Session 4

Amaranthaceae plants pollination in the city of Vinnytsya, Ukraine

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Introduction: The living nature changes in response to changes of the environment. The consequences of climate change are getting still more sensible also in Ukraine. During the recent 20 years average annual temperature has risen up by 0.8^{0}C, which caused the changes of the seasonal rhythms of biota including flowering of plants. Thus, a considerable increase in the concentration of plant pollen in the air in Vinnytsya has been recorded. Because of the rise of the plant pollen concentration in the air, the increase inallergic rhinitis symptoms in people sensitive to a given pollen is suspected. In literature, special attention is paid to the allergenicity of weed pollen of the Amaranthaceae family. Their pollination takes place in the period of pollen allergy exacerbation.

Methods: The pollen concentrations were obtained at Vinnytsya National Pirogov Memorial Medical University (VNMU) in 2013-1017 by the volumetric method, using the Burkard trap (Hirst type). Pollen grains were counted in 12 vertical transects. The study was conducted at VNMU in association with the European Aeroallergen Network (EAN).

Results: The pollen season of the plants of the Amaranthaceae family in Vinnytsya begins from the middle of May and lasts till the end of September. Peak concentrations were recorded from August 10 to 20 depending on the year of observation. A clear increase in the maximum daily pollen concentration has been noted during the recent years. Thus, for the last 5 years, the peak pollen concentration of the plants of the Amaranthaceae family ranged from 12 pollen/m^3 of air (in 2015) to 33 pollen/m^3 of air (in 2013), while in 2017 the concentration increased up to 76 pollen/m^3, exceeding the values achieved in the previous years. Amaranthaceae Pollen Index in 2017 was 905 pollen/m^3, exceeding the previous annual Indexes. Therefore, the rise in the number of people, who are sensitive to Amaranthaceae pollen is also possible in the next years in Vinnytsya.

Conclusions: In Vinnytsya, the peak of the Amaranthaceae pollen concentration and annual pollen index of Amaranthaceae in 2017 have risen twice and more times as compared to the previous years of observation. This may favour the increase in the number of people sensitive to Amaranthaceae pollen.

Artemisia campestris – an important source of airborne allergens

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Artemisia species are wind-pollinated weeds, which belong to the family *Asteraceae*. Their pollen is an important cause of allergy in Europe. In Poland, *Artemisia* is the third most allergenic plant after birch and grasses. *Artemisia vulgaris*, the most common species, is considered to be the main source of allergenic pollen. The genus of *Artemisia* is very large and comprises about 500 taxa, of which about 50 taxa occur in Europe. In Wielkopolska, there are seven species, but only three of them are relatively common: *A. vulgaris*, *A. campestris* and *A. absinthium*.

The results of our multi-layered study showed that *A. campestris*, the species occurring in almost the whole of Poland, should also be considered as an important source of allergens. We found homologues of allergens from *A. vulgaris* in the pollen of *A. campestris*. Sequencing experiments showed that in both species, the proteins are almost identical and differ only in several amino acid positions. Using the precise and sensitive real-time PCR method, we determined the level of the allergen expression in *Artemisia* species. Our investigations showed that the level of the main allergen expression in *A. campestris* is approximately twice as high as in *A. vulgaris*. Phenological observations indicated that *A. vulgaris* began to flower earlier than *A. campestris*. We found that the bimodal curve of the *Artemisia* pollen season recorded in Poznań-Morasko was related to the flowering of these two *Artemisia* species: *A. vulgaris* corresponded to the first peak (July-August), while the flowering of *A. campestris* coincided with the second pollen peak (end of August). *A. campestris* produced considerably less pollen than *A. vulgaris*, however, due to its common occurrence in Poznań, it contributed markedly (30%) to the summation of total recorded pollen. Additionally, the allergenicity of airborne *Artemisia* pollen detected by immunoenzymatic analysis turned out to be different in two peaks of pollen seasons. We noted that during the second peak, when *A. campestris* is flowering, the amount of the main allergen release per pollen (Art v 1/pollen) was 75% higher than during the first peak ($\alpha<0.05$).

Overall, in the areas where *A. campestris* commonly occurs, it should be considered an important pollen allergen contributor, and might be, therefore, the main cause of allergic reactions during late summer.

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Alder pollen seasons in 1997-2017, in Sosnowiec

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Introduction: The *Alnus* pollen is believed to be one of the main causes of pollen allergy in northern and central Europe. The concentrations of alder pollen are high and often exceed the threshold values causing allergy symptoms and also cross reactions with other pollen such as hazel, birch, hornbeam, oak and beech. The pollen monitoring conducted in Sosnowiec shows significant time differences in the appearance of pollen grains, the number and duration of pollen seasons. Due to differences in the course of pollen seasons in the above-mentioned plants, an attempt was made to classify them using an objective k-means method of clustering multi-characteristic objects. It was based mainly on differences in the curve course of pollen concentration, establishing of peaks with maximum concentration values and time of their occurrence.

Methods: The analysis of alder pollen concentration in Sosnowiec air was based on data in 1997-2017. In the research, the volumetric method using the Burkard's trap was applied. For the classification of pollen seasons, cluster analysis was used including non-hierarchical clustering for the multi-characteristic objects – k-means method. The following method deals with automatic clustering of objects similar in relation to each other. The alder pollen seasons were divided into five groups.

Results: The types of alder pollen seasons varied in the duration of pollen seasons, the number of peaks with maximum concentration and their location as well as the values of daily concentrations. The first type is characterized by a very long period of pollination with low values of pollen grain concentration. The occurrence of several peaks separated from each other by periods of lower concentration is also another distinguishing feature. The second type has two peaks, the first, lower at the beginning of the pollen season, the second one, higher in the third quarter of the season. Both peaks are separated by a period of zero concentrations of pollen. The third and fourth types are similar. They are characterized by high concentrations of pollen and one main three-peak maximum. The difference between those types is that the peak pollination of the third type starts approx. 20 days after the first pollen grains appear, while in the fourth type this period is shorter. The differences also occur in the pre-peak period, which in the third type is longer and in the post-peak period, which in turn is longer in the fourth type. The pollen season of the fifth type is dispersed with a single two-peak maximum in the middle of the season. The maximum daily concentration in the discussed type is low, slightly exceeding 800 grains/m^3.

Conclusions: The first type of the pollen season appeared to be the most characteristic for alder, which took into account the most seasons of the studied years. It was distinguished by a long period of condensed pollination with low values of pollen grain concentration. The presence of several peaks during the pollen season was also characteristic for the following type. The other four types were characterized by higher concentrations of pollen grains than the first type and one condensed seasonal maximum.

Application of heating degree days and the ERA5 dataset for determining the start of the Betula pollen season over Poland – 1st step of the pollen emission module development

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Previous studies on the birch phenology have shown that the temperature sum threshold for both the start and the end of the season is stable from year to year. Sofiev *et al*. (2013), on the basis of phenological observations and pollen concentrations, provided the heating degree days (HDD) thresholds for the start of the *Betula* season (Hs) for the whole Europe.

Here we have applied recently released, high resolution ERA5 reanalysis dataset (https://www.ecmwf.int/) to calculate the HDD map for Poland. ERA5 covers the Earth on a 30 km x 30 km grid and is available at one hour temporal resolution. The database provides the information among others on: temperature at 2 m (T2), relative humidity at 2 m (RH2), wind components at 10 m and sum of rainfall (R). Therefore, it covers all of the most relevant meteorological parameters influencing tree pollen emissions. Here, on the ground of HDD calculations we indicated the start date of the *Betula* pollen season and we compared the results to the start date indicated on the basis of tree pollen concentrations at different locations in Poland. In the next step, we will use the ERA5 database to build a *Betula* pollen emission model, which will provide pollen emission at one hour temporal resolution for the whole area of Poland.

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Application of classification trees in the morphological feature selection for birch, hazel and alder pollen grains

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Introduction: The task of pollen recognition is difficult and time-consuming as the differences in the morphological structure of pollen grains of some taxa are very small and finding them largely depends on the position of the grain on the tape. Therefore, there is a need to automatize or facilitate this process. It seems that indicating features with the highest discriminative potential could improve the pollen grain identification procedures. Thus, our research presents a selection of morphological features of pollen grains that not only most strongly discriminate birch, alder and hazel taxa but are also easily determined automatically from a microscope image.

Results: For this purpose, a database of morphological features of the studied taxa was created manually. Values of these features were read under a microscope for 225 pollen grains (75 grains for each taxon). The following attributes were measured or counted: minimum and maximum axis (min axis, max axis), difference between the maximum and minimum axis (axes diff), exine thickness (wall), number of visible pores, with distinction between pores visible from above (number of top pores), laterally situated pores (number of lateral pores), and obliquely situated pores (number of oblique pores), and also the total number of visible pores (number of pores), oncus height (min oncus height, max oncus height), oncus width (min oncus width, max oncus width) as well as pollen grain position (position). The selection was based on the results of J4.8 classification trees built for different subsets of features. The models were verified using the 5-fold cross-validation method.

Conclusions: Among the studied attributes, the most strongly discriminating features were the following: number of pores, max axis, min axis, axes diff, max oncus width, and number of lateral pores. The mean classification accuracy based on this subset was 93.95% for the 5-fold cross-validation method. repeated 1000 times, and was better than that based on the full set.