



Assessment of urban allergophytes using an allergen index

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Abstract

Utilizing data on the biological and phenological characteristics of allergophytes in various urban ecosystems of central Italy and taking into consideration some allergologic characteristics of their pollens, an allergen index (A.I.) is proposed. On the basis of this index, plants are grouped into strongly allergenic (A.I. = 7–10), moderately allergenic (A.I. = 4–6), and slightly allergenic or of uncertain effect (A.I. $\leq$ 3). The index can be used to conduct a rapid survey of a city's phytoallergenic potential. Follow-up assessment of allergophyte distribution through selective floristic cartography and identification of the maximum pollen production period can facilitate preventative treatment and lessen the symptomatology of pollinosis in the human population.

Abbreviations: A.I. – Allergen Index

1. Introduction

Due to the progressive increase in the human population of allergic manifestations brought on by pollen allergens, the need to study the phenomenon of pollinosis is becoming increasingly more urgent. This disease is particularly frequent in the urban environment, greatly altered as it is by pollution. The interaction of pollens and air-borne pollutants influences the symptomatology and clinical presentation in sensitized patients, and often complicates their treatment (D'Amato et al. 2001). Thus there is an ever more urgent need to integrate allergological and immunological studies with consideration of phenological and epidemiological aspects in order to identify the most suitable treatment for pollinosis. Already, a survey of allergenic pollens present in Italy has proven a very effective part of preventive measures (Mandrioli and Ariatti 2001). In order to improve the quality of life of persons affected by these manifestations, it is useful to assess allergophyte presence and distribution directly in the city and to identify the urban areas particularly dangerous for the onset of pollinosis.

Allergophyte studies conducted in several urban ecosystems of central Italy have noted a dearth of methodological contributions based on the use of data on allergenic flora, which could also be useful in evaluating the quality of the urban outdoor environment. A need was seen for an approach that takes into consideration the presence and abundance of allergophytes, integrates phenological, chorological and allergological data on individual species, and expresses its results simply and accessibly, so that they can be applied by professionals from different fields. In sight of these practical objectives, an allergen index was proposed as a tool to help assess the interaction of the above-described factors and thus to aid preventative efforts to safeguard human health.

2. Materials and methods

Research began with collection of allergophyte phenology data following the method of Marcello (1959). This information was integrated with observations on the presence and abundance of allergophytes in

Table 1. Numeric values of the parameters used in evaluating the allergenicity of individual plants

Life cycle	Phenanthestic period	Cross reactivity	Abundance
Annuals = 1	less than one month = 0.5	none present = 0	rare = 0.5
Biennials = 2	more than one month = 2	present = 1	present = 1
Perennials = 3			rather common = 2
			abundant = 3
			very abundant = 4

some urban ecosystems of central Italy already chosen for studies of urban ecology. The particularly allergenic urban allergophytes were identified and their phenograms were constructed. Data on their distribution throughout a given city were obtained using selective floristic cartography in order to identify the urban biotopes with the greatest concentration of these plants. The archives of the local health administration and of the public and private analysis laboratories were consulted in order to conduct epidemiological studies on the number of cases of allergic manifestations in inhabitants. The results obtained, part of which have already been published (Hruska and Piarulli 1995; Telloni and Hruska 1997), were compared with the phenology of the urban allergophytes.

Comparative evaluation of all the above-described data led to the choice of parameters required to define the allergenicity of the pollen produced by a single species. The parameters adopted were assigned values on an appropriate numeric scale. The allergenic indices were ascertained using partial or complete lists of the urban flora as well as floristic data obtained from published and unpublished phytosociological tables.

3. Results and discussion

In order to calculate the allergen index of a single species, the following parameters were taken into consideration:

- life cycle,
- length of the phenanthestic period,
- presence of phenomena of cross reactivity,
- species abundance.

These parameters were assigned numeric values in ascending order, (Table 1), which express the potential of a plant species, through its pollen, to cause allergic manifestations in man. The allergen index value (A.I.) is the sum of the pre-chosen values for each of the partial characteristics outlined above.

Table 2. Evaluation of the abundance of allergophytes through % cover

Species	Cover (%)	Numeric value
rare	< 1	0.5
present	1 ÷ 25	1
rather common	25 ÷ 50	2
abundant	50 ÷ 75	3
very abundant	75 ÷ 100	4

Plants considered dangerous in terms of the onset of allergies in the human population are those perennials with a phenanthestic period lasting over a month or those that flower repeatedly during the same vegetative season. In addition, species considered strongly allergenic for man are those whose pollen provokes allergic reactions that are aggravated by food-related allergic reactions, particularly those from fruits or vegetables, through the phenomenon of cross reactivity (Eriksson 1993). Studies on the presence and mechanisms of these reactions among pollen allergens of various plants and foods are still underway.

The geographic position of an urban ecosystem influences the presence and abundance of allergophytes. A species is usually more abundant in the central part of its areal and thus can be strongly allergenic in the center of its area of distribution and moderately dangerous on the edges of this area. A similar observation can be made about the species capable of occupying different habitats. In fact, a species develops most abundantly in its optimal habitat, and here, as well, the allergenic effects provoked by its pollen will also be most evident.

A plant's abundance in a certain area is evaluated according to the scale shown in Table 2. Visual estimate of the surface covered by the individuals of a species is useful in choosing the numeric value to attribute to its presence/abundance.

On the basis of calculations done on the lists of urban flora from various Italian cities, the specific allergen index numeric value varies to reach a maximum of 10. No “zero” value of A.I. is used since the pollen of every plant species can be considered potentially allergenic and thus capable of provoking allergenic manifestations in man, on the basis of the subject’s sensitization and the time spent in contact with the pollen. Table 3 presents calculation of the allergen index for the most common allergophytes in the central Italian urban ecosystems, utilizing the scales of the proposed parameters from Table 1.

Comparing the allergenic indices obtained with the allergic manifestations of pollinosis patients, the numeric values were subdivided into the following three groups:

A.I. up to 3	species with slightly allergenic pollen or with no effect ascertained to date
A.I. from 4 to 6	species with moderately allergenic pollen
A.I. from 7 to 10	species with strongly allergenic pollen

The final pollinosis symptomatology is influenced by many factors, such as climatic conditions, the person’s age, genetic predisposition, etc. (Ricci et al. 1993). A positive correlation was seen between the progressive worsening of the pathological picture in sensitized subjects and increase of the index number.

3.1. Applications of the allergen index

Table 4 and Table 5 show some examples of allergen index calculation for two different urban biotopes of the city of Jesi (near Ancona), chosen as sample. Table 4 shows the allergen indices calculated for the flora of the city walls in the city center, while Table 5 refers to the vegetation of a road embankment in the city’s periphery. More details about the biotopes taken into consideration are shown in appendices to the tables. Comparing the allergen index values calculated for these two urban biotopes, one can note that the periphery areas host various allergophytes that are strongly dangerous for the onset of allergies in inhabitants. This confirms the results obtained during some previous studies (Hruska and Piarulli 1995). These allergophytes are prevalently species of the *Graminaceae* and *Compositae* families, which are becoming ever more abundant in the cities, especially because of

Table 3. Examples of allergen index calculation (A.I.) for some plants frequently present in urban Italian ecosystems

Species	Abundance	A.I.
<i>Abies alba</i> Miller	0.5	4 = 3+0.5+0+0.5
<i>Acer campestre</i> L.	0.5	4 = 3+0.5+0+0.5
<i>Amaranthus retroflexus</i> L.	1	5 = 1+2+1+1
<i>Artemisia vulgaris</i> L.	3	9 = 3+2+1+3
<i>Corylus avellana</i> L.	2	8 = 3+2+1+2
<i>Cupressus sempervirens</i> L.	2	8 = 3+2+1+2
<i>Cynodon dactylon</i> (L.) Pers.	2	7 = 3+2+1+2
<i>Dactylis glomerata</i> L.	3	9 = 3+2+1+3
<i>Fraxinus ornus</i> L.	1	6 = 3+2+0+1
<i>Lolium perenne</i> L.	3	9 = 3+2+1+3
<i>Medicago sativa</i> L.	1	6 = 3+2+0+1
<i>Mercurialis annua</i> L.	1	4 = 1+2+0+1
<i>Olea europaea</i> L.	4	10 = 3+2+1+4
<i>Parietaria diffusa</i> M. et K.	4	10 = 3+2+1+4
<i>Parietaria officinalis</i> L.	3	9 = 3+2+1+3
<i>Plantago lanceolata</i> L.	1	6 = 3+2+0+1
<i>Poa annua</i> L.	3	9 = 3+2+1+3
<i>Poa pratensis</i> L.	2	8 = 3+2+1+2
<i>Polygonum aviculare</i> L.	2	6 = 1+2+1+2
<i>Populus alba</i> L.	0.5	4 = 3+0.5+0+0.5
<i>Quercus pubescens</i> Willd.	2	7 = 3+2+0+2
<i>Robinia pseudoacacia</i> L.	1	6 = 3+2+0+1
<i>Rumex crispus</i> L.	0.5	5 = 3+0.5+1+0.5
<i>Salix alba</i> L.	0.5	4 = 3+0.5+0+0.5
<i>Sambucus nigra</i> L.	1	6 = 3+2+0+1
<i>Ulmus minor</i> Miller	1	4.5 = 3+0.5+0+1
<i>Urtica dioica</i> L.	4	10 = 3+2+1+4

the particular urban climate (Palmieri and Siani 2000). By indicating the period of maximum phenantesis of these plants it is possible to establish a preventative therapy for subjects who suffer from pollinosis.

A group of moderately allergogenic species, numerically very similar in both biotopes studied, shows the urban flora’s elevated allergenic potential. From this one can see that the urban ecosystem hosts a rich reservoir of strongly allergogenic plants. The presence of the latter is continually increasing, as various species are brought into the city accidentally or deliberately by man.

As already established, the period of time spent in contact with allergogenic species can influence the pathogenesis of pollinosis in people already sensitized to pollens (Ricci et al. 1993). Take, for example, the allergy suffered by urban children, caused by the pollen of *Aesculus hippocastanum*, an ornamental tree

Table 4. Allergen indices (A.I.) of the flora of the city walls of Jesi (near Ancona), central Italy

Species/pollen	A.I.
– strongly allergenic	
<i>Parietaria diffusa</i> M. et K.	10 (3+2+1+4)
– moderately allergenic	
<i>Calamintha nepeta</i> (L.) Savi	4 (3+0.5+0+0.5)
<i>Capparis spinosa</i> L.	6 (3+2+0+1)
<i>Cymbalaria muralis</i> Gaertn., Mey. et Sch.	6 (3+2+0+1)
<i>Dactylis glomerata</i> L.	5.5 (3+0.5+1+1)
<i>Diplotaxis tenuifolia</i> (L.) DC.	6 (3+2+0+1)
<i>Foeniculum vulgare</i> Miller	4 (3+0.5+0+0.5)
<i>Hyoseris radiata</i> L.	4.5 (3+0.5+0+1)
<i>Hypericum perforatum</i> L.	4.5 (3+0.5+0+1)
<i>Melica ciliata</i> L.	6 (3+2+0+1)
<i>Mercurialis annua</i> L.	5.5 (3+2+0+0.5)
<i>Oxalis corniculata</i> L.	4 (3+0.5+0+0.5)
<i>Reichardia picroides</i> (L.) Roth	4.5 (3+0.5+0+1)
<i>Sonchus tenerrimus</i> L.	6 (3+2+0+1)
– slightly allergenic	
<i>Avena barbata</i> Potter	2.5 (1+0.5+0+1)
<i>Bromus hordeaceus</i> L.	2 (1+0.5+0+0.5)
<i>Catapodium rigidum</i> (L.) Hubbard	2 (1+0.5+0+0.5)
<i>Hyoscyamus albus</i> L.	2 (1+0.5+0+0.5)
<i>Sonchus oleraceus</i> L.	3 (1+2+0+1)
<i>Veronica cymbalaria</i> Bodard	2 (1+0.5+0+0.5)

Appendix to Table 4. The city walls near Porta Valle, southern exposure, 100 m² surface area, sampling date: May 15, 2000.

often used in urban parks (Popp et al. 1992). City park management can directly influence the allergic responses of inhabitants, as has been noted in Switzerland (Frei and Leuschner 2000).

The numeric increase in pollinosis patients is especially accentuated in large towns and cities, where studies of allergenic flora are fairly demanding. Selective floristic cartography (Hruska 2000) has helped reduce money and monitoring time employed for study of urban allergophytes. Allergophyte distribution is assessed and urban areas particularly invaded by these species are identified, thus indicating residential zones unsuitable for pollinosis patients. Since the symptomatology of these illnesses varies considerably over the course of a year, it is very useful to indicate the periods of a given pollen's maximum production. To this end, phenograms of the most important entities from the allergologic point of view can be used specifically for a certain urban area (Telloni and Hruska 1997). Utilizing this data, one can define

Table 5. Allergen indices (A.I.) of road embankment flora in the periphery of the city of Jesi (near Ancona), central Italy

Species/pollen	A.I.
– strongly allergenic	
<i>Achillea collina</i> Becker	9 (3+2+0+4)
<i>Agropyron repens</i> (L.) Beauv.	7.5 (3+0.5+0+4)
<i>Arrhenatherum elatius</i> (L.) Presl	6.5 (3+0.5+0+3)
<i>Artemisia vulgaris</i> L.	10 (3+2+1+4)
<i>Avena barbata</i> Potter	7 (1+2+0+4)
<i>Cichorium intybus</i> L.	7 (3+2+0+2)
<i>Dactylis glomerata</i> L.	10 (3+2+1+4)
<i>Plantago lanceolata</i> L.	7 (3+2+1+1)
– moderately allergenic	
<i>Cardaria draba</i> (L.) Desv.	5.5 (3+0.5+0+2)
<i>Clematis vitalba</i> L.	6 (3+2+0+1)
<i>Convolvulus arvensis</i> L.	5.5 (3+0.5+0+2)
<i>Diplotaxis tenuifolia</i> (L.) DC.	4 (3+0.5+0+0.5)
<i>Galium verum</i> L.	4.5 (3+0.5+0+1)
<i>Geranium pyrenaicum</i> Burm.f.	4 (3+0.5+0+0.5)
<i>Linaria vulgaris</i> L.	4 (3+0.5+0+0.5)
<i>Medicago sativa</i> L.	6 (3+2+0+1)
<i>Melilotus officinalis</i> (L.) Pallas	4.5 (2+0.5+0+2)
<i>Origanum vulgare</i> L.	5.5 (3+2+0+0.5)
<i>Pastinaca sativa</i> L. ssp. <i>urens</i> (Req.) Celak.	4.5 (3+0.5+0+0.5)
<i>Salvia verbenacca</i> L.	4.5 (3+0.5+0+1)
<i>Saponaria officinalis</i> L.	4 (3+0.5+0+0.5)
<i>Silene alba</i> (Miller) Krause	5 (2+2+0+1)
<i>Symphytum bulbosum</i> Schimper	4 (3+0.5+0+0.5)
<i>Taraxacum officinale</i> Weber	6 (3+2+0+1)
– slightly allergenic	
<i>Bromus sterilis</i> L.	2.5 (1+0.5+0+1)
<i>Crepis sancta</i> (L.) Babc.	2.5 (1+0.5+0+1)
<i>Medicago lupulina</i> L.	2 (1+0.5+0+0.5)
<i>Papaver rhoeas</i> L.	2 (1+0.5+0+0.5)
<i>Stellaria media</i> (L.) Vill.	2 (1+0.5+0+0.5)

Appendix to Table 5. Road embankment on Via Roma, southern exposure, 30 m² surface area, 20° inclination, sampling date: June 3, 2001.

prevention and treatment measures for people who suffer from allergenic manifestations caused by urban pollens in order to ease the symptomatology of the illness.

4. Conclusions

The results of this research directed to assess urban allergenic flora using an allergen index confirm the importance of an approach that integrates the biological and phenological characteristics of the individual

allergophytes, keeping in mind both the allergenic characterization of the pollen and the abundance of an allergenic species in certain urban areas. Trials of this index in different central Italian urban ecosystems have demonstrated that:

- the numeric index in ascending order obtained for an individual allergophyte correlates well with the symptomatology provoked by its pollen in sensitized persons,
- on the basis of the numeric value of the allergen index, three groups of plants can be identified, among which the most numerous are the moderately allergogenic ones,
- the flora of urban Italian ecosystems possesses a high allergenic potential,
- the presence of allergophytes varies in the different biotopes. Abandoned areas of the periphery host more allergophytes than do urban central zones.

Through assessment of an allergophyte's distribution in a given city with the help of selective floristic cartography, one can identify the urban area to be avoided by allergy sufferers. With the availability of phenograms to provide precise information on the period of maximum allergogenic pollen production, preventative measures can be facilitated. Correct treatment for pollinosis sufferers, therefore, must take into consideration the quality of their daily environment.

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