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POLLEN MORPHOLOGY OF SELECTED ALLERGENIC SPECIES AT BEŞEVLER 10. YEAR CAMPUS, ANKARA UNIVERSITY, TURKEY

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ABSTRACT. Although airborne pollen is invisible to the eye, it has been known as a major source to respiratory allergic reactions. For this reason, relationship between the morphological characteristics of airborne pollen and their potential tendency as an allergen are still obscure. In the present study, we selected 29 allergenic species at Beşevler 10. year campus and investigated their detail pollen characteristics using light and scanning electron microscopies. 11 of the allergic plants on campus are also important for beekeeping.

1. INTRODUCTION

Recently, allergic diseases have developed pandemic health problem. That's why allergic diseases are considered to be one of the most important contemporary public health problems affecting up to 15–35% of humans worldwide. In our country, it has been reported that 25-30% of the population is affected by one or more allergic diseases [1]. Generally, abundant allergenic pollen plants are located in suitable green space of urban areas, producing allergenic pollen. University campuses have very important green space and plant diversity. A large number of allergic pollen spreads from campus plants and they disperse in the atmosphere of the city. Allergies during college years impact the quality of life by interfering with the daily activities, poor attendance to college, sleep disturbances, and inability to perform academical as well as extracurricular activities. In Basra University, majority of medical students were discovered symptoms of different allergies to 55.6% of them were allergic to dust, 26% to pollen, 18.1% to food and 10.5% to drugs [2]. An epidemiological study was performed in the students of Hacettepe University from various parts of Turkey to find the prevalence of asthma and allergic diseases and search for geographical

Keyword and phrases. Allergy, plant, pollen, beekeeping, Beş evler 10. year campus, Ankara, Turkey

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differences in Turkey by Kalyoncu et al. [3]. A questionnaire related with symptoms of asthma and allergic diseases was distributed to 4600 students and filled by 4331 students (1884 males, 43.5%-2447 females, 56.5%). They found that the current prevalences of the seasonal and perennial pollen hypersensitivities were 5.2%. Again, Kalyoncu et al. found that the first-year university students to determine prevalence of asthma, and allergic diseases and prevalence % of asthma, current wheeze and seasonal rhinitis were 2.1, 6.9 and 12.7 in boys, and 2.5, 7.2 and 14.5 in girls [4]. No such study has been conducted for the Beşevler 10. year campus.

The pollen morphology studies are used in systematics, melissopalynology, jeopalynology and aeropalynology [5–7]. Pollen characters such as number and position of the apertures and details of sculpturing of the exine are of taxonomic values among of allergenic pollen grains. To provide scientific basis for campus green space construction, the pollen morphology of allergenic plants were reviewed in this study. In this study, pollen grains of 29 widely herbs, shrubs, beside planted campus trees are examined and measured and photographed by light (LM) and scanning electron (SEM) microscopes.

2. Materials and Methods

The materials used for the present study were collected from the Beşevler 10. Year campus during February-December 2019. The study area is situated at an altitude of 860 m above sea level. The taxonomic status of studied species, their life form and span, and collector names were given in Table 1. Pollen slides were prepared using the technique of Wodehouse [8]. Pollen grains were placed in glycerin jelly, stained with safranin, and studied under a light microscope. Photographs were taken with a Leica DM 1000 digital photomicrograph system (Germany). Measurements were based on 20 or more pollen grains for each species.

For SEM studies, dry pollen grains were mounted on stubs and coated with gold. Morphological observations were made with a ZEISS EVO 40 Scanning Electron Microscope. The terminology used is mainly that of Faegri and Iversen [9], and Punt et al. [10,11].

TABLE 1. The taxonomic status of studied species, their life form and span, and collector name

Family	Species	Life form	Life span	Collector	Blooming time	Origin
Sapindaceae	*Acer pseudoplatanus*	Tree Deciduous	Perennial	Aydan Acar Şahin	March-May	Native
Betulaceae	*Betula pendula*	Tree Deciduous	Perennial	Aydan Acar Şahin	April-May	Native
Betulaceae	*Carpinus betulus*	Tree Deciduous	Perennial	Aydan Acar Şahin	July-August	Native
Cupressaceae	*Chamaecyparis lawsoniana*	Tree Evergreen	Perennial	Aydan Acar Şahin	March-April	Exotic
Cupressaceae	*Cupressus arizonica*	Tree Evergreen	Perennial	Aydan Acar Şahin	March-April	Exotic
Oleaceae	*Fraxinus excelsior*	Tree Deciduous	Perennial	Aydan Acar Şahin	March-April	Native
Juglandaceae	*Juglans regia*	Tree Deciduous	Perennial	Nur Münevver Pınar	May	Native
Moraceae	*Morus alba*	Tree Deciduous	Perennial	Nur Münevver Pınar	May	Native
Platanaceae	*Platanus orientalis*	Tree Deciduous	Perennial	Aydan Acar Şahin	March-May	Native
Salicaceae	*Populus alba*	Tree Deciduous	Perennial	Nur Münevver Pınar	March-April	Native
Fagaceae	*Quercus robur*	Tree Deciduous	Perennial	Nur Münevver Pınar	April	Native
Salicaceae	*Salix babylonica*	Tree Deciduous	Perennial	Nur Münevver Pınar	April	Native
Ulmaceae	*Ulmus campestris*	Tree Diciduous	Perennial	Aydan Acar Şahin	February-March	Native
Betulaceae	*Corylus avellana*	Shrub Deciduous	Perennial	Aydan Acar Şahin	February-March	Native

TABLE 1. The taxonomic status of studied species, their life form and span, and collector name (continued)

Family	Species	Life form	Life span	Collector	Blooming time	Origin
Anacardiaceae	*Cotinus coggygria*	Shrub Deciduous	Perennial	Nur Münevver Pınar	May-June	Native
Cupressaceae	*Juniperus oxycedrus*	Shrub Evergreen or Tree Evergreen	Perennial	Aydan Acar Şahin	late October to early November	Native
Oleaceae	*Ligustrum japonicum*	Shrub Evergreen	Perennial	Nur Münevver Pınar	late May to early June	Exotic
Asteraceae	*Artemisia vulgaris*	Herb	Perennial	Aydan Acar Şahin	July-September	Native
Amaranthaceae	*Atriplex laevis*	Herb	Annual	Aydan Acar Şahin	May-July	Native
Asteraceae	*Cirsium arvense*	Herb	Perennial	Aydan Acar Şahin	May-October	Native
Poaceae	*Cynodon dactylon*	Herb	Perennial	Nur Münevver Pınar	April-November	Native
Amaranthaceae	*Chenopodium album*	Herb	Annual	Nur Münevver Pınar	May-August	Native
Apiaceae	*Daucus carota*	Herb	Biennial	Nur Münevver Pınar	June	Native
Poaceae	*Dactylis glomerata*	Herb	Perennial	Nur Münevver Pınar	May-July	Native
Poaceae	*Phleum exaratum*	Herb	Perennial	Nur Münevver Pınar	June-August	Native
Poaceae	*Poa pratensis*	Herb	Perennial	Nur Münevver Pınar	May-August	Native
Asteraceae	*Senecio vulgaris*	Herb	Annual	Aydan Acar Şahin	March-August	Native

3. Results and Discussion

A total of 29 allergenic plants were collected from Beşevler 10. year campus of Ankara University-namely-trees; *Acer pseudoplatanus, Betula pendula, Carpinus betulus, Chamaecyparis lawsoniana, Cupressus arizonica, Fraxinus excelsior, Juglans regia, Morus alba, Platanus orientalis, Populus alba, Quercus robur, Salix babylonica, Ulmus campestris,-* shrubs*; Corylus colurna, Cotinus coggygria, Juniperus oxycedrus, Ligustrum japonica,- herbs; Artemisia vulgaris, Atriplex laevis, Cirsium arvense, Cynodon dactylon, Chenopodium album, Daucus carota, Dactylis glomerata, Phleum exaratum, Poa pratensis, Senecio vulgaris, Urtica dioca* and *Xanthium spinosum.* The allergenic plants collected belonged to 12 families identified included Amaranthaceae, Anacardiaceae, Apiaceae, Asteraceae, Betulaceae, Cupressaceae, Fagaceae, Juglandaceae, Moraceae, Oleaceae, Platanaceae, Poaceae, Salicaceae, Sapindaceae and Ulmaceae. Among them 11% are exotic taxa and 89% are native (Table 1 and Figure 1). The use of some exotic species as ornamentals in towns and cities release large amounts of pollen with a demonstrated allergenic capacity [12,13]. It has been established that 51% of exotic plants used in Ankara landscape cause allergic reactions [13]. Among the studied most allergenic plants in campus, the percentage of the herbaceous was 21.42%, the woody was 42.85% and the shrubby was 35.73%.

When spring allergy season first starts, causing you to sniffle and sneeze, tree pollen is to blame. Trees start producing pollen as early as February in the campus. The trees keep producing pollen through June and produce exhibiting the highest pollen production levels between anemophilous species [13]. General blooming times of all allergenic plants are February-December. A significant portion of allergenic pollen is produced by larger perrennial plants, shrubs and trees. Pollen production per inflorescens in perrennial grasses was up to 3.5 times higher than annual [14]. The percentage of the perrennial plant was 11%, and the annual was 89% in the campus (Figures 1-2).

The main palynological features of the allergenic specimens that were examined are summarised in the Table 2 and are shown in Figures 3-9. The size, symmetry, shape, aperture, ornamentation of the pollen were determined and the results were compiled.

Table 2. The main palynological features of the allergenic specimens of Beştepe 10. Year campus

Species	Polar axes (P) (µm)	Equatorial axes (E) (µm)	Pollen shape	Exine thickness (µm)	Intine thickness (µm)	Ornamentation	Aperture type	Aperture percullarities	Polarity	Pollen unit	Pollen coating	Tectum type	Ubish Bodies	Pollination type Abiotic-wind / Biotic-insect)s/ Both
Acer pseudoplatanus	23-32 µm	24-41	Oblate Or Spheroidal	1.25 - 1.75	0.25-1	Striate-Reticulate -Perforate	Tricolpate	Aperture Membran Smooth	Isopolar	Monad	Pollenkitt	Eutectate	+	Both
Betula pendula	16-32	23-34	Suboblate Or Spheroidal	1-2	0.75-1	Granulate	Triporate, Rarely Diporate Or Tetraporate	Vestibulum, Oncus, Operculum	Isopolar	Monad	--	Pertectate	+	Wind
Carpinus betulus	32-40	38-45	Suboblate	1-1,25	0.5	Granulate	Tetra Or Pentporate	Oncus, Operculum	Isopolar	Monad	-----	Pertec	+	Wind
Chamaecyparis lawsoniana	25-32	25-32	Spheroidal	0.5	0,1-0,3	Granulate	Inaperturate Pseudoporate	---	Isopolar	Monad	------	Eutectate	+	Wind
Cupressus arizonica	25-30	25-30	Spheroidal	0.6-1	0,3-0,5	Granulate	Inaperturate-Pseudoporate	---	Isopolar	Monad	-----	Eutectate	+	Wind
Fraxinus excelsior	17-25	18-28	Spheroidal, Suboblate	1-1.5	0,75-1	Reticulate	Tricolpate	Aperture Membrane Granulate	Isopolar	Monad	Pollenkitt	Semitectate	-----	Wind
Juglans regia	35-46	42-47	Spheroidal, Suboblate	1-1.5	0,25-0,5	Scabrate	Pantoporate	Operculum, Annulus	Isopolar	Monad	----	Eutectate	----	Wind
Morus alba	17-21	18-23	Spheroidal	0.9	1	Granulate	Triporate, Rarely Tetraporate	Operculum	Isopolar	Monad	---	Pertectate	---	Wind
Platanus orientalis	17-25	17-25	Spheroidal	2,5-3	0.75-1	Reticulate	Tricolpate Rarely Tetracolpate	Aperture Membrane Granulate	Isopolar	Monad	----	Semitectate	+	Wind
Populus alba	22-36	22-36	Spheroidal	1-1.3	0,5-1	Granulate	Inaperturate	----	Isopolar	Monad	Pollenkitt		+	Wind
Quercus robur	21-25,7	23.7 - 28.7	Spheroidal Rarely Suboblate or Oblate	1,2-1,5	0.5-1	Verrucate	Tricolpate	---	Isopolar	Monad	----	Semitectate	+	Wind
Salix babylonica	14-15	18-25	Spheroidal	0,9-1,5	0.25-6	Reticulate	Tricolpate	Aperture Membrane Granulate	Isopolar	Monad	Pollenkitt	Semitectate	----	Insects
Ulmus campestris	25-35	28-35	Spheriodal	0.9-3	1-1,17	Rugulate	Tetraporate Or Hekzaporate	---	Heteropolar	Monad	---	Semitectate	---	Wind

Species	Polar axes (P) (µm)	Equatorial axes (E) (µm)	Pollen shape	Exine thickness (µm)	Intine thickness (µm)	Ornamentation	Aperture type	Aperture percullarities	Polarity	Pollen unit	Pollen coating	Tectum type	Ubish Bodies	Pollination type Abiotic-wind / Biotic-insect)s/ Both
Corylus avellana	20-25	25-30	Suboblate	1,2-1,5	0.5	Granulate	Triporate Rarely Tetraporate	Annulus, Operculum, Oncus	Isopolar	Monad	----	Semitectate	+	Wind
Cotinus coggygria	25-30	20-32	Subprolate	1-1,5	0.5-1	Striate-Reticulate	Tricolporate	----	Isopolar	Monad	----	Semitectate	----	Insects
Juniperus oxycedrus	20-36	20-36	Spheroidal	0.6-1.5	0,3-0,8	Granulate	Inaperturate, -Pseudoporate	----	Heteropolar	Monad	-----	Eutectate	+	Wind
Ligustrum japonicum	25-30	30-34	Spheroidal	1.9	1	Reticulate	Tricolporate	Aperture Membrane Psilate	Isopolar	Monad	-----	Semitectate	----	Insects
Artemisia vulgaris	10-25	10-25	Spheroidal	2-3	0,75-1	Scabrate	Tricolporate	Aperture Membrane Granulate	Isopolar	Monad	-----	Semitectate	-----	Wind
Atriplex laevis	13,5-25	13,5-25	Spheroidal	1-1.6	0,5-0,8	Scabrate	Pantoporate	Operculum	Isopolar	Monad	Pollenkitt	Semitectate	+	Both (Mostly Wind)
Cirsium arvense	25-32	30-35	Suboblate	3-5	0,75-1	Echinate-Perforate	Tricolporate Rarely Tetracolporate	----	Isopolar	Monad	Pollenkitt	Semitectate	-----	Insects
Cynodon dactylon	25-30	25-30	Spheroidal	1-1.25	0,5-0,75	Granulate	Monoporate	Annulus, Operculum	Heteropolar	Monad	-----		+	Wind
Chenopodium album	20-35	20-35	Spheroidal	1-1.25	0,3-0,	Scabrate	Pantoporate	Operculum	Isopolar	Monad	Pollenkitt	Semitectate	+	Both (Mostly Wind)
Daucus carota	20-27	12-17	Perprolate	3,6	1.1	Rugulate-Perforate	Tricolporate	Costae	Isopolar	Monad	---	Semitectate	+	Wind
Dactylis glomerata	26-38	26-38	Spheroidal	0.75-1	0,98-1,25	Granulate	Monoporate	Operculum, Annulus	Heteropolar	Monad	----	Semitectate	+	Wind
Phleum exaratum	25-30	25-30	Spheroidal	1-1.25	0,5-0,75	Granulate	Monoporate	Operculum, Annulus	Heteropolar	Monad	----	Semitectate	+	Wind
Poa pratensis	20-25	20-25	Spheroidal	0,7-1	0,7-1	Granulate	Monoporate	Operculum, Annulus	Heteropolar	Monad	----	Semitectate	+	Wind
Senecio vulgaris	20-23	17-22	Spheroidal or Suboblate	3-4	1	Echinate	Tricolporate	Operculum	Isopolar	Monad	Pollenkitt	Semitectate	----	Insects
Urtica dioca	10-15	12-16	Suboblate	0.7-1.0	0.1-0.4	Granulate	Triporate	Operculum, Annulus, Oncus	Isopolar	Monad	----	Eutectate	+	Wind
Xanthium spinosum	20-25	22-27	Spheroidal	1-1.5	0.75-1	Scabrate	Tricolporate	Operculum	Isopolar	Monad	Pollenkitt	Semitectate	----	Insects

*The information about the presence of ubisch bodies in pollen was adopted by PalDat (Palynological Database) [15]

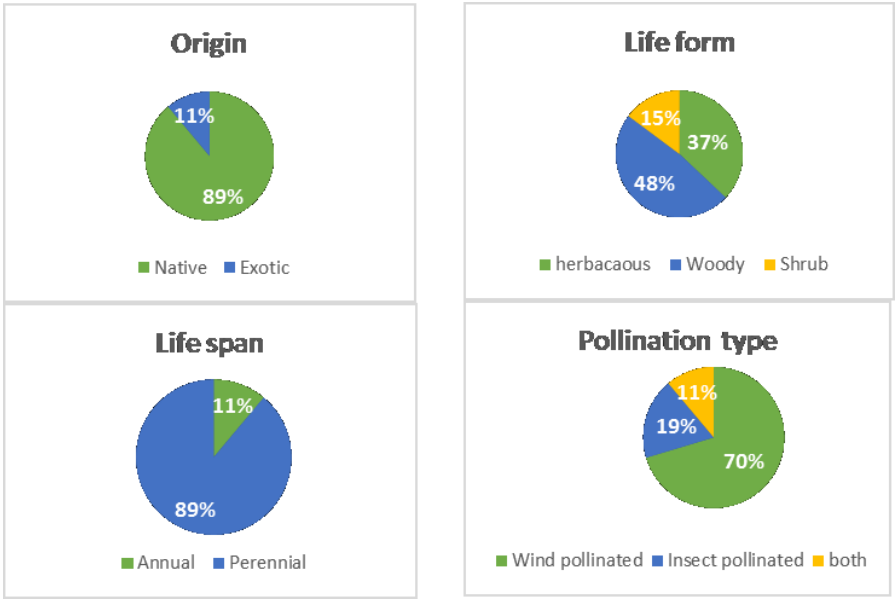

FIGURE 1. The percentages value of studied species, their origin, life form, life span and pollination type.

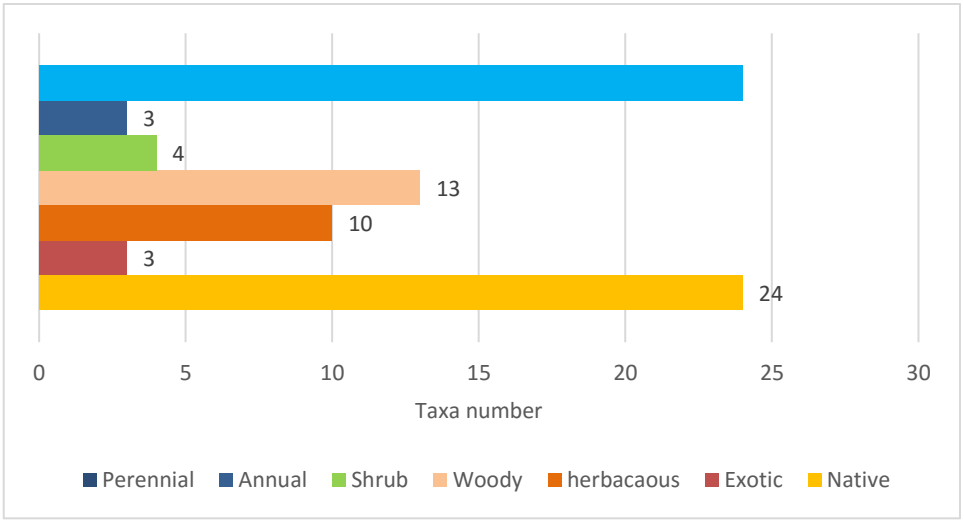

FIGURE 2. The taxa number based on the main characters of the studied taxa

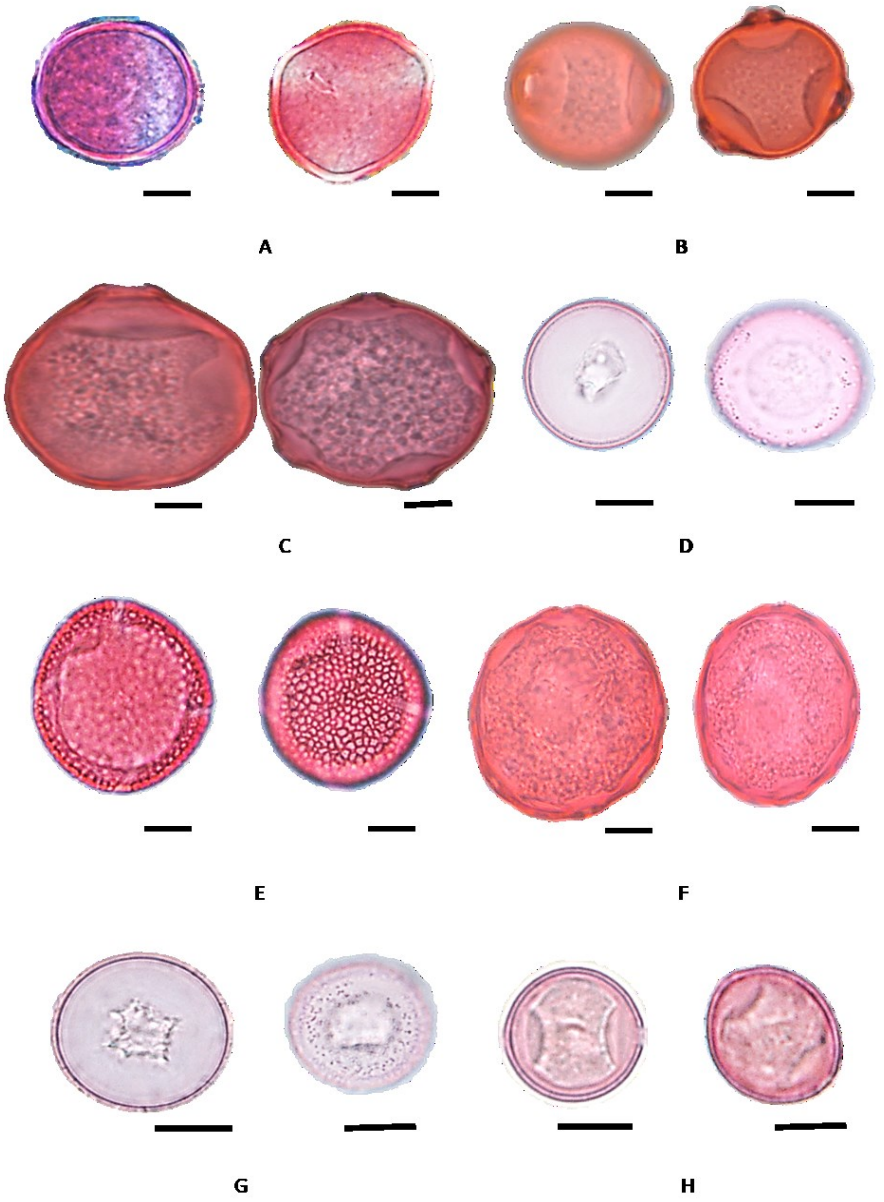

FIGURE 3. Light microscopy photos (LM) of pollen of allergic trees. A. *Acer pseudoplatanus*, B. *Betula pendula*, C. *Carpinus betulus*, D. *Cupressus arizonica*, E. *Fraxinus excelsior*, F. *Juglans regia*, G. *Chamaecyparis lawsoniana*, H. *Morus alba* (Bar=10˘m).

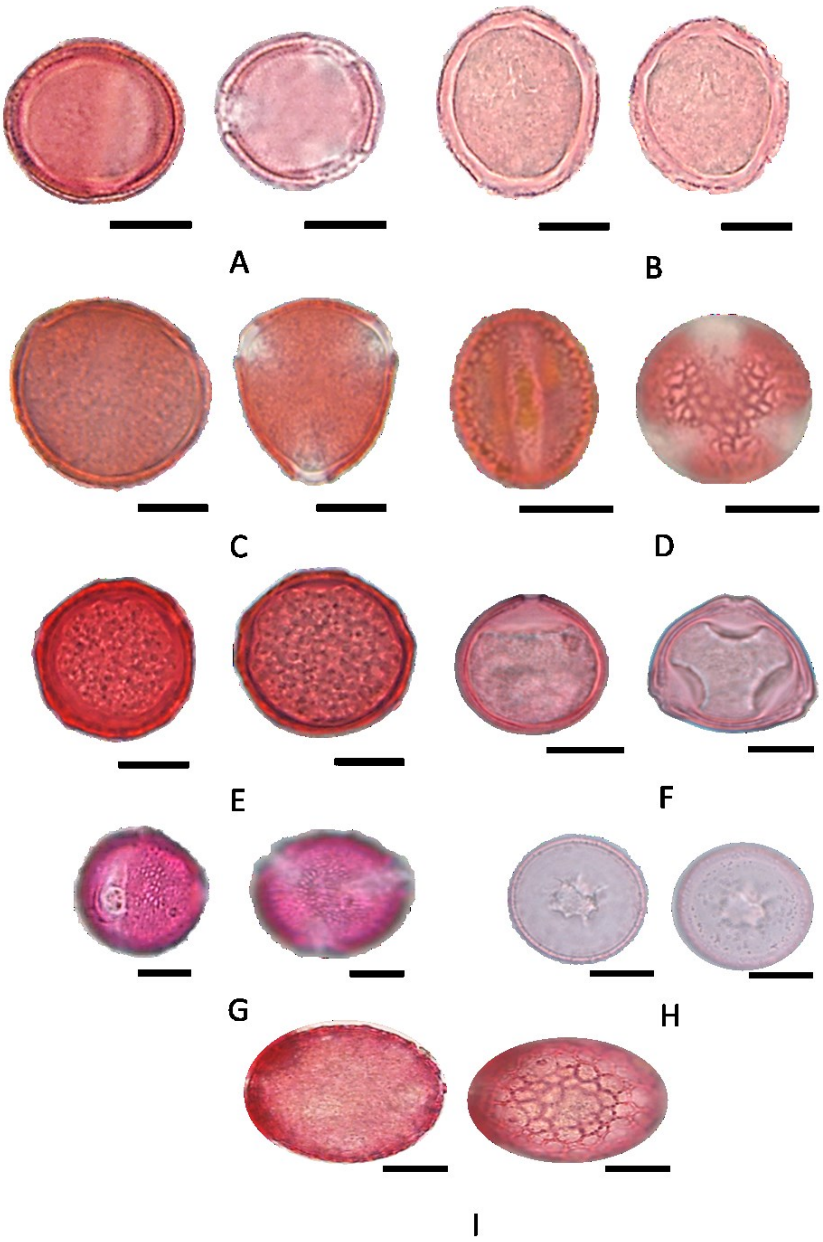
A
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FIGURE 4. Light microscopy photos (LM) of pollen of allergic trees. A. *Platanus orientalis*, B. *Populus alba*, C. *Quercus robur*, D. *Salix babylonica*, E. *Ulmus campestris,* F. *Corylus colurna,* G. *Cotinus coggygria,* H. *Juniperus oxycedrus,* I. *Ligustrum japonica* (Bar=10µm).

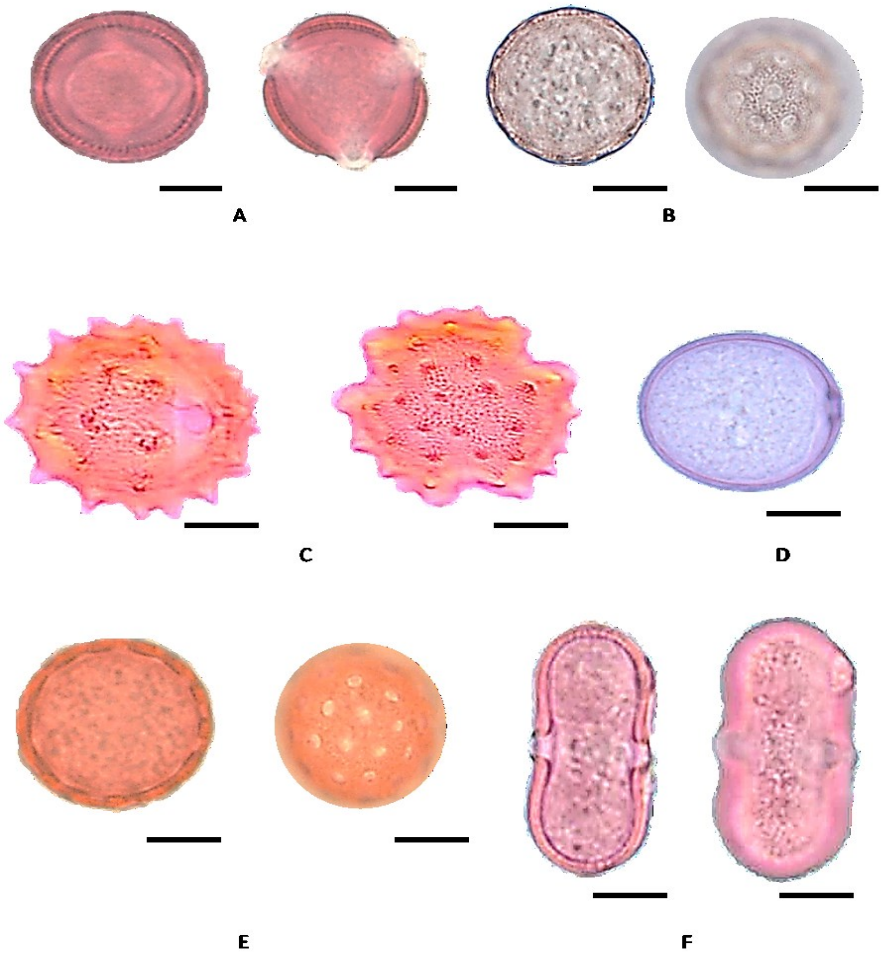

FIGURE 5. Light microscopy photos (LM) of pollen of allergic trees. A. *Artemisia vulgaris,* B. *Atriplex laevis*, C. *Cirsium arvense*, D. *Cynodon dactylon,* E. *Chenopodium album* F. *Daucus carota* (Bar=10µm).

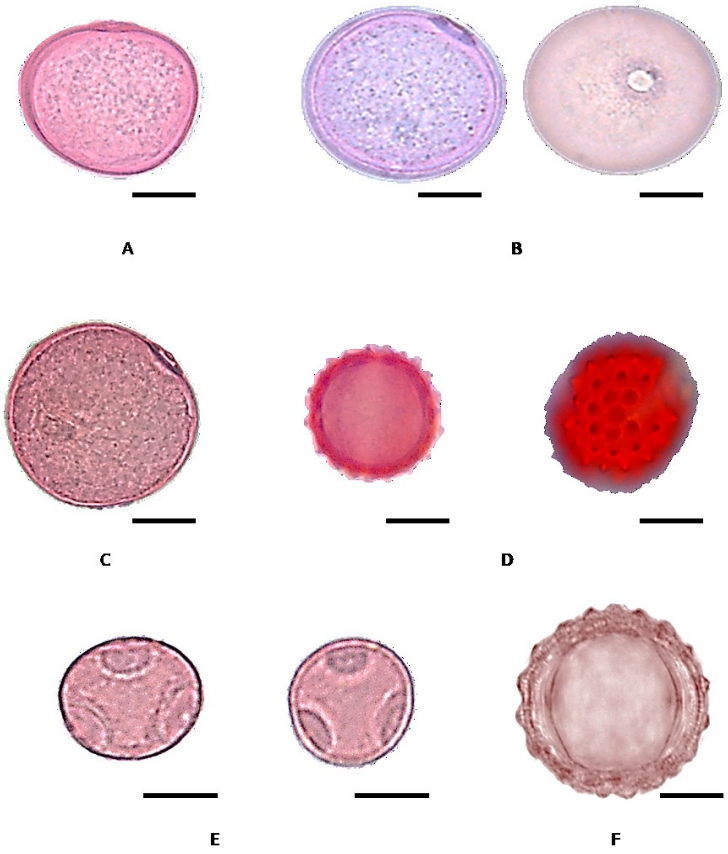

FIGURE 6. Light microscopy photos (LM) of pollen of allergic trees. A. *Dactylis glomerata,* B. *Phleum exaratum*, C. *Poa pratensis*, D. *Senecio vulgaris,* E. *Urtica dioca,* F. *Xanthium spinosum* (Bar=10µm).

The pollen grains of the allergenic plants are usually radially symmetrical and isopolar, rarely heteropolar (*Cynodon dactylon*, *Dactylis glomerata*, *Juniperus oxycedrus*, *Phleum exaratum*, *Poa pratensis* and *Ulmus campestris*). Allergenic pollen shapes of campus is oblate, spheroidal (22), suboblate (8), oblate (2), subprolate (1) and perprolate (1). Subprolate and perprolate shaped pollen grains were seen in insect pollinated. The polar axis ranging from 13.5 to 46 µm and the equatorial axis from 12 to 47 µm in this study. The dimensions are smaller in *Artemisia vulgaris* and larger in *Carpinus betulus*. Size of pollen grains vary in size (12-300 um), but are light enough to allow the wind to carry them for miles. So, in

general, wind-pollinated plants pollen grains are relatively small in size [16]. The pollen with large size, are less likely to irrittate lower airways [17].

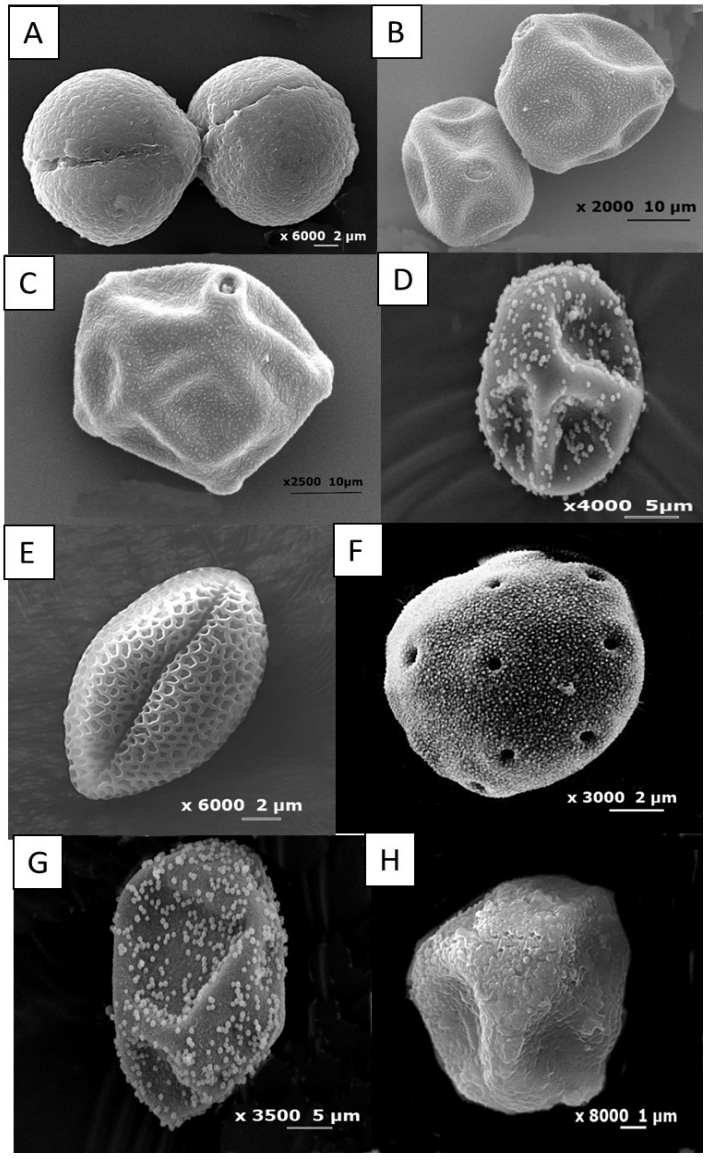

FIGURE 7. Scanning electron microscopy photos (SEM) of pollen of highly allergic trees. A. *Acer pseudoplatanus*, B. *Betula pendula*, C. *Carpinus betulus*, D. *Cupressus arizonica*,

E. *Fraxinus excelsior*, F. *Juglans regia*, G. *Chamaecyparis lawsoniana*, H. *Morus alba*. (Bar=10µm).

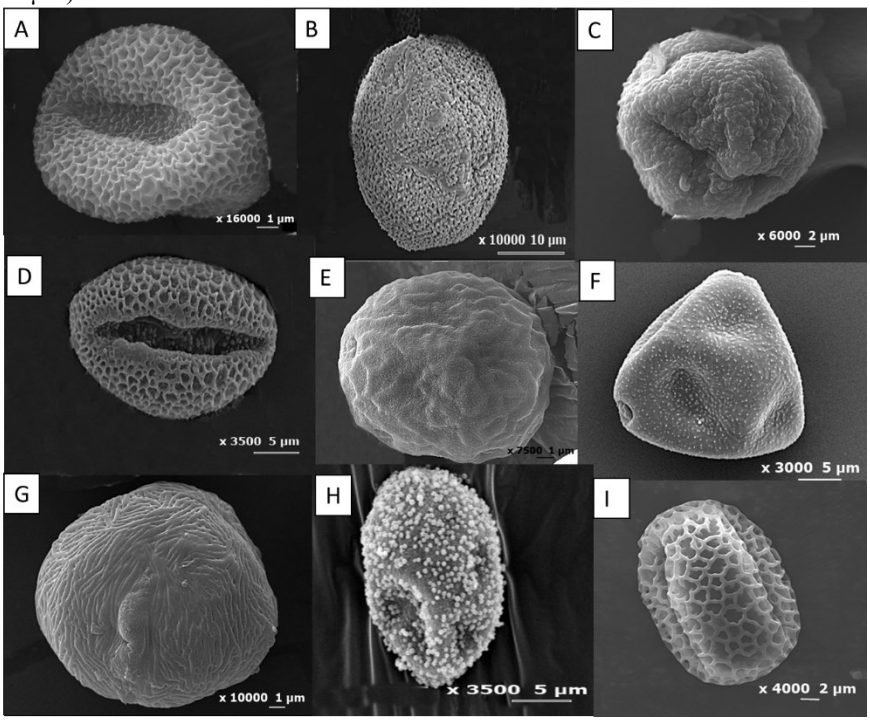

FIGURE 8. Scanning electron microscopy photos (SEM) of pollen of highly allergic trees. A. *Platanus orientalis*, B. *Populus alba*, C. *Quercus robur*, D. *Salix babylonica*, E. *Ulmus campestris,* F. *Corylus colurna,* G. *Cotinus coggygria*, H. *Juniperus oxycedrus,* I. *Ligustrum japonica* (Bar=10µm).

We could define several pollen types according to their number of aperture and surface ornamentations. The distribution of the apertures on the surface of the pollen grain is an important diagnostic feature. Six aperture types were recorded in the study (Table 2, Figure 3). This includes; inaperturate (*Chamaecyparis lawsoniana, Cupressus arizonica, Juniperus oxycedrus* and *Populus alba*), monoporate (*Cynodon dactylon, Dactylis glomerata, Phleum exaratum and Poa pratensis*), triporate or tetraporate or pentaporate (*Betula pendula*, *Carpinus betulus, Morus alba, Ulmus campestris* and *Corylus avellana*), pantoporate (*Juglans regia, Atriplex laevis* and *Chenopodium album*), tricolpate or tetracolpate (*Acer pseudoplatanus, Fraxinus excelsior, Platanus orientalis, Quercus robur* and *Salix babylonica*), tricolporate (*Artemisia vulgaris, Cirsium arvense, Cotinus coggygria, Daucus carota, Ligustrum japonicum* and *Senecio vulgaris*). All grass pollen grains are allergenic and

monoporate, having a single circular or oval pore. Worldwide, at least 40% of allergic patients are sensitized to grass pollen allergens [18]. Gymnospermae allergenic species (juniper and cypress) and poplar (Angiospermae) that can be carried long distances by the wind have inaperturate pollen.

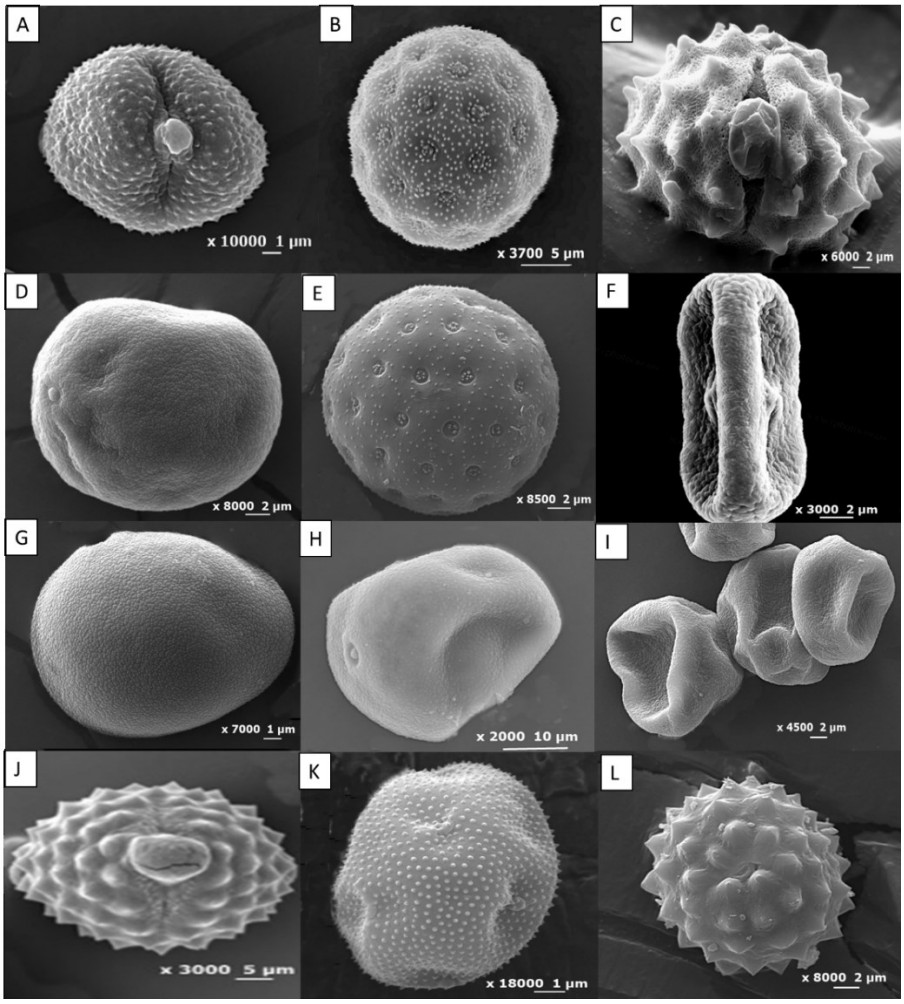

FIGURE 9. Scanning electron microscopy photos (SEM) of pollen of highly allergic weeds. A. *Artemisia vulgaris* B. *Atriplex laevis*, C. *Cirsium arvense*, D. *Cynodon dactylon,* E. *Chenopodium album* F. *Daucus carota,* G. *Dactylis glomerata,* H. *Phleum exaratum*, I. *Poa pratensis*, J. *Senecio vulgaris,* K. *Urtica dioca,* L. *Xanthium spinosum* (Bar=10µm).

Surface pattern recorded for this study as evident in Table 2 and Figure 3, include echinate *Senecio vulgaris*), echinate-perforate (*Cirsium arvense*), granulate (*Betula pendula, Carpinus betulus*, *Chamaecyparis lawsoniana, Corylus avellana, Cupressus arizonica, Cynodon dactylon, Dactylis glomerata, Juniperus oxycedrus, Morus alba, Phleum exaratum, Poa pratensis, Populus alba, Urtica dioca),* reticulate (*Fraxinus excelsior, Ligustrum japonicum, Platanus orientalis* and *Salix babylonica*), rugulate (*Ulmus campestris*), regulate-perforate (*Daucus carota*), scabrate (*Artemisia vulgaris, Atriplex laevis, Chenopodium album*, *Juglans regia, Xanthium spinosum*), striate-reticulate-perforate (*Acer pseudoplatanus*) striate-reticulate (*Cotinus coggygria*) and verrucate (*Quercus robur*). We observed that granulate is the most common ornamentation between allergic plants. Generally, granulate ornamentation was observed in pollen of wind-pollinated plants. In general, wind-pollinated plants should produce large quantities of pollen to increase pollination success [16]. In Kermanshah, 56 allergenic pollens were directly collected from nature and examined by a light and scanning electron microscope by Masoumi [15]. In our study, pollen grains were classified as reticulate, striate-reticulate, granulate, psilate, echinate, echinate-perforate, scabrate, rugulate, rugulate-perforate, verrucate and striate-reticulate-perforate in terms of ornamentation (Figure 10). Also, Moon et al. said that the echinate surface ornamentation could act as a stimulus for allergy by accumulated more allergen in the pollen ectexine [15].

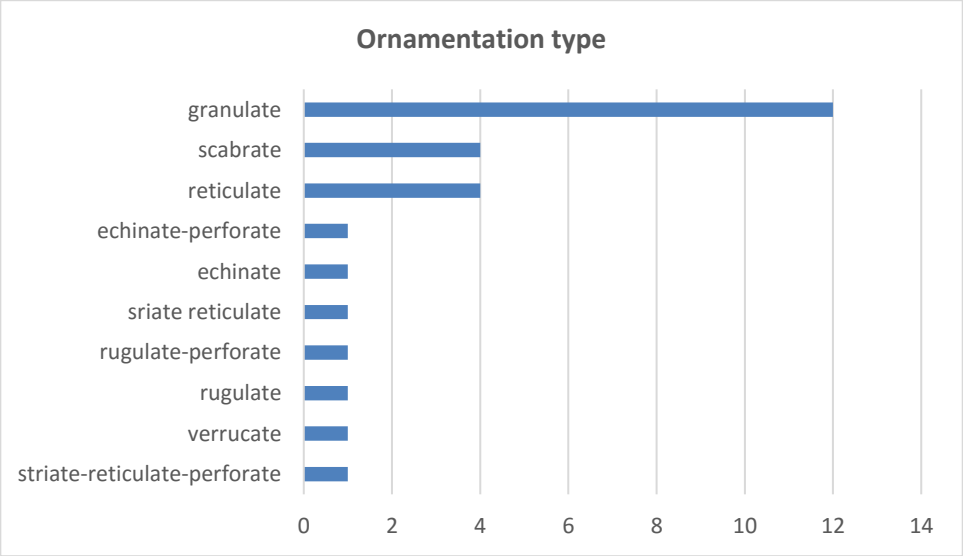

FIGURE 10. Ornamentation types of studied taxa.

Pollenkitt is a viscous material that coats grains of pollen and plays important roles in pollen dispersion and plant reproduction. Oily layer pollenkitt play a role in allergy and asthma. Because lipids can be ligands to allergenic proteins [19,20]. Pollen grains of *Acer pseudoplatanus, Atriplex laevis, Chenopodium album, Cirsium arvense, Fraxinus excelsior, Populus alba, Salix babylonica* and *Senecio vulgaris* have pollenkitt.

Most angiosperms with a secretory tapetum produce not only tryphine and pollenkitt, but also Ubisch bodies (orbicules) at the final stages of pollen maturation. It has been investigated whether orbicules also contain allergens [21]. Orbicules were detected in pollen belonging to the Betulaceae, Chenopodiaceae, Fagaceae, Poaceae, Polygonaceae and Urticaceae families. However, some clinically important *Ambrosia coronopifolia* Torr. and A. Gray, *Artemisia vulgaris* L. (Asteraceae) and *Olea europaea* L. (Oleaceae) species do not have orbicules [22,23]. It is stated that the orbicules can act as vectors in the allergen distribution in the atmosphere [23]. In our studied taxa, the orbicules are found in *Acer pseudoplatanus, Betula pendula*, *Carpinus betulus, Chamaecyparis lawsoniana, Corylus avellana, Cupressus arizonica, Juniperus oxycedrus, Platanus orientalis, Populus alba*), *Quercus robur, Ligustrum japonicum, Atriplex laevis, Cynodon dactylon, Dactylis glomerata, Phleum exaratum, Poa pratensis, Chenopodium album* and *Daucus carota* pollen. Due to their small size, orbicules can easily penetrate deeper into the lower respiratory airways than the pollen grains if dispersed into the atmosphere and inhaled by individuals [24].

Flowers provide nectar and pollen as rewards [25,26]. Despite the importance of floral diversity for proper bee nutrition, urban development has drastically altered resource availability and diversity for these important pollinators. Lau et al. (2019) have said that understanding the floral resources foraged by bees in urbanized areas is key to identifying and promoting plants that enhance colony health in those environments. They also reported that “predominant” and “secondary” pollen types belonged to the families Arecaceae, Sapindaceae, Anacardiaceae, Apiaceae, Asteraceae, Brassicaceae, Fabaceae, Fagaceae, Lythraceae, Myrtaceae, Rhamnaceae, Rosaceae, Rutaceae, Saliaceae, and Ulmaceae. Among these families, their pollen are found in highly allergic plants [27]. In Table 1, you can see the families of allergic plants in Beşevler 10. Year Campus. Allergenic *Quercus robur, Daucus carota, Acer pseudolatanus, Populus alba, Artemisia vulgaris, Juglans regia, Ligustrum japonicum, Cirsium arvense, Chenopodium album,* and *Senecio vulgaris* might respectively represent dominant, secondary, minor pollen yields for bee species in Beşevler 10. Year Campus. The pollen and nectar yields of allergenic *Salix* species are dominant and secretion honey is produced by collecting the

secretions of insects living on trees in September by honey bees [28]. It's relatively common for the pollen and other plant allergens to contaminate honey which can cause allergies. Symptoms from a honey allergy may resemble common pollen allergy symptoms [29,30]. Dutau and Rance (2009) have said that allergy to pollen grains, particularly of the Asteraceae family (mugwort, chamomilla, dandelion) are a risk factor for allergy to honey and royal jelly [31].

4. Conclusion

In this study, we have selected 29 allergenic species in Beşevler 10. year campus and investigated the detail pollen morphological properties of them using light and scanning electron microscopies. The relationship between the morphological characteristics of airborne pollen and their potential tendency as allergens has been tried to be revealed. In addition, 11 of the allergic plants on campus were observed to be important for beekeeping.

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