ASTIM ALLERJi iMMÜNOLOJi
ASTHMA ALLERGY IMMUNOLOGY

Asthma Allergy Immunol 2013;11:86-95

ARAŞTIRMA RESEARCH ARTICLE

Investigation of airborne pollen grains in Kirsehir

Kırşehir atmosferindeki polenlerin araştırılması

Ali Savaş BÜLBÜL[1], Sevil PEHLİVAN[2]

[1] **Department of Molecular Biology and Genetics, Faculty of Science, Bartin University, Bartin, Turkey**
Bartın Üniversitesi Fen Fakültesi, Moleküler Biyoloji ve Genetik Bölümü, Bartın, Türkiye

[2] **Department of Biology, Faculty of Science, Gazi University, Ankara, Turkey**
Gazi Üniversitesi Fen Fakültesi, Biyoloji Bölümü, Ankara, Türkiye

ABSTRACT

This research is an aeropalynological study performed in Kirsehir in the period of March 1st, 2005-February 28th, 2006. Samples which obtained from Golhisar, Bahcelievler and Karayolları in Kirsehir have been analyzed at two different stations by using the application of Durham-gravimetric method. The amount of the pollen grains in Kirsehir atmosphere per certain area has been measured as cm^2 units with respect to the specified area within weekly and monthly periods by the help of the microscope slides placed in the Durham instrument and the obtained results are shown through graphics. A total 24 taxa of 12 trees and scrubs, and of 12 herbaceous plants, have been determined in the research area. The increase in the temperature, wind speed and relative humidity rates have affected the amount of pollens positively but also effected the precipitation negatively. The results are compared with the meteorological factors. The monthly pollen calender is prepared. In conclusion, it is expected that these data would be helpful for the researchers in the area of aeropalinology and for the clinicians to evaluate allergic diseases.

(Asthma Allergy Immunol 2013;11:86-95)

ÖZ

Bu araştırma 01 Mart 2005-28 Şubat 2006 tarihleri arasında Kırşehir'de yapılan aeropalinolojik çalışmadır. Bu çalışmaların verilerinin, konu ile ilgili diğer araştırmacılara ve allerjik hastalıkların değerlendirmesinde klinisyenlere yardımcı olacağı umut edilmektedir. Kırşehir ili içerisinde Gölhisar, Bahçelievler ve Karayolları Müdürlüğü istasyonları olmak üzere üç farklı istasyonda Gravimetrik yöntemin uygulama aracı Durham kullanılarak elde edilen örnekler incelenmiştir. Kırşehir atmosferindeki polenlerin belli bir alan başına düşen miktarı, Durham aracına yerleştirilen preparatlar yardımıyla cm^2 alan birimi olarak haftalık ve aylık periyotlarda saptanmış, elde edilen veriler grafiklendirilmiştir. Çalışma bölgelerinde 12'si ağaç ve çalı, 12'si otsu olmak üzere toplam 24 takson belirlenmiştir. Sıcaklık, rüzgar hızı ve nispi nem oranı artışları, polen miktarını pozitif olarak, yağış ise negatif yönde etkilemiştir. Sonuçlar, meteorolojik faktörlerle karşılaştırılarak, aylık polen takvimi hazırlanmıştır.

(Asthma Allergy Immunol 2013;11:86-95)

Yazışma Adresi/Address for Correspondence
Prof. Dr. Sevil PEHLİVAN
Gazi Üniversitesi Fen Fakültesi, Biyoloji Bölümü, Ankara, Türkiye
e-posta: asavasbulbul@gmail.com

Key words: Turkey, Kirsehir, pollen calender, aeropalynology

Received: 17/12/2012 • Accepted:10/01/2013

Anahtar kelimeler: Türkiye, Kırşehir, polen takvimi, aeropalinoloji

Geliş Tarihi: 17/12/2012 • Kabul Ediliş Tarihi: 10/01/2013

INTRODUCTION

Pollen and spores in the atmosphere enter the human body through the respiratory system, especially sensitive individuals feel severe reactions in the respiratory system due to these pollens and spores. Microorganisms in the air are pollen, spores, bacteria, viruses, hyphae parts, algae, small seeds, larvae of insects, and protozoa. Most of these particles are the factors of disease. Especially some pollen grains are known to cause allergic asthma and hayfever. These diseases mostly appear during the flowering periods of plants. Especially in highly populated cities determination of the pollen types and their concentration in the atmosphere is very important. It is a well known fact that pollen grains of several plant taxa, such as *Acer* spp., *Populus* spp., *Cupressaceae, Salix* spp., *Platanus* spp., *Quercus* spp., *Juglans regia*, *Pinus* spp., Moraceae, Oleaceae, Urticaceae, Umbelliferae, Chenopodiaceae/Amaranthaceae, Compositae, *Artemisia* spp., *Taraxacum* spp., Gramineae, Plantaginaceae and Polygonaceae have allergic effects (asthma, hayfever etc.) on humans[1-3]. For this reason, studies of the pollen content in the atmosphere of different areas have been carried out by researchers worldwide and Turkey. In Sweden, in Finland, in Italy, in France, in Netherlands, in England, in Spain (1990), in Greece, in Argentina made investigations on the pollen content in the atmosphere[4-12]. In Turkey, Istanbul, Serik (Antalya), Kirikkale, Sivas, Balikesir, Isparta, Afyon, Usak, Edirne, Izmir, Bartin, Samsun, Diyarbakir, Trabzon, Eskisehir, Kastamonu, Bilecik, Ankara, Tekirdag, Konya, Kirklareli were the investigated provinces by researches[15-33]. The aim of this study was to determine pollen grains and to determine the 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.

MATERIALS and METHODS

Kirsehir is situated at 38° 50′-39° 50′ North and 33° 30′-34° 50′ East in the north-west of Turkey at an altitude of 985 m above sea level. Kirsehir is in Irano-Turanion phytogeographic region, and generally has a Mediterranean climate. Acording to Emberger's (1952) bioclimate essentials, the study area is under the influence of a low precipitation Mediterranean bioclimate level[34]. The most frequent winds are from the north-northwest with an average 2.4 m/s, an average annual mean temperature of 11.3°C, a mean rainfall of 383.3 mm/year, and a mean humudity 59.0% (Figure 1). The following species are found in Kirsehir: *Astragalus* spp., *Alyssum* spp., *Verbascum* spp., *Centaureae* spp., *Silene* spp., *Pinus nigra* subsp. *nigra, Cedrus libani, Quercus cerris* var. *cerris, Q. pubescens, Cupressus sempervirens L., Acer* spp., *Juglans regia L., Betula pendula Roth., Platanus orientalis L., Sa-*

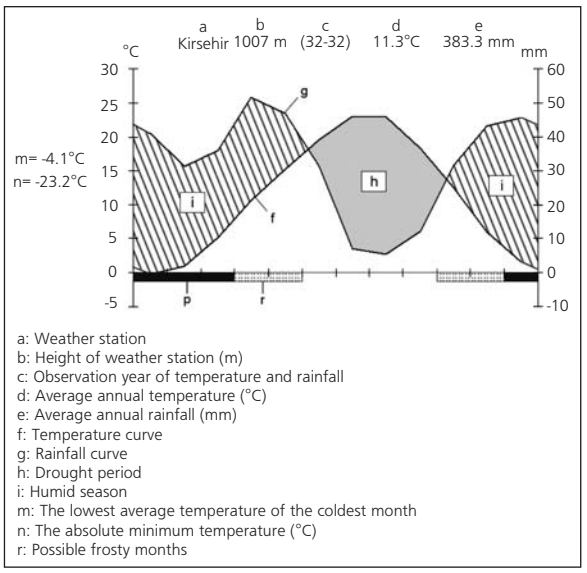

Figure 1. Climate diagram of Kirsehir (1975-2006).

lix spp., *Populus* spp., *Fraxinus* spp., *Juniperus* spp., and *Morus alba* L., In addition to the natural vegetation around Kirsehir, the following species are frequently seen in parks, gardens, and streets of the city: Platanus orientalis *L., Salix* spp., *Populus* spp., *Fraxinu*s spp., *Pinus nigra L., Acer* spp., and *Betula* spp.

In this study, Durham apparatus were placed in three different locations on roofs, at the approximate height of 10 m above ground level. All sides of the roof were open to air flow, and there are no high buildings blocking air flow in surrounding. Slides placed on the Durham apparatus were changed weekly.

Before exposure, slides were covered with glycerin jelly mixed with basic fuchsine[35]. The slides were examined weekly under a light microscope. In most cases the grains were identified and counted at genus level, and at family level in the rest. The grains that could not be identified were considered as unidentified types. The number of pollen grains was expressed as grains per square centimetre of microscope cover glass (20 x 20 mm).

RESULTS

During observation, 6446 pollen grains/cm^2 belonging to 12 (74.8%) arboreal and 12 non-arboreal (23.9%) pollen types were found. Unidentified pollen types accounted for (1.3%) (Table 1,2). In the atmosphere of Kirsehir arboreal pollen grains were dominants. 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 were also dominant: in Finland (82%); in Bursa, Turkey (78.6%); in Perugia (71%) and Ascoli-Piceno (55%); in Kutahya, Turkey (82%); in Canakkale, Turkey (86.7%); in Eskisehir, Turkey (81%); in Konya, Turkey (87.5%); in Bilecik, Turkey (75.7%); in Tekirdag, Turkey (64.1%); in Kirklareli, Turkey (71.0%)[27,29,31-33,36,37].

The main arboreal plants' pollens in the atmosphere of Kirsehir were the following: Pinaceae (33.7%), *Salix* spp. (15.1%), Cupressaceae (9.6%), Betulaceae (4.7%), *Populus* spp. (3.8%), Aceraceae (2.0%), *Quercus* spp. (1.7%), Juglans regia (0.98%), *Platanus* spp. (1.2%) and Oleaceae (1.2%). They form 72.5% of the total pollen fall (Table 1). Poaceae (10.3%), Chenopodiaceae/Amaranthaceae (4.3%), Compositae (2.6%) and *Artemisia* spp. (1.7%) were frequently found as non-arboreal plants taxa in the atmosphere of Kirsehir, making up 18.9% of the total pollen grains (Tables 1,2).

Table 1. Total biannual percentage values of the main pollen types in the atmosphere of Kirsehir (%)

Taxa	Annual totals of weekly pollen counts/cm^2	%
Aceraceae	0.21	2.0
Betulaceae	0.49	4.7
Chenopodiaceae	0.45	4.3
Compositae	0.28	2.6
Artemisia	0.18	1.7
Taraxacum	0.036	0.4
Cruciferae	0.054	0.5
Cupressaceae	0.99	9.6
Quercus	0.176	1.7
Juglans regia	0.10	0.98
Leguminosae	0.146	1.2
Moraceae	0.034	0.4
Oleaceae	0.121	1.2
Pinaceae	3.36	33.7
Plantaginaceae	0.125	1.2
Platanus	0.121	1.2
Poaceae	1.069	10.4
Polygonaceae	0.01	0.2
Populus	0.38	3.8
Salix	1.55	15.1
Rosaceae	0.05	0.5
Rubiaceae	0.02	0.3
Umbelliferae	0.04	0.4
Urticaceae	0.15	1.3
X	0.14	1.3

Table 2. Pollen grains (per cm^2) of taxa by month, Kirsehir

Months	March	April	May	June	July	August	September	October	November	December	January	February	Total
Betulaceae	54	129	21	2	-	-	-	-	6	11	39	49	311
Chenopodiaceae	-	-	2	21	57	137	40	20	3	-	-	-	280
Compositae	-	3	5	19	42	52	38	18	-	-	-	-	167
Aceraceae	67	64	-	-	-	-	-	-	-	-	-	-	131
Artemisia	-	-	1	3	16	43	28	21	-	-	-	-	120
Taraxacum	-	-	1	11	10	1	-	-	-	-	-	-	23
Cruciferae	-	3	23	7	-	-	-	-	-	-	-	-	31
Cupressaceae	153	77	72	15	5	-	-	-	-	43	79	172	616
Salix	150	796	26	-	-	-	-	-	-	-	-	-	972
Quercus	-	-	83	13	13	-	-	-	-	-	-	-	109
Juglans regia	-	19	36	5	3	-	-	-	-	-	-	-	63
Leguminosae	-	-	22	25	20	13	2	3	-	-	-	-	85
Moraceae	-	14	8	-	-	-	-	-	-	-	-	-	22
Oleaceae	-	-	33	30	11	-	-	-	-	-	-	-	74
Pinaceae	36	43	726	227	85	40	256	609	125	-	3	21	2171
Plantaginaceae	-	-	3	37	19	10	9	-	-	-	-	-	78
Platanus	3	59	13	-	-	-	-	-	-	-	-	-	75
Poaceae	2	18	171	251	141	50	17	8	4	-	-	-	662
Polygonaceae	-	-	2	3	6	-	-	-	-	-	-	-	11
Populus	53	190	3	-	-	-	-	-	-	-	-	-	246
Rosaceae	-	-	6	14	9	2	-	-	-	-	-	-	31
Rubiaceae	-	-	-	15	2	-	-	-	-	-	-	-	17
Umbelliferae	-	-	-	12	9	11	-	-	-	-	-	-	32
Urticaceae	-	-	-	9	21	32	23	-	-	-	-	-	85
Unidentified	9	6	5	10	18	9	12	15	-	-	-	-	84

From the herbaceous plants, Poaceae, Chenopodiaceae/Amaranthaceae, Plantaginaceae, Compositaeae, *Taraxacum* spp., *Artemisia* spp. and Urticaceae were found frequently in the atmosphere of Kirsehir making up 21.8% of the total pollen fall (Table 1).

The earliest pollen grains in the atmosphere of Kirsehir were recorded in january (Figure 1). In January, pollen grains of Cupressaceae, Betulaceae and Pinaceae were observed in small amounts during this month. Number of pollen grains started to increase in february, march and april and reached the highest level in may. Betulaceae, *Populus* spp., *Salix* spp., Cupressaceae, *Junglans regia,* Pinaceae, Poaceae, *Platanus* spp. and *Quercus* spp. disperse high amount of pollen into the Kirsehir atmosphere throughout their pollination period and formed 20% of the total pollen grains in may (Table 2).

In june 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 period of many arboreal plants which produced and released high amounts of pollen grains into the atmosphere (Figure 2, Table 2). In june Poaceae, Pinaceae Oleaceae and Plantaginaceae; in july Poaceae, Pinaceae, Chenopodiaceae/Amaranthaceae, Compositae and Urticaceae; in august and september, Poaceae, Pinaceae, Chenopodiaceae/Amaranthaceae and Compositae; in october, Poaceae, Pinaceae, Chenopodiaceae/Amaranthaceae, *Artemisia* spp. and Compositae; in november and december Pinaceae and Cupressaceae were recorded as dominant taxa (Table 2).

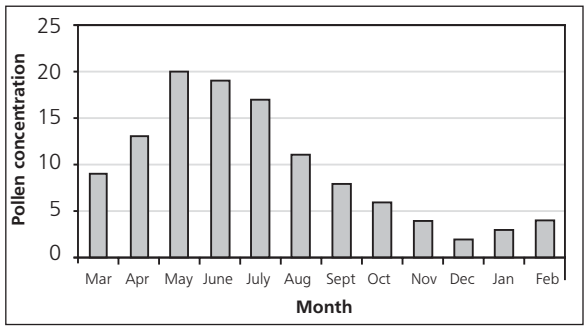

Figure 3. Total pollen content and variation in the number of airborne pollen in Kirsehir.

The types of pollen presented in the atmosphere of Kirsehir are shown as a pollen calendar in Figure 3; based on the total counts of pollen grains on months/cm^2 in 2005. The following 15 taxa produced the greatest amount of pollen (Table 2, Figure 3).

Aceraceae: Pollen grains of this family presented 2.0% of total pollens. Pollen grains in this family for the first three stations were observed during the first week of march. The most intense observation period of this family in Golhisar is the second week of april and the latest period was the last week of april. In Bahcelievler, the most intense observation period of this family was the third week of april and the latest period was the last week of april. In Karayollari, the most intense observation period of this family was the first week of april and the latest period was the last week of april.

Betulaceae: Pollen grains of this family presented 4.7% of total pollens. From the first week of march, the pollens of this family in the atmosphere were started to be seen. In Golhisar station in the third week of april, in Bahcelievler station in the first week of may, in Karayollari station the first week of april was recorded as the maximum level. Also in june, july, august, september and october pollen grains were found. From november till february 2006 the pollen grains were observed as least.

Chenopodiaceae/Amaranthaceae: Pollen grains of this family presented 4.3% of total pollens. In Golhisar station pollen first started in the first week of june and reached the maximum level in the third week of august, and the was observed finally in the second week of october. In Bahcelievler station from the first week of may pollens started to be seen, the maximum level was reached in the third week of august, and the first week of november pollens stopped. In Karayollari the first week of june,

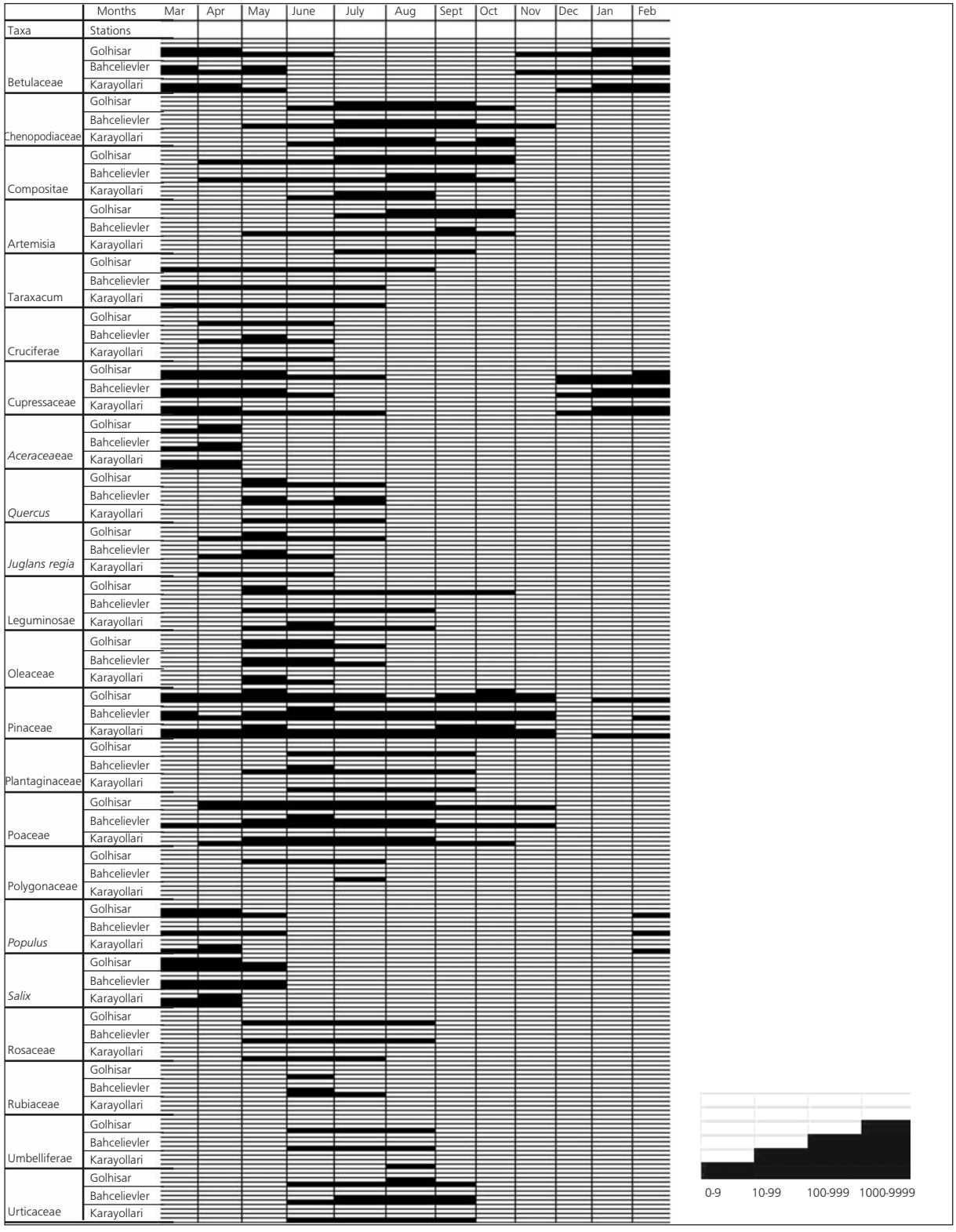

Figure 2. Pollen calendar of Kirsehir.

the pollens started to be seen in the atmosphere, the maximum level was reached in the second week of august and finallized in the first week of november.

Compositae (Asteraceae): Pollen grains of this family presented 2.6% of total pollens. In Golhisar station pollens were first seen in the last week of april and last seen in the first week of october, the maximum level was reached in the second week of august. In Bahcelievler station pollens were first seen in the third week of april and last seen in the first week of october, the maximum level was reached in the second week of august. In Karayollari station pollens were observed starting from the first week of may until the second week of september, the maximum level was reached in the third week of july.

Cupressaceae: Pollen grains of this family presented 9.56% of total pollens. In Golhisar and Karayollari stations the pollens were first observed in first week of march, also in august, september, october and november. In Golhisar station pollens have reached the maximum level in the first week of march. In Karayollari station the amount of pollens reached the maximum level in the first week of april. In Bahcelievler station pollens were first observed in first week of march, also in july, august, september, october and november pollens were found. The amount of pollen has reached the maximum level in the first week of may.

***Quercus* spp.:** Pollen grains of this genus presented 1.7% of total pollens. Pollens of this genus first observed starting from the first week of may until the first week of july in Golhisar, Karayollari and Bahcelievler stations. The pollen amount reached the maximum level in the second week of may in Golhisar and Karayollari stations, and station in the third week of may in Bahcelievler.

Juglans regia: Pollen grains of this species presented 0.98% of total pollens. Pollens of this genus first observed starting from the third week of april until the first week of june in Golhisar and Karayollari station and ended in july in Bahcelievler station. The pollen amount reached the maximum level in the first week of may in Golhisar, Bahcelievler and Karayollari stations.

Leguminosae (Fabaceae): Pollen grains of this family presented 1.2% of total pollen grains. The pollen grains of this family members were first seen in the second week of may until the third week of october in Golhisar. The pollen amount reached the maximum level in the second week of may. The pollen grains of this family members were first seen in the third week of may until the last week of august in Bahcelievler. The pollen amount reached the maximum level in the third week of august. In Karayollari station the pollen grains were first seen in the second week of may until the last week of july. The pollen amount reached the maximum level in the third week of may.

Oleaceae: Pollen grains of this family presented 1.2% of total pollens. Pollen grains of this family were first seen in the second week of may in the Golhisar station and last in the last week of july. The pollen amount reached the maximum level in the third week of may. In Bahcelievler station pollens were first seen in the second week of may and last seen in the third week of july, the maximum level was reached in the second week of may. The pollen amount reached the maximum level in the third week of may. In Karayollari station pollens were first seen in the first week of may and last seen in the last week of june, the maximum level was reached in the second week of may.

Pinaceae: Pollen grains of this family presented 33.7% of total pollens. In Golhisar station pollen grains appear from the first week of march till the end of november. In january 2006 pollens started to appear again. The maximum level was reached in first week of october, also encountered at the end of november and in Bahcelievler station appeared again in january 2006. The maximum level was reached in the first week of june. In Karayollari station,

pollen grains appeared latest at the end of november and in january 2006 appeared again. The maximum level in the atmosphere was reached in the last week of september.

Plantaginaceae: Pollen grains of this family presented 1.2% of total pollens. In Golhisar station pollens were first seen in the last week of june and last seen in the first week of september, the maximum level was reached in the last week of june. In Bahcelievler station pollens were first seen in last week of may and last seen in the second week of september, the maximum level was reached in the second week of june. In Karayollari station, pollens were observed starting from the second week of june until the second week of september, the maximum level was reached in the last week of july.

***Platanus* spp.:** Pollen grains of this genus presented 1.2% of total pollens. In Golhisar and Karayollari stations pollen grains were found in the atmosphere from the last week of march, and the pollen grains of this genus has reached the maximum level in the third week of april. In Bahcelievler station pollen grains first appeared in the beginning of april and in the last week of april the pollen amount has reached the maximum level. In all three stations pollens could be observed since the last week of may.

Poaceae (Gramineae): Pollen grains of this family presented 10.3% of total pollens. In Bahcelievler stations pollen grains were first observed in the third week of april and in Golhisar and Karayollari stations were first observed in the last week of march. Pollination lasted the first week of november in Golhisar and Bahcelievler stations and, lasted in the third week of september in Karayollari station. In Golhisar and Bahcelievler stations pollen amount reached the maximum level in the third week of may and in the first week of june respectively.

***Populus* spp.:** Pollen grains of this genus presented 3.8% of total pollens. In Golhisar, Bahcelievler and Karayollari stations pollen grains were appeared in the first week of march and reached the maximum level in the first week of april in three stations. They were last seen in the atmosphere in the first week of may in all three stations. In the second week of february 2006, pollen grains of *Populus* were seen again in all three stations.

***Salix* spp.:** Pollen grains of this genus presented 15.1% of total pollens. Pollen grains of this genus in all three stations appeared in the first week of march. The maximum amount of pollen level was reached in the first week of april in Golhisar and Karayollari stations. In Bahcelievler station maximum pollen amount of was measured in the last week of march. Pollen grains in the atmosphere of this genus were last found in the first week of may in Golhisar and Bahcelievler stations and in Karayollari station were last found in the forth week of april.

Urticaceae: Pollen grains of this family presented 1.3% of total pollens. In Golhisar station the pollens of this family were appeared in the second week of may and in Bahcelievler station pollens were appeared in second week of june and in Karayollari station were appeared in the first week of June. In Golhisar pollens stop appearing in the second week of september, in Bahcelievler station pollens stop appearing in the third week of september and in Karayollari station pollens stop appearing in the second week of september. The pollen amount has reached the maximum level in Golhisar, Bahcelievler and Karayollari stations in the last week of august, in the second week of september and in the third week of august respectively.

Conclusion

In 2006, pollen grains of 24 taxa were identified during March 1st, 2005-February 28th 2006 in the atmosphere Kirsehir: of which 16 formed about 94.8% of the total pollen spectrum (Tables 1,2, Figure 3). In the region investigated, pollen grains were recorded all year round and reached their maximum levels in may

(Table 2, Figure 1). For economic reasons, the gravimetric method was used, but again, we want to use volumetric method, The pollen calendar for this region presented in this study may be useful for allergologists to establish exact diagnosis.

REFERENCES

1. *Buck P, Leventin E. Hay fever plants in Oklahoma. Ann Allergy 1980;45:26-32.*
2. *Bousquet J, Cour P, Guerin B, Michel FB. Allergy in the Mediterranean area, I. Polen counts and pollinosis of Moltpellier. Clin Allergy 1984;14:249-58.*
3. *Spieksma FThM. Pollinosis in Europe: new observations and developments. Rev Paleobot Palynol 1990;64:35-40.*
4. *Nilsson S, Persson S. Three pollen espectra in the Stockholm region (Sweden), 1973-1980. Grana 1981;20:179-82.*
5. *Kapyla M. Diurnal variation of tree pollen in the air in Finland. Grana 1984;23:167-76.*
6. *Mandrioli P, Negrini MG, Zanotti AL. Airborne pollen from Yugoslavian coast to the Po Valley (Italy). Grana 1982;21:121-8.*
7. *Donini D, Sutra JP. Recherches aeropalynologiques a Paris et dans sa banlieue: Nouveaux resultats. Grana 1987;28:37-44.*
8. *Spieksma FThM, Nolard N, Jager S. Fluctuations and trends in airborne corcentrations of some abundant pollen types, monitored at Vienna, Leiden and Brussels. Grana 1991;31:61-6.*
9. *Soler J. Annalisi del contenido polinico atmosferico en Barcelona y Bellaterra, perido 1983 a 1987. Granada 1990;369-76.*
10. *Apostolou EK, Yannitsaros, AG. Atmospheric pollen in the area of athens. Acta Allergologica 1977;32:109-17.*
11. *Latorre F, Perez CF. One year of airborne pollen sampling in Mar Del Plata (Argentina). Grana 1997;36:49-53.*
12. *Perez CF, Gardiol JM, Paez MM. Comparison of Diurnal variation of airborne pollen in Mar del Plata Argentina. Grana 2003;42:161-7.*
13. *Aytuğ B. İstanbul yöresinin polinizasyon takvimi. İst Üniv Orm Fak Derg 1973;23:1-33.*
14. *İnceoğlu Ö, Pınar NM, Şakıyan N, Sorkun K. Airborne pollen concentration in Ankara, Turkey. Grana 1994;33:158-61.*
15. *İnce A, Pehlivan S. Serik (Antalya) havasının alerjik polenleri ile ilgili bir araştırma. Gazi Tıp Dergisi 1990; 1:35-40.*
16. *İnce A. Kırıkkale ili atmosferindeki alerjik polenlerin incelenmesi. Tr J of Botany 1994;18:43-56.*
17. *Pehlivan S, Özler H. Sivas ili atmosferindeki polenlerin araştırılması. J Ins Sci And Tech 1995;7:69-77.*
18. *Bıçakçı A, Akyalçın H. Analysis of airborne pollen fall in Balıkesir, Turkey, 1996-1997. Ann Agric Environ Med 2000;7:5-10.*
19. *Bıçakçı A, Akkaya A, Malyer H, Ünlü M, Sapan N. Pollen calendar of Isparta, Turkey. Isr J of Plant Sci 2000;48:67-70.*
20. *Bicakci A, Koç RD, Tatlidil S, Benlioğlu ON. Airborne pollen grains of Usak, Turkey. Pak J Bot 2004;36:711-7.*
21. *Bicakci A, Olgun G, Aybeke G, Erkan P, Malyer H. Airborne pollen grains of Edirne, Turkey. Acta Botanica Sinica 2004;46:1149-54.*
22. *Guvensen A, Öztürk M. Airborne pollen calendar of Buca-Izmir, Turkey. Aerobiologia 2002;18:229-37.*
23. *Kaya Z, Aras A. Airborne pollen calender of Bartin, Turkey. Aerobiologia 2004;20:63-7.*
24. *Erkan P, Bicakci A, Aybeke M. Analysis of airborne pollen fall in Tekirdag, Turkey. Asthma Allergy Immunol 2010;8:46-54.*
25. *Bursalı B. Diyarbakır İli Atmosferindeki Polen ve Sporlarının Araştırılması, Doktora Tezi. Hacettepe Üniversitesi Fen Bilimleri Enstitüsü, Ankara, 2007:1-186.*
26. *Yavru A. Trabzon İli Atmosferindeki Polenlerin Araştılması, Yüksek Lisans Tezi. Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara, 2007:1-101.*
27. *Potoglu Erkara I, Pehlivan S, Tokur S. Concentrations of airborne pollen grains in Eskisehir City, Turkey. Journal of Applied Biological Sciences 2007;1:33-42.*
28. *Çeter T. Kastamonu İli (Merkez) Atmosferik Polen ve Sporları ve Bunların Meteorolojik Faktörlerle Değişimi. Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara, 2008:1-153.*
29. *Türe C, Böcük H. Analysis of airborne pollen grains in Bilecik, Turkey. Environmental Monitoring and Assessment 2009;1-4, 27-35, 151.*
30. *Kızılpınar İ, Doğan C. Investigation of pollens in the atmosphere of Camkoru, Ankara, Turkey. Asthma Allergy Immunol 2010;8:180-8.*
31. *Bicakci A, Tatlıdil S, Sapan N, Malyer H, Canitez Y. Airborne pollen grains in Yalova, Turkey, 2004. Biologia 2008;63/5:658-63.*
32. *Altunoglu MK, Toraman E, Temel M, Bicakci A, Kargıoglu M. Analysis of airborne pollen grains in Konya, Turkey, 2005. Pak J Bot 2010;42:765-74.*
33. *Erkan P, Bicakci A, Aybeke M, Malyer H. Analysis of airborne pollen fall in Kirklareli, Turkey. Turk J Bot 2011;35:57-65.*
34. *Akman Y. İklim ve Biyoiklim. Ankara: Palme Yayın, Ankara, 1990:317-9.*

35. *Charpin J, Surinyach R, Frankland AW. Atlas of European Allergenic Pollens. Sandoz Editions, Paris, 1974:27-9.*

36. *Koivikko A, Kupias R, Makinen Y, Pohjola A. Pollen seasons: forecasts of the most important allergenic plants in Finland. Allergy 1986;41:233-42.*

37. *Romano B, Mincigrucci G, Frenguelli G, Bricchi E, Murgia M, Cresti M, et al. Pollen concentrations in central Italy, Ascoli, Piceno, Siena. Grana 1986;25:215-20.*