FLOWERING DYNAMICS OF SELECTED PLANTS WITH ALLERGENIC POLLEN

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Abstract
The Lednice-Valtice area is one of the important recreational areas that offer a wide range of recreation. The surroundings are also interesting for visitors, bike rides are popular. It is advisable to arrange the stay of visitors suffering from allergies with regard to the flowering of plants with allergenic pollens. Plants whose pollen is allergenic were selected from the database of phenological observations of the Czech Hydrometeorological Institute in the Lednice area. The data of the flowering phenophase were statistically processed and on their basis the periods with the occurrence of allergenic pollens were defined. It is a question whether there is sufficient information for tourists about periods with allergens.

Keywords: Flowering phenophase, allergies, Lednice-Valtice area, air temperature

Introduction

In connection with the earlier onset of higher air temperatures in spring, especially in recent years, plants are also flowering earlier. Consequently, pollen is released into the air earlier, triggering an inappropriate immune response in sensitive individuals, a condition referred to as "seasonal allergic rhinitis". Pollen particles, present in the air, can settle on the skin, in the eyes, nose, and bronchi, inducing symptoms such as profuse runny nose, itching, and sneezing (often paroxysmal), swelling of the nasal mucosa resulting in a stuffy, red nose, watery eyes, and difficulty breathing. Most individuals with pollen allergies are sensitive to several types of pollen and may also react to certain foods containing similar proteins, a phenomenon known as "cross-allergy". A classic example is the cross-allergy between birch pollen and apples (https://www.pylovasluzba.cz/alergie/pylova-alergie). Pollen allergens have the capability to stimulate the release of pro-inflammatory and immunomodulating mediators, accelerating the development of IgE-dependent sensitization and allergy. Studies have indicated that plants exhibit enhanced photosynthesis and reproductive effects, producing more pollen in response to elevated atmospheric carbon dioxide levels (Chong-Neto et al., 2020).

As reported by Asam et al. (2015), pollen allergy affects approximately 40% of allergic individuals. Tree pollen allergies, in general, are predominantly triggered by allergenic trees belonging to the orders Fagales, Lamiales, Proteales, and Pinales. Over 25 years ago, the gene encoding the major birch pollen allergen Bet v 1 was the first of its kind to be cloned, and its product characterized. Since then, 53 pollen allergens from trees have been identified and recognized by the WHO/IUIS Allergen Committee. Among the most effective and common sources of allergens are pollens from trees of the beech family (Fagales), olive trees (Oleaceae), and cypresses (Cupressaceae) (Mothes et Valenta, 2004).

Pollen allergy issues in urban areas are also attributed to inadequate urban design and selection of ornamental species, contributing to one of the most prevalent diseases in urban populations: pollen allergy. The primary causes of this extensive allergenicity include low species biodiversity at planting, overpopulation of certain species acting as key specific pollen sources, planting of exotic species causing new allergies, selection of male individuals producing pollen in dioecious species, and the presence of invasive species. Clear guidelines are necessary regarding the design and planning of urban green spaces to minimize allergy impacts (Cariñanos & Casares-Porcel, 2011).

According to Lake et al. (2017), ragweed is poised to become a common health issue across many parts of Europe due to its allergenic pollen. Sensitization to ragweed is expected to more than double, rising from the current 33 million to 77 million people by 2041–2060. Sensitized individuals may experience more severe symptoms due to higher levels of ragweed pollen and

prolonged pollen seasons, lasting until September and October in many parts of Europe. These projections primarily stem from climate change assumptions (66%) but also reflect current trends in the spread of this invasive plant species across Europe.
Puc (2003) defines allergies as excessive reactions of the body to foreign substances (antigens) that are harmless to others' bodies in similar amounts and under similar conditions. Allergic reactions occur when the natural immune defense mechanism, responsible for the appropriate response to environmental factors, is disrupted. The most common allergens from the natural environment are inhaled allergens present in plant pollen. Allergens from the natural environment typically consist of proteins with a high molecular weight, greater than 10 kDa. Pollen allergens are water-soluble proteins or glycoproteins with molecular masses ranging from 10 to 70 kDa. The most significant contributors to pollen allergy include genetic and environmental factors (air pollution, allergen exposure, respiratory infections, diet), and the microflora of plant pollen.
Chen et al. (2016) propose a model explaining how pollen allergens were created and maintained in plants. Prediction and systematic analysis of pollen allergens in model plants indicate that pollen allergens arose by gene duplication and subsequent functional specification. This study provides insight into the phylogenetic and evolutionary scenario of pollen allergens, which will be useful for future characterization and pollen allergen epitope screening.
Vrtala et al. (1993) investigated the kinetics of allergen release from birch pollen (Betula verrucosa) and timothy grass pollen (Phleum pratense) using various protein extraction procedures, immunoblotting with specific antibodies, and immunoelectron microscopy. Major birch pollen allergen Bet v I, major timothy grass pollen allergens Phl p I and Phl p V, and group II/III allergens from timothy grass pollen and profilin were rapidly and abundantly released from hydrated pollen. Pollen allergens could be detected within minutes in aqueous supernatants prepared from birch and grass pollen with serum IgE or specific antibodies. Consistent with previous observations, they concluded that the allergenic properties of proteins are more closely associated with the quantity and rate of dissolution from airborne particles than with intrinsic properties. The length of specific phenophases was reduced by 2.3 days in oak, 0.8 days in hawthorn, and 1.3 days in wild garlic. The onset of phenophases shifted by 9 to 10 days over a 47-year period.

Materials and methods
The phenological observations, conducted by Assoc. Prof. Zdeněk Bauer, CSc., Data on the phenological phase of flowering of Tillia cordata, Fraxinus angustifolia, Acer campestre, Sambucus nigra in the area of Lednice in Moravia were analyzed The date of each phenophase was converted into so-called Julian days, as sequential days in the year counted from January 1 of the given year. These data were processed using basic statistical methods, and the temporal variability of the onset of phenophases was defined for the period from 1961 to 2015.

Results
The results of the statistical analysis are presented in Table 1. They include the occurrences of the earliest and latest onsets of the phenophases of initiation and full flowering. Furthermore, the difference between these onsets, the average ordinal day for a given phenophase, the standard deviation, and the coefficient of variation are provided. Environmentally, Acer campestre burdens the surroundings with its pollen first, followed by Tillia cordata, and finally, Fraxinus angustifolia, with Sambucus nigra being the latest.

Tab. 1: Statistical characteristics of the phenophases of initiation and full flowering, Lednice na Moravě

Tilia cordata Bud		**Tilia cordata Full development**	
min	29.3.1974	min	20.4.1989
max	28.4.1980	max	20.5.1980
amp	31	amp	31
average	104	average	124
standard deviation	7.832	standard deviation	6.540
coefficient of variation	0.075	coefficient of variation	0.053

Fraxinus angustifolia Bud		**Fraxinus angustifolia Full development**	
min	12.4.1974	min	8.5.2009
max	13.5.1982	max	8.6.1980
amp	31	amp	32
average	117	average	142
standard deviation	7.705	standard deviation	7.286
coefficient of variation	0.066	coefficient of variation	0.051

Acer campestre Bud		**Acer campestre Full development**	
min	20.3.1990	min	16.4.1989
max	21.4.1969	max	13.5.1980
amp	32	amp	28
average	96	average	121
standard deviation	7.442	standard deviation	6.582
coefficient of variation	0.078	coefficient of variation	0.055

Sambucus nigra First flower		**Sambucus nigra Full bloom**	
min	5.5.2000	min	11.5.2000
max	5.6.1980	max	15.6.1966
amp	31	amp	34
average	140	average	149
standard deviation	7.175	standard deviation	7.112
coefficient of variation	0.051	coefficient of variation	0.048

Discussion

In recent decades, much research activity has been devoted to studying the manifestation of climate change. The increasing dynamics of weather and demonstrable changes in climate, especially rising temperatures, alter conditions for plants and thus their reactions. The timing and duration of phenological phases are changing. From the perspective of conditions for human outdoor activities, knowledge of the flowering phenophase and its duration is important because pollen from certain plants causes allergies. As documented in the literature review, the occurrence of pollen allergens is a serious issue receiving considerable attention. Our results demonstrate that it is necessary, also from a recreational standpoint, to know the flowering periods of plants with allergenic pollen. Due to the evident warming and thus earlier onset of flowering phenophases, and thus earlier pollen occurrence, conditions for the beginning of the recreational period are essentially improving. This is because the largest numbers of visitors to the Lednice-Valtice area come during the summer months. At its beginning, elderflower pollen is prevalent, thus improving conditions for allergy sufferers due to its earlier flowering.

Conclusion

The data on the phenological phases of flowering in Tillia cordata, Fraxinus angustifolia, Acer campestre, and Sambucus nigra were analyzed. Statistical analysis indicates that Acer campestre blooms first, with the latest onset of full flowering occurring in the second decade of April. The latest full flowering occurs in Tillia cordata, at the turn of the second and third decades of May. Fraxinus angustifolia exhibits the latest occurrence of full flowering at the end of the first decade of June. Among the evaluated species, this phase is the latest in Sambucus nigra. However, considering the earlier onsets of flowering, it is reasonable to assume that full flowering in Sambucus nigra will also occur earlier, resulting in significantly less manifestation by early May. In this regard, warming will have a positive impact on recreational conditions. Certainly, the extent to which high air temperatures will burden visitors to the area is a question. A comprehensive assessment of the occurrence of allergenic pollen would require an analysis of the flowering of all plants with this pollen; however, phenological data are not available for most of them.

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Souhrn

Změna klimatu, která se projevuje statisticky prokazatelným zvyšováním teploty vzduchu, ovlivňuje také fenologické projevy rostlin. Z hlediska podmínek pro pobyt člověka v přírodě jsou důležité poznatky o fenofázi kvetení a její délce proto, že pyly určitých rostlin jsou příčinou alergií. Problematika výskytu a působení alergenního pylů je celosvětovým tématem a je studována z mnoha pohledů.

Uváděny jsou výsledky statistického hodnocení fáze kvetení u druhů Tillia cordata, Fraxinus angustifolia, Acer campestre, Sambucus nigra v katastru Lednice. Naše výsledky dokládají, že je potřeba i z hlediska rekreace znát doby kvetení u rostlin s alergenním pylem. Díky prokazatelnému oteplování, a tím dřívějším nástupům fenofáze kvetení, a tím i dřívějšímu výskytu pylů se v podstatě zlepšují podmínky pro období počátku rekreace. Je to dáno tím, že

největší počty návštěvníků Lednicko-valtického areálu přichází až v letním období. Na jeho počátku jde o výskyt pylu bezu černého, jeho dřívější kvetení tak pro alergiky podmínky zlepší. V tomto ohledu se oteplování projeví na podmínky rekreace pozitivně. Jistě, že je otázkou, nakolik zatíží návštěvníky areálu vysoké teploty vzduchu. Pro jednoznačné posouzení výskytu alergenního pylu by bylo potřebné provést analýzu kvetení všech rostlin s tímto pylem, ovšem u většiny nejsou k dispozici fenologická data.

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