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TYPES OF HAZEL (*Corylus* spp.) AND ALDER (*Alnus* spp.) POLLEN SEASONS IN SOSNOWIEC 1997 – 2007 (POLAND)

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A b s t r a c t

This paper investigates pollen seasons for *Corylus* spp. and *Alnus* spp. for the years 1997-2007 in Sosnowiec, southern Poland. The research was conducted by means of the volumetric method using a Burkard-type spore trap. The duration of pollen seasons was determined by means of the 98% method.

The aim of this study was to distinguish the types of the course of hazel and alder pollen seasons using cluster analysis, including non-hierarchical clustering of multi-feature objects – k-means clustering. The pollen seasons were divided into five types because of considerable variations from one year to another. For both taxons one dominant type was found, which was characterized by a very long period of compact pollen release with low values of the pollen count and by the occurrence of several maximums divided by periods of a lower pollen count. This work contains only a preliminary analysis on the types of pollen seasons because of relatively short data set. Future research on a larger series of measurements should be proved.

Key words: types of pollen seasons, hazel, alder, Sosnowiec, Poland

INTRODUCTION

In the temperate climate zone in northern and central Europe, the pollen seasons of trees which flower in early spring are characterized by a distinct variation in subsequent years (J ä g e r et al. 1996). During an analysis of the beginning, end and the duration of the pollen seasons over the eleven years examined, it was found that the largest variation with regard to the beginning and the end of the pollen seasons in Sosnowiec is demonstrated by the taxons of plants which flower earliest, that is the hazel and the alder. Their pollen seasons usually last from late January or early February to late March or early April. However, the start dates of the pollen seasons of those taxa varied in some years even by over two months and the end dates of the season by over a month for the hazel and by almost two months for the alder. The large differences between the starts of the pollen seasons of hazel and alder in consecutive years were confirmed by other researchers (W e r y s z k o - C h m i e l e w s k a et al. 2001; K a s p r z y k et al. 2004; P i o t r o w s k a , 2004; P i o t r o w i c z and M y s z k o w s k a , 2006; E m b e r l i n et al. 2007a; S m i t h et al. 2007; M y s z k o w s k a et al. 2010)

Variations in the values of maximum pollen counts and in the dates of their occurrence were also observed. These trees flower in spring and their pollen occur in the air in high or relatively high concentrations, being a cause of pollen allergies (K a s p r z y k et al. 2004). Pollen of these taxa are recognized as important allergen sources both in their own right and because of cross-reactivity with pollen grains other genera belonging to the Betulaceae and Fagaceae families (J ä g e r and H o r a k , 1991; M a t t h i e s e n et al. 1991; V i k et al. 1991; K n o x and S u p h i o g l u , 1996; F i l o n et al. 2000; R o d r i g u e z - R a j o et al. 2004). Exposure to hazel and alder pollen early in the spring may cause allergic people to be more sensitive to other pollen grains later in the season. For example, their allergens may cause stronger reactions during the birch pollen season by a long period of priming in susceptible individuals, so that allergic reactions occur at a lower threshold concentration (E m b e r l i n et al. 1997; E m b e r l i n , 2000; R o d r i g u e z - R a j o et al. 2004; E m b e r l i n et al. 2007).

This paper aims to investigate changes and features in the pollen seasons of the early flowering spring species of trees, alder and hazel in Sosnowiec from 1997 to 2007 and the creation, on the basis of these features, of a preliminary classification of their pollen seasons. Because of considerable variations in the course of the pollen seasons of the plants discussed, an attempt to classify them was made using an objective method of clustering of multi-feature objects – k-means. The method was mainly based on variations in the curves of the pollen count, the position of maximum count peaks and the time of their occurrence.

MATERIALS AND METHODS

An analysis of the hazel (*Corylus* spp.) and alder (*Alnus* spp.) pollen count in Sosnowiec was performed on the basis of data from the years 1997 – 2007. The research was conducted by means of the volumetric method using a Burkard-type spore trap which belongs to the Allergen Research Center. The sampling site was located at a height of approximately 20 metres above the ground on the premises of the Faculty of Earth Sciences at the University of Silesia in the northern part of Pogoń – a district of Sosnowiec – with well-spaced residential blocks of flats. The geographic coordinates for the sampling site are as follows: 50º 17' 50"N and 19° 08' 20"E.

Sosnowiec is situated in the south of Poland, in the eastern part of the Silesian Upland [*Wyżyna Śląska*]. In the Silesian Upland area, where Sosnowiec is situated, the influences of various air masses interact, therefore the climate is characterized by quite considerable variability and irregularity of the course of climatic elements. The city is situated in a temperate climate zone – it has a transitional climate between the oceanic and continental one. The weather in Sosnowiec on the majority of days throughout the year (63.5%) is determined by polar maritime air (Niedźwiedź, 2003). The average annual temperature is 8.1ºC. The warmest month is July (17.2ºC) and the coldest – January (-1.2ºC). The average annual precipitation is about 700 mm. The dominant winds are westerly ones: NW, W and SW (Łupikasza and Widawski, 2008).

Despite the fact that there are many residential and industrial buildings in Sosnowiec, it is an area where a large number of tracheophyte species belonging to many botanical families grow in different habitats. According to Jędrzejko (1993), green spaces within the city cover approximately 24.7% of its area.

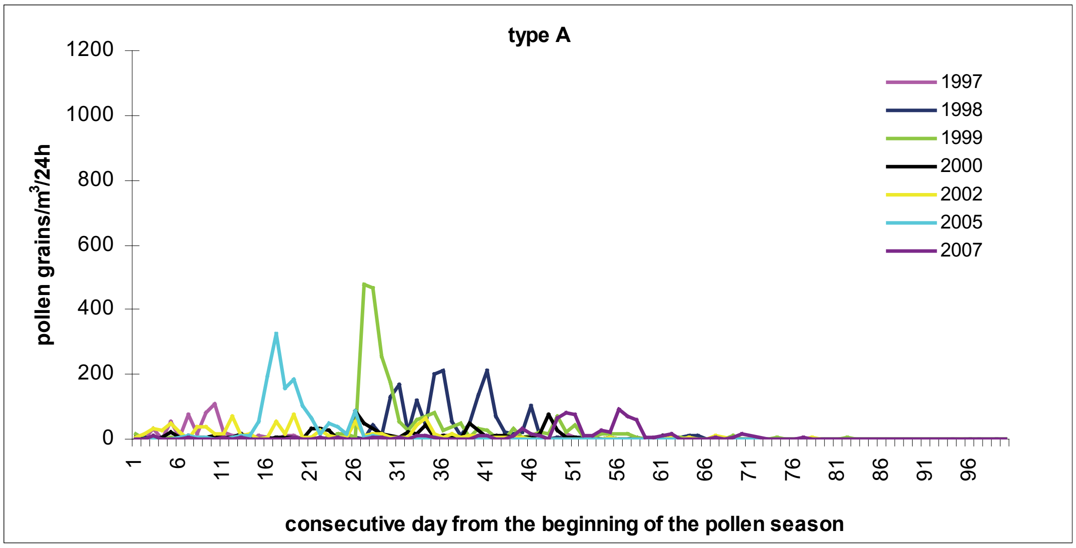
A microscopic analysis of hazel and alder pollen, after preparations had been stained with alkaline fuchsin, was performed on the surface of 4 horizontal strips (Mandrioli et al. 1998). The result was expressed as the average daily number of pollen grains per cubic metre of air. The duration of pollen seasons was determined by means of the 98% method, according to which the beginning of the season was on the day when 1% of the cumulative sum of a given taxon pollen was recorded and the end when 99% of pollen was found (Emberlin et al. 1994; Spieksma and Nikkels, 1998).

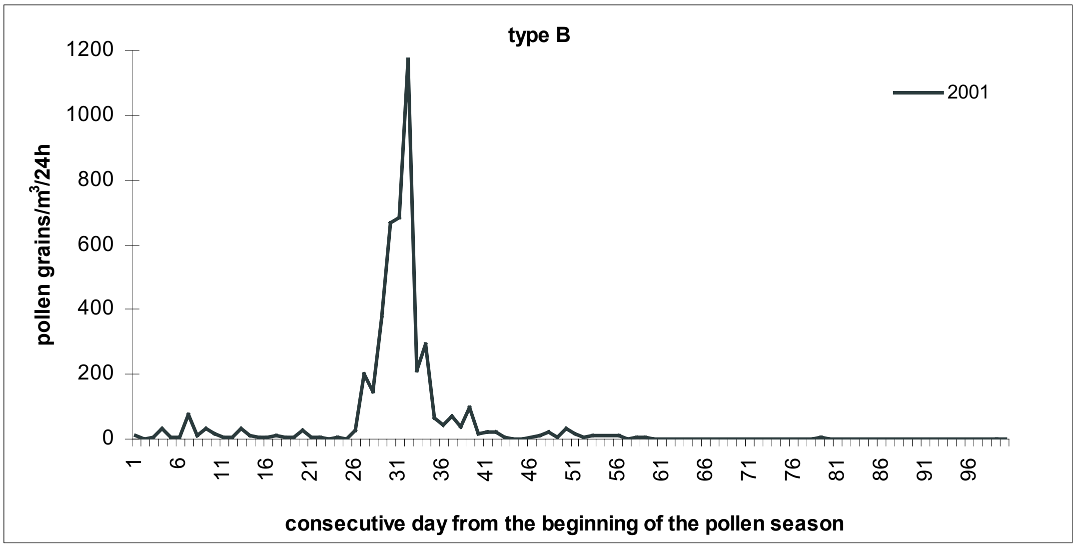
Cluster analysis was used to classify the course of pollen seasons, including non-hierarchical clustering of multi-feature objects – k-means clustering. This method is based on the automatic clustering of objects that are similar to each other. The k-means method is used to analyze large amounts of data, and its essence is to reduce the accumulated information into several basic categories, which makes it easy to understand the relevant phenomena and to draw general conclusions. In this method, the number of clusters is imposed by the researcher, so this is a subjective method. In this study, pollen periods were divided into five groups according to the author, because such a division best showed differences among individual groups. Some types distinguished in this work are represented by only one season. This is due to the fact that such season differs significantly from the others and therefore is automatically classified as a separate one. It must be noted that these are preliminary studies and in the future they should be supplemented with more data. The pollen seasons in the next years can be added to the types represented only by one season.

The dates of successive stages of the pollen season were determined as the next day of the year on which the accumulated number of pollen grains from the beginning of the year reached a specified percentage value of all the grains in a given year: the beginning of the season (1%), the first quarter of the season (25%), the middle of the season (50%), the third quarter of the season (75%) and the end of the season (99%).

RESULTS

The particular types of hazel pollen seasons differed in their duration, the number of maximum count peaks and their position as well as in the values of daily counts. The pollen seasons were divided into five types. The first type (Fig. 1, A), set apart on the basis of cluster analysis, is characterized by a very long period of compact pollen release with low values of the pollen count. This type is also characterized by the occurrence of several maximums divided by periods of a lower pollen count. The largest number of pollen seasons was classified as type A. The course of the second type (Fig. 1, B) is distinctly more compact when compared to the first type – with one clearly marked three-peak maximum. Pollen counts are higher and seasonal maximums are recorded shortly after the first pollen grains appear in the aeroplankton. Types C and E have a similar course. They are characterized by high daily pollen counts, the highest among all the types, and one peak of maximum pollen counts. However, at the beginning of the season daily pollen counts for these types are very low, close to zero. Another typical feature of them is a distinct post-peak period, longer than the other types. The difference between them concerns the time of the maximum peak occur-





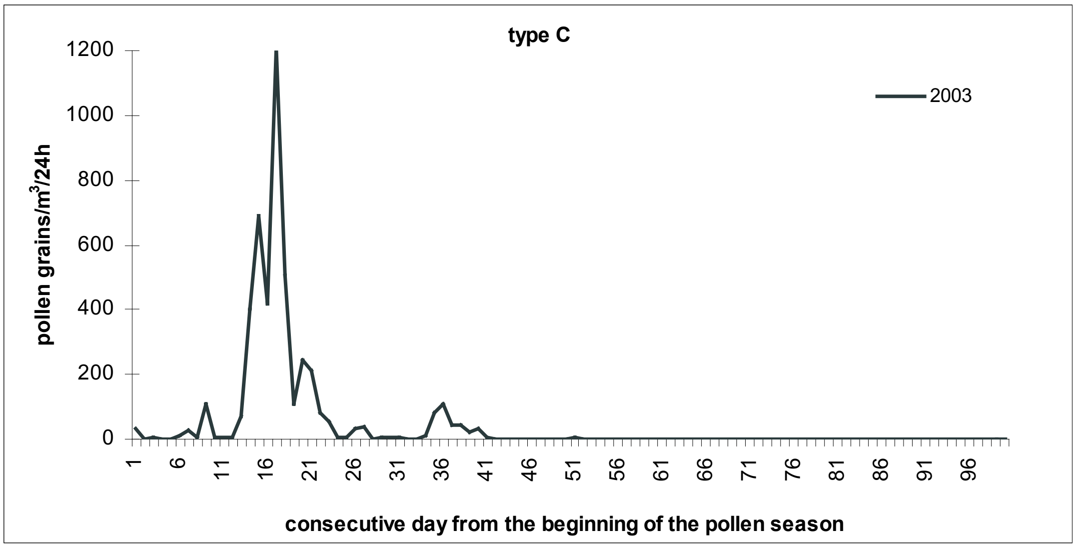
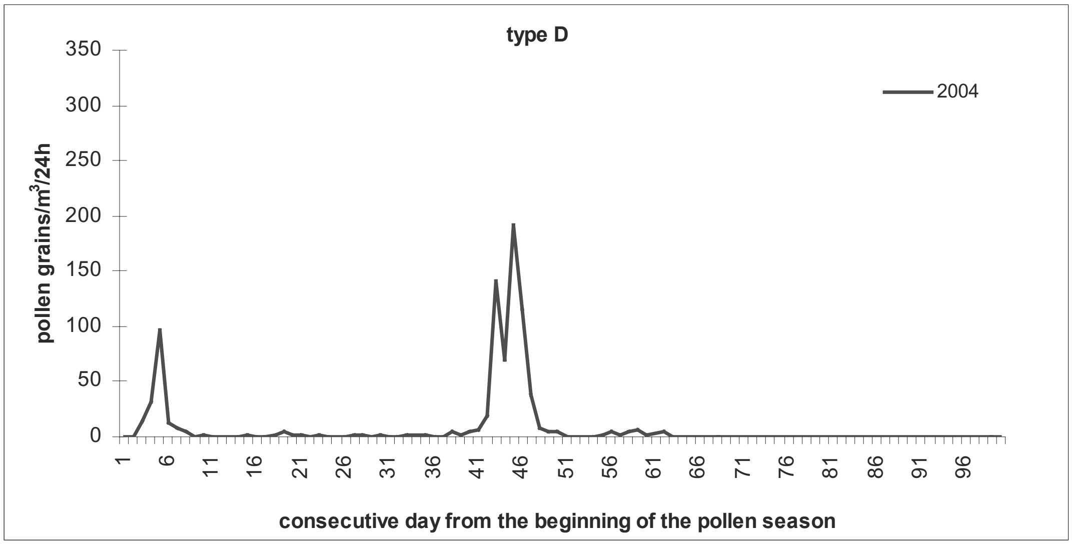
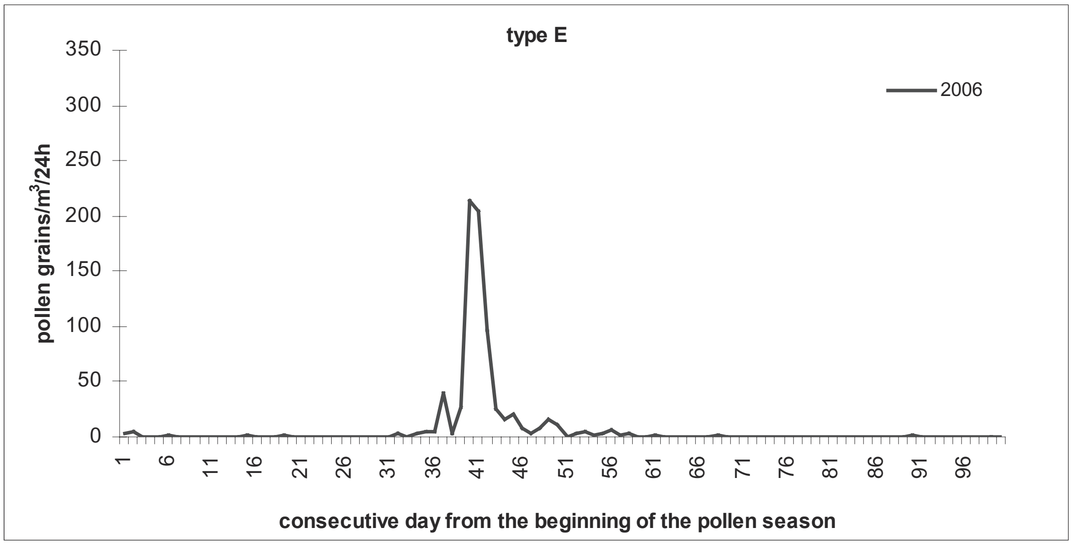


Fig. 1. Types of the hazel pollen seasons (A, B, C, D, E) distinguished with cluster analysis method





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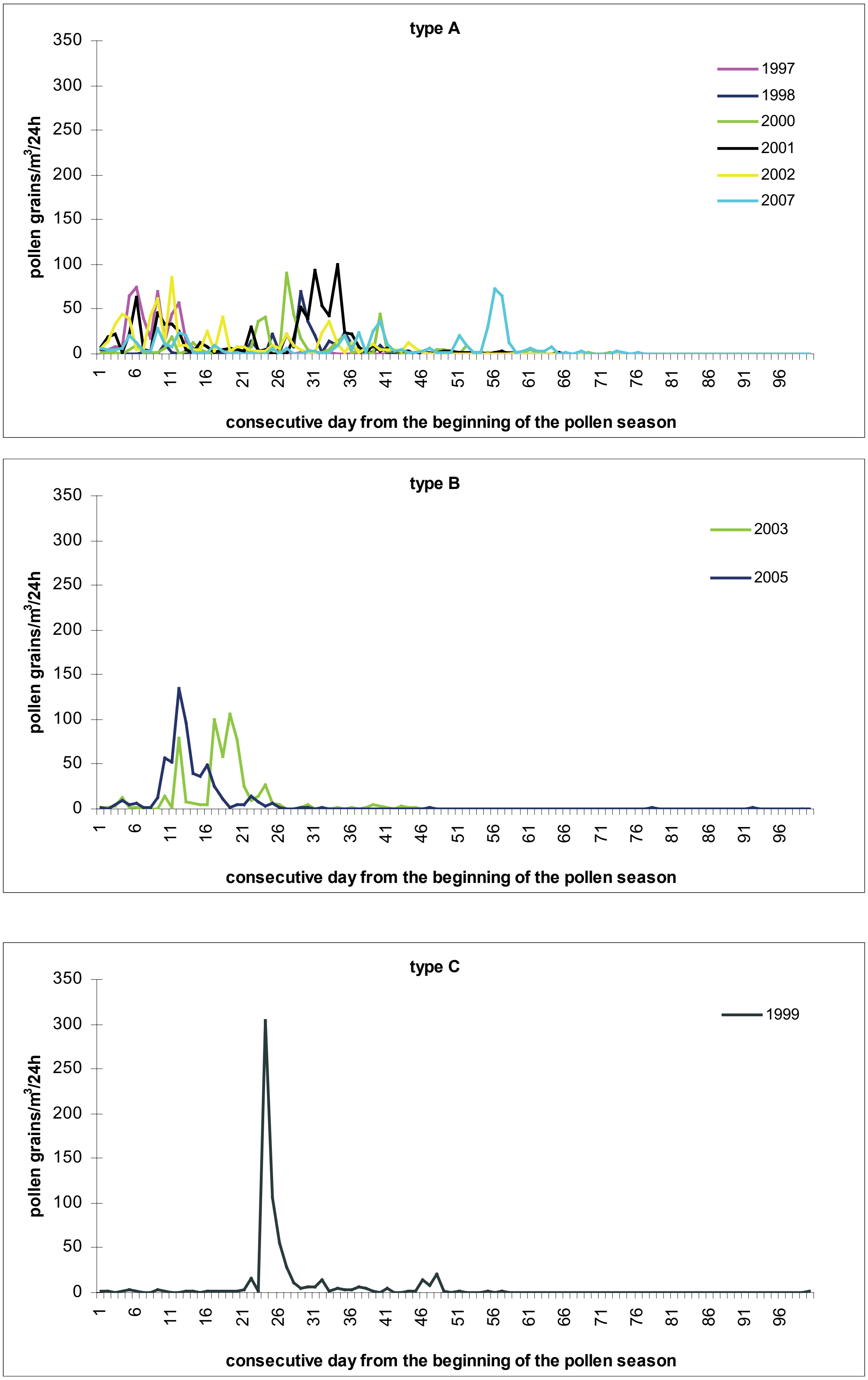
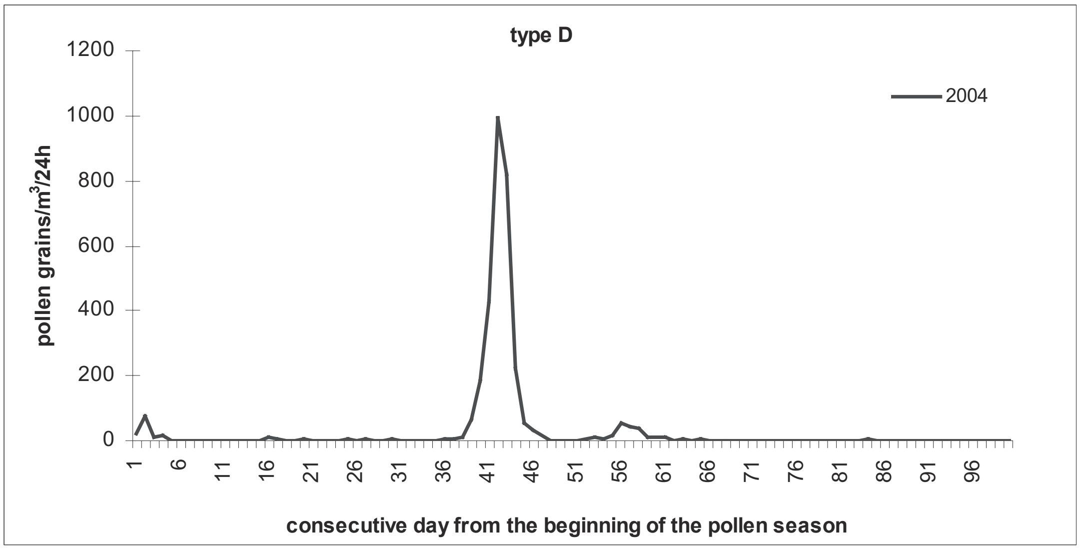
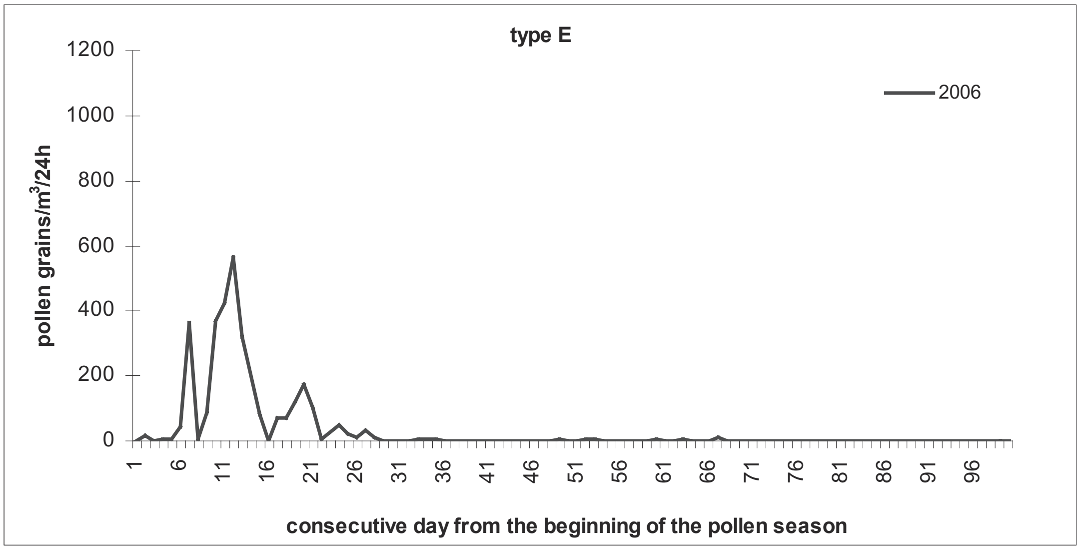


Fig. 2. Types of the alder pollen seasons (A, B, C, D, E) distinguished with cluster analysis method





cd. Fig. 2. Types of the alder pollen seasons (A, B, C, D, E) distinguished with cluster analysis method rence. For type C, the maximum occurs in the middle of the pollen season, whereas for type E in the third quarter of it. Type D has a course totally different from the four types described above. It has two maximums – the first one, lower, at the beginning of the pollen season, the second one, higher, in the third quarter of the season. Both maximums are separated by a period of very low or even decreased to zero pollen counts.

The dynamics of the course of the alder pollen count during particular seasons differed quite considerably, which made it possible to distinguish 5 types of the course of pollen seasons (Fig. 2). Type A, which covers the largest number of pollen seasons, is characterized by low counts and several peaks of maximum pollen counts stretched over a significant period of time. Types B and C are similar to each other. They are characterized by high pollen counts and one main three-peak maximum. The difference between them is that the maximum pollen release for type C starts shortly after the first pollen grains appear, whereas for type B the maximum is shifted more towards the middle of the pollen season. Type E is also characterized by a three-peak maximum at the beginning of the season; however, the pollen reaches significantly lower values of daily counts than for the two types described previously. Type E for the alder is similar with regard to its course to type B for the hazel. Type D starts with a slight peak at the beginning of the pollen season and then the daily pollen count drops dramatically, as it is the case with type D for the hazel. In the middle of the season a one-peak maximum occurs, reaching a value close to 1000 grains in one cubic metre (Fig. 2).

DISCUSSION

The process of pollen release by plants takes place over a specified period and is connected with the genetically conditioned biological rhythm, being modified by environmental factors. It depends, among other elements, on the region's geobotanical characteristics, the climate, the taxonomic rank of the taxon examined as well as the abundance and location of pollen sources (Emberlin et al. 1994; Latorre, 1997; Valencia-Barrera et al. 2001; Reese and Liu, 2005). That is why it is important for aeropalynological studies to be conducted locally. Studies carried out in Sosnowiec in 1997-2007 showed a significant difference in the course of pollen seasons of hazel and alder. Therefore, an attempt to divide the pollen seasons into different types was made. Although it should be added that these are preliminary studies on the distribution of pollen seasons and further studies are needed to verify these results.

In aerobiological literature there are already typologies of pollen seasons. For instance Hyde (1956) distinguished two basic types of pollen occurrence in the air during a year: compact and dispersed. As for the compact type, the number of grains in the air grows, reaches a distinct, usually one, maximum, and then drops. The second type is characterized by the lack of a distinct maximum phase – there are often several periods of an increased pollen count in the air. The pollen is in the air for a long time, usually with numerous breaks, and the season is not intensive.

Szczepanek (1994) divided pollen seasons into three groups depending on their duration. He distinguished short seasons, lasting from 30 to 35 days, medium-length seasons, lasting from 35 to 60 days, and long seasons, lasting from 60 to 120 days.

Studies conducted in Krakow (Myszkowska and Piotrowicz, 2009) allowed to distinguish two types of birch pollen seasons – highly dense and less dense, whose existence is dependent on meteorological conditions. This classification was based on the length of pollen seasons and the daily concentration of birch pollen grains.

The classification of pollen seasons in Sosnowiec was based, similarly to the one made by Hyde (1956), on the number of peaks with maximum pollen counts. However, the time of the occurrence of maximum pollen release counted from the beginning of the season was also taken into account. The division of pollen seasons into five types helped to distinguish additional types from among compact and dispersed seasons. Comparing the particular types of the courses of pollen seasons, it was found that the hazel and the alder have one dominant type, which covers the largest number of pollen seasons. The other types were very scattered, so to verify the particular types of pollen release a longer period of measurement is needed, because some types existing in nature might not have occurred at all in the years examined. Moreover, some types of pollen seasons were similar for both taxons discussed, for example type D, which occurred in 2004 both with regard to the hazel and the alder, and type B for the hazel was similar with regard to its course to type E for the alder. In many cases the course of pollen seasons was asymmetrical; the post-peak periods were longer than those before the maximum which were also found in other Polish cities (Kasprzyk et al. 2004). Curves with multiple peaks in some types may be due to differing weather conditions, but may also be attributable to the different species included in the same pollen type (Alcázar et al. 2009).

CONCLUSIONS

This paper presents only a preliminary study on the typology of pollen seasons. However, to consider this issue further, we need a greater number of measurement years in order to establish if all the types which occur in nature were found. Future research should be done on a much larger data set with regard to weather conditions. Despite the small amount of data, it can be concluded that type A is the most characteristic for both hazel and alder. This type is characterized by a very long period of compact pollen release with low values of the pollen count and by the occurrence of several maximums divided by periods of a lower pollen count.

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Typy sezonów pyłkowych leszczyny (*Corylus* spp.) i olszy (*Alnus* spp.) w Sosnowcu 1997 – 2007 (Polska)

Streszczenie

Praca przedstawia analizę sezonów pyłkowych leszczyny i olszy w Sosnowcu na podstawie danych z lat 1997 – 2007. Badania prowadzono metodą wolumetryczną przy użyciu aparatu typu Burkard. Czas trwania sezonów pyłkowych wyznaczono metodą 98%.

Celem pracy było wydzielenie typów przebiegu sezonów pyłkowych leszczyny i olszy przy użyciu analizy skupień (Cluster analysis) w tym niehierarchicznej metody grupowania obiektów wielocechowych – metody k-średnich. Sezony pyłkowe podzielono na pięć typów ze względu na znaczne zróżnicowanie w poszczególnych latach. Dla obydwu taksonów znaleziono jeden dominujący typ, który charakteryzował się bardzo długim okresem zwartego pylenia o niskich wartościach stężenia ziaren pyłku. Charakterystyczne dla tego typu było także występowanie kilku maksimów oddzielonych od siebie okresami o niższym stężeniu ziaren pyłku. Praca ta zawiera wstępną analizę dotyczącą typów sezonów pyłkowych ze względu na krótką serię danych.