Ecological and coenotic analysis of the bryoflora of the Urgut botanical-geographical region (Uzbekistan)

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Abstract: The bryoflora of the middle reaches of the Urgut botanical-geographical region consists (determined) of 78 species of bryophytes. To identify the characteristics of the distribution of bryophyte species throughout the middle reaches of the Urgut botanical-geographical region, in the course of bryological studies, the ecological and cenotic location of bryophyte species was recorded, as well as the nature of their participation in the composition of the plant world. Based on the nature and degree of soil moisture, the habitats in which bryophytes grow in the middle reaches of the Urgut botanical-geographical region were divided into 3 groups of ecotopes (*Moderately Wet Habitats, Dry, Specific*), and, in addition, a group of specific habitats was identified and considered separately.

1 Introduction

The first researchers who visited Central Asia in 1859 and collected bryological material were A. Fedchenko and O. Fedchenko. They collected more than 100 herbarium sheets of bryophytes from the vicinity of Samarkand and Penjikent.

Subsequently, mosses were collected in various regions of the Pamir-Alai and Tien Shan during the period of botanical and geographical research in 1870-1900, famous botanists A.E. Regel, V.L. Komarov, V.I. Lipsky, S.I. Korzhinsky, B.A. Fedchenko. The collections of bryophytes (more than 300 sheets) of these botanists, which significantly supplemented the collections of A. and O. Fedchenko, have been preserved and are located in the Herbarium of the Botanical Institute of V.L. Komarova Academy of Sciences of the USSR (Leningrad) (Zhalov, & Abdirasulov, 2022).

Mosses are found in all types of vegetation the middle reaches of the Urgut botanical-geographical region. Each type is dominated by certain complexes of bryophyte species and their communities. This is due to the sharp differentiation of the geographical environment, due to the history of the formation of vegetation types and the heterogeneity of flora elements.

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We present a bryological characteristic of the main types of vegetation in the middle reaches of the Urgut botanical-geographical region, indicating the degree of development of the moss cover. We consider the distribution of bryophytes according to the types of vegetation identified by P.N. Ovchinnikov /1957, 1973/ for the Tajik part of the Pamir-Alai territory.

Bryophytes play an important role in the composition of the vegetation cover of the middle reaches of the Urgut botanical-geographical region, as well as in other areas of the region. They are found in almost all cenoses and often dominate or co-dominate with the soil cover, forming both pure moss and mixed moss-lichen, grass-moss, shrub-moss communities on various relief elements [1-4].

To identify the characteristics of the distribution of bryophyte species throughout the territory of bryophytes in the middle reaches of the Urgut botanical-geographical region, during the bryological studies carried out, the ecological and cenotic occurrence of bryophyte species was recorded, as well as the nature of their participation in the composition of the plant world.

The systematization of data on the distribution of bryophytes by habitat types and the study of their role in the composition of plant communities for their ecological-coenotic assessment made it possible to build a fairly detailed diagram of the types of bryophyte habitats, presented below.

Field studies have shown that, along with many other factors influencing the distribution of bryophytes, the most important in the study region are the following: the nature and degree of soil moisture and conditions for the distribution of snow cover and air humidity. It can be assumed that these factors are no less, and perhaps more important, in arid conditions, since in such conditions the influence of snow cover redistribution and humidity increases, which undoubtedly increases the contrast of the moisture regime in different ecotopes.

2 Material and methods

According to the breadth of ecological amplitude, species of leaf-stemmed bryophytes are divided into eurytopic, hemieurytopic, hemistenotopic and stenotopic. We assessed the occurrence (constancy) of the species in ecotopes on the following scale: very rarely, rarely, sporadically, usually, often and very often. According to the degree of abundance, we divided species into 3 categories: dominants (and codominants), abundant and non-abundant [5-6].

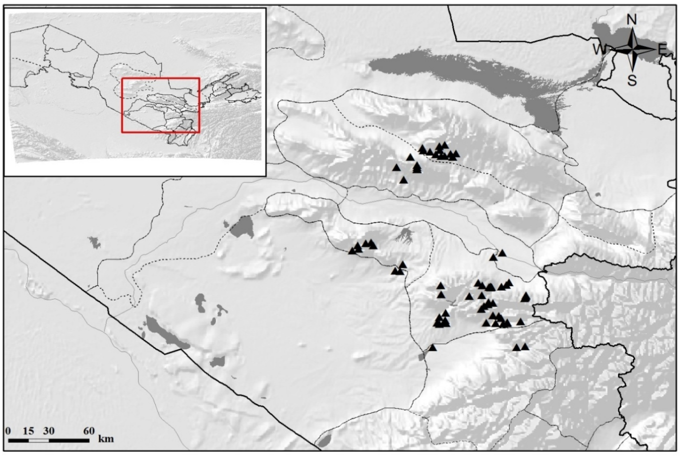

Fig.1. Study area: material collection points

To designate sets of species of a specific flora with similar ecological-coenotic areas (i.e., with a similar distribution pattern in ecological and cenotic spaces), the term "ecological-coenotic groups" was proposed (Yurtsev, Petrovsky, 1971). Identification of ecological-coenotic groups or elements is a popular way of analyzing floristic and geobotanical data (Lapshina, 2003; Zubkova, 2011; Ebel, 2011; etc.).

3 Results and discussion

Based on the nature and degree of soil moisture, the habitats in which bryophytes grow in the middle reaches of the Urgut botanical-geographical region were divided into 3 groups of ecotope types, and, in addition, a group of specific habitats was identified and considered separately. For each of these groups, a specific set of species, a specific composition of dominants, and varying degrees of participation of individual species in the composition of plant communities have been identified. Within each group, the behavior of bryophytes in individual ecotopes is examined in detail (table).

The following scheme of habitat types for bryophytes in the middle reaches of the Urgut botanical-geographical region has been developed:

1. Moderately wet habitats
1.1 Mosses of herbaceous vegetation
1.2 Mosses of tree and shrub vegetation
2. Dry habitats
2.1 Dry rocky and gravelly
2.2 Mosses of subshrub and shrub vegetation
3. Specific habitats (regardless of the nature and degree of moisture)
3.1 Stone surfaces: wet and dry.
3.2 Cracks in rocks: wet and dry.
3.3 Marshy habitats.
3.4 Reservoirs and riparian habitats.

Table 1. Distribution of bryophytes by habitat type

Habitat types	Total in the pool	Local bryofloras			
		1	**2**	**3**	**4**
1. Moderately wet habitats					
1.1 Herbaceous (mesomorphic) communities	11	7	6	3	4
1.2 Woody and shrubby	21	11	9	7	3
2. Dry habitat					
2.1 Dry rocky and gravelly	5	3	1	3	-
2.2 Shrub and subshrub thickets	10	9	7	8	2
3. Specific habitat					
3.1 Surfaces of stones	15	10	8	6	3
3.2 Cracks in the rocks	12	9	9	7	2
3.3 Marshy habitats.	9	8	6	4	-
3.4 Reservoirs and riparian habitats	7	5	3	2	-

Note. 1- Karatepa Mountains, 2- southern part of the Nurata ridge, 3- northern part of the Zarafshan ridge, 4- Zirabulak-Ziaddinsky mountains

3.1 Moderately wet habitats

Habitats with moderately moist soils are confined to depressions on slopes and terraces and to the lower parts of mountain slopes; they are also common on plains. The type of moderately humid habitats for all ecological groups contains the highest number of taxa in the bryoflora of the Karatepa Mountains, and the lowest in the flora of the Zirabulak Mountains, where such habitats are less common than in other bryofloras.

3.2 Mosses of tree and shrub vegetation

In the groups of tree and shrub vegetation, 19 species of bryophytes were identified. The ground cover of the maple tree contains *Brachythecium albicans*, *Bryum caespiticum* and *Syntrichia princeps*. Epiphytic mosses here are represented by the species *Orthotrichum crenulatum* and *Syntrichia laevipila*. A total of 5 species have been recorded in maple forests. In contrast to the previous formation, hazel trees (Juqlans regia) have a somewhat depleted floristic composition and a less developed moss cover. The ground cover is dominated by *Bryum capillare* and *B.albicans*. Epiphytic mosses are represented by *Brachythecium velutinum*, *Orthotrichum cupulatum*, and *Pseudoleskeella papillosa*. A total of 6 species have been recorded in hazel trees.

The ground cover of shrub communities is dominated by *Funaria hygrometrica*, *Dicranum elongatum*, and *D.brevifolium* and *Bryum schleicheri.* Epiphytic mosses are developed only in the lower part of the trunks and are represented by *Brachythecium salebrosum* and *Schistidium apocarpum*. *Orthotrichum crenulatum* and *Isothecium alopecuroides* are often found in the basal part of trees and at the base of trunks. A total of 8 species have been recorded in poplar forests.

In formations of tugai vegetation, in particular in turangians, jidovniks (*Populus pruinosa*, *Elaeagnus angustifolia*, types of p. *Salix species*), mosses develop poorly. With the exception of some willow formations, where the moss cover is more or less developed. Epiphytic mosses are practically absent here. The ground cover of turangians and jidovniks contains *Bryum funckii*, *B. Lonchocaulon*, *Barbula unguiculat*, *Crossidium squamiferum* and *Pterygoneurum subsessile*. A total of 5 species were identified in the turangi and loha groups.

From a bryological point of view, formations of subshrub communities in foothill areas, thyme and tragacanth forests were studied. In the general species composition of the flora, mosses in the groups of shrub and semi-shrub vegetation are represented by the species *Syntrichia caninervis*, *Tortula muralis*, *Bryum terskeiense*.

Mosses of herbaceous vegetation. The bryophyte flora of herbaceous vegetation in the middle reaches of the Urgut botanical-geographical region is very poor. In bryologically studied groups of foothill vegetation (*Erianthus ravennae*, *Imperata cylindrica*), mosses develop very poorly, and there is almost no moss cover in them. Here the following species are found in the ground cover: *Funaria hygromotrica*, *Bryum funckii*, *B. Argenteum*, *Tortula mucronifolia*. Mosses are somewhat better represented in the groups of low-grass foothills in communities dominated by *Poa buldosa* and *Carex pachystylis*. The moss cover here is relatively better developed and has a fairly rich and varied composition. The ground cover contains *Tortula muralis*, *Syntrichia caninervis*, *T. Subulata*, *Crossidium squamiferum*, *Bryum funckii*, etc. A total of 11 species have been recorded.

The moss cover is most developed in groups of herbaceous vegetation with the following species: *Bryum schleicheri Schwaegr., B. pseudotriquetrum, Brachythecium plumosum, B.*

rivulare, Philonotis fontana and etc. Here, mosses are not only part of the community, but are also the main edifiers of their phytocenoses. A total of 9 species have been recorded.

Thus, in the vegetation types of the middle reaches of the Urgut botanical-geographical region, a certain pattern is observed in the distribution of bryophytes and their communities.

The moss cover is most developed in groups of herbaceous vegetation in the formations of marshy. Here, mosses are not only part of the community, but are also the main edifiers of their phytocenoses.

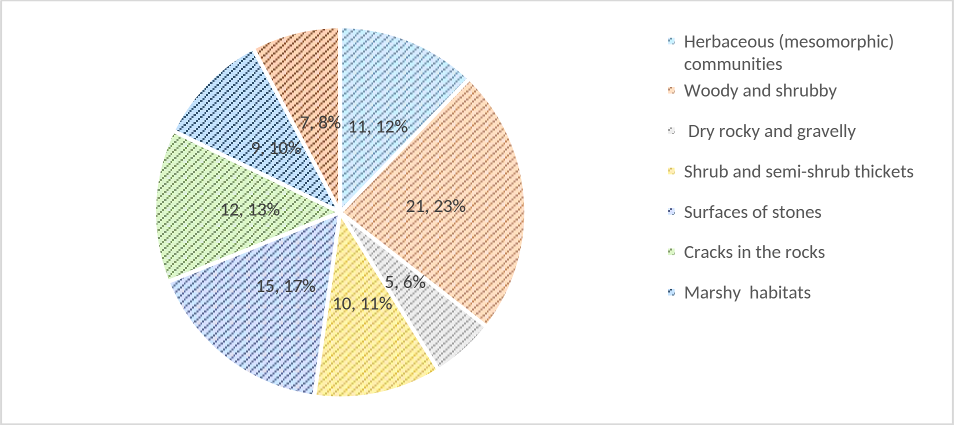

Fig.2. Spectrum of ecological-coenotic groups (ECG) of bryoflora of the studied territory

1. Dry habitats. From a bryological point of view, formations of subshrub communities in foothill areas, thyme and tragacanth forests were studied. In the general species composition of the flora, mosses in the groups of shrub and subshrub vegetation are represented by the species *Syntrichia caninervis* Mitt., Tortula *muralis* Hedw., *Bryum terskeiense* Par.

9 species of bryophytes were found on dry rocky and gravelly screes, as well as dry pebble banks. Many species found in this group of ecotopes are also included in the previous one. The majority of species have a narrow ecological range, although mosses with a fairly wide distribution are also present, for example, 4 species of the genus *Dicranum* and *Dicranella* are noted. A characteristic species for this group of habitats can be called *Orthotrichum crenulatum*, which in boreal conditions is an epiphyte, and in the highlands it is noted in another, similar type of habitat, rocky. It is noteworthy that the only record of the boreal-nemoral species *Distichium inclinatum* also belongs to this group of ecotopes.

3. Specific habitats. The special conditions of specific habitats determine the very large diversity and originality of the species composition of bryophytes. Unlike all other groups of habitats, this combined and heterogeneous group was identified mainly without taking into account the factor of substrate moisture. The species characteristic of this association of ecotopes are most likely brought together by the fact that they form small moss groups or synusias, and in conditions where a cenosis, as such, has not been formed.

15 bryophyte taxa were noted on the surfaces of stones. In this case, several groups are distinguished: a) species growing on stones immersed in water and periodically flooded *(Syntrichia laevipila, Gymnostomum calcareum, Grimmia pulvinata, G. commutate, G. anodon, Distichium capillaceum, Cratoneurum glaucum, Schistidium apocarpum)* species and varieties growing on dry surfaces of stones *(Orthotrichum anomalum, Pseudoleskeella papillosa)*. *Pellia epiphylla* and *Fissidens grandifrons* are also found on water rocks.

Cracks in rocks and their surfaces have become a haven for 12 species of bryophytes. This is the highest indicator of species diversity, probably due to the richness of rocks in the studied region, and the fact that this group combines both wet and dry rock ecotopes. A variety of species have been recorded in this group of habitats: widespread (species of the genera *Grimmia, Dicranum, Encalypta, Hygrohypnum, Cratoneuron, Bryum,* etc.), rare stenotopic (species of the genera *Conocephalum, Marchantia, Gymnostomum, Seligeria*) and many others. The largest number of rare and very rare species was noted precisely in this group of ecotopes (*Conocephalum conicum, Gymnostomum calcareum*). An interesting feature has been noted for a number of bryophytes of this group of habitats: some of them, which are epiphytes in the taiga zone, behave like epiliths in the highlands. These are, for example, species such as *Brachythecium albicans*, *Isothecium alopecuroides*.

In the type of nival habitats, the number of taxa in ecotope groups is also higher in the flora of the Nurata Range. The same pattern can be seen in the type of dry habitats.

Specific habitats are also richer in species in the same local flora, although some variations in the number of taxa in the ecological groups of this type of ecotopes can be noted. Thus, almost the same number of taxa (from 8 to 12) was noted on the surface of the stones, except for the bryoflora of the Zirabulax Mountains, where this figure is half as much. Rock cracks and rock surfaces in the bryoflora of the Karatepa Mountains are relatively richer in moss population (10), while other bryofloras have smaller but similar indicators (from 2 to 12).

3.3 Mosses of reservoirs

The reservoirs of the middle reaches of the Urgut botanical-geographical region are distinguished by exceptional abundance of water. The abundance of springs has led to a dense river network here. High mountain ranges that condense atmospheric moisture give rise to many rivers, streams and small rivers. Mosses are widespread in water bodies, especially in stream habitats.

Found from the foothill plains to the middle mountain zones, they play a significant role in the life of fresh waters and participate in the processes of overgrowing and swamping. Large rivers in the study area are almost devoid of aquatic bryoflora, at least in quantities sufficient to form aquatic moss vegetation.

4 Conclusion

Thus, the most bryofloristically rich in the middle reaches of the Urgut botanical-geographical region are some types of specific habitats: cracks and cornices of rocks (12 species or 15.4% of the entire flora of leaf-stemmed bryophytes), which retain this position in all local bryofloras, floodplain thickets of trees and shrubs (10 species or 12.8% of the entire flora of bryophytes) and moderately moist thickets of bushes (10 species or 12.8% of the total bryophyte flora).

The species diversity of bryophytes is significantly lower (20-35 species) in the type of waterlogged habitats, in thickets of bushes in the type of dry habitats, and on dry rocky screes and pebble banks in the type of specific habitats. It is interesting to note that in the type of surface of stones and moderately humid habitats, all groups of ecotopes have a fairly high (average) floristic richness. Mountain belts of dry habitats should be considered poor in bryofloristic terms (10-15 species).

An important factor influencing the development of bryophytes in water bodies is also the composition of the water. The bryophyte flora of reservoirs and stream habitats contains 7 species, which makes up 8.9% of the bryoflora of the basin. Mosses are distributed among systematic groups as follows: Riccia fluitans L., Ricciocarpus natans (L.) Corda., *Fissi dens grandifrons* (Brid.) Limpr., *Cratoneuron commutatum* Broth.**,** *C. filicinum* (Hedw.) Spruce., *Philonotis seriata* Mitt.

The composition of true hydrophytes in the bryophyte flora of the middle reaches of the Urgut botan ical-geographical region is extremely poor in both quantity and diversity of species. The general composition of hydrophytes is 7 species.

Authors' contributions

Kh. Zhalov conceived the study; M.Jabborov and O.Khurramov collected and analyzed the data; Kh. Zhalov, F. Abdirasulov, M.Jabborov and G. Suvonova wrote the manuscript; Kh. Zhalov, M.Jabborov, O.Khurramov and N.Turniyozova discussed the results and revised the manuscript. All authors have read and approved the manuscript.

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