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A.N. Sarsenova[1]*, S.A. Abiev[2], T.E. Darbayeva[1], G.A. Nam[3], G.S. Kaisagaliyeva[1], N.A. Utarbayeva[4]

[1]Makhambet Utemisov West Kazakhstan University, Kazakhstan, Uralsk
[2]L.N. Gumilyov Eurasian National University, Kazakhstan, Astana
[3]Institute of Botany and Phytointroduction, Almaty
[4]Aktobe Regional University named after K. Zhubanov, Kazakhstan, Aktobe
*e-mail: assemgulsarsenova@gmail.com

DIVERSITY OF MACROMYCETES OF RAVINE BIRCH FORESTS ON THE LEFT BANK OF THE URAL RIVER WITHIN THE WEST KAZAKHSTAN REGION

Biodiversity and its conservation remain fundamental aspects of contemporary biology, continually sparking interest and requiring active research. Presently, significant disparities persist in our understanding of the distribution and habitats of various living organisms. Among the most diverse and crucial groups warranting intensive and comprehensive analysis are fungi. The data obtained significantly contributes to the study of macromycete diversity within the birch forests of the Ural River valley. However, information regarding these fungi within the territory of Kazakhstan remains incomplete and fragmented.

The article presents data on the biodiversity of the mycobiota within the ravine birch forests situated along the left bank of the Ural River in the West Kazakhstan region. As of the current date, the biota study has identified 43 species belonging to 26 genera, spanning across 17 families and six orders. Predominant families include *Polyporaceae*, *Russulaceae*, *Pluteaceae*, *Amanitaceae*, and *Strophariaceae*. The trophic analysis of the mycobiota within birch forests revealed a notable diversity of xylotrophs, with 25 species identified, primarily associated with the families *Fomitopsidaceae*, *Polyporaceae*, *Pluteaceae*, and *Strophariaceae*. Additionally, the group of mycorrhizal fungi comprises 15 species, predominantly represented by the families *Amanitaceae*, *Boletaceae*, *Russulaceae*, and *Paxillaceae*.

Thus, the highest richness of macromycetes is noted in birch forests located in the lowlands of deep gullies. Species diversity of macromycetes tends to decrease in birch forests growing along slopes of various orientations, along the edges of gullies, and on eroded slopes. Moreover, in new pioneer sites such as the sole of the indigenous bank of the Ural River, the species composition of mushrooms is notably impoverished. This study represents the first taxonomic analysis of mycobiota diversity in the ravine birch forests.

Key words: macromycetes, birch forests, Ural river valley, West Kazakhstan Region, species composition, biodiversity.

А.Н. Сарсенова[1]*, С.А. Абиев[2], Т.Е. Дарбаева[1], Г.А. Нам[3], Г.С. Кайсагалиева[1], Н.А. Утарбаева[4]

[1]М. Өтемісов атындағы Батыс Қазақстан университеті, Қазақстан, Орал қ.
[2]Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Қазақстан, Астана қ.
[3]Ботаника және фитоинтродукция институты, Қазақстан, Алматы қ.
[4]Қ. Жұбанов атындағы Ақтөбе өңірлік университеті, Қазақстан, Ақтөбе қ.
*e-mail: assemgulsarsenova@gmail.com

Батыс Қазақстан облысы Жайық өзенінің сол жағалауы шегіндегі байрақты қайың ормандары макромицеттердің алуантүрлілігі

Биоалуантүрлілікті зерттеу және сақтау мәселелері қазіргі биологияның өзекті мәселелері болып қала береді. Бүгінде әртүрлі тірі ағзалардың таралуы мен кездесуі туралы мағлұматтардың зерттеу дәрежесі әлі де біркелкі емес. Осындай қарқынды, түбегейлі зерттеуді қажет ететін алуан түрлі және маңызды топтардың бірі – саңырауқұлақтар. Алынған нәтижелер Қазақстан аумағында әлі күнге дейін мәліметтер жеткіліксіз және фрагменттік болып табылатын Жайық өзені аңғары байрақты қайың ормандары макромицеттерінің алуантүрлілігін тануға елеулі үлес қосады.

Мақалада Батыс Қазақстан облысы шегіндегі Жайық өзенінің сол жағалауында ғана таралған байрақты қайыңды ормандары микобиотасының биоалуантүрлілігі туралы деректер қамтылған. Зерттеу нәтижелері негізінде бүгінгі таңда биотада 6 қатар, 17 тұқымдас және 26 туысқа біріккен 43 түр анықталды. Жетекші тұқымдастарды *Polyporaceae, Russulaceae, Pluteaceae, Amanitaceae, Strophariacea* құрайды. Қайың ормандары микобиотасын трофикалық талдау ксилотрофтардың әртүрлілігі жоғары екенін көрсетті – 25 түр. Ксилотрофтардың басым бөлігі *Fomitopsidaceae, Polyporaceae, Pluteaceae, Strophariaceae* тұқымдасының негізгі өкілдері. Микориза түзушілер тобы 15 түрді құрап, ксилотрофтардан кейінгі орында. Микоризатүзушілер тобы *Amanitaceae, Boletaceae, Russulaceae, Paxillaceae* тұқымдастарына жатады.

Қайың ормандарындағы макромицеттердің түрлік құрамы терең сайлардың түптерінде таралған қайыңды алқапта бай екендігі анық байқалады. Әртүрлі экспозициялардың беткейлерінде, сайлардың тарамдарында және эрозиялық беткейлерде өсетін қайың ормандарында макромицеттердің түрлік әртүрлілігі азаяды. Ал жаңа пионер жерлерде, мысалы, Жайық өзенінің байырғы жағасының етегінде саңырауқұлақтардың түрлік құрамы әлдеқайда кедей екенін көре аламыз. Байрақты қайың ормандарындағы макромицеттердің әртүрлілігін зерттеу, микобиотаның таксономиялық құрылымын анықтау зерттеу аймағы үшін алғаш рет жүргізілді.

Түйін сөздер: макромицеттер, қайың ормандары, Жайық өзені аңғары, Батыс Қазақстан облысы, түрлік құрамы, биоалуантүрлілік.

А.Н. Сарсенова[1]*, С.А. Абиев[2], Т.Е. Дарбаева[1],
Г.А. Нам[3], Г.С. Кайсагалиева[1], Н.А. Утарбаева[4]

[1]Западно-Казахстанский университет им. М. Утемисова, Казахстан, г. Уральск
[2]Евразийский национальный университет им. Л.Н. Гумилева, Казахстан, г. Астана
[3]Институт ботаники и фитоинтродукции, Казахстан, г. Алматы
[4]Актюбинский региональный университет им. К. Жубанова, Казахстан, г. Актобе
*e-mail: assemgulsarsenova@gmail.com

Разнообразие макромицетов байрачных березовых лесов в левобережье р. Урал в пределах Западно-Казахстанской области

Биоразнообразие и его сохранение остаются важными аспектами современной биологии, непрерывно вызывающими интерес и необходимость активных исследований. На сегодняшний день неравномерность в степени изученности распределения и обитания различных живых организмов продолжает оставаться значительной. Одной из самых разнообразных и важных групп, требующих интенсивного и фундаментального анализа, являются грибы. Полученная информация вносит значительный вклад в изучение разнообразия макромицетов байрачных березовых лесов долины реки Урал. Сведения о них на территории Казахстана до сих пор являются недостаточными и фрагментарными.

В статье представлены данные о биоразнообразии микобиоты байрачных березовых лесов, распространённых в левобережье р.Урал в пределах Западно-Казахстанской области. На сегодняшний день, на основе результатов исследования биоты, было выявлено 43 вида, относящихся к 26 родам, 17 семействам и шести порядкам. Ведущими семействами являются *Polyporaceae*, *Russulaceae*, *Pluteaceae*, *Amanitaceae*, *Strophariacea*. Трофический анализ микобиоты березовых лесов показал высокое разнообразие ксилотрофов – обнаружено 25 видов. Большинство из них относятся к семействам *Fomitopsidaceae*, *Polyporaceae*, *Pluteaceae* и *Strophariaceae*. Группа микоризообразующих грибов включает 15 видов, чаще всего представленных семействами *Amanitaceae*, *Boletaceae*, *Russulaceae* и *Paxillaceae*.

Таким образом, наибольшее богатство отмечается в березняках, которые произрастают по днищам глубоких балок. Видовое разнообразие макромицетов уменьшается в березняках, которые произрастают по склонам различных экспозиций, по отвершкам балок и по пологим балкам, эрозионным склонам. А по новым пионерным местам, например по подошве коренного берега р.Урал видовой состав грибов более бедный. Изучение разнообразия макромицетов байрачных березовых лесов проведено впервые для данного района исследования, включая таксономическую структуру микобиоты.

Ключевые слова: макромицеты, березовые леса, долина реки Урал, Западно-Казахстанская область, видовой состав, биоразнообразие.

Introduction

Birch forests represent vital ecosystems renowned for their ecological significance and diverse array of flora and fauna [1, 2]. Within these ecosystems, macromycetes, or large fungi, play a crucial role in nutrient cycling, decomposition, and symbiotic relationships with plants [3-5]. Understanding the distribution and diversity of macromycetes in birch forests is essential for unraveling their ecological functions and the impacts of environmental factors and human activities [6-8].

The species composition and abundance of macromycetes in birch forests are influenced by a multitude of factors, including soil properties, microclimate, vegetation structure, and anthropogenic disturbances [9-11]. Despite their ecological importance, there remains a considerable knowledge gap regarding the specific factors shaping macromycete communities within birch forest ecosystems.

This study aims to address this gap by conducting a comprehensive analysis of macromycete diversity and distribution patterns in birch forests across our study area. By employing rigorous field surveys, species identification, and statistical analyses, we aim to elucidate the key environmental drivers influencing macromycete communities.

Furthermore, understanding how macromycete communities vary across different habitat types within birch forests, such as lowland gullies, slope gradients, and pioneer areas, will provide valuable insights into their ecological preferences and habitat associations.

Ultimately, the findings of this study will contribute to advancing our understanding of the ecological dynamics of birch forest ecosystems and inform conservation and management strategies aimed at preserving their biodiversity and ecological integrity. By shedding light on the intricate relationships between macromycetes and their environment, this research endeavor seeks to foster a deeper appreciation for the intricate web of life within birch forests and the importance of preserving their ecological balance.

The ravine forests are widespread in the steppe zone. They occupy hollows and gullies that arise as a result of deep soil erosion [15, 16] in the form of refugiums, individual ravine tracts are living witnesses of the ways of formation, migration and imposition of the processes of vegetation and soil evolution.

The relevance of studying ravine birch forests is determined by the narrow-locality distribution of small-leaved forests only on the left bank of the Ural River in the West Kazakhstan region [15]. Here, peculiar trophic connections of birch and macromycetes are formed, which ensure the decomposition of cellulose compounds of wood and their return to the circulation of substances necessary for the stable existence of the birch forest [17, 18]. The relevance of the study should also include the low level of knowledge of the biota of the macromycetes of the ravine birch forests of the studied region.

The research area is located in the West Kazakhstan region, Terekti district (in the north-eastern part of the West Kazakhstan region) on the left bank of the Ural River between the settlements of Kabyltobe (N51°18’52” E51°52’32”) and Sharakap (N51°22’17” E51°57’47”). From here begins the spurs of the Pre-Syrtic ledge, the height of which is 90-100 m [15]. The territory is divided by deep ravines and 9 gullies, their depth varies from 7 to 13 meters, the deepest are the holes of the Akhmadievskaya beam up to 15 m. The length of the beams is from 2 to 5 km. They begin at the highest point of the Pre-Syrtic ledge, which is 100 m and flow into the floodplain of the Ural River. Gullies overgrown with woody and shrubby vegetation at one time Belgard called ravine forests, which consist of formations of oak (*Quercus robur*) [19], aspen (*Populus tremula*), birch (*Betula pendula, B. pubescens*).

Materials and methods

The object of the study is the macromycetes of the ravine birch forests on the left bank of the Ural River within the West Kazakhstan region.

Macromycetes are understood to be a group of fungi having macroscopic fruit bodies of a fleshy, cartilaginous or leathery, cork consistency [20].

The aim of the work is to study the biota of macromycetes in the birch formation in the valley of the Ural River within the West Kazakhstan region.

The main tasks were as follows:

1. Conduct a geobotanical description of birch formations.

2. Identify the species composition of macromycetes in birch forests based on spatial distribution.

3. 3. Determine the distribution regularities of mycocenoses in different types of birch forests.

The study involved the utilization of our own collections amassed between 2019 and 2023. Collection, drying, and storage procedures for fungal fruit bodies adhered to established protocols in mycology and botany. Geobotanical descriptions of the birch formations were carried out, and the species composition of macromycetes was delineated based on spatial distribution patterns. Distribution patterns of mycocenoses across different types of birch forests were elucidated through meticulous field observations and subsequent analysis. Herbarization of collected material adhered to the standardized procedure as outlined by Bondartsev and Singer, with adjustments made to accommodate modern requirements [21]. Detailed descriptions of color and morphological features of fruit bodies, encompassing cap shape, surface texture, color palette, pulp structure, and numerical measurements such as diameter and dimensions, were meticulously recorded. Photographic documentation was extensively conducted for the majority of collected samples, providing visual documentation of morphological variations and ecological contexts.

Geobotanical studies were conducted according to established methodologies (Shennikov, 1964) [22]. Vegetation assessments involved describing floral composition, canopy structure, shrub and herbaceous cover, and considering species abundance using the Drude scale. These descriptions enabled the identification of dominants and subdominants across different vegetation layers. Additionally, 27 birch trees were individually described.

Mushroom fruit bodies were photographed using a Canon EOS 4000D camera. To prepare them for herbarium and long-term storage, they were disinfected in drying cabinets at 50-55°C for 30-40 minutes to eliminate pests. Each mushroom sample was then stored in a uniquely numbered package, including details such as the registration number, species name, collection location and date, and the collector's name.

Fungal species identification relied on morphological characteristics of the samples using specialized determinants. Macro- and micro-measurements of fruit bodies, basidia, and spores were conducted and documented through binocular magnifiers and an EVOS® FL/FL Color fluorescence microscope.

Plant names were provided in Latin, and taxonomic changes were referenced based on the compilation by S.K. Cherepanov (1995) [23] and the "List of vascular plants of Kazakhstan" by S.A. Abdullina (1999) [24]. Taxonomic classification of mycobiota followed the system outlined in the 10th edition of Ainsworth & Bisby's Dictionary of Fungi (Kirk et al., 2008) [25], with updates from modern data obtained from the Index Fungorum electronic databases (www.indexfungorum.org) and "MycoBank" (www.mycobank.org/MB) [26, 27].

The trophic structure was characterized using the trophic group scale proposed by A.E. Kovalenko [27], with additional contributions by O.V. Morozova [28]. The scale includes the following gradations of indicators and their corresponding symbols (trophic groups): saprotrophs (Fd: on litter (foliadejecta), St: on litter (stramentum), Hu: on humus (humus), Le: on wood (lignumepigaeum), Lei: on undisturbed (lignumepigaeumintegrum), Lep: on destroyed (lignimiepigaeumputridum), Lh: on roots and wood buried in the soil (lignumhypogaeum), He: on rags, plant stems (herba), M: on mosses (musci), Mm: on fruit bodies of macromycetes (macromycetes), Ex: on excrement (excrementum), C: on coals (carbo); symbiotrophs (Mr: mycorrhizators, Lf: lichenophilic fungi (lichenicolousfungi)); parasites (Pf: facultative on trees and shrubs; P: obligate parasites).

These trophic group classifications were employed to characterize the ecological roles of fungal species within the study area. The assignment of fungal species to specific ecological and trophic groups was based on the author's own field observations as well as data from relevant literature sources.

Data visualization was performed in R 4.2.2 (https://www.r-project.org/) and RStudio 2022.12.0 (https://posit.co/) software using the following packages and the corresponding functions are given in brackets. The package ggplot2 (ggplot, geom_bar) Wickham, 2016) was applied to make barplots of taxonomy and dominant families [29]. The function facet_wrap was used to group the barplots. In addition, the package patchwork (plot_layout) (Pedersen, 2022) was applied to merge plots into one [30].

Results and discussion

The research area belongs to the fescue – feathered grass steppes, among which the ravine forests with their distinctive myco – and floral complex stand out sharply.

A characteristic feature of the birch formation (*Betula pendula, B. pubescens*) is its proximity to the slopes and lower parts of the western and eastern exposures, as well as growth in growing ravines and along the erosive slopes of Akhmadievskaya (N51°19.044' E51° 54.648'), Vorovskaya (N51°19.968' E51° 55.951') and Birch beams (N51° 20.677' E51° 56.584') (Figure 1).

Birch forests prefer the banks of streams, springs, ponds in forested gullies, and sometimes birch forests develop at the foot of the root bank of the Ural River

The basis of the stand is formed by birch. *Quercus robur, Ulmus laevis, Acer negundo, Fraxinus exelsior* and *Populus alba, Populus nigra, Populus tremula* are found in the stand. Very rich shrub cover consisting of forest species: *Ribes nigrum, Euonymus verrucosa, Frangula alnus, Padus racemosa, Viburnum opulus, Malus sylvestri*s. On the edge of birch forests are characterized by: *Lonicera tatarica, Rhamnus cathartica, Crataegus ambigua, Prunus spinosa, Rosa majalis*. At the same time, there are steppe shrubs *Amygdalus nana, Cerasus fruticose, Chamaecytisus ruthenicus, Caragana frutex.*

Figure 1 – Map-scheme of the study area

In the semi-shrub layer grows *Rubus caesius, Solanum dulcamara*; and in the semi-shrub layer there is a boreal species – *Rubus saxatiles.*

The herbage of birch forests is rare. Their projective coverage is 40-50%. *Poa pratensis, Melic nutans, Bromopsis riparia, Bromus inermis, Elytrigia repens, Calamagrostis canescens, Agrostis albida, Phragmites australis, etc. are characteristic of cereals.*

Among the sedges, there are also species such as *Carex atheroides, C.melanostahya, C.leporina*. Of the various grasses, the most common are *Viola collina, V.hirta, Galiumboreale, Scrophularia nodosa, Veronica longifolia, Inula salicina*, etc.

It should be noted a rare combination of ferns (*Dryopteris filix-mas, Pteridium aquilinum*), horsetails (*Equisetum arvense, E. palustre, E. sylvaticum*), strawberries (*Fragaria vesca*), elecampane (*Inula helenium*), Solomon's seal (*Polygonatum odoratum*). As can be seen from the listed species, birch forests are diverse in their structure, as favorable conditions for the growth of forest mesophytic species develop here.

A total of 122 species have been registered according to 27 descriptions, 52% of which are forest species, meadow species are almost half 23%, forest-steppe make up 13%, meadow-steppe – 9%. The proportion of the remaining groups is insignificant.

The birch formation is represented by the following associations: butterbur, sedge, bentgrass, lily of the valley, bracken-fern, euonymus, rosehip, reed, nettle. In the birch formation, we distinguish 4 groups of associations: butterbur, lily of the valley, fern, blackberry, couch grass, birthwort, sedge, rosehip, reed, euonymus, horsetail, nettle, weed-ruderal with tansy. The floral composition of the associations ranges from 28 to 53 species.

There are a lot of dead wood in birch forests – fallen birch trunks, as well as stumps, fallen branches and small twigs. Therefore, xylotrophs, an ecological group of basidial fungi, are the component of forest ecosystems that ensures the decomposition of ligninocellulose compounds of wood and the return to the circulation of substances necessary for the circulation of substances and for the stable existence of the forest. During the study period, 43 species of macromycetes belonging to 26 genera and 17 families were identified in the territory (Table 1).

Table 1 – Taxonomic structure of the biota of the ravine birch forests on the left bank of the Ural River within the West Kazakhstan region

Order	Family	n of genus	Genus	n of species
Agaricales	***Amanitaceae***	**1**		**3**
			Amanita	3
	Mycenaceae	**1**		**1**
			Mycena	1
	Omphalotaceae	**1**		**1**
			Gymnopus	1
	Physalacriaceae	**1**		**1**
			Hymenopellis	1
	Pluteaceae	**1**		**4**
			Pluteus	4
	Psathyrellaceae	**2**		**2**
			Coprinellus	1
			Coprinopsis	1
	Strophariacea	**2**		**3**
			Kuehneromyces	1
			Pholiota	2
Auriculariales	***Auriculariaceae***	**1**		**1**
			Auricularia	1
Boletales	***Boletaceae***	**2**		**2**
			Leccinum	1
			Xerocomellus	1
	Paxillaceae	**1**		**1**
			Paxillus	1
	Sclerodermataceae	**1**		**1**
			Scleroderma	1
Hymenochaetales	***Hymenochaetaceae***	**1**		**1**
			Inonotus	1

Table continuation

Order	Family	n of genus	Genus	n of species
Polyporales	***Cerrenaceae***	**1**		**1**
			Cerrena	1
	Fomitopsidaceae	**2**		**2**
			Fomitopsis	2
	Panaceae	**1**		**1**
			Panus	1
	Polyporaceae	**6**		**9**
			Cellulariella	1
			Fomes	1
			Ganoderma	1
			Lentinus	1
			Trametes	4
			Trichaptum	1
Russulales	***Russulaceae***	**2**		**9**
			Lactarius	2
			Russula	7
6 orders	**17 families**	**26 genus**		**43 species**

The leading families of the mycobiota under consideration are *Polyporaceae* (9 species), *Russulaceae* (9 species), *Pluteaceae* (4 species), *Amanitaceae* (3 species), *Strophariacea* (3 species). *Boletaceae*, *Fomitopsidaceae,* and *Psathyrellaceae* were each represented by two species (Figure 2).

Additionally, one species was identified for each of the following families: *Auriculariaceae*, *Cerrenaceae*, *Hymenochaetaceae, Mycenaceae, Omphalotaceae*, *Panaceae*, *Paxillaceae*, *Physalacriaceae* and *Sclerodermataceae*. The leading position of the first two of the noted families is characteristic of the mycobiota of the ravine birch forests.

By trophic affiliation, the species were distributed as follows: 25 species belong to xylotrophs, the vast majority of which live on destroyed, buried wood, as well as species that are participants in the initial stages of wood destruction and are marked on a whole or with a slight degree of destruction of the shaft. Most xylotrophs are the main members of the families *Fomitopsidaceae*, *Polyporaceae*, *Pluteaceae*, *Strophariaceae*. The macrofungi belonging to this group were commonly found in living birch trees, as well as in the decaying remnants of birch trees such as fallen trunks, which are prevalent in ravine birch forests. Additionally, they were observed on stumps, fallen branches, and small twigs.

The mycorrhiza-forming group comprises 15 species, second only to xylotrophs. This group includes species from the families *Amanitaceae*, *Boletaceae*, *Russulaceae*, and *Paxillaceae*.

The humus saprotrophs are represented by *Coprinopsis atramentaria* (Bull.) Redhead, Vilgalys & Moncalvo, *Scleroderma citrinum* Pers. In birch forests, the forest litter is well developed, with *Gymnopus dryophilus* (Bull) Murrill being the sole representative of the litter saprotroph.

The species composition of macromycetes in the study area is influenced by a multitude of factors operating in concert. These factors encompass a range of abiotic elements, the characteristics of the plant habitat, as well as human activities impacting various facets of the ecosystem, thereby directly or indirectly affecting all others. Fungal species composition and their natural associations within communities are intricately linked to all environmental components, but are particularly influenced by vegetation characteristics and anthropogenic pressures on the biotope.

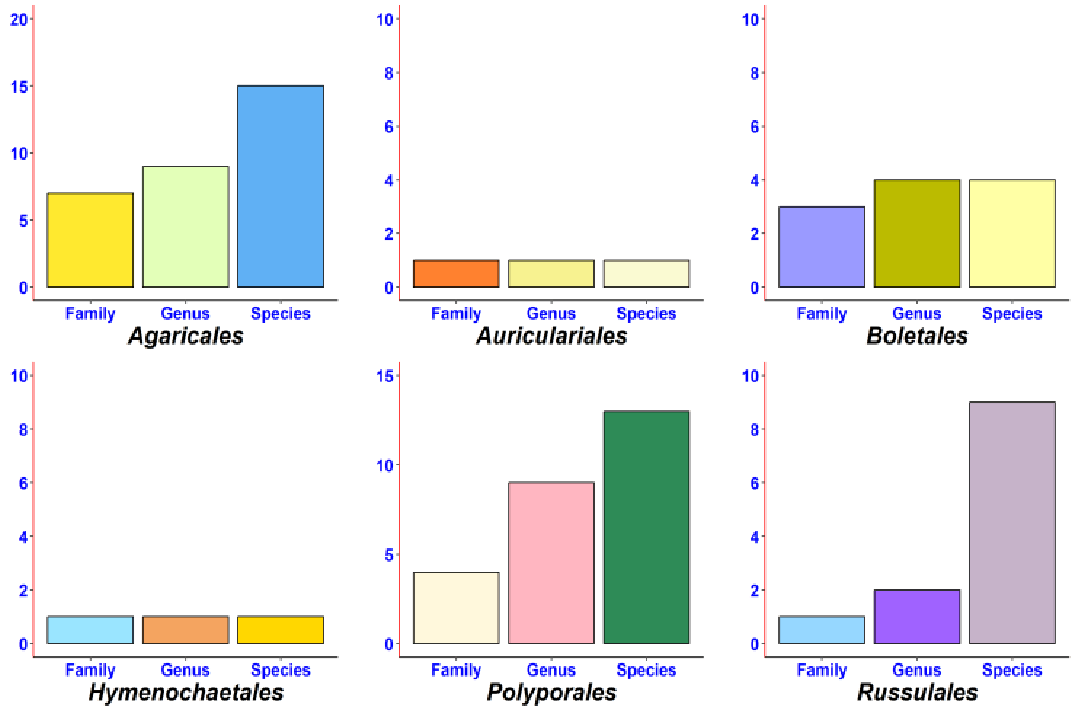

Figure 2 – Taxonomic structure of birch forests

In the ravine forests, where the main factor in our case is moisture, in this case a constant watercourse, the following birch forests are formed: birch rosehip association, birch reed association, birch sedge association, birch bentgrass association, birch horsetail association. In these associations we have noted the following fungi: *Leccinum scabrum* (Bull.) Gray, *Russula fellea* (Fr.) Fr., *Russula betularum* Hora, *Trichaptum biforme* (Fr.) *Ryvarden, Gymnopus dryophilus* (Bull.) *Murrill* (Collybia dryophila (Bull.) P. Kumm.), *Lactarius resimus* (Fr.) Fr., *Lentinus arcularius* (Batsch) *Zmitr., Pholiota aurivella* (Batsch) P. Kumm., *Pholiota squarrosa* (Vahl) P. Kumm., *Pluteus leucoborealis Justo*, E.F. *Malysheva, Bulyonk. & Minnis*, *Xerocomellus chrysenteron* (Bull.) Šutara, *Trametes hirsuta* (Wulfen) Lloyd., *Auricularia auricula-judae* (Bull.) Quél*, Cerrena unicolor* (Bull.) *Murrill* and *Trametes* versicolor (L.) Lloyd. Also here, along the slopes of various expositions, *Russula grisea* Fr., *Xerocomellus chrysenteron* (Bull.) Šutara are found in bedstraw birch forests in combination with mouse peas, and *Amanita sp.* grow in the mouse pea birch forest (Figure 3).

Ravine forests with a temporary watercourse, where birch forests, lily-of-the-valley birch, nettle birch, weed-ruderal birch with tansy are formed. Here we discovered such macromycetes as *Amanita pantherina* (DC.) Kromk., *Fomitopsis pinicola* (Sw.) P. Karst., *Amanita muscaria* (L.) Lam., *Russula betularum* Hora, *Hymenopellis radicata* (Relhan) R.H. Petersen, *Paxillus involutus* (Batsch) Fr., *Fomes fomentarius* (L.) Fr., *Lenzites betulinus* (L.) Fr., *Inonotus obliquus* (Fr.) Pilát.

In the gullies where the groundwater is located, completely different birch forests are formed. They are represented by such birch forests: birch lily-of-the-valley birch, birch bracken fern, birch blackberry, couch grass birch, sedge birch, birthwort birch. Here we have noted the following types of macromycetes*: Inonotus obliquus* (Fr.) Pilát., *Amanita muscaria* (L.) Lam., *Amanita pantherina* (DC.) Kromk., *Fomitopsis pinicola* (Sw.) P. Karst., *Kuehneromyces mutabilis* (Schaeff.) Singer & A.H. Sm., *Ganoderma applanatum* (Pers.) Pat., *Trametes gibbosa* (Pers.) Fr., *Russula betularum* Hora, *Leccinum scabrum* (Bull.) Gray, *Russula fellea* (Fr.) Fr., *Pluteus leucoborealis* Justo, E.F. Malysheva, Bulyonk. & Minnis, *Trametes pubescens* (Schumach.) Pilát, *Trichaptum biforme* (Fr.) Ryvarden, *Gymnopus dryophilus* (Bull.) Murrill, *Xerocomellus chrysenteron* (Bull.) Šutara, *Coprinellus micaceus* (Bull.) Vilgalys, *Fomes fomentarius* (L.) Fr.

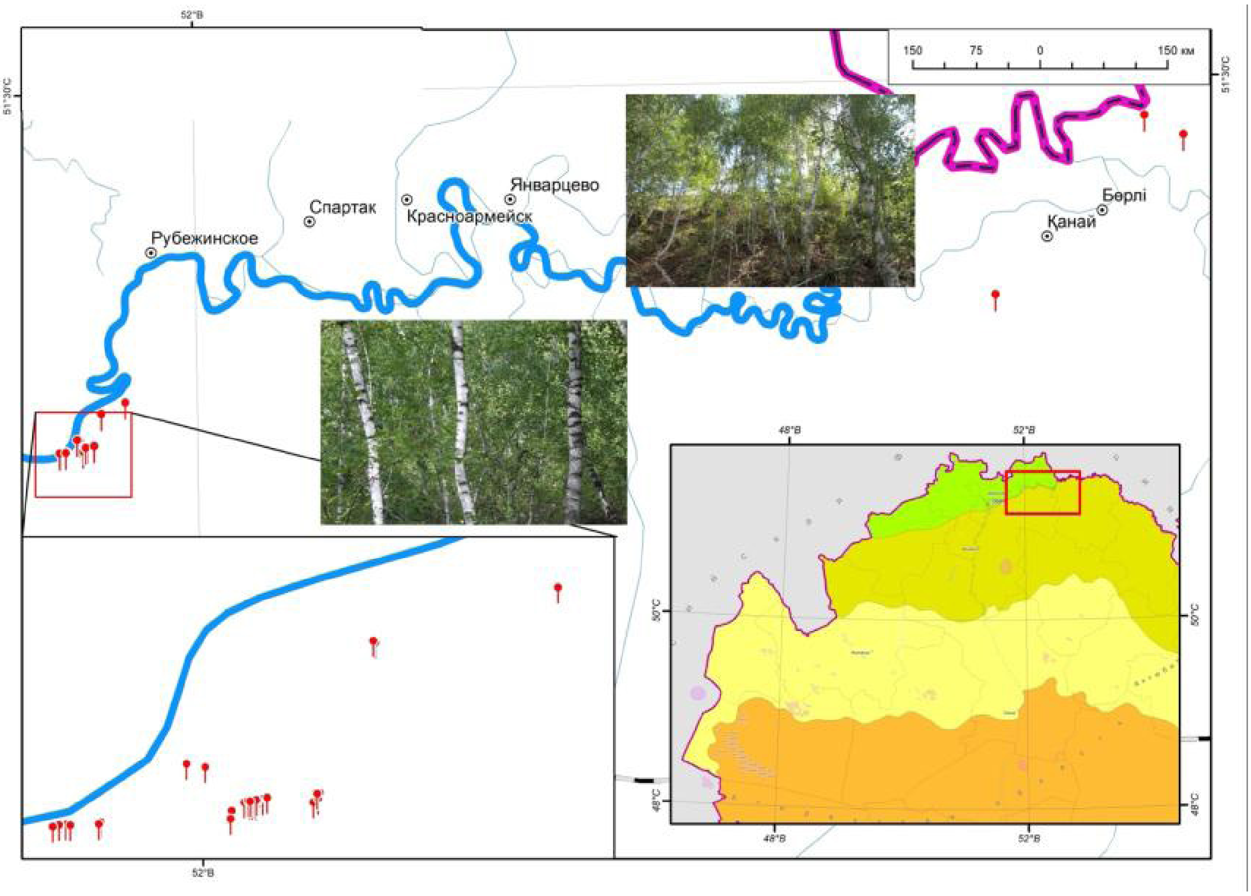

Figure 3 – Map-scheme of macromycetes distribution in ravine birch forests

At the foot of the root bank, a white birch, a sedge birch tree develops. *Mycena galericulata* (Scop.) Gray, *Amanita pantherina* (DC.) Kroos., *Russula fellea* (Fr.) Fr., *Pluteus leucoborealis* Justo, E.F. Malysheva, Bulyonk & Minnis, *Trichaptum biforme* (Fr.) Ryvarden, *Russula exalbicans (Pers.) Melzer & Zvára, Russula anthracina* Romagn., *Xerocomellus chrysenteron* (Bull.) Šutara are formed there.

Conclusion

Thus, as evidenced by the observations in the birch forests within our territory, the highest richness of macromycetes is typically found in birch forests situated in the lowlands of deep gullies. Conversely, the species diversity of macromycetes tends to decrease in birch forests growing along slopes of various orientations, along the edges of gullies, and on eroded slopes. Additionally, in new pioneer areas, such as the foot of the riverbank of the Ural River, the species composition of mushrooms is notably poorer.

The taxonomic structure of mycobiota in ravine birch forests was investigated for the first time in this research area, aiming to explore the diversity of macromycetes.

Conflict of interest

The authors declare no conflict of interest.

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Information about authors:

Sarsenova Assemgul (corresponding author) — PhD, Senior lecturer of the Faculty of Natural Geography of Makhambet Utemisov West Kazakhstan University (Uralsk, Kazakhstan, email: assemgulsarsenova@gmail.com).

Abiyev Sardarbek – Doctor of Biological Sciences, Professor of the Department of General Biology and Genomics of L.N. Gumilyov Eurasian National University (Astana, Kazakhstan, email: abiev.sardarbek@yandex.kz)

Darbayeva Talshen – Doctor of Biological Sciences, Professor of the Faculty of Natural Geography of Makhambet Utemisov West Kazakhstan University (Uralsk, Kazakhstan, email: dtalshen@mail.ru).

Nam Galina – Candidate of Biological Sciences, Leading researcher of the Laboratory of Mycology and Algology of Institute of Botany and Phytointroduction (Almaty, Kazakhstan, email: namg@mail.ru)

Kaisagaliyeva Gulzhakhan – Candidate of Biological Sciences, Senior lecturer of the Faculty of Natural Geography of Makhambet Utemisov West Kazakhstan University (Uralsk, Kazakhstan, email: gusm_@mail.ru).

Utarbayeva Nurlygul – PhD, Senior lecturer of the Department of Biology of Aktobe Regional University named after K.Zhubanov (Aktobe, Kazakhstan, email: Nurlygul.utarbaeva@mail.ru).

Авторлар туралы мәлімет:

Сарсенова Асемгуль Нурсаиновна (корреспонденттік автор) – PhD, М.Өтемісов атындағы Батыс Қазақстан университеті, жаратылыстану-география факультетінің аға оқытушысы (Орал, Қазақстан, email: assemgulsarsenova@gmail.com)

Абиев Сардарбек Абиевич – Биология ғылымдарының докторы, Л.Н.Гумилев атындағы Еуразия ұлттық университеті, Жалпы биология және геномика кафедрасының профессоры (Астана, Қазақстан, email: abiev.sardarbek@yandex.kz)

Нам Галина Алексеевна -Биология ғылымдарының кандидаты, Ботаника және фитоинтродукция институты, микология және альгология зертханасының жетекші ғылыми қызметкері (Алматы, Қазақстан, email: namg@mail.ru)

Дарбаева Талшен Есеномановна – Биология ғылымдарының докторы, М.Өтемісов атындағы Батыс Қазақстан университеті, жаратылыстану-география факультетінің профессоры (Орал, Қазақстан, email: dtalshen@mail.ru)

Кайсагалиева Гульжахан Смаиловна – Биология ғылымдарының кандидаты, М.Өтемісов атындағы Батыс Қазақстан университеті, жаратылыстану-география факультетінің аға оқытушысы (Орал, Қазақстан, email: gusm_@mail.ru)

Утарбаева Нурлыгул Асылбековна – PhD, Қ. Жұбанов атындағы Ақтөбе өңірлік университеті, биология кафедрасының аға оқытушысы (Ақтөбе, Қазақстан, email: Nurlygul.utarbaeva@mail.ru)

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