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ANALYSIS OF AIRBORNE POLLEN GRAINS IN KONYA, TURKEY, 2005

MUSTAFA KEMAL ALTUNOGLU[1*], ERKAN TORAMAN[2], MEHMET TEMEL[2], ADEM BICAKCI[1] AND MUSTAFA KARGIOGLU[2]

[1]*Department of Biology, Faculty of Science, Uludag University, Gorukle, Bursa, Turkey*
[2]*Department of Biology, Faculty of Science, Afyon Kocatepe University, Afyon, Turkey.*

Abstract

In this study, airborne pollen grains of Konya province were investigated using Durham sampler from January to December 2005. A total of 4420 pollen grains/cm^2 which belonged to 29 taxa and 9 unidentified pollen grains were recorded. From identified taxa, 19 belong to arboreal and 10 taxa to non-arboreal plants. Total pollen grains consist of 87,49% arboreal, 12,31% non-arboreal plants and 0,20% unidentified pollen grains. In the investigated region, from arboreal plant taxa *Pinus* spp. (21,63%), *Fraxinus* spp. (21,13%), Cupressaceae (15,84%), *Ailanthus* spp. (7,47%), *Platanus* spp. (3,80%), *Acer* spp. (3,28%), *Populus* spp. (1,86%), *Sophora* spp. (3,85%) and from non-arboreal plant taxa Chenopodiaceae / Amaranthaceae (4,77%), Poaceae (3,67%) were responsible for the greatest amount of pollen. During the study period, the pollen fall reached its highest level in March.

Introduction

In the past few years, air quality analysis in city centres has taken on an important role in the field of environmental research and prevention (Ballero & Maxia, 2003). Airborne bio-particles include pollen grains from wind-pollinated plant, viruses, bacteria, spores, of fungi, mosses, ferns, fungi hyphal fragments, algae, and other plant fragments (Hasnain *et al*., 2005). Most of the airborne pollen grains are composed of arboreal and nonarboreal plants and most of them are allergic for human health. Determination of the pollen types and their concentration is very important especially in the atmosphere of highly populated cities. These data prove helpful in the treatment of patients suffering from such diseases. For this reason, studies of the pollen content in the atmosphere of different areas have been carried out by researchers worldwide and Turkey. Finlad (Koivikko *et al*., 1986), Italy (Romano *et al*., 1988, Ballero & Maxia, 2003), Poland (Kasprzyk, 1996), Portugal (Abreu *et al*., 2003), Iberian peninsula (Cariñanos *et al*., 2004), Croatia (Peternel *et al*., 2005) and Spain (García-Mozo *et al*., 2006, Doacmpo *et al*., 2007) were investigated many countries by researchers in the world. Also in Turkey, Balikesir (Bicakci & Akyalcin, 2000), Isparta (Bicakci *et al*., 2000a), Burdur (Bicakci *et al*., 2000b), Rize (Bicakci *et al*., 2002a), Afyon (Bicakci *et al*., 2002b), Bursa (Bicakci *et al*., 2003), Usak (Bicakci *et al*., 2004a), Edirne (Bicakci *et al*., 2004b), Izmir (Guvensen & Ozturk, 2002), Bartin (Kaya & Aras, 2004), Bitlis (Celenk & Bicakci, 2005), Sakarya (Bicakci, 2006), Bilecik (Ture & Bocuk, 2008) and Yalova (Altunoglu *et al*., 2008) were investigated provinces by researchers.

The aims of this study was to determine pollen grains and changes in pollen fall per cm^2 weekly, monthly and annually. The results of this study are expected to be useful for allergist in establishing a right diagnosis.

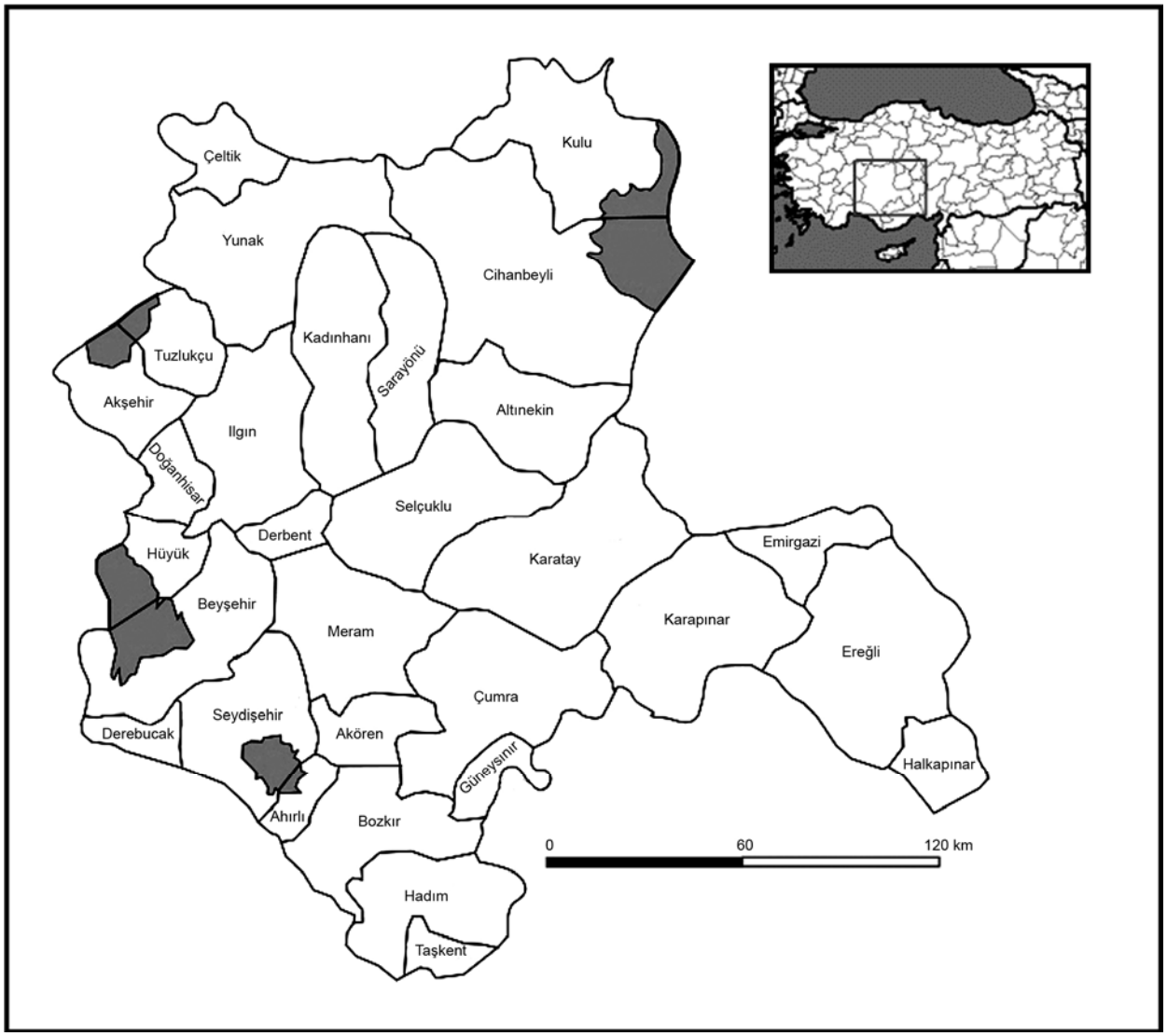

Fig. 1. Map of Konya Province.

Description of the study area: Konya situated in 36° 41' N, 31° 14' E (Fig. 1) with its population (approximately 2,000,000), the field (40.813,52 km^2). Konya is located in the inner Anatolia Region and surrounded with Toros Mountains and its branches in the direction of southeast, south and southwest. Konya have 70 families and 600 taxon belong to 292 genus. The plants determined foristic zone are Irano-Turaian (31%), widespread (22,4%), Mediterranean (14,6%) and Euro-Sberian (3%). Of these 29% is undetermined. Endemizm rate in the region is 13%. The following species are found in Konya: *Juniperus excelsa* M. Bieb. *J. foetidissima* Willd., *J. oxycedrus* L. subsp. *oxycedrus Ephedra major* Host, *Cedrus libani* A.Rich. *Picea orientalis* (L.) Link, *Pinus nigra* J.F.Arnold. subsp. *nigra* var. caramanica (Loudon) Rehder, *Acanthus hirsutus* Boiss., *Acer monspessulanum* L. subsp. monspessulanum, Acer *negundo* L., *A. platanoides* L., *Pistacia terebinthus* L .subsp. *palaestina* (Boiss.) Engler, *Echinophora tenuifolia* L. subsp. *sibthorpiana* (Guss.) Tutin, *Torilis leptophylla* (L.) Reichb., *Turgenia latifolia* (L.) Hoffm. *Achillea biebersteinii* Afan., *A. phrygia* Boiss. & Bal., *A. wilhelmsii* C. Koch., *Anthemis tinctoria* L. var. *Tinctoria*, *Centaurea balsamita* Lam., *Berberis crataegina* DC., *Echium italicum* L., *Lappula barbata* (M. Bieb.) Gürke, *Brassica elongata* Ehrh., *Isatis tinctoria* L. subsp. *tomentella* (Boiss.) P. H. Davis, *Malcolmia africana* (L.) R. Braga, *Sisymbrium altissimum* L., *Lonicera etrusca*

Santi var. *etrusca*, *Bolanthus minuartioides* (Jaub. & Spach) Hub.-Mor., *Cerastium dichotomum* L. subsp. *dichotomum*, *Holosteum umbellatum* L. var. *umbellatum*, *Helianthemum nummularium* (L.) Miller subsp. *lycaonicum* Coode & Cullen, *Scabiosa argentea* L., *Elaeagnus angustifolia* L., *Alhagi pseudalhagi* (M. Bieb.) Desv., *Astragalus angustifolius* Lam. subsp. *longidens* Hub.-Mor. & Matt., *A. condensatus* Ledeb., *Colutea cilicica* Boiss. & Bal., *Coronilla varia* L. subsp. *varia*, *Melilotus officinalis* (L.) Desr., *Trigonella spruneriana* Boiss. var. *spruneriana*, *Quercus pedunculiflora* C. Koch., *Q. cerris* L. var. *cerris*, *Q. coccifera* L., *Q. robur* L.var.*robur*, *Erodium cicutarium* (L.) L' Her. subsp. *cicutarium*, *Globularia orientalis* L., *Juglans regia* L., *Stachys lavandulifolia* Vahl., *Teucrium chamaedrys* L. subsp. *chamaedrys*, *Wiedemannia orientalis* Fisch. & C.A. Mey., *Alcea pallida* Waldst. & Kit., *Malva neglecta* Wallr., *Morus alba* L., *M. nigra* L., *Fontanesia phillireoides* Labill. subsp. *phillireoides*, *Fraxinus angustifolia* Vahl subsp. *angustifolia*, *F. ornus* L. subsp. ornus, *Jasminum fruticans* L., *Ligustrum vulgare* L., *Glaucium corniculatum* (L.) J.O.Rudbeck subsp. *corniculatum*, *Plantago lanceolata* L., *Acantholimon venustum* Boiss. var. *venus*, *Polygonum bellardii* All., *Adonis flammea* Jacq., *Nigella arvensis* L. var. *glauca* Boiss., *Ranunculus arvensis* L., *Rhamnus petiolaris* Boiss., *R. oleoides* L. subsp. *graecus* (Boiss. et Reut.) Holmboe., *R. rhodopeus* Velenovsky., *Amygdalus communis* L., *A. orientalis* Miller. *Cotoneaster nummularia* Fisch. et Mey. *Crateagus aronia* (L.) Bosc.ex DC., *C. monogyna* Jacq. subsp. *monogyna*, *Crateagus orientalis* Pallas ex Bieb. var.*orientalis*, *Cydonia oblonga* Mill., *Prunus divaricata* Ledeb. subsp. *ursina* (Kotschy) Browicz., *Pyracantha coccinea* Roem., *Pyrus elaeagnifolia* Pall. subsp. *elaeagnifolia*, *Rosa canina* L., *Populus alba* L., *P.nigra* L.subsp.*nigra*, *Salix alba* L., *S. caprea* L., *Verbascum cheiranthifolium* Boiss. var. *heldreichii* Boiss., *Ailanthus altissima* (Miller) Swingle., *Hyoscyamus reticulatus* L., *Daphne oleoides* Schreb., *Tilia rubra* DC. subsp. *caucasica* (Rupr.) V. Engl. *Celtis tournefortii* Lam., *Ulmus minor* Miller., *Juncus inflexus* L. *Aegilops triuncialis* L. subsp. *triuncialis*, *Bromus tectorum* L. and *Cynodon dactylon* (L.) Pers. (Dural & Ekim, 1984).

Material and Methods

In this study, gravimetric method and Durham sampler were used. The Durham sampler was placed on the roof of an appartment at a height of 15 m above ground level in Alaaddin hill. Slides placed in the Durham sampler were changed weekly. Before exposure, the slides were coated with glycerine jelly mixed with basic-fuchsin (Charpin & Surinyach, 1974). The slides were examined weekly by light microscope. The analysis of the pollen concentration pattern in 2005 was performed using the annual sum of the weekly mean values. The pollen was counted at a magnification of X400, in 11 vertical lines and total daily counts were converted into the number of pollen grains per m^2 of air. A pollen calendar was prepared on the basis of weekly means for Konya.

Results and Discussion

The number of total pollen grains collected from 1st January to 31st December 2005 using Durham sampler was counted as 4420 pollen grains/m^2 and 29 taxa were identified. From identified taxa, 19 belong to arboreal (AP) and 10 taxa to non-arboreal plants (NAP). Total pollen grains consist of 3867 (87,49% arboreal, 544 (12,31%) non-arboreal and 9 (0,20%) unidentified pollen grains. (Tables 1-2).

Table 1. Annual totals of weekly pollen counts for Konya.

	Total	%
Arboreal (AP)		
Pinus	956	21,63
Fraxinus	934	21,13
Cupressaceae	700	15,84
Ailanthus	330	7,47
Sophora	170	3,85
Acer	168	3,80
Populus	145	3,28
Ostrya	82	1,86
Quercus	79	1,79
Salix	75	1,70
Abies	72	1,63
Ulmus	59	1,33
Juglans	50	1,13
Moraceae	21	0,48
Alnus	8	0,18
Tilia	6	0,14
Ericaceae	6	0,14
Ligustrum	4	0,09
Pistacia	1	0,02
Total AP	**3697**	**87,49**
AP %	87,49	
Non Arboreal (NAP)		
Chenopodiaceae/Amaranthaceae	211	4,77
Poaceae	162	3,67
Urticaceae	75	1,70
Xanthium	38	0,86
Mercurialis	25	0,57
Plantago	17	0,38
Apiaceae	7	0,16
Centaurea	5	0,11
Artemisia	3	0,07
Asteraceae	1	0,02
Total NAP	**211**	**4,77**
NAP %	12,31	
Unidentified	9	0,20

In the atmosphere of Konya arboreal pollen grains were dominant. The frequency of arboreal pollen grains generally depends on the distribution and density of the local vegetation and rate of pollen production. According to other studies carried out in Europe, arboreal pollen grains are also dominant in Finland (82,00%) (Koivikko, 1986); Bursa, Turkey (78,61 %) (Bicakci *et al*., 2003); Ostrowiec Swietokrzyski, Poland (73,00%) (Kasprzyk, 1995); Perugia (71,00%) and Ascoli-Piceno (55,00%) (Romano *et al*., 1988); Balikesir, Turkey (70,92 %) (Bicakci & Akyalcin, 2000).

Table 2. The highest pollen concentrations in consecutive mounts and their yearly composition (%), Konya, Turkey.

Taxa	Jan.	Feb.	Mar.	Apr.	May	June	July	Agu.	Sep.	Oct.	Nov.	Dec.	Total
Pinus	-	-	-	1,109	3,416	15,792	1,131	0,181	-	-	-	-	21,63
Fraxinus	-	-	19,638	0,520	0,882	0,090	-	-	-	-	-	-	21,13
Cupressaceae	-	0,023	7,443	4,299	3,439	0,633	-	-	-	-	-	-	15,84
Ailanthus	-	-	-	-	0,045	6,855	0,566	-	-	-	-	-	7,47
Chenopodiaceae/Amaranthaceae	-	-	-	-	-	0,136	0,430	1,561	2,421	0,226	-	-	4,77
Sophora	-	-	-	-	-	-	0,113	3,416	0,317	-	-	-	3,85
Platanus	-	-	-	3,597	0,204	-	-	-	-	-	-	-	3,80
Poaceae	-	-	0,385	0,181	0,588	1,629	0,452	0,136	0,204	0,090	-	-	3,67
Acer	-	-	-	2,036	1,176	0,068	-	-	-	-	-	-	3,28
Populus	-	-	0,317	1,335	0,204	-	-	-	-	-	-	-	1,86
Ostrya	-	-	-	1,787	-	-	-	-	-	-	-	-	1,79
Quercus	-	-	-	0,226	1,199	0,271	-	-	-	-	-	-	1,70
Urticaceae	-	-	-	0,814	0,747	0,136	-	-	-	-	-	-	1,70
Salix	-	-	-	1,154	0,475	-	-	-	-	-	-	-	1,63
Abies	-	-	-	0,023	0,860	0,158	0,294	-	-	-	-	-	1,33
Ulmus	-	-	1,109	0,023	-	-	-	-	-	-	-	-	1,13
Total	-	0,02	28,89	17,10	13,24	25,77	2,99	5,29	2,94	0,32	-	-	96,56
Others	-	-	0,05	0,41	0,72	0,59	0,34	0,20	0,90	0,02	-	-	3,24
Unidentified	-	-	-	-	0,05	0,11	0,05	-	-	-	-	-	0,20
Total	**-**	**0,02**	**28,94**	**17,51**	**14,00**	**26,47**	**3,37**	**5,50**	**3,85**	**0,34**	**-**	**-**	**100,00**

The main pollen producers in the atmosphere of Konya were the following arboreal plants: *Pinus* spp. (21,63%), *Fraxinus* spp. (21,13%), Cupressaceae (15,84%), *Ailanthus* spp. (7,47%), *Sophora* spp. (3,85%), *Platanus* spp. (3,80%), *Acer* spp. (3,28%) and *Populus* spp. (1,86%). They form 78,86% of the total pollen grains (Table 1-2). From non-arboreal plants taxa Chenopodiaceae/Amaranthaceae (4,77%) and Poaceae (3,67%) were found frequently in the atmosphere of Konya making up 8,44% of the total pollen grains (Tables 1-2). According to the other studies carried out in Europe, the most common pollen producers taxa was found as *Acer* spp., Cupressaceae, Poaceae, Hamamelidaceae, Pinaceae, *Quercus* spp., Urticaceae in Porto region (Portugal), (Abreu *et al*., 2003); *Pinus* spp., Cupressaceae / Taxaceae, *Platanus* spp., *Quercus* spp., *Ailanthus* spp., Moraceae, Chenopodiaceae / Amaranthaceae and Asteraceae in Afyon, Turkey, (Bicakci *et al*., 2002b); Cupressaceae, *Quercus* spp., *Populus* spp., *Poaceae* spp., *Olea* spp. *Platanus* spp., *Ulmus* spp. and *Morus* spp. in Toledo, Central Spain, (García-Mozo *et al*., 2006); *Cupressus* spp., *Platanus* spp., *Quercus* spp., *Olae* spp., Poaceae, Urticaceae, *Artemisia* spp.and Chenopodiaceae in Iberian Peninsula (Cariñanos *et al*., 2004); *Alnus* spp., *Ambrosia* spp., *Betula* spp., *Carpinus* spp., Poacae, *Quercus* spp., *Taxus / Juniperus* and Urticaceae in Croatia (Peternel *et al*., 2005); Poaceae, *Pinus* spp., *Quercus* spp., Cupressaceae / Taxaceae, *Salix* spp., *Platanus* spp., *Populus* spp., *Carpinus* spp., *Fagus* spp., Chenopodiaceae / Amaranthaceae, *Xanthium* spp., Moraceae, *Corylus* spp., *Fraxinus* spp. and Urticaceae in Sakarya, Turkey (Bicakci, 2006); *Pinus* spp., *Olea* spp., *Platanus* spp., Cupressaceae / Taxaceae, *Quercus* spp., *Acer* spp., *Morus* spp., *Castanea* spp., *Corylus* spp., *Fraxinus* spp., Poaceae, *Xanthium* spp., Chenopodiaceae / Amaranthaceae, *Artemisia* spp. in Bursa, Turkey, (Bicakci *et al*., 2003); Cupressaceae, Pinaceae, Urticaceae, Anacardiaceae, Oleaceae and Polygonaceae in Cagliari, Italy, (Ballero & Maxia, 2003).

Monthly variation of arboreal and non-arboreal pollen grains recorded in the atmosphere of Konya is shown in Fig. 2. Arboreal pollen grains are dominant in the springtime, non-arboreal in the summer and autumn (Fig. 2). The earliest pollen grains in the atmosphere of Konya were noted in February. In this month, low amount was recorded for Cupressaceae (0,02%) (Table 2). In March *Fraxinus* ssp. (19,63%) and Cupressaceae (7,44) were recorded as dominant taxa. Owing to *Fraxinus* ssp. released high amount of pollen into the atmosphere throughout their pollination period, total pollen grains reached their maximum levels in March (28,94%) (Table 2). The numbers of pollen grains were also high in April, May and June. In April, Cupressaceae (4,30%), *Platanus* spp. (3,60%) and *Acer* spp. (2,03), in May, Cupressaceae (3,44%) and *Pinus* spp. (3,42%), in June, *Pinus* spp. (15,80%) and *Ailanthus* spp. (6,86%) were recorded as dominant taxa. In July, the amount of pollen was lower than in springtime. This decrease was correlated with the end of the pollination period of many arboreal plants which produce and release high amount of pollen grains into the atmosphere. In July, *Pinus* spp. (1,13%) and in August, *Sophora* spp. (3,42%), Chenopodiaceae / Amaranthaceae (1,56%), In September, Chenopodiaceae / Amaranthaceae (2,42%), in October, Chenopodiaceae / Amaranthaceae (0,23%) were recorded as dominant taxa. In November and in December no pollen grains were recorded (Table 2).

In the other studies, dominant pollen garins were recorded in Toledo, Spain from March to May and also in January (García-Mozo *et al*., 2006); inland Croatia in April and August (Peternel *et al*., 2005); in Cagliari, Italy between February and May (Ballero & Maxia, 2003); in Porto, Portugal between the end of March and the first two weeks of April (Abreu *et al*., 2003); in Bursa, Turkey in April (Bicakci *et al*., 2003); in Afyon, Turkey in May (Bicakci *et al*., 2002b); in Balikesir, Turkey May (Bicakci & Akyalcin, 2000).

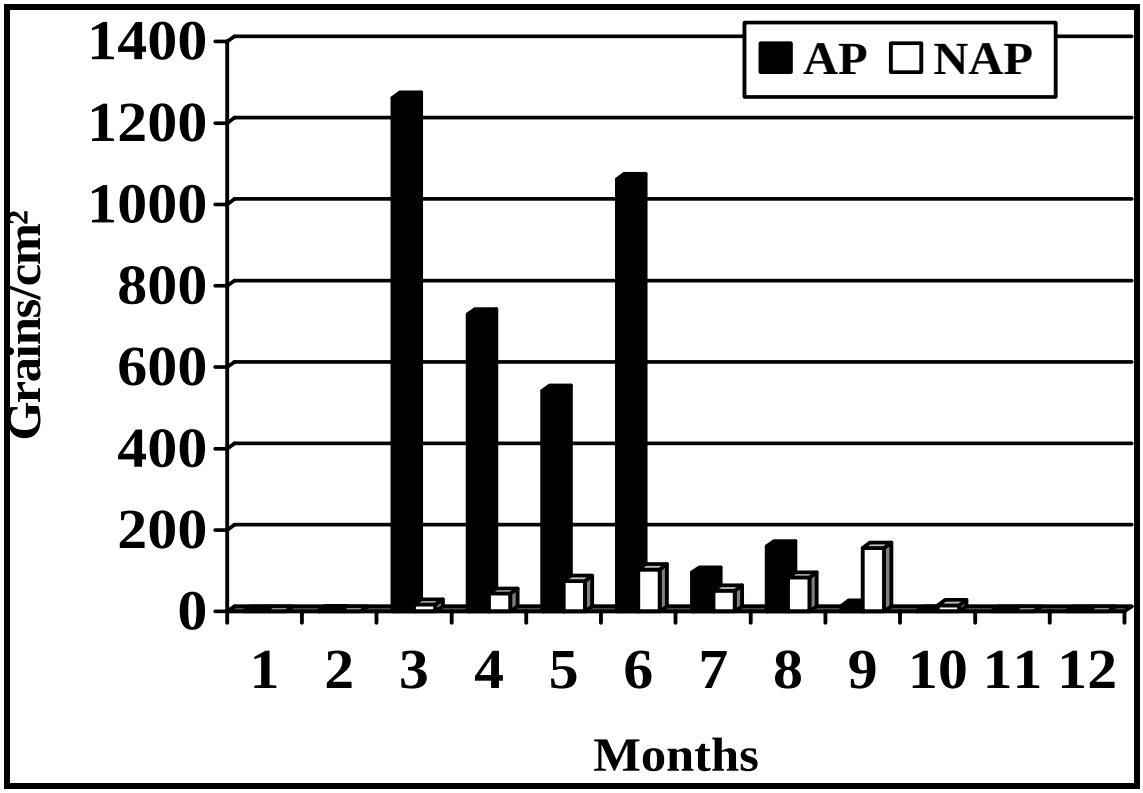

Fig. 2. Monthly variation in AP (arboreal pollen) and NAP (non-arboreal pollen) in the atmosphere of Konya.

The types of pollen presented in the atmosphere of Konya are shown as a pollen calendar in Figure 3 based on the total counts of pollen grains on weeks / cm² in 2005. The following 16 taxa produced the greatest amount of pollen (Table 2, Fig. 3):

***Pinus* spp:** Pollen grains of this genus presented 21,63 % of total pollen. The pollen season started in the first week of April (14th week) and ended in the last week of August (34th week). The peak value of the pollen was determined in the third and fourth weeks of June (15,79%) (24th and 25th weeks).

***Fraxinus* spp.:** Pollen grains of this genus presented 21,13 % of total pollen. The pollen season started in the first week of March and lasted in the second week of May. The peak value of the pollen was determined in the second week of March (19,64%) (10 th week).

Cupressaceae: Pollen grains of these taxa presented 15,84% of total pollen. The pollen season started in the last week of February and ended in the last week of June. The peak value of pollen was determined in the second week of March (7,44%).

***Ailanthus* spp.:** Pollen grains of this genus presented 7,47 % of total pollen. The pollen season started in the last week of May and lasted upto fourth week of July. The peak value of the pollen was determined in the third and fourth weeks of June (6,86%).

Chenopodiaceae/Amaranthaceae: Pollen grains of this genus presented 4,77 % of total pollen. The pollen season started in the last week of June and lasted upto third week of October. The peak value of the pollen was determined between the second week of August and the last week of September (0,43%) (32nd and 38th weeks).

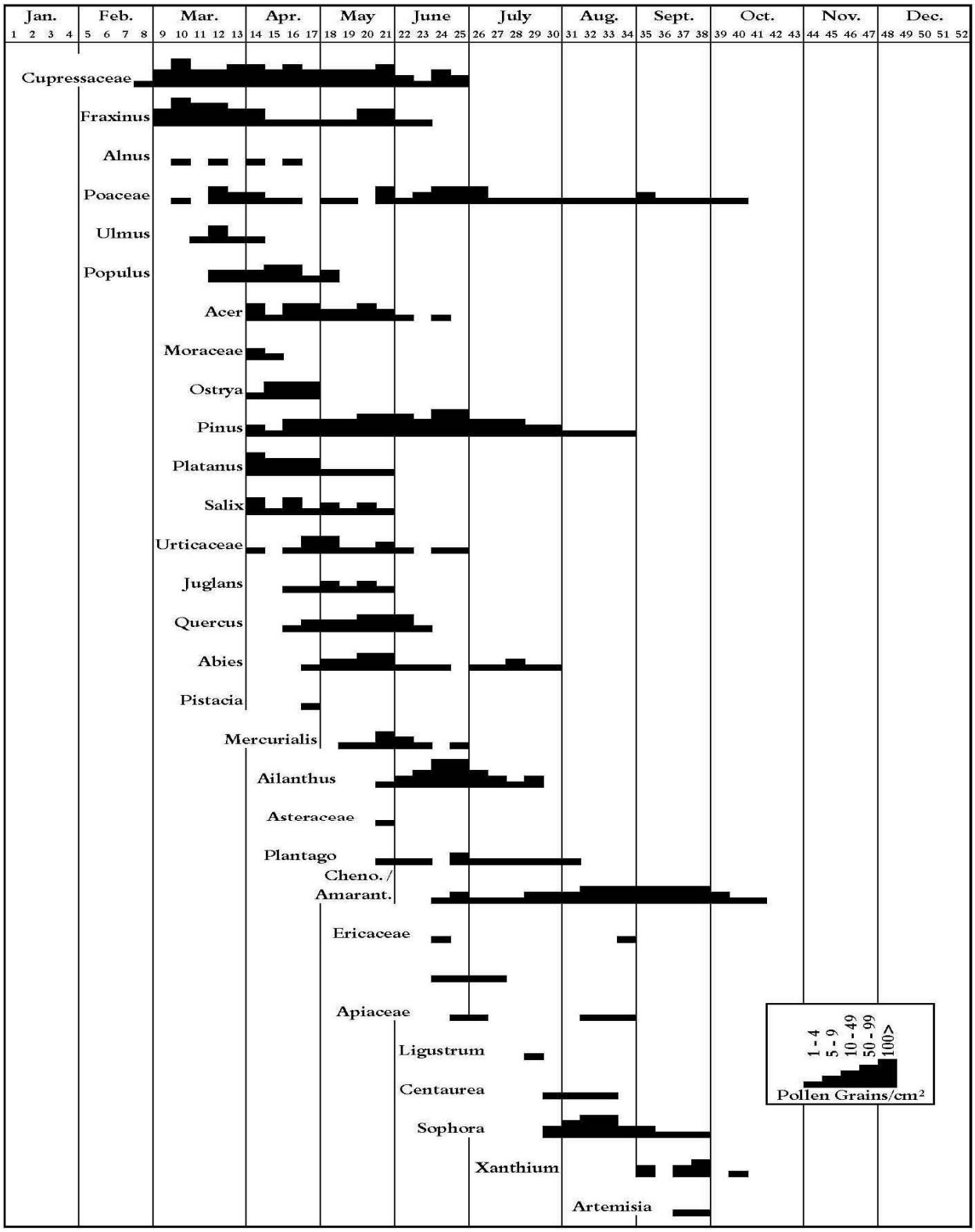

Fig. 3. Pollen calendar of Konya.

***Sophora* spp.:** Pollen grains of this genus presented 3,85 % of total pollen. The pollen season started in the last week of July and ended in the last week of September. The peak value of the pollen was determined in the second and third weeks of August (3,42%) (32nd and 33rd weeks).

***Platanus* spp.:** Pollen grains of this genus constituted 3,80% of total pollen in the atmosphere of Konya. The pollen season started in the first week of April and ended in the last week of May. The peak value was noted in the first week of April (3,60%).

Poaceae: Pollen grains of this family presented 3,67% of total pollen. The pollen season started in the second week of March and lasted in the second week of October. The peak value of pollen was determined between the fourth week of May and the first week of July (1,63%) (24th and 26th weeks).

***Acer* spp.:** Pollen grains of this genus presented 3,28 % of total pollen. The pollen season started in the first week of April and lasted in the third week of June. The peak value of the pollen was determined between the first and the last week of April (2,04%). (14th and 17th weeks).

***Populus* spp.:** Pollen grains of this genus presented 1,86 % of total pollen. The pollen season started in the third week of March and lasted in the first week of May. The peak value of the pollen was determined in the second and third week of April (1,34%) (14th and 16th weeks).

***Ostrya* spp.:** Pollen grains of this genus presented 1,79 % of total pollen. The pollen season started in the first week of April and ended in the last week of April. The peak value of the pollen was determined between the second and the last week of April (1,79%) (15th and 17th weeks).

***Quercus* spp.:** Pollen grains of this genus presented 1,70 % of total pollen. The pollen season started in the third week of April and lasted in the second week of June. The peak value of the pollen was determined between the third week of May and the second week of June (1,20%) (20th and 22nd weeks).

Urticaceae: Pollen grains of this genus presented 1,70 % of total pollen. The pollen season started in the first week of April and ended in the last week of June. The peak value of the pollen was determined between the last week of April and the first week of May (0,81%) (17th and 18th weeks).

***Salix* spp.:** Pollen grains of this genus were presented 1,63 % of total pollen. The pollen season started in the first week of April and ended in the last week of May. The peak value of the pollen was determined in first and third weeks of April (1,15%).

***Abies* spp.:** Pollen grains of this family presented 1,33% of total pollen. The pollen season started in the last week of April and ended in the last week of July. The peak value of pollen was determined in the third and fourth weeks of May (0,86%) (20th and 21st weeks).

***Ulmus* spp.:** Pollen grains of this genus were presented 1,13 % of total pollen. The pollen season started in the fourth week of March and lasted in the first week of April. The peak value of the pollen was determined in the fourth week of March (1,11%) (12nd week).

Conclusion

Pollen grains of 30 taxa were determined during the pollen season in the atmosphere of Konya, 16 of them formed about 96,56% of the total spectrum (Table 2). In the region investigated pollen grains were recorded all the year round and reached their maximum levels in March. The pollen calendar for this region presented in this study may be useful for allergologists to establish exact diagnosis.

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