i>Ulmus</i>              | 27           | 15           | 42            | 0.24          |
| <i>Ligustrum</i>          | 39           | 2            | 41            | 0.24          |
| <i>Cedrus</i>             | 31           | 2            | 33            | 0.19          |
| Oleaceae                  | 11           | 20           | 31            | 0.18          |
| <i>Aesculus</i>           | 13           | 17           | 30            | 0.17          |
| <i>Acer</i>               | 13           | 15           | 28            | 0.16          |
| <i>Tilia</i>              | 23           | 1            | 24            | 0.14          |
| <i>Sambucus</i>           | 4            | -            | 4             | 0.02          |
| <b>Total AP</b>           | <b>5,934</b> | <b>6,304</b> | <b>12,238</b> | <b>70.92</b>  |
| <b>Non-arboreal (NAP)</b> |              |              |               |               |
| Gramineae                 | 1,196        | 1,249        | 2,445         | 14.17         |
| Urticaceae                | 184          | 159          | 343           | 1.99          |
| <i>Plantago</i>           | 170          | 122          | 292           | 1.69          |
| Compositae                | 190          | 80           | 270           | 1.56          |
| Cheno./Amarant.           | 137          | 129          | 266           | 1.54          |
| <i>Rumex</i>              | 84           | 66           | 150           | 0.87          |
| <i>Typha</i>              | 45           | 69           | 114           | 0.66          |
| <i>Xanthium</i>           | 19           | 53           | 72            | 0.42          |
| Umbelliferae              | 50           | 17           | 67            | 0.39          |
| Cyperaceae                | 34           | 24           | 58            | 0.34          |
| <i>Artemisia</i>          | 16           | 37           | 53            | 0.31          |
| <i>Taraxacum</i>          | 19           | 24           | 43            | 0.25          |
| <i>Helianthus</i>         | 18           | 17           | 35            | 0.20          |
| <i>Centaurea</i>          | 10           | 14           | 24            | 0.14          |
| Juncaceae                 | 6            | 8            | 14            | 0.08          |
| Labiatae                  | 10           | 4            | 14            | 0.08          |
| Leguminosae               | 11           | -            | 11            | 0.06          |
| Rubiaceae                 | 3            | 7            | 10            | 0.06          |
| Cruciferae                | 1            | 8            | 9             | 0.05          |
| Caryophyllaceae           | 1            | -            | 1             | 0.01          |
| <b>Total NAP</b>          | <b>2,204</b> | <b>2,087</b> | <b>4,291</b>  | <b>24.87</b>  |
| Unidentified              | 438          | 289          | 727           | 4.21          |
| <b>Total</b>              | <b>8,576</b> | <b>8,680</b> | <b>17,256</b> |               |
| <b>%</b>                  | <b>49.70</b> | <b>50.30</b> |               | <b>100.00</b> |



**Figure 1.** Total monthly variation in the amount of atmospheric pollen, Balikesir, 1996–1997.



**Figure 2.** Monthly variation of arboreal (AP) and non-arboreal (NAP) pollen grains, Balikesir, 1996-1997.

of pollen grains into the atmosphere (Fig. 1–2). In July, Gramineae, *Pinus* spp., *Olea* spp., *Ailanthus* spp., *Castanea* spp. were recorded as dominant taxa (Tab. 2). In August there prevailed Chenopodiaceae/Amaranthaceae, Gramineae, Compositae, *Xanthium* spp., Cupressaceae/Taxaceae; in September - Chenopodiaceae/Amaranthaceae, Gramineae, *Xanthium* spp., Compositae, *Artemisia* spp.; and in October - *Cedrus* spp., Gramineae, Chenopodiaceae/Amaranthaceae, Ericaceae, *Xanthium* spp. In November, only arboreal pollen types such as *Cedrus* spp., were recorded; and in December Cupressaceae/Taxaceae, *Corylus* spp. and *Ulmus* spp.

The types of pollens present in the atmosphere of Balikesir are shown in the form of a pollen calendar (Fig. 3), based on the counts made in 1996–1997. The following taxa produced the greatest amounts of pollens in the atmosphere of Balikesir:

*Pinus* spp. The pollen season started in the third week of March (12th week of the year) and ended in the second week of August (33rd week). The highest values were noted in the second week of May (19th week).

Cupressaceae/Taxaceae. Pollen grains of these families were recorded all year round. The highest counts were recorded in the last week of March (13th week).

**Table 2.** Maximal airborne pollen falls in subsequent months and their yearly composition (%), Balikesir, Turkey.

| Taxa                 | Jan.        | Feb.        | Mar.        | Apr.         | May          | June         | July        | Aug.        | Sep.        | Oct.        | Nov.        | Dec.        |
|----------------------|-------------|-------------|-------------|--------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| <i>Pinus</i>         | -           | -           | 0.06        | 4.49         | 16.2         | 1.75         | 0.5         | 0.03        | -           | -           | -           | -           |
| Cupress./Taxaceae    | 0.06        | 2.89        | 3.54        | 4.65         | 3.59         | 0.12         | 0.04        | 0.22        | 0.01        | 0.01        | 0.02        | 0.58        |
| <i>Platanus</i>      | -           | -           | -           | 1.22         | 6.06         | 0.02         | -           | -           | -           | -           | -           | -           |
| <i>Quercus</i>       | -           | -           | -           | 1.15         | 5.61         | 0.01         | -           | -           | -           | -           | -           | -           |
| <i>Olea</i>          | -           | -           | -           | -            | 1.2          | 1.6          | 0.01        | -           | -           | -           | -           | -           |
| <i>Salix</i>         | -           | -           | 0.02        | 0.18         | 2.03         | -            | -           | -           | -           | -           | -           | -           |
| Moraceae             | -           | -           | 0.03        | 0.26         | 1.45         | -            | -           | -           | -           | -           | -           | -           |
| <i>Ailanthus</i>     | -           | -           | -           | -            | 0.28         | 0.94         | 0.03        | -           | -           | -           | -           | -           |
| <i>Juglans</i>       | -           | -           | -           | 0.06         | 1.08         | -            | -           | -           | -           | -           | -           | -           |
| <i>Carpinus</i>      | -           | -           | -           | 0.27         | 0.83         | -            | -           | -           | -           | -           | -           | -           |
| Rosaceae             | -           | -           | -           | 0.15         | 0.9          | -            | -           | -           | -           | -           | -           | -           |
| Gramineae            | -           | 0.02        | 0.09        | 0.65         | 7.32         | 3.76         | 1.46        | 0.61        | 0.18        | 0.08        | -           | -           |
| Urticaceae           | -           | -           | -           | 0.15         | 1.3          | 0.28         | 0.14        | 0.12        | -           | -           | -           | -           |
| <i>Plantago</i>      | -           | -           | -           | 0.06         | 1.25         | 0.19         | 0.16        | 0.03        | -           | -           | -           | -           |
| Compositae           | -           | -           | 0.02        | 0.05         | 0.59         | 0.25         | 0.24        | 0.34        | 0.07        | -           | -           | -           |
| Cheno./Amaranthaceae | -           | -           | -           | -            | 0.04         | 0.1          | 0.32        | 0.81        | 0.21        | 0.06        | -           | -           |
| <i>Rumex</i>         | -           | -           | -           | 0.12         | 0.61         | 0.12         | 0.01        | 0.01        | -           | -           | -           | -           |
| Total                | 0.06        | 2.91        | 3.76        | 13.5         | 50.4         | 9.14         | 2.91        | 2.17        | 0.47        | 0.15        | 0.02        | 0.58        |
| Others               | 0.1         | 0.84        | 1.03        | 0.64         | 3.88         | 1.04         | 0.95        | 0.84        | 0.23        | 0.17        | 0.03        | 0.06        |
| Unidentified         | -           | 0.02        | 0.02        | 0.8          | 2.4          | 0.7          | 0.27        | -           | -           | -           | -           | -           |
| <b>Total</b>         | <b>0.16</b> | <b>3.77</b> | <b>4.81</b> | <b>14.90</b> | <b>56.63</b> | <b>10.88</b> | <b>4.13</b> | <b>3.01</b> | <b>0.70</b> | <b>0.32</b> | <b>0.05</b> | <b>0.64</b> |



**Figure 3.** Pollen calendar of Balikesir. The heights of bars are proportional to pollen fall (grains/cm<sup>2</sup>), as marked by letters: a: 1-9, b: 10-49, c: 50-99, d: 100-199, e: >200.

Gramineae. Pollen grains were recorded during the greater part of the year, from February to October. The highest counts were recorded in the last week of May (22nd week). The Gramineae family was the only herbaceous taxon dispersing high amount of pollen into the atmosphere.

*Platanus* spp. The pollen season was relatively short. It started in the first week of April (14th week) and ended in the first week of June (23rd week). The highest counts were recorded in the first and second weeks of May.

*Quercus* spp. Pollen production was continued from the second week of April (15th week) to the first week of June (23rd week). The highest counts were recorded in the first and second weeks of May (18–19th week).

*Olea* spp. The pollen season started in the second week of May and ended in the first week of July (27th week). The peak value was noted in the last week of May and in the first and second weeks of June.

*Salix* spp. Pollen production was continued from the third week of March (12th week) to the last week of May (22nd week). The highest counts were recorded in the first week of May (18th week).

Urticaceae. Pollen production was continued from the third week of April to the last week of August. The highest counts were recorded in the second and third weeks of May.

Moraceae. The pollen season started in the third week of March and ended in the fourth week of May (21st week). The peak value was noted in the first and second weeks of May.

*Plantago* spp. The pollen season started in the second week of April and ended in the last week of August (35th week). The highest value was noted in the fourth week of May.

Compositae. Pollen production was continued from the second week of April to the third week of October. The highest counts were recorded in the third week of May (20th week) and in the first week of June (22nd week).

Chenopodiaceae/Amaranthaceae. Pollen production was continued from the second week of May to the last week of October (43rd week). The highest counts were recorded in the third and last weeks of August (33rd–34th week).

*Ailanthus* spp. The pollen season started in the last week of May (15th week) and ended in the fourth week of July (30th week). The highest value was recorded in the last week of May and in the first, second and third weeks of June.

*Juglans* spp. The pollen season started in the third week of April and ended in the last week of May. The highest value was noted in the first and second weeks of May.

*Carpinus* spp. Pollen production was continued from the first week of April to the second week of May. The highest counts were recorded in the first week of May.

Rosaceae. The pollen season started in the first week of April (15th week) and ended in the last week of May. The highest value was recorded in the first week of May.

## DISCUSSION

In the atmosphere of Balıkesir, arboreal pollen types were dominant; this is due to the character of vegetation and geographical location of the town. According to other studies carried out in Europe, arboreal pollen types are also dominant in Finland (82%) [13], Ankara, Turkey (76%) [10], Ostrowiec Świętokrzyski, Poland (73%) [12], Perugia, Italy (71%) [16], Bursa, Turkey (70.01%) [1] and Ascoli Piceno, Italy (55%) [16].

Some important allergenic pollens such as *Pinus*, *Platanus*, Gramineae, Urticaceae and *Plantago* [2, 3, 5, 7, 9, 14] were also found in high concentrations in Balıkesir. In Europe, the dominant airborne species have been determined to be Gramineae, *Alnus*, *Artemisia*, *Urtica*, *Betula* in Leiden, the Netherlands [11, 18]; Gramineae, Urticaceae, Oleaceae, *Artemisia* in Ascoli Piceno, Italy [16]; *Betula*, *Pinus*, *Alnus*, *Platanus*, *Plantago* in Brussels, Belgium [11, 18]; Cupressaceae, Gramineae, *Quercus*, *Plantago* in Montpellier, France [18]; Pinaceae, *Alnus*, *Betula*, *Quercus*, Gramineae, *Artemisia* in Jyvaskylan, Finland [13]; *Alnus*, *Betula*, Gramineae, *Corylus* in Ostrowiec Świętokrzyski, Poland [12]; *Betula*, *Quercus*, Gramineae, Urticaceae in Vienna, Austria [11]. The airborne pollen types mentioned above are responsible for many cases of pollinosis in Europe.

## CONCLUSION

Pollen grains of 50 taxa were determined during the pollen season in the atmosphere of Balıkesir, of which 17 taxa formed about 85.98% of the total spectrum. In the region investigated, pollen grains were recorded all year round and reached their maximum levels in May. The pollen calendar for the region presented in this paper may be useful for allergologists to establish an exact diagnosis.

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