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AIRBORNE POLLEN CONTENT OF TAVŞANLI, KÜTAHYA (TURKEY)

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ABSTRACT
A qualitative and quantitative evaluation of pollen fall in the atmosphere of Tavşanlı (Kütahya) is presented in this study. A continuous aerobiological survey of the atmosphere of Tavşanlı was carried out from beginning of January 2003 to end of December 2004 by means of the gravimetric method using Durham apparatus. Weekly pollen grains in per cm^2 were calculated. During two years, a total of 17 079 pollen grains/ cm^2 which belong to 52 taxa, 25 of total belong to arboreal plants (AP) and 27 of total non-arboreal (NAP) plants and unidentified pollen grains were recorded. 11 630 and 5 449 pollen grains were recorded in the years 2003 and 2004 respectively. Total pollen grains consist of 88.46 % AP, 9.67 % NAP plants and 1.87% unidentified pollen grains. Pinus sp., Cupressaceae/Taxaceae*, Quercus sp.,* Gramineae*, Platanus sp., Salix sp.* Moraceae *and* Oleaceae *were responsible for the greatest amounts of pollens in the investigated region. 67.48 % of total pollen grains appeared during May.*

KEYWORDS: *aeroallergen, aerobiology, pollen fall, pollen calendar.*

INTRODUCTION

In the last decades, the prevalence of pollen related allergies, rhinitis, and asthma, has increased all around the world. Especially in developed countries, atmospheric pollen is a major cause of allergies (D'Amato *et al*, 1998; Patz & Kovats, 2002). There are different species that compound a characteristic airborne pollen calendar controlled by the meteorological conditions changeable in areas and years in each geographical area. The release and dispersion of pollen depend on the microclimates which explain the differences observed regarding the onset of flowering within the same species (Fernández-González *et al,* 1999; García-Mozo *et al,* 2001). Aerobiological studies are of a great interest from an ecological and agricultural point of view, but they have a special interest for clinicians and allergic patients in order to establish a chronological correlation between the air pollen concentration and hay-fever and asthma symptoms (D'Amato *et al*, 1998). These data prove helpful in the treatment of patients suffering from such diseases. For this reason, studies of the pollen content in the atmosphere of different areas have been carried out by researchers all around the world (Romano *et al,* 1988; Spieksma *et al,* 1991; Bicakci *et al*, 2002; Bicakci *et al*, 2004; Ianovici *et al*, 2015).

The aim of this study is to i) identify the airborne pollen flora of Tavşanlı, ii) present different calendar types include the periods of pollen grains fall, aeroallergen plant taxa and aeroallergen types and iii) identify the months with/without pollen allergen.

MATERIALS AND METHODS

Tavşanlı (Kütahya), an important mining center in Turkey, is a town with 100.000 inhabitants and situated at 39° 33' N, 29° 29' E with an altitude of approximately 850 m (Fig.1). The rainfall in the region is approximately 611 mm (yearly mean). Tavşanlı is a district in the Kütahya and has steppe vegetation. The plain area near the town is a forest. The main plants in the town are *Pinus nigra, Pinus nigra* ssp. *pallasina* var. *pyramidata, Quercus cerris, Tilia tomentosa, Juniperus communis, Juniperus excelsa, Juniperus oxycedrus, Quercus* sp., *Crateagus monogyna, Crateagus orientalis, Cupressus sempervirens, Prunus divaricata, Rosa cannina, Centaurea cyanus, Centaurea virgata, Viola parvula, Viola occulata, Tussilago farfara, Acer campestre, Cornus mas, Corylus avellana , Hedera helix, Vibirnum lantana.*

Pollen sampling was carried out using a gravimetric trap (Durham sampler) placed about 15 m above ground level. The slides were mounted and stained in glycerin jelly mixed with basic fuchsine (Charpin & Surinyach, 1974) and examined microscopically as weekly. The studies were undertaken from beginning of January 2003 to end of December 2004. The pollen was counted at a magnification of ×400. Total weekly counts were converted to the number of pollen grains in per cm^2 and a pollen calendar for investigated region was given. In the pollen calendars, pollen grains of per cm^2 was marked and colored as 1-9 low, 10-49 moderate and 50> high.

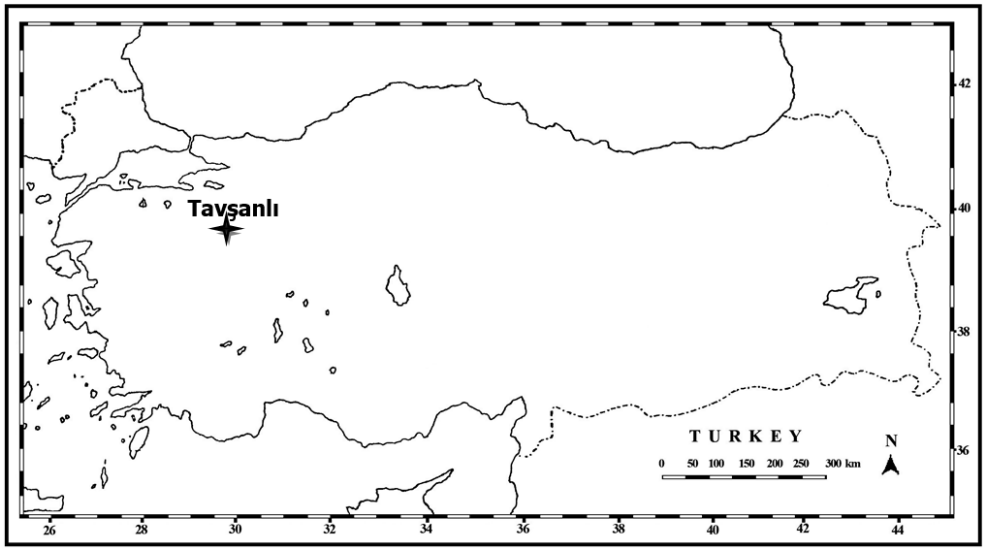


FIG 1. Place of the investigated region (Tavşanlı) on the map

RESULTS AND DISCUSSIONS

During the two yearly periods (2003-2004), a total of 17079 pollen grains from 52 taxa, 11630 in 2003 and 5449 in 2004, have been identified in the atmosphere of Tavşanlı (Tab. 1). Out of 52 taxa, 25 were arboreal while the others were non-arboreal plants. Of the total pollen grains, 88.46% were arboreal, 9.67% non-arboreal and 1.87% unidentified (Tab. 1). The best-represented pollen type throughout the studying period was *Pinus* sp., which attained an average of 51.56% of the annual total (Tab.1). Other pollen types represented in the atmosphere of Tavşanlı, accounting for an average of a bi-annual total of 89.71%as a whole, where: Cupressaceae/Taxaceae, *Quercus* sp., Gramineae, *Platanus* sp., *Salix* sp. Moraceae and Oleaceae. The highest percentages in relation to the annual total were obtained from March to June and peaked in May. The monthly variation of arboreal and non-arboreal pollen concentrations are given in Figure 2.

The types of pollens present in the atmosphere of Tavşanlı are shown in the form of different pollen calendar types (Fig. 3, 4A-C). Figure 3 based on the mean counts made in two yearly periods. Pollen calendars shown in figure 4 was prepared to base on allergy potential of pollen in the air. Allergens grouped mainly cross-reactivity potential (Lorenz *et al.* 2009). Identified aeroallergen flora of investigated region was shown as special allergen molecule group, aeroallergen plant taxa and allergen plant group (Fig. 4 A-C).

The annual highest percentages of pollen grains in the air were obtained from March to June and peaked in May (Fig. 2). Pollen grains of March to June accounted for 93.97% of the recorded total pollen (Tab. 2). High concentration was obtained in spring time. November and December were the months with the no pollen grains recorded and marked as pollen free months (Fig. 4A).

The main pollen producers in the atmosphere of Tavşanlı were the following arboreal plants: *Pinus* sp. (51.56 %), Cupressaceae/Taxaceae (14.75%), *Quercus* sp.(8.09%), *Platanus* sp. (4.76%), *Salix* sp. (2.01%), Moraceae (1.63%) and Oleaceae (1.10%). They form 83.90% of the total pollen fall (Tab. 1-2).

From herbaceous plants, Gramineae (5.81) was the most important pollen in the atmosphere of Tavşanlı (Tab.1-2) and seen on the atmosphere during 8 months. The season of maximum pollen concentration was from April to June.

A noticeable change in monthly pollen composition was observed during the sampling period (Fig. 2-4). The earliest pollen grains in the atmosphere of Tavşanlı were noted as Cupressaceae/ Taxaceae in January (Tab. 2, Fig.3-4). The number of pollen grains increased gradually from March to April and reached its maximum level in May (67.48 %) (Tab. 2, Fig.2-4). In May, 34 taxa were identified and 17 of them belong to AP. *Pinus* sp. (40.55%), Cupressaceae / Taxaceae (7.88%), *Quercus* sp. (7.27%), *Platanus* sp. (3.75%), *Salix* sp. (1.82%), Moraceae (1.60%) and Gramineae (2.19%) were releasing high amounts of pollen into the atmosphere throughout their pollination period, and formed more than 65% of the total pollen grains in May (Tab. 2).

In June, 28 pollen taxa (7 AP and 21 NAP) were founded in the atmosphere of Tavşanlı. *Pinus* sp. dominated the pollen spectrum of Tavşanlı in June. Pollen grains of Gramineae (2.71%) were identified as a high amount in June (Tab. 2).

In July, a number of pollens were lower than it was in springtime and early summer. The reason for this decrease was correlated with the end of the pollination periods of many

AP which released high amounts of pollen into the air. 22 taxa (4 of them AP) were found in July (Fig.3-4).

In August, 12 taxa were identified (2 of them AP). The lowest pollen grains were recorded in September and October.

The followings are the 8 taxa which produced the greatest amount of pollens in the atmosphere of Tavşanlı.

***Pinus* sp.:** Pollen grains of this genus constituted 51.56% of total pollen in the atmosphere of Tavşanlı (Tab. 1-2). The pollen season started the third week of March (12th week) and lasted the third week of September (38th week). The highest values were noted from April to June (Figs. 3-4).

Cupressaceae / Taxaceae: Pollen grains of this family constituted 14.75% of total pollen in the atmosphere of Tavşanlı (Tab. 1-2). The pollen season was started the first week of January and lasted the third week of September. The highest counts were recorded from the first week of March to last week of May (22^{nd} week of the year) (Figs. 3-4).

***Quercus* sp.:** Pollen grains of this genus constituted 8.09 % of total pollen in the atmosphere of Tavşanlı (Tab. 1-2). Pollen production was continued from the last week of March (13^{th} week) to the third week of June (25^{th} week). The highest counts were recorded during May (Figs.3-4).

***Platanus* sp.:** Pollen grains of this genus constituted 4.76 % of total pollen in the atmosphere of Tavşanlı (Tab. 1-2). Pollen season started the first week of March (11^{th} week) and lasted the third week of June (Figs. 3-4).

***Salix* sp.:** Pollen grains of this genus constituted 2.01 % of total pollen in the atmosphere of Tavşanlı (Tab. 1-2). The pollen season started last week of February and lasted last week of May (Fig. 3-4).

Moraceae: Pollen grains of this family constituted 1.63 % of total pollen in the atmosphere of Tavşanlı. (Tab. 1-2). Pollen production of this family started the third week of April (16^{th} week of the year) and ended last week of May (Figs. 3-4).

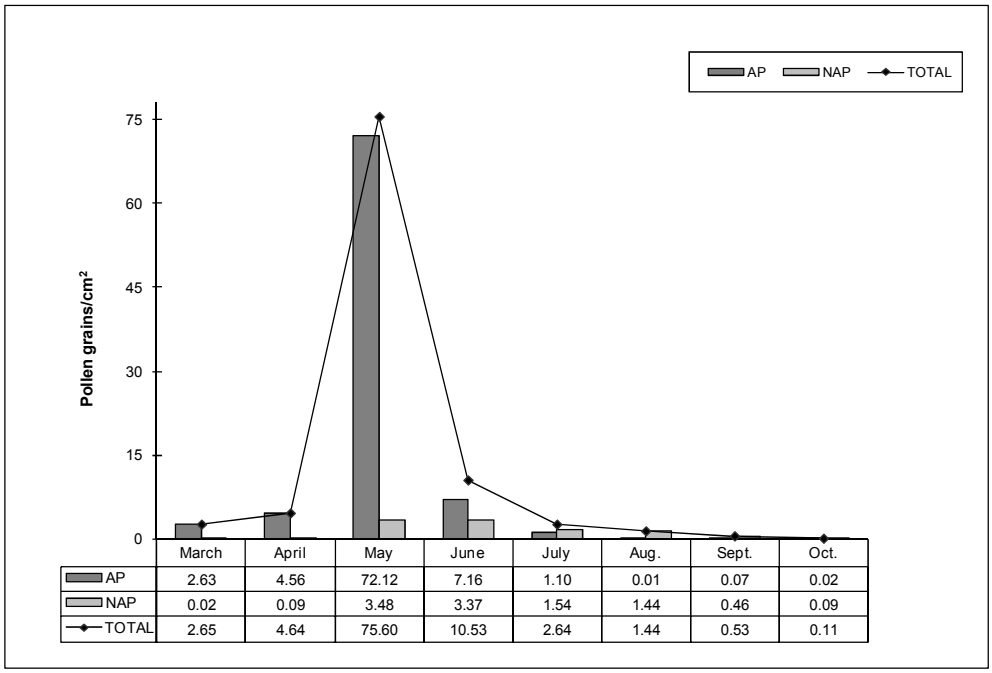
Oleaceae: Pollen grains of this genus constituted 1.10 % of total pollen in the atmosphere of Tavşanlı (Tab. 1-2). The pollen season started the third week of May (18^{th} week) and lasted the second week of July (28th week).

Gramineae: Pollen grains of this family constituted 5.81% of total pollen in the atmosphere of Tavşanlı (Tab. 1-2). Pollen grains were recorded during the greater part of the year. The pollen season started in the second week of March and ended in the last week (44^{th} week) of October. The highest values were noted in May and June (Figs. 3-4).

Variation of the tree flora is reflected in the quantitative and qualitative composition of pollen fall. Trees belong to the main pollen producers, because of their common incidence and large pollen production per anther, inflorescence or individual tree (Molina *et al*, 1996). These pollens can be transported with air over large areas. Herb plants like Gramineae, Urticaceae, Chenopodiaceae/Amaranthaceae, and *Artemisia* sp. are common, and the pollen production by these taxa is also large. The symptoms of pollen allergy confirm a good correlation with the airborne pollen count (Samolinski *et al*, 1996). However, the most important factors conducive to pollen allergy are genetic and environmental, the especially composition of the pollen flora in the air (Puc, 2003).

At the investigated sites, a smaller number of pollen grains were counted in 2004 than in 2003.This was a result of substantial differences in the amount of *Pinus* sp., *Quercus*, *Platanus* and Gramineae pollen between these two years (Tab. 1).

Pollen of some plants such as *Pinus* sp., Cupressaceae/Taxaceae, *Quercus* sp., Gramineae, *Platanus* sp., *Salix* sp. Moraceae and Oleaceae were found in high concentrations in Tavşanlı. The atmosphere of Tavşanlı, arboreal pollen types were dominant. The frequency of arboreal pollen grains generally depends on the distribution and density of the local vegetation and rate of pollen production. According to the other studies carried out in Turkey, arboreal pollen types are also dominant in Usak (79.12%) (Bicakci *et al*, 2004) and Afyon (69.67%) (Bicakci *et al*, 2002); similarly in Europe, the dominant airborne taxa have been determined as Gramineae, *Alnus* sp., *Artemisia* sp., *Urtica* sp., *Betula* sp. in Leiden, The Netherlands (Spieksma *et al,* 1991); Gramineae, Urticaceae, Oleaceae, *Artemisia* sp. in Ascoli Piceno, Italy (Romano *et al*, 1988), *Betula* sp., *Pinus* sp., *Alnus* sp., *Platanus* sp., *Plantago* sp. in Brussels, Belgium (Spieksma *et al,* 1991); Cupressaceae, Gramineae, *Quercus* sp., *Plantago* sp. in Montpellier, France (Spieksma *et al*., 1991); *Alnus* sp., *Betula* sp., Gramineae, *Corylus* sp. in Ostrowiec (Kasprzyk, 1996); *Betula* sp., *Quercus* sp., Gramineae, Urticaceae in Vienna, Austria (Spieksma *et al,* 1991); *Betula* sp., *Corylus* sp., *Ambrosia* sp., Urticaceae in Zagreb, Croatia (Peternel *et al*, 2003); *Pinus* sp., *Platanus* sp., *Quercus* sp., *Betula* sp., Gramineae, *Castanea* sp. in Santiago de Compostela, Spain (Jato *et al,* 2002).



	March	April	May	June	July	Aug.	Sept.	Oct.
AP	2.63	4.56	72.12	7.16	1.10	0.01	0.07	0.02
NAP	0.02	0.09	3.48	3.37	1.54	1.44	0.46	0.09
TOTAL	2.65	4.64	75.60	10.53	2.64	1.44	0.53	0.11

FIG 2. Monthly total variation in pollen grains in the atmosphere of Tavşanlı (Kütahya), 2003-2004

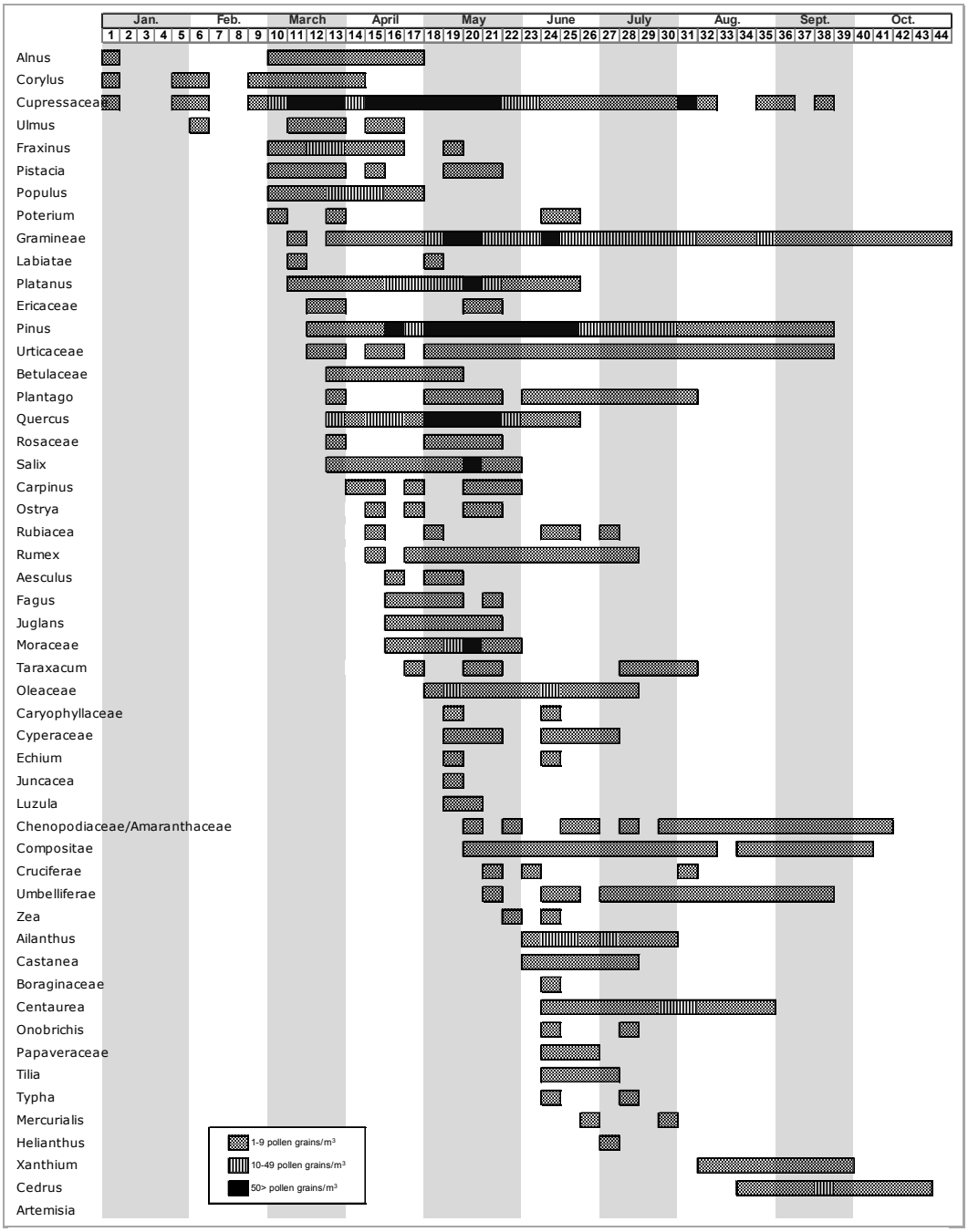


FIG. 3. Pollen calendar with all pollen types for Tavşanlı, Kütahya (2003-2004)

TABLE 1. Annual totals of average weekly pollen counts of Tavşanlı.

		2003	2004	TOTAL	%
Arboreal Plants	Pinus	6297	2509	8806	51,56
	Cupressaceae	1178	1341	2519	14,75
	Quercus	1011	371	1382	8,09
	Platanus	633	180	813	4,76
	Salix	323	21	344	2,01
	Moraceae	258	20	278	1,63
	Oleaceae	117	71	188	1,10
	Fraxinus	30	129	159	0,93
	Populus	95	62	157	0,92
	Ailanthus	84	15	99	0,58
	Cedrus	10	46	56	0,33
	Juglans	34	11	45	0,26
	Alnus	19	22	41	0,24
	Corylus	14	21	35	0,20
	Castanea	16	10	26	0,15
	Fagus	-	25	25	0,15
	Pistacia	13	10	23	0,13
	Carpinus	17	5	22	0,13
	Rosaceae	10	11	21	0,12
	Tilia	16	0	16	0,09
	Ulmus	4	12	16	0,09
	Betulaceae	-	15	15	0,09
	Ericaceae	7	3	10	0,06
	Ostrya	6	1	7	0,04
	Aesculus	3	2	5	0,03
	Total (AP)	**10195**	**4913**	**15108**	**88,46**
Non-arboreal Plants	Gramineae	782	210	992	5,81
	Centaurea	117	3	120	0,70
	Compositae	68	18	86	0,50
	Cheno./Amarantha	26	48	74	0,43
	Plantago	56	16	72	0,42
	Rumex	49	19	68	0,40
	Urticaceae	17	38	55	0,32
	Artemisia	24	24	48	0,28
	Umbelliferae	20	17	37	0,22
	Taraxacum	17	3	20	0,12
	Xanthium	7	9	16	0,09
	Rubiacea	10	2	12	0,07
	Cyperaceae	9	1	10	0,06
	Labiatae	4	2	6	0,04
	Cruciferae	2	3	5	0,03
	Papaveraceae	-	5	5	0,03
	Typha	4	1	5	0,03
	Poterium	-	4	4	0,02
	Caryophyllaceae	3	0	3	0,02
	Boraginaceae	2	0	2	0,01
	Echium	-	2	2	0,01
	Luzula	-	2	2	0,01
	Mercurialis	-	2	2	0,01
	Onobrichis	1	1	2	0,01
	Zea	-	2	2	0,01
	Helianthus	1	0	1	0,01
	Juncacea	1	0	1	0,01
	Total (NAP)	**1220**	**432**	**1652**	9,67
	Unidentified	215	104	319	1,87
	TOTAL	**11630**	**5449**	**17079**	**100,00**

TABLE 2. Percentage (%) of the highest airborne pollen grains in the atmosphere of Tavşanlı.

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	TOTAL
Pinus	-	-	0,11	0,98	40,55	8,94	0,85	0,08	0,05	-	51,56
Cupressaceae	0,04	0,07	2,86	3,48	7,88	0,33	0,06	0,01	0,02	-	14,75
Quercus	-	-	0,20	0,60	7,27	0,03	-	-	-	-	8,09
Platanus	-	-	0,02	0,97	3,75	0,02	-	-	-	-	4,76
Salix	-	-	0,01	0,19	1,82	-	-	-	-	-	2,01
Moraceae	-	-	-	0,03	1,60	-	-	-	-	-	1,63
Oleaceae	-	-	-	-	0,38	0,70	0,02	-	-	-	1,10
Gramineae	-	-	0,01	0,09	2,19	2,17	0,68	0,43	0,18	0,06	5,81
Others	0,03	0,03	1,59	1,11	1,38	1,38	0,97	1,14	0,69	0,12	8,42
Unidentified	-	0,01	0,07	0,22	0,68	0,39	0,28	0,14	0,05	0,04	1,87
TOTAL	**0,06**	**0,11**	**4,87**	**7,66**	**67,48**	**13,96**	**2,86**	**1,80**	**0,98**	**0,22**	100,00

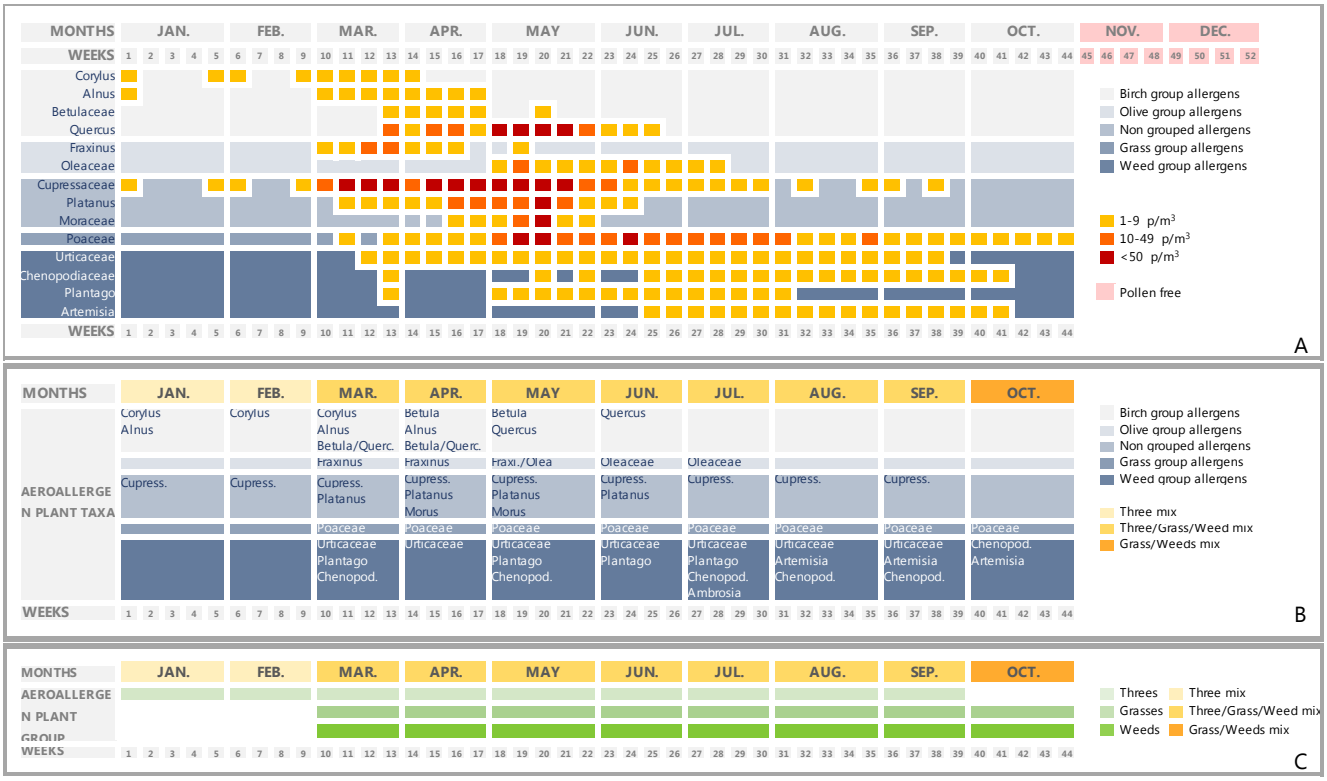


FİG. 4. Pollen calendar for allergen group (A), aeroallergen plant taxa (B) and aeroallergen plant group (C) for Tavşanlı (Kütahya).

CONCLUSIONS

As a result of annual evaluation of aeroallergens in the investigated region, January and February were identified as important for birch group three allergens and Cuppressaceae allergens. The period of between beginnings of March to October was important for whole allergen types and October was important for grass and weed pollen allergens. Pollen grains of 52 taxa were determined during the pollen season in the atmosphere of Tavşanlı, 8 of them formed about 89.71% of the spectrum and 39.05% of annual pollen grains have an importance for allergological point of view. Pollen grains were recorded 10 months of the year and reached their maximum levels in May. The presented data and pollen calendars for the region in this paper may be useful for allergologist and patients who suffer from pollen allergy.

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