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AIRBORNE POLLEN GRAINS IN BURSA, TURKEY, 1999–2000

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Abstract: In this study, pollen grains were sampled by using a Lanzoni trap (Lanzoni VPPS 2000) in atmosphere of Bursa in 1999 and 2000. During two years, a total of 13,991 pollen grains/m³ which belonged to 59 taxa and unidentified pollen grains were recorded. A total of 7,768 pollen grains were identified in 1999 and a total of 6,223 in 2000. From these taxa, 36 belong to arboreal and 23 taxa to non-arboreal plants. Total pollen grains consist of 78.61% arboreal, 20.37% non-arboreal plants and 1.03% unidentified pollen grains. In the region investigated, *Pinus* sp., *Olea* sp., *Platanus* sp., *Gramineae*, Cupressaceae/Taxaceae, *Quercus* sp., *Acer* sp., *Morus* sp. *Xanthium* sp., *Castanea* sp., Chenopodiaceae/Amaranthaceae, *Corylus* sp., *Artemisia* sp., *Urtica* sp. and *Fraxinus* sp. were responsible for the greatest amounts of pollen. During the study period the pollen concentration reached its highest level in April.

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Key words: Turkey, Bursa, pollen, pollen calendar.

INTRODUCTION

Airborne pollen grains are inhalant allergens which are natural-source related. When released by the sources in sufficient amounts, allergenic pollen may evoke allergic responses in sensitive patients, leading to pollinosis. These diseases appear especially during flowering periods of plants. Determination of a type and concentrations of pollen grains will be helpful for patients suffering from allergic diseases. For this reason, annual pollen calendars have been prepared in many countries [2, 6, 14, 17, 19].

The aim of this study is to present the results of two years (1999–2000) continuous volumetric sampling of airborne pollen in the Bursa atmosphere, their percentage values, pollen season periods and pollen calendar for Bursa.

MATERIAL AND METHOD

Bursa is a city with two million inhabitants, situated at 41° 11' N, 29° 04' E in north-western Turkey at an altitude of 100 m above sea level, located on a plain flanked by Mount Uludag to the south and the Samanli Range to the north. Bursa has a Mediterranean vegetation and climate in general. The plain near the metropolitan district comprises agricultural land: vineyards, plum, quince, peach, olive groves and land suitable for the growth of sunflower, tobacco, etc.

Analysis of the flora of Mount Uludag shows that Euro-Siberian elements (63%) are dominant while 31% Mediterranean and 6% Iran-Turan elements can be observed. In the vegetation zones the following species are found: Lauretum (*Laurus nobilis*, *Olea europaea*, *Juniperus oxycedrus*, *Cercis siliquastrum*, *Erica arborea*), Castanetum (*Castanea sativa*, *Ulmus minör*, *Juglans regia*, *Corylus avellana*, *Quercus* sp.), Fagetum (*Fagus orientalis*, *Carpinus betulus*), Pinetum (*Pinus nigra*), Abietum (*Abies nordmanniana* subsp. *bornmüelleriana*) and Alpinetum (*Junipreus nana*, *Vaccinium myrtillus*, *Thymus* sp., *Daphne oleoides*, *Digitalis ferruginea*). In the Samanli Mountains, the local flora features Mediterranean elements such as *Pinus nigra*, *Juniperus oxycedrus*, *Qurcus* sp., *Olea europaea*, *Laurus nobilis*).

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Table 1. Annual totals of average daily pollen counts, Bursa 1999–2000.

	1999	2000	Percent	Percent
Arboreal Plants				
Pinus	1832	1088	2920	20.87
Olea	949	1044	1992	14.24
Platanus	1248	713	1961	14.01
Cupressaceae/Taxaceae	712	609	1321	9.44
Quercus	382	246	628	4.49
Acer	142	164	306	2.19
Morus	215	55	270	1.93
Castanea	101	144	245	1.75
Corylus	126	88	215	1.54
Fraxinus	68	85	153	1.09
Alnus	62	74	136	0.97
Carpinus	73	52	125	0.89
Salix	52	72	125	0.89
Pistacia	78	27	105	0.75
Ericaceae	49	40	90	0.64
Ostrya	43	18	61	0.43
Juglans	35	23	58	0.42
Ailanthus	33	18	52	0.37
Robinia	37	14	52	0.37
Populus	20	25	45	0.32
Ulmus	21	17	38	0.27
Fagus	10	11	22	0.15
Oleaceae	18	2	19	0.14
Rosaceae	7	8	15	0.11
Betula	12	3	15	0.11
Tilia	4	6	9	0.07
Sophora	5	1	6	0.04
Aesculus	4	2	5	0.04
Abies	1	1	3	0.02
Celtis	2	0	2	0.02
Cedrus	1	1	2	0.01
Ligustrum	1	1	2	0.01
Poterium	1	0	1	0.01
Total	6346	4652	10998	78.61
Percent	45.36	33.25	78.61	
Non-arboreal Plants (NAP)				
Gramineae	730	923	1653	11.82
Xanthium	114	138	252	1.80
Chenopodiaceae/Amaranthaceae	75	162	237	1.70
Artemisia	66	115	181	1.29
Urtica	93	63	156	1.12
Plantago	85	54	138	0.99
Rumex	48	20	68	0.49
Parietaria	34	15	49	0.35
Compositae	25	14	39	0.28
Umbelliferae	12	9	21	0.15
Carex	11	3	14	0.10
Cruciferae	13	1	14	0.10
Taraxacum	3	1	4	0.03
Typha	3	1	4	0.03
Centaurea	1	2	3	0.02
Juncaceae	2	1	3	0.02
Rubiaceae	2	1	3	0.02
Labiatae	2	0	2	0.01
Caryophyllaceae	1	1	2	0.01
Luzula	1	0	1	0.01
Leguminosae	1	0	1	0.00
Ranunculaceae	1	0	1	0.00
Helianthus	1	0	1	0.01
Papaveraceae	1	0	1	0.01
Onobrichis	1	0	1	0.01
Malvaceae	1	0	1	0.01
Total	1324	1526	2850	20.37
Percent	9.46	10.91	20.37	
Unidentified	98	46	143	1.03
Total	**7768**	**6223**	**13991**	**100.00**
Percent	**55.52**	**44.48**	**100.00**	

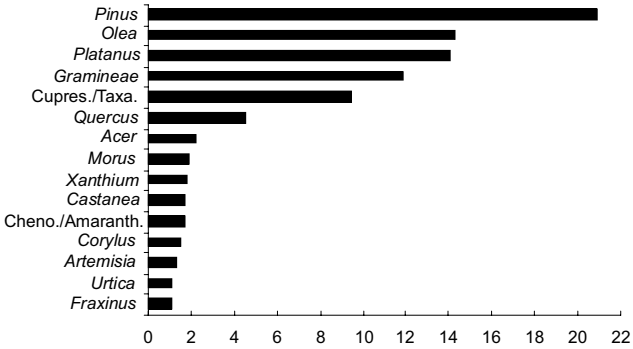

Figure 1. Total annual percentage of the main pollen types in the atmosphere of Bursa (1999-2000).

In addition to the natural vegetation around Bursa, the following species are frequently seen in parks, gardens and on streets of the town: *Acer campestre*, *Acer negundo*, *Aesculus hippocastanum*, *Ailanthus altissima*, *Albizzia julubrissin*, *Berberis thrunbergii*, *Betula verrucosa*, *Buxus sempervirens*, *Catalpa bignonioides*, *Celtis australis*, *Crataegus monogyna*, *Cryptomeria japonica*, *Cupressus semperviren*, *Cydonia japonica*, *Euonymus japonica*, *Ficus carica*, *Forsythia intermedia*, *Fraxinus excelsior*, *Ginko biloba*, *Hedera helix*, *Ligustrum vulgare*, *Magnolia grandiflora*, *Magnolia soulangiana*, *Morus nigra*, *Nerium oleander*, *Ostrya carpinifolia*, *Pinus brutia*, *Populus tremula*, *Prunus persica*, *Prunus laurocerasus*, *Prunus granatum*, *Phillyrea latifilia*, *Robinia pseudoacacia*, *Salix babylonica*, *Salix alba*, *Sambucus nigra*, *Sophora japonica*, *Syringa vulgaris*, *Taxus baccata*, *Thuja orientalis*, *Tilia tomentosa*, *Ulmus glabra*, *Vibirnum opulus*, *Wistaria sinensis*.

Pollen sampling was carried out using a volumetric trap (VPPS 2000 Lanzoni, Bologna, Italy) placed about 25m above ground level, on the roof of the Almira Hotel which is located in the center of the city in a densely populated zone. The sampling airflow rate was 10 l/min. Pollen was caught on a 24 mm wide transparent tape coated by a thin film of silicon oil. The tape was mounted on a cylinder rotating at a speed of 2 mm per hour. A complete rotation of the cylinder took seven days. Weekly tape strips were cut into 7 pieces, each 48 mm in length. Each piece corresponded to one day sampling. They were then mounted and stained in glycerine jelly mixed with basic fuchsine and examined microscopically. A sampling method, slide preparation and data interpretation were performed according to the standard method of the Italian Network for the Aerobiological Monitoring [6], and pollen concentrations were expressed as number of pollen grains per cubic meter ($p/m^3/24h$).

The analysis of the pollen concentration trend from 1999 to 2000 was performed using the annual sum of the daily mean values. The pollen was counted at a magnification of × 100, in 24 transverse bands corresponding to every full hour, and total daily counts were converted into the number of pollen grains per m^3 of air.

Pollen calendar for Bursa is given in the figures on the basis of 10 day means.

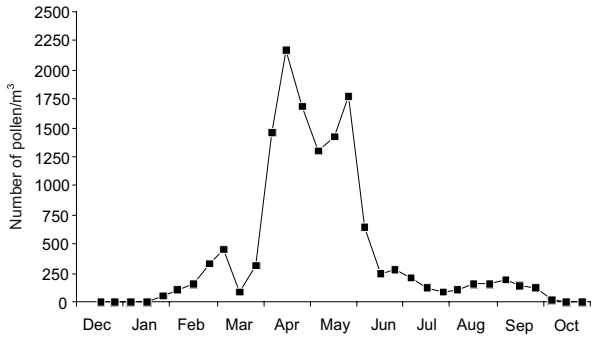

Figure 2. Total pollination in decade periods (1999-2000).

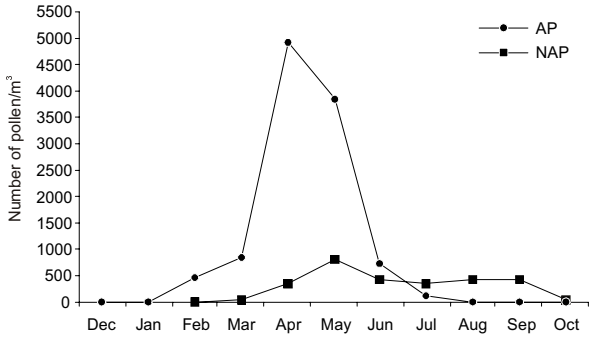

Figure 3. Monthly total variation in pollen grains in the atmosphere of Bursa (1999-2000).

RESULTS

A total of 13,991 pollen grains/m^3 from 59 taxa, 7,768 in 1999 and 6,223 in 2000, were identified in the atmosphere of Bursa during the two years. Of these, 36 taxa were arboreal and the others non-arboreal plants. A total of 10,998 pollen grains were found to be arboreal (78.61%), 2.850 as non-arboreal (20.37%) and 143 as unidentified (1.03%) (Tab. 1).

The main pollen producers were arboreal plants such as *Pinus* sp., *Olea* sp., *Platanus* sp., Cupressaceae/Taxaceae, *Quercus* sp., *Acer* sp., *Morus* sp., *Castanea* sp., *Corylus* sp. and *Fraxinus* sp. These give 71.55% of the total pollen grains (Tab. 1, Fig. 1). Among herbaceous plants Gramineae, *Xanthium* sp., Chenopodiaceae/Amaranthaceae, *Artemisia* sp. and *Urtica* sp. were found frequently in the atmosphere making up to 17.73% of the total (Tab. 1, Fig. 1).

Ten day means of total pollen grains recorded in the atmosphere are shown in Fig. 2. Five peaks in concentration were recognized. The first peak occurred from mid-February to mid-March, caused by Cupressaceae/Taxaceae, *Corylus* sp., *Fraxinus* sp. and *Alnus* sp. pollen. The second and the highest peak occurred from the end of March to the end of April and was caused by Cupressaceae/Taxaceae, Gramineae, *Acer* sp., *Morus* sp., *Platanus* sp., *Pinus* sp. and *Quercus* sp. pollens. The third peak occurred from the middle of May to the beginning of June with an increase in numbers of pollen of Gramineae, *Pinus* sp., *Olea* sp. and *Urtica* sp. The fourth peak occurred at the end of June, caused by Gramineae and *Castanea* sp. polen. The fifth peak occurred at the beginning September with an increase in the pollen of *Xanthium* sp. and Chenopodiaceae/Amaranthaceae.

The seasonal variation in arboreal and non-arboreal pollen grains are given in Fig. 3.

The earliest pollen grains in the atmosphere of Bursa were noted in January (Fig. 3). The main arboreal pollen grains were observed during this month. In January, low counts were recorded for *Corylus* sp. (0.24%), Cupressaceae/

Table 2. The highest airborne pollen concentrations in consecutive months and their yearly composition (%), Bursa, Turkey.

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (%)
Pinus	-	-	0.02	9.49	10.14	1.12	0.09	0.01	-	-	-	-	20.87
Olea	-	-	-	0.03	11.53	2.63	0.04	-	-	-	-	-	14.24
Platanus	-	-	0.05	12.56	1.40	-	-	-	-	-	-	-	14.01
Cupressacea/Taxaceae	0.07	1.23	2.72	4.25	1.11	0.05	0.01	-	0.001	0.00	-	0.001	9.44
Quercus	-	-	0.01	3.32	1.16	-	-	-	-	-	-	-	4.49
Acer	-	-	1.64	0.54	0.001	-	-	-	-	-	-	-	2.19
Morus	-	-	0.03	1.66	0.25	-	-	-	-	-	-	-	1.93
Castanea	-	-	-	-	0.01	1.17	0.57	0.005	-	-	-	-	1.75
Corylus	0.24	0.97	0.32	-	-	-	-	-	-	-	-	0.001	1.54
Fraxinus	0.07	0.27	0.38	0.38	-	-	-	-	-	-	-	-	1.09
Gramineae	-	0.01	0.24	2.21	4.66	2.32	1.33	0.86	0.18	0.02	-	-	11.82
Xanthium	-	-	-	-	-	-	0.002	0.94	0.85	0.01	-	-	1.80
Chenopodiaceae/Amaranthaceae	-	-	-	0.001	0.04	0.04	0.18	0.66	0.75	0.04	-	-	1.70
Artemisia	-	-	-	-	-	-	0.02	0.21	1.01	0.05	-	-	1.29
Urtica	-	-	-	0.01	0.40	0.33	0.17	0.18	0.02	0.003	-	-	1.12
Total	0.38	2.49	5.41	34.46	30.68	7.65	2.41	2.86	2.81	0.12	0	0.002	89.28
Others	0.07	0.71	0.91	3.46	2.66	0.62	0.76	0.24	0.20	0.02	0	0.002	9.65
Unidentified	0.01	0.02	0.11	0.26	0.36	0.13	0.06	0.03	0.04	0.01	0.00	0.00	1.03
Total	0.46	3.22	6.43	38.18	33.76	8.40	3.23	3.13	3.04	0.16	0.00	0.004	100.00

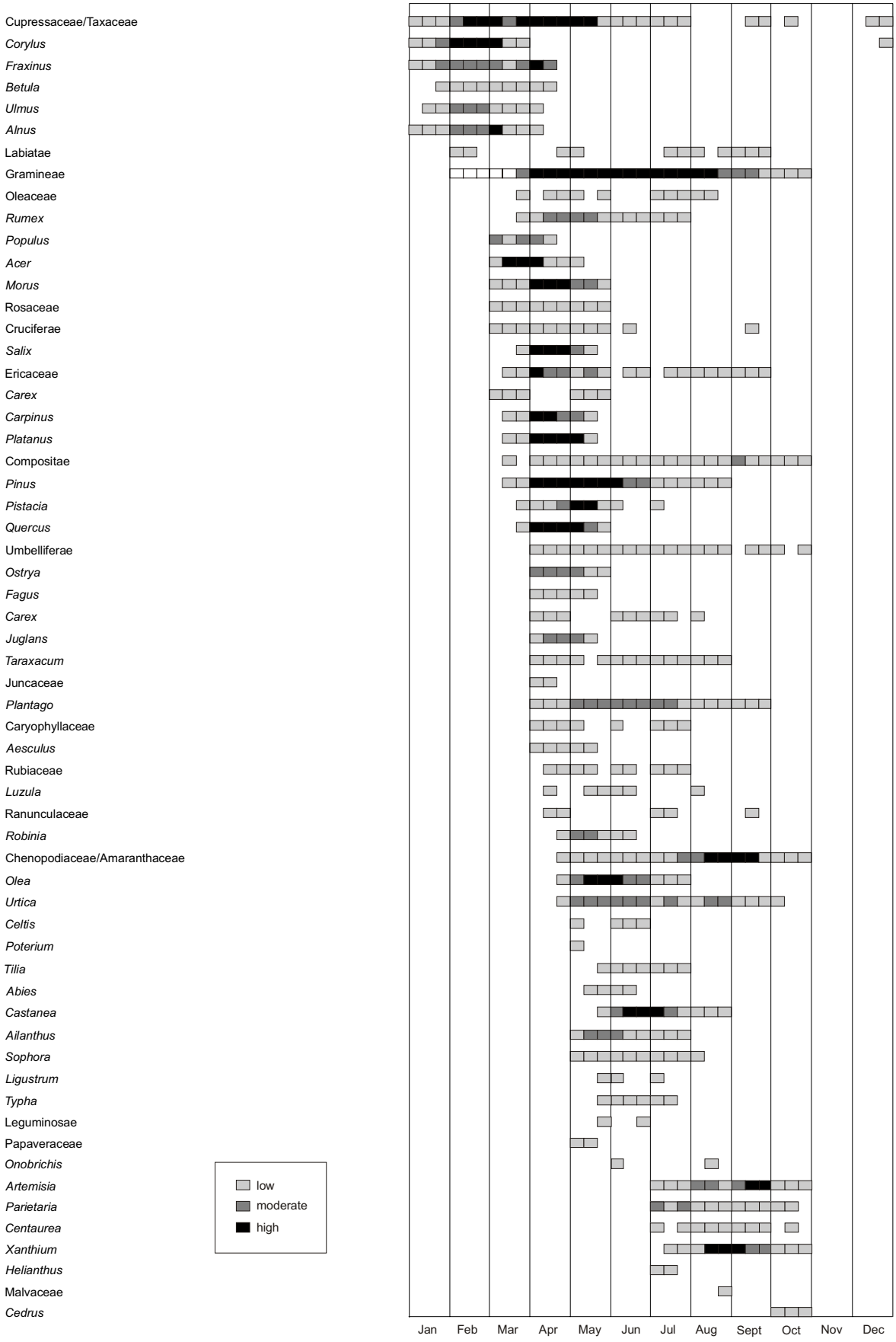

Figure 4. Pollen calendar of Bursa (1999-2000).

Taxaceae and *Fraxinus* sp. (0.07%) (Tab. 2). Number of pollen grains increased in February–March and reached its maximum level in April (38.18%). *Platanus* sp. (12.56%), *Pinus* sp. (9.49%), Cupressaceae/Taxaceae (4.25%), *Quercus* sp. (3.32%), Gramineae (2.21%), *Morus* sp. (1.66%), *Acer* sp. (0.54%), *Fraxinus* sp. (0.38%), *Olea* sp. (0.03%), *Urtica* sp. (0.01%) and Chenopodiaceae/Amaranthaceae (0.001%) released high amounts of pollen into the atmosphere throughout their pollenseason, and were responsible for more than 34.46% of the total pollen grains in April (Tab. 2). The numbers of pollen grains were also high in May. From July, the pollen grains of weeds became dominant, but the amount of pollen was lower than in springtime. The reason for this decrease was associated with the end of the pollination periods of many arboreal plants which produced and released high amounts of pollen grains into the atmosphere (Fig. 3). In June and July *Olea* sp., Gramineae, *Castanea* sp. and *Pinus* sp.; in August *Xanthium* sp., Gramineae, Chenopodiaceae/Amaranthaceae; in September Artemisia sp., *Xanthium* sp. and Chenopodiaceae/ Amaranthaceae; in October *Artemisia* sp., Chenopodiaceae/ Amaranthaceae were recorded as dominant taxa (Tab. 2). In November, no pollen grains were recorded; In December, only arboreal pollen types such as of Cupressaceae/ Taxaceae, *Corylus* sp. and *Alnus* sp. were recorded.

The types of pollen present in the atmosphere of Bursa are shown as a pollen calendar in Fig. 4, based on the total counts pollen grains 10 days/m^3 in 1999–2000. The following taxa produced the greatest amount of pollen:

Pinus sp. The pollen season started in the second decade of March and ended in the third decade of August. The highest values were noted in April, May and in the first days of June (Tab. 2, Fig. 4).

Olea sp. The pollen season started in the last days of April and ended in the first days of July. The peak value was noted in mid-May and in the first days of June (Tab. 2, Fig. 4).

Platanus sp. The pollen season was relatively short. It started in mid-March and ended in mid-May. The highest counts were recorded in April and the first decade of May (Tab. 2, Fig. 4).

Gramineae: Pollen grains were recorded during the greater part of the year, from February to October. The highest counts were recorded from April to mid-August. The Gramineae family was one of those herbs, which released high amount of pollen into the atmosphere (Tab. 2, Fig. 4).

Cupressaceae/Taxaceae: Pollen grains of these families were recorded all year round. The highest counts were recorded from February to May (Tab. 2, Fig. 4).

Quercus sp. Pollen release continued from the third decade of March to the third decade of May. The highest counts were recorded in April and the first days of May (Tab. 2, Fig. 4).

Acer sp. Pollen release continued from the first days of March to the first days of May. The highest counts were recorded from mid-March to the first days of April (Tab. 2, Fig. 4).

Morus sp. The pollen season started in the first decade of March and ended in the third decade of May. The peak value was in April (Tab. 2, Fig. 4).

Xanthium sp. The pollen season started in mid-July and ended in the last days of October. The highest counts were recorded from mid-August to the first days of September (Tab. 2, Fig. 4).

Castanea sp. The pollen season started in the last days of May and ended in the last days of July. The highest value was from mid-June to the first days of July (Tab. 2, Fig. 4).

Chenopodiaceae/Amaranthaceae: Pollen release continued from the third decade of April to the third decade of October. The highest counts were recorded from mid-August to the middle of September (Tab. 2, Fig. 4).

Corylus sp. The pollen season started in the last days of December and ended in the last days of March. The highest value was in February and the first days of March (Tab. 2, Fig. 4).

Artemisia sp. The pollen season started in the first days of July and ended in the last days of October. The highest value was in mid-September and last days of September (Tab. 2, Fig. 4).

Urtica sp. Pollen release continued from the third decade of April to the first decade of October. The highest counts were recorded in May, June, mid-July and August (Tab. 2, Fig. 4).

Fraxinus sp. Pollen release continued from the first days of January to mid-April. The highest counts were recorded from the last days of January to the middle of April (Tab. 2, Fig. 4).

DISCUSSION

In the atmosphere of Bursa, arboreal pollen types were dominant; this is due to the vegetation composition and geographical location of the town. According to other studies carried out in Europe, arboreal pollen types are also dominant in Finland (82%) [10], Ostrowiec Świętokrzyski, Poland (73%) [9], Isparta, Turkey (71%) [2], Perugia, Italy (71%) [16], Bursa, Turkey (70.01%) [1] and Ascoli Piceno, Italy (55%) [16].

Some important pollen of plants such as *Pinus* sp. [15], *Olea* sp. [8, 13], *Platanus* sp. [7], Gramineae [8], Cupressaceae/Taxaceae [11], *Quercus* sp. [18], *Acer* sp. [5], *Morus* sp. [3], *Xanthium* sp. [5], *Castanea* sp. [11], Chenopodiaceae/ Amaranthaceae [11], *Corylus* sp. [7], *Artemisia* sp. [19], *Urtica* sp. [4] and *Fraxinus* sp [11] were also found in high concentrations in Bursa. In Europe, the dominant airborne taxa have been determined as Gramineae, *Alnus*, *Artemisia*, *Urtica*, *Betula* in Leiden, The Netherlands [18, 19]; Gramineae, Urticaceae, Oleaceae, *Artemisia* in Ascoli Piceno, Italy [16]; *Betula*, *Pinus*, *Alnus*, *Platanus*, *Plantago* in Brussels, Belgium [18, 19]; Cupressaceae, Gramineae, *Quercus*, *Plantago* in Montpellier, France [19]; Pinaceae, *Alnus*, *Betula*, *Quercus*, *Betula*, Gramineae, *Artemisia* in Jyvaskylan, Finland [10, 18]; *Alnus*, *Betula*, Gramineae, *Corylus* in Ostrowiec Świętokrzyski, Poland [9]; *Betula*,

Quercus, Gramineae, Urticaceae in Vienna, Austria [18]. The airborne pollen types mentioned above are responsible for many cases of pollinosis in Europe.

CONCLUSION

Pollen grains of 59 taxa were identified during the pollen season in the atmosphere of Bursa, 15 of them formed about 89.28% of 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 make an exact diagnosis.

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