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Study Of The Airborne Pollen Grains In Rosetta, Egypt

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Abstract: An aeropalynological study was carried out in the atmosphere of Rosetta city, Egypt during a period of one year from August 2015 until July 2016, using a Hirst type volumetric pollen trap. An annual pollen index of 1991 grains was obtained with the highest pollen records from February till May. The main pollen taxain abundance order are Poaceae, Arecaceae, Chenopodiaceae/Amaranthaceae complex, Casuarina, Cupressaceae, Urtica, Pinus, Myrtaceae. A total of eight pollen types with minimum 10-day mean equal to or greater than 0.1 pollen grains/m^3 of air are involved to construct an approximate pollen calendar.The data obtained in this work was compared with others elsewhere in the world. Correlation effects between pollen counts and different meteorological parameters (temperature, rainfall and relative humidity) as well as number of allergic patients were investigated. Most of the recorded pollen grains are of allergenic effects.

Keywords: Rosetta- Egypt- Pollen calendar- Aerobiology- Pollen allergy.

Introduction

Pollen allergy is considered the most typical form of allergic disease. It is obvious that its frequency increased during recent years.Medical palynology aims to reduce effects of some respiratory diseases. This science works on defining the allergens and determines the exposure-response thresholds. So it can help physicians and allergy sufferers to eliminate sources, adjust medication, and avoid exposure (O'Rourke, 1996). Some aeroplaynological studies were carried out in Egypt. However, this is the first study developed in Rosetta (Northern Egypt). The aim of this work is to present a study of the airborne pollen content of the locality by constructing an approximate pollen calendar. Also the main elemental composition of the most dominant pollen was also studied. As well as the effect of meteorological parameters on pollen concentration were also discussed.

Materials and Methods

Rosetta district (north Egypt) is located on the Mediterranean, east of Alexandria, by the estuary to the west of the Nile River (Figures 1 and 2). It is under the jurisdiction of Al-Behaira Governorate. Rosetta is located between latitudes 31° 12' to31° 28'N and longitudes 30° 16' to 30° 32' E. The city is well known because of the "Rosetta Stone" which is considered a document giving us information about the ancient Egyptian civilization.

Figure 1: *Location of the studied area, Rosetta in Egypt.*

Figure 2: *Location of the studied area, Rosetta in delta region.*

The study area is surrounding by several wild plants and also some cultivated plants. The district is dominated by variety of grasses and weeds such as Asteraceae and Chenopodiaceae. Phoenix dactylifera L. is planted by thousands in this area. According to the climate data obtained from the Egyptian Meteorological Authority in Cairo, Egypt, we can describe the region by being hot and dry in most of the months with moderate relative humidity. The maximum temperature reaches 32.2ºC in August and minimum temperature is 10.8ºC in January. The relative humidity ranges from 66 % in May to 73% in August. The rate of precipitation in the studied area is considerably low throughout the year with maximum precipitation in November (58.7 mm/month). In this study, airborne pollen grains in Rosetta atmosphere from August 2015 to July 2016 were studied using Hirst type volumetric pollen trap supplied by Burkrad Scientific (UK). A Burkard volumetric seven-day recording trap was operated on the roof of Basha Specialist Hospital, Rosetta, Egypt. The height of the hospital is about 18 m above the ground and its coordinates are 31° 23' 53" North, 30° 24' 44" East.The mechanism of the sampler is that a vacuum pump draws 10 l/min airflow through an orifice continuously oriented towards the wind. Pollen grains are impacted on an adhesive coated transparent plastic tape (Melinex) supported on a drum with a fixed circumference driven by a 7-jewel clockwork movement. The drum rotated past the orifice at 2 mm/hour. The drum is changed weekly (O'Rourke, 1996). The sampling method used is by Hirst 1952. After exposure, the Melinex tape coated with 10% gelvatol and then the adhesive mixture (Vaseline and wax) was cut into 48 mm or 24 hours segments, then mounted on slides using glycerin jelly stained with basic fuchsin. The slides were examined under light microscope; four longitudinal horizontal sweeps per slides were counted at magnification of 400x, according to the methodology proposed by Spanish Aerobiology Network, REA (Galán etal., 2007).Pollen counts should be expressed as the daily mean count per cubic meter of air.An approximation to pollen calendar was constructed by following Spieksma's model (Spieksma, 1991), which transforms 10-day mean pollen concentrations into a series of classes represented as columns of increasing height. In the calendar here only those taxa, the dominant pollen, with minimum 10-day mean equal to or greater than 0.1 pollen grains/m^3 of air are involved. The prepared slides were preserved in Environmental Sciences Department, Faculty of Science, Alexandria University X-ray analysis of the pollen grains for the most dominant families; their yearly count is over 100 pollen/m^3 of air; was carried to investigate the main elemental composition. The data on numbers of patients suffering from chest diseases for the studied year (August 2015-July 2016) was obtained from LocalRosetta Hospital in Rosetta, Egypt (Table 3). The environmental parameters such as maximum, minimum and average temperature, relative humidity and total rainfall, and the number of patients were subjected to multiple regression analysis using Pearson product-moment correlation coefficient (Cohen, 1988) between the transformed values of the environmental parameters and number of patients at confidence limit 95%. Correlation coefficient (r) is such that $-1 < r < +1$ and probability value (P) of less than 0.05 was considered significant. This analysis was carried out by using Statistica V.8 (StatSoft Inc., Tulsa, OK).

Results

Pollen Grains

The annual pollen index throughout the study periodfrom August 2015 until July 2016 was 1991. The maximum monthly pollen index for the study year was observed in March and April 2016 (380 and 419 respectively, figure 3). The minimum monthly pollen index was in August 2015, December 2016 and July 2016 (50, 41 and 47 respectively, figure 3). The results were ten types of pollen grains, in addition to a group of unidentified pollen arranged in alphabetic order. The pollen of Poaceae dominated the assemblage and represents 20.4%. The rare representative families are Apiaceae and Asteraceae. The monthly pollen indices of different pollen types are given in table (1). An approximation to a pollen calendar is constructed for the eight dominant taxa (Figure 4).

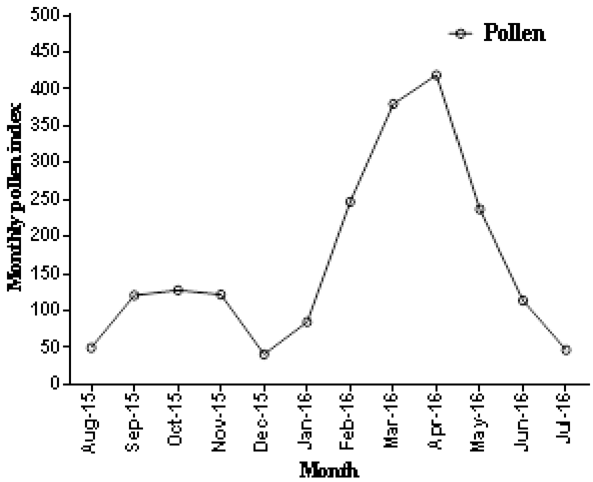

Figure 3: *Monthly pollen index during the period from August 2015 to July 2016 in Rosetta, Egypt.*

Table 1: Monthly pollen index spanning the period from August 2015 to July 2016 in Rosetta, Egypt.

Pollen \ Month	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Yearly influx	Percentage*
Apiaceae	1	1	0	0	0	0	0	0	0	1	1	1	5	0.3
Arecaceae	0	0	0	0	0	0	0	134	127	4	0	0	265	13.3
Asteraceae	3	1	1	0	1	3	1	1	1	2	1	0	15	0.8
Casuarina	1	8	2	7	1	3	11	95	10	3	2	1	144	7.2
Chenopodiaceae/ Amaranthaceae complex	17	39	36	10	5	9	40	30	22	16	9	5	238	12.0
Cupressaceae	0	0	4	24	1	1	39	3	51	8	4	1	136	6.8
Myrtaceae	1	0	2	6	2	3	13	4	8	12	2	1	54	2.7
Pinus	0	2	0	0	1	0	4	13	22	20	16	4	82	4.1
Poaceae	3	38	69	48	22	18	52	51	47	29	17	12	406	20.4
Urtica	0	1	1	3	3	25	25	13	16	6	2	4	99	5.0
Unidentified pollen	24	31	13	24	5	23	62	36	115	136	60	18	547	27.5
Monthly influx	50	121	128	122	41	85	247	380	419	237	114	47	1991	

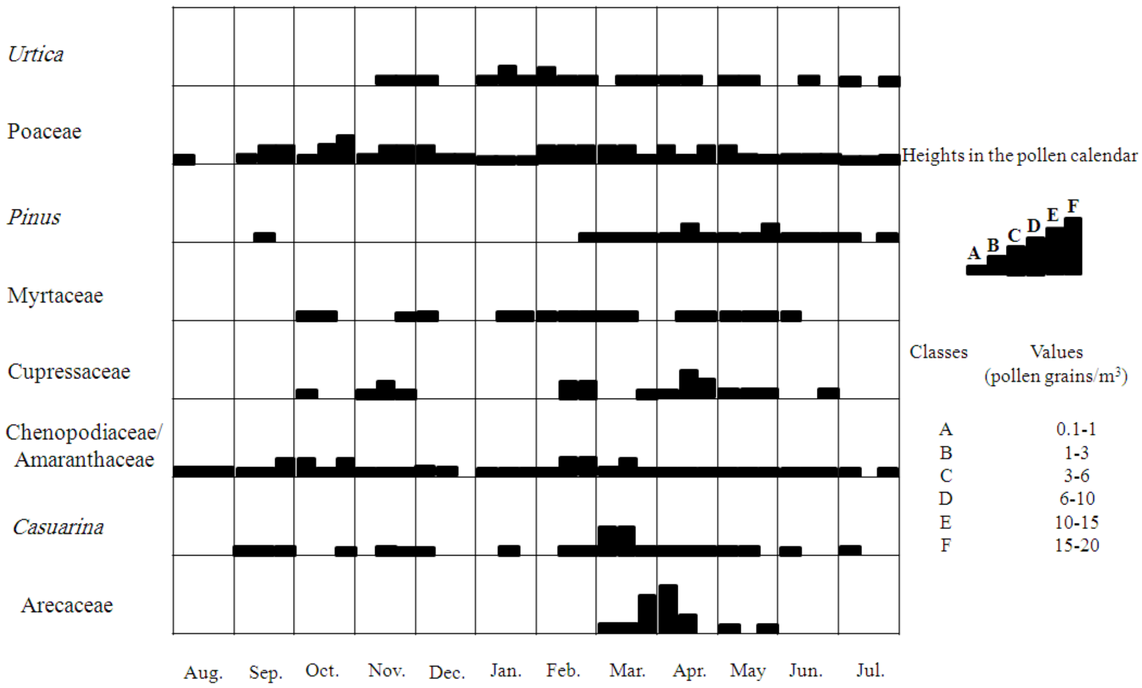

***Figure 4:** An approximate pollen calendar for Rosetta, using data from August 2015 to July 2016. Classes and pollen concentration values are represented in the calendar*

The following taxa produced the greatest amount of pollen:

1. Arecaceae Plate 1, Figs. 1, 2

Arecaceae is considered the second largest family in the present records; the annual pollen index was 265 (13.3%, table 1). Arecaceae pollen is found mainly in two months; March and April. The highest peaks are in the last decade of March and the first decade of April (Figure 4).

2. Casuarina Plate 1, Figs. 3, 4

The annual pollen index of Casuarina was 144 that accounts for 7.2% of the total assemblage throughout the studied period (Table 1). The highest peak is on March that particulary in the first and second decades of March (Figure 4). The rest of the year contains a very small amount of Casuarina pollen (Figure 4).

3. Chenopodiaceae/ Amaranthaceae complex Plate 1, Figs. 5, 6

Chenopodiaceae/Amaranthaceae complex comes in the third place among the abundant families. It contributed with 12% of the total assemblage of the whole families (Table 1). The highest peaks were recorded in September, October andFebruary, while the minimum records were in December and July (Figure 4).

4. Cupressaceae Plate 1, Figs. 7, 8

The annual pollen index of Cupressaceae was 136 representing 6.8% of the total catch (Table 1). Cupressaceae shows three peaks; November, February and April. The maximum record was in the second decade of April (Figure 4). Cupressaceae pollen is found in small record in the rest of the year.

5. Myrtaceae Plate 1, Figs. 9, 10
The annual pollen index of Myrtaceae is 54 (2.7%, table 1). This pollen exhibits two main peaks; February and May (Figure 4).

6. Pinus Plate 1, Figs. 11, 12
Pinus contributes with 4.1% of the total pollen assemblage (Table 1). The highest peaks were in April and May (Figure 4).

7. Poaceae Plate 1, Figs. 13, 14
The largest among all families is Poaceae, it contributes with 20.4% of the total pollen records (Table 1). Poaceae pollen is found all over the year (Figure 4). The highest peak is in October with the maximum count occurred in the third decade (Figure 4). The minimum record is in August.

8. Utrica Plate 1, Figs. 15, 16
The annual pollen index of Urtica is 99 (5.0%, table 1). The maximum peaks were in January and February (Figure 4). The chemical analysis for the most dominant pollen taxa showed that there is similarity in the elemental composition in most of them. The main elements that found are aluminum, phosphorous, sulfur, chloride, potassium, calcium, copper and zinc. Sodium, magnesium, silicon and iron are found in a very small amount in some species. Potassium is the main element that occurred nearly in all species tested in a high percentage. Sulfur, chloride and calcium are found in the all six species in a relatively moderate amount (Table 2).

Table 2: *Element composition and its percentage in the pollen grains.*

Pollen	Percentage of element in pollen grains											
	Na	Mg	Al	Si	P	S	Cl	K	Ca	Fe	Cu	Zn
Lolium perenne L. (Poaceae)	0	0	11.2	0	10.9	4.5	9.4	50	4.3	0	6.3	3.4
Phoenix dactylifera L. (Arecaceae)	0	2.9	0.6	0	28.9	9.8	5.6	30.8	13.2	0	4.4	3.8
Chenopodium murale L. (Chenopodiaceae)	0	0	11.9	0	18.7	5.2	8.6	34.9	5	2.5	8	5.3
Amaranthus lividus L. (Amaranthaceae)	0	0	16.6	0	11.4	8.2	7.2	45.8	4.6	1.5	3.4	1.6
Casuarina sp. (Casuarinaceae)	2.7	0	10.8	2.6	0	2.8	25.8	8.4	36.5	0	7.2	3.2
Cupressus sp. (Cupressaceae)	0	4.2	0	3.9	11	7.1	16.8	32.6	24.5	0	0	0

Data Analyses

The Multiple regression analysis between numbers of patients recorded in Local Rosetta Hospital during the study period and the environmental parameters shows that correlation coefficient value equals 0.815 at probability < 0.02. This means that there is a significant correlation between the environmental parameters (minimum temperature, total rainfall and relative humidity) and number of patients. Pollen grains data did not give any significant statistical analysis withenvironmental parameters.

Discussion

Allergy is considered as a chronic disease that weakens the physical condition and the ability to concentrate in the sufferers. To minimize the symptoms of pollen allergy is to avoid inhaling large doses of allergen. Thus, the knowledge of allergenic pollen count in a given area is of great importance for those suffering from allergy.Frei and Wüthrich (1997) noted to increase in the number of people suffering from allergy especially pollinosis and reached 15-30% of the inhabitants of our planet. This study carried out at Rosetta district which is surrounded by the farms of palms and guava and allocated at the Nile Valley with rich vegetation and wild plant species. The objective of this work is to construct pollen calendar to give information about the concentration of allergenic pollen at that area and to elaborate the forecasts of the occurrence of these pollen grains taxa in this district. The highest airborne pollen records in the present study were from February to May. The monthly pollen indices were 247, 380, 419 and 237 in February, March, April and May respectively (Table 1). The same has been obtained by Docampo et al. (2007) who made an aeropalynological study in the atmosphere of the city of Nerja (southern Spain) andfound the highest counts of airborne pollen grains (80-85%) were recorded from February to May. Türe and Böcük (2009) studied the pollen grains in the atmosphere of Bilecik, Turkey. They found that the main pollen producers are Pinus sp., Poaceae, Cupressaceae, Platanus sp., Quercus sp., Salix sp., Ailanthus sp., Fagus sp., Urticaceae, and Chenopodiaceae/Amaranthaceae, with the highest records obtained in May. Some of these pollen types such as Poaceae, Chenopodiaceae/Amaranthaceae, Cupressaceae, Urticaceae and Pinus were also trapped in the present study, but the highest count was in April. Apiaceae and Asteraceae have the lowest annual pollen index in Rosetta equals to 5 and 15 respectively(Table 1). The former represented by only one species; Daucus sp. which is more probably an annual herb and it is expected to be represented by few pollen grains. The latter was found with a variety of species probably pollinated by insects and thus, their record in the air was few. Arecaceaeis represented by Phoenix dactylifera which is a dioecious plant that produces plenty of light pollen grains and found by hundreds in Rosetta. So it is the second largest annual pollen index in this study equals to 265 (13.3%, table 1). Radwan et al. (2006) studied and characterized the allergenicity of extracted proteins from date palm pollen. Hasnain et al. (2012) found that the most allergenic tree in Kingdom of Saudi Arabia and the United Arab Emirates was Phoenix dactylifera (dates). The trapped Casuarina pollen in Rosetta was considerably high; the annual pollen index was 144 (Table 1) with its peak in March.In Egypt, Casuarina tree is introduced and planted in the streets to prevent erosion of sandy soils.Burton and Katelaris (2007) studied the pollen season of Casuarina pollen in two regions in Australia. They found that the mean duration of the pollen season being fourteen days.Garcia et al. (1997) found, as well, that Casuarina pollen season in general is relatively short. Agashe et al. (1994)suggested that Casuarina pollen is a significant potential aeroallergen which deserves the serious attention of the allergists. De La Cruz et al. (2012) found the pollen type of Chenopodiaceae-Amaranthaceae was obviously monitored in the atmosphere of Salamanca (mid-west Spain) between late spring and late summer. It is found that this pollen type increased with temperature and decreased with rainfall and relative humidity. This data was comparable with our results, as the trapped pollen grains of Chenopodiaceae-Amaranthaceae complex increased in late summer (from August to October). The annual pollen index of this complex is 238 (Table 1); it is the third after Poaceae and Arecaceae. Hasnain et al. (2012)found that some species of both families; Chenopodiaceae and Amaranthaceae; are important allergens in Saudi Arabia and Sudan. The genus Cupressus is composed of many species that are widely spread over East Mediterranean, central Asia, China and the western North America. In the Mediterranean area the most allergenic species are Cupressus arizonica and Cupressus sempervirens (Charpinet al., 2005). Di Felice et al. (2001) announced that allergy to Cupressaceae pollen is a worldwide pollinosis caused by several species. This study found that the monthly pollen index for Cupressaceae is considerably high equals to 136 (Table 1) D'Amato et al. (2007)considered Cupressusasone of the most allergenic tree pollen in the Mediterranean regions**.** Ishizakiet al. (1987) warned fromthe increasing in using Cupressaceae trees for gardening and reforestation in the epidemiologic impact of pollinosis induced by these species. Myrtaceae pollen was recorded in a relatively small amount with annual pollen index equals to 54 (Table 1), as these trees are insect pollinated.Roopashree et al. (2014) recorded that from the most predominant pollen in the atmosphere of Bangalore city (India) wasEucalyptus spp. (7.58%). Gibbs (2015) found that Eucalyptus is an important allergen for children with asthma and its pollen grains promote positive skin prick test (SPT). Pinus pollen was found with a relatively low annual pollen index in the present study equals to 82 (Table 1). Myszkowska et al. (2011) found that the highest daily pollen concentrations in Kraków, Poland in 1991–2008 were caused by Betula and Pinus pollen. In general Pinus has not been detected to be a serious allergenic problem. This may be associated to large size of the grains which makes them so poor to penetrate the respiratory tract and also due to their hydrophobic nature and low protein content (Howlett et al., 1981). Majd and Ghanati (1995) showed the allergenic effect of some species of Pinus. They found that an extract of Pinus elderica pollen could cause anaphylactic shock. Also the study carried by Fountain and Cornford (1991) investigated that there is a preliminary evidence of presence of allergenic proteins in Pinus radiate, possibly cross-reactive with rye grass pollen allergens. The grasses are the highest number within the trapped pollen grains; the annual pollen index was 406 (Table 1). El-Ghazaly and Fawzy (1988), and Essien and Agwu (2013) found that grasses represented the most common sources of airborne pollen in Alexandria and Nigeria. Sahney and Chaurasia (2008) found that most of the pollen of Allahabad (India) came from anemophilous trees and grasses. Grass pollen is considered the major cause of pollen allergy in many parts of the world (Friedhoff et al., 1986). In Europe the most common pollen allergy is that induced by grasses (D'Amato et al., 2007)**.** The genus Urtica belonging to Urticaceae has been found mainly from January till May, with very few records in the rest of the year (Table 1).Dušička et al. (2013) pointed that the highest pollen totals for the period of their study were recorded in the Urticaceae, and April was the month with the highest pollen yield.Tiotiu et al. (2016) indicated that exposure to Urtica pollen can be responsible of allergic reactions. Pollen data in the studied area is in accordance with most of the studied Mediterranean area as well as most of the aeropalynological studies throughout the world. Saad (1958) found that Gramineae and Chenopodiaceae were the most dominant pollen in Alexandria, Egypt throughout the year. He also recorded pollen of Palmae, Polygonaceae, Cruciferae, Cyperaceae, Myrtaceae, Moraceae and Casuarinaceae during the spring season. Another study done in Alexandria, Egypt was that of El-Ghazaly and Fawzy (1988) who recorded several allergenic taxa including Gramineae, Casuarina, Urtica, Cupressus, Chenopodiaceae, Cruciferae, Leguminosae, Pinus, Rosaceae, and Compositae. Haberle et al. (2014) found that the most significant taxa are Poaceae and Cupressaceae, making up over 50% of the total airborne pollen in urban environments throughout the year in Australia and New Zealand. Minerals play many important roles in regulating body chemistry. Minerals are not only required for glandular activity, but also they serve to regulate the nervous system and every other system of the body. Toxic amounts of any nutrient will displace other vital nutrients and by doing so, result in various metabolic dysfunctions, including a wide variety of allergies. Chemical analysis of pellets containing pollen grains for the most expected allergic taxa was done to investigate the type of elements they contain; the results showed that all the pollen grains contain S, Cl, K and Ca with different amounts. Al and P are found in most taxa in moderate amounts. Cu and Zn present in most of the taxa, but in very few amounts. Na, Mg, Si and Fe are the lowest amounts and in very few taxa only (Table 2). Stohs and Miller (2014)studied a caseof individualsallergic to sulfite and sulfonamides and became allergic to acesulfame potassium and sulfur containing compounds. These results indicate that S and K may induce allergic symptoms. When comparing the numberof patients having chest problems during the year of study in Rosetta, Egypt with the number of pollen trapped during this period (Table 3), we found that pollen grains may affect in some months but there are other factors rather than pollen causing allergy in Rosetta. The Multiple regression analysis between numbers of patients and the environmental parameters shows that there is a significant correlation between the environmental parameters (minimum temperature, total rainfall and relative humidity) and number of patients.

Table 3: Numbers of patients having chest problems versus number of airborne pollen during the year of study in Rosetta, Egypt.

Month	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16
Pollen	50	121	128	122	41	85	247	380	419	237	114	47
Number of Patients	360	322	240	270	351	466	465	330	420	320	225	226

Conclusions

The pollen calendar of Rosetta, Egypt is similar to most of Mediterranean studies as nearly all pollen types are recorded in other studies in the Mediterranean area and elsewhere in the world. Most of the recorded pollen grains exhibit allergenic effects and the most influential in Rosetta are pollen of Poaceae, Arecaceae, Chenopodiaceae, Amaranthaceae, Casuarina, Cupressaceae and Urtica.According to the present study, pollen found in the atmosphere may affect the number of patients but there are other factors rather than pollen causing allergy in Rosetta such as dust and pollution.

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References

[1]. Agashe, S. N., Bapat, B. N., Bapat, H. N. and Philip, E., 1994. Aerobiology of Casuarina pollen and its significance as a potential aeroallergen. Aerobiologia,10(2): 123-128.

[2]. Burton, P. K. and Katelaris, C. H., 2007. Characteristics of the Casuarina pollen season in the Sydney District, NSW. J. Allergy Clin. Immunol., 119(1): S102.

[3]. Charpin, D., Calleja, M., Lahoz, C., Pichot, C. and Waisel, Y., 2005. Allergy to cypress pollen. Allergy, 60: 293–301.

[4]. Cohen, J., 1988. Statistical power analysis for the behavioral sciences (2nd edition). Hillsdale, NJ: Lawrence Erlbaum Associates.

[5]. D'Amato, G., Cecchi, C., Bonini, S., Nunes, C., Annesi-Maesano, I., Behrendt, H., Liccardi, G., Popov, T. and van Cauwenberge, P., 2007. Allergenic pollen and pollen allergy in Europe. Allergy, 62: 976-990.

[6]. De La Cruz, D. R., Sánchez-Reyes, E. and Sánchez-Sánchez, J., 2012. Analysis of Chenopodiaceae-Amaranthaceae airborne pollen in Salamanca, Spain. Turk. J. Bot., 36: 336-343.

[7]. Di Felice, G., Barletta, B., Tinghino, R. and Pini, C., 2001. Cupressaceae pollinosis: identification, purification and cloning of relevant allergens. Int. Arch. Allergy Immunol., 125(4): 280-289.

[8]. Docampo, S., Recio, M., Trigo, M. M., Melgar, M. and Cabezudo, B., 2007. Risk of pollen allergy in Nerja (southern Spain): a pollen calendar. Aerobiologia, 23:189–199.

[9]. Dušička, J., Mičieta, K., Brutovska, E., Samelova, A., Ščevkova, J., Zamečnikova, M. and Terenova, A., 2013. Aeropalynological aspects in the detection of the quality of air in Bratislava. Ekol. Bratislava, 32 (1): 39‒53.

[10]. El-Ghazaly, G. and Fawzy, M., 1988. Pollen calendar of Alexandria (Egypt), 1981-1982. Grana 27: 85-87.

[11]. Essien, B. C. and Agwu, C. O. C., 2013. Aeropalynological study of Anyigba, Kogi State, Nigeria. Stand. Sci. Res. Essays, 13: 347-351.

[12]. Fountain, D. W. and Cornford. C. A., 1991. Aerobiology and allergenicity of Pinus radiate pollen in New Zealand. Grana, 30: 71-75.

[13]. Frei, T. and Wüthrich, B., 1997. Das nationale Pollen messnetz in der Schweiz auf Hintergrund epidemiologischer Entwicklung zur Pollen allergie. In: 4. Europäisches Pollenflug-Symposium, 28 February–2 March 1997, Bad Lippspringe, p. 27-29.

[14]. Friedhoff, L. R., Ehrlich-Kantzky, E., Grant, J. H., Meyers, D. A. and Marsh, D. G., 1986. A study of the human response to Lolium perenne (rye) pollen and its components, Lol p 1 and 2 (rye I and rye II). J. Allergy Clin. Immunol., 78:1190-1201.

[15]. Galán, C., Carinanos, P., Alcázar, P. and Dominguez, E., 2007. Spanish Aerobiological Network (REA): Management and Quality Manual. Ed. Córdoba: Servicio de Publicaciones de la Universidad de Córdoba, Spain.

[16]. Garcia, J. J., Trigo, M. M., Cabezudo, B., Recio, M., Vega, J. M., Barber, D., Carmona, M. J., Cervera, J. A., Toro, F. J. and Miranda, A., 1997. Pollinosis due to Australian pine (Casuarina): An aerobiologic and clinical study in southern Spain. Allergy, 52(1):11-17.

[17]. Gibbs, J. E. M., 2015. Eucalyptus pollen allergy and asthma in children: A cross-sectional study in South-East Queensland, Australia. PLoS One, 10(5): e0126506.

[18]. Haberle, S. G., Bowman, D. M. J. S., Newnham, R. M., Johnsyin, F. H., Beggs, P. J., Buters, J.,

Campbell, B., Erbas, B., Godwin, I., Green, B. J., Huete, a., Jaggard, A. K., Medek, D., Murray, F., Newbing, Ed., Thibaudon, M., Vicendese, D., Williamson, G. J. and Davies, J. M., 2014. The Macroecology of airborne pollen in Australian and New Zealand urban areas. PLoS One, 9(5): e97925.

[19]. Hasnain, S. M., Al-Frayh, A. R., Subiza, J. L., Fernández-Caldas, E., Casanovas, M., Geith, T., Gad-El-Rab, M. O., Koshak, E., Al-Mehdar, H., Al-Sowaidi, S., Al-Matar, H., Khouqeer, R., Al-Abbad, K., Al-Yamani, M., Alaqi, E., Musa, O. A. and Al-Sedairy, S., 2012. Sensitization to indigenous pollen and molds and other outdoor and indoor allergens in allergic patients from Saudi Arabia, United Arab Emirates, and Sudan. World Allergy Organ. J., 5(6): 59-65.

[20]. Hirst, J. M., 1952. An automatic volumetric spore trap. Ann. Appl. Biol., 39: 257-265.

[21]. Howlett, B. J., Vithanage, H. M. V. and Knox, R. B. 1981. Pollen antigens, allergens and enzymes. - In: Commentaries in plant science. Vol. 2. (ed. H. Smith), Pergamon Press, Oxford, p. 191-207.

[22]. Ishizaki, T., Koizumi, K., Ikemori, R., Ishiyama, Y. and Kushibiki, E., 1987. Studies of prevalence of Japanese cedar pollinosis among residents in a densely cultivated area. Ann. Allergy, 58:265‑270.

[23]. Majd, A. and Ghanati, F., 1995. The effect of air pollution on pollen grain allergenicity of Pinus elderica (Pinaceae) pollen. Grana, 34: 208-211.

[24]. Myszkowska, D., Jenner, B., Stępalska, D. and Czarnobilska, E., 2011. The pollen dynamics and the relationship among some pollen season characteristics (start, end, annual total, pollen season phases) in Kraków, Poland, 1991–2008. Aerobiologia, 27(3): 229–238.

[25]. O'Rourke, M. K., 1996. Chapter 23F. Medical palynology; in Jansonius, J. and McGregor, D. C. (ed.), Palynology; principles and applications. American Association of Stratigraphic Palynologists Foundation, 3: 945-955.

[26]. Radwan, R. A., Barakat, M. M., Selim, M. A. and Fouda, E. E., 2006. Date palm pollen: A significant asthma and allergy inducer. J. Allergy Clin. Immunol., 117(2): S111.

[27]. Roopashree, S., Somashekar, R. K. and Prasanna Kumar, C. N., 2014. Study on airborne pollen in the atmosphere of Bangalore city. Int. J. Adv. Res., 2(4): 83-89.

[28]. Saad, S. I., 1958. Studies in atmospheric pollen grains and fungus spores at Alexandria. I. A daily census of pollen. Egypt. J. Bot., 1: 53-61.

[29]. Sahney, M. and Chaurasia, S., 2008. Seasonal variations of airborne pollen in Allahabad, India. Ann. Agric. Environ., 15: 287–293.

[30]. Spieksma, F. Th. M., 1991. Regional European pollen calendars. In G. D'Amato, F. Th. M. Spieksma, and S. Bonini (Eds.), Allergenic pollen and pollinosis in Europe (p.49–65). Oxford: Blackwell Sci. Publ.

[31]. Stohs, S. J. and Miller, M. J., 2014. A case study involving allergic reactions to sulfur-containing compounds including sulfite, taurine, acesulfame potassium and sulfomnides. Food Chem. Toxicol., 63: 240-243.

[32]. Tiotiu, A., Brazdova, A., Longé, C., Gallet, P., Morisset, M., Leduc, V., Hilger, C., Broussard, C., Couderc, R., Sutra, J. P., Sénéchal, H. and Poncet, P., 2016. Urticadioica pollen allergy: Clinical, biological, and allergomics analysis. Ann. Allergy Asthma Immunol., 117(5):527-534.

[33]. Türe, C. and Böcük, H., 2009. Analysis of airborne pollen grains in Bilecik, Turkey. Environ. Monit. Assess., 151: 27‑35.

PLATE 1

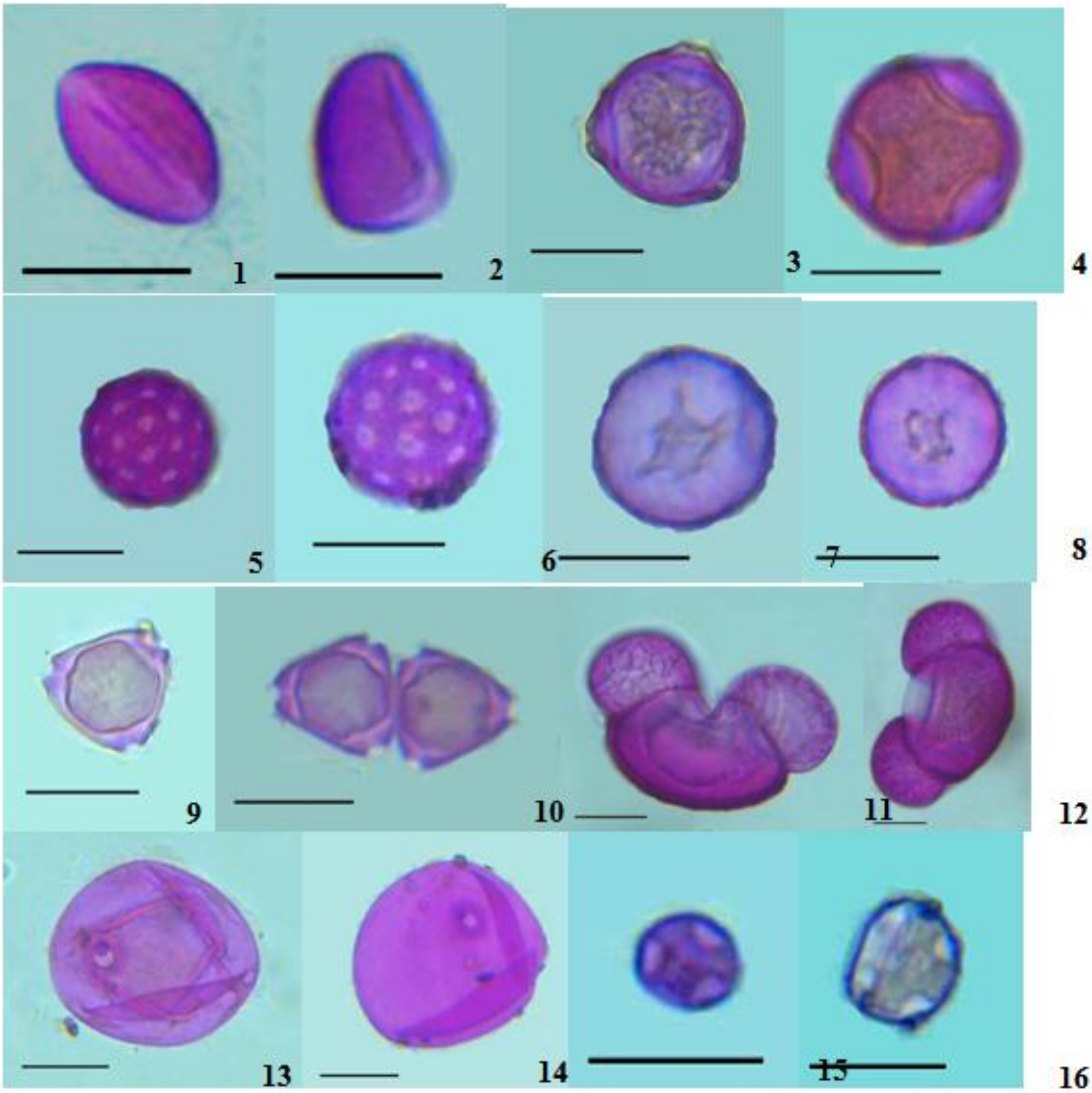

Plate 1. *(Scale bar = 20 µm): 1, 2. Arecaceae; 3, 4.Casuarina sp.;5, 6. Chenopodiaceae/Amaranthaceae; 7, 8. Cupressaceae; 9, 10.Myrtaceae;11, 12.Pinussp.; 13, 14.Poaceae; 15, 16. Urtica spp.*