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REGIONALLY UNIQUE LICHENS OF THE UKRAINIAN CARPATHIANS AND PERSPECTIVES OF THEIR PROTECTION

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The Carpathian Mts, showing the highest lichen biodiversity in Ukraine, i.e. 1,395 species of 2,106 of the total Ukrainian lichens, have been found to contain the highest proportion of regionally unique taxa (i.e. so far recorded only from the Carpathian Mts) (i.e. 551 species, or 39.5% of the Carpathian and 26.2% of the total Ukrainian lichen flora). Species diversity of widely distributed lichens (i.e. which hitherto known from all five macroregions of Ukraine), as well as 'scarcely distributed' lichens (i.e. missing at least in one or more macroregions) are also discussed. Representation of these three groups of lichens in the geomorphological districts of the Carpathian Mts and the administrative oblasts Zakarpattia, Lviv, Ivano-Frankivsk and Chernivtsi is shown.

The Chornohora Mts, a district of the Carpathian Mts, found to show the highest proportion of species so far recorded from this district of the Carpathian Mts, while the Eastern Beskydy and the Gorgany Mts are characterised hitherto by the highest species diversity of lichens. That is established that among geomorphological districts of Zakarpattia oblast, the Eastern Beskydy and the Gorgany Mts parts of Zakarpattia oblast territory are characterised by the highest number of species of lichen-forming and lichenicolous fungi in the Carpathian macroregion (674 and 611 species, respectively), and the proportion of regionally unique taxa in these two florae is also the highest (483 species or 71.6% and 453 species or 74.1%, respectively). Lichens of the Chyvchyn Mts of Ivano-Frankivsk oblast are found to be the most diverse in this oblast (344 species totally), and they include the highest proportion of regionally unique taxa (171 species or 49.7%). The Eastern Beskydy Mts, part of Lviv oblast territory, the only part of this oblast in the Carpathian Mts, are found to be represented by 224 lichen species of which 32 (i.e. 14.3%) are regionally unique to the Carpathian Mts.

List of the rarest taxa of the regionally unique group (hitherto known from single or a few localities) proposed as candidates for including to regional red lists of Zakarpattia, Lviv, Ivano-Frankivsk and Chernivtsi oblasts since the whole nature protection activity in Ukraine is done according to oblast division. 254 lichen species are proposed for including in the red list of Zakarpattia oblast, while 44, 4 and 9 species in the red lists of Ivano-Frankivsk, Lviv and Chernivtsi oblasts, respectively. The smallest amount of these taxa is proposed for the red list of Lviv oblast, which includes also the Forest zone of the Ukrainian Plains.

Key words: administrative oblast, geomorphological district, nature protection, red list

INTRODUCTION

The first special analysis of lichen biodiversity of the Eastern Carpathians of Ukraine was provided by the famous Ukrainian lichenologist M. F. Makarevich (Makarevych 1963, Kondratyuk 2007). Geographical distribution of the Ukrainian Carpathians known at that time was mapped in the 'Atlas of geographic distribution of lichens in Ukrainian Carpathians' (Makarevych *et al.* 1982). The special comparative analysis of lichen diversity of various geomorphological, floristical districts or administrative oblasts of the Ukrainian Carpathians was not presented, although the lists of known localities were provided after the administrative oblasts of Ukraine (Makarevych *et al.* 1982).

Detailed data mostly on the distribution of rare species were included in the fundamental taxonomic treatment 'Flora of the lichens of Ukraine' (Oxner 1956, 1968, 1993, 2010), while data on more or less widely distributed species were usually omitted (to save space of the editions mentioned).

Analysis of the species biodiversity of various geomorphological districts of the Ukrainian Carpathians was for the first time provided in 2003 and predominance of lichen species biodiversity in the Eastern Beskydy and the Chornohora Mts at that time was illustrated (Kondratyuk *et al.* 2003). Data on distribution within the Carpathian region were recently provided in numerous floristical papers (list of references see in Kondratyuk *et al.* 2021*a, b*).

However, only the 'Fourth checklist of lichen-forming and lichenicolous fungi of Ukraine', published as 'Prodromus of spore plants of Ukraine: lichens' (Kondratyuk *et al.* 2021*b*) for the first time included unified data on all published localities of each taxon, as widely distributed as rare, and it has allowed to carry out analysis of lichens distribution within the five macroregions, as well as to recognise the importance of regionally unique species at recent stage.

The aim of this paper was to analyse the distribution of regionally unique lichen species of the Ukrainian Carpathians according to geomorphological districts, as well as administrative oblasts of Ukraine, and to propose further ways of their protection. We do hope that species diversity of regionally unique lichens of the Ukrainian Carpathians presented here will be the basis for the future comparison of regionally unique lichens of other parts of the Eastern Carpathians or the whole Carpathian Mts in general.

MATERIAL AND METHODS

Lichens hereafter includes lichen-forming and lichenicolous fungi traditionally investigated by lichenologists. Lichen diversity of Ukraine discussed here is based on data of the 'Fourth checklist of lichen-forming and lichenicolous fungi of Ukraine' (Kondratyuk *et al.* 2021*a, b*) or on our current knowledge on species diversity of the Ukrainian lichens and their distribution up to 2021.

Geomorphological districts of the Ukrainian Carpathians (i.e. Chornohora Mts, Eastern Beskydy Mts, etc.) are provided after the 'Checklist of Eastern Carpathian lichens' (Kondratyuk *et al.* 2003). Data on distribution of each taxon within the macroregions of Ukraine are based on Ukrainian version of the fourth checklist (Kondratyuk *et al.* 2021b).

Nomenclature of lichens is given after Kondratyuk *et al.* (2021a) with a few additions of recent taxonomy of the Physciaceae (Kondratyuk *et al.* 2021*c*).

RESULTS

Regionally unique lichens of the Ukrainian macroregions

Carpathian lichens were found mostly in four of 30 distributional groups (see Table 1), where regionally unique taxa were registered to have the highest number of species. Thus 551 lichen species (i.e. 39.5% of Carpathian lichens and 26.2% of total Ukrainian lichens) are hitherto known in Ukraine only from this macroregion. The lichen flora of the Carpathian Mts in Ukraine hitherto includes totally 1,395 species (or 66.2% of total 2,106 species of the Ukrainian lichens), has also the highest number of regionally unique lichen species.

It should be emphasised that it is the highest species diversity of regionally unique lichens in Ukraine, while the Crimean and the Steppe zone macroregions have lower species diversity. So, there are 224 species (i.e. 21.3% of the Crimean and 10.6% of the total Ukrainian lichens) and 162 lichen species (i.e. 19.35% of the Steppe diversity, and 7.7% of the total Ukrainian lichens) are recorded from Crimea and the Steppe zone of Ukraine, respectively.

The lowest number of regionally unique lichen species is known from the Forest zone – 36 species (i.e. 5.8% of the Forest lichens and 1.7% of the total Ukrainian taxa) and the Forest-Steppe zone (41 species, i.e. 6.2% of the Forest-Steppe lichens and 1.9% of the total Ukrainian taxa).

The 'widely distributed taxa' (i.e. lichens hitherto known from all macroregions), the second distributional group of the Ukrainian lichens after regionally unique ones in the Carpathian Mts, were found to be represented by 249 species (or 17.8% of the total Carpathian lichens). It should be mentioned that the proportions of widely distributed taxa in the other macroregions of Ukraine are much higher (between 23.7% in Crimea and 40.4% in the Forest zone (Table 2). Proportion of widely distributed taxa in the Steppe and the Forest-Steppe zones is in intermediate position (i.e.: 29.6% and 37.3%, respectively) (see Table 1, Fig. 1).

Except for the Carpathian macroregion, the group of widely distributed taxa is very diverse in the Forest (40.4% of the total Forest species) and the Forest-Steppe zones (37.3% of the total Forest-Steppe taxa).

Table 1

Species biodiversity of distributional groups in main macroregions of Ukraine (with % of total Ukrainian lichens = tUl) (macroregions: Ca = Carpathians, Fo = Forest zone, Fo/S = Forest-Steppe zone, S = Steppe zone, Cr = Crimea (mountainous and Mediterranean portions)

Distributional groups / macroregions	Ca	%	Fo	%	Fo-S	%	S	%	Cr	%	% of tUl
Ca	551	39.5									26.2
Fo			36	5.8							1.7
Ca + Fo	46	3.2	46	7.4							2.2
Fo-S					41	6.2					1.9
Fo+ Fo-S			11	1.8	11	1.7					0.5
Ca + Fo-S	35	2.5			35	5.3					1.7
Ca + Fo + Fo-S	41	2.9	41	6.7	41	6.2					1.9
S							162	19.3			7.7
Fo-S + S					21	3.2	21	2.5			1.0
Fo + S			13	2.1			13	1.5			0.6
Fo + Fo-S + S			9	1.4	9	1.4	9	1.1			0.4
Ca + Fo-S +S	17	1.2			17	2.6	17	2.0			1.4
Ca + S	29	2.1					29	3.4			0.8
Ca + Fo + S	14	1.0	14	2.3			14	1.7			0.7
Ca + Fo + Fo-S + S	29	2.1	29	4.7	29	4.4	29	3.4			1.4
Cr									224	21.3	10.6
S + Cr							96	11.4	96	9.1	4.6
Fo-S + Cr					13	2.0			13	1.2	0.6
Fo-S + S + Cr					36	5.5	36	4.3	36	3.4	1.7
Fo + Cr			11	1.8					11	1.0	0.5
Fo + Fo-S +S + Cr			26	4.2	26	3.9	26	3.1	26	2.5	0.6
Fo + S + Cr			12	1.9			12	1.4	12	1.1	1.2
Ca + Cr	134	9.6							134	12,7	6.4
Ca + S + Cr	47	3.4					47	5.6	47	4.5	2.2
Ca + Fo-S + Cr	30	2.2			30	4.5			30	2.9	1.4
Ca + Fo-S + S + Cr	54	3.9			54	8.2	54	6.4	54	5.1	2.6
Ca + F + Fo-S + Cr	48	3.4	48	7.8	48	7.3			48	4.6	2.3
Ca + F + Cr	44	3.2	44	7.1					44	4,2	2.1
Ca + Fo + S +Cr	27	1.9	27	4.4			27	3.2	27	2.7	1.3
Ca + Fo +Fo-S + S +Cr	249	17.8	249	40.4	249	37.7	249	29.6	249	23.7	11.8
Total	1,395		616		660		841		1,051		2,106

Among the taxa with 'scarcely distributed', i.e. taxa hitherto missing at least in one or more macroregions of Ukraine, as well as known from two or more macroregions, species diversity of only one group is rather high. That is the group of Ukrainian-Crimean taxa known hitherto from the Carpathian and the Crimean mountainous regions (134 lichen species, i.e. 9.6% of the Carpathian and 12.7% of the Crimean taxa, and 6.4% of the total Ukrainian lichens), while the other 13 distributional groups are represented only by between 14 and 54 species (or between 1 and 4% of the total diversity of the Ukrainian lichen flora) (Table 1).

Only five distributional groups of 'scarcely distributed' taxa of the Forest zone show rather high species diversity, while the group of the regionally unique species is ranked in the fifth position (36 species or 5.8% of the total Forest lichens).

It is also found that only two groups of scarcely distributed taxa of the Forest-Steppe zone show higher species diversity than the group of regionally unique lichens. So, 54 lichen taxa or 8.2% of taxa missing in the Forest zone, but known from the other macroregions and 48 species, or 7.3% of taxa, which are hitherto missing in the Steppe zone, but known from the other macroregions, while regionally unique taxa are positioned in the third and fourth places among the 15 distributional groups of the Forest-Steppe zone. The group of regionally unique species is positioned on the second place in the Steppe zone and the Crimean lichen florae after widely distributed taxa (Table 1). Furthermore, the group of the Steppe-Crimean distributional group is positioned on the third place of the Steppe zone. The Carpathian-Crimean taxa from the third distributional group in the Crimean lichen flora, while the Steppe-Crimean taxa are positioned in the fourth place.

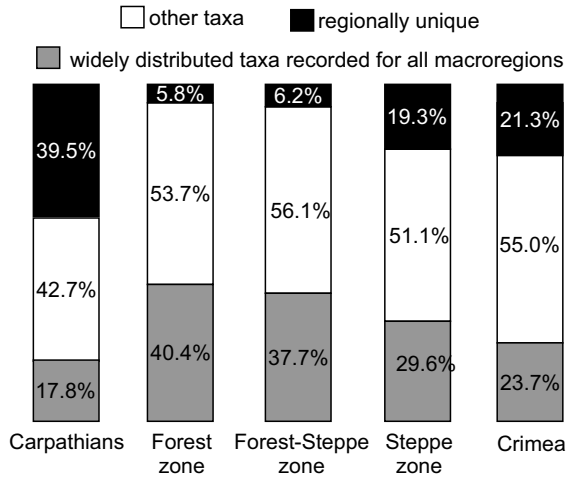

Fig. 1. Proportions of distributional groups in lichen flora of Ukraine (with % of total Ukrainian lichen species) and florae of main macroregions of Ukraine (with % of total taxa of each macroregion) (macroregions: Ca = Carpathians, Fo = Forest zone, Fo/S = Forest-Steppe zone, S = Steppe zone, Cr = Crimea (mountainous and Mediterranean portions)

It is also important to emphasise that the number of taxa known in both the Carpathians and the Crimean macroregion is rather high (134 lichen species, i.e. 9.6% of the Carpathian and 12.7% of the Crimean taxa), as well

as taxa hitherto recorded from all macroregions of Ukraine is the lowest in the Carpathians Mts (i.e. 249 species, or 17.8% of the Carpathian lichens in contrast to 23.7, 29.6, 37.3 and 40.4% in Crimea, the Steppe, the Forest-Steppe and the Forest zones lichen florae, respectively) (see Table 1, Fig. 1). The latest group of lichens, i.e., taxa known from all macroregions, hereafter are mentioned as 'widely distributed' in Ukraine taxa.

Among lichen taxa of scarcely distributed in various macroregions (hereafter as 'scarcely distributed', i.e. known from two or more macroregions, but missing at least in one of them) the highest species diversity was found to be in the Carpathian and the Crimean mountain systems (134 species, or 9.6% of the Carpathian and 12.7% of the Crimean, and 6.4% of the total Ukrainian lichens). Additionally, to these two regions lichen taxa known from these two regions, as well as from the Forest-Steppe and the Steppe zone (54 species – 2.6% of the total Ukrainian) and in two mountainous macroregions and the Steppe zone – 48 species (2.3% of the total Ukrainian taxa), as well as in two mountainous macroregions and the Steppe zone – 47 species (2.2% of the total Ukrainian lichens).

Proportion of the Carpathian lichens scarcely distributed in the other macroregions of the Ukrainian Plains is usually lower of 42 species (or 2% of the total Ukrainian lichen diversity) (Table 1).

Lichens of geomorphological districts of the Carpathian Mts

Total species diversity – The number of taxa of lichen florae of the Eastern Beskydy and the Gorgany Mts was found to be hitherto the highest among the 10 geomorphological districts of the Carpathian Mts including 710 and 708 species, respectively. Lichen flora of the Chornohora Mts district is represented by 522 species (Table 2, Fig. 2).

Further three geomorphological districts of the Carpathians macroregion, i.e.: the Volcanic Carpathians, the Chyvchyn Mts and the Maramorosh Mts have shown lower total species number: 464, 454 and 431 species, respectively. Among these three districts the highest proportion of the Carpathian regionally unique species is present in the Chyvchyn Mts (23.3% of the total Chyvchyn diversity), followed by the Maramorosh and the Volcanic Carpathian Mts (20.9% and 15.5% of the total species diversity of the latter geomorphological districts, respectively).

Species diversity of the Carpathian regionally unique lichens – The Chornohora Mts show the highest proportion of the Carpathian regionally unique taxa (175 species or 33.5% of the total Chornohorian diversity), while after total species diversity of the Chornohora Mts (522 species) is positioned only on the third place after the Eastern Beskydy and the Gorgany Mts after species diversity of lichens in geomorphological districts (Fig. 2).

Table 2
Total number of lichen taxa in geomorphological districts of the Carpathian Mts and administrative oblasts of Ukraine

District	Total species number	Oblasts		
		total	recorded only from this oblast	%
Eastern Beskydy	710	Lv 224	32	14.3
		Zak 674	483	71.6
Gorgany	708	IF 253	95	37.5
		Zak 611	453	74.1
Chornohora	522	IF 229	60	26.2
		Zak 452	284	62.8
Volcanic Carpathians	464	Zak 464	65	14.0
Chyvchyn Mts	454	IF 344	171	49.7
		Chev 277	106	38.2
Maramorosh	431	Zak 431	43	9.9
Svydovets	312	Zak 312	20	6.4
Pricarpathian	215	Chev 71	19	26.8
		IF 150	99	66.0
		Lv 80	30	37.5
Transcarpathian plains	142	Zak 142	2	1.4
Transcarpathian poloninas	76	Zak 76	1	1.3

At the same time the proportion of regionally unique taxa of the Carpathian Mts in the Gorgany Mts established to be higher (i.e. 203 species or 28.7% of the total Gorganian diversity) than the proportion of the Carpathian regionally unique taxa in the Eastern Beskydy Mts (196 species or 27.6% of the total Eastern Beskydian diversity).

Among the Volcanic Carpathians, the Chyvchyn Mts and the Maramorosh Mts, the highest proportion of the Carpathian regionally unique species are present in the Chyvchyn Mts (23.3% of the total Chyvchyn diversity), followed by the Maramorosh and the Volcanic Carpathian Mts (20.9% and 15.5% of total species diversity of latter geomorphological districts, respectively).

Lichens of administrative oblasts of the Carpathian Mts

Total species diversity – Since all kind of nature protection activity is carried out in Ukraine at level of administrative oblasts, we analysed the distribution of regionally unique lichens within the separate administrative oblast

of the Carpathian mesoregion: Zakarpattia, Lviv, Ivano-Frankivsk and Chernivtsi oblasts.

Territories of the Eastern Beskydy Mts and the Gorgany Mts within Zakarpattia oblast show the highest number of lichen species (674 and 611 species, respectively) among the administrative oblasts of the Ukrainian Carpathians. However, there are also five other geomorphological districts in Zakarpattia oblast, i.e.: the Chornohora Mts (portion) and the entire Volcanic Carpathians, the Maramorosh Mts, the Svydovets, and the Transcarpathian Poloninas (Table 2, Fig. 1).

The highest proportion of regionally unique lichens found to be present in the Pricarpathian region (66.0%) among geomorphological districts of the Carpathian Mts in Ivano-Frankivsk oblast, while the species diversity of this district is rather low (i.e. the fourth place among the Carpathian districts of this oblast). The highest species diversity within Ivano-Frankivsk oblast territory is recorded for the Chyvchyn Mts (partially) (344 species), the Gorgany Mts (partially) (253 species), and the Chornohora Mts (partially) (229 species). Furthermore, among these three districts the Chyvchyn Mts is characterised by the highest proportion of regionally unique taxa (171 species, 49.7%) fol-

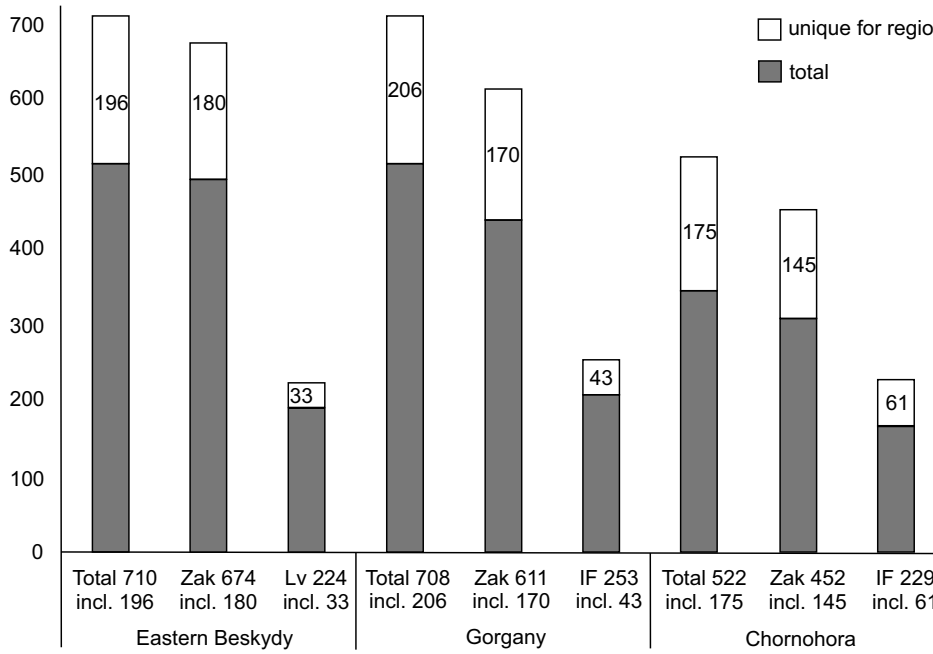

Fig. 2. Proportions of the Carpathian regionally unique taxa in lichen florae of various administrative oblasts of three geomorphological districts of the Ukrainian Carpathians (oblasts: IF = Ivano-Frankivsk, Lv = Lviv, Zak = Zakarpattia)

lowed by the Gorgany Mts (95 species, 37.5%) and the Chornohora Mts (60 species, 26.2%).

The territory of Chyvchyn Mts in Chernivtsi oblast, is the most diverse (277 species) among two geomorphological districts of the Carpathian Mts represented within the territory of this oblast, while lichen biodiversity of the Pricarpathian district is so far very low (only 71 species). Similarly to the total diversity the proportion of regionally unique Carpathian lichens are much higher in the Chyvchyn Mts part (106 species, 38.2%) than in the Pricarpathian region (19 species, 26.8%).

Lichen flora of the Eastern Beskydy Mts within Lviv oblast includes 224 species (Table 2), of which only 32 species (14.3%) are so far known only from The Carpathian Mts in Ukraine.

Regionally unique lichens in the administrative oblasts of Ukraine

As it was shown above among all Carpathian geomorphological districts the Gorgany Mts of Zakarpattia oblast territory includes the highest proportion of regionally unique lichens (74.1%), followed by the Eastern Beskydy Mts having slightly lower proportion of regionally unique lichens (71.6%).

Similarly to the total lichen species diversity the Eastern Beskydy Mts (partially) and the Gorgany Mts (partially) within the territory of Zakarpattia oblast show the highest proportion of the Carpathian regionally unique lichen biodiversity (180 and 170 species, respectively) among administrative oblasts of the Ukrainian Carpathians. The Chornohora (partially) within the territory of Zakarpattia oblast contains lower proportion of the Carpathian regionally unique taxa (i.e. 145 species), while three other geomorphological districts within the territory of Zakarpattia oblast, i.e.: the Maramorosh Mts, the Svydovets, and the Volcanic Carpathians include about twice lower proportion of the Carpathian regionally unique taxa (90, 75, and 72 species, respectively) (Table 1, Fig. 1). The lowest proportion of the Carpathian regionally unique species found to be hitherto recorded for the Transcarpathian plains (5 species) and the Transcarpathian poloninas (1 species). In general, from our point of view the latter five geomorphological districts (i.e. Maramorosh Mts, Svydovets, Transcarpathian plains, Trascarpathian Poloninas, and Volcanic Carpathians) are still waiting for special inventory of their lichen flora and special analysis of their current preservation.

The Gorgany Mts, the Eastern Beskydy and the Chornohora Mts include the highest proportion of taxa recorded only from this oblast among the geomorphological districts within the territory of Zakarpattia oblast (i.e. 93.5%, 88.3% and 74.0%, respectively) (Table 3).

Table 3
Total number of lichen taxa of the Carpathian regionally unique lichens according to geomorphological districts of the Carpathian Mts and administrative oblasts of Ukraine

district	Total per district		Per oblasts within the oblast			
	species diversity	%	total	recorded only from this oblast	%	no. rare species
Eastern Beskydy	196	35.6	Lv 33	13	6.6	4
			Zak 180	159	81.1	63
Gorgany	206	37.4	IF 43	34	16.5	12
			Zak 170	159	11.2	83
Chornohora	175	31.8	IF 61	23	13.1	7
			Zak 145	108	61.7	41
Volcanic Carpathians	72	15.5	Zak 72	26	36.1	26
Chyvchyn Mts	106	23.3	IF 83	66	79.5	23
			Chev 39	25	64.1	9
Maramorosh	90	20.9	Zak 90	23	25.6	23
Svydovets	75	24.0	Zak 75	17	22.7	17
Pricarpathian	16	7.4	Chev 2	1	50.0	–
			IF 13	12	92.3	3
			Lv 3	2	66.7	–
Transcarpathian plains	5	3.5	Zak 5	1	20.0	1
Transcarpathian poloninas	1	1.3	Zak 1	–	–	–
Total	[551]					312

Among three districts in Ivano-Frankivsk oblast with the highest lichen species diversity the Chyvchyn Mts is characterised by the highest proportion of the regionally unique taxa (171 species, 49.7%) followed by the Gorgany portion (95 species, 37.5%) and Chornohora (60 species, 26.2%). It is interesting to mention that proportion of taxa so far recorded only from this oblast is almost the same in the Chyvchyn Mts and the Gorgany Mts of this oblast (i.e. 79.5% and 79.0%, respectively).

Similarly to the total diversity of Chernivtsi oblast the proportion of the regionally unique Carpathian lichens is much higher in the Chyvchyn Mts (106 species, 38.2%) than in the Pricarpathian region (19 species, 26.8%).

Only 32 lichen species (14.3%) are so far known only from the Carpathian Mts in Ukraine in the Eastern Beskydy Mts within Lviv oblast.

Table 4
Proportions of regionally unique and scarcely distributed lichens of the main macroregions of Ukraine in the 'Red data book of Ukraine' (Didukh 2009)

Distributional groups of lichens / macroregions	Total in Ukraine		RDBU		
	number of species	%	number of species	% of taxa included to RDBU	% of total number of Ukrainian lichen
Regionally unique taxa	1,014	48.1	30	57.7	1.4
Ca	551	26.2	11	21.2	0.5
Fo	36	1.7	–	–	–
Fo/S	41	1.9	–	–	–
S	162	7.7	2	3.8	0.1
Cr	224	10.6	17	32.7	0.8
Scarcely distributed taxa	844	40.1	22	42.3	1.0
Widely distributed taxa	248	11.8	–	–	–
Total	2,106	100	52	100.0	2.4

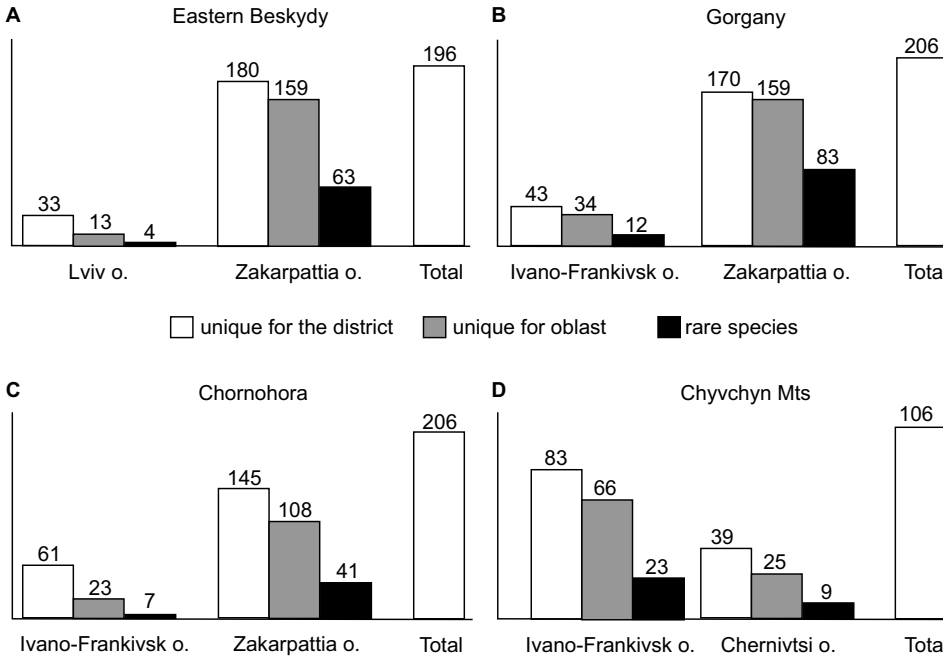

Fig. 3. Proportions of regionally unique taxa of various administrative oblasts (o.) and rare lichen taxa in four geomorphological districts of Ukrainian Carpathians

Table 5

List of the rarest Carpathian regionally unique lichens and lichenicolous fungi (322 taxa) proposed for red regional lists of administrative oblasts of the Ukrainian Carpathians (Oblasts: Zak = Zakarpattia, IF = Ivano-Frankivsk, Lv = Lviv, Che = Chernivtsi. – Geomorphological districts: Go = Gorgany, Cho = Chornohora, VC = Volcanic Carpathians, EB = Eastern Beskydy, Chy = Chyvchyn Mts, Sv = Svydovets, ZP = Transcarpathian Poloninas, Ma = Maramorosh Mts, Pri = Pricarpathian, UL = uncertain locality)

Species name	Zak	IF	Lv	Che	UL
Abrothallus usneae		Go			
Absconditella annexa	Cho				
Absconditella sphagnorum	Cho				
Acarospora gallica	VC				
Acarospora nitrophila			EB		
Acarospora peliocypha	EB				
Acrocordia bukowiensis				Chy	
Adelolecia kolaensis	Cho				
Adelolecia pilati	Cho				
Agonimia flabelliformis	Go				
Agonimia globulifera	Ma				
Ainoa mooreana	Cho				
Allantoparmelia alpicola	Ma				
Alyxoria ochrocheila	Go				
Anisomeridium macrocarpum	Go				
Arctoparmelia incurva		Pri			
Arthonia helvola	Go				
Arthonia ilicina	EB				
Arthonia subvarians	Cho				
Arthopyrenia inconspicua		Chy			
Arthopyrenia salicis	EB				
Arthrorhaphis aeruginosa	Go				
Aspicilia lapponica	Sv				
Bacidia absistens	EB				
Bacidia igniarii	Ma				
Bacidia viridofarinosa	EB				
Bacidina chloroticula	EB				
Bacidina etayana	Go				
Bacidina mendax	Go				

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Biatora bacidioides	Go				
Biatora fallax	VC				
Biatora longispora	Go				
Biatora mendax	Go				
Biatora meiocarpoides	VC				
Biatora pumilionis	Cho				
Biatora radicicola	Go				
Blastenia fuscorufa	Sv				
Blastenia scabrosa	Sv				
Brianaria sylvicola	EB				
Brodoa atrofusca	Cho				
Bryodina rhypariza	Cho				
Bryopogon negativus f. *barbatus*	EB				
Bryoria carpatica	Cho				
Bryoria divergescens	Sv				
Bryoria intricans		Chy			
Bryoria positiva		Chy			
Bryoria pseudocyphellata		Chy			
Bryoria vrangiana		Chy			
Bryostigma biatoricola	Go				
Bryostigma muscigenum	Sv				
Buellia zahlbruckneri	EB				
Calicium adaequatulum	Go				
Calicium carpaticum	Go				
Calicium corynellum	EB				
Calicium huculinum	Cho				
Calicium montanum	Go				
Caloplaca borreri		Go			
Caloplaca isidiigera	Sv				
Caloplaca lojkae	VC				
Caloplaca turkuensis	Go				
Carbonea aggregantula	Cho				
Carbonea invadens	Sv				

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Carbonea supersparsa	Cho				
Catapyrenium daedaleum	Ma				
Catapyrenium michelii		Chy			
Catillaria subviridis	Cho				
Catolechia wahlenbergii	Cho				
Chaenothecopsis consociata	EB				
Chaenothecopsis epithallina	EB				
Chaenothecopsis faginea					Zak
Chaenothecopsis gracilis	EB				
Cheiromycina petri	Go				
Chrysothrix caesia	VC				
Cladonia ciliata	EB				
Cladonia grayi					+
Coelocaulon divergens	Cho				
Coppinsidea alba	EB				
Corticifraga fuckelii		Chy			
Cryptothele rhodosticta	VC				
Cyphelium karelicum	EB				
Cystocoleus ebeneus	Cho				
Dacampia hookeri		Chy			
Dactylospora homoclinella	Go				
Dactylospora lobariella	Go				
Dermatocarpon meiophyllizum	Cho				
Dermatocarpon rivulorum	VC				
Didymella globularis	Ma				
Didymocyrtis melanelixiae	Cho				
Didymocyrtis pseudeverniae		Go			
Diplotomma margaritaceum	EB				
Endococcus brachysporus	Cho				
Eocronartium muscicola	EB				
Eopyrenula avellanae	EB				
Ephebe lanata	VC				
Epigloea medioincrassata	Sv				

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Epilichen scabrosus	EB				
Fellhanera subtilis	EB				
Fellhaneropsis vezdae	EB				
Flavopunctelia flaventior	VC				
Frutidella furfuracea	Go				
Frutidella pullata	Go				
Fuscidea pusilla	EB				
Fuscopannaria praetermissa	Cho				
Gyalecta croatica	Go				
Gyalecta friesii	EB				
Gyalecta incarnata					+
Gyalidea fritzei	Sv				
Gyalidea lecideopsis		Chy			
Gyalideopsis helvetica	Go				
Halecania viridescens	Go				
Hazslinszkya gibberulosa	Go				
Hydropunctaria rheitrophila	EB				
Hymenelia heteromorpha		Chy			
Hypotrachyna britannica		Pri			
Hysteropatella prostii	EB				
Inoderma byssaceum	Go				
Intralichen lichenum	Go				
Ionaspis lacustris	VC				
Japewia subaurifera		Go			
Karstenia rhopaloides	Go				
Kirschteiniothelia atra	EB				
Lasallia rossica		Cho			
Lecania cuprea	EB				
Lecanora circumborealis	EB				
Lecanora czarnohorensis	Cho				
Lecanora epanora					+
Lecanora exspersa	Go				
Lecanora farinaria	EB				

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Lecanora marginata		Cho			
Lecanora multispora				Chy	
Lecanora stanislai	Go				
Lecanora substerilis	Go				
Lecanora transcendens		Chy			
Lecanora umbrosa auct. brit.	EB				
Lecanoropsis anopta	Go				
Lecidea hillmannii	EB				
Lecidea personata	Cho				
Lecidea phaeops	EB				
Lecidea praenubila	VC				
Lecidea swartzioidea	EB				
Lecidella patavina	Cho				
Lecidella subviridis	Go				
Lecidella viridans	Ma				
Lendemeriella lucifuga	Go				
Lendemeriella sorocarpa	Go				
Lepra ophthalmiza	Cho				
Lepraria alpina					Zak
Lepraria celata					Zak
Lepraria ecorticata	Go				
Leptorhaphis maggiana	EB				
Leptosphaerulina heterophracta	Go				
Lichenopeltella peltigericola		Chy			
Lithothelium hyalosporum	Go				
Lophiostoma corticola	EB				
Marchantiana asserigena	VC				
Massalongia carnosa	Sv				
Melanelia panniformis	VC				
Melaspilea granitophilla	Go				
Menegazzia subsimilis	Go				
Micarea anterior	Go				
Micarea byssacea	Go				

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Micarea deminuta	Go				
Micarea incrassata	Cho				
Micarea marginata	Go				
Micarea melaeniza	EB				
Micarea melanobola	Go				
Micarea micrococca	Go				
Micarea perparvula	Go				
Micarea soralifera	Go				
Micarea turfosa	Cho				
Micarea viridiatra		Go			
Micarea viridileprosa		Go			
Microcalicium ahlneri	EB				
Microcalicium arenarium	Go				
Milospium lacoizquetae		Go			
Miriquidica garovaglii	Cho				
Miriquidica subplumbea	Cho				
Multiclavula vernalis		Go			
Mycocalicium compressula	Ma				
Mycomicrothelia macularis	Sv				
Nanostictis christiansenii	EB				
Navicella pileata	EB				
Nephroma arcticum		Chy			
Normandina acroglypta	Go				
Ochrolechia crozalsiana	Cho				
Ochrolechia trochophora	Go				
Opegrapha corticola	Go				
Opegrapha fumosa	Go				
Opegrapha pulvinata	EB				
Opegrapha thelotremalis	Go				
Parmelina carporrhizans	Go				
Parmeliopsis afrorevoluta	Go				
Peltigera neckeri		Chy			
Peltigera neopolydactyla		Chy			

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Pertusaria borealis	EB				
Pertusaria macounii	Go				
Pertusaria obtecta					+
Pertusaria oculata	Ma				
Pertusaria pseudophlyctis	EB				
Pertusaria szatalai	Go				
Petractis hypoleuca	Go				
Phaeocalicium compressulum	EB				
Phaeocalicium populneum	Go				
Phaeocalicium praecedens	Cho				
Phaeographis inusta	Ma				
Phaephyscia hirsuta	EB				
Phaeospora rimosicola	Cho				
Phaeosporobolus usneae	EB				
Phoma pisutii		Pri			
Physcia albinea	VC				
Polyblastia abscondita		Chy			
Polyblastia bavarica	Go				
Polyblastia buerensis				Chy	
Polyblastia lojkana	Ma				
Polyblastia nadvornikii	EB				
Polyblastia plicata	Go				
Polyblastia schaereriana	Cho				
Polyblastia tirolensis				Chy	
Polycoccum microcarpum		Chy			
Polycoccum umbilicariae	Cho				
Polydesmia lichenis	EB				
Porina grandis	Ma				
Porina guentheri		Go			
Porina sudetica	Cho				
Porocyphus coccodes	Cho				
Porpidia macrocarpa var. *convexa*		Cho			
Pronectria fissuriproidens	EB				
Pronectria oligospora	EB				

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Protoparmelia nephaea	Cho				
Protoparmeliopsis macrocyclos	EB				
Protothelenella corrosa			EB		
Psammina stipitata		Go			
Psilolechia clavulifera	Sv				
Psoroglaena stigonemoides	Go				
Pycnora leucocca	Go				
Pycnora xanthococca	EB				
Pyrenula chlorospila	Go				
Ramalina carpatica		Chy			
Ramonia chrysophaea	EB				
Rebentischia pomiformis	EB				
Rhizocarpon geographicum subsp. *kittilense*	VC				
Rhizocarpon subgeminatum		Cho			
Rinodina atrocinerea	VC				
Rinodina badiella	Cho				
Rinodina excrescens					IF
Rinodina malangica	Go				
Rinodina moziana	VC				
Rinodina trachytica	VC				
Rinodina turfacea				Chy	
Rostania occultata	Ma				
Sarcocladium strictum	Ma				
Sarea resinae	EB				
Schismatomma cretaceum		Go			
Sclerococcum griseisporodochium	Ma				
Sclerophora coniophaea			EB		
Scoliciosporum curvatum	Go				
Scoliciosporum pruinosum	EB				
Scoliciosporum schadeanum	Go				
Scytinium biatorinum		Chy			
Segestria byssophila	Go				
Sparria endlicheri	VC				
Sphaerophorus globosus	Ma				

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Sphinctrina anglica				Chy	
Sphinctrina leucopoda	Go				
Spiloma fuliginosum	Ma				
Sporastatia testudinea	Ma				
Sporodictyon terrestre	Sv				
Staurothele rupifraga				Chy	
Stereocaulon dactylophyllum	ZP				
Stereocaulon vesuvianum	Ma				
Stictis urceolata	VC				
Stigmidium peltideae		Chy			
Taeniolella friesii	EB				
Taeniolella toruloides	Go				
Tetramelas chloroleucus	Go				
Thelidium fontigenum		Chy			
Thelidium methorium	Cho				
Thelidium nadvornikii	VC				
Thelidium pyrenophorum		Chy			
Thelidium rehmii	EB				
Thelocarpon lichenicola	Go				
Thelocarpon robustum	Sv				
Thelocarpon strasseri	EB				
Thelopsis flaveola	Go				
Thermutis velutina	VC				
Toensbergia leucococca	Go				
Trapeliopsis aeneofusca	EB				
Trapeliopsis glaucolepidea	Sv				
Trapeliopsis wallrothii	Ma				
Tremella cladoniae	EB				
Tremella lobariacearum	Go				
Umbilicaria cirrosa	Ma				
Umbilicaria spodochroa	Ma				
Umbilicaria subglabra		Cho			
Umbilicaria vellea	Ma				
Usnea aciculifera	Cho				

Table 5 (continued)

Species name	Zak	IF	Lv	Che	UL
Usnea caucasica	EB				
Usnea cavernosa subsp. *sibirica*		Cho			
Usnea cinchonarum					+
Usnea dubia	EB				
Usnea mollis	Sv				
Usnea motykana		Cho			
Usnea syriaca	Sv				
Vahliella saubinetii					+
Verrucaria anceps				Chy	
Verrucaria andesiatica	VC				
Verrucaria aquatilis	VC				
Verrucaria fuscoatra		Go			
Verrucaria hegetschweileri	Go				
Verrucaria keissleri	Ma				
Verrucaria mutabilis	VC				
Verrucaria phloeophila	Go				
Verrucaria subtilis			EB		
Verrucaria transiliens				Chy	
Verrucaria veronensis		Chy			
Vezdaea retigera	Go				
Vezdaea stipitata	Cho				
Wadeana dendrographa	Go				
Xenonectriella septemseptata	Go				
Xylographa trunciseda	Go				
Zamenhofia pseudohibernica	Go				
Zwackhiomyces macrosporus					
Total	254	44	4	9	10 (1 IF, 3 Zak, + 6)

Proposals to the red lists of the administrative oblasts of Ukraine

Distribution analysis of regionally unique lichens was completed within the separate administrative oblasts of the Carpathian mesoregion (Zakarpattia, Lviv, Ivano-Frankivsk and Chernivtsi oblasts) since all kind of nature protection activity is carried out in Ukraine at the level of administrative oblasts.

The 'Red data book of Ukraine' (Didukh 2009) includes only 2.4% of the total number of species of Ukraine (Table 4), of which 57.7% (or 30 species) of regionally unique (detailed by the main macroregions of Ukraine), and 42.3% (or 22 species) of scarcely distributed taxa. However, widely distributed taxa are not represented at all.

Regarding the macroregions the 'Red data book of Ukraine' includes the biggest number of species i.e. 17 species (32.7%) of the Crimean regionally unique lichens, while there are only 11 species (21.2%) of the Carpathian, and only 2 species (3.8%) of the Steppe lichens. It should be also emphasised that among scarcely distributed taxa (totally 22 species or 42.3%) included hitherto in the 'Red data book of Ukraine' there are also 8 species known from both the Carpathian and the Crimean macroregions, as well as 3 species recorded from the Steppe zone and the Crimean mesoregion. However, the representativeness of regionally unique taxa in the 'Red data book of Ukraine' cannot be satisfactorily accepted in general. Thus we have to make the conclusion that the 'Red data book of Ukraine' cannot provide prevention of regionally unique taxa of the lichen flora of Ukraine. So consequently we have to plan other ways of monitoring and preservation of rare species of Ukraine and the Carpathian region in particular.

On one side, we propose to include all rare regionally unique taxa to the local red lists, which can provide the further monitoring of their number of localities as well as situation in each administrative oblast, and on another side to carry out special analysis which proportion of the regionally unique lichens are currently confirmed on the protected territories of the Ukrainian Carpathians. Thus the rarest taxa of the group of regionally unique lichens are proposed here to be considered as candidates to the red lists of separate oblasts to be the object of future monitoring. They are listed in Table 5. The highest number of rare lichen taxa (83 species) are hitherto recorded from the Gorgany Mts in Zakarpattia oblast, while number of such taxa in parts of the Eastern Beskydy and Chornohora Mts in Zakarpattia oblast is much lower (63 and 41 species, respectively) (Tables 3 and 5).

Number of rare lichen species known so far only from Ivano-Frankivsk oblast is rather lower than in Zakarpattia oblast, namely 23 species recorded from territories of the Chyvchyn Mts, as well as 12 and 7 species from the territories of the Gorgany Mts and the Chornohora in Ivano-Frankivsk oblast (Table 3).

Analysis of regionally unique taxa as well as distribution of rare lichen species after administrative oblasts within the territory of the Ukrainian Carpathians are provided here for the first time, and these data cannot be compared with data on other districts of the Eastern Carpathians or the whole Carpathian Mts. However, we do hope that above data on regionally unique taxa of the Ukrainian Carpathians can be used in future for comparison of

similar regionally unique proportion of the lichen flora for another regions of the Eastern Carpathians in Poland, Slovakia, and Romania, as well as in the whole Carpathians in the frame of future planning nature protection activity in the Carpathian region.

CONCLUSIONS

The Carpathian macroregion of Ukraine was found to include the majority of the regionally unique taxa on the basis of the first results of special analysis of distribution of the regionally unique lichens in the five macroregions of this country. The first results of the distribution of the regionally unique lichen taxa in geomorphological districts of the Eastern Carpathians and administrative oblasts of Ukraine in this macroregion are discussed. Further analyses of regionally unique species of each administrative oblast, geomorphological districts of the Carpathian Mts, as well as their distribution within the various protected territories (reserves (= zapovidnyk in Ukrainian or 'zapovednik' in Russian), national parks, reservations, etc.) are planned for future special studies of lichen species diversity of this region.

The species diversity of the regionally unique lichens of the Ukrainian Carpathians, which can be compared with the regionally unique portion of other parts of the Eastern Carpathians or the whole Carpathian Mts in general are to be analysed in the nearest future, when the same detail data on species distribution in these regions will be summarised/updated.

*

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