About some features of steppe communities of the Amalat river basin (Northern Transbaikalia)

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Abstract. The Vitim upland, in the central part of which the Amalat River basin is located, is still one of the least studied floristically areas of Northern Transbaikalia. The flora of the steppe areas (uburs) in this territory still remains unexplored. The study of the flora by the method of specific floras and the identification of diagnostic groups of species in the analysis of geobotanical descriptions using the IBIS program made it possible to identify the features of the steppe communities of the Amalat River basin. It has been established that in the studied territory the uburs are small fragments of steppes (up to 5 hectares) on steep (15–35 °) slopes of southern exposures; the largest area is occupied by steppe communities on the left bank of the river. Quite peculiar steppe communities have been found on carbonates in the upper reaches of the Klyuch Berezovyi, Bagdarinka, Khoigot and other rivers. The flora of the studied steppes is represented by 47 families, 104 genera, and 177 species. An analysis of its arealogical structure showed that boreal species form the basis of the flora of the studied steppe communities, and the combination of species with the South Siberian, North Asian, and Manchurian-Daurian ranges determines its originality. The study of the belt-zonal structure showed a natural predominance of species of the steppe floristic complex (57%), the overwhelming majority of which are mountain-steppe and forest-steppe species; the proportion of steppe species proper is insignificant (9%). The ecological-biomorphological structure is characterized by the prevalence of perennials.

1. Introduction

The uburs are an original element of extrazonal vegetation in Transbaikalia. They represent an original landscape complex of the warmed southern slopes of the mountains [1]. The diversity of local and scientific names of this complex is historically conditioned - these are «uburo» (from the Buryat words "uber", "ubur", "uvur" - "south", "before", "southern slope"), elakans (meadow-steppe areas in the form of islands in the forest), sun scorch [2], sites mountain exposition forest-steppe [1] or steppe [3]. In addition to quantitative indicators of heat and moisture, the reason for the appearance of island steppes in the study area is the altitude (on average 700 m), mountainous broken rock, the presence of a permafrost zone. Steppe cenoses appear on steep mountain slopes (25–40°) of low mountain ridges, with a large number of outcrops and outcrops of bedrock rocks (granites, shales, dolomite limestones, basalts, etc.). Within the framework of this work, the task was to identify the features of steppe cenoses on the basis of a systematic and ecological-geographical analysis of the flora of fragmentary steppes (uburs) in the Amalat River basin.
The studies were carried out in the central part of the Vitim upland in the basins of the Great and Little Amalat rivers (from 53° 40' to 54° 40' N and from 112° 30' to 114° 30' E) (figure 1). The conformation is characterized by alternation of relatively low flat-topped ridges-ridges (1200-1600 metres above sea level) and intermontane basins (750-1100 metres above sea level). This is the territory dominated by daurian-larch forests from *Larix dahurica* Lawson., interspersed with dwarf birch meadows, boggy meadows and swamps. Sharply continental climate (average annual temperature - 6.5...-7.0°C, frost-free period from 45 to 60 days, sum of active temperatures in the range of 1050-1250°C, 300 mm of precipitation, winter with little snow and short cool summer) in combination with continuous distribution of the permafrost zone determines the presence of a special cryophyte flora and vegetation here. The soil cover is characterized raw soil, with an abundance of gravel and landwaste, a thin accumulative horizon, gritty consistency, seasonal contrast of water regime of soils, and turfness. The soils of "uburs" are close to mountain black soil (the amount of humus is 6.5-7.0%). Deep freezing of soils is characteristic [4].

![Figure 1. Quick map of the exploration area.](image)

2. Materials and Methods
The article is based on expedition materials from 2016-2020, carried out by the Department of Botany of Buryat State University. Detailed studies of the flora of the central part of the Vitim upland were carried out in the basin of the Great and Little Amalat rivers on the territory of the Bauntovsky district of the Republic of Buryatia. Herbarium material was collected, including about 1000 sheets, which was transferred to the herbarium of the Buryat State University [UUDE]. 90 descriptions were made on the basis of generally accepted methods of geobotanical research. The floristic survey of the territory was carried out by the route method, the study of the flora was carried out according to the methodology of specific floras A.I. Tolmachev [5] modified by B.A Yurtseva and R.V. Kamelina [6]. The Latin names for vascular plants are given according to the Flora of Siberia (1987-1997, 2003)[7].

3. Results and Discussion
In the studied area, "uburs" are small fragments of steppes (up to 5 hectares) on steep (15-35 °) slopes of southern exposures. The steppe areas are highly isolated (figure 2). The greatest manifestation is noted on the left bank of the Great Amalat River and its tributaries. We found unique steppe
communities on carbonates, which were noted in the upper reaches of the Berezovy, Bagdarinka, Khoigot, etc. Until now, the question of identifying such steppe islands remains controversial, since the set of species composing such areas is mostly random. In our opinion, there are certain patterns in the composition of the vegetation cover of the uburs. The vegetation of the "uburs" is mainly steppe. "Uburs" are quite clearly demarcated from the surrounding forest vegetation, nevertheless, sometimes the border between forest and steppe vegetation is gradual - individual trees and young growth enter the steppe areas and form small forest groves in the hollows. The process of the advance of forest vegetation on the steppe areas is also confirmed by studies of the soils of this region [5].

We examined the vegetation of steppe communities using the example of a key site in the Baysa area (left tributary of the Great Amalat River). The descriptions were made on July 13, 2020, mainly on the slopes of the western and southern exposure, the steepness of the slopes is from 15 to 30 degrees. The projective cover varies depending on the microrelief from 20 to 60%, the height of the vegetation is on average 20-25 cm, on steep slopes up to 10 cm, the species diversity is scarce, the communities included from 9 to 27 species (on average, 19-20 species). The grass stand of the communities is sparse, mosaic; the layering is not expressed (figure 3).

We have analyzed 14 descriptions made at a key site in the area of the river Baysa (table 1). The cenoflora of the site is 81 species, a group of species is distinguished that take an equal part in the addition of steppe vegetation, especially the species that occur constantly and with a high abundance – *Agropyron cristatum* (L.) Gaerth, *Carex pediformis* C.A. Mey, *Silene repens* Patrin, *Artemisia frigida* Willd., *Festuca hubsgulica* Krivot., , background for this key site are *Pulsatilla tenuiloba* (Turcz.) Juz., *Papaver rubro-aurantiacum* (Fisch. ex DC.) Lundstr. The selection of diagnostic groups was carried out using the IBIS program. The analysis revealed two clusters in the cenoflora, one of the reasons for their formation, probably, is the steepness of the slope, as well as the nature of the soil profile.
Thus, all descriptions of cluster 1 were carried out in the upper part of the ravine, the steepness of the slopes, on average, 30 degrees, a poorly developed soil profile is characteristic, and outcrops of carbonate rocks are noted. The core of the first cluster is formed by the specieses – Artemisia gmelini Weber ex Stechm., Bupleurum bicaule Helm, Thymus baicalensis Serg., Chamaerhodos grandiflora (Pall. ex Schult.) Bunge, Artemisia borealis Pall., Helictotrichon schellianum (Hack.) Kitag., Potentilla bifurca L., Allium senescens Thunb., Alyssum tortuosum Waldst. & Kit. ex Willd., Astragalus inopinatus Boriss., proper steppe of this group is only Chamaerhodos grandiflora, rpyyna the group of mountain steppe includes 3 species (Artemisia gmelini, Thymus baicalensis, Helictotrichon schellianum). It should also be noted that the core is heterogeneous, it contains species that are present in all descriptions, but in a low abundance, less than 1% or single. Thus, this cluster unites the richest in species diversity communities, which mainly include petrophylous species. The species of the second cluster were described mainly in the lower part of the ridge, the steepness of the slope is less than 20 degrees, the core of the group is – Potentilla tanacetifolia Willd. ex Schltl., Achnatherum confusum (Litv.) Tzvelev, Agropyron cristatum, Veronica linariifolia Pall. ex Link, Silene jenisseensis, Artemisia commutata Besser, Dendranthema zawadskii (Herbich) Tzvelev, Artemisia sericea Weber ex Stechm., Oxytropis strobilacea Bunge, Stellaria cherleriæ (Fisch. ex Ser.) F.N. Williams, Aizopsis aizoon (L.) Gruilich. This cluster is more sparse in composition, but the species participating in its composition are distinguished by a high abundance, and, in contrast to the first cluster, there are no background species. The steppe proper is also 1 species, it is Artemisia commutata, the group of mountain-steppe species is richer, includes 5 species (Veronica linariifolia, Silene jenisseensis, Dendranthema zawadskii). This cluster is notable for its poor species diversity, which is associated with the underdevelopment of the soil profile.
### Table 1. A fragment of vegetation

| Description number | z1-12 | z1-14 | z1-16 | z1-18 | z1-20 | z1-24 | z1-13 | z1-19 | z1-21 | z1-17 | z1-15 | z1-11 | z1-26 |
|--------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Altitude           | 831   | 852   | 864   | 871   | 928   | 924   | 902   | 919   | 849   | 841   | 820   |       |       |
| Angle of slope     | 30    | 30    | 30    | 30    | 20    | 20    | 23    | 23    | 25    | 20    |       |       |       |
| Saturation         | 19    | 21    | 22    | 23    | 10    | 27    | 16    | 19    | 19    | 19    | 25    | 15    |       |
| Orostachys         | +     | +     |       |       |       |       |       |       |       |       |       |       |       |
| malacophylla       | r     |       |       |       |       |       |       |       |       |       |       |       |       |
| Papaver rubro-aurantiacum |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Agropyron cristatum | 1+    | 2     | 2     |       | 2     | 1     | 1     |       |       |       |       |       |       |
| Pulsatilla tenuiloba |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Carex pediformis   | 1     | r     | +     | 2     | 2     | 1     | +     | 2     | 1     | 1     |       |       |       |
| Silene repens      | +     | 1     | +     |       | 1     | +     |       | +     | 1     |       |       |       |       |
| Artemisia frigida  | 2     | 1     | 1     | 1     | 1     |       |       |       |       |       |       |       |       |
| Festuca hubsgulica | 1     | 2     | 2     |       | 2     | 1     | 1     |       |       |       |       |       |       |
| Artemisia gmelinii |       |       |       |       |       |       |       |       |       |       |       |       | +     |
| Bupleurum bicaule  | +     | +     | +     | +     | +     |       |       |       |       |       |       |       |       |
| Thymus baikalensis |       |       |       |       |       |       |       |       |       |       |       |       | +     |
| Thalictrum minus   | r     | +     | +     |       |       |       |       |       |       |       |       |       |       |
| Helictotrichon     |       |       |       |       |       |       |       |       |       |       |       |       |       |
| schelkianum        | 2     | 2     | 2     | +     |       |       |       |       |       |       |       |       |       |
| Potentilla bifurca | 1     | 1     | 2     | 2     | 1     | 1     |       |       |       |       |       |       |       |
| Allium senescens   | +     | +     | +     | +     | 1     |       |       |       |       |       |       |       |       |
| Alyssum tortuosum  | +     | 1     | +     | +     | +     |       |       |       |       |       |       |       |       |
| Astragalus         | +     | 1     | 1     | 1     | r     | r     |       |       |       |       |       |       |       |
| inopinatus         |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Chamaerhodos       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| grandiflora        |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Artemisia borealis |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Artemisia commutata |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Potentilla         |       |       |       |       |       |       |       |       |       |       |       |       |       |
| tanacetifolia      |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Achnatherum        |       |       |       |       |       |       |       |       |       |       |       |       |       |
| confusum           |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Veronica linariifolia |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Silene jenisseensis |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Dendranthera       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| zawadskii          |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Artemisia sericea  |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Oxytropis          |       |       |       |       |       |       |       |       |       |       |       |       |       |
| strobilacea        |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Stellaria cherleriae |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Aizopsis aizoon    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Galium verum       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Equisetum sp       |       |       |       |       |       |       |       |       |       |       |       |       | 2     |

Legend: + - before 1 %, 1 – from 1-5 %, 2 – from 5-25%
The flora of "ubur" is represented by 47 families, 104 genuses and 177 species (table 2). The family spectrum includes 10 families, the total number of species of these families (117) is 66.1% of the total flora (table 2). Comparative analysis of the family spectrum of the study area with the spectrum of the entire steppe flora of Baikal Siberia [6] showed a clear similarity (data are shown in table 2). It should be noted that the leading position of the Poaceae family is provided by a high diversity of genuses (13), some of which are found only on "ubur" and are strictly confined to limestone outcrops. (Festuca hubisugulica, F. komarovi Krivot., F. rubra L.). The high positions of the families Asteraceae, Rosaceae, Fabaceae are ensured by high positions in the generic spectrum of their representatives: Artemisia (7), Potentilla u Astragalus (6), Oxytropis (4). In general, there are few multi-species genera, usually the generic spectrum includes 10 genera, but for the Amalat River basin, the spectrum of genuses was 18, 3 species each - Festuca, Poa, Carex, Allium, Betula, Silene, Dianthus, Alyssum, Pedicularis.

| №    | Family               | Number of species | Number of genuses | I | №   | genus               | Number of species |
|------|---------------------|------------------|------------------|---|-----|---------------------|------------------|
| 1    | Poaceae             | 22               | 13               | 3 | 1   | Artemisia           | 7                |
| 2    | Asteraceae          | 19               | 12               | 1 | 2-3 | Potentilla          | 6                |
| 3    | Rosaceae            | 17               | 8                | 4 | 2-3 | Astragalus          | 6                |
| 4    | Fabaceae            | 13               | 4                | 2 | 4-8 | Pulsatilla          | 4                |
| 5    | Caryophyllaceae     | 11               | 6                | - | 4-8 | Thalictrum          | 4                |
| 6    | Brassicaceae        | 10               | 8                | 6 | 4-8 | Oxytropis           | 4                |
| 7    | Ranunculaceae       | 9                | 3                | 9 | 4-8 | Viola               | 4                |
| 8    | Scrophulariaceae    | 6                | 3                | - | 4-8 | Androsace           | 4                |
| 9-10 | Cyperaceae          | 5                | 2                | - |      |                     |                  |
| 9-10 | Lamiaceae           | 5                | 3                | 7-8|      |                     |                  |
| Total|                     | 117              | 62               |   |      |                     | 39               |

Legend: I - rank of the family in the steppe flora of Baikal Siberia; II - the rank of the genus in the steppe flora of Baikal Siberia [9].

Analysis of the belt-zonal groups of the flora of the "uburs" showed the following features (table 3). Flora species are distributed over 12 types of habitats, with 35.02% being widespread in the boreal region. The location of the study area in the Asian part of Eurasia explains the dominance of the species with the South Siberian (37 species or 20.0%: Stellaria cherleriae, Silene chamaensis Terz.s.str., Astragalus kaufmannii Krylov ssp. atratus (Turcz.) Jurtzev. and etc.), North Asian (23 species – 12.0 %: Kobresia filifolia (Turcz.) C.B. Clarke, Poa botryoides (Trin. ex Griseb.) Kom., Artemisia gmelinii and etc.) and the Manchurian-Daurian range (14 species or 7.9%: Pedicularis striata Pallas, Viola dactylodes Schultes, Orostachys malacophylla (Pall.) Fisch. and etc.)

Analyzing the distribution of flora by belt-zonal groups showed a regular predominance of species of the steppe floristic complex (101 species or 57.0%). At the same time, the participation of proper steppe species is insignificant (16 species or 9.0%: Astragalus versicolor Pallas., Alyssum microphyllum (C.A. Mey.) Steud., Chamaerods grandiflora etc.), a higher proportion of forest-steppe species (34 species or 19.2%: Artemisia sericea, Hemerocallis minor Mill., Pulsatilla taurzianovii Krylov et Serg. and etc. Mountain-steppe species make up 28.8%, this is explained by the fact that the study area has an absolute height of 1200-1800 above sea level, it is on such mountain exposure areas that favorable conditions are created for mountain-steppe species (Ephedra monosperma C.A. Mey., Lilium pumilum Delile, Allium altaicum Pall., Thymus baicalensis, Patrinia rupestris (Pallas) Durf. and etc.).

Earlier, we drew attention to the fact that the proportion of participation of zonal species of the forest complex increases in the composition of steppe communities in the Amalat River basin. Thus,
there is a high participation of species of the light coniferous group (19.0% - *Artemisia tanacetifolia* L., *Zigadenus sibiricus* (L.) A. Gray, *Achnatherum confusum* and others), usually found in the forest edge, in erosional hollows, under the outcrops of outliers, etc.

**Table 3.** The ratio of species in the belt-zonal groups (BZG) and Horological groups of flora.

| BZG | Arealogical group | C | AA | Eu | ES | PA | NA | SS | CA | NA | EA | MD | En | Итого: |
|-----|-------------------|---|----|----|----|----|----|----|----|----|----|----|----|-----|
| HA  |                   | 2 | 1  | 1  | 1  | 4  | 1  | 4  | 1  | 4  | 1  | 4  | 2   | 3   |
| TH  |                   | 2 | 1  | 3  | 2  | 2  | 2  | 2  | 2  | 2  | 1  | 1  | 1   | 1   |
| MV  |                   | 1 | 4  | 2  | 2  | 2  | 2  | 2  | 2  | 2  | 2  | 2  | 2   | 2   |
| H   |                   | 3 | 3  | 3  | 4  | 4  | 4  | 4  | 5  | 5  | 5  | 1  | 1   | 3   |
| DF  |                   | 1 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1   | 3   |
| LC  |                   | 6 | 6  | 6  | 4  | 4  | 4  | 4  | 5  | 5  | 5  | 1  | 1   | 2   |
| Pb  |                   | 1 | 1  | 1  | 1  | 1  | 1  | 1  | 2  | 2  | 2  | 2  | 2   | 4   |
| FS  |                   | 3 | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3   | 16  |
| MS  |                   | 1 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1   | 1   |
| S   |                   | 3 | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3   | 1   |
| R   |                   | 1 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1   | 1   |
| M   |                   | 3 | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3   | 3   |
| Aph |                   | 2 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1   | 3   |
| Total|                  | 25| 7  | 28 | 9  | 23 | 37 | 4  | 5  | 12 | 14 | 11 | 177 |

Note: C – circumpolar, AA – American-Asian, Eu – Eurasian, PA – pan-Asian, NA – north asian, SS – South Siberian, CA – Central Asian, NA – northeast asian, EA – east asian, En – endemic, ES – Euro-Siberian, MD – Manchu-Daurian, HA – high-altitude, TH – tundra-high-altitude, MV – mountain, H – hyarctic, DF – dark coniferous forest, LC – light coniferous, Pb - preboreal, FS – forest-steppe, MS – mountain steppe, R – Riverbed, S – steppe, M– meadow, Aph - anthropophyte species.

The ecological and biomorphological structure of the uburs flora has its own characteristics due to the stony substrate, low soil moisture capacity, drying winds, high temperature ranges, which results in the natural prevalence of perennials (97.2%). Among herbaceous perennials, rhizomes (37.3% - *Veronica linariifolia*, *Thalictrum foetidum* L., *Viola dactyloides*), taproot (28% - *Astragalus versicolor Pallas, Phlojodicarpus sibiricus* (Stephan ex Spreng.) Kosoy-Plant., *Patrinia rupestris*) and turf (15.3% - *Kobresia filifolia*, *Achnatherum confusum*, *Helictotrichon schellianum*) species. The share of woody plants is small - 8.5%, mainly representatives of the light coniferous group (*Betula fruticosa* subsp. *montana* Shemberg, *Spiraea dahurica* (Rupr.) Maxim, *Cotoneaster melanocarpus* Fisch. ex Blytt и др.). Biomorphs of semi-woody plants (4.5%) are mainly represented by steppe dwarf shrubs - *Chamaerodos grandiflora*, *Alyssum microphyllum*, *Thymus baicalensis*, in carbonate areas dominated by *Dryas sumneviczii* Serg. Only one dwarf shrub is noted on the uburs *Artemisia gmelinii*.

**4. Conclusion**

In the Amalat river basin, uburs are small fragments of steppes (up to 5 hectares) on steep (15-35 °) slopes of southern exposure. The appearance of steppe vegetation in the zone of domination of the zonal cryophyte dahuks-leaved taiga is a consequence of the ultra-continentality, altitude, high degree of rockiness of substrates, temperature amplitudes, and widespread cryolithozone. The described flora is represented by 47 families, 104 genera and 177 species, of which mountain-steppe and forest-steppe species constitute a significant part. The ecological and biomorphological structure is characterized by the natural prevalence of perennials. Fragmented areas of steppe vegetation (uburs) in the conditions of taiga-permafrost landscapes of Northern Transbaikalia can be considered as relic phenomena preserved from the xerothermal interglacial epochs of the Pleistocene time [10] in the zone of dominance of light coniferous taiga.
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