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Summary of PhD thesis entitled: **Evaluation of the pollen seasons of trees with particular emphasis on the allergenic taxa in Kielce in 2012-2017**

Allergic diseases are now a very important social problem. Poland is among countries with a high percentage of people with allergy problems recorded. The severity of pollen allergy symptoms depends on the concentration of allergens in the atmospheric air, which is why monitoring the pollen concentration is a very important task. The results of aerobiological monitoring can be used by allergy doctors for the diagnosis of allergies and for the prevention in sensitized people.

In individual regions of the country there is a species diversity among the vegetation and specific meteorological conditions, therefore it is necessary to conduct monitoring on a global, national, but above all on regional scale. Currently, almost all regions of Poland operate aerobiological monitoring centers, which provide information on the temporal and spatial variability of pollen concentration of sensitizing plants in relation to the region. The first aerospallological examination device in Kielce was launched in 2011.

The aim of the presented work was to compare the characteristic features of pollen seasons of selected taxa of trees in the atmospheric air of Kielce in 2012-2017. 9 taxa recommended by International Association for Aerobiology (IAA) were chosen for the research, such as: hazel (*Corylus*), alder (*Alnus*), birch (*Betula*), elm (*Ulmus*), ash (*Fraxinus*), oak (*Quercus*), poplar (*Populus*), willow (*Salix*), maple (*Acer*). Tree taxa that produce pollen with strong, medium and low allergenic properties were selected.

In the pollen grain concentration study, the volumetric method was applied, the Lanzoni Sampler VPPS suction apparatus was used (based on the Hirst structure from 1952), recommended by the International Aerobiological Association. In total, 761 preparations were made and analyzed. Nikon ECLIPSE 80i light microscope with Nikon NIS graphics program - Elements BR was used to analyze the formulations. After analyzing all of the specimen, the duration of the pollen season was determined using the 98% method, and the dynamics of pollen seasons were specified by determining the phase of the season according to the method described by Latałowa and co-authors (2002). Pollen calendars and predictive models were also developed for the studied taxa.

Additionally, the morphological analysis and measurements of tree pollen grains using optical microscopy and Nomarski contrast techniques using the Nikon ECLIPSE Ti microscope and the Nikon NIS - Elements AR program were performed. To compare the ultrastructure of pollen grains of individual taxa studied, preparations were made according to the modified methodology of Marzella and Glaumana (1980). The formulations were analyzed using the TECNAI G2 Spirit transmission electron microscope (FEI Company), photographic documentation was taken, and the pollen grains cell wall thickness measurements were taken using the TIA program (TEM Imaging & Analysis 3.2 SP6).

The obtained results were subjected to statistical analysis using basic methods of descriptive statistics, calculating arithmetic means and standard deviation, the trend line and the determination coefficient were determined in the diagrams. To describe the variability of the obtained data, the coefficient of variation was determined, while the degree of asymmetry of the distribution of variables was presented using the coefficient of skewness. Distributions of variables deviated from normal distribution (normality test of the W Shapiro-Wilk distribution), therefore the Spearman rank correlation coefficient was used to analyze the relationship between individual variables. To assess the dependence of the occurrence of pollen grains on atmospheric factors, data from the Meteorological Station on the Święty Krzyż were used, prepared in cooperation with the Department of Environmental Protection and Shaping at the Jan Kochanowski University in Kielce. Microsoft Excel 2007 and the statistical package Statistica 13.1 were used to perform analyzes and calculations. Predictive models were created on data series from 2012-2016 for each of the analyzed taxa, while the forecasts were presented in relation to data from 2017 (Provost and Fawcett, 2015).

Bio-aerosol monitoring in the air of Kielce was conducted for the first time in 2012-2013. The obtained results indicate annual differences in monitored parameters, including annual concentrations, dusting periods, dust pollen season length, etc. The total number of pollen grains identified in the evaluated six-year period was 119,490 grains in 1 cubic meter, of which 88,988 grains, i.e. 80% were birch and alder pollen grains (birch pollen - 62 753 ie 56%, alder pollen - 26 235, ie 24%), only 20% of the total number fell on the pollen of the remaining seven taxa. The dominant taxon in consecutive years was birch, its percentage in annual totals constituted from 60-66%, except for 2013, when the lowest value of birch pollen was only 26% of the total annual amount. The course of the tree pollen season in the analyzed years showed significant variability in relation to the value of maximum concentrations,

annual totals of most taxa, as well as the dates of pollen season of early flowering trees, hazel and alder.

Analyzing the results of Spearman's rank correlation, it was shown that a positive, statistically significant dependence of pollen grain concentration occurred most frequently with air temperature, whereas the negative correlation of pollen concentration was most frequently recorded with relative air humidity. Wind speed showed a variable effect on pollen concentration, however, a negative relationship was more often observed for this factor.

It was shown that the low air temperature and high humidity in January, February and March in 2013 significantly delayed the start of the pollen season and caused a lower intensity of the pollen season for the majority of analyzed taxa. Whereas the high temperature recorded in 2014 and 2017 in February affected the earlier start of pollen seasons. The most favorable weather conditions were recorded in 2015 and 2016, in which also the most intense season of dusting *Corylus*, *Alnus*, *Betula* were demonstrated.

The concentration of pollen in the ambient air is influenced by factors such as: average air temperature, relative humidity at the day of pollen concentration or wind speed the day before pollen occurred from 2012-2016 for each of the analyzed taxa, while the forecasts were presented in relation to data from 2017.

The percentage of correct predictions within the examined taxa ranged from 60 to 80%, which proves the good predictive value of the created models. The effectiveness of predictions was slightly different depending on the investigated taxa. The applied predictive models are characterized by high verifiability and quality, they can be successfully used for forecasting pollen seasons.

An important element of the work was the development of pollen calendars of the analyzed taxa characteristic in the Kielce area, which can provide knowledge about the phenology of plants, their flowering and the impact of meteorological factors, but can also be useful in medicine, industry and agriculture.

The photographs, prepared with the use of the transmission electron microscope TECNAI G2 Spirit, document the ultrastructural changes of the pollen grains of individual taxa studied, with particular emphasis on the complicated cell wall structure. It was shown that the cell wall of pollen grains of analyzed taxa shows a layered structure with a strongly different layer thickness. The cell wall of taxa producing pollen grains containing highly

sensitizing allergens (birch, alder, hazel) is characterized by a massive tectum, a wide plant and a very thin insertion. On the other hand, the cell wall of trees, whose pollen shows medium or weak allergenic properties, is characterized by a very thin tectum and a thick, extensive insertion. The demonstrated large diversity of ultrastructural pollen grains of the studied taxa, and especially the specific cell wall structure, may be related to pollen allergenic properties.

The results presented in this paper may contribute to the broadening of knowledge in the field of aerobiology and many related fields. The research was conducted for the first time in this region and is of an applied nature. The obtained data show high variability, especially as to the time of occurrence and course of individual pollen seasons in Kielce. Significant fluctuations were found in relation to the dates of occurrence of maximum concentrations, maximum values of concentrations and annual pollen numbers between seasons, as well as between data from the other regions of the country. Pollen calendars developed and prognostic models proposed indicate the need of conducting annual, regional pollen monitoring, useful in the diagnosis and treatment of pollen allergy as well as in prophylaxis.