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Analysis of the Meadows Flora at the Ashit River Floodplain (Tatarstan Republic).

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ABSTRACT

This paper deals with the multilateral analysis of the flora of floodplain meadows in the valley of one of the small rivers of the Republic of Tatarstan - the Ashit River. A complete floristic survey of the flood plain of the Ashit River conducted in 2012-2015 revealed the local flora of vascular plants on the floodplain meadows and allowed us to make a list of species of flora with a brief description of each species of plant. As the result of analysis of the meadow flora, we identified 247 species of vascular plants. The taxonomic analysis showed that the flora refers to arctic-boreal East Asian *Cyperacea* type. The dominant elements of this flora, based on the arealogical analysis, are Euro-Western Asian, Eurasian and Holarctic geographical elements. According to the ecobiomorphic analysis, the main species composition of flora is represented by perennial herbs, mainly summergreen hemicryptophytes, and to a lesser extent cryptophytes, mainly long-rooted, tap-rooted, short-rooted, and loose-bunched. Ecological analysis of the flora revealed the overwhelming predominance of light-loving plants in the meadow herbage. Megatrophic and mesotrophic plant species were the most numerous, which indicates the prevalence of rich enough soil in the territory of the floodplain meadows. In relation to soil humidification, mesophytic and to a lesser extent hygrophytic floral components were abundant, which indicates a sufficiently high level of soil humidification in the studied meadows.

Keywords: Flora, meadows, floodplain, the Ashit River, the Republic of Tatarstan.

INTRODUCTION

Floodplain meadows in the territory of the Middle Volga region have been actively used as a source of high-quality and cheap fodder for livestock. The meadows have also attracted attention as an interesting object of ecological studies, but active research started only in the middle of the 20th century. However, already in 1955-1957, most of the meadows in the flood plains of the Volga and Kama Rivers were flooded with waters from the Kuibyshev water reservoir, and in 1979, with waters of the Nizhnekamsk water reservoir. From one of the best European floodplain meadows (in terms of hay harvest and species diversity), only small areas remained near the city of Yelabuga in the territory of Tatarstan.

After losing meadows in the floodplains of major rivers, the value of meadows in the floodplains of small rivers has increased, but they have been studied least of all. The Ashit River floodplain meadows, not yet subjected to serious studies, have their own characteristics and require special approaches in terms of agricultural usage. This explains the importance of studying the flora of the floodplain meadows of the Ashit River. Therefore, the objective of this work was to perform a comprehensive analysis of the meadows flora in the floodplain of the River Ashit.

THE REGION UNDER INVESTIGATION AND RESEARCH METHODS

The object of study was the flora of the meadows in the floodplain of the River Ashit. The Ashit River (Fig. 1) rises in Pre-Kama region at 56°17'54"N and 49°49'7"E of the Republic of Tatarstan and flows into the Ilet River at 56°11'58"N and 48°57'31"E. The length of the Ashit River bed is 82.8 km, the water catchment area takes 1087.0 km². The riverbed is tortuous, the prevailing river width is 10-20 m, and mean annual water flow at the mouth of the Ashit River is 5.3 m³/s.

The river has a two-sided floodplain, the riverhead width reaches tens of meters and downstream, the width is up to 1.5 km. The floodplain area is 67 km², about 30% of the floodplain is covered with trees and shrubs, and 70% is covered with meadows. The Ashit River has 23 tributaries [1].

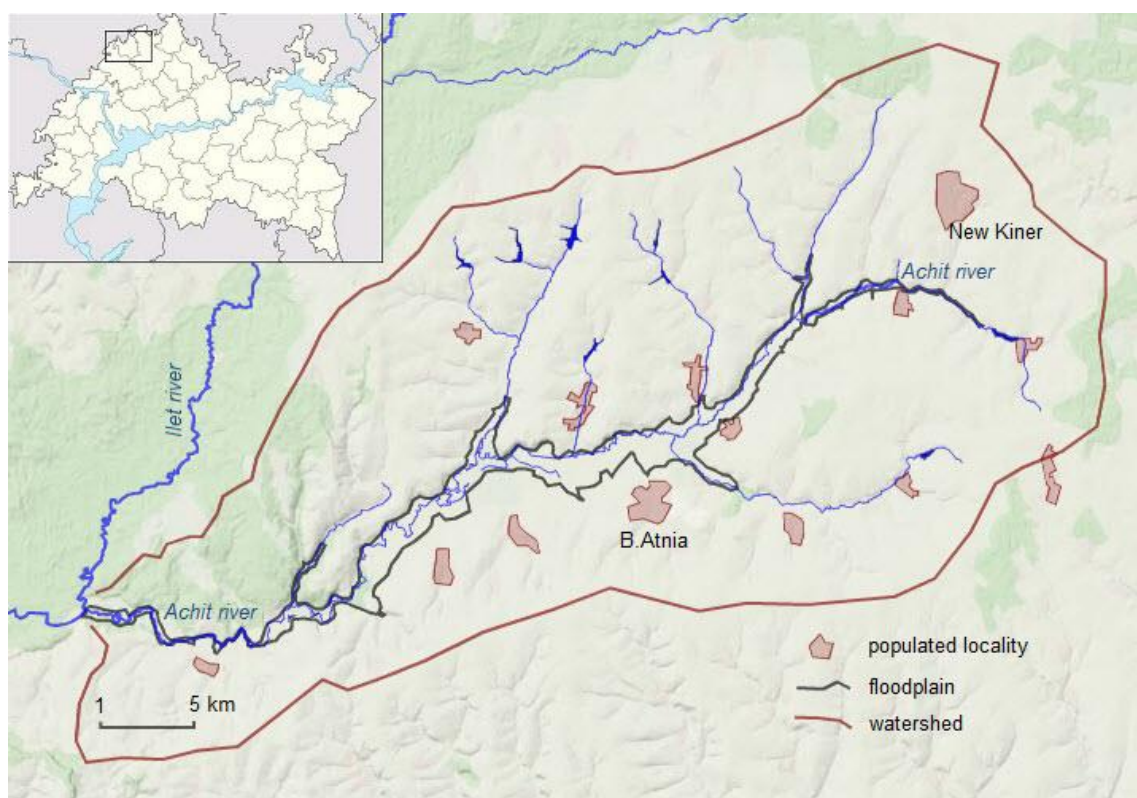


Fig. 1. The Asit River, its floodplain and catchment area.

During the period of 2012-2015, we surveyed the flora of the meadows in the floodplain of the Ashit River in the entire floodplain territory, collected a large herbarium, determined the plants and completely identified all species of the flora. We conducted a comprehensive analysis of the flora: taxonomic, arealogical, ecobiomorphic, and ecological.

Latin names of the plants are given based on summary by S.K. Cherepanov [2].

RESULTS OF THE STUDY AND DISCUSSION

Flora is a historically developed complex of plant species in a particular area. As a rule, the florists study the flora of sufficiently large areas in certain physical and geographical boundaries, within which the local floras can be distinguished [3]. The flora of the entire array of the meadows in the floodplain of the Ashit River is the local flora, limited by natural physical and geographical boundaries and existing in a typical floodplain environment.

The flora of the meadows in the floodplain of the Ashit River includes 247 vascular plant species belonging to 149 genera and 43 families, which is 15.23% of the total flora of vascular plants of Tatarstan (1610 vascular plant species, according to the data collected in 2000) [4]. The dominant role in the flora of the floodplain meadows of the Ashit River belongs to angiosperms (*Magnoliophyta*) - 243 species, most of which are dicotyledons (*Magnoliopsida*) - 193 species. Monocotyledons (*Liliopsida*) are represented by 50 species, and horsetails (*Equisetophyta*) by 4 species.

An important role in assessing the similarity and difference between floras belongs to the first triad of floral families in terms of the number of species, defining the "type" of flora, and the supporting role belongs to the second triad, determining the "subtype" of flora [5, 6]. Table 1 contains a list of families represented in the flora of the floodplain meadows of the Ashit River. The three largest families in terms of the number of species are *Asteraceae* (16.0%), *Poaceae* (10.1%), and *Cyperaceae* (7.1%) (Table 1).

Table 1. Families represented in the flora of the floodplain meadows of the Ashit River.

	Family	Number of species		Number of genera
		abs.	%	
1	<i>Asteraceae</i>	41	16.6	27
2	<i>Poaceae</i>	26	10.5	14
3	<i>Cyperaceae</i>	18	7.3	3
4	<i>Fabaceae</i>	16	6.5	7
5	<i>Lamiaceae</i>	12	4.9	10
6	<i>Rosaceae</i>	12	4.9	7
7-8	<i>Scrophulariaceae</i>	11	4.5	6
7-8	<i>Apiaceae</i>	11	4.5	9
9-10	<i>Brassicaceae</i>	10	4.0	9
9-10	<i>Ranunculaceae</i>	10	4.0	4
Total in first 10 families		167	68.0	96
11-12	<i>Polygonaceae</i>	9	3.6	4
11-12	<i>Caryophyllaceae</i>	9	3.6	9
13-14	<i>Boraginaceae</i>	5	2.0	4

13-14	<i>Rubiaceae</i>	5	2.0	1
15-17	<i>Equisetaceae</i>	4	1.6	4
15-17	<i>Onagraceae</i>	4	1.6	3
15-17	<i>Juncaceae</i>	4	1.6	1
18-22	<i>Primulaceae</i>	3	1.2	2
18-22	<i>Salicaceae</i>	3	1.2	1
18-22	<i>Violaceae</i>	3	1.2	1
Total in first 20 families		216	87.4	126
Others:		31	12.6	23
Total		247	100	149

By the first tirade of the range of families, the flora of vascular plants of floodplain meadows of the Ashit River corresponds to the flora of Tatarstan and Ulyanovsk region [4]. In terms of the leading families, the flora of the floodplain meadows of the Ashit River refers to arctic-boreal East Asian *Cyperaceae* type. The family *Cyperaceae* is the third largest in terms of the number of species, which indicates the predominance of floodplain soils with high humidification level. The presence of *Fabaceae* and *Cyperaceae* among the leading families suggests a relatively wide variety of conditions [4].

The leading genera in terms of the number of species are *Carex* (16 species), *Poa* and *Ranunculus* (each of 6 types), as well as *Veronica*, *Rumex*, *Galium*, and *Agrostis* (each of 5 species). The rest of the genera have four or less species each. Nearly two-thirds (99) of the genera of the flora of floodplain meadows of the Ashit River are monotypic and include 40.5% of the flora species.

In the meadows, we found three species of plants that are included in the Red Book of the Republic of Tatarstan [7]: *Parnassia palustris* (Status: Category 3 (Vu), Rare species), *Cirsium palustre* (Status: Category 2 (En), Population-reducing species), and *Dactylorhiza incarnata* (Status: Category 3 (Vu), Rare species).

Areological analysis of the flora of floodplain meadows of the Ashit River (Table 2) shows that the dominant geographical elements of the flora are Euro-West Asian (31.2%), Euro-Asian (19.8%) and Holarctic (15.4%) elements. This ratio of geographical elements of the flora is typical for the entire flora of Tatarstan [4].

No endemic species were found in the flora of the floodplain meadows of the Ashit River. The number of invasive species in the flora is small, their share is only 4.5%, indicating a relatively low anthropogenic transformation of flora. Invasive species are *Veronica agrestis*, *Xanthium strumarium*, *Acer negundo*, *Medicago sativa*, *Conyza canadensis*, *Oenothera biennis*, *Lepidotheca suaveolens*, *Bunias orientalis*, *Onopordum acanthium*, *Echinocystis lobata*, *Vicia villosa*, *Heracleum sosnowskyi*, and *Xanthium albinum*.

Table 2. Areological composition of flora of the floodplain meadows of the Ashit River.

Geographical floraelements	Number of species	
	abs.	%
Euro-West-Asian	77	31.2
Eurasian	49	19.8
Holarctic	36	14.9
Invasive	13	5
Euro-West-Siberian	10	4.0
Hemicosmopolitan	9	3.6
European	8	3.2
Euro-South-West-Asian	8	3.2

Unknown	4	1.6
American-Euro-West-Asian	6	2.4
Euro-Siberian	5	2.0
Euro-Siberian-South-West-Asian	4	1.6
Circumboreal	3	1.2
East-European-West-Asian	3	1.2
American-European	2	0.8
Euro-Siberian-West-Asian	2	0.8
East-European	1	0.4
East-European-South-West-Asian	1	0.4
American-Euro-South-West-Asian	1	0.4
North-East-European-West-Siberian	1	0.4
Euro-South-Siberian	1	0.4
Euro-Siberian-Central-Asian	1	0.4
Euro-Siberian-East-Asian	1	0.4
American-Euro-South-Siberian	1	0.4
Numberofspecies	247	100

A life form of plants (ecobiomorph) is highly important for the assessment of the environmental status of the species. Table 3 shows a number-based range of species of basic life forms of plants by I.G. Serebryakov (1962, 1964) in the flora of the floodplain meadows of the Ashit River.

Table 3. A range of basic life forms (ecobiomorph) of vascular plants based on number of species in the flora of the floodplain meadows of the Ashit River.

Biomorphs	Numberofspecies	
	abs.	%
Treeandshrubplants	5	2.0
Herbaceousplants:	242	98.0
Annuals	43	17.5
Short-livedperennials	9	2.8
Perennials:	190	76.8
Tap-rooted	36	30.0
Cluster-rooted	10	4.1
Short-rooted	32	13.0
Long-rooted:	55	22.0
firm-bunch	5	2.0
loose-bunch	18	7.3
Earth-creeping	11	4.4
Soboliferous	10	4.1
Tuberous	6	2.4
Bulbous	1	0.4
Herblikeclimbers	2	0.8
Semiparasites	4	1.6
Total	247	100

We may note a completely natural dominance of herbaceous plants. Despite that here we consider the meadow flora, the latter contains also wood moisture-loving plants in the form of annual shoots, the species of the genus *Salix*, *Acer negundo*. Among herbaceous plants, 76% of species are represented by

perennial polycarpic plants. Most common among them are long-rooted plants (22%), including the basis of hay meadows, the long-rooted graminoids. Tap-rooted perennials (14.6%) are the main plants of pasture meadows. There is also a significant number of short-rooted plants. Annuals and short-lived perennials count for 21% of flora of the floodplain meadows, while about half of them is ruderal species (46%) and a quarter of annuals is represented by adventitious species (27%).

In terms of assessment of adaptation of different plant species to adverse climatic and weather conditions during the year, and the safety of the renewing buds of perennials, the system of life forms by Raunkiaer C. is the most convincing [10]. Figure 2 shows a number-based range of species of basic life forms of plants by Raunkiaer C. in the flora of the floodplain meadows of the Ashit River. Hemicryptophytes and cryptophytes represent 63.6% and 9.3%, respectively, of the species composition of the flora in the range of life forms in the meadows, which is characteristic for floodplain meadow communities. About 17% are therophytes, which indicates the presence of areas of disturbed vegetation, whether it be molehills, ant hills, roads, or trampled down areas of vegetation. Adventitious species account for 27% of therophytes. There are also phanerophytes (2%) *Salix triandra*, *Acer negundo*, etc., in the form of seedlings or one-biennial shoots, not yet cut with a mower or eaten by cattle in case of pasture meadows.

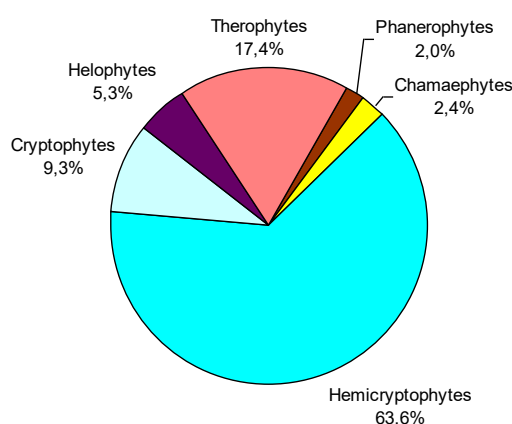


Fig. 2. A number-based range of species of basic life forms of plants in the floodplain meadows of the Ashit River.

Considering the ratio of biomorphs of vascular plants by vegetation nature in the composition of the flora of the floodplain meadows of the Ashit River (Table 4), we have found that the flora of the floodplain meadows in the Ashit River is actually divided into two major groups of species by vegetation nature. The most numerous group of species, 68%, is summergreen plants. They include the most feed-valuable meadow herbs, such as *Bromopsis inermis*, *Elytrigiarrepens*, etc. The second largest group (29%) of species is winter-summergreen plants. There are many valuable fodder plants among them, e.g. *Poa angustifolia*, *P. pratensis*, *Dactylis glomerata*, *Phleum pratense*, *Festuca pratensis*, etc. They also include many species of plants presented in the pastures, such as *Poa angustifolia*, *P. pratensis*, *Achillea millefolium*, etc. The remaining groups of species are less represented, for example, ephemeroids are only two species *Draba nemorosa* and *Ficari averna*.

Table 4. Biomorphs of vascular plants by vegetation nature in the flora of the floodplain meadows of the Ashit River.

Biomorphs	Number of species	
	abs.	%
Summergreen	170	68.3
Summer-wintergreen	73	29.7
Autumn-winter-summergreen	1	0.5
Summergreen or autumn-winter-early-summergreen	1	0.5
Ephemers and ephemeroids	2	1.0
Total	247	100

To assess the ecology of various species of flora, we used ecological scales [11-15]. The conducted analysis considered three parameters: relation of species to the light conditions, the richness of soil, and soil humidification.

Considering the flora of the floodplain meadows of the Ashit River in terms of species relation to the light factor, the plants of open, well-lit spaces rank first. Heliophytes account for 84.6% of the species of flora (Table 5). The next are sciophytes (8.9), being significantly behind in number of species. Heliosciophytes and sciophytes account for 3.7% and 2.8%, respectively. Sciophytes and sciophytes in the floodplain meadows of the Ashit River are forest or marginal plants that have entrenched in a meadow.

Table 5. Range of ecological group of vascular plants in relation to light factor in the flora of the floodplain meadows of the Ashit River.

Ecological group	Number of species	
	abs.	%
Heliophyte	209	84.6
Heliosciophyte	9	3.7
Sciophyte	22	8.9
Sciophyte	7	2.8
Total	247	100

In relation to the soil richness, there are three groups of species (Table 6). The most numerous group is mesotrophic plants (54.5%). However, a megatrophic group is also rather large (41.8%). This indicates the presence of rich soil in the territory of the floodplain meadows. There are also halomegatrophs among megatrophic plants. Oligotrophs take a small part in the flora (3.7%), but their presence indicates a high diversity of conditions within the floodplain meadows.

Table 6. Range of ecological group of vascular plants in relation to soil richness in the flora of the floodplain meadows of the Ashit River.

Ecological group	Number of species	
	abs.	%
Megatroph	101	41.8
-halomegatroph	2	1
Mesotroph	135	54.5
Oligotroph	9	3.7
Total	247	100

Table 7. Range of ecological group of vascular plants in relation to soil humidification in the flora of the floodplain meadows of the Ashit River.

Component	Ecological group	Number of species	
		abs.	%
Hygro-	Hygrophyte	40	16.5
	Mesohygrophyte	23	9.5
Mezo-	Hygromesophyte	13	5.1
	Mesophyte	116	47
	Xeromesophyte	32	13.1
Xero-	Mesoxerophyte	13	5.1
	Xerophyte	9	3.7
	Total	247	100

In relation to soil humidification (Table 7), the mesophytic component accounts for 65.2% of the flora. At the same time, more than a quarter of species (26%) is represented by hygrophytic component, which implies the sufficient soil humidification of the studied meadows, and the close occurrence and discharge of ground water. Moreover, most of the floodplain area is occupied by marshes. The presence of xerophytic

component (8.8%) indicates a variety of conditions, the floodplain has sand ridges and drained areas, where the species *Nonea rossica*, *Echinops ruthenicus*, *Artemisia absinthium*, and *A. marschalliana* are common.

CONCLUSION

The flora of the floodplain meadows of the Ashit River is represented by 247 species of vascular plants, and refers to arctic-boreal East Asian *Cyperacea* type in terms of the leading families. The dominant geographical elements of this flora are Euro-Western Asian, Eurasian and Holarctic. The meadow herbage is commonly represented by perennial grasses, mostly light-loving summergreen hemicryptophytes. The most numerous are megatrophic and mesotrophic plant species, indicating sufficiently rich soil in the territory of the floodplain meadows. In relation to soil humidification, mesophytic and to a lesser extent hygrophytic floral components constitute large parts of the flora, which indicates a sufficiently high level of soil humidification in the studied meadows.

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