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THE ALLERGENIC FLORA OF TRIESTE (NE ITALY)

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ABSTRACT

In order to establish the allergenic flora of Trieste, aerobiological monitoring, clinical analysis and fieldwork were carried out at the same time. Using data from the medical and aerobiological literature, and on the basis of the data resulting from the local aerobiological and epidemiological monitoring, a selection of the over 1000 species recorded in the urban area was made to recognize the species locally inducing allergic diseases. The allergophytes growing in Trieste are 264, belonging to 26 allergenic families.

Key words: aerobiological monitoring, allergenic flora, clinical data, pollen calendar, Trieste, Italy

FLORA ALLERGENICA DI TRIESTE (ITALIA NE)

SINTESI

In parallelo al censimento floristico della città sono stati effettuati un monitoraggio aerobiologico ed un'analisi clinica al fine di conoscere la flora allergenica di Trieste. Durante il lavoro di campo sono state raccolte nell'area urbana oltre 1000 specie, poi selezionate per identificare quelle potenzialmente in grado di indurre manifestazioni allergiche da polline in sede locale. Tale selezione è stata fatta sulla base dei dati della letteratura medica e aerobiologica, dei risultati del monitoraggio pollinico dell'atmosfera di Trieste e di quelli derivanti dall'indagine clinica sulle pollinosi. Il contingente allergofitico della città risulta costituito da 264 specie appartenenti a 26 famiglie allergeniche.

Parole chiave: monitoraggio aerobiologico, flora allergenica, dati clinici, calendario dei pollini, Trieste

INTRODUCTION

Pollen with allergenic properties can induce pollenosis. The severity of the symptoms depends both on the amount of pollen grains occurring in the air and the sensitivity degree of the subject. The amount of the different pollen types occurring in the air varies greatly. Some pollen types are recorded only sporadically, others are always present in great amounts. Seasonal variations occur, depending on the flowering time of every species. Great variations in airborne pollen concentration are possible from year to year. Pollen from anemophilous species is usually the most relevant in inducing allergic disease due to high quantity in the air (D'Amato *et al.*, 2001). Grass pollen is the most common cause of pollenosis in Europe (Weeke & Spieksma, 1991). According to Jäger & D'Amato (2001), the most allergenic trees in Europe are *Betula*, *Olea* and *Cupressus*; of reduced allergenic significance are *Alnus*, *Corylus*, *Platanus* and *Castanea*. The most allergenic weeds are *Ambrosia*, *Artemisia* and *Parietaria*, while *Plantago*, *Chenopodium*, *Rumex*, *Mercurialis annua* and *Brassica napus* show minor allergological interest. Entomophilous species are scarcely significant in pollen allergy due to their low pollen amount in the environment, although they can be allergenic in subjects living in their proximity (Ariano *et al.*, 1991a). Isolated cases of occupational pollenosis have also been reported for some cultivated plants (*e.g.* Ariano *et al.*, 1991b; Garcia-Ortega *et al.*, 2001).

The aim of the present study is to draw up the allergenic flora of the town of Trieste. Aerobiological monitoring, clinical analysis and field work were carried out at the same time, in order to recognise, according to specific literature and on the basis of the data resulting from the local aerobiological and clinical monitoring, the town's allergenic flora.

MATERIAL AND METHODS

Study area

Trieste is situated on the coast of the North-Adriatic Sea and at the base of the Karst plateau. The town lies on clay and sandy rocks (Eocenic flysch) and deposited quaternary sediments, sited mainly along the coast. In the studied area, Euro-Siberian and Mediterranean vegetation coexist (Poldini, 1989). On the coast, hop hornbeam and holm oak scrub prevail, while the arenaceous hills around the town are rich with mixed mesophilous and thermophilous oak woods. On the outskirts of the town and in its urban area, anthropogenic and ruderal vegetation is common, due to the construction of buildings, roads, highways, and relating to industrial ducts and horticultural activities (Rizzi Longo & Martini, 2000).

Aerobiological data

Airborne pollen was collected using a Hirst type 7-day recording volumetric spore trap (Burkard type) placed 20 m above the ground level at Bastione Fiorito of San Giusto Castle, in the town centre. The samples were collected, prepared, and analysed according to the standard method adopted by the Italian Aeroallergen Network (Mandrioli, 1990). On the basis of the most abundant airborne pollen grains recorded from 1996 until 1999, the pollen calendar for Trieste was constructed.

Clinical data

Clinical analyses were carried out at the Department of Occupational Medicine between January 1st 1996 ad December 1999 on 3,089 subjects of both sexes with allergic symptoms believed to be IgE mediated. The history of all the subjects was taken before clinical examination. Skin prick tests were performed with perennial allergens (house dust mites *Dermatophagoides pteronyssinus* and *D. farinae)* and pollens: Poaceae, Asteraceae, *Parietaria*, *Ambrosia*, Oleaceae, Corylaceae/Betulaceae, Cupressaceae and Platanaceae produced by Lofarma Allergeni, Milano. Skin reactions were read after 15 minutes using a millimetre rule. The reaction was compared to the size of a positive histamine control (10 mg/ml) and to a negative control (extraction solution without allergen), and was considered positive when the diameter was >= 3 mm. Symptoms were defined as seasonal when they were present only during certain months of the year, from January to October.

Floristic data

The mapping project of the urban flora of Trieste, which began in 1992 (Rizzi Longo *et al.*, 1994) and ended in 2002, permitted us to implement about 48,000 floristic data. For this purpose, the urban area of Trieste (28 km^2) was subdivided by a conventional grid into 282 Operational Geographic Units (OGUs), following the methods of the quantitative phytogeography (Ehrendorfer & Hamann, 1965; Crovello, 1981). The monitoring of the vascular flora was carried out in each OGU measuring 15" x 10" (about 325 x 307 m). Systematic nomenclature follows Poldini *et al.* (2001); life forms and chorological groups were detected from Poldini (1991) or Pignatti (1982).

RESULTS

Aerobiological data

The pollen calendar of the town is shown in Figure 1. In the calendar, the most frequent pollen types

monitored in the atmosphere of Trieste between January 15th and October 15th in the 1996-1999 period are listed in alphabetical order. These pollen types reach 85% of the year's total. The airborne pollen counts were expressed as pollen grains per cubic meter of air (p/m^3). The pollen calendar was drawn using the four-year average of the monthly sums of the daily pollen counts. The quantitative intervals were selected to show the pollination peaks of the different pollen types. Very low monthly pollen quantities (<50 p/m^3) or sporadically occurring pollen grains were not indicated.

As pointed out in previous papers (Rizzi Longo & Cristofolini, 1987; Rizzi Longo, 2002), pollen of trees prevails in the air of Trieste. The most common arboreal pollen types account together for 64% of the year's total. Particularly abundant are the pollen grains of Cupressaceae, reaching nearly one fourth of the year's total. Very great amounts of airborne pollen of Moraceae, almost all of *Broussonetia papyrifera*, are also present. Pollen grains from Corylaceae, Fagaceae, Oleaceae and Pinaceae are abundant. The higher monthly mean air concentrations for the indicated years are recorded in March for pollen from Cupressaceae (13,918 p/m^3) and in May for pollen from Moraceae (10,632 p/m^3). Other pollen types show very lower monthly mean values.

Non-arboreal pollen types are less abundant. Only Urticaceae release great pollen concentrations in air, reaching globally almost one fifth of the year's total. Starting from March, the pollen counts of Urticaceae, mostly due to *Parietaria* pollen grains, increase quickly, reaching their peak in May (5,468 p/m^3) and remaining high during the entire summer. Pollen from Poaceae is abundant, too, but the monthly amounts are lower. The pollen shedding of Poaceae is long, beginning in April, peaking in May (1,216 p/m^3) and decreasing after September. Pollen grains from Asteraceae (mostly due to the pollen shedding of *Artemisia* and *Ambrosia*) and Chenopodiaceae/Amaranthaceae are less abundant, showing only in late summer enough great air concentrations, with peaks in August (679 and 128 p/m^3 respectively). Plantaginaceae and Polygonaceae (mostly *Rumex*) also show rather low pollen concentrations, the former occurring in spring/summer and peaking in July (203 p/m^3), the latter having a significant occurrence (63 p/m^3) only in May.

The pollen calendar of Trieste shows the occurrence

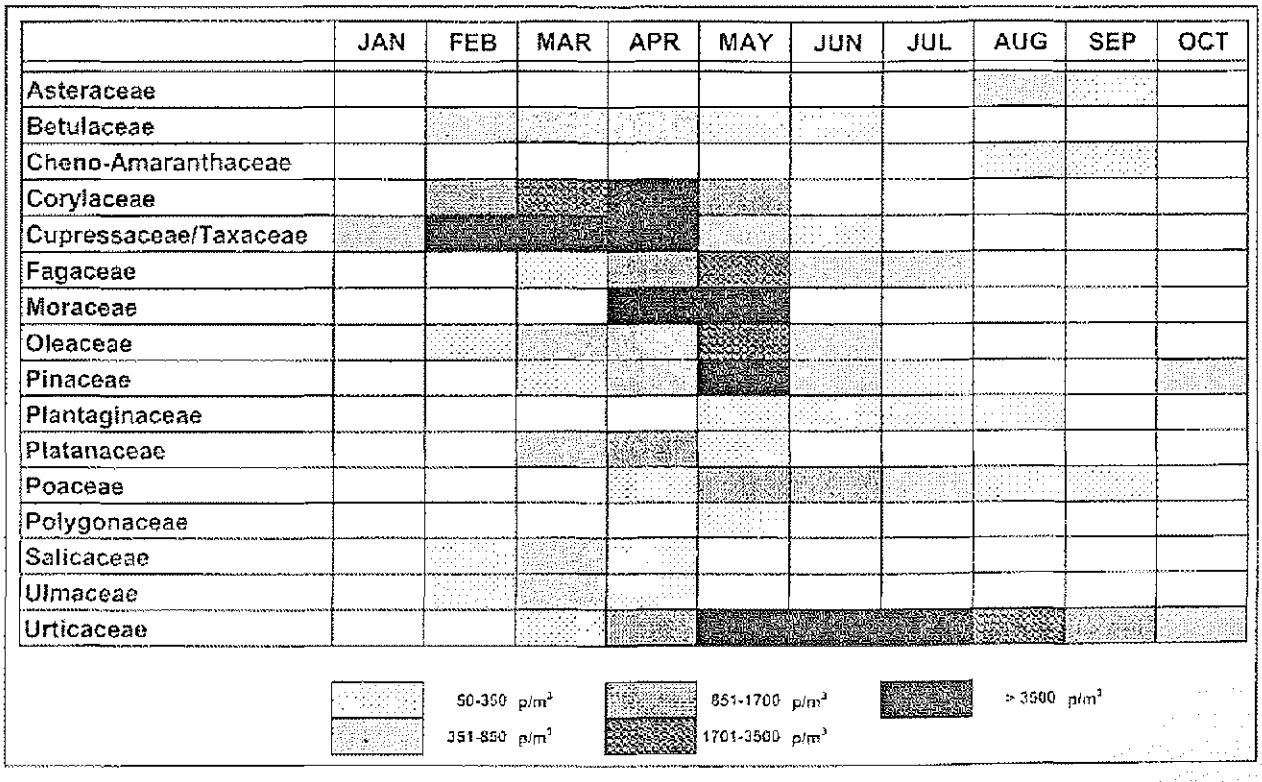

Fig. 1: Pollen calendar of Trieste. Only major airborne pollen types are represented. Monthly mean values from daily pollen counts are reported.
Sl. 1: Tržaški pelodni koledar. Vključeni so samo poglavitni v zraku pojavljajoči se pelodni tipi s srednjimi mesečnimi vrednostmi njihovega dnevnega štetja.

of three pollen seasons: winter, spring, and summer. The winter season is marked by the highest pollen shedding from Cupressaceae/Taxaceae and by the increasing pollen values for Betulaceae (mostly *Alnus*), Corylaceae (mostly *Corylus*), Salicaceae, and Ulmaceae. The spring season shows the occurrence in the air of the more frequent pollen types; it is dominated by the highest airborne pollen values for Corylaceae (mostly *Ostrya*), Fagaceae (mostly *Quercus*), Moraceae (fast all *Broussonetia*), Oleaceae (mostly *Fraxinus ornus* and *Olea*), Pinaceae (mostly *Pinus*), Platanaceae, Poaceae and Urticaceae (mostly *Parietaria*). The summer season, on the other hand, is marked by decreasing values of all the previous pollen types, and by the highest pollen shedding from Chenopodiaceae/Amaranthaceae, Asteraceae and Plantaginaceae. During the summer, Poaceae and Urticaceae pollen grains maintain relative high values. After September, only Pinaceae and Urticaceae show a relatively high pollen concentration in the air, the former because of the pollen shedding from *Cedrus*, the latter because of the long pollen season of *Parietaria*.

Clinical data

The mean age of the studied population is 41±17.2 years, with the women in majority (58.3%). 1768 persons were atopic by prick test and 676 resulted sensitized to almost one pollen extract. The most common symptom is rhinitis (40.9%), less common asthma (28.5%) while others report conjunctivitis, pharingitis and urticaria (30.6%).

Subjects with pollenosis present frequently a skin prick test positive to Poaceae (64.9%), less common sensitisation to Oleaceae (48.8%), Betulaceae/Corylaceae (37%), *Parietaria* (35%), Cupressaceae (29%), Asteraceae (27.1%), Platanaceae (19.2%) and *Ambrosia* (14.2%). The clinical data reveal sensibility to 9 taxa (Fig. 2), 4 of which are herbaceous families and genera (Poaceae, Asteraceae, *Ambrosia*, *Parietaria*) and 5 woody families (Oleaceae, Corylaceae, Betulaceae, Cupressaceae and Platanaceae).

Floristic data

Over 1000 species belonging to 106 families have been recorded so far in the town of Trieste. A selection of these species was made to recognize the species locally inducing allergic diseases.

The allergenic significance of some genera or families is well known (D'Amato, 1981; D'Amato & Spieksma, 1992; D'Amato *et al.*, 1991a, 1998, 2001). Species belonging to these taxa were therefore inserted in the allergenic floristic list, where some species reported as allergenic in Ciampolini & Cresti (1981), Crimi *et al.* (1985), De Leonardis *et al.* (1985-1987) and reaching enough airborne pollen amounts were also included.

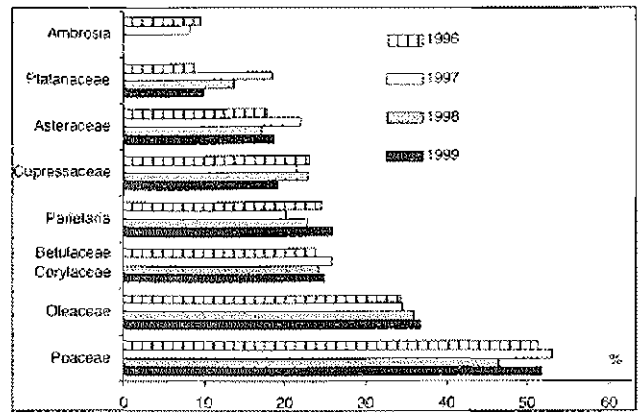

Fig. 2: Pollen sensitisation trend in the 4 considered years in Trieste.
Sl. 2: Pelodni senzibilizacijski trendi v štirih preučevanih letih v Trstu.

It is not known yet whether many other species recorded in the urban area produce pollen with allergenic properties. The identification of pollen allergens or the biochemical characterisation of the pollen has been made only for some plants of allergological interest (*e.g.* Shibata *et al.*, 1989; Matthiesen *et al.*, 1991; Baldo *et al.*, 1992; Mondal *et al.*, 1997; Patriarca *et al.*, 2000; Pini, 2001). Skin test reactivity to pollen extracts or clinico-immunological studies are sometimes reported for some species, which have not been known as allergenic, and not for other closely linked species (*e.g.* Fountain & Cornford, 1991; Ariano *et al.*, 1993; Parui *et al.*, 1998; Chakraborty *et al.*, 1999; Ravat *et al.*, 2000).

Therefore, it is very difficult to draw up a realistic list of allergenic species, as also pointed out by Driessen & Derksen (1989), Pecere & Chiesura Lorenzoni (1992), Selle *et al.* (1992), Leporatti *et al.* (2000) and Lorenzoni-Chiesura *et al.* (2000).

To summarise, on the basis of these considerations the following list contains: species with pollen allergen characterization; the species unanimously acknowledged as allergenic in the medical literature; all species belonging to genera known as allergenic in the medical literature; all species reaching high airborne pollen concentrations belonging to families known as allergenic in the medical literature.

Species not mentioned in any studies, belonging to genera or families till now unknown as allergenic or known as scarcely significant in inducing pollenosis, were not inserted. For example, the following species, though recorded in the town of Trieste and listed as allergenic in Crimi *et al.* (1985), were not included in the following list owing to their sporadical pollen occurrence in the air, too low for inducing allergic diseases: *Arum italicum*, *Heliotropium europaeum*, *Campanula rapunculus*, *Capparis spinosa*, *Cornus sanguinea*, *Ecballium elaterium*, *Carex flacca* and *C. pendula*, *Iris ger-*

manica, Laurus nobilis, Acacia dealbata, Cercis siliquastrum, Lotus corniculatus, Medicago sativa, Robinia pseudacacia, Spartium junceum, Trifolium pratense, Malva sylvestris, Papaver rhoeas, Consolida regalis, Ranunculus bulbosus, Prunus spinosa, Sanguisorba minor, Galium mollugo, Solanum nigrum, Thypha latifolia, Daucus carota, Smyrnium olusatrum, Vitis vinifera. Though listed in Ciampolini & Cresti (1981) and Crimi *et al.* (1985), even *Hedera helix*, whose pollen grains were abundantly found in the atmosphere of Trieste (Rizzi Longo & Martini, 2000) and frequently occur in the air (Nilsson *et al.*, 1977), was not included in the following list, as there is no evidence of sensitisations in literature.

In the floristic list of the local allergophytes, which are presented in systematic order, the family, the biological form, the life form and the chorological group are given for each taxon, the area of provenance only for the adventitious plants. The cultivated plants *sensu* Viegi *et al.* (1974) are listed in bold.

PINACEAE

Pinaceae are reported as not-recommended plants by Lorenzoni-Chiesura *et al.* (2000), even if they are of low allergenic interest (Rogers, 2001). All the species found in the urban area are included in the present list due to their local airborne abundance of pollen grains.

***Abies alba* Mill.**	**P scap**	**cult.(S-European-montane)**
***Abies cephalonica* Loudon**	**P scap**	**cult. (Greece)**
***Abies nordmanniana* (Steven) Spach**	**P scap**	**cult.(Caucasus)**
***Abies pinsapo* Boiss.**	**P scap**	**cult. (SW-Spain)**
***Cedrus atlantica* (Endl.) Carriere**	**P scap**	**cult. (Morocco)**
***Cedrus deodara* (D. Don) Don**	**P scap**	**cult. (Himalaya)**
***Cedrus libani* A. Richard**	**P scap**	**cult. (Lebanon)**
***Picea abies* (L.) H. Karst.**	**P scap**	**cult. (Eurosiberian)**
***Picea orientalis* (L.) Link**	**P scap**	**cult. (Asia minor-Caucasus)**
***Picea pungens* (Sieb & Zucc.) Carriere**	**P scap**	**cult. (N-America)**
***Pinus brutia* Ten.**	**P scap**	**cult. (NE-Mediterran.-montane)**
***Pinus halepensis* Mill.**	**P scap**	**cult. (Stenomediterran.)**
Pinus nigra J.F. Arnold ssp. *nigra*	P scap	S-Illyric
***Pinus pinaster* Ait.**	**P scap**	**cult. (W-Stenomediterran.)**
***Pinus pinea* L.**	**P scap**	**cult. (Eurimediterran.)**
***Pinus strobus* L.**	**P scap**	**cult. (N-America)**
***Pinus sylvestris* L.**	**P scap**	**cult. (Eurosiberian)**
***Pinus wallichiana* Jackson**	**P scap**	**cult. (Central Asia)**

CUPRESSACEAE

Cupressaceae, Fagaceae and Oleaceae are the most relevant tree families in inducing allergic diseases (D'Amato, 2001). Pollen grains of Cupressaceae are responsible for winter pollenosis (Panzani *et al.*, 1991).

***Chamaecyparis lawsoniana* (A. Murray bis) Parl.**	**P scap**	**cult. (W-USA)**
***Cupressus arizonica* Green**	**P scap**	**cult. (N-America)**
***Cupressus macrocarpa* Hartweg**	**P scap**	**cult. (N-America)**
***Cupressus sempervirens* L.**	**P scap**	**cult. (E-Mediterran.)**
***Juniperus chinensis* L.**	**P scap**	**cult. (China, Japan)**
Juniperus communis L. ssp. *communis*	P caesp	Circumboreal
***Juniperus virginiana* L.**	**P caesp**	**cult. (N-America)**
***Thuja occidentalis* L.**	**P scap**	**cult. (N-America)**
***Thuja orientalis* L.**	**P scap**	**cult. (E-Asia)**

TAXACEAE

Pollen grains of *Taxus* are similar to grains of Cupressaceae, and are generally counted together in the aerobiological studies. *Taxus baccata* is reported as allergenic in Ciampolini & Cresti (1981) and Driessen & Derksen (1989).

Taxus baccata L.	P scap	Palaeotemperate

CHENOPODIACEAE

Pollen grains of Chenopodiaceae may be responsible for summer pollenosis (Bricchi *et al.*, 1997), even if of minor allergological interest (Jäger & D'Amato, 2001).

Arthrocnemum fruticosum (L.) Moq.	Ch succ	Eurimediterran.
Atriplex hortensis L.	T scap	Eurasiatic
Atriplex micrantha Ledeb.	T caesp	Anthropochore (E-Europe)
Atriplex patula L.	T scap	Circumboreal
Atriplex portulacoides L.	Ch suffr	Circumboreal
Atriplex prostrata Boucher ex DC.	T scap	Circumboreal
Bassia scoparia (L.) A.J. Scott ssp. *scoparia*	T scap	Anthropochore (Europe/E & Centr. Asia)
Beta vulgaris L	H bienn	Eurimediterran.
Chenopodium album L.	T scap	Cosmopolitan
Chenopodium ambrosioides L.	T scap	Anthropochore (Tropical America)
Chenopodium botrys L.	T scap	Cosmopolitan
Chenopodium hybridum L.	T scap	Circumboreal
Chenopodium murale L.	T scap	Cosmopolitan
Chenopodium polyspermum L.	T scap	Palaeotemperate
Salicornia patula Duval-Jouve	T scap	European
Salsola soda L.	T scap	Palaeotemperate
Suaeda maritima (L.) Dumort ssp. *maritima*	T scap	Cosmopolitan

AMARANTHACEAE

The pollen grains of Amaranthaceae and Chenopodiaceae are very much alike. In the aerobiological studies they are counted together as Cheno-Amaranthaceae. In some cases they are responsible for seasonal allergic diseases (Lombardero *et al.*, 1991).

Amaranthus albus L.	T scap	Anthropochore (N-America)
Amaranthus blitoides S. Watson	T scap	Anthropochore (N-America)
Amaranthus blitum L. ssp. *blitum*	T scap	Eurimediterran.
Amaranthus bouchonii Thell.	T scap	Anthropochore (unkn.)
Amaranthus cruentus L.	T scap	Anthropochore (America)
Amaranthus deflexus L.	T scap	Anthropochore (S-America)
Amaranthus graecizans L.	T scap	Anthropochore (Subcosmopolitan)
Amaranthus hybridus L.	T scap	Anthropochore (N & SW-America)
Amaranthus retroflexus L. ssp. *retroflexus*	T scap	Anthropochore (N-America)

POLYGONACEAE

Rumex, put by D'Amato (2001) in the group of allergenic weeds, releases in the air pollen of minor allergological interest (Jäger & D'Amato, 2001). *Rumex* shows a not well-defined clinical relevance (Frank *et al.*, 1991).

Rumex acetosa L. ssp. *acetosa*	H scap	Circumboreal
Rumex conglomeratus Murray	H scap	Eurasiatic
Rumex crispus L. ssp. *crispus*	H scap	Cosmopolitan
Rumex kerneri Borbás	H scap	Anthropochore (SE-European)
Rumex obtusifolius L. ssp. *obtusifolius*	H scap	European
Rumex pulcher L. ssp. *pulcher*	H scap	Eurimediterran.

PLATANACEAE

The pollen of *Platanus* is allergenic, but Platanaceae are of reduced allergenic importance in Europe (Jäger & D'Amato, 2001).

Platanus × *hispanica* Mill. ex Münchh.	P scap	Eurimediterran.

FAGACEAE

Cross-reactivity is frequent among Fagales (D'Amato, 2001). When airborne pollen grains are abundant, Fagaceae could be responsible for allergic manifestations (Ickovic & Thibaudon, 1991).

Castanea sativa Mill.	P scap	SE-European
Quercus cerris L.	P scap	Eurimediterran.
Quercus ilex L. ssp. *ilex*	P scap	Stenomediterran.
Quercus petraea Liebl.	P scap	European
Quercus pubescens Willd.	P caesp	Pontic

BETULACEAE

Pollen from Betulaceae, particularly from *Betula*, is a significant contributor to the incidence of pollenosis in northern and central Europe (D'Amato, 1991; Vik *et al.*, 1991). *Alnus* shows a high degree of cross-reactivity with *Betula* pollen allergens (Spieksma & Frenguelli, 1991).

Alnus glutinosa (L.) Gaertn.	P scap	Palaeotemperate
***Betula pendula* Roth**	**P scap**	**cult. (Eurosiberian)**

CORYLACEAE

Cross-reactivity is frequent among Fagales, *i.e.* between *Corylus* of reduced allergenic importance (Jäger & D'Amato, 2001) and *Betula* (D'Amato, 2001). *Ostrya carpinifolia* has recently shown an increased allergenic interest (Voltolini, 2001).

Carpinus betulus L.	P scap	European
Carpinus orientalis Mill.	P caesp	Pontic
Corylus avellana L.	P caesp	European
***Corylus colurna* L.**	**P caesp**	**cult. (Balkan Peninsula)**
***Corylus maxima* Miller**	**P caesp**	**cult. (Pontic)**
Ostrya carpinifolia Scop.	P caesp	Mediterran.-Pontic

ULMACEAE

Ulmus is also a plant of allergological interest (Matthiesen *et al.*, 1991). A low skin test reactivity to pollen of *Celtis* is reported in Rogers (2001).

Celtis australis L.	P scap	Eurimediterran.
Ulmus laevis Pall.	P caesp	Anthropochore (Central Europe)
Ulmus minor Mill. ssp. *minor*	P caesp	European
***Ulmus pumila* L.**	**P scap**	**Anthropochore (E-Asia)**

MORACEAE

Morus is an important plant in inducing pollen allergy (Matthiesen *et al.*, 1991). *Broussonetia papyrifera*, a doubtful allergenic species, was put on the present list due to the high amount of airborne pollen grains detected in the air of the town.

Broussonetia papyrifera (L.) Vent.	P caesp	Anthropochore (E-Asia)
Morus alba L.	P scap	Anthropochore (E-Asia)

CANNABACEAE

Pollen of *Humulus* is reported as allergenic in Ciampolini & Cresti (1981).

Humulus lupulus L.	P lian	European

URTICACEAE

Parietaria is the most relevant allergenic genus in the Mediterranean region, while *Urtica* shows a small clinical relevance (D'Amato *et al.*, 1991b).

Parietaria judaica L.	H scap	Eurimediterran.
Parietaria officinalis L.	H scap	European
Urtica dioica L. ssp. *dioica*	H scap	Cosmopolitan
Urtica urens L.	T scap	Cosmopolitan

JUGLANDACEAE

A moderate skin test reactivity to pollen of *Juglans* is reported in Rogers (2001).

Juglans regia L.	P scap	Anthropochore (SW-Asia/E-Mediterran.)

ACERACEAE

Acer is one of the plants of allergological interest (Matthiesen *et al.*, 1991).

Acer campestre L.	P scap	European
Acer monspessulanum L. ssp. *monspessulanum*	P scap	Eurimediterran.
Acer negundo L.	P scap	Anthropochore (N-America)
Acer platanoides L.	P scap	European
Acer pseudoplatanus L.	P scap	European

HIPPOCASTANACEAE

Aesculus is reported as a not-recommended tree in Lorenzoni-Chiesura *et al.* (2000). A very low skin test reactivity to pollen of *Aesculus* is reported in Rogers (2001).

Aesculus hippocastanum L.	P scap	Anthropochore (SE-European)
***Aesculus* × *carnea* Hayne**	**P scap**	**cult. (unkn.)**

EUPHORBIACEAE

Mercurialis releases pollen of minor allergological interest (Jäger & D'Amato, 2001).

Mercurialis annua L. ssp. *annua*	T scap	Palaeotemperate
Mercurialis ovata Sternb. & Hoppe	G rhiz	Pontic
Mercurialis perennis L.	G rhiz	European

BRASSICACEAE

Brassica napus is a weed of minor allergological interest (Jäger & D'Amato, 2001). *Capsella bursa-pastoris* and *Erysimum cheiri*, collected in the town, are listed among allergenic species in Crimi *et al.* (1985), but were not inserted in the present list owing to their small airborne pollen amount and scarce clinical data.

Brassica napus L. ssp. *napus*	T scap	Anthropochore (unkn.)
Brassica oleracea L.	Ch suffr	Mediterr.-Atlantic
Brassica rapa L.	T scap	Eurimediterran.

SALICACEAE

Populus is a tree of allergological interest (Matthiesen *et al.*, 1991). *Salix alba* is noted as allergenic in Driessen & Derksen (1989).

Populus alba L.	P scap	Palaeotemperate
Populus nigra L. ssp. *nigra*	P scap	Palaeotemperate
Populus tremula L.	P scap	Eurosiberian
Populus × *canescens* (Aiton) Sm.	P scap	SE-European
Salix alba L. var. *alba*	P scap	Palaeotemperate
***Salix babylonica* L.**	**P scap**	**cult. (E-Asia)**
Salix caprea L.	P caesp	Eurasiatic
Salix cinerea L. ssp. *cinerea*	P caesp	Palaeotemperate
Salix daphnoides Vill.	P caesp	Eurasiatic

Salix purpurea L. ssp. *purpurea*	P caesp	Eurasiatic
***Salix × sepulcralis* L.**	**P scap**	**cult. (unkn.)**

TILIACEAE

Tilia seems responsible for allergic manifestations (Ciampolini & Cresti, 1981; Mur *et al.*, 2001).

Tilia cordata Mill.	P scap	European
Tilia platyphyllos Scop. ssp. *platyphyllos*	P scap	European

OLEACEAE

There is a high degree of cross-reactivity among *Olea* and other genera of Oleaceae. Pollen from *Olea* is one of the most relevant allergenic pollens in Mediterranean Europe (Macchia *et al.*, 1991).

***Forsythia × intermedia* Zab.**	**P caesp**	**cult. (E-Asia)**
***Forsythia viridissima* Lindl.**	**P caesp**	**cult. (E-Asia)**
Fraxinus excelsior L. ssp. *excelsior*	P scap	European
Fraxinus ornus L. ssp. *ornus*	P scap	Mediterr.-Pontic
***Jasminum nudiflorum* Lindl.**	**P caesp**	**cult.**
Ligustrum lucidum Ait.	P scap	Anthropochore (E-Asia)
Ligustrum vulgare L.	NP	European
***Olea europaea* L.**	**P caesp**	**cult. (Stenomediterran.)**
Syringa vulgaris L.	P caesp	Mediterr.-Montane

CAPRIFOLIACEAE

Sambucus nigra is reported as allergenic in Driessen & Derksen (1989), the same as *S. ebulus* in Ciampolini & Cresti (1981).

Sambucus ebulus L.	H scap	Eurimediterran.
Sambucus nigra L.	P caesp	European

ASTERACEAE

A great number of species recorded in the town of Trieste belongs to Asteraceae, but only the wind pollinated species belonging to *Artemisia* and *Ambrosia* are relevant in inducing allergic diseases (Jäger, 1991; Jäger & D'Amato, 2001). Pollen grains from a small number of entomophilous plants belonging to Asteraceae, such as *Solidago*, *Taraxacum* and *Helianthus*, may be incidentally released into the air, but are obviously of minor allergenic significance (Spieksma & Von Wahl, 1991). *Xanthium* and *Chrysanthemum* (in the past including *Leucanthemum* and *Tanacetum*) are listed among the taxa of allergological interest (Matthiesen *et al.*, 1991) and were therefore included in the present list. Other species recorded in the urban area release into the air a little amount of pollen grains, too low for inducing allergic diseases. They were therefore not inserted in this list, the same as, for instance, *Aster squamatus*, *Centaurea calcitrapa* and *Inula viscosa* listed in Crimi *et al.* (1985), *Tussilago farfara* mentioned by Ciampolini & Cresti (1981), *Bellis perennis* and *Matricaria chamomilla* reported in Leporatti *et al.* (2000).

Ambrosia artemisiifolia L.	T scap	Anthropochore (N-America)
Artemisia absinthium L.	Ch suffr	Eurimediterran.
Artemisia alba Turra ssp. *lobelii* (All.) Gams	Ch suffr	Eurimediterran.
Artemisia annua L.	T scap	Eurasiatic
Artemisia caerulescens L. ssp. *caerulescens*	Ch suffr	Eurimediterran.
Artemisia verlotorum Lamotte	H scap	Eurasiatic
Artemisia vulgaris L. ssp. *vulgaris*	H scap	Circumboreal
Chrysanthemum segetum L.	T scap	Mediterr.-Atlantic
Helianthus annuus L.	T scap	Anthropochore (N-America)
Helianthus tuberosus L.	G bulb	Anthropochore (N-America)
Leucanthemum ircutianum (Turcz.) DC.	H scap	Eurimediterran.
Leucanthemum platylepis Borbás	H scap	S-Illyric
Solidago gigantea Aiton	H scap	Anthropochore (N-America)
Solidago virgaurea L. ssp. *virgaurea*	H scap	Circumboreal

Tanacetum corymbosum (L.) Sch. Bip. ssp. *corymbosum*	H scap	Eurimediterran.
Tanacetum parthenium (L.) Sch. Bip.	H scap	Anthropochore (SE-Europe/SW-Asia)
Tanacetum vulgare L.	H scap	Eurasiatic
Taraxacum laevigatum (Willd.) DC.	H ros	Palaeotemperate
Taraxacum officinale aggr.	H ros	Circumboreal
Xanthium italicum Moretti	T scap	Eurimediterran.

PLANTAGINACEAE

Pollen from Plantaginaceae is of minor allergological interest (Jäger & D'Amato, 2001) and may contribute to pollenosis only under exceptional conditions (Watson & Constable, 1991).

Plantago argentea Chaix ssp. *liburnica* Ravnik	H ros	Pontic
Plantago coronopus L. ssp. *coronopus*	T scap	Eurimediterran.
Plantago holosteum Scop.	H ros	Pontic
Plantago lanceolata L.	H ros	Eurasiatic
Plantago major L.	H ros	Eurasiatic
Plantago media L. ssp. *media*	H ros	Eurasiatic

POACEAE

Pollen from Poaceae is the major cause of pollenosis in the world (D'Amato, 2001). All species recorded in the town were put on the list due to their known cross-reactivity (Weeke & Spieksma, 1991), the widespread lasting pollen shedding and the high frequency of sensitisations to Poaceae recorded in the locally studied population.

Aegilops cylindrica Host	T scap	Pontic
Aegilops geniculata Roth ssp. *geniculata*	T scap	Stenomediterran.
Agrostis capillaris L. ssp. *capillaris*	H caesp	Circumboreal
Agrostis stolonifera L.	H rept	Circumboreal
Aira elegantissima Schur	T scap	Eurimediterran.
Alopecurus myosuroides Huds.	T scap	Palaeotemperate
Anisantha diandra (Roth) Tutin ex Tzvelev ssp. *diandra*	T scap	Eurimediterran.
Anisantha madritensis (L.) Nevski ssp. *madritensis*	T scap	Eurimediterran.
Anisantha sterilis (L.) Nevski	T scap	Eurimediterran.
Anisantha tectorum (L.) Nevski	T scap	Palaeotemperate
Anthoxanthum odoratum L. ssp. *odoratum*	H caesp	Eurasiatic
Apera spica-venti (L.) P. Beauv.	T scap	Eurosiberian
Arrhenatherum elatius (L.) P. Beauv. ex J. Presl & C. Presl ssp. *elatius*	H caesp	Palaeotemperate
Arundo donax L.	G rhiz	Anthropochore (Asia)
Avena barbata Pott. ex Link ssp. *barbata*	T scap	Eurimediterran.
Avena fatua L. ssp. *fatua*	T scap	Eurasiatic
Avena sativa L.	T scap	Anthropochore (E-Asia)
Avena sterilis L. ssp. *sterilis*	T scap	Eurimediterran.
Bothriochloa ischaemum (L.) Keng	H caesp	Mediterr.-Pontic
Brachypodium rupestre (Host) Roem. & Schult. ssp. *rupestre*	H caesp	European
Brachypodium sylvaticum (Huds.) P. Beauv. ssp. *sylvaticum*	H caesp	Palaeotemperate
Briza media L. ssp. *media*	H caesp	Eurosiberian
Bromopsis condensata (Hack.) Holub ssp. *microtricha* (Borbás) Jogan & Bačič	H caesp	Illyric-S-Alpine
Bromopsis erecta (Huds.) Fourr.	H caesp	Palaeotemperate
Bromopsis inermis (Leyss.) Holub	H caesp	Eurasiatic
Bromus commutatus Schrad.	T scap	European

Bromus hordeaceus L.	T scap	Cosmopolitan
Bromus japonicus Thunb. ssp. *japonicus*	T scap	Palaeotemperate
Calamagrostis arundinacea (L.) Roth ssp. *arundinacea*	H caesp	Eurasiatic
Calamagrostis epigejos (L.) Roth ssp. *epigejos*	H caesp	Eurosiberian
Catapodium marinum (L.) C.E. Hubb.	T scap	Mediterr.-Atlantic
Catapodium rigidum (L.) C.E. Hubb. ex Dony ssp. *rigidum*	T scap	Eurimediterran.
Cenchrus longispinus (Hack.) Fernald	T scap	Anthropochore (America)
Ceratochloa cathartica (Vahl) Herter	H caesp	Anthropochore (S-America)
Chrysopogon gryllus (L.) Trin.	H caesp	Eurosiberian
Cleistogenes serotina (L.) Keng	H caesp	Eurimediterran.
Cynodon dactylon (L.) Pers.	G rhiz	Cosmopolitan
Cynosurus cristatus L.	H caesp	European
Cynosurus echinatus L.	T scap	Eurimediterran.
Dactylis glomerata L. ssp. *glomerata*	H caesp	Palaeotemperate
Danthonia decumbens (L.) DC. ssp. *decumbens*	H caesp	European
Dasypyrum villosum (L.) P. Candargy	T scap	Eurimediterran.
Deschampsia flexuosa (L.) Trin. ssp. *flexuosa*	H caesp	Cosmopolitan
Digitaria ischaemum (Schreb. ex Schweigg.) Schreb. ex Muhl.	T scap	Cosmopolitan
Digitaria sanguinalis (L.) Scop. ssp. *sanguinalis*	T scap	Cosmopolitan
Echinochloa crus-galli (L.) P. Beauv. ssp. *crus-galli*	T scap	Cosmopolitan
Eleusine indica (L.) Gaertn. ssp. *indica*	T scap	Cosmopolitan
Eleusine tristachya (Lam.) Lam.	T scap	Anthropochore (S-America)
Elytrigia atherica (Link) Kerguélen ex Carreras Martínez	G rhiz	Eurimediterran.
Elytrigia intermedia (Host) Nevski ssp. *intermedia*	G rhiz	Eurosiberian
Elytrigia intermedia (Host) Nevski ssp. *barbulata* (Schur) Á. Löve	G rhiz	Eurosiberian
Elytrigia repens (L.) Desv. ex Nevski	G rhiz	Circumboreal
Eragrostis cilianensis (All.) Vignolo ex Janch.	T scap	Cosmopolitan
Eragrostis minor Host	T scap	Cosmopolitan
Eragrostis pectinacea (Michx.) Nees	T scap	Anthropochore (N-America)
Eragrostis pilosa (L.) P. Beauv.	T scap	Cosmopolitan
Eragrostis virescens J. Presl	T scap	Anthropochore (S-America)
Festuca arundinacea Schreb. ssp. *arundinacea*	H caesp	Palaeotemperate
Festuca heterophylla Lam. ssp. *heterophylla*	H caesp	European
Festuca pratensis Huds. ssp. *pratensis*	H caesp	Eurasiatic
Festuca rubra L. ssp. *rubra*	H caesp	Circumboreal
Festuca rupicola Heuf. ssp. *rupicola*	H caesp	SE-European
Festuca valesiaca Schleich. ex Gaudin ssp. *valesiaca*	H caesp	European
Holcus lanatus L.	H caesp	Circumboreal
Hordeum murinum L. ssp. *leporinum* (Link) Arcang.	T scap	Eurimediterran.
Hordeum murinum L. ssp. *murinum*	T scap	Circumboreal
Koeleria lobata (M. Bieb.) Roem. & Schult.	H caesp	Medit.-Mont.
Koeleria macrantha (Ledeb.) Schult	H caesp	Circumboreal
Koeleria pyramidata (Lam.) P. Beauv. ssp. *pyramidata*	H caesp	European
Lagurus ovatus L. ssp. *ovatus*	T scap	Eurimediterran.
Lolium multiflorum Lam.	T scap	Eurimediterran.
Lolium perenne L.	H caesp	Eurasiatic
Melica ciliata L.	H caesp	Eurimediterran.

Melica uniflora Retz.	H caesp	Palaeotemperate
Molinia caerulea (L.) Moench ssp. *arundinacea* (Schrank) H.K.G. Paul	H caesp	European
Muhlenbergia vaginiflora (Torr. ex A.. Gray) Jogan	T caesp	Anthropochore (N-America)
Panicum capillare L.	T scap	Anthropochore (N-America)
Panicum dichotomiflorum Michx.	T scap	Anthropochore (N & C-America)
Panicum miliaceum L. ssp. *miliaceum*	T scap	Anthropochore (Asia)
Parapholis incurva (L.) C.E. Hubb.	T scap	Medit.-Atlan.
Paspalum dilatatum Poir.	H caesp	Anthropochore (S-America)
Paspalum distichum L.	G rhiz	Anthropochore (Neotropical)
Phalaris arundinacea L. ssp. *arundinacea*	He	Circumboreal
Phalaris canariensis L.	T scap	Anthropochore (W-Mediterran.)
Phalaris paradoxa L.	T scap	Stenomediterran.
Phleum bertolonii DC.	H caesp	Eurimediterran.
Phleum pratense L.	H caesp	European
Phragmites australis (Cav.) Trin. ex Steud.	He	Cosmopolitan
Piptatherum miliaceum (L.) Coss. ssp. *miliaceum*	H caesp	Stenomediterran.
Poa angustifolia L.	H caesp	Cosmopolitan
Poa annua L. ssp. *annua*	T caesp	Cosmopolitan
Poa bulbosa L. ssp. *bulbosa*	H caesp	Palaeotemperate
Poa compressa L.	H caesp	Circumboreal
Poa nemoralis L. ssp. *nemoralis*	H caesp	Circumboreal
Poa pratensis L.	H caesp	Circumboreal
Poa trivialis L. ssp. *sylvicola* (Guss.) H. Lindb.	H caesp	Eurimediterran.
Poa trivialis L. ssp. *trivialis*	H caesp	Eurasiatic
Polypogon monspeliensis (L.) Desf.	T scap	Subtropical
Polypogon viridis (Gouan) Breistr.	H caesp	Eurimediterran.
Puccinellia festuciformis (Host) Parl. ssp. *festuciformis*	H caesp	Stenomediterran.
Rostraria cristata (L.) Tzvelev	T caesp	Palaeotemperate
Sesleria autumnalis (Scop.) F.W. Schultz	H caesp	SE-European
Setaria italica (L.) P. Beauv. ssp. *italica*	T scap	Cosmopolitan
Setaria pumila (Poir.) Roem. & Schult.	T scap	Cosmopolitan
Setaria verticillata (L.) P. Beauv.	T scap	Cosmopolitan
Setaria verticilliformis Dumort.	T scap	Cosmopolitan
Setaria viridis (L.) P. Beauv.	T scap	Cosmopolitan
Sorghum halepense (L.) Pers.	G rhiz	Cosmopolitan
Sporobolus indicus (L.) R. Br.	H caesp	Anthropochore (N-America)
Sporobolus neglectus Nash	T caesp	Anthropochore (N-America)
Stipa eriocaulis Borbás ssp. *austriaca* (Beck) Martinovsky	H caesp	Eurimediterran.
Trisetum flavescens (L.) P. Beauv. ssp. *flavescens*	H caesp	Eurasiatic
Triticum aestivum L.	T scap	Anthropochore (SW-Asia)
Vulpia ciliata Dumort.	T caesp	Eurimediterran.
Vulpia myuros (L.) C.C. Gmel. ssp. *myuros*	T caesp	Cosmopolitan

DISCUSSION

Among the over 1000 wild and cultivated species found in the urban area during the field work, in order to draw up the allergenic flora of Trieste, were selected those ones locally inducing allergic diseases. The selection was carried out using the data resulting from the local aerobiological and epidemiological monitoring and on the basis of the medical literature. About a quarter of the recorded species were regarded as allergenic. In the following discussion, it does not consider the cultivated species.

The family composition of the allergenic wild flora (Tab. 1) shows that the core of the group is represented by Poaceae (50.4%), which account for about a half of the total number of taxa, followed by Asteraceae (8.8%) and Chenopodiaceae (7%). Amaranthaceae, Salicaceae, Plantaginaceae, Polygonaceae and others have a clearly subordinate role.

Tab. 1: Family composition of the allergenic flora of Trieste.
Tab. 1: Sestava tržaške alergene flore po družinah.

Family	%	Family	%
Poaceae	50.4	Cruciferae	1.3
Asteraceae	8.8	Euphorbiaceae	1.3
Chenopodiaceae	7.0	Caprifoliaceae	0.9
Amaranthaceae	3.9	Moraceae	0.9
Salicaceae	3.9	Tiliaceae	0.9
Plantaginaceae	2.6	Betulaceae	0.4
Polygonaceae	2.6	Cannabaceae	0.4
Aceraceae	2.2	Cupressaceae	0.4
Fagaceae	2.2	Hippocastanaceae	0.4
Oleaceae	2.2	Juglandaceae	0.4
Corylaceae	1.8	Pinaceae	0.4
Ulmaceae	1.8	Platanaceae	0.4
Urticaceae	1.8	Taxaceae	0.4

Tab. 2: Life form and growth form spectra of the allergenic flora of Trieste.
Tab. 2: Spekter življenjskih in rastnih oblik tržaške alergene flore.

Life form	Growth form	%
Therophytes		**37.7**
	scapose	34.6
	caespitose	3.1
Hemicryptophytes		**34.2**
	caespitose	21.9
	scapose	8.3
	rosulate	3.1
	biennial	0.4
	reptant	0.4
Phanerophytes		**19.7**
	scapose	12.7
	caespitose	6.1
	nanophanerophytic	0.4
	lianas	0.4
Geophytes		**4.8**
	rhizomatous	4.4
	bulbous	0.4
Chamaephytes		**2.6**
	suffrutescent	2.2
	succulent	0.4
Helophytes		**0.9**

The life form spectrum of the allergenic wild species (Tab. 2) is dominated by therophytes and hemicryptophytes (together more than 70% of the total); the therophytes are dominated by the scapose (34.6%), and the hemicryptophytes by the caespitose (21.9%). The presence of parks and gardens, especially on the town's outskirts, is well outlined by the high percentage of phanerophytes scapose (12.7%) and caespitose (6.1%), as *Pinus nigra* ssp. *nigra*, *Quercus pubescens*, *Carpinus orientalis*, *Corylus avellana*, *Ostrya carpinifolia*, *Ulmus minor*, *Broussonetia papyrifera*, *Acer campestre*, *Fraxinus ornus*, *Sambucus nigra* and others.

The chorological spectrum (Tab. 3) is highlighted by the adventitious element (18.9%) and particularly by the N-American neophytes (Tab. 4), which constitute more than a third of the total percentage (34.8%) of the anthropochores. Other macrothermic chorotypes *(sensu* Poldini & Martini, 1995) as Eurimediterranean (16.7%) are also well represented, the same as some mesothermic geoelements as European (11.4%) or palaeotemperate (9.2%).

Tab. 3: Chorological spectrum of the allergenic flora of Trieste.
Tab. 3: Kronološki spekter tržaške alergene flore.

Chorological group	%
Adventitious	18.9
Eurimediterranean	16.7
Cosmopolitan	11.8
European	11.4
Palaeotemperate	9.2
Circumboreal	8.3
Eurasian	8.3
Eurosiberian	3.1
Pontic	2.6
Stenomediterranean	2.2
Mediterr.-Atlantic	1.8
SE-European	1.8
Mediterr.-Pontic	1.3
Mediterr.-Montane	0.9
S-Illyric	0.9
Illyric-S-Alpine	0.4
Neotropical	0.4

Tab. 4: Origin of the anthropochores of the allergenic flora of Trieste.
Tab. 4: Izvor antropohornih elementov v tržaški alergeni flori.

Origin	%
America	**53.5**
North & Central Am.	34.8
South Am.	13.9
North & South Am.	4.7
Asia	**18.6**
Europe	**14.0**
Mediterranean basin	**6.9**
Neotropical	**2.3**
unknown	**4.7**

Regarding the origin of the allergophytic anthropochores, Table 4 shows that the American species (53.5%) distinctly prevail over the others, particularly Asiatic (18.6%) and European neophytes (14%).

The results of this research have shown that 264 allergenic taxa (species, subspecies and hybrids), belonging to 26 allergenic families, are found in the urban flora of Trieste. Of these, 35 are cultivated species and hybrids *(e.g. Salix x sepulcralis* or *Aesculus x carnea)* not growing wild and not considered in the previous discussion, while 229 are indigenous or adventitious taxa. Most of these are hemerophytic species as defined by Ahti & Hamet Ahti (1971). There are also several species belonging to the semi-natural vegetation, for instance *Quercetalia pubescenti-petraeae, Festuco-Brometea* or *Molinio-Arrhenatheretea,* growing in some natural parks inside the town, as Villa Giulia and Bosco Farneto, or on the town's outskirts.

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POVZETEK

Med preučevanjem alergene flore v Trstu so avtorji članka opravljali aerobiološki monitoring, klinične analize in terensko delo hkrati. Z uporabo podatkov iz medicinske in aerobiološke literature in tudi na osnovi podatkov, pridobljenih z lokalnim aerobiološkim in epidemiološkim monitoringom, so napravili izbor več kot tisoč vrst, zabeleženih v mestnem urbanem okolju, da bi identificirali vrste, ki povzročajo alergijske bolezni. Ugotovljeno je bilo, da v Trstu raste 264 alergofitov, pripadajočim 26 alergenim družinam.

Ključne besede: aerobiološki monitoring, alergena flora, klinični podatki, pelodni koledar, Trst, Italija

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