

The relationship between airborne pollen and fungal spore concentrations and seasonal pollen allergy symptoms in Cracow in 1997–1999

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Abstract

The investigation of airborne pollen and fungal spore concentrations was carried out in Cracow between 1997–1999. For this study the volumetric method has been employed (Burkard). At the same time the clinical diagnosis of pollen allergy in 40 patients was obtained on the basis of an interview, positive skin prick tests with pollen extracts and increased specific IgE level. An increase in seasonal allergy symptoms in all patients occurred from the middle of May to the middle of August. Eighty eight percent of the patients (35 out of 40) were sensitive to Poaceae pollen and about 50% of them were additionally sensitive to tree and herb pollen excluding grasses. For patients with additional allergy to tree pollen the seasonal symptoms started at the end of March (*Betula*) while for patients with additional allergy to herb pollen it was extended to the middle of September (*Artemisia*).

Five people out of 40 revealed positive skin reactions to *Alternaria* spores and an increase in specific IgE level. Positive skin reaction to *Cladosporium* spores with no increase in specific IgE level occurred in 2 patients. The increase in seasonal allergy symptoms in people sensitive to *Alternaria* spores noted in July and August could be caused not only by these spores but also by Poaceae pollen.

Introduction

Aerobiological studies, which provide data on exposure of people to allergens in the air, are of substantial importance in the pollen allergy diagnosis (Obtulowicz et al., 1990). The most important agent causing pollinosis in Europe as a whole is grass pollen. Approximate estimations indicate that in Europe 3–5% of the population, i.e. 15 million people suffer from pollinosis from May to July during the flowering season for Poaceae (D'Amato and Spieksma, 1991). In this time high concentrations of grass pollen occur also in Poland.

From the beginning of February to the middle of May tree pollen – mainly of *Corylus*, *Alnus*, *Betula*, *Fraxinus* and *Quercus* – occurs in the atmosphere. *Betula* pollen grains which are the most allergenic tree pollen grains are noted from the middle of April to the middle of May, whereas in summer pollen grains

of herbs such as *Artemisia* and *Ambrosia* appearing from the end of July to the end of September, are responsible for allergic response in susceptible people.

More than 90% of people sensitive to pollen present the highest symptom score during the Poaceae flowering period (Obtulowicz and Myszkowska, 1996; Zawisza and Samolińska-Zawisza, 1991).

The additional reason for the increase in seasonal allergy symptoms could be fungal spores, primarily of *Alternaria* and *Cladosporium* which are often present in the air in high concentrations at the same time (D'Amato and Spieksma, 1995). According to Tariq (1996) 4–7% of the European population shows sensitivity to *Alternaria* and *Cladosporium* spores.

The aim of our study was to define the relationship between airborne pollen, fungal spore concentrations and seasonal pollen allergy symptoms in Cracow between 1997–1999.

Material and methods

Aerobiological monitoring

The results of our investigations are based on aerobiological monitoring performed in Cracow in 1997–1999. Cracow is situated in the Vistula river valley in Southern Poland, 220 m a.s.l., 50°03' N, 19°57' E. The city is surrounded by pine-oak forests north-east of Cracow and association of Carpinion betuli south of Cracow and farming lands (rye and wheat).

For this study the volumetric method has been employed using the Burkard 7 Day Recording Spore Trap with a flow rate of 10 L m⁻¹. The trap was installed on the roof top in the centre of Cracow at the height of 20 m above ground level.

The Melinex tape used for catching pollen and spores was replaced every Tuesday at 8 a.m. and cut into segments corresponding to 24 h periods. 12 transverse bands on each slide were analysed at magnification of 400×. Concentration values were expressed as the number of pollen grains and fungal spores m⁻³ / 24 h. These values are presented in histograms as weekly mean values.

Clinical studies

The studies were performed in 40 patients of either sex (20 women and 20 men, mean age 28 years, range 13–66 years) suffering from pollen allergy, whose clinical characteristics are presented in Table 1. The clinical diagnosis of pollinosis was obtained on the basis of the interview, seasonal allergy symptoms, positive skin prick tests (SPT) with tree, grass and herb pollen allergens (standardized allergen diagnostic extracts from Biomed, Poland and Allergopharma were used) and the increase in specific immunoglobulin E (IgE) antibodies level in relation to allergens of *Phleum* (G6), *Betula* (T3) and *Artemisia* (W6), with the use of ELISA (enzyme-linked immunosorbent assay). Additionally skin prick tests with *Alternaria* and *Cladosporium* spore extracts were carried out and specific IgE serum levels for these allergens were estimated.

Nasal, eye and asthma symptoms of allergy were scored daily on a scale of 0–3. The maximum sum of daily symptoms would be 9. The symptom score was expressed as mean daily value for a seven day period.

Results

During the aeropalynological analyses performed in Cracow in 1997–1999 40 taxa of plants were identified including 24 taxa of trees and 16 taxa of herbs and grasses. Fungal spores of *Alternaria* and *Cladosporium* from the class of the Deuteromycetes were also determined.

Pollen

Pollen concentrations varied in consecutive seasons (Table 2). Tree pollen concentration was the highest in 1998 while in 1997 it was the lowest (about one third of the value for 1998). The number of *Betula* pollen grains which was about 30% of the total number of tree pollen grains was also the lowest in 1997 while it increased three-fold in the next two years.

Tree pollen was noted from the end of January (*Alnus*) to the middle of July (*Tilia*) (Figure 1). In 1997 the period of abundant tree pollen occurrence was divided into three episodes. The first increase in pollen concentration was caused by the presence of *Alnus* and *Corylus* pollen. Then a 1–2 week decrease in concentration occurred in the second half of March. The third episode referred to the next increase in pollen concentration which was associated with the flowering period of *Betula*, *Pinus*, *Ulmus*, *Fraxinus* and *Salix*. This increase occurred in 1997 in May, in 1998 in April and in 1999 in the first half of April, and the reason for such an increase was the high concentration of *Betula* pollen in all the seasons under study (Figure 2).

Variations in the first Poaceae pollen grain occurrence were of about two weeks. High concentrations of Poaceae pollen (more than 10 grains m⁻³ / 24 h) were observed from the second half of May to the end of July in all the years (Figure 3). The highest values were noted in the first half of July in 1997 and 1998, and in the first week of June in 1999. Herb pollen (excluding Poaceae) appeared in the air usually during May and lasted to the middle of September (Figure 4). The highest concentration of herb pollen occurred in July or August. It was associated with high concentrations of *Plantago*, *Rumex*, *Urtica* and *Chenopodiaceae* pollen.

The number of *Artemisia* pollen grains was the highest in the first half of August in all the years (Figure 5).

Table 1. Clinical characteristics of examined patients

(His – histamine, Alt – *Alternaria*, Clad – *Cladosporium*, s-IgE – specific IgE, t-IgE – total IgE, G6 = *Phleum pratense*, T3 = *Betula verrucosa*, W6 = *Artemisia vulgaris*, kl-class)

Normal value: t-IgE <150 IU/ml; s-IgE < 0.35 IU/ml

No. of pat.	Sex	Age	Maximum symptoms	Skin prick tests							s-IgE	s-IgE	s-IgE	s-IgE	s-IgE
				His	Grasses	Trees	Weeds	Alt	Clad	t-IgE	G6	T3	W6	Alt	Clad
1	F	36	V-VII	2	5	0	8	0	0	275	2kl	<	<	<	<
2	F	18	V-IX	5	6	10	9	0	0	250	3kl	<	<	<	<
3	M	18	V-VII	—	—	—	—	—	—	—	3kl	<	<	<	<
4	F	25	I-II,V-VIII	4	10	0	0	0	0	105	3kl	<	<	<	<
5	F	22	IV-IX	5	0	0	0	0	0	175	2kl	<	<	<	<
6	M	30	V-VIII	5	3	0	8	0	0	75	3kl	<	<	<	<
7	F	19	V-VII	10	8	12	10	0	0	200	3kl	<	<	<	<
8	M	44	V-VII	5	8	3	8	0	0	200	3kl	<	<	<	<
9	F	25	V-IX	0	2	0	2	0	0	125	3kl	<	<	<	<
10	F	19	III-IX	3	6	—	9	0	0	105	<	2kl	2kl	<	<
11	M	44	V-IX	7	10	8	4	11	8	137	4kl	3kl	2kl	3kl	<
12	F	18	V-VIII	5	8	3	8	4	0	465	3kl	2kl	2kl	<	<
13	F	66	IV-VII	2	4	3	—	0	0	33	2kl	4kl	1kl	<	<
14	M	23	V-IX	4	10	7	10	10	2	1110	3kl	1kl	2kl	3kl	<
15	M	19	V-VII	4	8	2	20	0	0	415	4kl	2kl	2kl	<	<
16	F	19	VI-VII	4	10	—	10	0	0	203	4kl	1kl	4kl	<	<
17	M	24	V-VIII	5	9	8	6	0	0	1250	4kl	<	<	<	<
18	F	60	V-VII	4	8	3	8	0	0	120	3kl	<	<	<	<
19	M	19	V-VII	5	10	0	0	0	0	100	3kl	<	<	<	<
20	M	25	V-VII	7	8	0	7	0	0	150	3kl	<	<	<	<
21	M	26	V-VII	5	8	3	3	0	0	290	3kl	<	<	<	<
22	F	49	III-V	3	8	5	6	0	0	200	3kl	4kl	1kl	<	<
23	F	34	VI-IX	3	4	3	4	0	0	122	1kl	3kl	4kl	<	<
24	M	17	V-IX	2	10	6	7	0	0	496	4kl	4kl	3kl	<	<
25	F	42	V-VII	4	18	10	2	0	0	472	4kl	4kl	0	<	<
26	M	29	V-IX	10	10	6	5	16	0	145	1kl	<	<	3kl	<
27	M	20	V-VIII	5	12	7	7	0	0	563	6kl	4kl	4kl	<	<
28	F	33	V-VII	6	6	7	5	0	0	110	3kl	3kl	<	<	<
29	M	39	V-VII	5	10	10	0	0	0	38,6	3kl	3kl	2kl	<	<
30	M	62	V-VI	6	10	2	10	0	0	899	4kl	2kl	2kl	<	<
31	F	23	VIII-X	4	0	0	3	0	—	36	<	<	<	—	—
32	M	21	V-VIII	3	7	2	5	0	0	80	2kl	—	—	—	—
33	M	15	IV-VIII	10	14	—	16	0	0	1440	3kl	—	—	—	—
34	F	33	V-VII	4	0	0	0	0	0	464	2kl	0	0	0	0
35	M	19	V-VII	5	8	0	0	0	0	395	2kl	0	0	0	0
36	F	21	V-VIII	5	20	5	0	7	0	101	4kl	1kl	2kl	1kl	0
37	F	15	V-IX	5	5	0	0	10	0	238	2kl	0	0	0	0
38	F	13	V-IX	3	0	2	2	3	0	60	4kl	<	<	2kl	<
39	M	39	VI-VIII	2	18	10	2	0	0	472	4kl	4kl	0	0	0
40	M	57	IV-IX	5	4	3	0	0	0	33	2kl	4kl	1kl	0	0

Table 2. Annual sums of daily average concentrations and maximum daily average concentrations of pollen grains and spores in Cracow in 1997–1999

Season	Taxa					
	Annual sums of daily average concentrations			Maximum daily average concentrations		
	1997	1998	1999	1997	1998	1999
Trees	2479	8406	6737	216 (03.05)	481 (11.04)	762 (06.04)
<i>Betula</i>	869	2501	2546	198 (03.05)	451 (11.04)	540 (06.04)
Poaceae	5940	2299	1262	437 (10.07)	106 (11.07)	116 (07.06)
Weeds	14228	10033	6427	642 (03.08)	449 (19.07)	272 (28.07)
<i>Artemisia</i>	1526	715	660	189 (10.08)	75 (05.08)	42 (15.08)
<i>Alternaria</i>	4344	5782	3331	267 (09.08)	340 (09.08)	211 (27.07)
<i>Cladosporium</i>	172203	254651	130157	6182 (19.06)	11290 (15.07)	4018 (12.08)

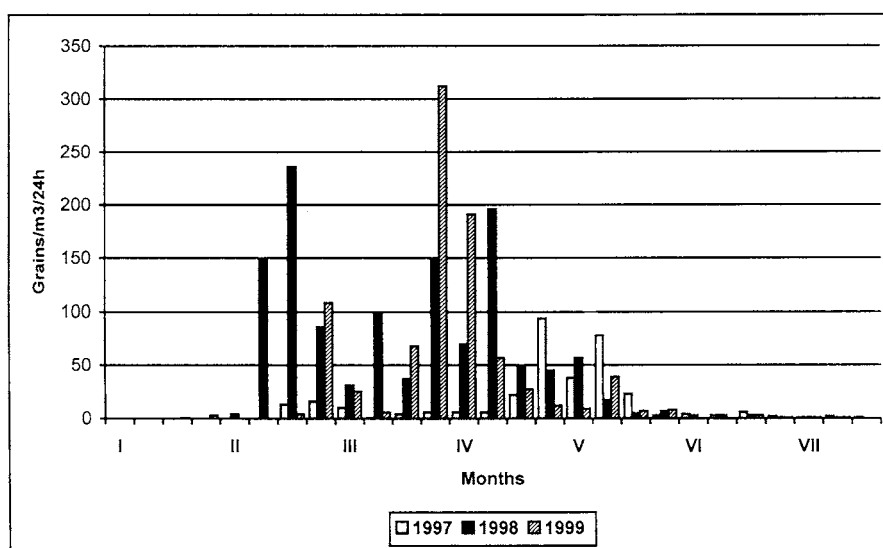


Figure 1. Tree pollen grain concentration in Cracow in 1997–1999 (weekly mean values).

Alternaria and *Cladosporium*

The fungal spores reached the highest concentration in 1998 and the lowest in 1999 (Table 2). The number of *Cladosporium* spores was approximately forty times as high as the number of *Alternaria* spores. *Alternaria* spores occurred from the middle of April to October while *Cladosporium* spores were noted all year round. The highest concentrations of *Alternaria* spores were recorded in July and August in 1998 and 1999. In 1997 the period of spore occurrence was shorter and lasted from the middle of July to the middle of August but the concentration was the highest (Figure 6). Abundant *Cladosporium* spore occurrence was observed from

the beginning of May in 1997 and from the beginning of June in 1998 and 1999. This period extended to the middle of August in all the seasons (Figure 7).

Seasonal symptoms

All patients enrolled in this study showed seasonal symptoms of rhinitis, conjunctivitis and 60% of them showed also bronchial asthma symptoms. The period of symptom occurrence did not change in consecutive seasons, and the longest lasted from the end of March to the end of September.

The skin prick tests performed in 40 patients have shown positive reactions to grass pollen in 35 cases

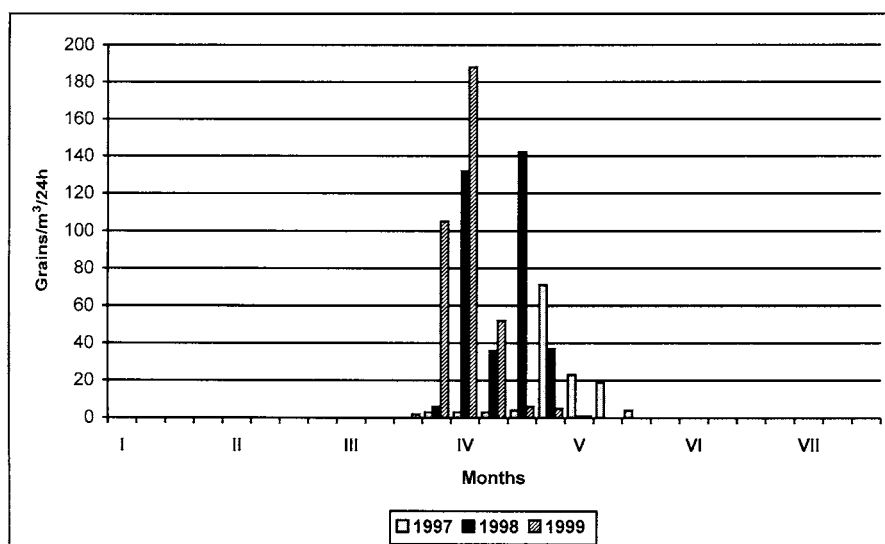


Figure 2. *Betula* pollen grain concentration in Cracow in 1997–1999 (weekly mean values).

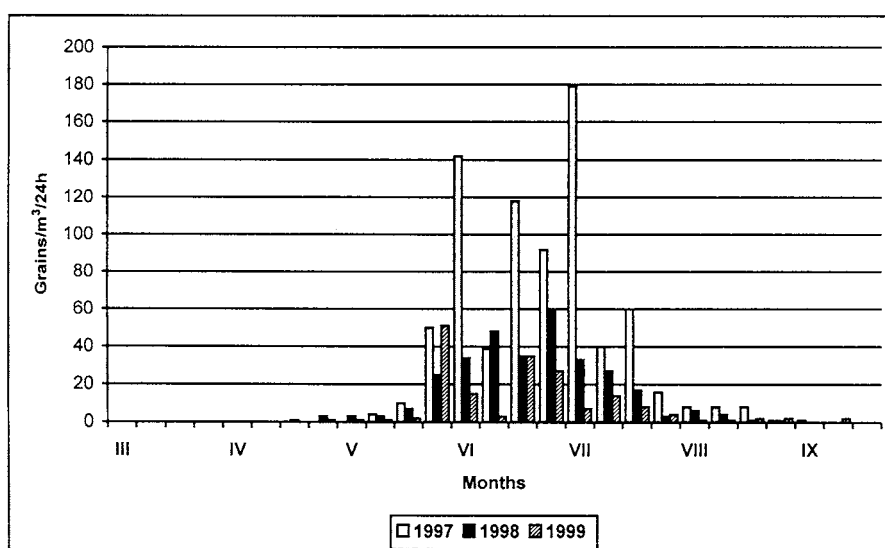


Figure 3. Poaceae pollen grain concentration in Cracow in 1997–1999 (weekly mean values).

(88%), and additional positive reaction to pollen of trees and weeds in 20 cases out of 35 (57%), to grasses and trees in 4 cases out of 35 (11%), and to grasses and weeds in 7 cases out of 35 (20%) (Table 1). Positive tests with allergen of *Alternaria* have been established in 5 cases and with allergen of *Cladosporium* in 2 cases. The increase in specific IgE antibodies level for grasses was found in 38 cases, for trees in 18 and for weeds in 15 cases. In 5 patients the increase in specific IgE level for *Alternaria* allergens was noted while

nobody showed an increase for *Cladosporium* allergens. Twenty patients out of 40 have demonstrated the increase in total IgE serum level (ELISA) and in 12 patients family predisposition to allergy was recorded. The increase in pollen allergy symptoms in patients with positive reaction to tree allergens (*Betula*) and with an increase in specific IgE level, generally started in the first half of May (Table 1). The increase in symptoms in patients sensitive to Poaceae pollen lasted from the middle of May to the end of July.

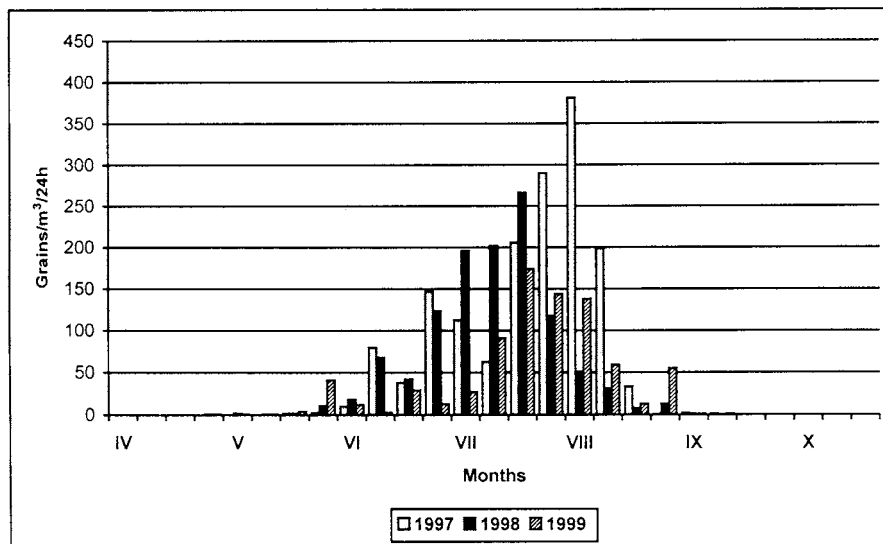


Figure 4. Herb pollen grain concentration (excluding Poaceae) in Cracow in 1997–1999 (weekly mean values).

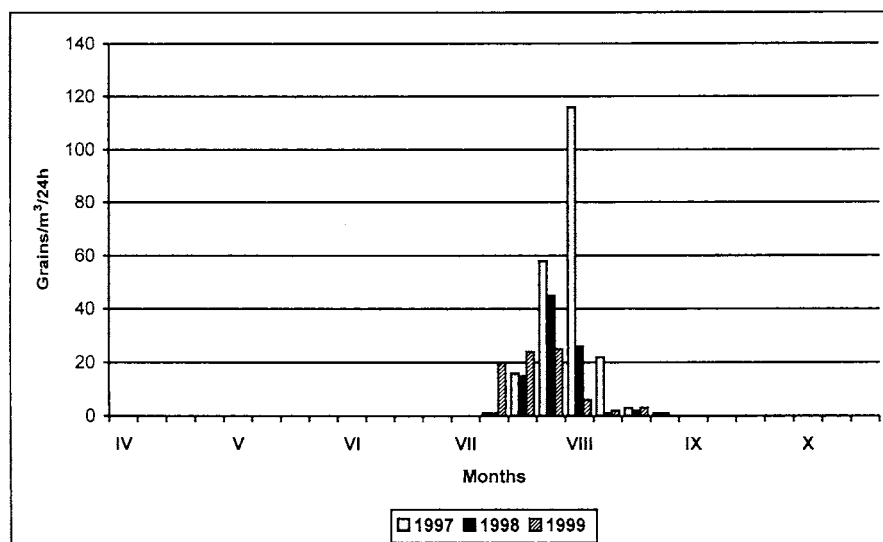


Figure 5. *Artemisia* pollen grain concentration in Cracow in 1997–1999 (weekly mean values).

From May to July most of studied patients (36, 39, 37 cases) showed the highest symptom scores (Figure 8). Among them 26, 29 and 27 patients respectively were sensitive to grasses. These results are given on the basis of the positive skin prick tests.

Twenty eight persons out of 40 revealed positive reactions to herb pollen. Twelve of them showed also an increase in specific IgE level while 2 persons who revealed the increase in specific IgE level did not show positive skin prick tests. Seasonal symp-

toms in these 28 persons occurred from the beginning of May to the end of July, August or September. Three patients out of 40 presented allergy symptoms to herb pollen to the middle of September in spite of the lack of positive skin reaction and of the increase in specific IgE level. Only 5 persons out of 40 revealed positive reactions to *Alternaria* allergens and an increase in specific IgE level for these allergens. The five persons' group mentioned above revealed an increase in allergy symptoms from the middle of May

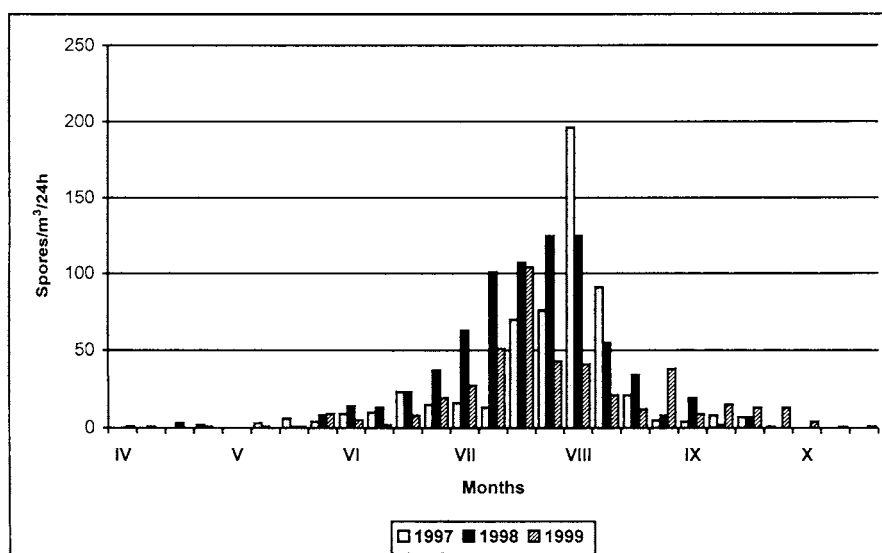


Figure 6. *Alternaria* spore concentration in Cracow in 1997–1999 (weekly mean values).

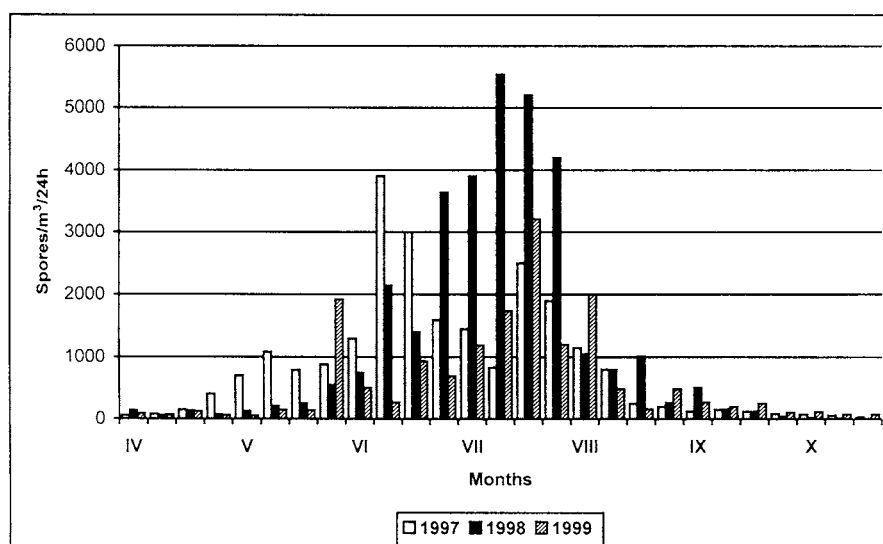


Figure 7. *Cladosporium* spore concentration in Cracow in 1997–1999 (weekly mean values).

to the end of August (Table 1). Two patients showed the positive skin prick tests to *Cladosporium* allergens with no increase in the specific IgE antibody levels. As the group of 5 patients examined reacted positively to *Alternaria* allergens it seemed that fungal spores could enhance allergic response to grass and weed pollen of which the highest concentrations occurred from the middle of May to the middle of August (Table 1).

Discussion

The palynological data in Cracow between 1997–1999 showed interannual fluctuations of pollen concentrations which were similar to those observed in previous investigations (Szczepanek, 1994; Obtulowicz and Myszkowska, 1996). However, we did not find any distinctive increasing or decreasing tendency during a three year observation similarly as Szczepanek (1994)

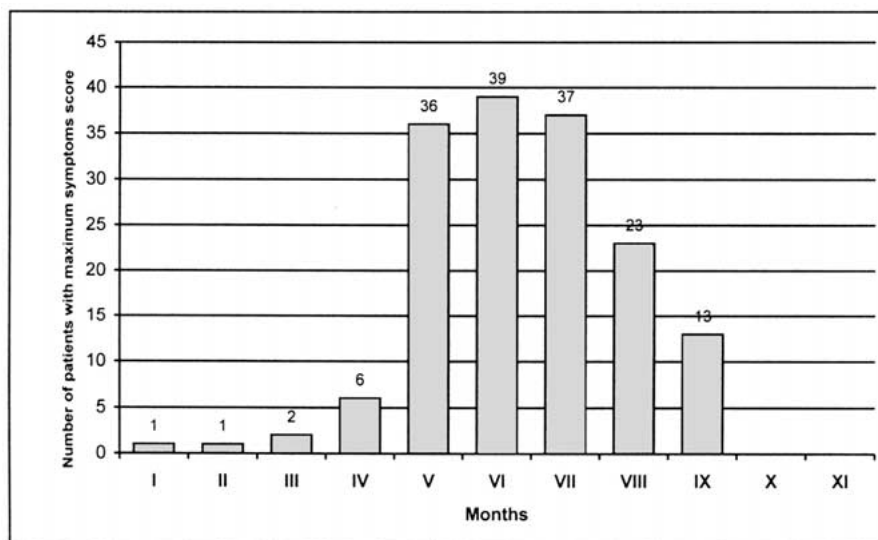


Figure 8. Number of patients with maximum symptoms score in consecutive months (average of 1997–1999).

did not find it in his ten years' study in Cracow. Spieksma et al. (1995) reported, on the basis of studies in five European cities between 1961–1993, weakly rising trends in *Betula* pollen concentrations and a cyclic alternating pattern of high and low concentrations in consecutive seasons with some asynchronous years.

In this report the periods of occurrence of particular taxa were comparable in consecutive seasons. The periods of abundant occurrence of pollen grains of the early-spring trees coincided with those of high *Betula* pollen concentrations. Poaceae pollen concentrations varied considerably in the years under investigation. Similar results were reported in Leiden where, on the basis of a 26 year observation, annual totals of daily average grass pollen concentrations fluctuated irregularly from year to year and showed no increasing or decreasing trend (Spieksma and Nikkels, 1998).

The presence of Poaceae pollen in Cracow from the beginning of May to the first half of September and its high concentration in the air from the middle of May to the middle of July were comparable with results obtained earlier in Cracow (Szczepanek, 1994).

The high concentrations of herb pollen from the middle of July to the middle of August were associated mainly with abundant occurrence of *Urtica* pollen which is not highly allergenic (Rapiejko, 1997). Other herb pollen such as *Artemisia* and *Ambrosia* pollen may cause and intensify allergy symptoms in people suffering from pollinosis (May, 1990; Obtulowicz and

Myszkowska, 1996). *Artemisia* pollen is a causative agent of a seasonal rhinitis during August or even a whole year's rhinitis.

The studies of concentrations of *Alternaria* and *Cladosporium* spores in 1997–1999 were incorporated in this report. Comparing the obtained results to those of Stępańska et al. (1999) referring to fungal spore concentrations from five stations in 1995–1996 there may be found much higher concentrations in Cracow in 1997–1999 than in the two previous seasons. *Cladosporium* spores were dominant and present in the air almost all year round whereas *Alternaria* spores were noted from the middle of April to the end of October.

In the Mediterranean region the situation is different. In Spain where favourable weather conditions exist all year round the fungal spores were also found during late autumn and winter, and the peak periods appeared to be twice a year – from May to July and in September (Munuera Giner et al., 1998). On the basis of aerobiological and clinical data the distinctive relationship between tree, grass and herb pollen occurrence and allergy symptoms we found in patients with positive skin prick test with pollen extracts and increased specific IgE level.

During from May to July nearly 100% of the patients showed the highest allergy symptom score, which was associated with the Poaceae pollen season. Isolated allergy only to tree and only to weed pollen occurred less often than allergy to Poaceae, tree and

weed pollen all together (Obtułowicz et al., 1991; Obtulowicz and Myszkowska, 1996). The increase in allergy symptoms during April and May could be caused by an overlapping reaction to tree and grass pollen allergens, and from June to the middle of September the positive reaction to weed pollen probably joined that of grass pollen.

The additional agents which provoke allergic response are fungal spores. In accordance with Tariq et al. (1996) *Alternaria* and *Cladosporium* spores are the third reason for symptoms of asthma, eczema and rhinitis following house dust mite and grass pollen. On the basis of our study it has been established that the relationship between the clinical symptoms and the presence of *Alternaria* spores in the atmosphere exists whereas much higher concentrations of *Cladosporium* spores do not clearly affect the symptom score in sensitive people. Probably it is a result of a less allergenic activity of *Cladosporium* spores.

Conclusions

1. Pollen and fungal spore concentrations varied in consecutive years
2. Pollen and fungal spore occurrence, and high concentrations were observed in similar periods in consecutive seasons
3. The distinctive relationship between the increase in tree, grass and herb pollen concentrations and the increase in allergy symptom score was recorded
4. Patients with additional allergy to tree pollen revealed symptoms from the middle of March and people with additional positive reaction to herb pollen (excluding Poaceae) showed symptoms to the middle of September
5. In 11% of the patients allergy to *Alternaria* spores was diagnosed on the basis of the increase in symptoms in July and August, positive skin prick tests and the increase in specific IgE level
6. None of the group studied showed symptoms of allergy to *Cladosporium* spores in spite of their high concentrations in the air

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