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Bryophytes of the upper reaches of the Western Bug River (Lviv Region, Ukraine)

Introduction

The upper reaches of the Western Bug River (Lviv Region) are physically and geographically located within the boundaries of Male Polissya, partly Roztochia, and to a minor extent in the Gologoro-Voronyatsky denudo-structural hills. On the territory of Lviv Region, the natural area of Male Polissya lies within the central part of the Western Bug; its geological composition is dominated by marls covered with alluvial sand deposits. Only on the territory of the Batyatytsia remains, Neogene sandstones have been preserved, indicating the presence of a tertiary stratum in this area in the past (Tsys, 1962).

Geographers distinguish five main geomorphological regions within Male Polissya in Lviv Region: the Ratyn gently undulating aquaglacial alluvial denudation plain, the Bug-Styr gently undulating aquaglacial denudation alluvial plain, the Radekhiv undulating denudation plain, the Pidpodilska undulating-residual denudation plain, and the Upper Pobuzhia with aeolian loess ridges and wide valleys between the ridges (Nazaruk et al., 2018). The area is represented by pine, oak and pine, and occasionally hornbeam and oak forests, as well as floodplain meadows and swamps (eutrophic and less frequently meso- and oligotrophic). The latter are represented by a wide range of aquatic vegetation (Didukh, 2003).

The bryophytes of the above-mentioned area have not been studied well. The first scientific records of the bryophytes in Lviv Region can be found in the works of J.H. Lobarzewski, a botanist and a professor of the Lviv University who was the first to publish data on mosses of Galicia based on his own collection (Lobarzewski, 1847, 1849). Most data on bryophytes were published by J. Krupa: 71 species of liverworts and 225 species of mosses, some of which were collected outside the city of Lviv (Krupa, 1885). We can find some data in the work of bryologists such as A. Geheeb

(1899), F. Lilienfeldówna (1910, 1911, 1914), A.J. Żmuda (1911), T. Wilczyński in 1912 (Tasenkevich et al., 2013), who completed "Zielnik Wilczyńskiego" – a collection of bryophytes including those from the outskirts of Lviv and Roztochia, A.T. Wisniewski (1923) and others. However, this information concerns only individual collections from the outskirts of Lviv.

In the second half of the twentieth century, Zerov (1964), Slobodyan (1967), Ulychna (1978, 1979), Bradis (1969), and bryologists of the Institute of Ecology of the Carpathians (Danylkiv et al., 2002) studied bryophytes of this area. Among modern researchers, the most valuable contributions were made by a Lviv botanist A. Kuzyarin, who studied the floodplain vegetation of the upper reaches of the Western Bug basin and, in addition to vascular plants, collected mosses (Kuzyarin, 2010, 2012, 2013), and M. Ragulina, who studied bryophytes of quarry outcrops of Lviv Region (Ragulina et al., 2012; Ragulina, Kuzyarin, 2014). The bryoflora of the Chervonohrad coal basin was studied by Kuzyarin (2013) and Karpinets et al. (2017). I. Danylkiv compiled the first annotated list of bryophytes for the Chronicle of nature of the national park "Northern Podillya". However, this information was not published. Some data on mosses from the upper reaches of the Western Bug River are presented in the collections of The Moss Flora of the Ukrainian SSR and The Moss Flora of Ukraine (Bachuryna, Melnychuk, 1987, 1988, 1989, 2003).

This article reports new findings on the species composition and distribution of bryophytes, as well as analyses of substrate preferences, ecological groups and life forms of bryophyte species from the upper reaches of the Western Bug River.

Materials and methods

The field survey was carried out by the route method (Lazarenko, 1955; Ignatov, Ignatova, 2003) in the period from 2017 to 2019 in the upper reaches of the Western Bug River within Male Polissya and partly on the territory of the Gologoro-Voronyatsky denudo-structural hills (Fig. 1). In the course of the study, 14 sites were surveyed: the Volytsky Botanical Reserve of national importance, the Romaniv Landscape Reserve of local importance, the Storonybaby Nature Reserve of local importance, the Pidlyska Hill (Shashkevych Hill) complex natural monument of local importance, the Zhovkivska botanical natural monument of local importance, the Ivan Franko Park in Busk, a railway track outside the village of Zakomarya, a floodplain of the Solotvyna River, the outskirts of the villages of Kulychkiv, Zarvanytsia, Poltva, Zavady, Pidlyssia, Romaniv and Shopky. Various types of ecotopes were examined: swamps, swampy forests, floodplains of rivers, oak, pine, beech and mixed forests, urban ecosystems, railway tracks, etc.

Fig. 1. Map of the study area within the upper reaches of the Western Bug River (Numbers of research areas correspond to those in table 1 and table 2 – Appendix 1)

Tab. 1. Information on localities of the study area within the upper reaches of the Western Bug River

No.	Place	Coordinates	Date
1.	the Volytsky Botanical Reserve	50°17′25.2″N, 23°57′57.6″E	16.05.2018 29.04.2018
2.	swampy mixed forests near the village of Kulychkiv	50°16′50.3″N, 24°06′33.3″E	22.07.2018
3.	Ivan Franko Park in Busk	49°57′59.9″N, 24°36′30.3″E	28.03.2018
4.	floodplain of the Solotvyna River	49°56′55.0″N, 24°47U48.2″E	25.03.2017
5.	railway track near the village of Zakomarya	49°57′00.0″N, 24°45′30.2″E	28.03.2018
6.	the Storonybaby Nature Reserve	49°56′37.6″N, 24°39′44.9″E	03.09.2017
7.	swampy meadow near the village of Zarvanytsia	49°46′16.9″N, 24°59′36.0″E	17.07.2018
8.	mixed forest near the village of Zarvanytsia	49°45′21.8″N, 24°58′26.8″E	19.07.2018
9.	the outskirts of the village of Poltva	49°52′34.0″N, 24°30′47.4″E	24.09.2019
10.	the outskirts of the village of Romaniv and the Romaniv Landscape Reserve	49°41′57.4″N, 24°21′26.6″E	23.03.2018
11.	the outskirts of the village of Zavady and the Zhovkivska botanical natural monument of local importance	50°03′00.5″N, 23°54′25.2″E	28.08.2017
12.	the outskirts of the village of Pidlyssia and the Pidlyska Hill (Shashkevych Hill) complex natural monument of local importance	49°55′58.4″N, 24°51′06.0″E	16.04.2018
13.	the outskirts of the village of Shopky	49°44′51.7″N, 24°31′41.7″E	09.06.2018
14.	the outskirts of the village of Novyi Yarychiv	49°52′43.9″N 24°17′44.8″E	29.09.2019

Sample collection and identification was conducted by methods of bright-field microscopy. Latin names of taxa are given according to the checklists by Boiko (2014) and Mosyakin, Fedoronchuk (1999). Sozological assessment is given according to Boiko (2010) and Hodgetts et al. (2019). The following substrate types on which the species grew were noted: RO – rocks; StA – artificial stone; SG – soil with gravel or sand; SO – soil; SV – soil among grass or leaf litter; WR – rotten wood; WL – living wood; AM – aqueous medium. Ecological groups and life forms of are given according to Hill et al. (2007) and Ellenberg, Leuschner (2010).

Results

Based on our survey, 165 species belonging to 92 genera, 41 families, and 18 orders were identified (Tab. 2 – Appendix 1). Out of the recorded taxa, 151 species were mosses (Bryophyta), 13 species were liverworts (Marchantiophyta) and one was a hornwort (Anthocerotophyta). Families with the highest numbers of recorded species, which comprise 66.7% of all identified species, are: Brachytheciaceae (12.1%), Pottiaceae (11.5%), Amblystegiaceae (8.5%), Mniaceae (7.3%), Orthotrichaceae (6.1%), Hypnaceae (4.8%), Bryaceae (4.8%), Sphagnaceae (4.2%), Polytrichaceae (3.6%), Dicranaceae (3.6%).

Among the found species, three are on the list of species officially recognised as rare – *Alleniella besseri*, *Campyliadelphus elodes*, *Tomenthypnum nitens* and 16 are recognised as regionally rare – *Aloina rigida*, *Aulacomnium androgynum*, *Calliergon giganteum*, *Dicranum flagellare*, *Didymodon tophaceus*, *Encalypta streptocarpa*, *Porella platyphylla*, *Rhodobryum ontariense*, *Sciurohypnum plumosum*, *S. reflexum*, *Sphagnum cuspidatum*, *S. fallax*, *S. fimbriatum*, *Straminergon stramineum*, *Syntrichia papillosa*, *Taxiphyllum wissgrillii*.

Substrate preferences

By substrate preference, most of the identified species were epigean (116 species, 70.3%). They are dominated by bryophytes that grow on bare soil or with minor inclusion of grasses (SO – 98 species, 59.4%). Species that grow on soil among grass (SV – 33 species, 20%) and on sandy or gravelly soil (SG – 31 species, 18.8%) also constitute a significant share. The most frequent are typical forest species: *Atrichum undulatum*, *Dicranella heteromalla*, *Fissidens taxifolius*, *Polytrichum commune*, *Pseudoscleropodium purum*, *Rhytidiadelphus squarrosus*, *Eurhynchium angustirete*. Species *Cratoneuron filicinum*, *Drepanocladus aduncus*, *Kindbergia praelonga*, *Leptodictyum riparium*, *Oxyrrhynchium speciosum* and *Sciurohypnum plumosum* grow along the banks of rivers.

A group of epiphytes (46 species, 27.9%) is significantly represented by forest species: *Anomodon attenuatus*, *Homalia trichomanoides*, *Leucodon sciuroides*, *Metzgeria furcata*, *Porella platyphylla*, *Radula complanate*. These species are most commonly found in mixed forests on the bark of trees such as *Acer platanoides*, *A. pseudoplatanus*, *Alnus glutinosa*, *Fraxinus excelsior*, *Quercus robur*, occasionally *Fagus sylvatica* and others.

Due to the significant presence of wood at different stages of decomposition in moist fairly intact mixed forests, epixile species are quite common in the study area (WR – 56 species, 33.9%). Among the obligate epixiles, relatively rare species were found: *Dicranum flagellare*, *Lepidozia reptans*, *Nowellia curvifolia*, *Ptilidium pulcherrimum*, *Riccardia latifrons* and *Tetraphis pellucida*. Polysubstrate species also inhabit decaying wood; they include: *Brachythecium salebrosum*, *Callicladium haldanianum*, *Dicranum montanum*, *D. polysetum*, *Herzogiella seligeri*, *Hypnum cupressiforme*, *Platygyrium repens*, *Sciurohypnum populeum* and others.

The fourth most numerous bryophyte group is composed of epilithic species – 43 species (29.6%). Among them, 28 species (17.0%) grow on artificial rocky substrate (StA) and 23 species (13.9%) on natural stone or rock outcrops (RO). Seven species (4.2%) were found on both types of rocky substrates. The group is represented by both typical obligate epiliths (*Alleniella besseri*, *Didymodon rigidulus*, *Homalothecium lutescens*, *Orthotrichum anomalum*, *Rhynchostegium murale*, *Tortula muralis*) and facultative ones (*Amblystegium serpens*, *Ceratodon purpureus*, *Brachythecium rutabulum*, *Leskea polycarpa*, *Plagiomnium cuspidatum*).

The lowest number of identified species belong to a group of bryophytes that are completely or partially submerged in water (22 species, 13.3%). These are species that grow in swamps, ditches and other wetland areas – *Brachythecium mildeanum*, *Calliergon cordifolium*, *C. giganteum*, *Calliergonella cuspidata*, *Campyliadelphus elodes*, *Campylium stellatum*, *Cratoneuron filicinum*, *Leptodictyum riparium*, *Drepanocladus aduncus*, *Hygroamblystegium tenax*, *Fissidens adianthoides*, *Ptychostomum pseudotriquetrum*, *Scorpidium cossonii* and *Warnstorfia fluitans*.

Ecological groups

Although the substrate plays an important role in the life of the bryophytes, environmental conditions are no less important, since factors such as humidity, light and temperature play a decisive role for them. Thus, within the spectrum of heliomorphs, dominate the species that inhabit both moderately shaded and illuminated places – subheliophytes (51 species, 30.9%) and hemisciophytes (51 species, 30.9%). Slightly fewer of the identified species belong to the group of bryophytes adapted to a habitat with a very intensive insolation – heliophytes (24 species, 14.5%) and ultraheliophytes (14 species, 8.5%). A small number (19 species, 11.5%) of the identified bryophytes –

sciophytes, prefer well-shaded ecotypes. Six species (3.6%) are indifferent to light or the indicator has not been established.

The distribution of hydromorphs indicates the predominance of species with intermediate characteristics in relation to moisture among the studied bryophytes – mesophytes (49 species, 29.7%), hygromesophytes (35 species, 21.2%) and xeromesophytes (32 species, 19.4%). Significantly fewer species represent the groups of drought-tolerant species (xerophytes – 20 species, 12.1% and ultraxerophytes – 4 species, 2.4%) and species that inhabit wet and humid places (hygrophytes – 25 species, 15.2%).

In terms of temperature regime, more than half of the bryophytes are cold-tolerant (98 species, 59.4%). Significantly fewer moderately heat-tolerant (29 species, 17.6%) and heat-tolerant (6 species, 3.6%) species were found. Almost one-fifth of the species are indifferent or demonstrate no specific characteristics in relation to temperature.

By pH preference dominate neutrophils (83 species, 50.3 %) followed by acidophiles – species growing on acidic substrates (34 species, 20.6 %) and extreme acidophiles (2 species, 1.2 %). The smallest number of the detected species (19 species, 11.5 %) belong to sub-basophils and basophils (3 species, 1.8 %) that grow on substrates with free calcium carbonate, mainly chalk and limestone.

Life forms

In terms of the structure of life forms of the bryophytes distinguishes two groups of bryophytes: shoots that are not part of an organised colony and shoots that form a part

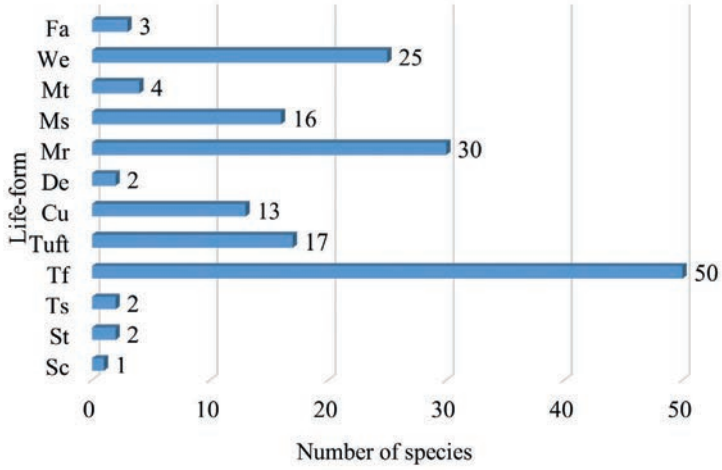

Fig. 2. The range of life forms of bryophytes in the upper reaches of the Western Bug River: Fa – fan, We – weft, Mt – thalloid mat, Ms – smooth mat, Mr – rough mat, De – dendroid, Cu – cushion, Tuft – loose cushion, Tf – turf, Ts – scattered turf, St – solitary thalloid, Sc – solitary creeping shoots

of an organised colony. In terms of the structure of life forms of the bryophytes (Fig. 2), in the study area, the first group was represented by only 5 species (2.9%): *Straminergon stramineum* – solitary creeping shoots (Sc), *Riccia glauca* and *Anthoceros agrestis* – solitary thalloid (St), *Aloina rigida* and *Phascum piliferum* – scattered turf (Ts). The second group is dominated by species forming turfs (Tf) – 50 species (30.3%), loose cushions (Tuft) – 17 species (10.3%). Next come species with a mat life form: rough mat (Mr – 30 species, 18.2%), smooth mat (Ms – 16 species, 9.7%), thalloid mat (Mt – 4 species, 2.4%). The third place is occupied by species that form tightly intertwined turf – weft (We) – 25 species (15.2%). The cushion life form (Cu) is characteristic of 13 species (7.9%) – these are mainly epiliths and epiphytes (*Orthotrichum* spp., *Dicranum montanum*, *Grimmia pulvinata* and others). The least numerous is dendroid (De) – 2 species (1.2%) and fans (Fa) – 3 species (1.8%).

Discussion

The upper reaches of the Western Bug River (Lviv Region) are distinguished by rich species diversity, a wide range of ecomorphs and substrate groups of the bryophytes due to heterogeneity of the relief, a considerable diversity of ecotopes (pine, oak and mixed forests, open and forest bogs, river floodplains, areas affected by anthropogenic transformations, etc.), as well as a significant number of protected areas (the Roztochia nature reserve, the Yavorivsky National Park, the Northern Podillya National Park, the Volytsky botanical reserve of national importance, the Romaniv landscape reserve of local importance, the Storonybaby nature reserve, the Pidlyska Hill (Shashkevych Hill) complex natural monument of local importance, the Zhovkivska botanical natural monument of local importance, the Hryada forest reserve and others).

The following nine species are reported for the first time for Lviv Region: *Orthotrichum patens*, *Palustriella falcata*, *Pedinophyllum interruptum*, *Ptychostomum torquescens*, *Rhodobryum ontariense*, *Sphagnum angustifolium*, *S. inundatum*, *Taxiphyllum wissgrillii*, *Tortella humilis* (Zerov, 1964; Bachuryna, Melnychuk, 1987, 1988, 1989, 2003; Boiko, 2014). We have also confirmed the presence of *Campyliadelphus elodes* on the outskirts of the village of Zarvanytsia (Kuzarin, 2012), which was found in a swampy reclamation canal. This is the third locality of the distribution of this species in Ukraine (Bachuryna, Melnychuk, 2003).

Pedinophyllum interruptum, which was found on soil in the wood on the outskirts of the village of Zarvanytsia, is reported for the first time not only for Lviv Region but also for the whole plain territory of Ukraine. Previous findings of this species were reported from the territory of the Ukrainian Carpathians (Zerov, 1964; Boiko, 2014). The families Brachytheciaceae and Pottiaceae typically dominate on most of the plains

of Lviv Region as well as the upper reaches of the Western Bug River (Kuzyarin, 2010, 2013; Mamchur et al., 2017a, b, 2018; Rahulina, Kuzyarin, 2014).

The bryoflora of this territory is represented by a large number of boreal and nemoral species as well as typical arid species characterised by a significant level of synanthropisation (Lazarenko, 1956; Boiko, 1999).

Relative to light tolerance, the spectrum of ecomorphs is dominated by hemisciophytes and subheliophytes, in relation to humidity – by mesophytes, and in terms of temperature regime – by cold-tolerant species, by substrate preference – by neutrophils.

A wide diversity in the life forms of bryophytes in the study area is also due to the variety of growth conditions. However, turf, rough mat, weft, tuft and smooth mat forms prevail. Apparently, the dominance of turfs is due the significant environmental tolerance of this life form, in particular, the species that represent it are capable of withstanding high levels of solar radiation. Such life forms as mat and weft are characteristic of the species with perennial life strategies and consequently are more widely distributed (During, 1979, 1992; Batista et. al., 2018). The bryophytes grow on a variety of substrates of both natural and anthropogenic origin. Among the variety of substrates, the bryophytes most often give preference to bare soil, or soil with a slight inclusion of grasses. In terms of moisture conditions, epigean bryophytes usually occur in turfs, mats or even wefts, which is characteristic of species of both natural and anthropogenically affected ecosystems (Mamchur et al., 2017b).

The epixile group is well represented due to the availability of wood at different stages of decomposition in the natural ecosystems. The most common life forms are rough mat, smooth mat, weft, tuft and turf.

The epilithic species grow on different types of rocky substrates, of both natural and artificial origin. An increase in the number of anthropogenic rocky ecotopes contributes to an increase in the proportion of epilithic species (Mamchur et al., 2018). The predominant life forms of epiliths are rough mats, turfs, tufts and cushions. The species that grow on natural rocks are dominated by rough mat, turf and weft, while those growing on artificial rock are mainly represented by rough mat, turf, tuft and cushion. Among the bryophytes that are partially or completely submerged in water, the most common life forms are turf, weft and rough mat. The life form of rough mat is the most common in the group of polysubstrate species, as it is suitable for bryophytes with various substrate preferences.

In general, the species composition of the bryophytes occurring in habitats under anthropogenic impact is relatively insignificant. It is mainly represented by synanthropic species distinguished by a considerable environmental plasticity: *Amblystegium serpens*, *Brachytheciastrum velutinum*, *Brachythecium glareosum*, *B. rutabulum*, *Bryoerythrophyllum recurvirostrum*, *Bryum argenteum*, *B. caespiticium*, *Ceratodon*

purpureus, *Fissidens taxifolius*, *Funaria hygrometrica*, *Hypnum cupressiforme*, *Plagiomnium cuspidatum*, *P. rostratum*, *Pohlia nutans*, *Syntrichia ruralis* (Ochyra,1983; Wolski, Fudali, 2013; Maslovsky, 2012; Godovičová, 2019; Szűcs, 2020).

Anthropotolerant epiphytes in the upper reaches of the Western Bug River are dominated by *Leskea polycarpa*, *Platygyrium repens*, *Pseudoleskeella nervosa*, *Ptychostomum moravicum*, *Pylaisia polyantha*, *Syntrichia papillosa* (Fudali, 2012; Marka, 2017; Mamchur et al., 2018; Szűcs, 2020). In terms of life forms, epiphytes are mainly represented by rough and smooth mats, much less frequently by cushions or turfs.

On the contrary, a considerable diversity of species is typical of various types of areas under protection. It was on those sites that the officially and regionally recognised rare species of the bryophytes were found. In particular, such species as *Alleniella besseri*, *Aloina rigida*, *Encalypta streptocarpa*, *Porella platyphylla*, *Taxiphyllum wissgrillii* were found on the territory of the Romaniv Landscape Reserve of local importance; *Tomenthypnum nitens*, *Calliergon giganteum*, *Sphagnum cuspidatum*, *S. fallax*, *S. fimbriatum*, *Straminergon stramineum*, *Syntrichia papillosa* – in the Volytsky Botanical Reserve of national importance; *Didymodon tophaceus*, *Rhodobryum ontariense* – on the territory of the Pidlyska Hill (Shashkevych Hill) complex natural monument of local importance; *Aulacomnium androgynum*, *Dicranum flagellare*, *Calliergon giganteum*, *Sphagnum cuspidatum*, *S. fallax* and *S. fimbriatum* – in the mixed forest on the outskirts of the village of Kulychkiv. This fact proves the significant role of protected areas for the preservation of the biodiversity of species, particularly the bryophytes (Virchenko, Orlov, 2009; Virchenko, 2014; Barsukov, 2015).

The study area is also distinguished by a significant number of species growing in wetlands. Given the large areas of drained land in Lviv Region, rare species are of particular value. Swamps and water bodies are among the most endangered habitats of the bryophytes in Europe, primarily due to drainage of wetlands (Hodgetts et al., 2019). Therefore, the preservation of the officially and regionally recognised rare species of the bryophytes in the upper reaches of the Western Bug River (19 species altogether) is particularly important, especially wetland species such as *Aulacomnium androgynum*, *Calliergon giganteum*, *Campyliadelphus elodes*, *Sphagnum cuspidatum*, *S. fallax*, *S. fimbriatum*, *Straminergon stramineum* and *Tomenthypnum nitens*.

In phytocenoses, the bryophytes are particularly sensitive components that respond to minor changes in the environmental conditions. In ecosystems, the bryophyte component plays a significant role in the nitrogen, carbon, biomass, and water balance cycles (Turetsky, 2003). In accordance with the Development Strategy of Lviv Region by 2027, the preservation of biodiversity, the protection of valuable natural areas and expansion of nature reserves are top priority issues (*Development strategy of Lviv Region*, 2019). Given that, inventory and further study of the bryoflora are highly important.

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Conflict of interest

The author declares no conflict of interest related to this article.

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Appendix 1

Tab. 2. Recorded species and substrate preferences of bryophytes in the upper reaches of the Western Bug River; explanation of abbreviations in the text (see "Materials and methods")

No.	Species	Substrate	Research area
		Anthocerotophyta	
1.	Anthoceros *agrestis*	SO	6
		Marchantiophyta	
2.	*Aneura pinguis*	AM	7
3.	*Conocephalum conicum*	RO	9, 10
4.	*Lepidozia reptans*	WR	2
5.	*Lophocolea heterophylla*	SG, WR, WL, AM	1, 2, 6, 8
6.	*Metzgeria furcata*	SO, WL	8, 10
7.	*Nowellia curvifolia*	WR	2
8.	*Pedinophyllum interruptum*	SO	8
9.	*Plagiochila asplenioides*	SO	10
10.	*Porella platyphylla*	RO, WL	3, 10
11.	*Ptilidium pulcherrimum*	WR	2
12.	*Radula complanata*	WR, WL	3, 4, 6, 8, 14
13.	*Riccardia latifrons*	WR	2
14.	*Riccia glauca*	SO	14
		Bryophyta	
15.	*Abietinella abietina*	RO, SG, SO, SV	1, 2, 8, 9, 10, 11, 12
16.	*Alleniella besseri*	RO	10
17.	*Aloina rigida*	SG	10
18.	*Amblystegium serpens*	RO, StA, SG, SO, SV, WR, WL	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 14
19.	*Anomodon attenuatus*	SO, WR, WL	4, 8
20.	*Anomodon longifolius*	WR, WL	4, 8
21.	*Anomodon viticulosus*	RO	10
22.	*Atrichum undulatum*	SG, SO, WR	6, 10, 11
23.	*Aulacomnium androgynum*	SO	2
24.	*Aulacomnium palustre*	SO, SV, AM	1, 2
25.	*Barbula convoluta*	RO, SG	5, 12
26.	*Barbula unguiculata*	RO, StA, SG	2, 4, 8, 10, 11
27.	*Brachytheciastrum velutinum*	RO, SO, WR, WL	2, 6, 8, 10, 11, 12
28.	*Brachythecium albicans*	StA, SG	1, 5, 11
29.	*Brachythecium campestre*	SO, WR	1, 2, 6
30.	*Brachythecium glareosum*	RO, StA, SG, SO, SV, WR, WL	4, 5, 8, 9, 10, 11, 12
31.	*Brachythecium mildeanum*	AM	1
32.	*Brachythecium rutabulum*	StA, SG, SO, SV, WR, WL	1, 2, 3, 4, 5, 6, 8, 9, 11, 14
33.	*Brachythecium salebrosum*	RO, StA, SG, SO, WR, WL	3, 5, 6, 8, 10, 14
34.	*Bryoerythrophyllum recurvirostrum*	SO	2
35.	*Bryum argenteum*	StA, SG	1, 2, 3, 4, 8, 10, 11

36.	*Bryum caespiticium*	RO, StA, SG	1, 5, 11, 12, 13, 14,
37.	*Bryum elegans*	SO	10
38.	*Callicladium haldanianum*	WR, WL	2, 6, 9
39.	*Calliergon cordifolium*	SG, SO, WR, AM	1, 2
40.	*Calliergon giganteum*	SV, AM	1, 2, 7
41.	*Calliergonella cuspidata*	SG, SO, SV, WR, AM	1, 2, 8, 9, 11
42.	*Campyliadelphus chrysophyllus*	RO, SO, SV	1, 10, 12, 13
43.	*Campyliadelphus elodes*	AM	7
44.	*Campylium sommerfeltii*	SG, SO	8
45.	*Campylium stellatum*	SO, SV, AM	1, 2, 7
46.	*Ceratodon purpureus*	StA, SG, SO, SV, WR, WL	1, 2, 3, 4, 5, 7, 9, 10, 11
47.	*Climacium dendroides*	SO, SV, AM	1, 10
48.	*Cratoneuron filicinum*	RO, AM	7, 12
49.	*Ctenidium molluscum*	RO, AM	7, 12
50.	*Dicranella heteromalla*	SO, SV	1, 6, 9, 11
51.	*Dicranella varia*	SO	4
52.	*Dicranum bonjeanii*	SO	1
53.	*Dicranum flagellare*	WR	2
54.	*Dicranum montanum*	SO, WR, WL	1, 2, 9, 10
55.	*Dicranum polysetum*	SO, WR	1, 9
56.	*Dicranum scoparium*	SO, WR	1, 2
57.	*Didymodon acutus*	SO	13
58.	*Didymodon fallax*	SO, WL	4, 10
59.	*Didymodon rigidulus*	StA, SG, SV	1, 2, 10
60.	*Didymodon tophaceus*	RO	12
61.	*Drepanocladus aduncus*	SV	1, 9
62.	*Drepanocladus polygamus*	SO, SV, WR	1
63.	*Encalypta streptocarpa*	SO, SV	7, 10, 13
64.	*Eurhynchium angustirete*	SO, WR, WL	2, 4, 6, 8,
65.	*Eurhynchium striatum*	SO, SV, WL	1, 6, 8
66.	*Fissidens adianthoides*	StA, SV, AM	1, 2, 7
67.	*Fissidens bryoides*	SO	6
68.	*Fissidens dubius*	SO	13
69.	*Fissidens taxifolius*	SO, AM	1, 3, 4, 6, 14
70.	*Funaria hygrometrica*	StA, SG	12, 13
71.	*Grimmia pulvinata*	SO	10
72.	*Herzogiella seligeri*	SO, WR	1, 9, 10
73.	*Homalia trichomanoides*	WR, WL	3, 4, 6, 8,
74.	*Homalothecium lutescens*	RO, SG	10
75.	*Hygroamblystegium tenax*	AM	7
76.	*Hygroamblystegium varium*	WL	6, 8
77.	*Hylocomium splendens*	SO	2
78.	*Hypnum cupressiforme*	SG, SO, SV, WR, WL	1, 2, 3, 4, 5, 6, 8, 9, 10, 12
79.	*Hypnum fertile*	WR	12
80.	*Hypnum pallescens*	WR, WL	1, 2, 11

81.	*Isothecium alopecuroides*	WL	8, 10
82.	*Kindbergia praelonga*	SO	4
83.	*Leptodictyum riparium*	StA, SG, SV, WR, AM	1, 3, 4, 11
84.	*Leskea polycarpa*	StA, SO, WR, WL	3, 4, 6, 8, 10
85.	*Leucobryum glaucum*	SO	2
86.	*Leucodon sciuroides*	WR, WL	12
87.	*Mnium marginatum*	SO	8
88.	*Mnium spinosum*	WL	4
89.	*Mnium stellare*	RO	10
90.	*Nyholmiella obtusifolia*	WR, WL	3, 6, 8
91.	*Orthotrichum affine*	WL	4, 8
92.	*Orthotrichum anomalum*	RO, StA, SG	2, 10, 12
93.	*Orthotrichum cupulatum*	WR	12
94.	*Orthotrichum diaphanum*	StA, WL	1, 3, 4
95.	*Orthotrichum pallens*	WL	4, 6, 8
96.	*Orthotrichum patens*	WL	8
97.	*Orthotrichum pumilum*	StA, WL	1, 14
98.	*Orthotrichum speciosum*	StA, WL	3, 4, 6, 8, 11, 14
99.	*Orthotrichum stramineum*	WR	4
100.	*Oxyrrhynchium hians*	SO, SV, WR, WL	3, 4, 6, 8,
101.	*Oxyrrhynchium speciosum*	SO, WR	4
102.	*Palustriella falcata*	AM	7
103.	*Phascum piliferum*	SO	4
104.	*Plagiomnium affine*	SO	1, 8
105.	*Plagiomnium cuspidatum*	RO, StA, SG, SO, SV, WR, WL	1, 2, 4, 5, 6, 8, 10, 14
106.	*Plagiomnium elatum*	SO, AM	1, 2, 8, 14
107.	*Plagiomnium ellipticum*	SO, SV	1, 2, 9
108.	*Plagiomnium rostratum*	RO, SG, SO, WR	4, 10, 11, 12
109.	*Plagiomnium undulatum*	SO, SV	4, 6, 8, 12
110.	*Plagiothecium cavifolium*	SO, WL	8
111.	*Plagiothecium denticulatum*	SO, WL	1, 8
112.	*Plagiothecium laetum*	SO, WR, WL	1, 8, 10
113.	*Plagiothecium nemorale*	SO, WR, WL	4, 6, 10
114.	*Platygyrium repens*	SV, WR, WL	1, 2, 3, 4, 6
115.	*Pleurozium schreberi*	SO, SV, WR	2, 8, 9
116.	*Pohlia nutans*	StA, SO, WR, WL	1, 2, 4, 8, 9
117.	*Pohlia wahlenbergii*	SO	10
118.	*Polytrichum commune*	SO, SV, AM	1, 2, 11
119.	*Polytrichum formosum*	SO	1, 10
120.	*Polytrichum juniperinum*	SG, SO	1, 2, 9
121.	*Polytrichum longisetum*	SO, WL	1
122.	*Polytrichum piliferum*	SG, SO	1, 11
123.	*Pseudoamblystegium subtile*	WR	8
124.	*Pseudoleskeella nervosa*	WR, WL	3, 4, 8, 10
125.	*Pseudoscleropodium purum*	SO	2, 9, 11

126.	*Ptilium crista-castrensis*	WR	2
127.	*Ptychostomum moravicum*	StA, SG, WR, WL	1, 2, 3, 6, 8, 12
128.	*Ptychostomum pallens*	SO	4
129.	*Ptychostomum pseudotriquetrum*	SG, SV, WR, AM	1, 7, 11
130.	*Ptychostomum torquescens*	SO	4
131.	*Pylaisia polyantha*	WR, WL	2, 3, 4, 6, 8, 9, 12, 14
132.	*Rhizomnium punctatum*	SO	4
133.	*Rhodobryum ontariense*	SO	12
134.	*Rhynchostegium murale*	StA	3
135.	*Rhytidiadelphus squarrosus*	SO	2, 9
136.	*Rhytidiadelphus triquetrus*	SO, SV	8
137.	*Schistidium crassipilum*	StA, SG	1, 10
138.	*Sciurohypnum plumosum*	StA	3
139.	*Sciurohypnum populeum*	SO, SV, WR	4, 6, 12
140.	*Sciurohypnum reflexum*	SO	4
141.	*Scorpidium cossonii*	AM	1, 7
142.	*Sphagnum angustifolium*	SO	2
143.	*Sphagnum cuspidatum*	SO	1, 2
144.	*Sphagnum fallax*	SO, SV	1, 2
145.	*Sphagnum. fimbriatum*	SO	1, 2
146.	*Sphagnum girgensohnii*	SO	1
147.	*Sphagnum inundatum*	SO, AM	11
148.	*Sphagnum palustre*	SO, SV	1, 2
149.	*Straminergon stramineum*	SO	1
150.	*Syntrichia papillosa*	StA, WR, WL	1, 3, 6
151.	*Syntrichia ruraliformis*	SO	4
152.	*Syntrichia ruralis*	StA, SG, SO, WL	1, 2, 12, 13
153.	*Taxiphyllum wissgrillii*	RO	10
154.	*Tetraphis pellucida*	WR	1, 2, 4
155.	*Thuidium assimile.*	SO, SV	2, 4, 8, 10, 12
156.	*Thuidium delicatulum*	SO	1
157.	*Tomenthypnum nitens*	SO	1
158.	*Tortella humilis*	SO	12
159.	*Tortella inclinata*	RO	12, 13
160.	*Tortula aestiva*	StA	1
161.	*Tortula caucasica*	SO	4
162.	*Tortula muralis*	StA, SG	1, 3, 10, 12
163.	*Tortula subulata*	WR	8
164.	*Tortula truncata*	SO	4
165.	*Warnstorfia fluitans*	SV	1

Abstract

In the article, the bryophytes of the upper reaches of the Western Bug River (Ukraine), which is physically and geographically located within Male Polissya, partly Roztochia, and to a minor extent in the Gologoro-Voronyatsky denudo-structural hills, have been studied. Based on our survey, a list of the bryophytes has been compiled for the first time. Ecological features, substrate preferences and life forms of the bryophytes have been analysed. According to the ecological features, subheliophytes (30.9%) and hemisciophytes (30.9%) predominate in the spectrum of heliomorphs; mesophytes (29.7%), hygromesophytes (21.2%) and xeromesophytes – in the spectrum of hydromorphs (19.4%); cold-tolerant species (59.4%) – in the spectrum of thermomorphs. Based on the analysis of the substrate preferences of the bryophytes, the following groups were identified: epigeans (116 species), epixils (56 species), epiphytes (46 species), epiliths (43 species), aquatic (22 species). The prevailing life forms are turf (30.3%), rough mat (18.2%), weft (15.2%), tuft (10.3%) and smooth mat (9.7%). 3 species that are officially recognised as rare and 16 species that are recognised as regionally rare have been found. In the group of bryophytes associated with wetland ecosystems, 2 officially rare and 6 regionally rare species were found in the study area. Given the large areas of drained land in Lviv Region, these species are of particular value, especially in the context of conservation of the biodiversity and protection of the valuable natural areas in accordance with the Development Strategy of Lviv Region by 2027.

Key words: rare bryophytes, ecomorphs, life forms, ecological groups

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Mszaki górnego biegu zachodniego Bugu (obwód lwowski, Ukraina)

Streszczenie

W artykule przedstawiono wyniki badań, dotyczących mszaków górnego biegu Zachodniego Bugu (Ukraina). Teren ten fizycznie i geograficznie położony jest w obrębie Małego Polesia, częściowo Roztochii oraz w niewielkim stopniu na wzgórzach Gołogóro-Woronieckich. Na podstawie badań terenowych, po raz pierwszy zestawiono listę mszaków tego obszaru. Przeanalizowano cechy ekologiczne, preferencje podłoża i formy życiowe stwierdzonych tu mszaków. Według cech ekologicznych w spektrum heliomorfów dominują subheliofity (30,9%) i hemisciofity (30,9%); mezofity (29,7%), higromezofity (21,2%) i kseromezofity – w spektrum hydromorfów (19,4%); gatunki tolerujące zimno (59,4%) – w spektrum termomorfów. Na podstawie analizy preferencji substratowych, zidentyfikowano następujące grupy mszaków: epigeity (116 gatunków), epiksylity (56 gatunków), epifity (46 gatunków), epility (43 gatunki), hydrofity (całkowicie lub częściowo zanurzone) (22 gatunki). Dominującymi formami życiowymi są formy darniowe (30,3%), tworzące szorstkie maty (18,2%), wełniste (15,2%), kępkowe (10,3%) oraz tworzące gładkie maty (9,7%). Znaleziono 3 gatunki w skali ogólnej uznane za rzadkie oraz 16 gatunków uznanych za rzadkie regionalnie. W grupie mszaków związanych z ekosystemami wodno-błotnymi, stwierdzono 2 gatunki ogólnie rzadkie i 6 gatunków rzadkich regionalnie. Ze względu na duże powierzchnie odwodnionych terenów w obwodzie lwowskim, gatunki te są szczególnie cenne, zwłaszcza w kontekście zachowania różnorodności biologicznej i ochrony ważnych przyrodniczo obszarów, zgodnie ze Strategią Rozwoju Obwodu Lwowskiego do 2027 roku.

Słowa kluczowe: mszaki rzadkie, ekomorfy, formy życiowe, grupy ekologiczne

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