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COMPARATIVE ANALYSIS OF POLLEN FALL AT THREE SITES IN SOUTH-EASTERN POLAND

Idalia Kasprzyk

Institute of Biology and Nature Protection, Pedagogical University of Rzeszów, Rzeszów, Poland

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Abstract: The aim of the research was to study spatial variations in the abundance and seasonal patterns of pollen fall. The investigation was carried out at three sites of different land use during two pollen seasons (1995 and 1996). The sites were located in an average town (Ostrowiec Św.), in a village (Brzóstowa) and in the open area near Ożarów. With the use of the gravimetric method, 55 taxa of sporomorphs were determined. There were small differences in seasonal incidence and in total pollen sums between the three sites. The differences in the abundance and percentage values of chosen pollen taxa (*Populus, Fraxinus, Pinus, Poaceae*) were bigger. Tree and shrub pollen dominated in pollen fall at the three sites. The preliminary results suggest that the pollen data differed more between the years than between the sites, which was probably due to meteorological patterns.

Address for correspondence: Dr Idalia Kasprzyk, Institute of Biology and Nature Protection, Pedagogical University of Rzeszów, Rejtana 16a, 35-110 Rzeszów, Poland.

Key words: aerobiology, pollen grain, pollen fall, gravimetric method, south-eastern Poland.

INTRODUCTION

The main aim of aerobiological studies is to assess seasonal appearance of pollen grains in the air and to make quantitative and qualitative analysis of pollen fall or of aeroplankton. Atmospheric pollen has been measured for many years at various locations in Europe, but this particular research deals mainly with allergenic pollen [5, 9].

In Poland, the first calendar of flowering allergenic plants elaborated by Nowakowski, was published by Obtułowicz [16] in 1939; the first pollen calendars were made in Warsaw and in Łódź [1, 2, 23]. Since 1982, the analysis of pollen fall has been carried out in Kraków [20]. In 1989, the Allergen Research Centre which operates monitoring network of samplers was established [17].

Papers on spatial variation in the incidence of pollen published to date concern remote sites from different climatic regions [13]. Only rarely were aerobiological investigations carried out at several sites in a small area of different land use [4, 18]. Some of the recorded spatial differences could be attributed to a combination of factors, such as vegetation patterns, topography, climate, urban structure [4].

The data presented here were obtained during two years of research conducted at three sites in south-eastern Poland. The gravimetric method was used. The aim of the investigation was to determine if there were essential differences in the seasonal incidence and in the abundance of pollen grains and pollen types in pollen fall between sites of different land use.

MATERIALS AND METHODS

The investigation was carried out from 03.01.1995 to 24.12.1996. The material was collected in south-eastern Poland, in Ostrowiec Św., in Brzóstowa, and in an area near Ożarów. The greatest distance between the places, i.e. between Ostrowiec Św. and Ożarów, was 23 km.

All the sites, according to the geobotanical division of Poland, are situated in the Miechów-Sandomierz Province, Sandomierz-Opatów District [19]. In accordance with the

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Table 1. Results of aerobiological study (a).

Site		Ostrowiec Św.		Brzóstowa		Ożarów	
		1995	1996	1995	1996	1995	1996
Alnus (a)	ps	7.02-18.04	2.04-23.04	7.02-25.04	2.04-23.04	7.02-9.05	2.04-14.05
	p	30.48	13.47	33.3	14.57	31.7	14.66
	n	1409	349	1438	167	1111	217
Corylus (a)	ps	7.02-18.04	2.04-30.04	7.02-18.04	2.04-30.04	7.02-11.04	2.04-23.04
	p	7.29	7.7	9.2	18.9	14.5	9.18
	n	337	202	399	217	509	136
Populus (a)	ps	7.03-25.04	16.04-7.05	28.03-25.04	16.04-30.04	28.02-9.05	16.04-30.04
	p	2.5	8.084	1.41	2	1.6	1.41
	n	116	229	61	23	57	21
Salix (a, e)	ps	14.03-6.06	16.04-7.05	4.04-23.05	16.04-30.04	21.03-16.05	16.04-14.05
	p	2.16	1.54	5.12	1.39	1.05	1.08
	n	100	40	221	16	37	16
Fraxinus (a)	ps	11.04-9.05	16.04-30.04	18.04-16.05	16.04-30.04	18.04-16.05	sporadically
	p	2.27	1.54	0.95	0.61	0.42	
	n	105	40	41	7	15	
Betula (a)	ps	11.04-30.05	16.04-7.05	18.04-16.04	16.04-21.05	18.04-30.05	9.04-4.06
	p	14.25	38.99	11.6	27.92	8.13	39.39
	n	659	1010	502	320	285	583
Quercus (a)	ps	2.05-27.06	30.04-11.06	25.04-6.06	30.04-21.05	2.05-6.06	30.04-21.05
	p	1.34	1.96	1.04	3.14	1.59	2.7
	n	62	51	45	36	56	40
Pinus (a)	ps	16.05-13.06	7.05-25.06	23.05-11.07	7.05-21.05	15.05-6.06	7.05-28.05
	p	1.12	2.81	1.55	2.09	5.3	3.51
	n	52	73	67	24	186	52
Poaceae (a)	ps	2.05-22.08	28.05-30.07	9.05-15.08	16.07-23.07 13.08-3.09	27.06-4.07	2.07-27.08
	p	12.4	5.4	9.34	5.14	12.9	8.04
	n	569	140	403	62	455	119
Rumex (a)	ps	30.05-22.08	28.05-25.06	23.05-1.08	sporadically	23.05-8.08	2.07-20.08
	p	1.96	1.42	4.4		1.96	1.61
	n	91	37	190		69	24
Chenopodium (a)	ps	11.07-29.08	9.07-20.08	4.07-22.08	16.07-23.07 13.08-3.09	27.06-22.08	9.07-27.08
	p	0.73	0.81	0.53	2.26	1.97	1.68
	n	34	21	23	26	70	25
Urtica (a)	ps	6.06-22.08	11.06-10.09	13.06-22.08	16.07-23.07 13.08-3.09	13.06-22.08	13.07-23.07 6.08-27.08
	p	2.59	5.05	1.99	5.14	2.31	5.74
	n	120	131	86	59	81	85
Artemisia (a)	ps	18.07-22.08	9.07-10.09	11.07-22.08	13.08-3.09	25.07-22.08	30.07-27.08
	p	5.99	2.24	1.64	5.49	3.6	1.75
	n	277	58	71	63	129	29

(a) – anemophilous, (e) – entomophilous, ps - pollen season, p - percent total sum of pollen grains, n - number of pollen grains.

climate-rural division they belong to the Radom Province [10]. The duration of the vegetative period is about 220 days and the average sum of annual precipitation ranges from 550–650 mm [14]. This area is slightly warmer than the areas to the north and to the east.

Ostrowiec Św. is an average industrial town, located partly in the Kamienna River Valley. Vegetation in the town and its surroundings consists of ruderal vegetation, pine forests, semi-natural community of grasses and antropomorphic habitats. The palynological analyses were carried out on material collected in the centre of the town, near the city park, and the Kamienna River. In the close vicinity of the measuring point there are *Populus*, *Fraxinus* and grasses. In the town park, *Corylus*, *Betula*, *Pinus*, *Quercus*, *Tilia* and *Carpinus* are planted. *Alnus* and *Salix* are common along the Kamienna River.

Table 2. Results of aerobiological study (b).

Site		Trees and shrubs		Herbs		Grasses and cereals			
		1995	1996	1995	1996	1995	1996	1995	1996
Ostrowiec Św.	N	46	38	22	19	21	16	3	3
	n	4622	2590	3403	2104	575	311	608	157
Brzóstowa	N	50	35	23	16	24	17	3	2
	n	4314	1148	3376	851	435	214	450	67
Ożarów	N	47	32	24	15	20	14	3	3
	n	3503	1480	2250	1117	452	204	469	150

N - number of taxa, n - number of pollen grains

Brzóstowa is located 8 km from Ostrowiec Św. It is a village situated on the main road to Lublin. The pollen for analyses was collected in the middle of the village, among houses, vegetable gardens and fields with mongold, wheat, millet. Additionally, in the vicinity there were patches of grasses and ruderal vegetation, group of *Alnus* and *Populus* near water-course and *Aesculus hippocastanus, Sambucus nigra, Betula, Populus* along the road.

Ożarów is located 15 km from Brzóstowa. The collection point was placed among the pine forest, fields with rape, rye, mongold, and a small housing estate with gardens.

Pollen fall was collected with the use of beakers 9 cm in diameter. Inside, there was a piece of blotting-paper soaked in a mixture of glycerine and thymol. They were placed at the height of 1.5 m and replaced every 7 days. The pollen deposit was washed out from the blotting-paper and subjected to Erdtman's acetolysis [6]. Pollen grains were determined, counted, and the qualitative result was calculated as the number of pollen grains per 150 mm^2.

RESULTS

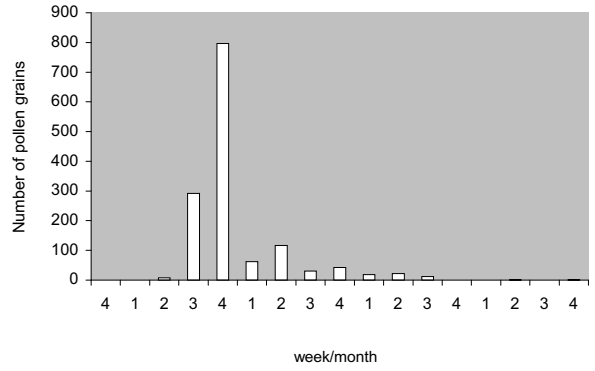
The investigations were carried out from 3.01.1995 to 24.12.1996. At all the sites during the two years of investigation, 53 taxa of pollen grains and 2 taxa of *Polypodiaceae* were recognised. The number of identified pollen taxa was 50 in 1995 in Brzóstowa, but only 32 in 1996 in Ożarów (Tab. 2). Unidentified pollen grains were classified as Varia group. Among all taxa, 31 occurred sporadically or in a small amount. Among them were *Picea, Juglans, Rubiaceae, Sparganium, Typha latipholia, Larix, Apiaceae*. The highest amount of the pollen grains was counted in Ostrowiec Św. in 1995 (n = 4622), the smallest number in Brzóstowa in 1996 (n = 1148, Tab. 2). At all three sites, the annual sums of pollen grains and sums of 3 determined groups of plants were less numerous in 1996 than in 1995 (Tab. 2). In Tab. 1, there are some data concerning chosen taxa, for example, dates of pollen seasons, annual sums and percentage values. Three main groups of plants were distinguished: trees and shrubs, grasses and cereals, and herbs (the family *Rosaceae* was classified into the trees and shrubs group). The data concerning the three groups of plants are presented in Tab. 2 and Fig. 4.

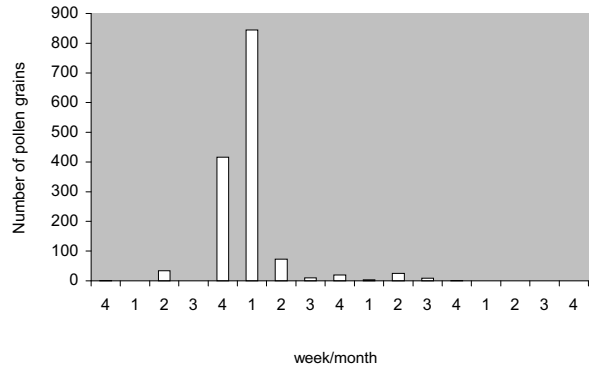
DISCUSSION

At all the investigated sites, pollen grains of anemophilous taxa dominated, while pollen grains of entomophilous taxa occurred, as a rule, in a smaller amount (*Tilia, Sambucus, Viburnum, Aesculus*). However, the number of determined entomophilous taxa was sometimes similar to the number of anemophilous taxa; for example, in 1995 in Brzóstowa among the total of 50 taxa, 25 were entomophilous. It happened that entomophilous taxa (*Centaurea cyanus, Ranunculus, Brassicaceae*), which as a rule are found sporadically [20], in 1995 in Brzóstowa occurred in a big amount. Sometimes, in the beakers from Brzóstowa, some insects were found which probably had many pollen grains of entomophilous plants on their bodies. Pollen grains of those taxa were found in big numbers, and usually in the same sample. This may be illustrated by results for the sample collected from 4.07.95 to 11.07.95: *Brassicaceae* n = 90, *Centaurea cyanus* n = 93, *Ranunculus* n = 159. Therefore, for further analysis these numbers were subtracted from the total sum of pollen grains.

Natural conditions, especially the composition of the tree flora, are - to some extent - mirrored in the quantitative and qualitative composition of pollen fall [12, 13]. Trees belong to the main pollen producers, because of their common incidence and large pollen production per anther, inflorescens or individual tree [15]. This pollen can be transported with air-masses over large areas [3, 7]. In Ostrowiec Św. and in Brzostowa, trees whose pollen grains were in abundance in the collected pollen (Tab. 1), occurred near to or in the immediate surroundings of the place were the samples were taken. In Ożarów, only *Pinus, Populus* and *Quercus* were in the surroundings of the collection point.

Herb plants like *Poaceae, Chenopodiaceae, Urtica* and *Artemisia* are common, and the pollen production by these taxa is also large [3]. Other herb plants, which can be considered characteristic of rural areas, such as *Centaurea cyanus*, are entomophilous, thus they produce





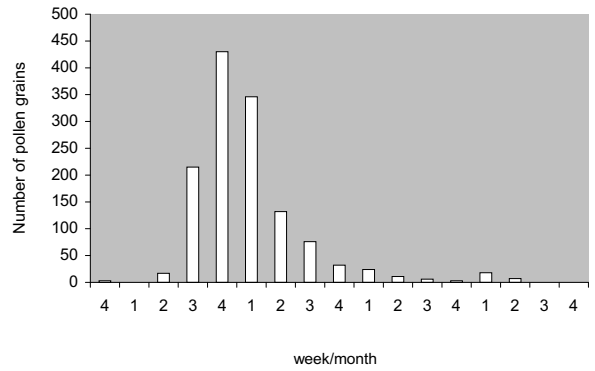


Figure 1a. Pollen fall of *Alnus* in (from top to bottom) Ostrowiec Świętokrzyski, Brzóstowa and Ożarów in 1995.

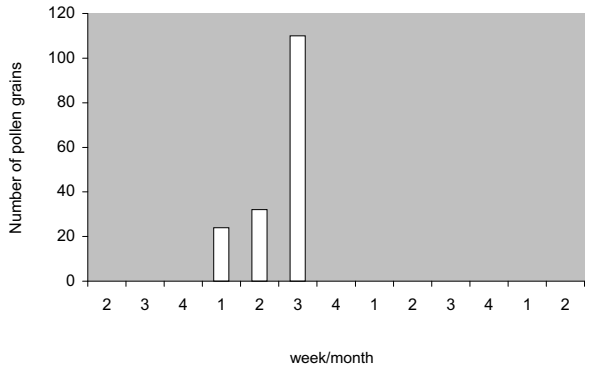
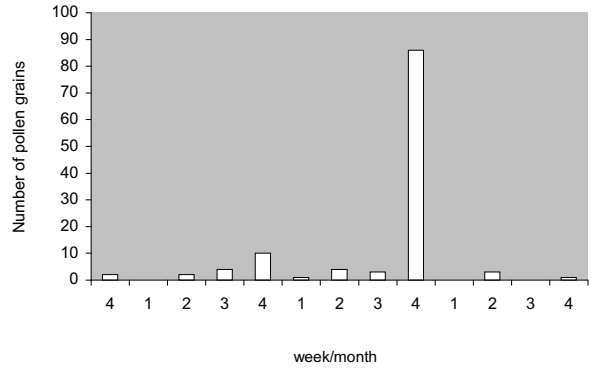
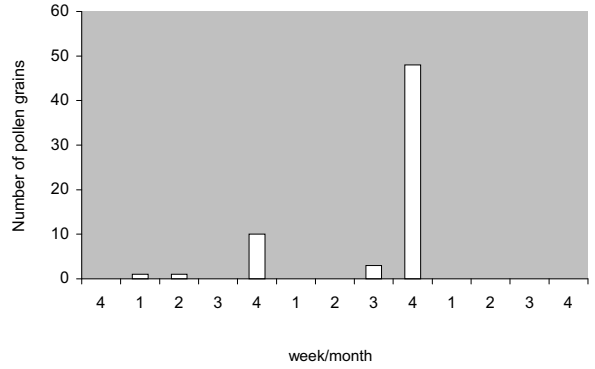


Figure 1b. Pollen fall of *Alnus* in (from top to bottom) Ostrowiec Świętokrzyski, Brzóstowa and Ożarów in 1996.

fewer pollen grains which are only rarely distributed over a large distance [3].

Hyde [13] observed that vegetation patterns influence the pollen fall, and that the highest numbers of pollen grains were found in samples taken at sites located in rural or suburban areas. The data presented here seem to contradict this point. During the two years of presented investigation, the highest numbers of pollen grains were found in samples collected in a town, namely, in Ostrowiec Św. There were, however, differences in the number of pollen grains between the years. At all the investigated sites, a smaller number of pollen grains was counted in 1996 than in 1995 (Tab. 2). This was probably a result of substantial differences in weather conditions between these two years. The number of taxa determined did not vary between the sites (Tab. 2), but it did vary with the years. In 1996, at all the sites, fewer taxa were identified than in 1995 (in Brzóstowa and Ożarów the difference was 15 taxa, in Ostrowiec Św. 8 taxa, Tab. 2). Only the number of grass and cereal taxa pollens was the same at the sites and in the years, because only three types of these plants were determined: *Poaceae, Triticum* and *Secale*. Tree and shrub pollen grains dominated in the pollen fall at all the sites; their percentage values ranged from 70-80% (Fig. 4). The percentage values of herb pollen grains were low, similar to the values of grass and





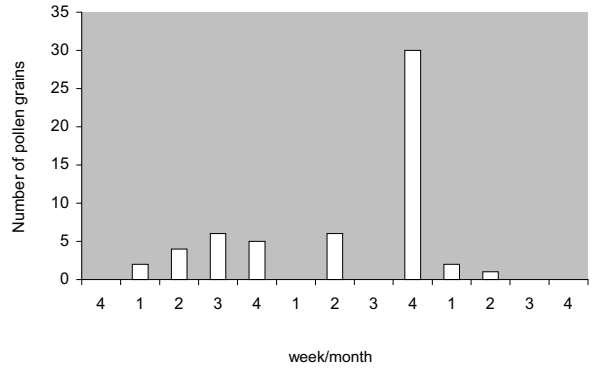
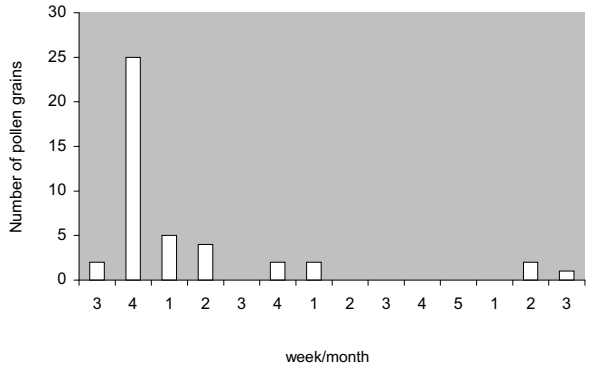
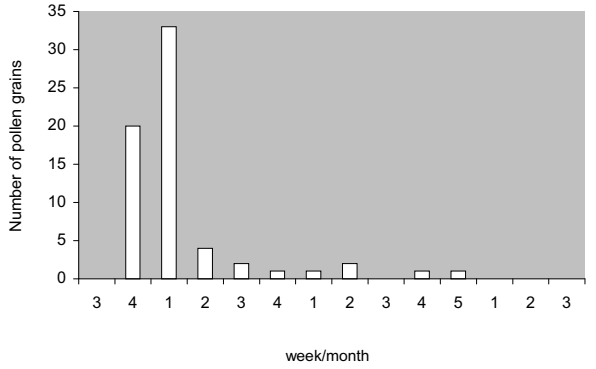


Figure 2. Pollen fall of *Populus* in (from top to bottom) Ostrowiec Świętokrzyski, Brzóstowa and Ożarów in 1995-1996.





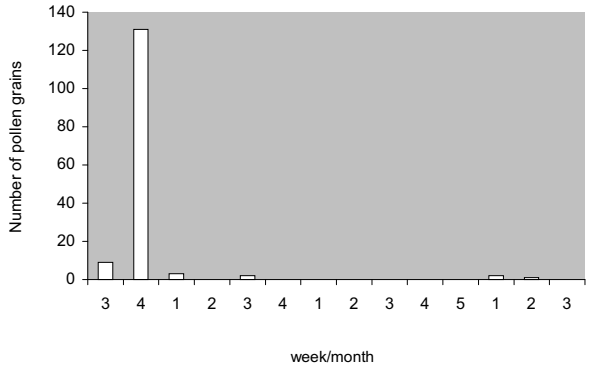


Figure 3. Pollen fall of *Pinus* in (from top to bottom) Ostrowiec Świętokrzyski, Brzóstowa and Ożarów in 1995-1996.

cereal pollen (Fig. 4). Between the sites, no marked differences were found in the percentage values of the three distinguished groups of plants; the only differences were in the numbers of pollen grains (Tab. 2). In Ostrowiec Św. during both seasons, there were more tree and shrub pollen grains than in Brzóstowa or Ożarów. This was a result of the incidence of trees in the surroundings of the sample collection point which was located near a park.

The effect of local vegetation patterns on the pollen fall was more marked in the annual numbers and in the percentage values of the total sum of individual taxa (Tab. 1). For example, distinct differences concerned *Pinus*. Its annual counts and percentage values in the total sum were highest in Ożarów. Not far from the collection point there was a large area of pine forest, which probably affected the results (Fig. 3). In Ostrowiec Św., compared with the other sites, more pollen grains of *Populus*, *Fraxinus*, and *Betula* were counted (Tab. 1, Fig. 2). *Populus* is very often planted along roads in towns. In Ostrowiec Św., not far from the collection point, there were stands of this tree. *Betula* and *Fraxinus* are commonly found in Ostrowiec Św. and in its surroundings. The differences, though smaller, concerned also taxa whose pollen grains incidenced in pollen fall in smaller numbers. In Ostrowiec Św., compared with Ożarów or Brzóstowa, during both seasons there were more pollen grains of *Acer negundo* which is a very commonly planted tree in this town. In

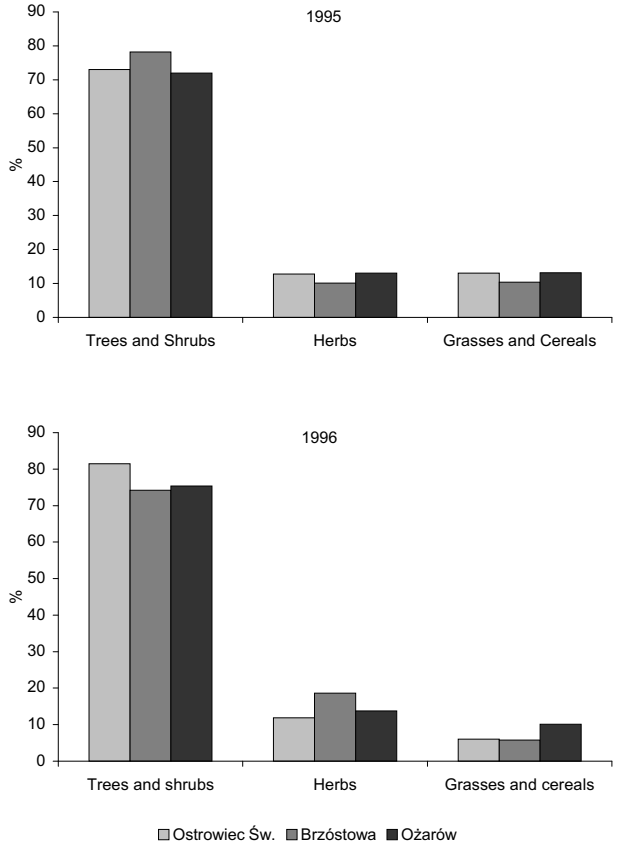


Figure 4. Percentage of pollen grains of main groups of plants in pollen fall at the three sites in 1995 and 1996.

Ożarów, small numbers of pollen grains of *Aesculus, Viburnum* and *Sambucus* occurred occasionally. These taxa are entomophilous. They are planted in Ostrowiec Św. and Brzóstowa, but not present in Ożarów. Stach [18] also suggested that incidence of pollen producers in the surrounding of the collection point could affect the numbers of pollen grains in pollen fall.

The numbers and percentage values of other taxa which occurred abundantly in pollen fall did not differ between the sites, only between the two years of study (Tab.1). At all three sites, fewer pollen grains of *Alnus, Corylus, Salix, Fraxinus, Poaceae, Rumex, and Artemisia* were counted in 1996 than in 1995. This was probably caused by less favourable meteorological patterns in that year. Szczepanek [21] and Weryszko-Chmielewska and Piotrowska [22] also determined in other locations in Poland, that in 1996 there were fewer pollen grains in the pollen fall than in 1995.

The pollen seasons of most taxa overlapped at all three sites (Tab. 1). Pollen grains of *Alnus* and *Corylus* were the first ones in the pollen fall. The dates of the beginning of their pollen seasons were the same at the three sites, while there were only small differences regarding the end of the pollen season. Similarly, the dates of the beginning of pollen season for *Betula* were the same at the sites. Meteorological patterns, which did not differ in the relatively small area of investigation, may explain this phenomena. Some trees form resting buds in the late summer and in the autumn. The buds require a "chilling-period" before growth [8]. In the following spring, a rise in temperature induces flowering, and all tress in a small area can start pollination at the same time, as was the case with *Alnus* and *Corylus* at all three sites in both seasons, or *Populus* and *Salix* at all the sites in 1996 (Tab. 1). The pollen seasons of the taxa blooming in late spring and summer differed only slightly between the sites during the periods of maximum incidence of pollen grains (Tab. 1, Fig. 1, 2). The dates of the end of pollen seasons of the taxa blooming in late summer (*Urtica* and *Artemisia*) were the same in 1995, and also partly the same in 1996.

Pollen grains of some taxa were also found in pollen fall out of the pollen season. This concerned mostly *Betula, Poaceae* and *Pinus* pollen grains and is explained by the second fall and the long distance pollen transport [3, 11, 20].

The biggest differences in the dates of pollen seasons concerned not spatial variations but years. In 1996, the pollen seasons of *Alnus, Corylus,* and *Populus* were delayed for two months because of a very long winter (Fig. 1, 3). In 1996, the first pollen grains were found in pollen fall only in April. Many trees started to bloom in 1996 at the same time, e.g. *Corylus, Alnus, Betula, Salix,* or *Fraxinus,* and therefore in the middle of April there were no differences in dates of pollen seasons for *Betula, Fraxinus,* and *Quercus* between the years (Tab. 1). This observation was confirmed also by Szczepanek [21], by Weryszko-Chmielewska, and Piotrowska [22].

The results and discussion presented in this paper are only an introduction to the subject of spatial variation in pollen fall. Thorough floristic information and many years of study at various sites are needed.

CONCLUSIONS

No clear differences in the numbers and phenology of incidence of pollen grains in pollen fall between sites located in areas of different land use were determined. Differences in percentage values of the total sums and in the numbers between sites concerned some taxa, e.g. *Populus, Pinus, Fraxinus,* and *Artemisia.*

The tree and shrub pollen grains dominated in pollen fall at all the investigated sites, while grass and cereal pollen grains were in the smallest numbers.

During both seasons in Ostrowiec Św. the total sums of pollen grains and sums of pollen grains from the distinguished three groups of plants were the biggest.

Quantitative composition of pollen fall and the phenology of pollen grains incidence were affected by meteorological patterns.

The study presented here is only preliminary; a long-term research is needed.

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