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ANALYSIS OF AIRBORNE POLLEN FALL IN CANAKKALE, TURKEY

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Abstract

Airborne pollen in the State of Canakkale was determined during 2000-2001 using two Durham samplers. The samplers were placed 15 m above the ground on the rooftops of the city hospital and of the meteorological station situated alongside the straits of Dardanelle. By the end of the year averages of pollen counts from the 2 samplers were calculated. In total 4095 pollen belonging to 39 taxa were counted. Out of these, 3548 belonged to the arboreal species (86.65%), 483 to non-arboreal taxa (11.78%) and 64 to the unidentified group (1.57%). The highest number of pollen of the arboreal taxa were in the following order: Pinaceae, *Quercus* sp., Cupressaceae/ Taxodiaceae and *Olea europaea*. In the non-arboreal group the order was Chenopodiaceae/ Amaranthaceae, Poaceae, *Xanthium strumarium* and *Plantago* sp. Maximum pollen was recorded during the spring season and minimum during winter. During our study period the number of allergic patients who were treated in the hospital was 534. There was an apparent increase in the number of patients during May-June that decreased in July. However, in August the number went up again. Such an increase in patients probably is the result from an increase in the airborne content of pollen of Chenopodiaceae/Amaranthaceae, Poaceae and *Xanthium*.

Introduction

Allergy diseases, with asthma in particular, have become a serious health problem in Turkey. The allergens leading to such diseases include pollen, spores, dust mites, insects and different kinds of foods. People of all ages are affected by such aerobiological disorders. The prevalence of asthma is increasing everywhere, specially among children. There are reports that the airborne pollen content as a major outdoor factor are responsible for allergy diseases (Keynan *et al.*, 1991; Spieksma & Frenguelli, 1991; Waisel *et al.*, 1997; Meiffren, 1998; Kobzar, 1999; Vera, 1999; Guvensen & Ozturk, 2002; Bicakci *et al.*, 2003**;** Guvensen & Ozturk, 2003; Peternel *et al.*, 2003; Piotrawska & Weryszko-Chmielewska, 2003; Porsbjerg *et al.*, 2003; Saar**,** *et al.*, 2003). The area around the straits of Dardanelles in the State of Canakkale was selected for the present investigation, because of a dramatic increase in the number of allergic patients reported from this area.

Canakkale with an area of 9.737 km^2 has some 500.000 inhabitants. It is located in the northwestern part of Turkey between 39^{0}27'-40^0-42' N latitudes and 25^{0}40'-27^{0}30' E longitudes, with an altitude varying from sea level to 1774 m. The city is divided into Gallipoli and Biga peninsulas by the straits of the Dardanelles (Fig. 1).

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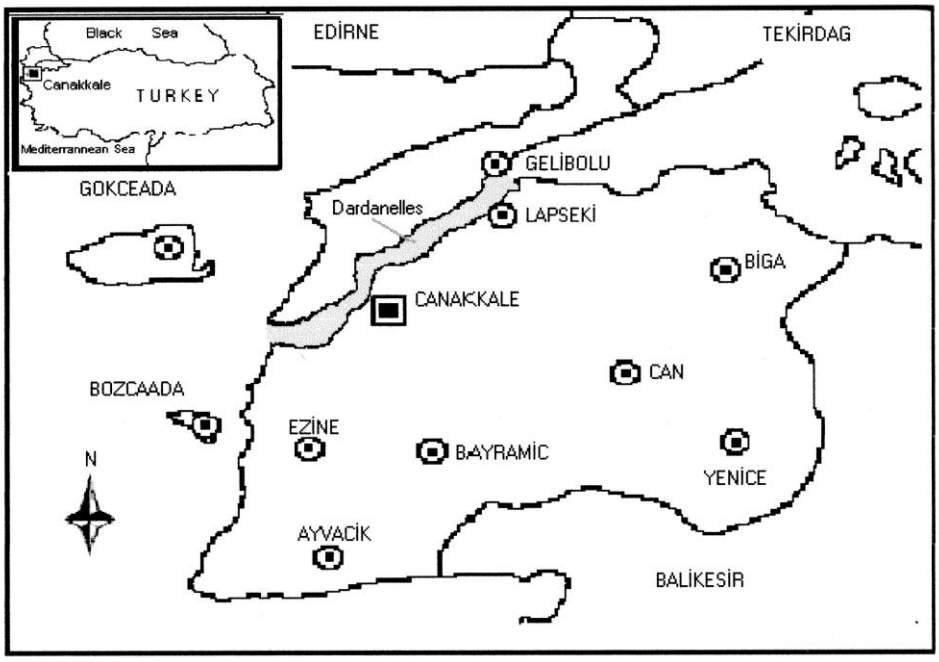

Fig. 1. Map showing the study area.

Canakkale experiences a mediterranean climate. Average annual maximal temperatures vary, being highest from the 3rd week of June till 1st week of September, ranging between 23.0 ^{0}C-27.2 ^{0}C. The lowest average temperatures that range between 4.8 ^{0}C and 13.2 ^{0}C were recorded in December and January. Rains are common in spring and winter, with a mean annual of 1000 mm at higher altitudes, but 600-800 mm along the coast. Dominant winds are northeast, north-north-east, with an annual average speed of ~ 14 km/h.

At higher altitudes forests comprised of *Abies nordmanniana* (Stev) Spach. subsp. *equi-trojani*, *Castanea sativa* Miller, *Fagus orientalis* Lipsky, *F. sylvatica* L., *Pinus brutia* Ten., *P. nigra* Arn., *Quercus frainetto* Ten., *Q. cerris* L., and *Q. petraea* (Mattuschka) Liebl., dominate and cover some 50% of the area. At lower altitudes maquis and phryganas cover large areas and include taxa such as; *Arbutus andrachne* L., *Asparagus acutifolius* L., *Asphodelus aestivus* Brot., *Coridothymus capitatus* (L.) Reichb., *Cistus creticus* L., *C. salviifolius* L., *Jasminum fruticans* L., *Juniperus oxycedrus* L., *Olea europaea* L., *Paliurus spina-chrtistii* Miller., *Phillyrea latifolia* L., *Pistacia terebinthus* L., *Quercus coccifera* L., *Q. infectoria* Oliver., *Q. ithaburensis* Decne. subsp. *macrolepis* (Kotschy) Hedge et Yalt., *Ruscus aculeatus* L., *Sarcopoterium spinosum* (L.) Spach, *Thymbra spicata* L. and *Vitex agnus-castus* L.

Many species of trees are planted in the parks and as street trees in the city. These include *Acer negundo* L., *Ailanthus altissima* (Miller) Swingle., *Alnus glutinosa* (L.) Gaertner, *Berberis* sp., *Buxus sempervirens* L., *Cedrus atlantica* Manetti, *Cercis siliquastrum* L., *Corylus* sp., *Cupressus sempervirens* L., *Elaeagnus angustifolia* L., *Eucalyptus* sp., *Ficus carica* L., *Hedera helix* L., *Jasminum* sp., *Juglans regia* L.,

Juniperus oxycedrus, Ligustrum vulgare L., *Morus alba* L., *Nerium oleander* L., *Olea europaea, Phillyrea latifolia, Phoenix latifolia* L., *Pinus brutia, P. pinea* L., *Platanus orientalis* L., *Populus tremula* L., *Quercus cerris, Q. ithaburensis* subsp. *macrolepis* , *Robinia pseudoacacia* L., *Salix babylonica* L., *Sophora japonica* L., *Taxus baccata* L., *Thuja orientalis* L., *Tilia argentea* Desf., *Ulmus glabra* Hudson., and *Washingtonia filifera* Wendl. The urban non-arboreal flora includes *Agrostis capillaris* L. var. *capillaris, Amaranthus* spp., *Anthemis spp., Bromus tectorum* L., *Capsella bursa-pastoris* (L.) Medik., *Carduus pycnocephalus* L., *Centaurea solstitialis* L., *Chenopodium album* L., *Cichorium intybus* L., *Chondrilla juncea* L., *Dactylis glomerata* L., *Daucus carota* L., *Festuca rubra* L. ssp. *pseudorivularis* Markgr-Dannenb., *Geranium molle* L., *Hedera helix* L., *Heliotropium hirsutissimum* Grauer., *Hordeum spp., Inula viscosa* (L.) Aiton., *Lamium amplexicaule* L., *Lolium perenne* L., *Lonicera etrusca* Santi, *Malva sylvestris* L., *Matricaria chamomilla* L., *Medicago* spp., *Melilotus* spp., *Onopordum illyricum* L., *Papaver rhoeas* L., *Picnomon acarna* (L.) Cass., *Plantago lanceolata* L, *Poa pratensis* L., *Ranunculus arvensis* L., *Rosmarinus officinalis* L., *Rumex* sp., *Sinapis alba* L., *Taraxacum* spp., *Tordylium apulum* L., *Trifolium* spp., *Urtica* spp., *Vicia* spp., and *Xanthium strumarium* L.

Apricot, cabbage, cherry, maize, blackberry, garlic, broad bean, leek, onion, peach, pear, pepper, quince, radish, tomato and wheat are grown widely on cultivated areas (30.75%) around the city. The present report describes the airborne pollen fall in Canakkale, Turkey.

Materials and Methods

Two sites at an altitude of 15 m from sea level were selected in the city very near the straits of Dardanelles. Durham samplers were fixed on the rooftops 15 m from the ground at the meteorological station and city hospital. Studies were carried out from 27 March 2000 till 21 March 2001. The slides**,** smeared with glycerine-jell stained with safranine**,** were changed weekly. For identification B-3000 binocular was used and counting was done on a 20x20 mm (4 cm^2) area of the slide. The data was then calculated on 1 cm^2 basis. The identification of pollen taxa was done using reference slides of 600 taxa that are present in the area. Identification was validated using the books on palynology (Charpin *et al.*, 1974; Moore *et al.*, 1991). The information regarding allergic patients visits was taken from the hospital records and meteorological data obtained from the local meteorological station.

Results and Discussion

Pollen of 39 taxa was recorded in the atmosphere of the city. Out of these 24 belong to the arboreal taxa and 15 to the non-arboreal ones. The average number of pollen sedimentation counted in the two stations was 4095 pollen/cm^2. Which include 3548 pollen of arboreal species (86.65%), and 483 of non-arboreal plants (11.78%) (Table 1). The dominant pollen of the arboreal taxa were of the Pinaceae, *Quercus* sp., Cupressaceae/ Taxodiaceae and of *Olea europaea.* The dominant non-arboreal taxa were Chenopodiaceae/ Amaranthaceae, Poaceae, *Xanthium strumarium* and *Plantago* sp. The large number of arboreal pollen grains seems to result from the lush forest vegetation of this area.

Table 1. Average total pollen counts of different taxa from two different stations and their percentage values and degree of allergenicity.

Plant Groups	Allergic Degree	Taxa	Pollen counts (cm^2)			%
			Site 1	Site 2	Average	
Arboreal Taxa	LAP	*Sarcopoterium spinosum*	73	87	80	1.95
		Morus	33	41	37	0.90
		Acer	33	30	31.5	0.77
		Rosaceae	17	22	19.5	0.48
		Pistacia	14	15	14.5	0.35
		Ligustrum vulgare	10	16	13	0.32
		Ailanthus altissima	7	6	6.5	0.16
		Sophora japonica	4	6	5	0.12
		Tilia	2	2	2	0.05
	AP	Pinaceae	2118	2472	2295	56.04
		Quercus	340	420	380	9.28
		Cupressaceae/Taxodiaceae	276	336	306	7.47
		Olea europaea	175	245	210	5.13
		Oleaceae	22	22	22	0.54
		Populus	24	20	22	0.54
		Platanus orientalis	17	26	21.5	0.53
		Salix	22	18	20	0.49
		Castanea sativa	21	15	18	0.44
		Corylus avellana	14	9	11.5	0.28
		Juglans regia	7	4	11	0.27
		Erica	6	11	8.5	0.21
		Betulaceae	7	4	5.5	0.13
		Alnus glutinosa	3	6	4.5	0.11
		Ulmus	2	5	3.5	0.09
		Total arboreal pollen	**3247**	**3838**	**3548**	**86.65**
Non-arboreal Taxa	LAP	*Asteraceae*	21	20	20.5	0.48
		Brassicaceae	9	9	9	0.22
		Cyperaceae	7	7	7	0.17
		Apiaceae	4	7	5.5	0.13
		Fabaceae	6	5	5.5	0.13
		Campanula	6	2	4	0.10
		Lamiaceae	1	3	2	0.05
		Euphorbia	2	1	1,5	0.04
	AP	Chenopodiaceae/Amaranthaceae	120	128	124	3.03
		Poaceae	103	112	107.5	2.63
		Xanthium strumarium	80	94	87	2.13
		Plantago	62	93	77.5	1.89
		Rumex	11	11	11	0.27
		Urticaceae	10	12	11	0.27
		Typha	9	11	10	0.24
	Total non-arboreal pollen		**451**	**515**	**483**	**11.78**
	Unidentified		**68**	**60**	**64**	**1.57**
	Total		**3766**	**4413**	**4095**	**100**

LAP: Low allergenic plants, AP: Allergenic plants

In the cities of Balikesir and Bursa similar results were obtained by using gravimetric methods (Bicakci *et al.*, 1996; Bicakci & Akyalcın, 2000). The studies covering the central part of Bursa city. Bicakci *et al.*, (1996) have reported 70.1 % pollen of arboreal taxa and only 27% of non-arboreal taxa. The former is dominated by *Pinus*, Cupressaceae/ Taxaceae, *Abies nordmanniana*, *Platanus orientalis*, *Olea europaea*, Poaceae, Urticaceae, Chenopodiaceae/Amaranthaceae, *Artemisia* sp., and Asteraceae pollen. In the Balikesir area arboreal taxa comprise 70.92% of the pollen and is dominated by *Pinus* sp., Cupressaceae/Taxaceae, *Platanus orientalis* and *Quercus* sp. Pollen of the Poaceae, Urticaceae, *Plantago* sp., Asteraceae and Chenopodiaceae/ Amaranthaceae comprised only 25% of the pollen grain (Bicakci & Akyalcın, 2000). The percentage of arboreal and non-arboreal pollen in the atmosphere of these cities are very close to our results, except for *Abies nordmanniana* that is not found in the Canakkale area. Pollen of *Platanus* sp., Asteraceae and Urticaceae are not abundant in our area. In the city of Isparta 71% of the pollen grain are of arboreal taxa and 25% of non-arboreal. These are dominated by *Pinus* sp., Cupressaceae, *Platanus* sp., *Quercus* sp., Poaceae, *Artemisia* sp., Chenopodiaceae/Amaranthaceae and Urticaceae (Bicakci *et al.*, 2000).

The only volumetric study undertaken in Bursa using Lanzoni samplers (1999-2000) has reported 78.61% pollen of arboreal and 20.37% of non-arboreal taxa. These were dominated by Pinaceae, Cupressaceae/Taxaceae, *Platanus orientalis*, *Populus* sp., *Acer* sp., Poaceae, Chenopodiaceae/Amaranthaceae, Asteraceae, *Rumex sp.* and Apiaceae (Bicakci *et al.*, 2003). Out of these *Platanus orientalis*, *Populus* sp., *Acer* sp., Asteraceae, *Rumex* sp., and Apiaceae were recorded in low numbers only in the atmosphere of Canakkale.

In the atmosphere of Canakkale arboreal taxa like Pinaceae (56.04%), *Quercus* sp., (9.28%), Cupressaceae/Taxodiaceaea (7.47%) and *Olea europaea* (5.13%) were abundant and form 77.92% of the total pollen counts. Non-arboreal taxa such as Chenopodiaceae/Amaranthaceae (3.03%), Poaceae (2.63%), *Xanthium strumarium* (2.13%) and *Plantago* sp., (1.89%) constituted only 9.68% of the total (Table 1). Airborne pollen was monitored throughout the year (Fig. 2). The main pollination period of the plants was April (44.47%), March (28.76%) and May (13.84%). The lowest pollen counts were found in October (0.25%), November (0.17%) and December (0.29%) (Table 2). Pollen of arboreal taxa were dominant during January till May; non-arboreal taxa are dominant from June till October (Fig. 3).

Pinaceae, *Quercus* sp., Cupressaceae/ Taxodiaceae, *Olea europaea* and *Sarcopoterium spinosum* pollen have formed 79.87% of total pollen counts in the state of Canakkale, whereas the non-arboreal taxa Chenopodiaceae/Amaranthaceae, Poaceae, *Xanthium strumarium* and *Plantago* sp., constituted only 9.68% of the total (Tables 1, 2). The lowest pollen counts were recorded from October till February. The average weekly pollen counts per cm^2 is given in Fig. 4.

The pollination characteristics of the 8 major taxa are given below:

Pinaceae: These pollen are found almost throughout the year except in February. Maximum pollen counts were observed during the 3rd week of April. Pollen of the Pinaceae are of low allergenic impact (Bousquet *et al.*, 1984; Middleton *et al.*, 1988).

***Quercus*:** Pollen was found from 2nd week of March till the end of May, with maximum counts during the 3rd week of March. High as well as medium allergenic reactions are reported for *Quercus* pollen (Chapman & Williams, 1984; Middleton *et al.*, 1988; Aytug *et al.*, 1995; Peternel *et al.*, 2003). It is reported to cause pollinosis (Middleton *et al.*, 1988).

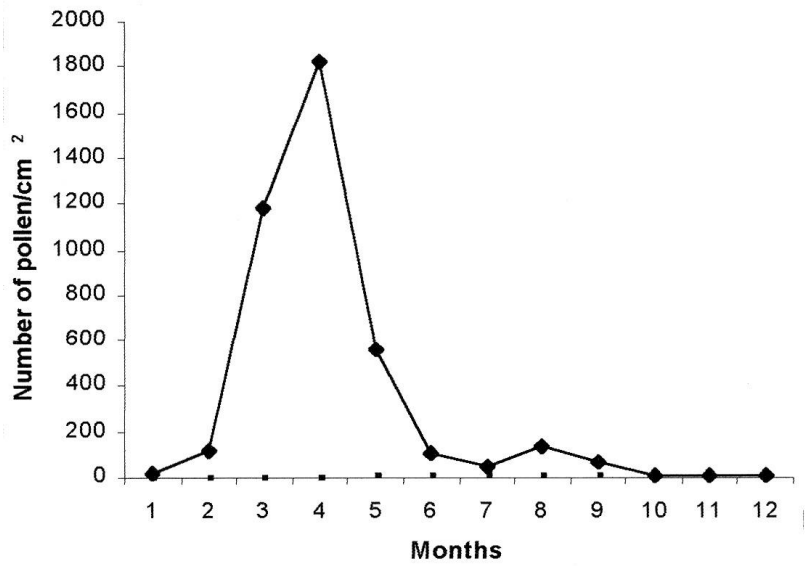

Fig. 2. Monthly average of total airborne pollen

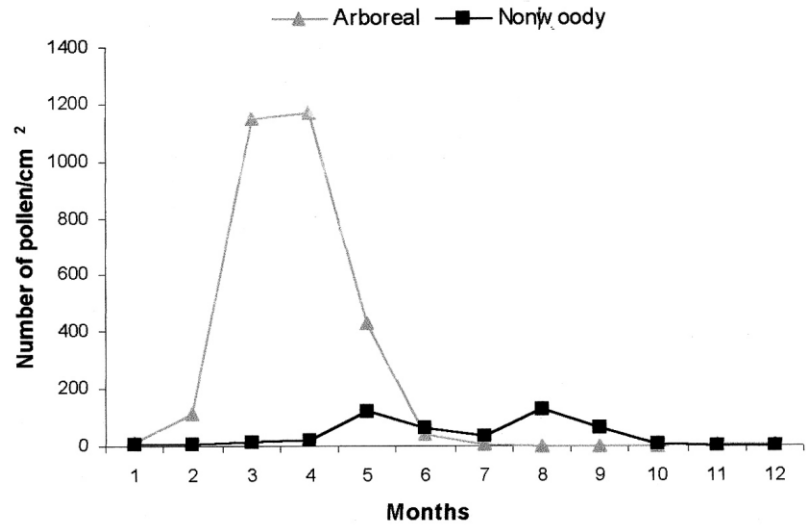

Fig. 3. Monthly average of total airborne pollen of arboreal and of non-arboreal taxa in Canakkale.

Cupressaceae/Taxodiaceae: Pollen of this group of taxa is very common in early spring, but high counts were observed from the 1st week of February till the 3rd week of April. They are among the most important aeroallergens in the Mediterranean area (Bar-Dayan *et al.*, 1995). Pollen of this group cause high allergic reactions (Bousquet *et al.*, 1984; Geller-Bernstein *et al.*, 2000).

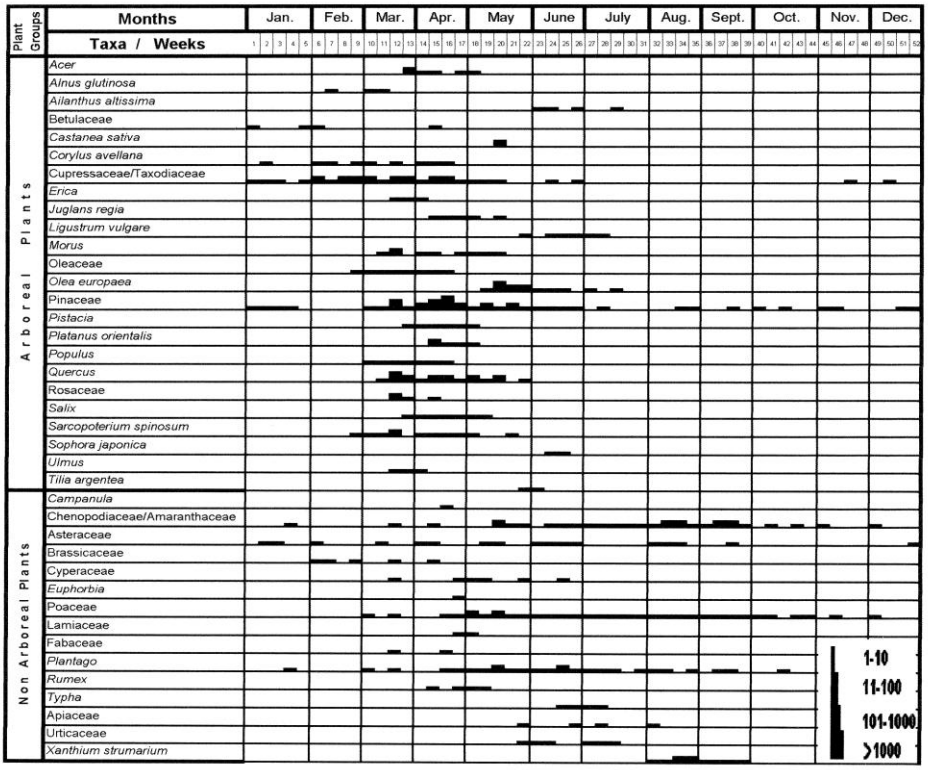

Fig. 4. Annual pollen calendar of Canakkale (grains/cm^2).

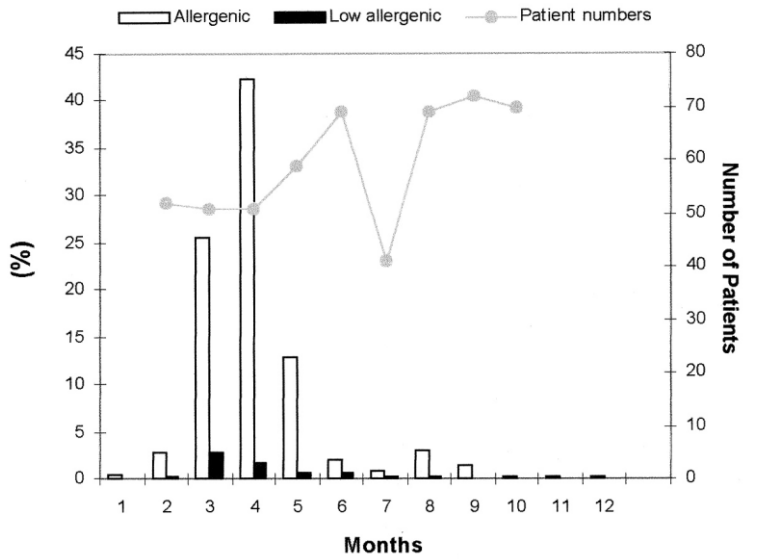

Fig. 5. Monthly variation in the percentage of allergenic/low allergenic species and time course of the number of patients.

Table 3. Estimation of the % of allergic patients in different countries.

Country	%	Country	%
Croatia	15-20	Netherlands	6.6
Denmark	3.2	New Zealand	15-20
England	11-24	Norway	10-20
Finland	14	Spain	10
France	6-18.5	Switzerland	4.4-14.2
Germany	9.5-22.5	Sweden	13
Italy	13	Turkey	15-18
Israel	15	USA	10-42
Japan	12.9-32.7		

Poaceae: Pollen of this family are typically found in our area during most of the year, from the second half of April till the first half of October. The counts reached maximum values during May. Species like *Cynodon dactylon* (L.) Pers., *Dactylis glomerata, Poa pratensis*, *Phleum pratense* L., *Agrostis* sp. and *Lolium* sp., are highly allergenic (Chapman, 1986; Garty, 1998).

Xanthium strumarium: The pollination period of this species lasts for 2 months, i.e., during August and September. *Xanthium strumarium* is reported to have medium to strong allergenic effects (Levetin & Buck, 1980; Chapman & Williams, 1984; Aytug *et al.*, 1995). The airborne pollen concentration of *Xanthium* was higher than that of the other non-arboreal taxa in our area and was exceeded only by that of the Chenopodiaceae/Amaranthaceae and of the Poaceae.

Plantago: Airborne pollens of *Plantago* were present from the 2nd half of April till mid July. *Plantago* pollen have medium allergenic effects (Nardi *et al.*, 1986).

Asthma is a serious disease, not only in terms of health care costs but also of the lost of productivity and reduced participation in family life. Asthma affects 5–7% of the population of North America and Europe and its prevalence is increasing (Keynan *et al.*1987; Burney, 1993; Weiss, 1993; Bousquet, 2001). The incidence of allergies in different countries is presented in Table 3. The highest percentages are found in the USA and least in Denmark. In Turkey incidence of allergies varies between 15-18%.

The degree of allergenicity of the pollen is presented in Table 1 following the different classifications (Middleton *et al.*, 1988; Aytug *et al.*, 1995; Peternel *et al.*, 2003). According to this table pollens of 21 taxa are highly allergenic (AP), 18 taxa show low pollen allergenicity (LAP). The monthly percentage averages of the highly allergenic pollens in the city atmosphere were; April (42.26%), March (25.49%) and May (12.82%) (Fig. 5). Pollen counts in the city center were highest during spring with the dominance of the highly allergenic *Quercus sp.*, Cupressaceae/Taxodiaceae and Oleaceae. However, in August (3.09%) the presence of pollen of non-arboreal taxa like Chenopodiaceae/ Amaranthaceae, Poaceae, *Plantago* and *Xanthium strumarium* in the atmosphere resulted in an increase in allergies (Figs. 4, 5).

During May, June, August and September allergic patients also showed an increase in their clinical responses (Fig. 5). During July pollen counts decreased (Figs. 2, 3) with a concomitant decrease in allergic diseases (Fig. 5). During August *Xanthium strumarium* pollen was very high whereas during August and September pollen of Chenopodiaceae/ Amaranthaceae are very high (Fig. 4; Table 1). This reflects the increase in the number of

patients during these months (Fig. 4, 5). In general, the months of May and August show the highest incidence of allergies, which appears to be an after effect of the high number of allergic pollen observed in March and April (Fig. 5). Allergic diseases can be controlled and symptoms can be minimized if we know what triggers them. The present pollen calendar will thus enable an improved life quality for the inhabitants of Canakkale.

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References

Aytug, B., F. Yaltırık and A. Efe. 1995. Allergenic pollen producing plants of Turkey. In: *Proceedings of the National Palynology Congress, Istanbul.* Forest Faculty, Istanbul University,

Bar-Dayan, Y., N. Keynan, Y. Waisel, A.I. Pick and R. Tamir. 1995. *Podocarpus gracilior* and *Callitris verrucosa*- newly identified allergens that crossreact with *Cupressus sempervirens*. *Clinical and Experimental Allergy*, 25: 456-460.

Bicakci, A., O. Inceoglu, N. Sapan and H. Malyer. 1996. Airborne pollen calendar of the central region of Bursa (Turkey). *Aerobiologia*, 12: 43-46.

Bicakci, A., A. Akkaya, H. Malyer, M. Unlu and N. Sapan. 2000. Pollen calendar of Isparta-Turkey. *Isr. J. Plant Sci*., 48: 67-70.

Bicakci, A and H. Akyalcın. 2000. Analysis of airborne pollen fall in Balikesir, Turkey, 1996-1997. *Ann. Agric. Environ. Med*., 7: 5-10.

Bicakci, A., S. Tatlidil, N. Sapan, H. Malyer and Y. Canitez. 2003. Airborne pollen grains in Bursa, Turkey. *Ann. Agric. Environ. Med*., 10: 31-36.

Bousquet, J., P. Cour, B. Guerin and F.B. Michel. 1984. Allergy in the mediterranean area, I. Pollen counts and pollinosis of montpellier. *Clinical Allergy*, 14: 249–258.

Bousquet, J. 2001. Epidemiology and genetics. Aria workshop report. *Allergy Clin. Immunol*., 108: 153-161.

Burney, P.G.L. 1993. Epidemiology of asthma. *Allergy*, 48:17–21.

Chapman, J.A. and S. Williams. 1984. Aeroallergens of the southeast area: A report of skin test frequencies and air sampling data. *Annals of Allergy*, 52: 411–417.

Chapman, J.A. 1986. Aeroallergens of southeastern Missouri, USA. *Grana*., 25: 235-246.

Charpin, J., R. Surinyach and A.W. Frankland. 1974. *Atlas of European Allergenic Pollens. Sandoz,* Paris.

Garty, B.Z., E. Kosman, E. Ganor, V. Berger, L. Garty, V. Tova, Y. Waisman, M. Mimouni and Y. Waisel. 1988. Emergency room visits of asthmatic children, relation to air pollution, weather and airborne allergens. *Ann Allergy Asthma Immunol.*, 81: 563- 570.

Geller-Bernstein, C., G. Arad, N. Keynan, C. Lahoz, B. Cardaba and Y. Waisel. 1996. Hypersensitivity to pollen of *Olea europaea* in Israel. *Allergy,* 51: 356- 359.

Geller- Bernstein, C., Y. Waisel and C. Lahoz. 2000. Environmental and sensitization to Cypress in Israel. *Allergie et Immunologie*, 3: 92-93.

Guvensen, A. and M. Ozturk. 2002. Airborne pollen calendar of Buca-Izmir, Turkey. *Aerobiologia*, 18: 1- 9.

Guvensen, A. and M. Ozturk. 2003. Airborne pollen calendar of Izmir-Turkey. *Ann. Agric. Environ. Med.*, 10: 37-44.

Keynan, N., C. Geller-Bernstein, Y. Waisel, A. Bejerano, A. Shomer-Ilan and R. Tamir. 1987. Positive skin tests to pollen extracts of four species of *Pistacia* in Israel. *Clinical Allergy*,, 17: 243-249.

Keynan, N., Y. Waisel, A. Shomer-Ilan, A. Goren and S. Brener. 1991. Annual variations of airborne pollen in the coastal plain of Israel. *Grana*., 30: 477- 480.

Kobzar, V.N. 1999. Aeropalynological monitoring in Bishkek, Kyrgyzstan. *Aerobiologia*, 15: 149–153.

Kosman, E., A. Eshel and Y. Waisel. 1997. The "Travelling Salesman Problem": A new approach for identification of differences among pollen allergens. *Allergy and Immunology*, 112: 371-377.

Levetin, E. and P. Buck. 1980. Hay fever plants in Oklohoma. *Annals of Allergy*, 45: 26-32. Lewis, W.H. and P. Vinay. 1979. North american pollinosis due to insect – Pollinated Plants. *Annals of Allergy*, 10: 211-215.

Meiffren, I. 1998. Airborne pollen of Toullouse, Southern France. *Grana*., 27:183–201. . Middleton, E., E.R. Charles, F.E. Elliott, N.F. Adkinson and J.W. Yunginger. 1988. *Allergy Principles and Practice*, Toronto.

Moore, P.D., J.A. Webb and M.E. Collinson. 1991. *Pollen Analysis.* Blackwel Scientific Publications, Marston Book Services Ltd, London.

Nardi, G., O. Demasi, A. Hegrani and D.R. Pier. 1986. A study on airborne allergenic pollen content in the atmosphere of Ascoli Pineco. *Annals of Allergy*, 57:193-197.

Peternel, R., J. Culig, B. Mitic, I. Vukusic and Z. Sostar. 2003. Analysis of airborne pollen concentration in Zagreb, Croatia. *Ann. Agric. Environ. Med.*, 10:107-112.

Piotrawska, K. and E. Weryszko-Chmielewska. 2003. Pollen count of selected taxa in the atmosphere of Lublin using two monitoring methods. *Ann. Agric. Environ. Med.*, 10: 79-85.

Porsbjerg, C., A. Rasmussen and V. Backer. 2003. Airborne pollen in Nuuk, Greenland, and the importance of meteorological parameters. *Aerobiologia*, 19: 29-37.

Saar, M., Z. Gudžinskas, T. Ploompuu, E. Linno, Z. Minkiene and V. Motiekaityte. 2000. Ragweed plants and airborne pollen in the Baltic states. *Aerobiologia*, 16: 101-106.

Spieksma, F.T.M. and G. Frenguelli. 1991. Allergenic significance of *Alnus* sp. (Alder) pollen. In: *Allergenic Pollen and Pollinosis in Europe*. (Eds.): G. D'Amato, F.T.M. Spieksma and S. Bonini Blackwell Scientific Publications, London.

Vera, N.K. 1999. Aeropalynological monitoring in Bishkek, Kyrgyzstan. *Aerobiologia*, 15: 149-153.

Waisel, Y., N. Keynan, C. Geller-Bernstein and Z. Dolev. 1991. Urban pollution with allergenic pollen sources. In: *Urban Ecology.* (Eds.): M. Ozturk, U. Erdem and G. Gork. Ege University Press, Izmir.

Waisel, Y., C. Geller-Bernstein, N. Keynan and G. Arad. 1996. Antigenicity of the pollen proteins of various cultivars of *Olea europaea. Allergy*, 51: 819- 825.

Waisel, Y., E. Ganor, M. Glickman, V. Epstein and S. Brener. 1997. Seasonal distribution of airborne pollen in the Coastal Plain of Israel. *Aerobiologia*, 13: 127-134.

Weiss, K.B. 1993. Breathing better or wheezing worse. The changing epidemiology of asthma morbidity and mortality. *Annu. Rev. Publ. Health*, 14: 491-513.

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