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THE MYCOBIOTA OAK FORESTS OF THE URAL RIVER VALLEY WITHIN THE WEST KAZAKHSTAN REGION

The study and conservation of biodiversity is one of the global problems of modern biology, since currently in many regions of the planet there is a decrease in the species composition of various organisms, including fungi. The obtained data make a significant contribution to the knowledge of the diversity of macromycetes of oak forests in the middle reaches of the Ural River, information about which is still insufficient and fragmented on the territory of Kazakhstan.

The article presents data on the biodiversity of mycobiota of the oak forests of the Ural River valley, growing not only in the floodplain of the river, but also in beams, that is, the ravine forests flowing into the central floodplain. We have registered 31 species belonging to 23 genera, 17 families and five orders. The leading families are Polyporaceae, Boletaceae, Russulaceae, Amanitaceae. As a result of our research, it has been found that the mycological composition in ravine oak forests is richer than in floodplain oak forests. The richness of the species composition of macromycetes appears to have been influenced by well-defined associations in ravine oak forests (22 associations), represented by forest boreal tree-shrub species absent in floodplain oak forests, as well as favorable microclimatic conditions, relief, soil cover and various ecotopes that are not observed in floodplain oak forests (16 associations).

Ecological-trophic analysis showed the predominance of mycorrhizal (45.1%) and xylotrophs (41.9%) over humus saprotrophs (12.9%). The considered taxonomic composition of macromycetes of the studied area is collected, identified and presented for the first time for this region.

Key words: mycobiota, macromycetes, oak forest, Ural river, biodiversity.

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Батыс Қазақстан облысы шегіндегі Жайық өзені аңғары еменді ормандарының микобиотасы

Биоалуантүрлілікті зерттеу және сақтау заманауи биологияның жаһандық мәселелерінің бірі болып табылады, өйткені қазіргі уақытта ғаламшардың көптеген аймақтарында әртүрлі ағзалардың, соның ішінде саңырауқұлақтардың түрлер құрамының азаюы байқалады. Алынған нәтижелер Қазақстан аумағында әлі күнге дейін мәліметтер жеткіліксіз және фрагменттік болып табылатын Жайық өзені аңғары еменді ормандары макромицеттерінің алуантүрлілігін тануға елеулі үлес қосады.

Мақалада Жайық өзені аңғарында өсетін жайылма, сондай-ақ сай – жыраларда таралған байрақты ормандарда кездесетін еменді ормандардар микобиотасының биоалуантүрлілігі туралы деректер берілген. Зерттеу нәтижелері негізінде бүгінгі таңда биотада 5 қатар, 17 тұқымдас және 23 туысқа біріккен 31 түр анықталды. Жетекші тұқымдастарды Polyporaceae, Boletaceae, Russulaceae, Amanitaceae құрайды. Біздің зерттеу жұмысымыздың нәтижесінде байрақты еменді ормандардағы микологиядық құрам жайылма еменді ормандардағы макромицеттер әртүрлілігіне қарағанда едәуір бай екендігі анықталды. Мұндай түрлік құрамның молдығына жайылма еменді ормандарда (16 ассоциация) байқалмайтын байрақты ормандардағы (22 ассоциация) орманды бореальді ағаш тектес-бұталы түрлері бар ассоциациялардың басымдық танытуы, қолайлы микроклиматтық жағдай, жер бедері, топырақ жамылғысы және түрлі экотоптардың әсерінен болуы мүмкін.

Экологиялық-трофикалық талдау Жайық өзенінің ортаңғы ағысындағы еменді ормандарда микоризатүзушілердің (45,1%), ксилотрофтар (41,9%) және қарашіріктік сапротрофтардан

(12,9%) басым екенін көрсетті. Макромицеттердің ең бай әртүрлілігі байрақты емендi ормандарда байқалды.

Түйін сөздер: микобиота, макромицеттер, емендi орман, Жайық өзені, биолауантүрлілік.

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Микобиота дубрав долины р. Урал в пределах Западно-Казахстанской области

Изучение и сохранение биоразнообразия является одной из глобальных проблем современной биологии, поскольку в настоящее время во многих регионах планеты происходит уменьшение видового состава различных организмов, в том числе и грибов. Полученные сведения вносят значительный вклад в познание разнообразия макромицетов дубрав среднего течения реки Урал, сведения о которых на территории Казахстана до сих пор недостаточны и фрагментарны.

В статье представлены данные о биоразнообразии микобиоты дубрав долины р.Урал, произрастающих не только в пойме реки, но и в балках, то есть байрачных лесах впадающих в центральную пойму. Нами зарегистрирован 31 вид относящихся к 23 родам, 17 семействам и пяти порядкам. Ведущими семействами являются Polyporaceae, Boletaceae, Russulaceae, Amanitaceae. В результате наших исследований установлено, что в байрачных дубравах микологический состав более богатый, чем в пойменных дубравах. Повидимому на богатство видового состава макромицетов повлияли хорошо выраженные ассоциаций в байрачных дубравах (22 ассоциаций), представленные лесными бореальными древесно-кустарниковыми видами отсутствующих в пойменных дубравах, также благоприятные микроклиматические условия, рельеф, почвенный покров и различные экотопы, которые не наблюдаются в пойменных дубравах (16 ассоциаций). Эколого-трофический анализ показал преобладание микоризообразователей (45,1%) и ксилотрофов (41,9%) над гумусовыми сапротрофовами (12,9%). Рассмотренный таксономический состав макромицетов исследуемого района собран, идентифицирован и представлен впервые для этого региона.

Ключевые слова: микобиота, макромицеты, дубрава, река Урал, биоразнообразие.

Introduction

Fungi are extremely heterogeneous organisms characterized by high levels of species diversity and are widespread in all environments [1]. Fungi are of great importance in forest ecosystems worldwide. As decomposers, they are the most important organisms for the degradation of organic matter, and play a key role in nutrient cycling [2]. Mycorrhizal fungi form symbiotic associations with higher plants, facilitating plant uptake of water and nutrients such as phosphorus and nitrogen, in exchange for photosynthetically fixed carbon [2, 3].

The magnitude of global fungal diversity is largely unknown and it is estimated that only around 2–6 % of the existing fungal richness has been formally described [4]. Since many years, Hawksworth's proposal of 1.5 million fungal species [5] is one of the most frequently cited estimates of global fungal richness. However, updated estimates assume a much higher number of fungal species, ranging from 3.5 up to 5.1 million species based on high-throughput sequencing methods [6]. In a most recent publication, a variety of estimation techniques suggest a range for the number of fungal species worldwide between 2.2 and 3.8 million [7, 8].

Currently, there is interest in macromycete distribution patterns in relation to forest tree species composition [9, 10]. The relationship between tree and fungal communities is reflected in host trees affecting fungal specialization and providing unique habitat availability and different resource quality [11, 12, 13].

In forest ecosystems, biological diversity is caused by the vital activity of many organisms, including macromycetes [14, 15, 16]. They are widespread in nature and are a permanent component of biogeocenoses [17, 18]. As heterotrophic organisms, they take an active part in the biological cycle of substances and energy [19, 20]

Currently, the main commonly accepted characteristics of biodiversity are species composition, taxonomic structure and spatial organization.

The valley of the Ural River is the intrazonal center of biodiversity of Western Kazakhstan. Therefore, the study of the mycobiota of oak forests of the Ural River valley within the West Kazakhstan region is considered relevant.

As noted earlier by S.A. Nikitin (1954, 1956), V.V. Ivanov (1960), A.Z. Petrenko (1971), depending on the habitat conditions, the forest vegetation of the West Kazakhstan region is represented by the following groups: floodplain forests, splits of sandy massifs and estuary type depressions, ravine forests A characteristic feature of forest-growing conditions of these forests is their confinement to habitats that receive additional moisture by river, rain and meltwater, or to places with close groundwater [21].

Floodplain forests are confined to river valleys. These forests receive additional moisture due to spring flood waters and are distributed mainly in the floodplain of the Ural River and its tributaries. Depending on the ability of trees to withstand prolonged flooding, formations are formed: willow forests, aspen forests, white poplar forests, elm forests, aspen forests, birch forests, oak forests.

By ravine forests S.A.Nikitin and V.V.Ivanov mean special types of deciduous forests with steppe shrubs on the edges. They are connected with ravines and beams, inter-szyrt depressions in the pre-szyrt and szyrt parts of the region [21].

Poplar (*Populus alba, P. nigra*), elm (*Ulmus laevis*), willow (*Salix alba, S. triandra*) and oak (*Quercus robur*) forests are developed in the valley of the Ural River, forming floodplain and ravine oak forests.

The only natural habitat of oak forests in the Republic of Kazakhstan is the floodplain of the Ural River, as well as ravines and beams within the West Kazakhstan region [22].

Pedunculate oak (*Quercus robur* L.) is a rare species listed in the Red Book of the Republic of Kazakhstan, and is subject to protection. The southern and eastern borders of the pedunculate oak distribution range pass through this territory and the territory we are exploring is the only location of this species in the valley of the middle reaches of the Ural River. Along the valley of the Urals River passes the southern border of the distribution of common oak. To the south of the border N 51°02119.8 E 051°05226.1 oak is not found [22].

In order to ensure the conservation and restoration of oak forests, it is necessary to to find out the features of the functioning of these ecosystems and their individual components. One of the most significant components of any forest ecosystem, including oak forests, is macromycete fungi, which are part of the decomposer system [9]. They ensure the return of matter and energy to ecosystems, as they decompose organic residues (primarily wood), converting them to more easily digestible forms available for consumption by other organisms [9]. In this regard, we conducted research on the biota of macromycetes of floodplain and ravine oak forests of the middle course of the Ural River within the West Kazakhstan region.

The aim of this study is to identify of species diversity and analyze the mycobiota of oak forests of the Ural River valley within the West Kazakhstan region.

Material and Methods

The object of the study is the macromycetes of oak forests of the middle reaches of the Ural River within the West Kazakhstan region.

The area of our research is located within N 51 ° 28.879 E 053 ° 07.049 and N51 ° 19.097 ‘E51 ° 52 .810’ starting from the village of Priuralnyi to the village of Kabyltobe (Burli and Terekti districts) and within N51°27.506 ‘E52°27.376’ and N51°21.698 ‘E51°50.326’ from the village of Kirsanovo to the village of Ozernoe (Baiterek district) (Figure 1).

The material for this work was the author's own mycological collections and observations in nature, carried out during the field seasons from 2019 to October 2021 in the studied region. The collection of material was carried out by the route method in the vicinity of various geographical points. The habitat was noted for the samples, geographical coordinates were taken, photographs and descriptions of macromorphological features disappearing during herbarization were taken. Fruiting bodies were photographed in natural habitats and data on the substrate, neighbouring plants and collection dates were noted. Morphological features of collected fruiting bodies, such as shape, size, colour, odor, hymenophore and velum types, etc., were analysed. For samples, the habitat was noted, geographical coordinates were taken, photographs were taken and descriptions of macromorphological features disappearing during herbarization. All collected fruiting bodies were photographed using the camera Canon EOS 4000D and iPhone 12 camera.

The collection, drying and storage of fruit bodies of fungi, the identification of their distribution features, the description of biotopes and substrates, plant communities in the growing environment were carried out on the basis of methods used in conventional methods in mycology and botany. The macromycetes were identified based on macro and micromorphological features according to the descriptions available on books and journal articles.

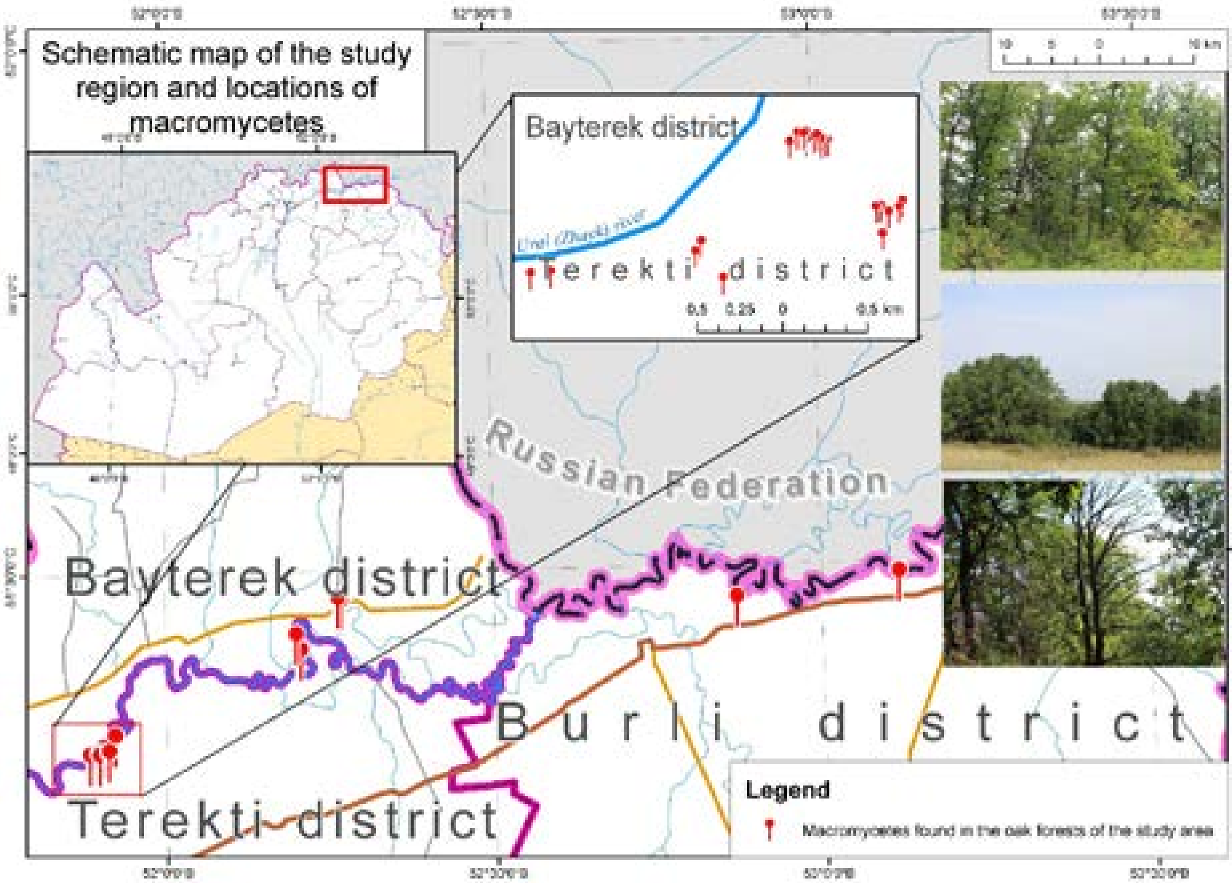

Figure 1 – Schematic map of the study region and locations of macromycetes

Macromorphological features were studied on the basis of fresh and dried material, as well as through analysis of photographs and descriptions taken in the field. Micromorphological structures have been studied on herbarium material. Identification, detailed examination of the material and photography were carried out using an Olympus DP72 microscope and an EVOS ® FL/FL fluorescent microscope.

At each site, geographical coordinates and elevation were recorded using a geographic positioning device (GPS, Garmin eTrex 30X).

Each sample was identified on the basis of macro- and micromorphological features. Names of fungi and author's abbreviations follow the Index Fungorum (http://www.indexfungorum.org/Names/Names.asp) [23] and Dictionary of the Fungi (Kirk et al.2008) [24]. Abbreviations of author's plant names comply with the standards established by the International Plant Names Index (IPNI 2008) [25].

Research results and discussion

According to our materials, 509 plant species were noted in the floodplain and ravine forests. In the flora of oak forests, 81 (15.9^0) woody and semi-woody species were identified in the flora of oak forests.. The main part of the flora is made up of perennial herbaceous plants of 428 species (84^0). There are 335 perennial herbaceous polycarpics (78.3^0), and there are fewer annual herbaceous monocarpics, they make up 93 species (21.7^0). Oak (*Quercus robur*) dominates in the tree cover of floodplain forests, besides it poplars (*Populus alba, P.nigra*), smooth elm (*Ulmus laevis*) live here.

Aspen (*Populus tremula*), birch (*Betula pendula, B. pubescens*), gray poplar (*Populus canescens*) are present in ravine forests. A rich shrub cover from forest boreal species is developed: hazel (*Coryllus avellana*), euonymus (*Euonymus verrucosus*), viburnum (*Viburnum opulus*), buckthorn (*Frangula alnus*), bird cherry (*Padus *avium*), currant (*Ribes nigrum*). In floodplain in the shrub layer, the composition is more depleted and consists of tatar honeysuckle (*Lonicera tatarica*), cherry (*Cerasus fruticosa*), brittle buckthorn (*Frangula alnus*), blackthorn (*Prunus spinosa*), wild rose (*Rosa majalis*). On the edges, dense shrubs of meadowsweet (*Spiraea hypericifolia*), caragana (*Caragana frutex*), broom (*Chamaecytisus borystenicus*) and bean (*Amygdalus nana*) are well developed.

As a result of our research, to date, 31 species of macromycetes belonging to 23 genera, 17 families and five orders have been identified in the mycobiota to date (Table 1).

Table 1 – Species diversity of macromycetes in oak forests of the Ural River valley within the West Kazakhstan region

Class, order, family (n of genus / n of species)	Genus (n of species)
Class: **AGARICOMYCETES (31)**	
Order: **AGARICALES (8/12)**	
Family: Agaricaceae (1/1)	*Agaricus (1)*
Amanitaceae (1/3)	*Amanita (3)*
Cortinariaceae (1/1)	*Cortinarius (1)*
Fistulinaceae (1/1)	*Fistulina (1)*
Hymenogastraceae (1/1)	*Hebeloma (1)*
Lycoperdaceae (1/2)	*Lycoperdon (2)*
Physalacriaceae (1/1)	*Hymenopellis (1)*
Psathyrellaceae (1/1)	*Coprinellus (1)*
Strophariaceae (1/1)	*Kuehneromyces (1)*
Order: **BOLETALES (2/6)**	
Boletaceae (3/5)	*Boletus (2), Suillellus (1), Xerocomellus (2)*
Sclerodermataceae (1/1)	*Scleroderma (1)*
Order: **GLOEOPHYLLALES (1/1)**	
Gloeophyllaceae (1/1)	*Neolentinus (1)*
Order: **POLYPORALES (3/7)**	
Fomitopsidaceae (1/1)	*Daedalea (1)*
Laetiporaceae (1/1)	*Laetiporus (1)*
Polyporaceae (4/5)	*Fomes (1), Lenzites (1), Lentinus (1), Trametes (2)*
Order: **RUSSULALES (2/5)**	
Russulaceae (2/4)	*Lactarius (3), Russula (1)*
Stereaceae (1/1)	*Stereum* (1)

Note: The taxonomic composition of the biota of macromycetes, presented for the first time for this area.

The leading families are *Polyporaceae, Boletaceae, Russulaceae, Amanitaceae*. In the families *Polyporaceae* – 5, *Boletaceae* – 5, *Russulaceae* – 4, *Amanitaceae* -3, *Lycoperdaceae* – 2 species, the remaining families are represented by one species

Floodplain oak forests occupy the terraced and central floodplain of the Ural River within the study area. The stand is dominated by oak (*Quercus robur*), besides it there are (*Populus alba, P.nigra*), smooth elm (*Ulmus laevis*). On the edge – maple (*Acer negundo*) and ash (*Fraxinus exelsior*). The shrub layer is well defined (*Lonicera tatarica, Rhamnus cathartica, Prunus spinosa*). Herbage rare ruderal. The floodplain oak forests occupying the terraced floodplain are characterized associations by oaks with forb-rose-hip (*Quercus robur, Rosa majalis*), broom (*Q.robur, Chamaecytisus borystenicus*), thorn (*Q.robur, Prunus spinosa*), blackberry (*Q.robur, Rubus caesius*), birthwort (*Q.robur, Aristolochia clematites*), bluegrass (*Q.robur, Poa angustifolia*); and for oak forests of the central floodplain associations oaks with lily-of-the-valley (*Q.robur, Convallaria majalis*), thorn-lily-of-the-valley (*Q.robur, Prunus spinosa, Convallaria majalis*), buckthorn-lily-of-the-valley (*Q.robur, Rhamnus cathartica, Convallaria majalis*), blackberry (*Q.robur, Rubus caesius*), sedge (*Q.robur, Carex acuta, C.supina, C. vulpina*), burdock (*Q.robur, Agrimonia pilosa*), horsetail-blackberry (*Q.robur, Equisetum arvense, Rubus caesius*), horsetail (*Q.robur, Equisetum arvense*), birthwort (Q.robur, Aristolochia clematites), mesophytic-sedge (*Q.robur, Carex supina*), bentgrass (*Q.robur, Agrostis albida*), sedge-lily of the valley (*Q.robur, Carex acuta, C. vulpina, Convallaria majalis*).

In the central floodplain in the oak-sedge association, *Fistulina hepatica* (Schaeff.) With, *Laetiporus sulphureus* (Bull.) Murrill, *Lactarius zonarius* (Bull.) Fr., *Lentinus arcularius* (Batsch) Zmitr., *Fomes fomentarius* (L.) Fr.; in oak -burdock *Fistulina hepatica* (Schaeff.) With; *Fistulina hepatica* (Schaeff.) With., *Laetiporus sulphureus* (Bull.) Murrill were registered in the oak forest of the horsetail-blackberry association; horsetail oak forest also contains *Laetiporus sulphureus* (Bull.) Murrill, *Fistulina hepatica* (Schaeff.) With.. *Fistulina hepatica* (Schaeff.) With., *Lycoperdon perlatum* Pers., *Lycoperdon excipuliforme* (Scop.) Pers.. Species *Neolentinus cyathiformis* (Schaeff.) Della Magg. & Trassin., *Xerocomellus pruinatus* (Fr. & Hök) Šutara, *Hebeloma crustuliniforme* (Bull.) Quél.), *Boletus* *edulis* Bull. identified in the oak-lily of the valley association.

In the associations characteristic of the terraced floodplain noted: in the oak blackberry, *Russula foetens* Pers, *Lactarius resimus* (Fr.) Fr., *Laetiporus sulphureus* (Bull.) Murrill, *Fistulina hepatica* (Schaeff.) With, *Hebeloma crustuliniforme* (Bull.) Quél.;in the oak birthwort *Fistulina hepatica* (Schaeff.) With, *Suillellus luridus* (Schaeff.) Murril; in oak bentgrass *Fistulina hepatica* (Schaeff.) With, *Laetiporus sulphureus* (Bull.) Murrill, *Lactarius deliciosus* (L.) Gray.

In the floodplain oak forests, macromycetes are most noted in the central floodplain, in which 11 species have been identified, and the near-terrace floodplain is represented by a meager species composition, where 7 species of macromycetes have been identified. This may be due to the fact that the central floodplain is flooded with spring thawed flood waters. And the poverty of the species composition of macromycetes of the near-terrace floodplain is explained by the fact that upland vegetation smoothly passes into the near-terrace floodplain and xerophilic oak forests developed here.

In turn, ravine oak forests are formed in the beams along different elements of the beams (the bottom, the lower part of the slope, the middle part of the slope, the edge of the beam). The depth of the ravine forests ranges from 20 to 25 m. Broad-leaved oak forests with a rich boreal and nemoral species diversity are formed in the ravine forests. Although the length of such oak forests is between 1500 and 2000 m.

A permanent stream flows along the bottom from the upper reaches of the beams to the mouth, a permanent stream flows along the bottom, near which oak forests are formed in combination with gray poplar and euonymus (*Q.robur, Populus canescens, Euonymus verrucosus*), oak euonymus-horsetail (*Q.robur, Euonymus verrucosus, Equisetum arvense*), oak lily-of-the-valley (*Q.robur, Convallaria majalis*), oak bentgrass (*Q.robur, Agrostis albida*), oak elecampane-sedge (*Q.robur, Inula helenium, Carex vulpina*), oak butterbur (*Q.robur, Petasites spurious*), oak herb-reed (*Q.robur, Galium boreale, Sonchus palustris, Equisetum arvense, Phragmites australis*), oak fern-brack (*Q.robur, Pteridium aquilinum*).

Here, in the oak forest of the euonymus-horsetail association, *Laetiporus sulphureus* (Bull.) Murrill was noted, in the lily-of-the-valley oak forest *Daedalea quercina* (L.) Pers., in the oak bentgrass *Lenzites betulinus* (L.) Fr., (Schaeff .) Singer & A.H. Sm., oak butterbur *Trametes versicolor* (L.) Lloyd, *Laetiporus sulphureus* (Bull.) Murrill, *Suillellus luridus* (Schaeff.) Murril and in oak bracken-fern *Suillellus luridus* (Schaeff.) Murril.

The following associations are characteristic along the bottom of the beams: oak with lily-of-the-valley (*Q.robur, Convallaria majalis*), euonymus-horsetail (*Q.robur, Euonymus verrucosus, Equisetum arvense*), aspen-oak-lily-of-the-valley (*Populus tremula, Q.robur, Convallaria majalis*), lily-of-the-valley-cherry (*Q.robur, Convallaria majalis, Cerasus fruticosa*), fern (*Q.robur, Dryopteris filix-mas*), broom (*Q.robur, Chamaecytisus borystenicus*), bluegrass (*Q.robur, Poa angustifolia*), mesophytic-fern-bracken (*Q.robur, Origanum vulgare, Galium boreale, Viola canina, Pteridium aquilinum*) sedge-horsetail (*Q.robur, Carex vulpina, Equisetum arvense*), horsetail (*Q.robur, Equisetum arvense*), sedge oak forest (*Q.robur, Aristolochia clematites*), sedge (*Q.robur, Carex vulpina, C.supina*).

In the oak forest of the lily-of-the-valley association of gully oak forests, such species of macromycetes as *Suillellus luridus* (Schaeff.) Murril, *Agaricus* sp., *Amanita pantherina* (DC.) Krombh., *Amanita muscaria* (L.) Lam., *Daedalea quercina* (L.) Pers., *Boletus reticulatus* Schaeff..

In the oak euonymus-horsetail associations *Fistulina hepatica* (Schaeff.) With., *Laetiporus sulphureus* (Bull.) Murrill, in the aspen-oak-lily-of-the-valley association we found *Daedalea quercina* (L.) Pers; .) Murril, in oak horsetail associations *Fistulina hepatica* (Schaeff.) With., *Laetiporus sulphureus* (Bull.) Murril, in oak birthwort associations *Cortinarius* sp., *Fistulina hepatica* (Schaeff.) With.

Suillellus luridus (Schaeff.) Murril, *Trametes versicolor* (L.) Lloyd were registered in the oak forest-forb-reed association; in the oak forest-sedge association *Fistulina hepatica* (Schaeff.) With., *Laetiporus sulphureus* (Bull.) Murrill, ex Watling) Šutara, in the ash-oak-lily-of-the-valley association *Trametes ochracea* (Pers.) Gilb. & Ryvarden, *Laetiporus sulphureus* (Bull.) Murrill, *Scleroderma citrinum* Pers. and *Fomes fomentarius* (L.) Fr., *Stereum subtomentosum* Pouzar were found in the oak-ash-sedge association.

The lower and middle parts are occupied by oak forests: hazel-lily of the valley (*Q.robur, Coryllus avellana, Convallaria majalis*), broom-forb (*Q.robur, Fritillaria meleagroides, Cucubalus baccifer, Melica nutans, Chamaecytisus borystenicus*), cherry (*Q.robur, Cerasus fruticosa*), broom with sedge (*Q.robur, Chamaecytisus borystenicus, C.supina*).

In associations of oak forests occupying the lower and middle parts of the slope, namely, in the hazel-lily of the valley *Boletus edulis* Bull., *Lactarius resimus* (Fr.) Fr., in the cherry oak forest *Xerocomellus porosporus* (Imler ex Watling) Šutara, *Lactarius deliciosus* (L.) Gray, *Coprinellus micace*us (Bull.) Vilgalys, in broom-sedge oak forest *Boletus reticulatus* Schaeff., *Amanita phalloides* (Vaill. ex Fr.) Link.

Along the edge of the ravines, oak – birthwort (*Q.robur, Aristolochia clematites*) associations were noted, where *Amanita phalloides* (Vaill. ex Fr.) Link, *Laetiporus sulphureus* (Bull.) Murrill, *Fistulina hepatica* (Schaeff.) With.

Thus, it can be seen that in ravine oak forests there is a richer species composition, where, according to our observations, 23 species of macromycetes and well-defined associations are noted, which are represented by forest boreal tree and shrub species absent in floodplain oak forests, and also favorable microclimatic conditions, unlike floodplain oak forests, which are more susceptible to natural, anthropogenic and technogenic impacts, due to the proximity of oil and gas condensate fields.

It should be noted that among the identified species *Fistulina hepatica* (Schaeff.) With and *Laetiporus sulphureus* (Bull.) Murrill were encountered much more often both in ravine and floodplain oak forests, in comparison with other species. It should be taken into account that both of them are wood-destroying fungi that parasitize *Quercus robur* L. If *Fistulina hepatica* (Schaeff.) causes dark brown butt or butt-stem rot and settles mainly on living trees, weakening them and reducing their vital activity, then *Laetiporus sulphureus* (Bull.) Murrill causes a red-brown butt-stem rot of a destructive type, which also affects living oak trees, but can also develop on dead wood (cut and fallen trunks, stumps). This species is a pronounced oligophagous inhabiting oak forests in addition to oak trees and other species.

One of the most significant characteristics of mycobiota is its trophic structure, since the study of the trophic relationships of fungi comes to the fore in the knowledge of ecological relationships in natural ecosystems, where fungi play an important role (Table 2).

Table 2 – Ecological and trophic confinement of macromycetes in the study area

№	**Species of macromycetes**	Mr	Hu	Le
1.	Agaricus sp.		+	
2.	Amanita muscaria (L.) Lam.	+		
3.	Amanita pantherina (DC.) Krombh.	+		
4.	Amanita phalloides (Vaill. ex Fr.) Link	+		
5.	Boletus edulis Bull.	+		
6.	Boletus reticulatus Schaeff.	+		
7.	Coprinellus micaceus (Bull.) Vilgalys, Hopple & Jacq. Johnson,			+
8.	Cortinarius sp..	+		
9.	Daedalea quercina (L.) Pers.			+
10.	Fistulina hepatica (Schaeff.) With.			+
11.	Fomes fomentarius (L.) Fr.-			+
12.	Hebeloma crustuliniforme (Bull.) Quél.)	+		
13.	Hymenopellis radicata (Relhan) R.H. Petersen			+
14.	Kuehneromyces mutabilis (Schaeff.) Singer & A.H. Sm.			+
15.	Lactarius deliciosus (L.) Gray	+		
16.	Lactarius resimus (Fr.) Fr.	+		
17.	Lactarius zonarius (Bull.) Fr.	+		
18.	Laetiporus sulphureus (Bull.) Murrill			+
19.	Lentinus arcularius (Batsch) Zmitr.			+
20.	Lenzites betulinus (L.) Fr.			+

Continuation of the table

№	Species of macromycetes	Mr	Hu	Le
21.	Lycoperdon excipuliforme (Scop.) Pers.,		+	
22.	Lycoperdon perlatum Pers.		+	
23.	Neolentinus cyathiformis (Schaeff.) Della Magg. & Trassin.			+
24.	Russula foetens Pers.	+		
25.	Scleroderma citrinum Pers.		+	
26.	Stereum subtomentosum Pouzar			+
27.	Suillellus luridus (Schaeff.) Murril	+		
28.	Trametes ochracea (Pers.) Gilb. & Ryvarden			+
29.	Trametes versicolor (L.) Lloyd			+
30.	Xerocomellus porosporus (Imler ex Watling) Šutara	+		
31.	Xerocomellus pruinatus (Fr. & Hök) Šutara	+		

Note: Mr- mycorrhizal, Hu – humus saprotrophs, Le (lignum epigaeum) – on wood

When analyzing the ecological and trophic confinement of macromycetes, it was noted that mycorrhizal are leading in the studied mycobiota, it accounts for 45.1% of the total number of species, xylotrophs account for 41.9%, and the share of humus saprotrophs is 12.9% of the total number of species.

Conclusion

As a result of research, we registered for the first time for the study area 31 species of macromycetes belonging to 23 genera, 17 families and five orders, and geobotanical descriptions of oak forests are also given.

The families *Polyporaceae*, *Boletaceae*, *Russulaceae*, *Amanitaceae* are the leaders in the taxonomic spectrum in the mycobiota of oak forests.

The spectrum of the ecological and trophic structure of the biota showed that the most numerous group is symbiotrophs, among which mycorrhizal fungi are 45.1%. Saprotrophs account for 17 species (54.8%), among them xylotrophs make up 41.9%, and the share of humus saprotrophs is 12.9%.

The obtained data make a significant contribution to the knowledge of the diversity of macromycetes of oak forests in the Ural River valley within the West Kazakhstan region, information about which in Kazakhstan is still insufficient and fragmentary on the territory of Kazakhstan.

Conflict of interest

All authors declare that they have no conflict of interest.

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