Assessment of palynological spectrum of air in Kazan

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Abstract. This article presents the results of a palynological air monitoring study in Kazan during the period of plant dusting from 2019 to 2022. The aeropalynological spectrum was assessed using a Lanzoni pollen trap. The data obtained during the monitoring demonstrates a rich spore-pollen composition in the air. Twenty-five different plant taxa, as well as two fungal taxa, were identified. *Betula* and *Poaceae* have been identified as dominant taxa. The variability in pollen concentrations confirms the need for timely information for the pollen-sensitive population.

1 Introduction

Modern humans are increasingly exposed to an increasing number of negative environmental factors, including various biological agents in the air. Among the many factors that can cause various negative manifestations in the population, the plant pollen, as well as the fungal spores, play an important role. In particular, these elements are the cause of seasonal allergic reactions - pollinosis. The pollinosis occurs in a large proportion of the population and affects the quality of life. In particular, the National Center for Health Statistics indicates that 25.7% of the adult population has a seasonal allergic rhinitis [1]. The publications investigating the mechanisms of pollen-induced allergic asthma have reported the rates of pollen sensitivity of up to 18 % of the global population [2]. The degree of occurrence as well as the frequency of symptoms of allergic rhinitis is directly related to the concentration of allergens in the air environment [3]. In addition, many observations indicate that the proportion of pollinoses is increasing due to the rapid urbanisation as well as the global warming [4]. In view of the above factors, it becomes a necessity to inform about the changing quantity and quality of the plant pollen and fungal spores in the atmospheric air of particular regions.

The flowering calendars and various mobile services are quite effective and useful sources of information to prevent the initial manifestations of seasonal allergies. All of these sources provide the information about the current allergen concentrations. A summary of the palynological spectrum is unique to each region, as it largely depends on the climatic characteristics of the growing area, as well as the taxonomic diversity.

The aim of this work is to assess the palynological spectrum in Kazan and to develop the methods for informing the pollen-sensitive population.

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2 Materials and Methods

This study was conducted in Kazan, the capital of the Republic of Tatarstan. The forest cover of the Republic is relatively low, averaging 17.4%. Most of the woody forms of vegetation are represented by the soft-leaved tree species as well as shrubs. It is worth noting that due to its geographical features, Tatarstan is characterized by both taiga and steppe species of flora.

The monitoring was conducted during the growing seasons of 2019 - 2022 from the beginning of April to the end of September. The standard aeropalynological methods were used during our surveys. A Lanzoni VPPS2010 pollen trap was used to capture the pollen, which was installed on the balcony of a residential building in the central district of Kazan at a height of 10 m. The pollen grains were deposited on a Melinex polyester tape that was coated with a gelatin and glycerol-based aggregating solution. On completion of the tape exposure, the preparations were made using the fuchsin dye. The obtained preparations were analyzed using a light microscope: 25% of the total preparation area was viewed at 400x magnification with four longitudinal lines [5]. The systematic identity of the pollen grains was identified using the palynological atlases [6]. The taxonomy of the objects was determined to the genus. The statistical data processing was performed using STATISTICA 10, by Kolmogorov-Smirnov criterion; the reliability was determined at $p<0.05$. The graphs were plotted using the GraphPad Prism 5.

The palynological calendar was developed according to the standard, generally accepted methodology. In particular, only those types of pollen grains that predominated in the air in the greatest number and had a pronounced allergenic potential were included in the calendar. The calendar was constructed using the Google Spreadsheet as a table, each cell of which illustrates the average concentration of pollen in the air for a decade of the month. The generally accepted concentration standards were used to interpret the results [7].

3 Results

The palynological assessment of the atmospheric air of Kazan revealed a wide taxonomic spectrum of pollen grains. In total, more than 30 types of different objects were recorded, of which 25 types of pollen grains of plants were reliably identified. A palynological calendar was compiled based on the data obtained and included 17 plant taxa (*Betula, Acer, Alnus, Quercus, Fraxinus, Picea, Pinus, Populus, Ulmus, Salix, Corylus, Poaceae, Rumex, Plantaginaceae, Urtica, Artemisia, Ambrosia*) as well as the spores from fungi of genera *Alternaria* and *Cladosporium* (Fig. 1, 2).

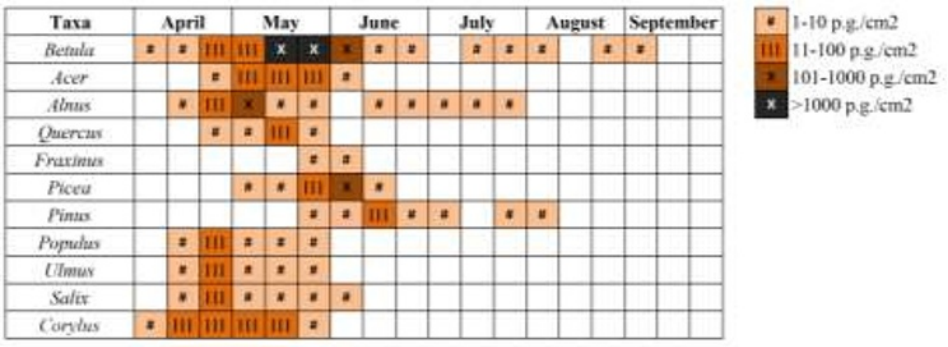

Fig. 1 Palynological calendar for the period of 2022 in Kazan (woody plants).

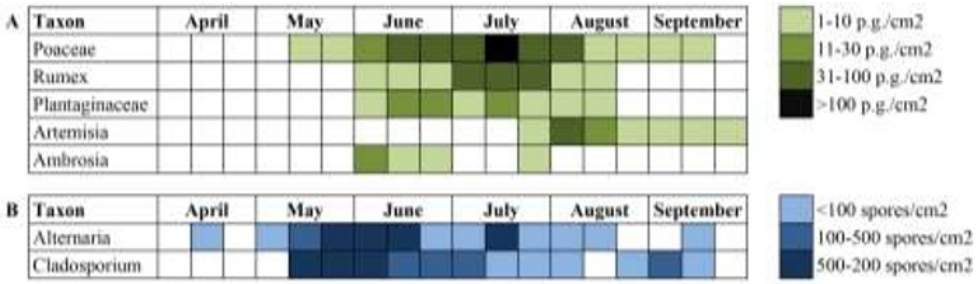

Fig. 2 Palynological calendar for the period of 2022 in Kazan for: A - herbaceous plants, B - fungal spores.

The palynological spectrum of Kazan is generally very similar to the Moscow Region. The results of the ten-year monitoring in Moscow show the similar dominant taxa (*Betula*, *Alnus*, *Poaceae*, *Urtica*) and similar pollen patterns. However, it should be noted that the presence of *Artemisia*, *Plantaginaceae* and *Urtica* pollen in much higher concentrations is characteristic of Moscow [8].

By analysing the distribution of pollen according to the duration of the growing season, we can see a clear periodicity in the timing of pollination of plants. In particular, based on our results, we can observe 3 main periods: spring period (April - May), summer period (June - July) and late summer and early autumn period (August - September) (Table 1).

Table 1. Proportion of pollen from plants at different time intervals.

April - May		**June - July**		**August - September**	
Taxa	**%**	**Taxa**	**%**	**Taxa**	**%**
Betula	54	*Poaceae*	42	*Artemisia*	74
Alnus	14	*Rumex*	24	*Poaceae*	19
Corylus	11	*Betula*	17	*Betula*	3
Pinus	7	*Plantaginaceae*	8	*Plantaginaceae*	3
Others	14	Others	9	Others	1

The pollen grains of woody plants, such as *Betula, Acer, Alnus, Picea, Pinus and Corylus*, accounted for most of the spectrum from early April to late May. At this time, the birch pollen dominated, accounting for 54% of total pollen. Other taxa were less represented and their average daily concentration did not exceed 14%. The period from June to July is characterized by the dominance of pollen of herbaceous plants: *Poaceae, Rumex, Plantaginaceae, Urtica*. The *Poaceae* pollen dominated, accounting for 42%. In this time interval, the richest pollen composition of the atmosphere in Kazan is observed, as the spectrum still contains the pollen grains of *Betula*, which on average accounted for 17%. The consequence of this is the greatest risks for people who are sensitive to pollen. The pollen from other trees had the least impact on the overall palynological background.

From the first decade of August onwards, the pollen concentrations from most plants begin to decrease, but the appearance of Artemisia pollen grains, which are an active allergen, should be noted as a contribution to the overall spectrum.

In addition to the above representatives, we also recorded the pollen grains of insect-pollinated plants (*Asteraceae, Fabaceae, Apiaceae, Castanea, Glechoma*). However, their

presence did not greatly affect the overall picture of the palynological spectrum. The pollen content of such plants was minimal and did not exceed an average daily concentration of 5 units/cm2.

The presence of *Alternaria* and *Cladosporium* spores in the atmosphere cannot be overlooked and it is worth noting that they occur throughout the study period. The spore concentration has a direct dependence on the weather conditions, in particular the air and soil humidity, so their concentration is highly variable. On average, an increase in the content of spores in the air was observed in the period from May to June.

The dynamics of changes in the pollen concentration in the air of plants of the genus *Betula* and the *Poaceae* family were subject to special control, as a significant number of allergic individuals are sensitive to these types of pollen [9]. In the course of observations, the significant changes in average concentrations of birch pollen were observed, especially with increasing number of particles in 2021 and 2022 (Fig. 3). No significant sharp fluctuations in the average daily concentrations of cereal plants were detected, but it is worth noting the consistently high levels of cereal pollen during each monitoring season.

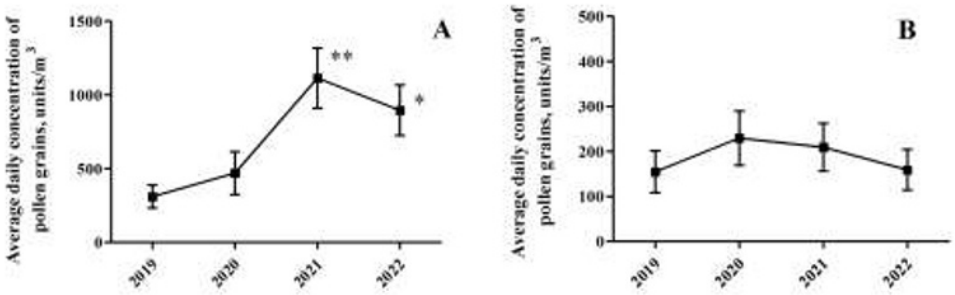

Fig. 3 Dynamics of pollen concentration of plants of the *Betula* (A) and Poaceae (B) genus in the period of 2019-2022 (** - indicates the significant difference at $p<0.01$; * - indicates the significant difference at $p<0.05$).

It should also be noted that there is a noticeable shift in the timing of pollination of the dominant taxa. This phenomenon is directly related to the temperature regime. In particular, in April 2019 the presence of birch pollen was observed in higher numbers than in later monitoring periods; the average shift was 10 days (Fig. 4).

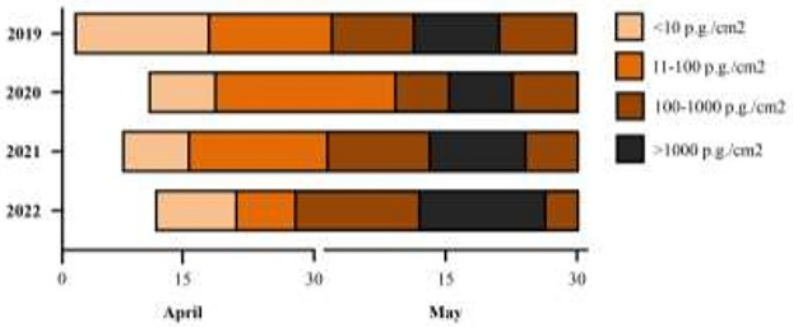

Fig. 4 The amount of *Betula* pollen in air samples.

Notably, the *Ambrosia* pollen grains, a strong allergen, were also detected in the total spectrum. *Ambrosia* is an alien species for Tatarstan, a quarantine weed, an atypical representative of the Kazan flora. According to our data, this plant produces a significant

number of pollen grains, which ultimately qualitatively affects the palynological spectrum [10].

4 Discussion

The aeropalynological data are important because they allow us to identify the features of the timing of plant dusting, as well as the spore-pollen composition of the atmosphere, information about which can be used by the patients who are sensitive to the plant pollen. Each region is characterised by its own individual palynological spectrum, which largely depends on the climatic regime as well as the biodiversity of the flora.

In Kazan, as in many regions of Russia and Europe, the plants of the *Betula* genus are a characteristic representative of the urban flora, and largely determine the pollen composition of the air environment. The results of many authors also indicate a significant proportion of birch pollen [11, 12]. This fact is important especially for the populations of the cities with a high degree of urbanization, since in these conditions the sensitivity to this pollen may increase [13]. For Kazan, which is a major industrial and transport centre of Tatarstan and Russia as a whole, the results of aeropalynological air assessment are particularly valuable for understanding the general allergological situation.

The pollen of *Poaceae*, *Artemisia* herbaceous plants, largely present in the samples obtained, is also responsible for the seasonal allergic diseases during the summer. [14, 15].

To summarise the above, the presence of plant pollen in the air can seriously affect the quality of life of the population. In view of this, the timely information about the changes in pollen concentrations becomes a necessity. The existing European information resources are an effective way to inform the allergy patients [16]. As part of our research, the Pollenlab.ru online portal was created where a summary of the current palynological spectrum in the atmosphere of Kazan is posted on a regular basis.

5 Conclusion

Based on the results of the study of the spore-pollen spectrum of atmospheric air in Kazan for the period of 2019-2022, 25 types of pollen and 2 types of spores were identified. Based on the analysis of the pollen and spore concentration dynamics of fungi, dusting calendars were constructed. These data, as well as daily pollen counts, were used to inform the population sensitive to these allergens on our new pollenlab web portal. The web portal created by us provides the information on the current concentration of pollen grains from different taxa and also gives a forecast for the next day, taking into account the weather conditions. In addition, the website contains an archive with a palynological atlas of pollen grains found during monitoring in the Kazan region. The analysis of site traffic using Google Analytics, as well as the general activity of participants in social networks demonstrates the demand for our resource, the average attendance of which is about 2,500 unique visitors per day.

The taxa such as *Betula, Alnus* had the greatest influence on the overall palynological spectrum in the spring period. The dominant taxon in summer was pollen grains of herbaceous plants, especially *Poaceae*. There was also a significant content of *Artemisia* pollen at the end of August. We have recorded the significant annual fluctuations of *Betula* pollen concentrations during monitoring. In recent years there has been an increase in the pollen content of this taxon in the air from late April to early June. On this basis, we can conclude that it is necessary to inform the population about the current palynological spectrum, which will eventually have a qualitative impact on everyday life.

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