

## FLORISTIC DIVERSITY AT BIOLOGICAL STATIONS OF KAZAN FEDERAL UNIVERSITY

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**Abstract:** The main aim of floristic research is to study the flora of a particular territory. Especially important are such studies on sites used for educational, familiarization purposes. The northwestern part of the Botanical Garden of the Kazan Federal University (KFU), its Geostation and their surrounding territories are used for conducting summer botanical training for students - bachelors in biology. In the course of the research, an inventory of floristic composition, floristic wealth, flora structure according to biomorphological, ecological features and economic significance of species was carried out, and adventive species were identified. For the study of flora, stationary and route-based methods of research were used. The route-based survey schemes were plotted taking into account the maximum number of different biotopes. Occurrence and abundance of species were determined on stationary sites, counts were conducted every 2-3 weeks. The role of the species in the community was judged by the integral coefficient of phytocenotic significance (PCS). The higher the value of the PCS, the more phytocenotically meaningful the corresponding species is. This indicator is especially important for species of meadow communities having the same abundance or projective coverage.

The flora under study involved no species listed in the Red Book of the Republic of Tatarstan and Russia.

**Keywords:** flora, flora structure, vegetation, species diversity, botany

### 1 Introduction

The Botanical Garden of Kazan University was established in 1806. The first planting of plant collections was in the courtyard of the university. Later, in 1829, a plot of 5 hectares was purchased on the shore of Lake Kaban, located in the center of the city. At present the Zoobotanical Garden of Kazan is located here. The botanical garden was laid down under the guidance of the professor of botany A.A. Bunge, later the work was supervised by the scientist - gardener N.P. Krylov. In the prerevolutionary period, the garden was an educational and auxiliary institution of KSU and was open to public visits (Gapchenko & Iund, 1957). After the October Revolution of 1917, the general devastation in the country led to the death of almost all the plants in the greenhouses of the garden and the open-ground collection, so the Botanical Garden lost all value for the university and the city. Restoration of the garden and collections started in 1924 by a student scientific group of nature lovers under the guidance of Professor A.Ia. Gordiagin and university teacher S.I. Petiaev. In summer 1926, the garden was again open for visits, and scientific and educational work was carried out there. A new stage in the development of the Botanical Garden at Kazan University began in 1984, when the university was allocated a new territory near the state farm "Berkutovsky" with an area of about 200 hectares. In 1986, Associate Professor of the Department of Botany R.G. Ivanova partially did geobotanical descriptions of vegetation and brief descriptions of the flora of the natural areas of the garden. At present, there is a need to make an inventory of the flora of the north-western part of the Botanical Garden, in connection due to the fact that it is planned to be used as a base for educational practice for university students (Smirnov, 1974; Villalobos Antúnez, 2015).

Table 1. Taxonomic structure of the flora

Division, class	Number of species		Number of genera		Number of families		Number of orders	
	Bot. garden	Geostation	Bot. garden	Geostation	Bot. garden	Geostation	Bot. garden	Geostation
Equisetophyta Equisetopsida	1	5	1	1	1	1	1	1
Polypodiophyta Polipodiopsida	-	7	-	6	-	4	-	1
Pinophyta Pinopsida	-	3	-	3	-	2	-	2
Magnoliophyta Magnoliida	70	228	55	161	20	50	18	35
Magnoliophyta Liliopsida	9	41	8	26	2	10	2	10
Total	80	283	64	197	23	67	21	49

Other surveyed territories were the University's Geostation and its vicinity. In 1958, the Kazan Magnetic Observatory was transferred under the auspices of the Department of Geophysical Methods of Exploration of Mineral Resources, on the territory of which the base of students' educational practice began to form. At present, it is the base of training practice for students of geophysicists, oil workers, hydrogeologists, biologists, etc. Flora and vegetation surveys of this territory have not yet been conducted (Muratet et al. 2008).

The objective of this research was to study and compare the floristic diversity of the territories of the bases of educational botanical practices - the inventory of floristic composition, the richness of flora, the structure of the flora according to biomorphological and ecological features. Such studies allow us to identify the most interesting, rare plant species, the mechanisms that affect the distribution of species in a human-dominated environment (Pyšek et al, 2002; Malyshev et al, 1994; Demina et al, 2012).

### 2 Methodology

The material was collected from 10.07.2015 to 28.09.2017. Routine and stationary research methods were used to identify the most complete species composition of the flora (Kulikova, 2006; Shcherbakov & Maiorov 2006). Routine survey schemes were laid taking into account the maximum number of different biotopes. Species affiliation is given in accordance with the report by S.K. Cherepanov. The occurrence and abundance of species were determined on stationary Raunkier's sites - 1x1 m. 25 such sites were laid down in the Botanical Garden during the northwestern transect and 2 sites S=100 m<sup>2</sup>, with five Raunkier's sites placed diagonally for more accurate recording of indicators. In the vicinity and on the territory of the Geostation in different ecologo-cenotic conditions, a similar number of registration areas was laid down. All counts were conducted every 2-3 weeks. The role of the species in the community can be judged by the integral coefficient of phytocenotic significance (PCS). It is the product of the average projective cover of a species for its occurrence. The higher the value of the PCA is, the more phytocoenotically meaningful the corresponding species is. This indicator is especially important for species of meadow communities having the same abundance or projective coverage (Cherepanov, 1995; Shekarbaghani, 2017).

### 3 Results

Discussion of the results will begin with a systematic analysis of the flora.

Flora of the northwestern part of the Botanical Garden is represented by 80 species of higher vascular plants of 64 genera, 23 families, 3 classes, 2 divisions; flora of the Geostation includes 283 species belonging to 197 genera, 67 families, 5 classes, 4 divisions (Table 1).

The main core of the flora of the Botanical Garden is represented by 12 families. The families are arranged in descending order by number of species as follows: Asteraceae (28%), Fabaceae (13%), Poaceae (12%), Caryophyllaceae (10%), Rosaceae (6%), Scrophulariaceae (6%), 4% for Polygonaceae, Brassicaceae and Plantaginaceae, 3% for Apiaceae and Rubiaceae. Flora of the vicinity of Geostation included 23 families identified. The first place in the number of species belongs to the family Asteraceae - 18% of the total number of species. Further in descending order, Fabaceae (9%), Rosaceae (8%), Poaceae, Caryophyllaceae and Brassicaceae (7%), Lamiaceae (4.5%), Polygonaceae (4%), Ranunculaceae and Apiaceae (3.5%), Scrophulariaceae and Cyperaceae (3%), etc.

During the research, the degree of participation of species in the composition of the vegetation cover was revealed. When characterizing the grass cover, both meadow and forest communities, it is highly importance to establish quantitative relations between species included in its composition. Quantitative analysis of the grass cover was carried out using the method of visual appraisal of the projective cover. Based on the obtained data, it is possible to identify plant species having the largest projective coverage. For the Botanical Garden, these are *Lotus ambiguus* - 30%, *Fragaria viridis* 28%, *Achillea millefolium* - 20%, *Carduus acanthoides* - 18%, etc. For the territory of the Geostation and its vicinity, these are *Equisetum arvense* - 20%, *Lathyrus vernus* - 20%, *Hypericum perforatum* - 15%. Consequently, these species can be considered conservative elements of the flora, which are in relative equilibrium with modern conditions of existence.

The smallest projective cover was noted for the following plant species of the Botanical Garden: *Stellaria graminea* - 5%, *Melilotus albus* - 3,3%, *Crambe tataria* - 3,5%; for the territory of the Geostation and its vicinity - *Geranium pratense* - 3%, *Solidago virgaurea* - 2%. For these species, the current conditions are apparently far from optimal.

Analyzing the occurrence of species on the sites, it is possible to identify species with the coefficient of occurrence equal to 60 - 70%. These are not common species. The north-western part of the Botanical Garden: *Trifolium pratense*, *Galium mollugo*, *Achillea millefolium*. In the territory of the Geostation and its vicinity, there are more such species: *Aegopodium podagraria*, *Geranium sylvaticum*, *Urtica dioica*, *Veronica chamaedrys*, *Glechoma hederaceae*. The majority of species have a coefficient of occurrence in the range of 30-50%. There are species with a very low occurrence rate of 10-20%. In the Botanical Garden such species are *Medicago sativa*, *Medicago falcate*, *Stellaria graminea*, *Diantus deltoides*; In the Geostation - *Solidago virgaurea*, *Fragaria vesca*. This indicates that the main types of

plant communities are unevenly distributed, confined to certain phytocenotic and ecological conditions.

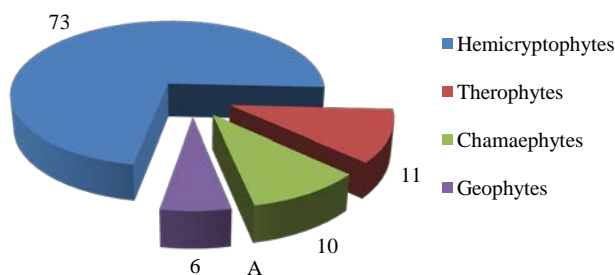
In addition to the above indicators, the phytocenotic significance (PCS) was calculated. Just a few species show the highest rates. In the Botanical Garden, these are *Fragaria viridi* and *Achillea millefolium*, both of which have the same coefficient of 1400. In Geostation, there is only one species - *Dactyli sglomerata*. These species are edifiers, the main environment-forming species of the community, the victors in the struggle for existence.

The group of highly abundant species may include species with PCS above 650. For the north-western part of the Botanical Garden they are: *Lotus ambiguus*, *Millium effusum*, *Rhinanthus minor*, *Galium mollugo*, for Geostation - *Galium mollugo* only. The presence of the semi-parasite (*Rhinanthus minor*) among them indicates the unfavorable situation prevailing in the plant community. Many species have very low PCS indices, less than 100; this is confirmed by the fact that the existing biotic conditions for these species are of little use for optimal life activity. For example, these are species such as *Agrimonia eupatoria*, *Stellaria graminea*, *Diantus deltoides*, etc. (Botanical Garden), *Melica nutans*, *Anthriscus sylvestris*, *Viola tricolor*, *Polemonium caeruleum* (Geostation), etc.

Floras of the north-western part of the Botanical Garden and the vicinity of Geostation strongly differ in their biomorpha. Only herbaceous forms are characteristic for the flora of the north-western part of the Botanical Garden. In the flora of the Geostation and its vicinity, there are herbaceous forms, as well as shrubs and trees. Moreover, herbaceous species are 246 (87%), shrubs - 20 (7%), trees - 17 (6%).

During the research, the analysis of the floras of the studied areas was carried out according to life forms (according to Raunkier). This analysis showed that the dominant form of the flora of the north-western part of the Botanical Garden is hemicryptophytes, comprising 73%, 11% of terophytes, 10% of chamaephytes. The prevalence of hemicryptophytes in general is typical for the temperate zones of the Northern Hemisphere. Identification of a fairly large number of terophytes, more characteristic of arid zones, is associated with a specific biotope and the presence of adventitious species, and hamefites (numerous in tundra and deserts) - with diverse terrain conditions.

The territory of the Geostation and its vicinity is characterized by the dominance of hemicryptophytes - 52%, terophytes - 16%, geophytes - 9%. A detailed analysis of the structure of the investigated floras is shown in Fig 1.



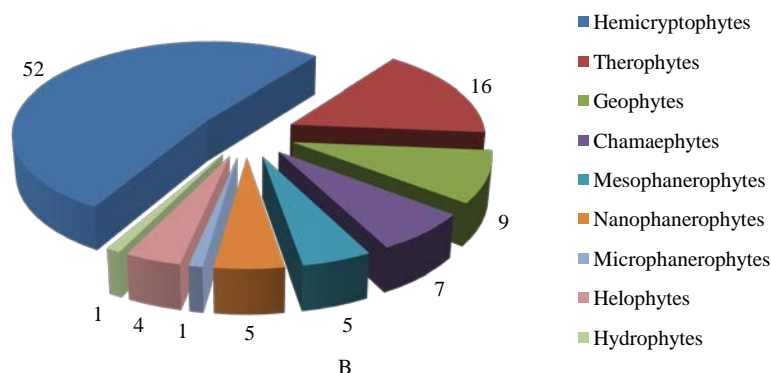


Fig 1. The structure of the flora subject to life forms (according to Raunkier), %: A - the north-western part of the Botanical Garden; B - Geostation and its vicinity

The conducted analysis made it possible to identify adventive (invasive) species in the flora. These species are studied in connection with their specific adaptations to various natural ecosystems and related environmental conditions (Kühn & Klot, 2008; Pyšek et al, 2003).

According to the time of immigration: archaeophytes - ancient adventive species - *Spergula arvensis*, *Capsella bursa-pastoris*, *Vicia tetrasperma*, *Centaurea cyanus*, *Setaria viridis*, kenophytes - new adventive species - *Lepidium densiflorum*, *Medicago sativa*, *Matricaria recutita*, *Conyza canadensis* (for the northwestern site of the Botanical Garden). For the territory of the Geostation and its environs - archaeofits: *Consolida regalis*, *Polygonum arevastrum*, *Viola arvensis*, *Sisymbrium officinale*, *Descurainia Sophia*; kenophytes - *Amaranthus retroflexus*, *Bunias orientalis*, *Rosa rugosa*, *Amelanchier ovalis*.

By immigration: xenophytes - unintentionally or accidentally brought, or feral species - *Spergula arvensis*, *Capsella bursa-pastoris*, *Lepidium densiflorum*, *Vicia tetrasperma*, *Matricaria recutita*, *Conyza sanadensis*, *Setaria viridis* (for the northwestern part of the Botanical Garden). For the territory of the Geostation and its vicinity - kenophytes - *Amaranthus retroflexus*, *Polygonum arevastrum*, *Arabidopsis thaliana*, *Bunias orientalis*, *Capsella bursa-pastoris*, *Lepidium densiflorum*.

By the degree of naturalization: ephemeroïds - not naturalized, not self-seeding species - *Lepidium densiflorum*, *Matricaria recutita*; epecofites - naturalized and spreading in secondary, disturbed biotopes, species forming field and waste phytocenoses - *Spergula arvensis*, *Capsella bursa-pastoris*, *Medicago sativa*, *Centaurea cyanus*, *Setaria viridis*; agriophytes - naturalized and spreading in natural phytocenoses species - *Vicia tetrasperma*, *Conyza Canadensis* (for the north-western part of the Botanical Garden). In the territory of the Geostation and its vicinity - ephemeroïds - *Lepidium densiflorum*, *Calendula officinalis*; epekofity - *Consolida regalis*, *Amaranthus retroflexus*, *Polygonum arevastrum*; agriophytes - *Cannabis sativa*, *Lupinus poliphyllus*, *Heracleum sosnowskyi*, *Sambucus racemosa*, *Conyza canadensis*.

According to phytocenotic association, the vascular plants of the northwestern part of the Botanical Garden are divided as follows: meadow are represented by 47 species, weeds - 23, forest - 15, steppe - 7 species. This indicates that the vegetation cover has undergone a long-term transformative man-made influence, as a result of which the number of weed species increased in the herbage and the specific gravity of forest and steppe species decreased. The predominant group are meadow species. For the Geostation, the distribution is as follows: forest plants - 143 species, meadow - 87, weeds - 44, steppe - 5. This territory and its vegetation cover has undergone less

anthropogenic influence; the herbage includes a fairly large number of forest species, which are the predominant group.

The analysis of the flora according to biomorphological and ecological features showed that perennials are the most common for the territory of the Botanical Garden, represented by 63 species, which is 78% of the total number of species; annuals - 8 species (12%), biennials - 10%. The dominant group involves the following biological types distinguished on the basis of breeding methods: rod-root plants - 21 species, long-root plants - 10, short-root plants - 8, root-shooters - 7, loose-bush - 6, creeping - 3, above-ground - 2. In the territory of Geostation, perennials also prevail - 188 species (71%). Annuals - 50 species (19%), biennials - 10%. Based on the methods of reproduction, the following biological types can be distinguished: taproot species - 40 species, long-root plants - 46, short-root plants - 30, root-shoots - 8, loose-bush - 14, creeping - 15, aboveground - 8.

Perennials constitute a group of so-called "prevailed", dominant plants, which are the main consumers of moisture and nutrients, the main producers of phytomass, firmly occupying their place in the phytocenosis. Other biomorphs constitute the so-called "ingredients" group, i.e. plants subordinate "to the prevailed".

Analysis of data on the economic significance of species made it possible to distinguish among them medicinal species - 39 species (62%), food - 8%, poisonous - 13% and economically insignificant - 17% (un the northwestern part of the Botanical Garden). In the territory of the Geostation and its vicinity there are: medicinal herbs - 127 species (45%), food - 3%, poisonous - 14%, economically insignificant - 38%.

The investigated flora included no species listed in the Red Book of the Republic of Tatarstan and Russia.

#### 4 Conclusion

Flora of the Geostation and the adjacent territories is much richer than the flora of the north-western part of the Botanical Garden in terms of species diversity, biomorphs and economic significance. The vicinity of the Geostation is more preferable for holding summer trainings for undergraduate biologists.

#### 5 Summary

1. Flora of the northwestern part of the Botanical Garden is represented by 80 species of higher vascular plants of 64 genera, 23 families, 3 classes, 2 divisions; flora of the Geostation includes 284 species belonging to 198 genera, 67 families, 5 classes, 4 divisions.
2. The core of the flora of the north-western part of the Botanical Garden is represented by 12 families; the vicinity of the Geostation - by 23 families. The first place in the

number of species in both floras is occupied by the family Asteraceae.

3. Analysis of the structure of the flora by biotypes indicates that the predominant group are perennials, the most common among which are taproot, long-rooted and short-stemmed plants.
4. The predominant life form in the studied flora are hemicryptophytes.

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