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Seasonal Variations in the Atmospheric *Chenopodiaceae / Amaranthaceae* Pollen Count in Timisoara, Romania

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Abstract

The aim of the present analysis was to describe the dynamics of the *Chenopodiaceae / Amaranthaceae* pollen in the atmosphere of Timisoara, by taking into consideration the data collected through volumetric method (identification, quantification). *Chenopodiaceae / Amaranthaceae* has a long pollen season with low concentrations in the air plankton. The period of *Chenopodiaceae / Amaranthaceae* flowering starts in June and continues until the half of October under climatic conditions from the Western Plain of Romania. The pollen belonging to *Chenopodiaceae / Amaranthaceae* was sampled during a 5-year (2000-2004) atmospheric pollen-monitoring programme in Timisoara, Romania, using a VPPS 2000 Lanzoni trap. *Chenopodiaceae / Amaranthaceae* air pollen constitutes between 2.20% and 5.52% of the annual total pollen grains. The highest annual level was attained in 2002 with 1108 PG. Pollen seasons were defined as the periods in which 90% of the total catch occurred. The highest concentration of *Chenopodiaceae / Amaranthaceae* pollen, equal to 50 PG/m^3/24h was identified in 2003.

Keywords: air plankton, air pollen, pollinosis, *Chenopodiaceae/Amaranthaceae*

Introduction

Chenopodium album (chenopod, commonly lamb's quarter) is a perennial plant of the *Chenopodiaceae* family that has been reported as responsible for hay fever in dried areas. Many members of this family, as well as from the closely related *Amaranthaceae* family, have been involved in inducing allergic diseases (Lombardero et al., 1991; Kay, 1997). Both *Chenopodiaceae* and *Amaranthaceae* weeds shed locally large amounts of pollen, being common in large areas of the United States, southern Canada, and central and southern Europe. The clinical incidence of chenopod pollinosis has been increasing mainly in desert areas and arid environments, where this weed is well adapted (Ezeamuzie et al., 1997).

The characterization of sensitizing allergens from *Chenopodium album* has received little attention, probably due to its concomitant apparition with other pollinosis. Allergens of 14 and 35 kd were detected by Lombardero et al. (1985) and protein bands of 15, 25, and 55 kd were detected by Wűrtzen et al. (1995). In addition, Barderas group reported the isolation, cloning, and sequencing of Che a 1 (17 kd), which has been characterized as a major allergen within this pollen (2002).

Most of the studies on chenopod pollen allergy have showed a high degree of cross-reactivity with amaranth and other less taxonomically related pollens (Barderas et al., 2002) as well as some foods, such as garlic, onion, and asparagus (Anibarro et al., 1997). IgE cross-reactivity mainly arises from the presence of panallergens, with the role of profilin and polcalcin in pollen-pollen cross-sensitization being relevant. These families of proteins possess highly conserved amino acid sequences, that explain their involvement in cross-reactivity (Barderas et al., 2003). Che a 3 displays similarity with polcalcins from pollens of olive, birch, alder, rapeseed, and timothy. Profilin and polcalcin are relevant panallergens in chenopod pollen and good candidates to be involved in IgE cross-reactivity with other pollen sources, thus explaining the highly frequent polysensitization of patients allergic to chenopod (Barderas et al., 2004).

The aim of the present analysis was to describe the dynamics of the *Chenopodiaceae / Amaranthaceae* pollen in the atmosphere of Timişoara, by taking into consideration the data collected through volumetric method (identification, quantification).

Materials and methods

The existing measurement methods for airborne pollen can be divided roughly into gravitational methods and volumetric methods. Airborne pollen in Timisoara was collected by use of a 7-day recording Lanzoni volumetric trap, during the period 2000-2004. The trap was placed

Table 1 Selected values characterizing *Chenopodiaceae/Amaranthaceae* pollen seasons in Timisoara during 2000-2004

	2000	2001	2002	2003	2004
First identification of the air pollen	8 VI	5 VI	17 VI	9 VI	21VI
Last identification of the air pollen	8 X	14 X	13 X	5 X	9 X
Chenopodiaceae/Amaranthaceae pollen in the air plankton (days)	123	131	119	119	111
Atmospheric Pollen Season – (Nilsson and Persson, 1981); 90%	82 days (28 VI-17 IX)	105 days (23 VI-5 X)	76 days (20 VII- 3 X)	70 days (14 VII-21 IX)	74 days (1 VII-12 IX)
Pollen Index (PI)	4.3%	2.2%	5.52%	42%	3.3%
Chenopodiaceae/Amaranthaceae air pollen on the peak days	24 PG/m^3 12 VIII	14/ PG/m^3 24 VIII	37 PG/m^3 28 VII, 23 VIII	50 PG/m^3 24 VIII	28 PG/m^3 11 IX

on the roof of a building in the centre of Timisoara, approximately 20 m above ground level, as recommended in aerobiological studies (Mandrioli et al., 1998). The trap is equipped with a vacuum pump drawing 10 L of air per minute through a thin orifice. Air particles are trapped on an adhesive coated transparent plastic tape, supported on a clockwork-driven drum, which moves at a speed of 2 mm/h making a complete revolution in a week. The tape was then removed and cut in seven equal sections, each representing a day of sampling (viz. of 48 mm of tape per day). The tape sections are stained with a solution of gelatin, glycerol and fuxine and are mounted on microscope slides, each slide representing a 24-h period. Identification and counting of pollen grains were performed under a light microscope at a magnification of X400. The daily pollen grains count per cubic meter of air (PG/m3) was calculated by multiplying the cumulative pollen count observed using a correction factor derived from the proportion between the scanning area of the microscope optical field and the area of the collecting tape. Our bulletins were provided weekly on the following websites: http://www.pollinfo.ini.hu, http://nspolen.com/nspolen.

Results and discussion

The study was focused on the analyses of the fluctuations observed in airborne pollen records from an urban area located in the west part of Romania. Flora in the surrounding area includes both natural plant species and introduced species, consisting in both ornamentals and crops. Pollen grains of allergenic taxa occur in the atmosphere of Timisoara in large quantities from early February untill late October. It is clear that the Romanian pollen seasons show 3 main parts: tree season (February–April), grass season (May–July), weed season (July–October) (Faur and Ianovici, 2003).

Pollen from *Chenopodiaceae/Amaranthaceae* species forms a stenopalynous group due to the morphological similarities of their pollen grains. The results of pollen count for all years are presented in table 1. Monthly variations of total pollen grains recorded in the atmosphere of Timişoara during the years 2000-2004 are presented in table 2. The monthly total concentration was the sum of all daily concentrations per one month, while the total annual concentration was the sum of all monthly concentrations per one year. The mean annual pollen count obtained during the period studied (2000-2004) was 723 pollen grains, the lowest value (349 PG/m^3) being identified in 2001 and the highest (1108 PG/m^3) in 2002. The maximum pollen concentrations were recorded in August for all investigated years, and occasionally in September (2000). The peak count of each season fluctuated between 14-50 PG/m^3. Inter-annual differences can be seen in the seasonal behaviour of the pollen, 2002 being the year in which the highest levels of airborne pollen were reached (Figure 1).

Table 2 Monthly pattern of *Chenopodiaceae/Amaranthaceae* airborne pollen (%), Timisoara, Romania

	June	July	August	September	October
2004	5.00%	15.50%	36.00%	42.50%	1.00%
2003	2.47%	12.75%	56.61%	27.67%	0.50%
2002	0.63%	23.92%	47.11%	18.41%	9.93%
2001	10.02%	26.10%	46.13%	9.45%	8.30%
2000	5.60%	15.42%	58.73%	19.14%	1.11%

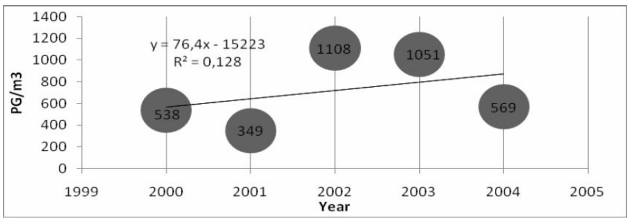

Figure 1 The annual concentrations in Timisoara (2000-2004)

Airborne pollen concentration was expressed as a Pollen Index (PI = this index is expressed in percentage from annual sum pollen types during sampling period 2000-2004). *Chenopodiaceae/Amaranthaceae* air pollen constitutes between 2.2% and 5.52% of the annual total of pollen grains.

The term Atmospheric Pollen Season is readily understood as the period of time during which pollen is present in the atmosphere, whilst Main Atmospheric Pollen Season could be used to delimit the period during which most pollen is recorded. Atmospheric Pollen Season appears to be the term best suited to describe this concept. The criteria for limiting the shortest and longest pollen season periods, as well as the earliest and latest start and end dates, varied according to the city and the taxon under study; in many cases, results for a given taxon also depended on the year (Jato et al., 2006).

The APS were determined in accordance with the criteria used by Nilsson and Persson (corresponding to 90% of the total pollen catch - 90% method). The blooming starts at different dates from year to year. The longest Atmospheric Pollen Season (ASP) was observed in the year 2001 (105 days). Five year average pollen season duration were 81.4 days. In 2003 pollen season in Timisoara lasted a shorter time.

The starts of these APS were uniform, finishing in October (see Figure 2). *Chenopodiaceae/Amaranthaceae* anthesis was prolonged at the beginning of October as well, along with that of plants belonging to genera such as *Ambrosia, Artemisia* and *Poaceae*. In the studied years, the Atmospheric Pollen Season showed numerous differences. In 2001, the season started earlier (23 June), was longer (105 days) and characterized by significantly lower concentration of air pollen. Pollens of *Chenopodiaceae/ Amaranthaceae* are detectable in the air for a period longer than the flowering time of the same species.

Season pollen *Chenopodiaceae/Amaranthaceae* is part of the season pollen weeds. Aeropollen values obtained in Timisoara are similar to those of Croatia, Poland, Spain and Turkey. In south-eastern Poland, herb plants like *Chenopodiaceae* are common, and the pollen production by these taxa is 0.53% - 2.26% percent total sum of pollen grains (Kasprzyk, 1999).

Chenopodiaceae/Amaranthaceae pollen type was found frequently in the atmosphere of Balikesir, Turkey (1.54%). Pollen production was continued from the second week of May to the last week of October (Bicakci and Akyalcin, 2000).

The pollen concentrations of Izmir was at lower level (1.60 m) 1.3% and at higher level (20 m), 1.7% (Guvensen and Ozturk, 2003). Among herbaceous plants *Gramineae, Xanthium sp., Chenopodiaceae/Amaranthaceae, Artemisia* sp. and *Urtica* sp. were found frequently in the atmosphere of Bursa, making up to 17.73% of the total. *Chenopodiaceae/Amaranthaceae* pollen release continued from the third decade of April to the third decade of October.

The highest counts were recorded from mid- August to the middle of September (Bicakci et al., 2003). Pollen grains of this family constituted 2.32% of total pollen in the atmosphere of Bitlis (Celenk and Bicakci, 2005). In Zagreb, Croatia, the first pollen grains are found in the air at the beginning of July, and the last at mid- September (Peternel et al., 2003). In Madrid, Spain, *Cheno-Amaranthaceae*, have very low concentrations (<2% yearly total pollens) (Subiza et al., 1995).

Chenopodiaceae pollen can be found in the atmosphere of Chirivel for more than 7 months a year, with peak concentrations in May, August or September (Cariñanos et al., 2004). The two association groups among pollen sensitizations found in Belver et al. study are not related to the different frequencies of sensitizations corresponding to different pollen levels in the Madrid environment.

Pollens of the association Group I (*Gramineae, Oleaceae, Cupressaceae, Chenopodiaceae* and *Plantaginaceae*) do not coincide with those collected in largest numbers in the Madrid atmosphere. Sensitizations to the *Chenopodiaceae* pollen were 211 patients (46.0%) in the Madrid assessed by skin prick tests (Belver et al., 2007).

For a proper interpretation will be needed correlation with the data obtained through clinical trials. Seasonal dynamics will be better analyzed using meteorological parameters. Anemophilous plants produce high amounts of pollen while the winds, a vector of pollination, reduce its efficiency.

The normal development of flowering in plant species is influenced by the bio-climatic conditions in which this flowering occurs. If the conditions are adverse, the plant species design phonological and physiological strategies to survive under new and changing conditions (Rodá et al., 1999), and pollen production may be significantly reduced.

The water stress induced by irregular distribution of rainfall has been identified as the most restrictive factors that affect the normal development (Hensen, 1999). Even if some species are able to adjust their vegetative and reproductive cycles to availability of water (Izco et al., 1997), most of them react negatively, keeping the reproductive functions at the minimum compatible with life. Similarly, extreme temperatures are also cause of responses deviated from the optimum on plant species.

Cold stress has been reported as a factor affecting microsporogenesis, and pollen production in consequence, both in cultivated species (Koike et al., 1997) and in growing in a natural environment (Garcia-Mozo et al., 2001). Another environmental adversity affecting normal growing may be the high mountain location, since differences in pollination with decreasing concentrations have been observed at heights above 1000 m (Frenguelli and Bricchi, 1998; Gehrig and Peeters, 2000).

A combination of the three factors above-mentioned (waters-stress, extreme temperatures and high mountain location) may start a variety of responses in the vegetation of an area in which these circumstances are present.

The airborne pollen records may be used as indicators to know these responses, taking into consideration that once the pollen grains are emitted from the plants into the air, they are likewise subject to the meteorological conditions of the surrounding atmosphere. Herbaceous species (*Urticaceae*, *Chenopodiaceae*, *Poaceae* species and *Artemisia* sp.) present an immediate response to weather conditions and this period lasts longer if rainfall occurs during their principal pollination period (Cariñanos et al., 2004). Average temperature showed a particularly positive strong correlation with *Chenopodiaceae/Amaranthaceae* pollen type, which reveals the importance of this meteorological parameter in flowering and pollen production. As Moseholm et al. (1987) have showed, the development of pollen grains, within the anther from the pollen mother cell is probably a temperature dependent process. The same can be said for sunshine, a meteorological variable that induces anther dehiscence and filament extension, together with a falling relative humidity, a meteorological parameter inversely related with standardised pollen concentration for *Chenopodiaceae-Amaranthaceae*.

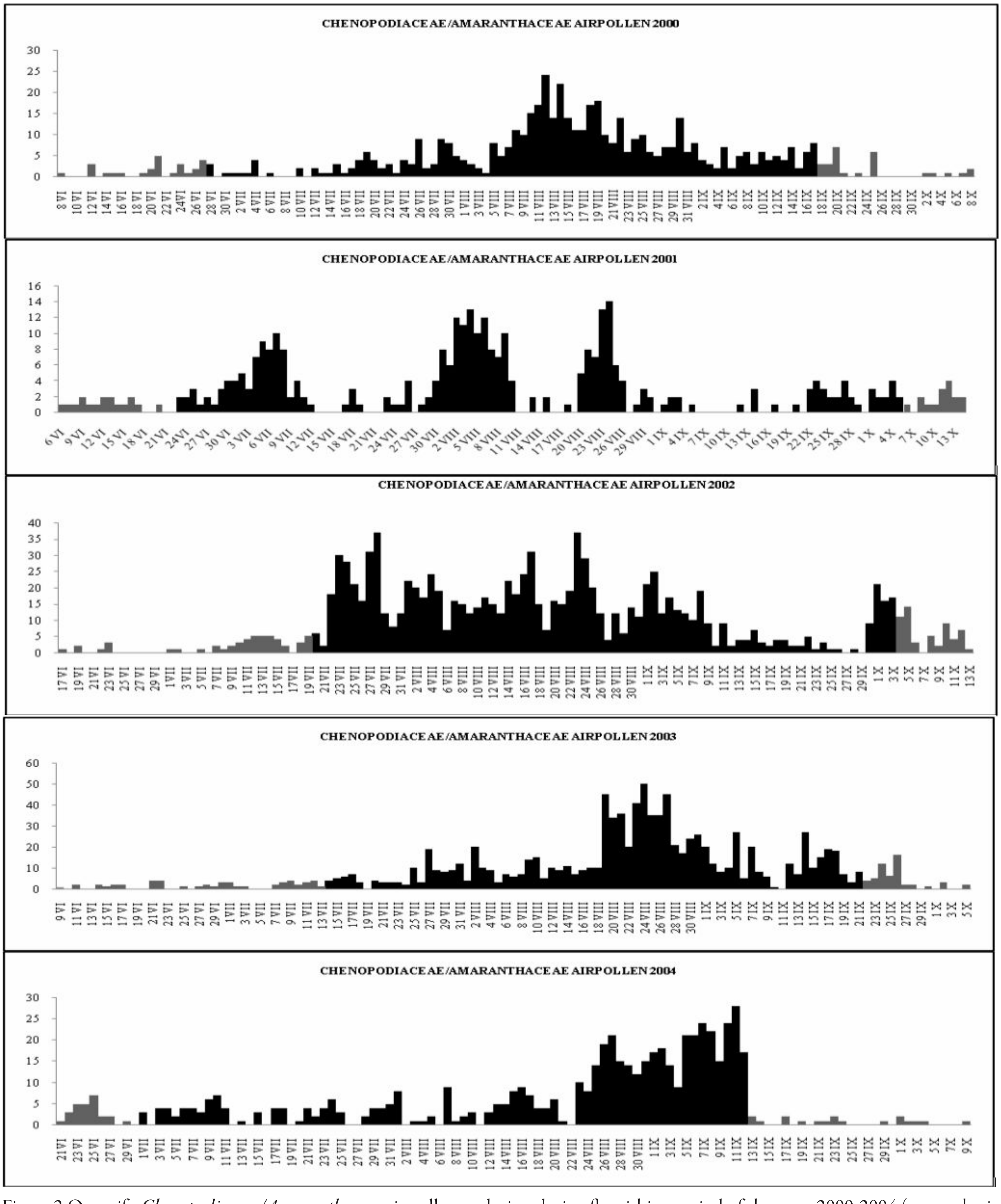

Figure 2 Quantify *Chenopodiaceae/Amaranthaceae* air pollen evolution during flourishing period of the years 2000-2004 (atmospheric pollen season with black)

The *Chenopodiaceae/Amaranthaceae* air pollen is a constant presence in the pollinic range in Timişoara, but it is moderately represented from a quantitative point of view. The pollen grains number reaches the quantitative peak of the year in August. The generally accepted conclusion is that the participation of arboreal pollen in the pollen fall reflects regional conditions, while the content of pollen of herbaceous plants reflects local ones (Gutiérrez et al., 1999). Overall, the pollen shedding course of the *Chenopodiaceae / Amaranthaceae* in Timişoara corresponds to that already described during the pollen season in other European areas.

Monitoring of the pollen counts in the aeroplankton of cities has a relevant medical importance. The number of people allergic to plant aeroallergens has substantially increased in big cities and industrial areas (Nilsson and Persson, 1981). Registered data confirm the fact that at lower concentrations the *Chenopodiaceae/Amaranthaceae* pollen is not an important allergenic factor in Timișoara (Faur and Ianovici, 2003).

Conclusions

The results of this study revealed that *Chenopodiaceae/Amaranthaceae* seasons occurred at regular intervals between June and October each year. Smaller airborne concentrations of *Chenopodiaceae/Amaranthaceae* were recorded out of each season. The start and the end of APS (Atmospheric Pollen Season) were relatively constant for *Chenopodiaceae/Amaranthaceae*. The pollen index in 2002 it was higher. The length of the studied APS differed from year to year, and as a result, the pollen concentrations recorded in each one of these periods varied from one year to the next. The results require an elaborate study of them and of the allergological implications for our geographic area, as well as of the possible correlations with the meteorological factors.

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