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**PRACÍ PŘÍRODOVĚDECKÉ FAKULTY OSTRAVSKÉ UNIVERZITY**

# **ENVIRONMENTAL CHANGES AND BIOLOGICAL ASSESSMENT IV**

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## Influence of an alien element on taxonomic composition of steppe and forest-steppe flora in Altai region (Russia)

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**Abstract:** In this paper the alien element influence on taxonomic composition of steppe and forest-steppe flora of Altai Region (Russia) is considered. The Barnaulka river basin is taken as a case study. The study made it apparent that the enrichment of steppe and forest-steppe flora by alien species results not only in the increase of total number of species, genera and families, but also in the change of relationship among them.

**Key words:** alien element, taxonomic composition, elementary regional flora, anthropogenic influence, anthropogenically transformed flora.

### Introduction

In 1995–2007, the flora of higher vascular plants in the Barnaulka river basin (Zolotov, Silantyeva 2000; Zolotov 2001, 2002, 2005) located on the Priobskoye plateau, Altai Region (167996 km<sup>2</sup>) was studied. The modern Barnaulka river basin occupies the area of 5720 km<sup>2</sup> and stretches for about 240 km from the south-west to the north-east. The basin appeared in Holocene at the terraced channel of an ancient flow, its most intensive formation fell on Pleistocene. Steppe and forest-steppe vegetation predominates on erosive terraces, while pine forests - on the bottom of the ancient flow channel. Such a diversity of landscapes and vegetation is representative for Altai plains and the site under study making the Barnaulka river basin suitable for studying flora composition and anthropogenic influence as well as for working out measures on natural flora conservation.

### Methods

To study the flora of Barnaulka river basin and differential species (Yurtsev 1983) distribution for revealing the elementary regional or specific floras as basic units of floristic regionalization, i.e. division into districts (Yurtsev 1987), the floristic method for studying total territorial aggregate of plant species from the whole spectrum of ecotopes present nearby the specific geographical point (Yurtsev 1975) was used. Owing to this method, five elementary regional floras that geographically correspond to 5 floristic districts were revealed, i.e. F1-F5 (table 1). Floristic districts of the Barnaulka river basin alternate from the south-west to the north-east; as this takes place, a number of forest ones increases, while steppe species (note: the both were partially used as differential species for setting the floristic borders) decreases. It is common knowledge that due to the anthropogenic pressure, flora could be enriched by alien plant species. The investigation by Silantyeva (2006) served as a basis for this study. Silantyeva (2006) specifies 1886 native and 300 alien species (archaeophytes and neophytes) of higher vascular plants found in Altai Region; of 2186 species, alien plants make up 13.7 %. For division of flora into the native species and alien ones, Silantyeva (2006) used practically all available floristic, geobotanical and paleobotanical data on Altai Region. In this paper, the data obtained by Silantyeva were compared with the ones received in the Barnaulka river basin.

Tab. 1: Zonal and area characteristics of the floristic districts in the Barnaulka river basin

Florae	BB				
	F1	F2	F3	F4	F5
Zone	Steppe		Forest-steppe		
Subzone	Droughty steppe	Temperate-droughty steppe	Southern forest-steppe		
Area, km <sup>2</sup>	1704	1145	834	967	1070

## Results

According to our data, the native flora of the Barnaulka river basin (BB) numbers 853 species from 372 genera and 99 families (table 2).

Tab. 2: Basic taxonomic parameters of the native flora of the Barnaulka river basin

Florae	Number			Average number		
	species	genera	families	species in family	genera in family	species in genus
BB:	853	372	99	8.6	3.8	2.3
F1	552	279	77	7.2	3.6	2.0
F2	543	272	80	6.8	3.4	2.0
F3	508	266	76	6.7	3.5	1.9
F4	542	288	77	7.0	3.7	1.9
F5	717	339	93	7.7	3.6	2.1

The alien element of the Barnaulka river basin flora numbers 128 species from 92 genera and 36 families (table 3).

Tab. 3: Basic taxonomic parameters of the alien element in flora of the Barnaulka river basin

Florae	Number			Average number		
	species	genera	families	species in family	genera in family	species in genus
BB:	128	92	36	3.5	2.5	1.4
F1	42	39	19	2.2	2.0	1.1
F2	23	22	12	1.9	1.8	1.0
F3	29	28	12	2.4	2.3	1.0
F4	32	31	17	1.9	1.8	1.0
F5	120	89	34	3.5	2.6	1.3

The check-list of alien species in the flora of the Barnaulka river basin is the following:  
**Ranunculaceae:** *Leptopyrum fumarioides* (L.) Rchb.; **Fumariaceae:** *Fumaria schleicheri* Soy.-Will.;  
**Portulacaceae:** *Portulaca oleracea* L.; **Caryophyllaceae:** *Agrostemma githago* L., *Psammophilella muralis* (L.) Ikonn., *Saponaria officinalis* L., *Silene dichotoma* Ehrh., *Stellaria media* (L.) Vill.; **Amaranthaceae:** *Amaranthus albus* L., *A. blitoides* S.Watson, *A. cruentus* L., *A. lividus* L.; **Chenopodiaceae:** *Atriplex hortensis* L., *A. patula* L., *A. sagittata* Borkh., *Chenopodium botrys* L., *Ch. novopokrovskianum* (Aellen) Uotila, *Ch. suecicum* J.Murr., *Ch. urbicum* L.; **Polygonaceae:** *Fagopyrum esculentum* Moench, *Fallopia convolvulus* (L.) A.Löve, *Polygonum aviculare* L., *P. propinquum* Ledeb.; **Violaceae:** *Viola arvensis* Murr., *V. tricolor* L., *V. × wittrokiana* Gams ex Hegi; **Salicaceae:** *Salix ledebouriana* Trautv.; **Cucurbitaceae:** *Echinocystis lobata* (Michx.) Torr. et A.Gray; **Brassicaceae:** *Brassica campestris* L., *B. juncea* (L.) Czern., *B. napus* L., *Capsella bursa-pastoris* (L.) Medik., *C. orientalis* Klok., *Erucastrum armoracoides* (Czern. ex Turcz.) Cruchet, *Lepidium ruderalis* L., *L. sativum* L., *Neslia paniculata* (L.) Desv., *Raphanus raphanistrum* L., *Rorippa sylvestris* (L.) Besser, *Sinapis arvensis* L., *Sisymbrium heteromallum* C.A.Mey., *S. loeselii* L., *S. officinale* (L.) Scop., *S. wolgense* M.Bieb. ex E.Fourn., *Thlaspi arvense* L.; **Malvaceae:** *Malva mauritiana* L., *M. mohileviensis* Downar; **Ulmaceae:** *Ulmus laevis* Pall.; **Cannabaceae:** *Cannabis sativa* L.; **Urticaceae:** *Urtica urens* L., **Grossulariaceae:** *Ribes aureum* Pursh; **Rosaceae:** *Fragaria moschata* Duch., *F. virginiana* Duch., *Malus baccata* (L.) Borkh., *Potentilla norvegica* L.; **Onagraceae:** *Epilobium adenocaulon* Hausskn.; *Oenothera biennis* L., *O. rubricaulis* Klebahn, *O. villosa* Thunb.; **Fabaceae:** *Lupinus polyphyllus* Lindl., *Pisum sativum* L., *Trifolium arvense* L., *T. hybridum* L., *Vicia angustifolia* L., *V. sativa* L.; **Aceraceae:** *Acer negundo* L.; **Linaceae** Gray: *Linum usitatissimum* L.; **Elaeagnaceae:** *Elaeagnus angustifolia* L.; **Apiaceae** Lindl.: *Anethum graveolens* L., *Conium maculatum* L.; **Valerianaceae:** *Valeriana officinalis* L.; **Rubiaceae:** *Galium mollugo* L., *G. vaillantii* DC.; **Solanaceae:** *Datura stramonium* L., *Hyoscyamus niger* L., *Nicandra physaloides* (L.) Gaertn., *Physalis alkekengi* L., *Solanum nigrum* L.; **Cuscutaceae:** *Cuscuta epilinum* Weihe; **Hydrophyllaceae:** *Phacelia tanacetifolia* Benth.; **Boraginaceae:** *Borago officinalis* L., *Buglossoides arvensis* (L.) Johnst., *Echium vulgare* L., *Symphytum officinale* L.; **Scrophulariaceae:** *Veronica verna* L.; **Plantaginaceae:** *Plantago lanceolata* L.;

**Lamiaceae:** *Elsholtzia ciliata* (Thunb.) Hyl.; **Campanulaceae:** *Campanula rapunculoides* L.; **Asteraceae:** *Ambrosia artemisifolia* L., *Arctium minus* Bernh., *Artemisia annua* L., *Centaurea apiculata* Ledeb., *C. cyanus* L., *C. diffusa* Lam., *C. jacea* L., *C. pseudomaculosa* Dobrocz., *Chamomilla recutita* (L.) Rauschert, *Ch. suaveolens* (Pursh) Rydb., *Cichorium intybus* L., *Cyclachaena xanthifolia* (Nutt.) Fres., *Erigeron canadensis* L., *Galinsoga parviflora* Cav., *Helianthus annuus* L., *H. tuberosus* L., *Helminthotheca echioides* (L.) Holub, *Lapsana communis* L., *Matricaria perforata* Mérat, *Pilosella aurantica* (L.) F.W.Schultz et Sch.Bip., *Senecio vulgaris* L., *Solidago canadensis* L., *Sonchus oleraceus* L., *Tragopogon dubius* Scop., *Xanthium strumarium* L.; **Commelinaceae:** *Commelina communis* L.; **Poaceae:** *Avena fatua* L., *A. sativa* L., *Bromus squarrosus* L., *Echinochloa crusgalli* (L.) P.Beauv., *Eragrostis pilosa* (L.) P.Beauv., *Hordeum jubatum* L., *H. murinum* L. s.l., *Panicum miliaceum* L. s.str., *P. miliaceum* L. subsp. *ruderalis* (Kitag.) Tzvelev, *Setaria pumila* (Poir.) Schult., *S. viridis* (L.) P.Beauv. s.str., *S. viridis* (L.) P.Beauv. subsp. *glareosa* (Petrov) Peschkova, *Triticum aestivum* L., *Zizania aquatica* L. subsp. *angustifolia* (Hitc.) Tzvelev.

Thus, the alien element in the total flora composition makes up 13.0 %, 12.7 % of its generic composition and 6.6 % of family composition. It should be noted that 7 families (**Portulacaceae**, **Cucurbitaceae**, **Ulmaceae**, **Aceraceae**, **Linaceae**, **Hydrophyllaceae**, **Commelinaceae**) and 54 genera are presented solely by alien species, namely: *Leptopyrum* Rchb., *Fumaria* L., *Portulaca* L., *Agrostemma* L., *Psammophiliella* Ikonn., *Saponaria* L., *Echinocystis* Torr. et A.Gray, *Brassica* L., *Capsella* Medik., *Erucastrum* (DC.) C.Presl., *Neslia* Desv., *Raphanus* L., *Sinapis* L., *Thlaspi* L., *Ulmus* L., *Cannabis* L., *Malus* Mill., *Oenothera* L., *Lupinus* L., *Pisum* L., *Acer* L., *Linum* L., *Elaeagnus* L., *Anethum* L., *Conium* L., *Datura* L., *Hyoscyamus* L., *Nicandra* Adans., *Physalis* L., *Phacelia* Juss., *Borago* L., *Buglossoides* Moench, *Echium* L., *Symphytum* L., *Elsholtzia* Willd., *Cichorium* L., *Helminthotheca* Vaill. ex Zinn, *Lapsana* L., *Ambrosia* L., *Chamomilla* Gray, *Cyclachaena* Fres. ex Schldl., *Galinsoga* Ruiz et Pav., *Helianthus* L., *Matricaria* L., *Xanthium* L., *Commelina* L., *Avena* L., *Bromus* L., *Echinochloa* P.Beauv., *Eragrostis* Wolf, *Panicum* L., *Setaria* P.Beauv., *Triticum* L., *Zizania* L.

In elementary regional floras of the Barnaulka river basin the portion of alien plants in number of species varies from 4.1 % to 14.3 % depending on the size of traffic centers (settlements) located within the corresponding floristic districts.

The anthropogenically influenced flora in the Barnaulka river basin unites 981 native and alien species of higher vascular plants from 426 genera and 106 families (table 4). When compared to the native flora, the anthropogenically influenced flora shows the disturbance in basic relationships among the parameters of taxonomic richness: numbers of species, genera and families.

Tab. 4: Basic taxonomic parameters of the anthropogenically influenced flora in the Barnaulka river basin

Flora	Number			Average number		
	species	genera	families	species in family	genera in family	species in genus
BB:	981	426	106	9.2	4.0	2.3
F1	594	300	80	7.4	3.7	2.0
F2	566	288	83	6.8	3.5	2.0
F3	537	283	77	7.0	3.7	1.9
F4	574	308	80	7.2	3.8	1.9
F5	837	392	99	8.4	4.0	2.1

Hence, the average number of species in a genus remains constant because the occurrence of new alien species is compensated by the occurrence of new alien genera. The spectrum of 9 genera leading in abundance of the alien element in flora of the Barnaulka river basin is as follows: *Centaurea* – 5, *Chenopodium* – 4, *Amaranthus* – 4, *Sisymbrium* – 4, *Atriplex* – 3, *Viola* – 3, *Brassica* – 3, *Oenothera* – 3, *Setaria* – 3. The share of 10 largest genera of the alien element spectrum includes 34 species or 26.6 % of alien species quantity in the flora of the Barnaulka river basin.

The average number of species in a family increases dramatically from 8.6 in the native flora up to 9.2 in the anthropogenically influenced one. This is because the alien species belong mainly to leading families of native flora. The spectrum of 13 families leading

in specific abundance of the alien element of the basin flora appears as follows: **Asteraceae** – 25, **Brassicaceae** – 17, **Poaceae** – 14, **Chenopodiaceae** – 7, **Fabaceae** – 6, **Solanaceae** – 5, **Caryophyllaceae** – 5, **Amaranthaceae** – 4, **Polygonaceae** – 4, **Rosaceae** – 4, **Onagraceae** – 4, **Boraginaceae** – 4, **Violaceae** – 3. It is necessary to note that 10 largest families of the spectrum unite 91 species or 71.1 % of species quantity of the BB flora alien element.

The average number of genera in the family demonstrates less growth: from 3.8 in the native flora up to 4.0 in the anthropogenically influenced one. This parameter varies because alien species exceed alien families in number essentially. The spectrum of families leading in generic abundance of the alien element in the flora of the Barnaulka river basin looks as follows: **Asteraceae** – 19, **Brassicaceae** – 10, **Poaceae** – 9, **Caryophyllaceae** – 5, **Solanaceae** – 5, **Fabaceae** – 4, **Boraginaceae** – 4, **Polygonaceae** – 3, **Rosaceae** – 3, **Apiaceae** – 2, **Chenopodiaceae** – 2, **Onagraceae** – 2. The share of 10 largest families of the spectrum includes 64 genera or 69.6 % of genera quantity of the alien element in the flora of the Barnaulka river basin.

## Conclusion

In conclusion it is necessary to emphasize that while studying anthropogenically influenced flora it is extremely important to divide the set of species into native and alien ones. The native flora composition reflects the history of its natural formation, zonal position and landscape features of the territory. The alien element composition and anthropogenically influenced flora shows the role of human activity in flora formation, the degree and character of this influence. Such a differential approach to the analysis allows us to gain a more penetrating insight into flora genesis, its relationship with the landscape structure of the territory and processes of anthropogenic impact. Besides, it promotes the development of floristic division into districts and the strategy of native flora preservation.

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