Aerobiologia (2015) 31:99–109
DOI 10.1007/s10453-014-9350-6

ORIGINAL PAPER

Atmospheric pollen concentrations in Antalya, South Turkey

Aycan Tosunoglu · Mustafa Kemal Altunoglu · Adem Bicakci · Ozkan Kilic · Taner Gonca · Ilkay Yilmazer · Gülsah Saatcioglu · Ahmet Akkaya · Sevcan Celenk · Yakup Canitez · Hulusi Malyer · Nihat Sapan

Received: 14 March 2014 / Accepted: 24 September 2014 / Published online: 1 October 2014

Abstract Airborne pollen distribution in Antalya was measured volumetrically during 2 consecutive years, 2008 and 2009. A total of 30,497 pollen grains/m^3 belonging to 44 taxa were recorded annually during the study period. Among the taxa recorded, 27 belonged to arboreal (88.29 %) and 17 to non-arboreal taxa (11.53 %). Seven plant taxa taken as predominant pollen types with the greatest influence in the atmosphere, Cupressaceae/Taxaceae (38.33 %), *Pinus* (24.18 %), *Olea europaea* (6.86 %), *Morus* (5.17 %), Poaceae (4.88 %), *Platanus* (4.66 %) and *Quercus* (4.58 %), showed maximum pollen distribution in the atmosphere. The season of maximum pollen concentration was from February to May, with a high prevalence of arboreal pollen grains.

Keywords Aerobiology · Pollen calendar · Pollen concentrations · Antalya · Turkey

A. Tosunoglu (✉) · A. Bicakci · S. Celenk · H. Malyer
Department of Biology, Faculty of Science and Arts, Uludağ University, Bursa, Turkey
e-mail: aycanbilisik@uludag.edu.tr

M. K. Altunoglu
Department of Biology, Faculty of Science and Arts, Kafkas University, Kars, Turkey

O. Kilic · T. Gonca · I. Yilmazer · A. Akkaya
Department of Pulmonology, Faculty of Medicine, Suleyman Demirel University, Isparta, Turkey

G. Saatcioglu
Battalgazi Vocational School, Inonu University, Malatya, Turkey

Y. Canitez · N. Sapan
Division of Pediatric Allergy, Faculty of Medicine, Uludag University, Bursa, Turkey

1 Introduction

Airborne pollen grains are inhalant allergens natural source related. When released by the sources in sufficient amounts, allergenic pollen may evoke allergic responses; such effects include mucus membrane irritation, chronic bronchitis, allergic rhinitis and asthma, extrinsic allergic alveolitis (hypersensitivity pneumonitis), inhalation fever, humidifier fever or organic dust toxic syndrome, and immunological response impairment (Lacey and Dutkiewicz 1994). Therefore, determination of pollen types and their concentrations are 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 airborne pollen variability and concentrations in different areas have been carried out by researchers worldwide and Turkey as well (Inceoglu et al. 1994; Giner et al. 2002; Peternel et al. 2003; Gioulekas et al. 2004; Weryszko-Chmielewska and Piotrowska 2004; Bicakci et al. 2002; Altunoglu et al. 2008; Celenk et al. 2010; Çeter et al. 2012).

The aims of this study are as follows: (1) To investigate the airborne pollen distribution and variability; (2) To represent pollen seasons; and (3) To prepare a pollen calendar for world-known tourism center, Antalya.

2 Materials and methods

2.1 Study area, flora and climate

Antalya is situated at 36°54.0′N—30°42.0′E in the south part of Turkey, on the coast of Mediterranean Sea (Fig. 1). City is located in the hillsides of the western Taurus mountain chains and surrounds the bay that has taken its name by the city. There are many invaluable historical sites, ruins, ancient cities in and around of Antalya and city is a world-known famous tourism center and welcomes nearly 11 million tourists per year.

The study area shows a thermo-mediterranean climate and according to 52 years of meteorological data provided by Turkish State Meteorological Service; July is the warmest month (28.4 °C), whereas January is the coldest month (9.8 °C). July was also the sunniest month with 12.1 h/day, and August was the least rainy month with a total of 1.8 mm rain. December was the rainiest month with 13 rainy days with a total of 251.2 mm rain. The most snow within the county was measured on January 7, 1993 at a depth of 5 cm.

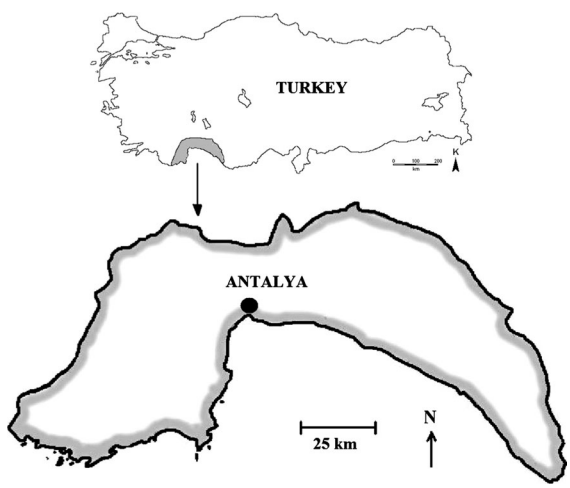


Fig. 1 Location of the study area (Antalya)

Antalya province is phytogeographically characterized by Mediterranean maquis elements. On the slopes of mountains *Pinus brutia* Ten. and *P. nigra* Arn., *Cedrus libani* A. Rich., endemic *Abies cilicica* (Ant. and Kotschy) Carr. subsp. *isaurica* Coode & Cullen forests can be seen and *Juniperus excelsa* Bieb. and *Juniperus foetidissima* Willd. as dominate at higher altitudes.

Other represented plants that are mostly found in parks and gardens are: *Juniperus drupacea* Labill, *J. sabina* L., *J. oxycedrus* L., *Cupressus arizonica* L., *Cupressus sempervirens* L. *var. pyramidalis, Thuja orienlalis* L., *Acer platanoides* L., *Acer negundo* L., *Eucalyptus camaldulensis* Dehnh, *Betula* sp., *Ligustrum vulgare* L., *Phoenix canariensis* Hort., *Phoenix dactylifera* L., *Phoenix theophrasti* Greuter, *Platanus orientalis* L., *Salix babylonica* L., *Schinus molle* L., *Mimosa* sp., *Melia azaderach* L., *Morus alba* L., *Olea europaea* L., *Citrus sinensis* (L.) Osbeck, *Citrus tangerina* Hort et Tanaka and *Citrus limon* (L.) Burm. and *Liquidambar orientalis* Mill..

2.2 Aerobiological method

An aeropalynological study was performed in Antalya with a Hirst-type volumetric pollen trap (Lanzoni VPPS 2000) during 2008 and 2009. The pollen trap was placed on a roof in the city center 28 m above the ground. The device operated continuously and was calibrated to aspirate 10 l/m^3 air. Melinex® tape, which was first placed by applying silicone oil, was taken from the 7-day sampling drum together with the adherent atmospheric particles and was cut into daily fragments. The tape fragments were mounted to slides and covered with glycerin jelly mixed with basic fuchsine (Charpin et al. 1974) and were examined by light microscopy at 400× magnification. Atmospheric sampling and analysis were performed as described by the Spanish Aerobiology Network (REA), which ascertains intradiurnal variation by transversally dividing slides into twenty-four 2-mm intervals (Galán et al. 2007). Pollen concentrations were stated as a number of pollen grains in 1 m^3 of air. The pollen grains that could not be identified were considered to be unidentified types.

Pollen types that comprised more than 1 % of the annual total pollen concentration were considered to be dominant. The main pollen season (MPS) for dominant pollen types was calculated according to

Table 1 Annual pollen counts and percentage of pollen taxa recorded in Antalya atmosphere (2008–2009)

	2008		2009		2008–2009	
	Annual total	%	Annual total	%	Annual mean	Mean (%)
Cupressaceae/Taxaceae	10,586	42.00	12,794	35.75	11,690	38.33
Pinus	5,209	20.67	9,542	26.66	7,376	24.18
Olea europaea	635	2.52	3,546	9.91	2,091	6.86
Morus	718	2.85	2,436	6.81	1,577	5.17
Platanus	1,840	7.30	1,001	2.80	1,420	4.66
Quercus	1,056	4.19	1,736	4.85	1,396	4.58
Betula	207	0.82	558	1.56	382	1.25
Acer	195	0.77	117	0.33	156	0.51
Fraxinus	229	0.91	59	0.16	144	0.47
Pistacia	149	0.59	118	0.33	134	0.44
Cedrus	117	0.46	118	0.33	117	0.38
Castanea sativa	164	0.65	16	0.05	90	0.30
Alnus	119	0.47	26	0.07	72	0.24
Ailanthus altissima	54	0.21	36	0.10	45	0.15
Ulmus	43	0.17	50	0.14	47	0.15
Populus	66	0.26	12	0.03	39	0.13
Ericaceae	56	0.22	9	0.03	33	0.11
Juglans	27	0.11	20	0.05	23	0.08
Salix	33	0.13	9	0.03	21	0.07
Rosaceae	4	0.02	33	0.09	18	0.06
Abies cilicica	16	0.06	16	0.04	16	0.05
Eucalyptus	15	0.06	15	0.04	15	0.05
Tilia	11	0.04	5	0.02	8	0.03
Ligustrum vulgare	3	0.01	9	0.03	6	0.02
Ostrya carpinifolia	0	0.00	12	0.03	6	0.02
Laurus nobilis	0	0.00	6	0.02	3	0.01
Mimosaceae	0	0.00	4	0.01	2	0.01
Arboreal plants	21,551	85.50	32,303	90.26	26,927	88.29
Poaceae	1,730	6.86	1,246	3.48	1,488	4.88
Mercurialis	500	1.98	1,028	2.87	764	2.50
Plantago	345	1.37	332	0.93	338	1.11
Urticaceae	255	1.01	409	1.14	332	1.09
Cheno./Amaranthaceae	380	1.51	121	0.34	251	0.82
Rumex	52	0.21	105	0.29	79	0.26
Asteraceae	106	0.42	38	0.11	72	0.24
Artemisia	76	0.30	35	0.10	55	0.18
Apiaceae	38	0.15	32	0.09	35	0.12
Xanthium	45	0.18	21	0.06	33	0.11
Brassicaceae	32	0.13	15	0.04	23	0.08
Humulus lupulus	14	0.06	10	0.03	12	0.04
Fabaceae	8	0.03	10	0.03	9	0.03
Lamiaceae	3	0.01	12	0.03	8	0.02
Ambrosia	7	0.03	5	0.01	6	0.02
Cyperaceae	5	0.02	5	0.02	5	0.02
Taraxacum	8	0.03	2	0.01	5	0.02
Non-Arboreal plants	3,604	14.30	3,427	9.58	3,515	11.53
Unidentified	50	0.20	59	0.16	54	0.18
Total	25,205	100.00	35,789	100.00	30,497	100.00

Andersen (1991), using the 95 % method; the start date of the MPS is defined as the day when the daily pollen count reached 2.5 % of the annual pollen index (API) with starting from 1 January, and the end occurs when 97.5 % of the annual pollen count had been reached.

The pollen calendar was constructed following the Spieksma model (Spieksma 1991); daily pollen counts from 10-day periods were summed and averaged for the years that were studied. These average sums were placed in 10-day mean pollen concentrations into a series of classes (Spieksma 1991) and were depicted by column growth heights in the calendar.

3 Results and discussion

In Antalya, a total of 60,994 pollen grains belonging to 44 taxa were recorded during the study period (January 2008–December 2009). In the first year, 25,205 pollen grains and in the following year and 35,789 pollen grains were recorded (Table 1).

For both years, pollen grains from woody plant taxa (27 taxa) had the largest atmospheric contribution, with a mean value of 88.29 % (85.50 % in 2008 and 90.26 % in 2009) of the total pollen count. Moreover, 11.53 % (14.30 % in 2008 and 9.58 % in 2009) of the annual total pollen count was from herbaceous plants (17 taxa)—6.86 % is belonging to Poaceae in 2008 and 3.48 % in 2009, and 0.18 % (0.20 % in 2008 and 0.16 % in 2009) of the pollen was unidentifiable (Table 1).

Seven different plant taxa comprised more than 3 % of the total pollen content, taken as predominant pollen types with the greatest influence in Antalya's atmosphere during the study period (Table 2); the woody taxa like Cupressaceae/Taxaceae (38.33 %), *Pinus* (24.18 %), *Olea europaea* (6.86 %), *Morus* (5.17 %), *Platanus* (4.66 %) and *Quercus* (4.58 %) showed maximum pollen distribution in the atmosphere. These taxa represented 83.78 % of the total pollen content in the atmosphere (Tables 1, 2). On the other hand, among herbaceous taxa, Poaceae pollen (4.88 %) is the only dominated pollen type in the area (Tables 1, 2).

In the first year of our study, there was an abrupt increase in number of pollen grains from January to April (Fig. 2). Significant differences in pollen amounts were recorded between the studied years, especially during the main pollen season. In the first year of the study, the maximal pollen concentration was recorded in April with a total of 8,827 pollen grains per cubic meter, or 35.02 % of the annual total, while March had the highest number of pollen grains in the following year, with 14051 pollen grains, or 39.26 % of the annual total (Fig. 2). We conclude that the spring peak in pollen grain number was a result of the woody plant taxa pollination season, which produces many pollen grains. In the summer and early autumn, very low pollen concentrations were recorded. In the late fall and early winter months of both years, there was a small increase in pollen during November, which declined through the end of the year (Fig. 2). December and September had the lowest pollen concentrations in order of years (Fig. 2; Table 2).

The total pollen content in the atmosphere during February, March, April and May was 10.63, 33.89, 30.41 and 13.55 % respectively (Fig. 3; Table 2). These values amount to 88.48 % of the total pollen content in the atmosphere of Antalya. Monthly variations of arboreal and non-arboreal pollen grains in the atmosphere are presented in Fig. 3. The frequency of pollen from both groups on a monthly basis shows that non-arboreal pollen dominate in July, August and September, whereas arboreal taxa are dominant in February, March, April, May and June (Fig. 3).

In the atmosphere of Antalya, it was determined that pollen seasons, intensities, pollen grain variations and identified taxa would be put into a calendar, which was prepared using the average pollen concentration values from these 2 years (Fig. 4). Pollen calendar showed that the earliest pollen grains in the atmosphere of Antalya were mostly belonging to winter- and spring-flowering arboreal plants like Cupressaceae/Taxaceae *Alnus, Betula* and *Fraxinus*. *Mercurialis,* Chenopodiaceae/Amaranthaceae, Urticaceae and Poaceae pollen grains are non-arboreal pollen types, found present in the air nearly whole of the year. Most of identified taxa in the atmosphere were spring-flowering plants and pollen types were abruptly decreased with forthcoming summer in the study area. Pollen calendar of Antalya may be characterized with low level pollen concentrations belonging to non-arboreal plants in summer and the most common types were Poaceae, *Plantago* and Chenopodiaceae/Amaranthaceae pollen grains together with *Olea europaea* in early summer. Also *Artemisia, Xanthium* and *Cedrus* were the frequented pollen types found in the air of Antalya in autumn (Fig. 4).

Table 2 Plant taxa in Antalya comprising more than 3 % of the total pollen content and their yearly percentage of composition as a mean value

Taxa/months	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Cupressaceae/Taxaceae	0.37	9.84	17.21	8.33	1.90	0.22	0.07	0.01	0.06	0.04	0.10	0.18	38.33
Pinus	0.01	0.05	8.36	10.89	3.83	0.84	0.18	0.03	–	–	–	–	24.19
Olea europaea	–	–	–	1.41	4.59	0.84	0.02	0.01	0.01	–	–	–	6.87
Morus	0.01	0.39	1.90	2.77	0.11	–	–	–	–	–	–	–	5.18
Poaceae	–	0.01	0.22	0.26	0.67	1.58	0.93	0.79	0.33	0.08	0.02	0.01	4.89
Platanus	–	0.01	3.33	1.26	0.08	–	–	–	–	–	–	–	4.67
Quercus	–	–	0.49	2.86	1.00	0.23	–	–	–	–	–	–	4.58
Others	0.27	0.34	2.38	2.65	1.37	1.11	0.64	0.83	0.53	0.39	0.70	0.19	11.40
TOTAL	0.66	10.64	33.89	30.41	13.55	4.82	1.83	1.67	0.93	0.50	0.82	0.38	100.00

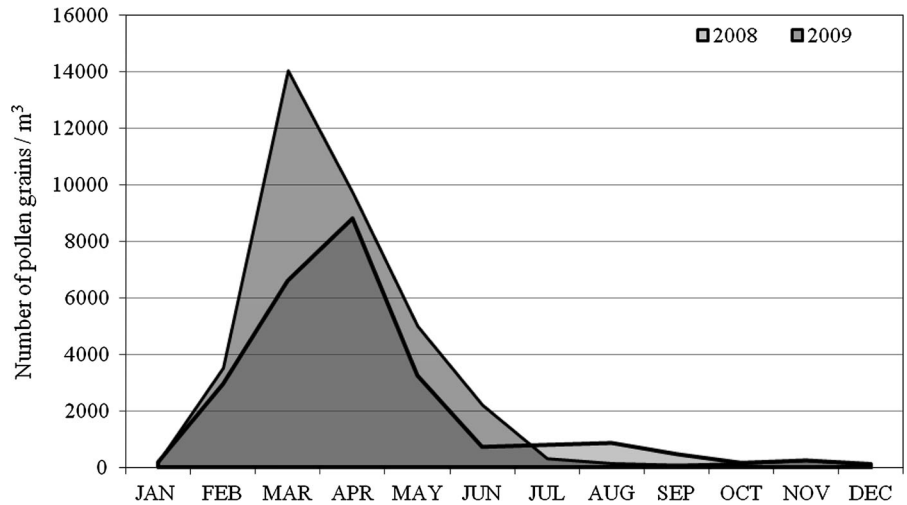
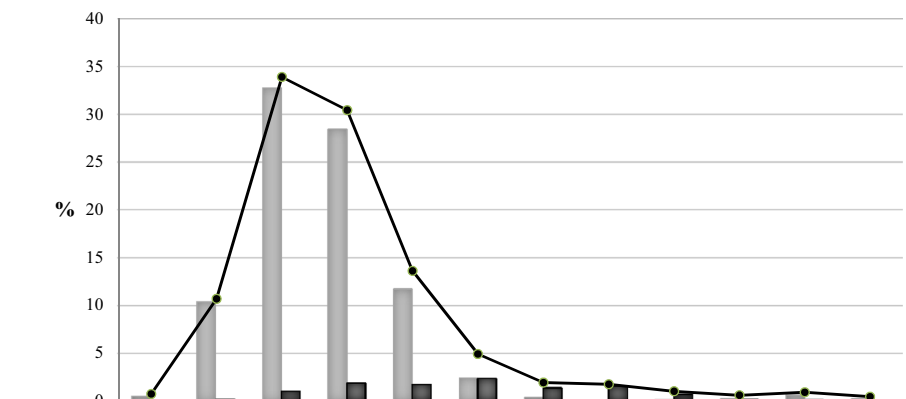


Fig. 2 Monthly variation of pollen concentration in Antalya



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AP	0.56	10.43	32.78	28.48	11.76	2.41	0.40	0.06	0.18	0.28	0.70	0.27
NAP	0.07	0.19	1.08	1.92	1.75	2.37	1.41	1.59	0.74	0.21	0.13	0.09
TOTAL	0.63	10.63	33.89	30.41	13.55	4.82	1.83	1.66	0.92	0.49	0.82	0.35

Fig. 3 Annual percentage of arboreal, non-arboreal pollen grains recorded in Antalya atmosphere

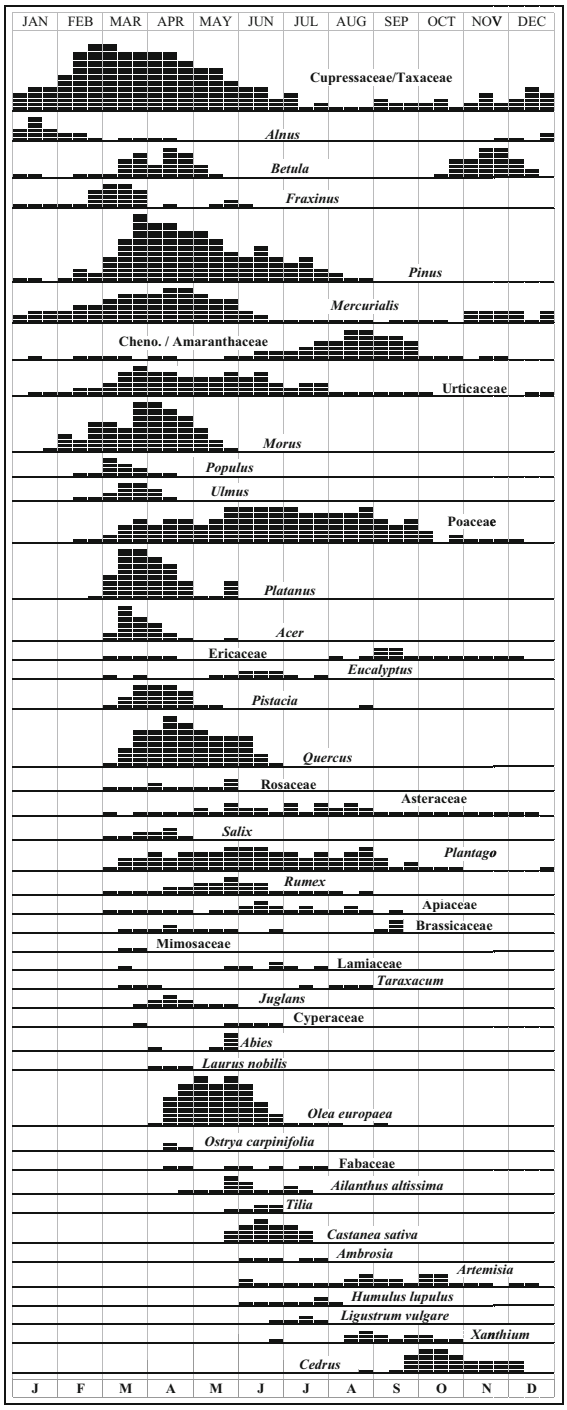


Fig. 4 Pollen calendar of Antalya (average values of 2008–2009)

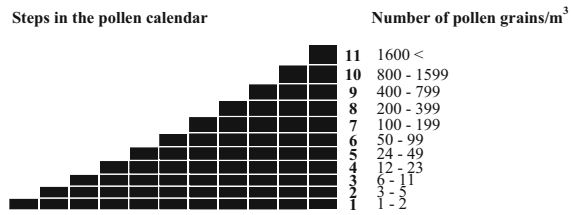


Fig. 4 continued

The number of pollen types was variable throughout the year, and greatest pollen diversity was found during spring. In April, pollen of 29 taxa was identified of which 14 was from arboreal and 15 from non-arboreal plants (Fig. 5). Among these, *Pinus* (10.89 %), Cupressaceae/Taxaceae (8.33 %), *Quercus* (2.86 %) and *Morus* (2.77 %) pollen grains were dominant in April (Table 2). Twenty-six types of pollen grains were recorded in March and May (Figs. 4, 5); dominant pollen types were Cupressaceae/Taxaceae (17.21 %), *Pinus* (8.36 %), *Platanus* (3.33 %) in March and *Olea europaea* (4.59 %), *Pinus* (3.83 %) and Cupressaceae/Taxaceae (1.90 %) in May (Fig. 4; Table 2). January is the month with less pollen diversity and characterized by low levels of Cupressaceae/Taxaceae, *Alnus* and *Mercurialis* pollen grains (Figs. 4, 5).

Cupressaceae/Taxaceae was the most abundant pollen type in Antalya's atmosphere; 10,586 (42.00 %) pollen accounted in 2008 and 12,794 pollen (35.75 %) in 2009 (Table 1). In Mediterranean countries, Cupressaceae/Taxaceae is reported a main type of atmospheric pollen in winter and early spring (Papa et al. 2001; Docampo et al. 2007). In our study, pollen grains of these families were detected in all months and pollen concentration reached the highest value in March with 17.21 % of the annual total (Table 2). The MPS was calculated between 23 February and 16 April in 2008 and 19 February to 24 April in 2009 and was recorded as 54–66 days long in Antalya (Fig. 6; Table 3). In parallel, the MPS duration was also recorded in Nerja, another Mediterranean city in southern Spain (Docampo et al. 2007).

The second most abundant pollen type was *Pinus*, which constituted 24.18 % of the annual pollen index (Table 1). *Pinus* pollen grains were detected in all months during the study period; however, this taxon reached the highest concentration in April at 10.89 % (Table 2). The MPS was 35–30 days long and mostly covering April in 2008 and March in 2009 (Fig. 6; Table 3), which was similar to study results from

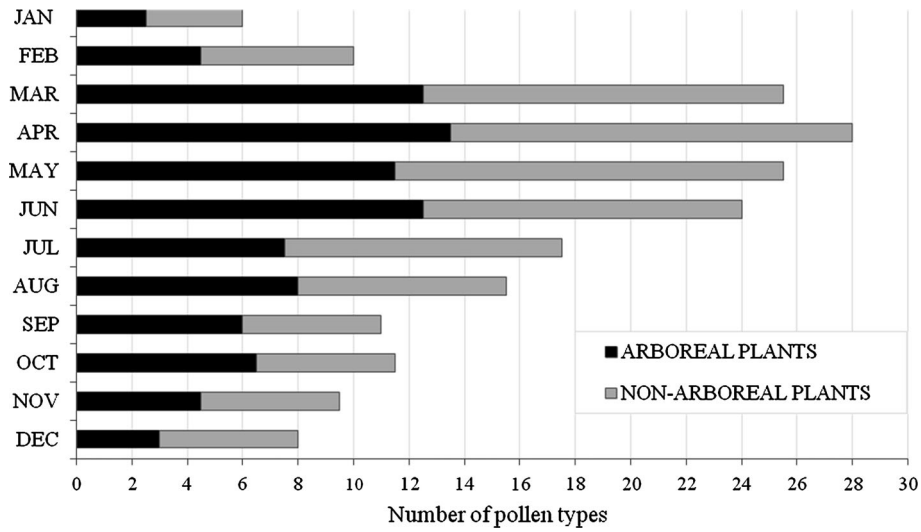


Fig. 5 Monthly variation of number of pollen types in the atmosphere of Antalya (mean values of 2008 and 2009)

Perugia, Italy (Frenguelli et al. 2002) and Nerja, southern Spain (Docampo et al. 2007).

Olea europaea pollen grains were recorded between April and September (Table 2), and the annual total was 6.86 % (Table 1). This pollen type reached its highest level in May with 4.59 % of the annual pollen amount (Table 2). In the second year, pollen concentration was threefold as high as the first year. *Olea europaea* aeropalynology has a typical biannual pattern of alternate pollen production; high pollination will therefore result in both reduced flowering and pollination in the following year, as was previously observed (Domínguez-Vilches et al. 1993; González Minero and Candau 1997). In Antalya, the MPS was 13–38 days long for *Olea europaea* (Fig. 6; Table 3). The MPS of this species in Spain was reported as 26–62 days in Córdoba, 32–57 days in Jaén, 44–75 days in Málaga, 35–79 days in Granada and 28–63 days in Seville (González Minero and Candau 1997; Diaz de la Guardia et al. 2003).

Morus pollen grains comprised 5.17 % of the annual pollen index, and their pollination period continued from February to May (Table 2). The highest pollen concentration was recorded in April with 2.77 % of the API (Table 2). *Morus* pollen grains were reported as a predominant pollen type also from La Plata City, Argentina (Nitiu 2006), Izmir, West Turkey (Guvensen and Ozturk 2003), Sakarya, NW Turkey (Bicakci 2006) and Koycegiz-SW Turkey (Tosunoglu et al. 2009). The *Morus* species main pollen season in Antalya was between 27 February and 14 April in 2008, 22 March–30 April in 2009 and lasted for 48–40 days in consecutive years (Fig. 6; Table 3).

Poaceae is the most abundant non-arboreal pollen type in Antalya atmosphere and represents 4.88 % of the annual pollen index (Table 1). Poaceae pollen grains are obtained during the year but mostly in low concentrations (Table 2) except January. This long pollination period is most likely due to limited identification; Poaceae pollen may be identified at the family level and originates from many wild grass species with different flowering times over several months. Pollen grains from this taxon reached their highest level in June, with 1.58 % of the API (Table 2). The MPS was 17–26 days long (Fig. 6, Table 3). In the other studies that were performed in southern Spain, the MPS was 21–76 days long in Córdoba, 11–52 days long in Priego and 25–66 days long in Ciudad Real (Sánchez Mesa et al. 2003).

Platanus pollen grains constituted 4.66 % of the annual pollen index (Table 1), and their pollination period continued from February to May (Table 2). The highest pollen concentration was recorded in March with 3.33 % of the API (Table 2). *Platanus* pollen grains were reported as a predominant pollen type also from Istanbul-NW Turkey (Celenk et al. 2010), Bursa-NW Turkey (Bicakci et al. 2003), Kusadasi, SW Turkey (Tosunoglu et al. 2013), and Denizli, SW Turkey (Guvensen et al. 2013). The *Platanus* species

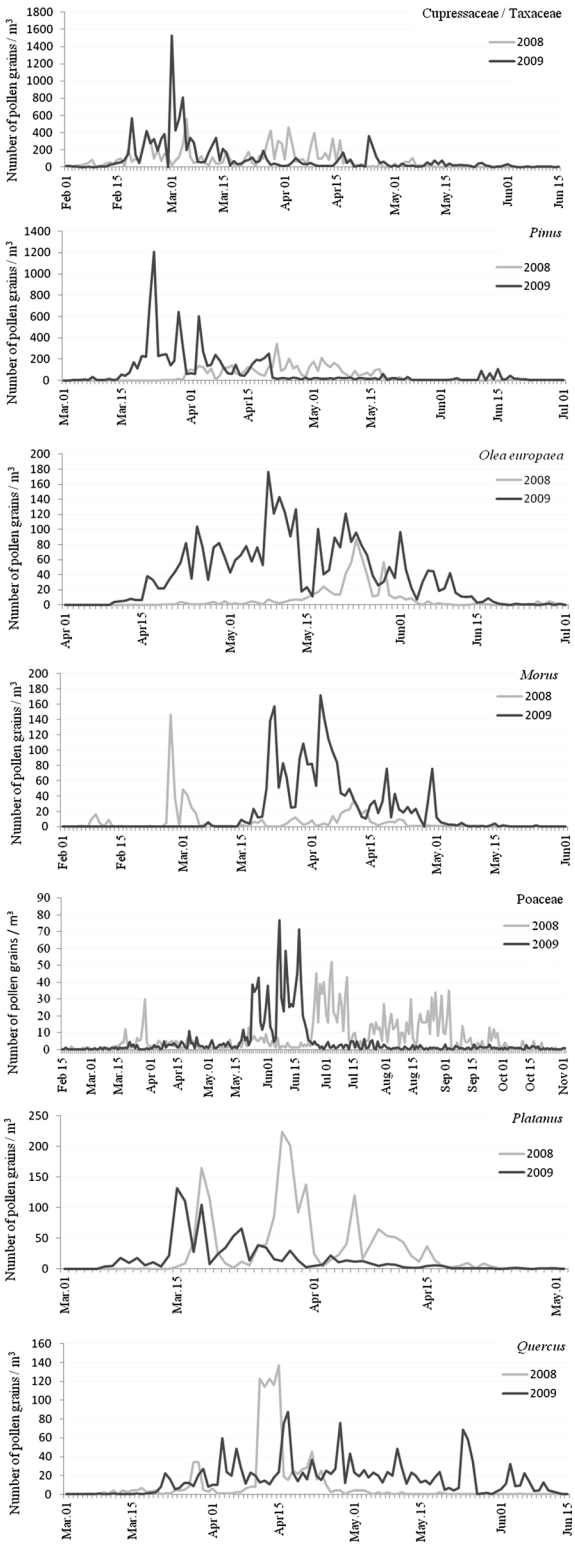


Fig. 6 Seasonal variation of dominated pollen types in Antalya atmosphere

main pollen season in Antalya was between 18 March–12 April in the first year and 15 March–29 March in the second year and also lasted for 26–15 days in consecutive years (Fig. 6; Table 3).

Quercus pollen grains comprised 4.58 % of the annual pollen index (Table 1). In Antalya, *Quercus* pollen grains were detected from March to June (Table 2), with pollen concentration from this taxon reaching its peak in April, with 2.86 % (Table 2). The *Quercus* species pollen grains were found as a predominated pollen type also in Cordoba-Spain (59.81 %) (Garcia-Mozo et al. 2007), Thessaloniki-Greece (20.8 %) (Damialis et al. 2005), Vinkovci-Croatia (4.89 %) (Stefanic et al. 2007), Yalova-NW Turkey (3.07 %) (Altunoglu et al. 2008), Fethiye-SW Turkey (2.34 %) (Bilisik et al. 2008b) and Savastepe-NW Turkey (1.59 %) (Bilisik et al. 2008a). The MPS was 26 days long in the first year and 53 days long in the second year (Fig. 6; Table 3).

In this study, Cupressaceae/Taxaceae pollen grains were the most abundant pollen type, which is not surprising because there are many cultivars in the city. Moreover, a predominance of this pollen type has also been recorded in Cagliari, Italy (Ballero and Maxia 2003), in Porto, Portugal (Abreu et al. 2003), and Thessaloniki, Greece (Gioulekas et al. 2004). However, in the other Turkish aeropalynological studies, the most abundant pollen type reported was *Pinus* (i.e., Bicakci et al. 2000; Bilisik et al. 2008b, c; Tosunoglu et al. 2009; Gucel et al. 2012). The aeropalynological spectrum of Antalya was found to be compatible with floral elements in this study.

Additionally, all of the dominant pollen types that were recorded in Antalya were reported to be important allergens in other studies worldwide. In this study, we recorded high levels of important allergic pollen grains such as Cupressaceae/Taxaceae (D'Amato and Liccardi 1994; D'Amato et al. 2007), *Pinus* (Bousquet et al. 1984; Harris and German 1985; Fang et al. 2001), *Olea europaea* (Bousquet et al. 1985; D'Amato and Lobefalo 1989; Negrini and Arobba 1992; Macchia et al. 1991; D'Amato and Liccardi 1994; Liccardi et al. 1996; Gioulekas et al. 2004), *Morus* (Chapman and Williams 1984; Benito Rica and Soto Torres 2001), Poaceae (Bousquet et al. 1984; D'Amato and Spieksma 1992; D'Amato et al. 2007; Mandal et al. 2008), *Platanus* (Subiza et al. 1994; Varela et al. 1997), *Quercus* (Levétin and Buck 1980; Spieksma 1990; D'Amato et al. 1991).

Table 3 Characteristics of the main pollen season for the most important taxa: start–ending dates and season length

		2008	2009
Cupressaceae/Taxaceae	Main pollen season	23/02–16/04	19/02–24/04
	Season length (days)	54	66
	Max. percentage of pollen/month	15.94/March	18.11/March
Pinus	Main Pollen season	03/04–07/05	22/03–20/04
	Season length (days)	35	30
	Max. percentage of pollen/month	12.53/April	13.94/March
Olea europaea	Main pollen season	17/05–29/05	25/04–01/06
	Season length (days)	13	38
	Max. percentage of pollen/month	2.19/May	6.27/May
Morus	Main pollen season	27/02–14/04	22/03–30/04
	Season length (days)	48	40
	Max. percentage of pollen/month	1.01/April	4.01/April
Poaceae	Main pollen season	26/06–12/07	24/05–18/06
	Season length (days)	17	26
	Max. percentage of pollen/month	1.97/July	11.95/June
Platanus	Main pollen season	18/03–12/04	15/03–29/03
	Season length (days)	26	15
	Max. percentage of pollen/month	4.82/March	2.27/March
Quercus	Main pollen season	28/03–22/04	03/04–25/05
	Season length (days)	26	53
	Max. percentage of pollen/month	3.55/April	2.37/April

In conclusion, pollen grains of 44 taxa were identified during the investigated period in Antalya. Among them, seven taxa produced the greatest amount of pollen and were recorded in concentrations of up to 3 % of the annual total. All of the dominated pollen types in Antalya were reported to be important allergens and formed 88.65 % of the total pollen concentration. In the Antalya atmosphere, pollen concentrations recorded in high levels from February to May and peaked in March and prominently decreased in the summer, in parallel with high temperatures. Thus, in this famous tourism center, allergenic pollen grains reportedly display minimum activity concurrent with summer dryness during the tourism season. Determination of pollen types, concentrations, and fluctuations through the year as well as intradiurnal variations will be useful for patients who suffer from pollen allergies, and the regional pollen calendar presented in this paper may be useful for visitors of the city for timing and may be useful for allergologists to establish an exact diagnosis.

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