Journal of Applied Biological Sciences 10 (1): 33-40, 2016
ISSN: 1307-1130, E-ISSN: 2146-0108

Relationship Between Meteorological Factors and Airborne Pollen Grains of Kızıltepe (Mardin), Turkey

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Received: January 8, 2016
Accepted: February 19, 2016

Abstract

The concentration of airborne pollen is related to meteorological parameters. The main purpose of this study was to determine the correlation between airborne pollen and meteorological parameters in Kızıltepe (Mardin based on sampling from 1 January 2010 to 31 December 2011 using a Durham sampler. During this period, pollen grains belonging to 26 taxa were recorded, 14 of which belonged to arboreal plants and 12 to non-arboreal. From these, 9177 were identified in 2010 and 10160 in 2011. Of the total pollen grains, 50,73% were arboreal, 48,65% non-arboreal, and 0,62% unidentifiable. The majority of the investigated allergic pollen grains were from Oleaceae, Chenopodiaceae/Amaranthaceae, Fabaceae and Poaceae, respectively. Pollen concentrations reached their highest levels in May. This information was then established into a calendar form according to the pollens determined in 2010–2011, in terms of annual, monthly and weekly numbers of taxa fall per cm2. The concentration of airborne pollen was correlated with meteorological parameters during the sampling period. Pollen concentrations were positively correlated with increasing temperature, sunshine and wind speed and negatively correlated with rainfall and relative humidity.

Keywords: Pollen, Pollen allergy, Pollen calendar, Mardin, Kızıltepe, Turkey

INTRODUCTION

Nowadays, increasing pollen concentrations is causing with an incidence in cases of pollen allergy. Most patients sensitive to tree and herbaceus pollen allergy. [1-3]. In the study of pollinosis, recent papers are being focused on aeroallergens rather than on airborne pollen counts, showing better results for studying the relationship with patient allergic response [2, 4-12]. In Turkey, researches regarding airborne pollen grains are cautiously gaining more importance [2, 4, 13-22].

The daily pollen concentrations can be accurately measured and helps to explain the allergen exposure in sensitive patients. In this case, pollen monitoring could be enough to offer accurate information to study the aeroallergen exposure in sensitive patients and to prevent symptoms, avoiding the need of using more expensive and time-consuming techniques to study the allergen content in the atmosphere [3, 6].

The purpose of this study was to classify the airborne pollen in Kızıltepe (Mardin), and to describe the relationship between meteorological parameters and airborne pollen dispersal. In order to achieve this, we analyzed the pollen scattering period, peak date and concentration of pollen of tree pollen and herbaceous pollen.

MATERIALS and METHODS

Kızıltepe (Mardin) is situated at 36°55′-38°51′ N, 39°56′-42°54′ E Southeast of Turkey (Fig. 1) at altitude 1400-400 m. Kızıltepe has a Irano-Turanion vegetation. The station flora has with Fabaceae, Liliaceaea, Asteraceae, Lamiaceae and Iridaceaea families being very common. It's Latitude is 37°13′48 38" N and Longitude: 40°30′22 84" E, with an Altitude of: 677 m. GARMIN GPS 12 CX device (Global Positioning System; Made in Taiwan, under USA patent) was used to measure the altitude of the research station. In addition to the natural vegetation, some species (i.e. Pinus spp.,Quercus spp., Olea europea L., Juglans regia L., Zea mays L., Triticum spp.,and Lens culinaris MEDİK) can be seen frequently in the parks, gardens, fields and streets of Kızıltepe. Upon examination of the flora of Kızıltepe, it can be seen that plant taxa belonging to Fabaceae, Liliaceaea, Asteraceae, Lamiaceae and Iridaceaea are dominant [23]. In the present study, gravimetric methods and a Durham sampler were used [2, 4]. The Durham sampler was placed at a height of 1.75 m above ground level in the garden of a house. The station is located in the center of Kızıltepe (Fig. 1). The position of the sampler allows air movement from all sides. Before exposure, slides were covered with glycerine jelly mixed with basic fuchsin [2]. The number of pollen grains is expressed as grains per cm2 of microscope cover glass (22 mm×22 mm). The grains were identified and counted under a light microscope, with identification at genus or family level. The grains that could not be identified were considered as unidentified types. Slides placed on the Durham sampler were changed weekly.

RESULTS

During the 2 year period, a total of 19337 pollen grains belonging to 26 taxa were identified and recorded in Kızıltepe's environment, 12 of which belonged to arboreal plants and 14 to non-arboreal. From these, 9177 were identified in 2010 and 10160 in 2011. In more specific terms, the breakdown occured thus: 9809 pollen grains were found to be arboreal (50,73%), 9407 were non-arboreal (48,65%) and 121 unidentifiable (0,62%; Table 1). Arboreal pollen types were found to be dominant due to the vegetation and geographical location of the city. Monthly variations of total pollen grains recorded in the atmosphere of Kızıltepe during the years 2010–2011 are shown in Fig. 2. The seasonal variation of arboreal and non-arboreal pollen falls is given in Fig. 3. The main pollen producers in the atmosphere of Kızıltepe were found to be the following arboreal plants: Oleaceae (36,11%), Fraxinus spp. (3,36%), Rosaceae (2,78%), Pinaceae (2,27%), Populus spp. (2,15%), Rhamnaceae (1%) Cupressaceae (0,91%), and Juglans spp.

(0,8%). They accounted for 50,73% of the total pollen fall. Herbaceous plants such as Poaceae (17,46%), Fabaceae (13,28%), Chenopodiaceae/Amaranthaceae (7,35%), Artemisia spp. (3,34%), Asteraceae (3,06%), Apiaceae (1,33%), Rumex spp. (1,26%) and Brassicaceae (0,67%) were discovered frequently in the atmosphere of Kızıltepe, making up 48,65% of the total (Table 1).

Arboreal pollen grains were higher in numbers than the non-arboreal pollen grains in total pollen concentrations. Arboreal pollen grains reached maximum levels in May, while non-arboreal pollen grains reached maximum levels in June (Fig. 3, Table 1). The earliest recorded pollen grains in the atmosphere of Kızıltepe, those of the predominant arboreals, were noted in January in 2010 (Fig. 4). Pollen grain numbers then began to increase in January, February, March and April and reached their maximum levels in May (3497 pollen grains in 2011). Fabaceae, Oleaceae, Poaceae and Populus disperse high amounts of pollen, more than 35,01%, into the atmosphere throughout their pollination period, especially in May. In June, non-arboreal pollen grains from Poaceae, Chenopodiaceae/Amaranthaceae and Fabaceae were observed alongside arboreal pollen grains from Oleaceae like in May, the numbers of non-arboreal pollen grains were also at high levels in June. From the beginning of July, the pollen grains of weeds had become dominant; however the amount of pollen was lower than that in Spring. One reason for the decrease seen after June might be that this period of the year is the end of the pollination period of many arboreal plants, which produce and release a high level of pollen grains into the atmosphere (Fig. 3). High levels of pollen grains were also observed in July. High amounts of pollen grains of Rosaceae, Artemisia spp. Poaceae, Oleaceae, Fabaceae and Chenopodiaceae/Amaranthaceae were recorded in August–October and low quantities of Poaceae, Asteraceae, Chenopodiaceae/Amaranthaceae and Artemisia spp. pollen grains were recorded in November and December. Pollen in the atmosphere of Kızıltepe was continuously observed between January and December for the whole of the 2 year period. Total pollen grains reached maximum levels in May during this period. The types of pollen present in the atmosphere of Kızıltepe are shown in the form of a pollen calendar (Fig. 4), based on the counts made in 2010–2011. The following is more taxa specific information regarding those taxa producing the highest amounts of pollens in the atmosphere of Kızıltepe. Oleaceae: Pollen grains were recorded during the greater part of the year, from January to December. The pollen season began in the second week of January and ended in the second week of December. The highest value was noted in the second week of May (36,11%). Poaceae: The pollen season started in the last week of January and ended in the second week of December. The maximum value was recorded in the second week of April (17,46%). Fabaceae: The pollen season started in the first week of March and ended in the second week of October. The maximum value was recorded in July (13,28%). Chenopodiaceae/Amaranthaceae: The pollen season started in the third week of March and ended in the first week of October. Maximum pollen concentration occured in the first week of August (7,35%). Fraxinus spp. Pollen production continued from the first week of March to the second week of August. The maximum value was recorded in the second week of April (3,36%). Artemisia spp. Pollen production was continuous between the second week of January to the third week of November. The maximum value was recorded in the second week of July (3,34%). Asteraceae: The pollen season started in the second week of February and ended in the second week of October. Maximum pollen concentration occured in the second week of April (3,06%).Rosaceae: Pollen grains were recorded in the second week of February and ended in the first week of June. The highest count was recorded in the first week of May (2,78%). Pinaceae: The pollen season started in the second week of February and ended in the third week of June. The highest pollen concentration was noted in the second week of April (2,27%). Populus spp. The pollen season commenced in the first week of February and ended in the first week of June. The highest pollen concentration was noted in the second week of April (2,15%). Apiaceae: Pollen grains were recorded in the first week of March and ended in the first week of September. The highest count was recorded in the second week of July (1,33%).

The correlation between the monthly pollen concentration and the monthly meteorological factors over the period January–December 2010-2011 is shown in Fig. 5. In January and February, since the temperature and wind speed were low, pollen counts were low. Low temperatures caused a drop in the concentration of pollen [24, 25]. However, this was followed in March by a significant increase in the number of pollen grains. This can also be correlated with higher temperatures and wind speed in comparison with the previous months. Pollen concentrations in April were different from those in March. A small decline was seen in pollen concentration in April, with heavy rain, high temperatures and lower wind speed and humidity in the third week of April all contributing to a lowering in the amount of pollen. This can be explained by the fact that the wind speed and the relative humidity were lower in April than in March (Fig. 5). The highest level of pollen concentration was observed in May. Lower rainfall and humidity and higher temperature and wind speed contributed to increasing pollen concentration in May (Fig. 5). In June, the increase in the total pollen amount was caused by the beginning of the pollination of herbs and the maximum pollen dispersal of Oleaceae, Fraxinus spp., Chenopodiaceae/Amaranthaceae, Cupressaceae, Fabaceae and Poaceae. The low humidity and rainfall, high temperature and wind speed seen during this month raised the pollen counts. In addition, rainfall in April increased flowering intensity [4]. The lower pollen concentration in July is attributed to a decline in pollen production by trees at the end of the flowering season rather than to weather conditions. There was a small increase in the pollen concentration of herbs between August and October (Fig. 5). The higher temperature and wind speed increased the amount of pollen dispersed by herbs. In November and December, the extremely low airborne pollen values recorded were due to higher rainfall levels and the lower temperatures than those of the other months.

DISCUSSION

The present study will contribute to our knowledge of airborne pollen grains in Kızıltepe. The dominance of arboreal pollen types in the atmosphere of Kızıltepe is due to the character of vegetation and geographical location of the study area. The important tree pollen types were Oleaceae (36,11%), Fraxinus spp. (3,36%), Rosaceae (2,78%), Pinaceae (2,27%), Populus spp. (2,15%), Rhamnaceae (1%) Cupressaceae (0,91%), and Juglans spp. (0,8%). Grass pollen appeared with the maximum flowering period lasting from the second week of January to the first week of December, with the highest count recorded in the second week of June to in the third week of July. The herb pollen season was recorded from the second week of January to the last week of October. The peak of herbaceous pollen production was recorded from the beginning of April to the beginning of the November, when Poaceae (17,46%), Fabaceae (13,28%), Chenopodiaceae/Amaranthaceae (7,35%), Artemisia spp. (3,34%), Asteraceae (3,06%), Apiaceae (1,33%), Rumex spp. (1,26%) and Brassicaceae (0,67%) were very abundant in the atmosphere. According to other studies carried out in Europe, arboreal pollen types are also dominant in other regions for the same reason, i.e. 82% in Finland [26], 76.51% in Burdur- Turkey [27], 94% in Zonguldak-Turkey [14], 55.0% in Ascoli piceno-Italy [28], and 73.0% in Ostrawiec Swietokryzyski-Poland [29]. From the main pollination period of the various types recorded, three groups could be distinguished: (1) pollen with a short principal period <9 weeks: Caryophyllaceae, Malvaceae, Plantaginaceae, Boraginaceae, Tiliaceae and Liliaceae (2) pollen with a medium principal period, between 9 and 15 weeks: Populus spp., Ulmus spp., Lauraceae, Aceraceae, Juglans spp. and Rhamnaceae, (3) pollen with a long principal period >15 weeeks: Poaceae, Oleaceae, Fraxinus spp., Asteraceae, Artemisia spp., Cupressaceae, Pinaceae, Rosaceae, Brassicaceae, Apiaceae, Fabaceae, Chenopodiaceae/Amaranthaceae and Rumex spp. However, the pollen grains of some plants found in city flora could not be distinguished. This may be down to many factors, such as different flowering periods, meteorological factors, the location of the durham sampler, anthesis, and dispersion [3-5, 7, 8, 10, 13]. The concentration of pollen in the atmosphere is closely related to the flowering period of plants, as well as meteorological characteristics. There is a significant correlation between the temperature increase seen in April and May and the pollen count [Fig. 5; 1, 24]. It can be seen that the atmospheric pollen concentration in February, March and November is less than that of the other months because of relatively low temperatures and more precipitation [Fig. 5; 4, 16]. Even though they represented only a small proportion of the airborne particles present in the atmosphere, pollen grains can be the cause of allergic responses in susceptible humans, and pollinosis (ocular rhinitis and asthma) is now a public health problem. Aceraceae spp., Apiaceae, Artemisia spp., Asteraceae, Chenopodiaceae/Amaranthaceae, Cupressaceae, Fraxinus spp., Juglans spp., Oleaceae, Pinaceae, Plantaginaceae spp., Poaceae and Rumex spp. all detectable in the atmosphere of Kızıltepe, may cause asthma and allergic rhinitis in susceptible individuals [2]. The pollen grains of Populus spp., Rosaceae and Caryophyllaceae taxa have also been shown to produce milder allergic pollen grains in Kızıltepe [27]. When the data are related to the allergic effects of these plant taxa, it can be seen that the Poaceae family is very important in terms of its long period of pollination (Fig. 4) and strong allergic effect, especially on patients with hayfever, and plants from this family can cause allergic reactions [20]. Some important allergic pollens, such as Pinus spp., Cupressaceae, Poaceae, and Oleaceae were also found in high concentrations in the atmosphere around Kızıltepe.

The correlation between the monthly airborne pollen counts and the monthly meteorological factors over the period 1 January 2010–31 December 2011 clearly indicated that pollen concentration was affected by all meteorological parameters (wind speed, temperature, rainfall and humidity). The lower pollen concentration found in April can be attributed to high rainfall and humidity and low temperature. The high and continuous level of rainfall depressed pollen dispersal. In addition, the lower wind speed slowed down pollen dispersal in the atmosphere [24, 25]. The higher quantity of pollen in the air samples in 2011 is attributed to greater wind speed, lower rainfall and higher temperature in spring. The mean wind speed in the spring of 2011 was 4.0 m/s, with the mean temperature for the same period 40.0°C and mean humidity 65.0%. Another reason for the greater amount of pollen recorded in 2010 is the lower amount of precipitation recorded between July and August 2011 (17.5-20.0 mm). Storage of water in the soil during the winter caused plant growth and increased flowering intensity in spring [2]. Seasonal totals of weekly concentrations for grass pollen were highest in 2011 (1815 grains/cm2) This was probably caused by the higher wind speed in March 2011 (4.0 m/s). Potoğlu Erkara [2] has showed that wind velocity has the greatest influence on the numbers of grass pollen in the atmosphere. We determined an increase in the total number of pollens in 2010–2011, which we attributed to the high amount of rainfall that Kızıltepe received over the 2 years. Both sunny and rainy weather have been reported to have a positive effect upon an increase in the total number of pollens, as humidity also increases with a rise in temperature. Heavy rain is known to hamper pollination, which results in a far slower increase in pollen in the area affected [2, 18]. A corresponding rise in the number of pollens was recorded with a rise in both temperature and humidity in the entire study area in the aftermath of rain (Figs. 1 and 5). Furthermore, periods with zero pollen concentrations in the air are attributed to the fact that a heavy rain cleanses the air [18]. The study area is significant in that it is northeasterly-southwesterly situated in terms of exposure to the wind and dissemination of pollination from both nearby and remote places. (Figs. 1 and 5).

We suggest that such studies as ours should be conducted routinely in consideration of changes in meteorological conditions, vegetation and cultivation areas. Some of the most important allergenic pollen grains, such as Oleaceae, Pinaceae, Cupressaceae, Artemisia spp., Chenopodiaceae/Amaranthaceae and Poaceae were also found in high concentrations in the study area. These pollen types are responsible for many cases of pollinosis in the Mediterranean region and other parts of the world [2, 4, 26, 30]. It has been suggested that if these types of studies are undertaken during certain periods, data obtained from the studies will help us to determine the distribution mechanisms of pollens and minimize the negative impact on the health of pollen-sensitive people [2, 13, 16, 18, 19, 21-22, 30].

Our results have shown that during aerobiological survey copious amount of pollen grains recorded in the study area. It is expected that the present study will provide useful data to the allergologists of Kızıltepe (Mardin) for selecting pollen allergens during calendar months of the year which will facilitate proper diagnosis and treatment.

The pollen calendar for the city of Kızıltepe (Mardin) presented in this paper is necessary to find out which pollen taxa and pollen concentration can affect allergic people inhabiting the area.

Acknowledgements

This is the MSc thesis of Kadir Osoydan's titled as "The Investigation of Kızıltepe District (Mardin) Atmosphere Pollens" by supervising İsmühan Potoğlu Erkara.

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Table 1. Annual totals of weekly pollen counts

	2010	2011	Total	Total %
Arboreal plants				
Aceraceae	36	23	59	0,30
Cupressaceae	80	96	176	0,91
Fraxinus	268	382	650	3,36
Juglans	67	88	155	0,80
Lauraceae	39	37	66	0,34
Oleaceae	3453	3530	6983	36,11
Pinaceae	217	223	440	2,27
Populus	170	245	415	2,15
Rhamnaceae	78	127	195	1,00
Rosaceae	258	279	537	2,78
Tiliaceae	8	12	20	0,10
Ulmus	16	57	73	0,38
Total grains from arboreal plants	4674	5135	9809	50,73
Non-arboreal plants				
Apiaceae	135	123	258	1,33
Asteraceae	281	310	591	3,06
Artemisia	329	317	646	3,34
Brassicaceae	35	95	130	0,67
Boraginaceae	10	17	27	0,14
Caryophyllaceae	34	25	59	0,30
Chenopodiaceae/Amaranthaceae	640	781	1421	7,35
Fabaceae	1252	1316	2568	13,28
Lamiaceae	6	10	16	0,08
Liliaceae	8	12	20	0,10
Malvaceae	10	14	24	0,12
Plantaginaceae	13	14	27	0,14
Poaceae	1562	1815	3377	17,46
Rumex	83	160	243	1,26
Total grains from non-arboreal plants	4372	5035	9407	48,65
Unidentified	89	32	121	0,62
Total pollen number	9177	10160	19337	100

Figure 1. A map of Kızıltepe (Mardin, Turkey) showing the province of Kızıltepe

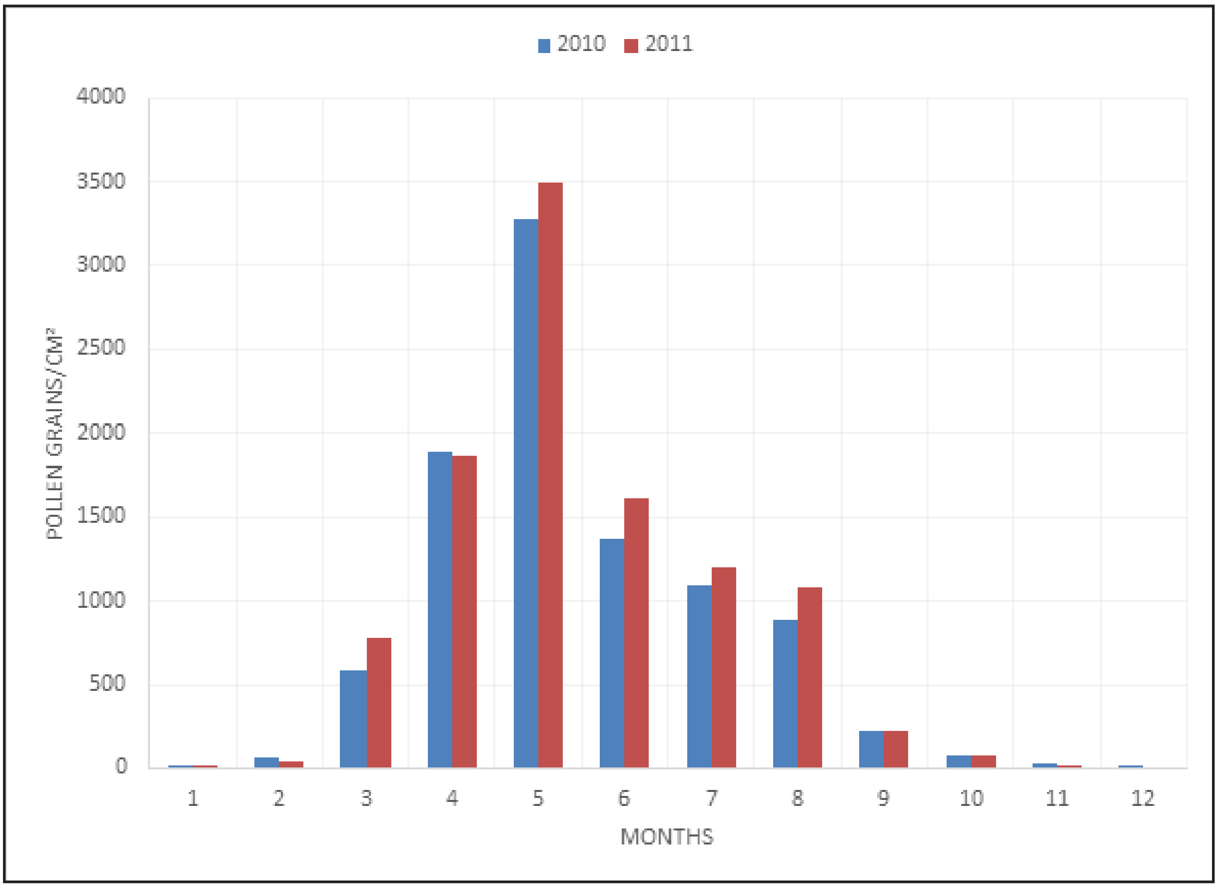

Figure 2. Monthly totals of atmospheric pollen in Kızıltepe, 2010–2011

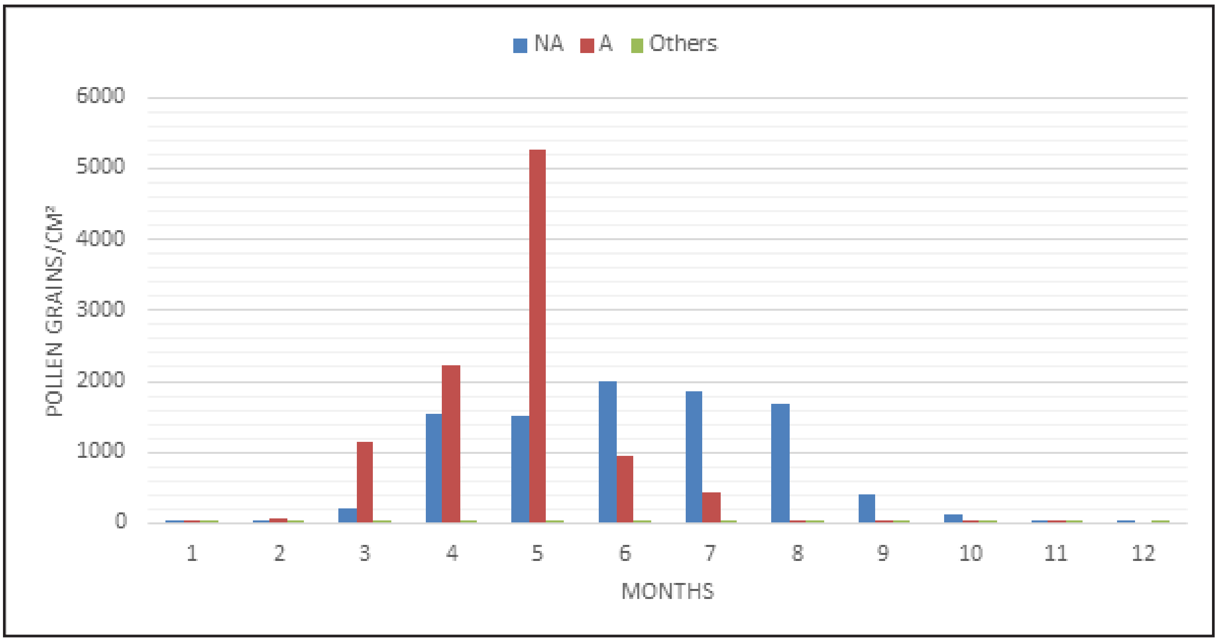

Figure 3. Monthly variations of arboreal (AP) and nonarboreal (NAP) pollen grains in Kızıltepe, 2010–2011

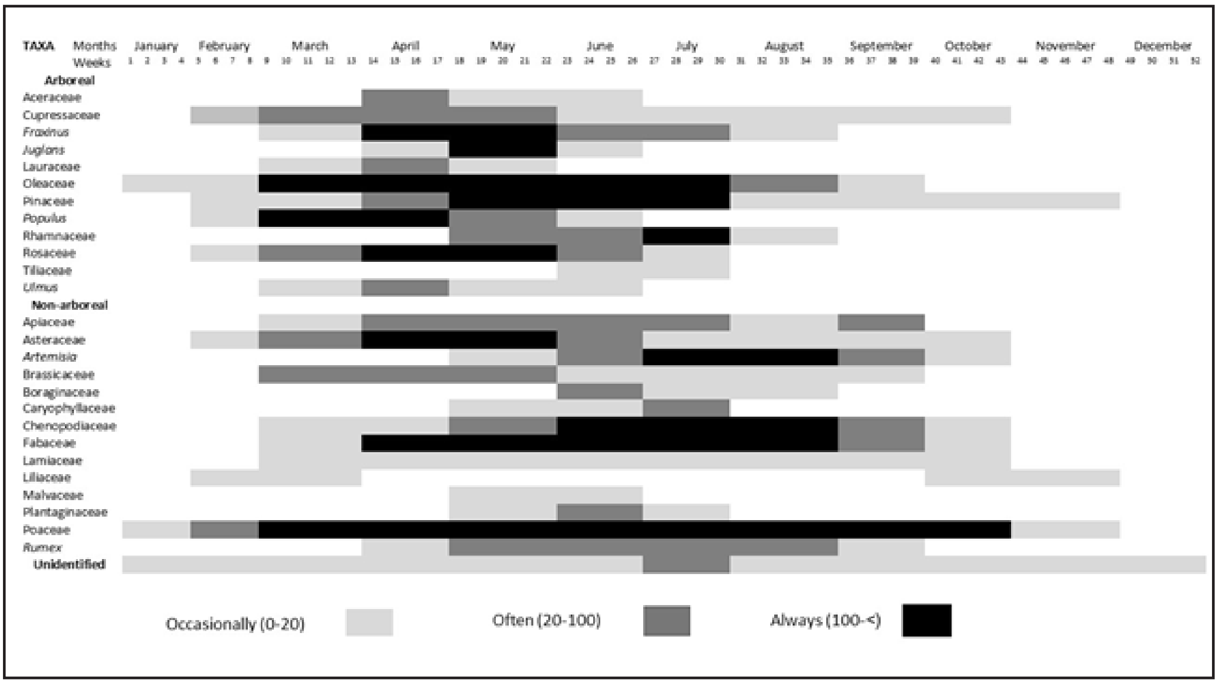

Figure 4. Pollen calendar of Kızıltepe

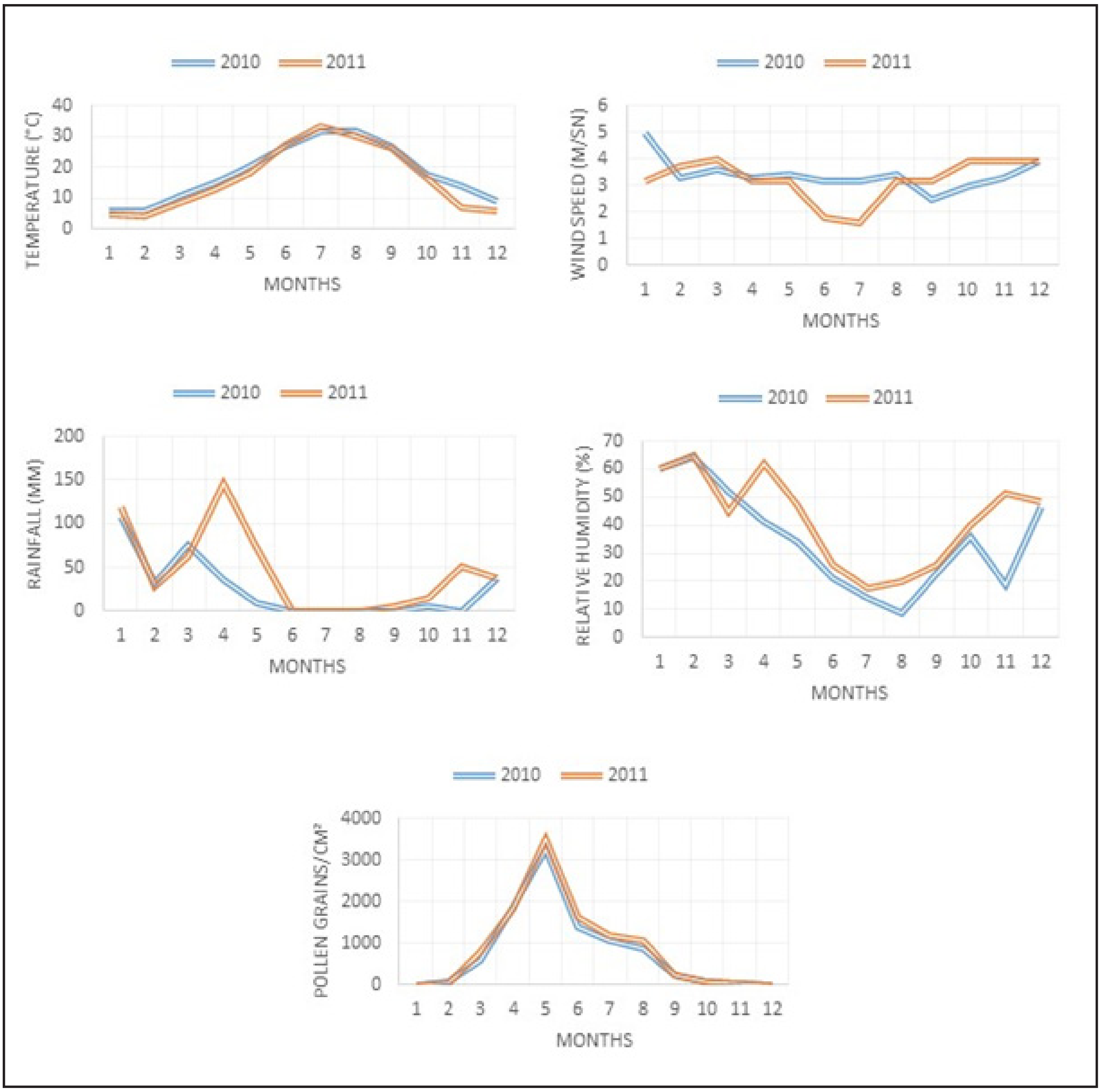

Figure 5. Monthly variations in atmospheric pollen and weather conditions in the atmosphere of Kızıltepe from 1 January 2010 to 31 December 2011