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The Upper Tisa River Basin

Sibiu - Romania - European Union

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The Upper Tisa River Basin

Editors

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IN MEMORIAM

Teodor Nalbant
(1933 - 2011)

Born on 18th December 1933 in Constanța, Romania, *Teodor Nalbant* fell in love with the creatures of the sea, due to his father, on the beaches of Mamaia and Constanța. After his family moved in 1939 to Tulcea, he followed the Black Sea with the acquaintance and continuous attraction of the Danube Delta.

His general and college studies took place in the capital city of Bucharest, at the "Titu Maiorescu" Highschool, at Nucet, at the Average Technical School of Fishery, as well as in Târgu Mures at the "Papiu Ilarian" Highschool.

Although his family wished that he follow a medical career, *Teodor Nalbant* preferred to attend the classes of the Biology Faculty at Babeş-Bolyai University, Cluj-Napoca, under the guidance of Sergiu Cărăuşu and Eugen A. Pora among others. His biology studies were completed in 1958 at the Biology Faculty of Bucharest University.

In 1953 he met the greatest ever Romanian ichthyologist, Academician Petru Mihai Bănărescu, who would decisively influence his ichthyologist career. In tandem, this valuable pair wrote more than 40 scientific works over 50 years.

Gifted with a fine sense of comparative observation, *Teodor Nalbant* dedicated himself especially to the study of the taxonomy, systematics, phylogeny and zoogeography of fishes (especially Gobioninae and Cobitidae), obtaining well-deserved national and international recognition in these fields.

After his 1958 graduation, he worked at the Institute of Hydrotechnical Studies and Research, than at the Fishery Research Institute, followed by a period at the National Museum of Natural Sciences Grigore Antipa of Bucharest, and finally at the Romanian Academy Biology Institute of Bucharest.

From 1956, *Teodor Nalbant* published more than 150 scientific works, focusing on marine as well as freshwater fish, both Romanian and exotic species. His contributions regarding the Romanian ichthyofauna were linked to some particulars of the taxonomy, systematics and zoogeography of the Petromyzonidae, Clupeidae, Cyprinidae, Cobotidae and Gobiidae groups. Especially interesting and detailed were also the works regarding the *Sabanejewia* and *Cobitis* groups.

One of his great successes as a researcher was the discovery, in 1965, of a unique phenomenon of migration in the species *Caspialosa pontica*, one that takes place only once every 10–20 years. He remained a prominent researcher on the northern and central Pacific, of the Atlantic and Indian Oceans, as well as of the rivers of Central Africa, Afghanistan, Himalayas, India, Iran, Turkey, Cuba, etc.

From his personal research and co-operation with other fish specialists, he discovered and described numerous new taxa from 24 genera, and 43 species and subspecies.

Among his most important publications one should cite: Fishes of the North-eastern Atlantic and Mediterranean (1984–88), The Catalogue in Four Languages of the Main Fish species of North Atlantic Ocean (1971), The Catalogue in Four Languages of the Fish of Romania (1971), etc.

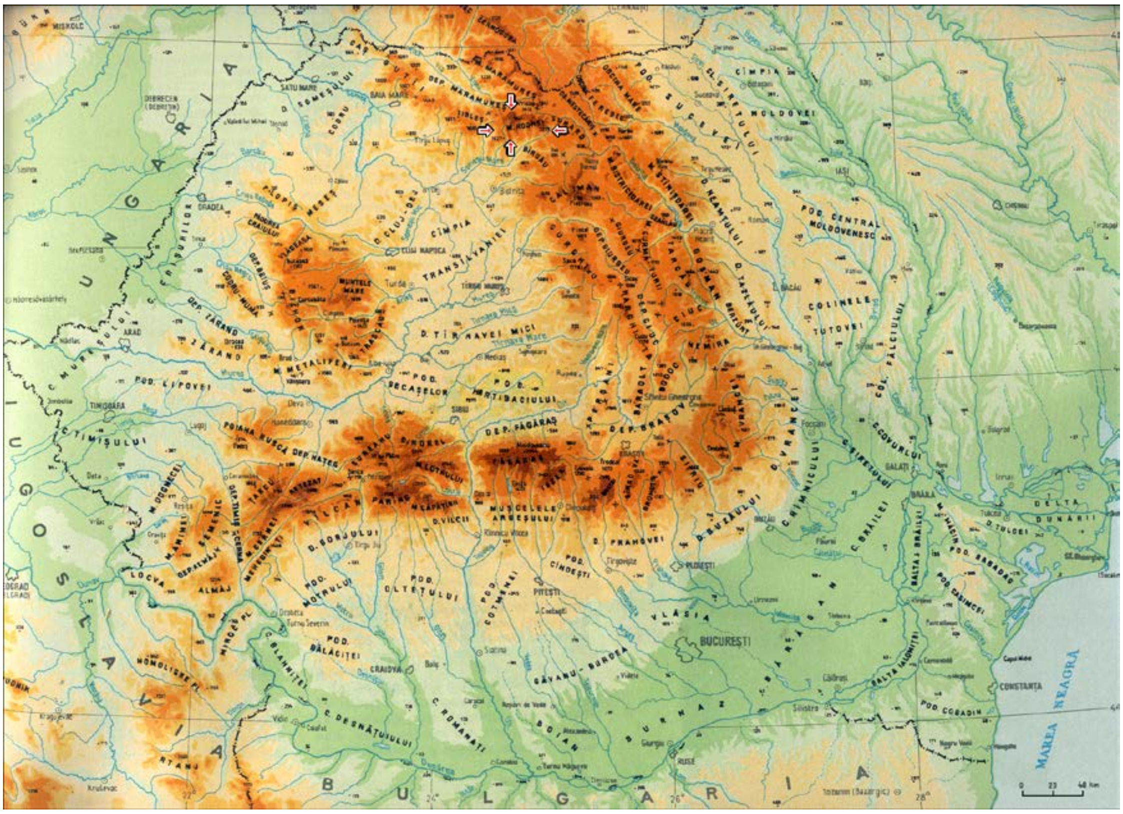
The name of the genus *Nalbatichthys* dedicated by the American ichthyologist Leonard Schultz in 1967, the subgenus *Nalbantius* described by Maugé and Bauchot (1984), and the species *Schistura nalbanti* described by Mîrza and Bănărescu (1984) represent perhaps the quintessence of the recognition of the professional value of a great Romanian ichthyologist, a professional value maybe surpassed only by his particular need of independence.

The Editors

CONTENTS

Preface

Rodna Mountains/Munţii Rodnei (47,975 ha) is located in the north of the Romanian Carpathians, in Transylvania-Maramureş regions area, in alpine bioregion. It overlaps the Rodna Mountains National Park, Pietrosu Mare Biosphere Reserve and two Natura 2000 sites ROSCI0125 Rodnei Mountains and ROSPA0085 Rodnei Mountains.



Location of the Rodna Moutains National Park (Badea et al., 1983 - modified).

The importance of this protected area lies in its geology, geomorphology, and numerous endemic or glacial relicts of flora and fauna, natural ecosystems at altitudes between 500 - 2,303 m.

Owing to its remarkable biodiversity and wildlife, the Rodna Mountains area was designated as a Special Area of Conservation (SAC) under the Habitats Directive and also, Special Protection Area (SPA) under Birds Directive, hosting 27 habitats and 25 species of community importance (six of which are priority species: *Ursus arctos*, *Canis lupus*, *Callimorpha quadripunctaria*, *Rosalia alpina*, *Campanula serrata* and *Pesudogaurotina excellens*), and five habitats are priority habitats: Bushes with Pinus mugo and Rhododendron myrtifolium - 4070*, Species-rich Nardus grasslands, in siliceous substrates in mountain areas - 6230*, Alluvial forest with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) - 91E0*, Active raised bogs - 7110*, Petrifying springs with tufa formations - Cratoneurion - 7220*, and Alpine pioneer formations of the Caricion bicoloris-atrofuscae 7240*).

These mountains harbour more than 7,200 species of flora and fauna, 270 of which are included on Rodna Mountains Red List. The most important nature values (endangered species, ecosystems) are included in four scientific reserves: Pietrosu Mare, Piatra Rea, Corongiş and Bila-Lala (in declaration process). Some vulnerable species which are spreading in Rodna Mountains are valuable species for biodiversity conservation, including brown bear (*Ursus artcos*), lynx (*Lynx lynx*), wolf (*Canis lupus*), Tatra pine vole (*Microtus tatricus* - in Romania present only in Rodna and Maramureş mountains), Carpathian newt (*Triturus montandoni*), *Carabus zawadszkii* (present only in Rodna and Maramureş Mountains), *Cucujus cinnaberinus* (rare in Romania), *Poa granitica disparilis* (present only in Rodna and Făgăraş mountains), *Pseudogaurotina excellens* (rare in Romania - Retezat, Parâng, Făgăraş, Rodna), *Carabus hampei* (present only in Făgăraş, Maramureş and Rodna mountains, and in Someşul Rece), *Hieraaetus pennatus* (rare in Romania), and *Silene nivalis* or Rodna Mountains rush-light (endemic species).

The Rodna Mountains appear as a horst of crystalline layers delimited by deep faults: Dragoş Vodă (to north) and Rodna (to south). There are three crystalline layers: Bretila, Repedea and Rebra. To south, some new volcanic rocks are to be found in the high hills located along the Someşul Mare River.

Sedimentary rocks (Cretaceous and Paleocene) surrounding the massif have been affected by tectonic movements and have stamped the landscape with some particular features. The mountain chain keeps the best traces of Quaternary glaciers. Glacial landscape is well developed on the northern slope where some glacial circuses can be found (Pietrosu, Buhăescu, Negoescu and so on). On the southern slope, the glacial landscape is less impressive: some suspended glacial circuses and snow niches. In the south, the limestone bedrock has made up a karst landscape, with some remarkable caves, such as Izvorul Tăuşoarelor (18 km), Jgheabul lui Zalion, Baia lui Schneider, Cobăşel, Grota Zânelor, and Izbucul Albastru al Izei. There are 26 mountain peaks higher than 2,000 m in the massif.

Different biological studies demonstrate the relevance of the Rodna Mountains from biodiversity point of view, especially by including the Pietrosu Mare site on the tentative list of UNESCO World Heritage Sites for Nature. The process of declaring as a full UNESCO site is ongoing, by collection of data in order to prove that the area is equivalent to an endemogenetic centre for an important constellation of flora and fauna species.

Inspired by the value of the area, the *Transylvanian Review of Systematical and Ecological Research* editors, with the support of the Rodna Mountains National Park Administration, have dedicated a first volume of this series to the Rodna Mountains National Park. This scientific volume represents an important step for promoting the nature values of this area, highlighting the relevance of the protected areas as biodiversity hotspots, and invites more and more naturalists to study and discover the mysteries of this wild area.

There is no doubt that these new data will develop knowledge and understanding of the ecological status of this special area, and that they will continue to evolve.

Acknowledgements

The editors would like to express their gratitude to the authors and the scientific reviewers whose work made the appearance of this volume possible, and to the Rodna Mountains National Park Administration, which supported a part of the field work on which a part of the necessary research was based, and also a part of the printing costs of this volume.

The Editors

GEOGRAPHICAL INTRODUCTARY CHARACTERIZATION OF THE UPPER TISA RIVER BASIN (ROMANIA-UKRAINE)

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KEYWORDS: Romania, Ukraine, upper Tisa/Tysa River basin, demarcation, relief, hydrology, climate, protected areas.

ABSTRACT

The upper Tisa River basin is situated in north-western Romania, Maramureş County, in the Maramureş Depression, and in south-eastern Ukraine, the Transcarpathia Region, in Rakhiv, Tiachiv, Khust and Mizhgiria counties. It thus occupies the largest depression of the Carpathian Mountain range. The surface of the catchment area is approximately 10,354 km², of which 3,381 km² are in Romania and 6,973 km² in Ukraine.

The present work refers to a clearly defined territory, geographically speaking, surrounded by mountains and characterised by a varied landscape, from river flood plains to mountain ridges. The lowest altitude is 157 m above sea level, at the Tisa's exit from the depression, and the highest point is situated in the Rodna Mountains, where the peak of Pietrosul Rodnei is 2,303 m above sea level.

This article presents a brief description of the situation, the delimitation, the landscape, the hydrography, the climate and the protected areas of the upper Tisa River basin.

RÉSUMÉ: Caractérisation géographique introductive du bassin supérieur de la rivière de Tissa (Roumanie-Ukraine).

Le bassin supérieur de la rivière de Tissa est situé au nord-ouest de la Roumanie, dans le département de Maramureş, se superposant sur la Dépression de Maramureş, ainsi que, respectivement, dans le sud-est de l'Ukraine, sur la Région Transcarpatie, le département de Rahiv, Tiaciv, Hust et Mijgiria, donc il se superpose sur la plus grande dépression de la chaîne des Carpates. La surface du bassin est de près de 10.354 km², desquels 3.381 km² se trouvent en Roumanie et 6.973 km² en Ukraine.

L'œuvre ici-bas décrit un territoire nettement individualisé de point de vue physico-géographique, entouré par des montagnes et caractérisé par un relief varié, des plaines basses des rivières aux crêtes montagneuses: le point le plus bas se trouve à 157 m, à la sortie de la rivière de Tissa de la dépression, pendant que le point le plus haut se trouve dans les montagnes de Rodna, le Pic de Pietrosul Rodnei, 2.303 m de hauteur.

Cette œuvre présente une courte description de la position, les limites, le relief, l'hydrographie, le climat et les zones protégées du bassin supérieur de la rivière de Tissa.

REZUMAT: Caracterizare geografică introductivă a bazinului superior a râului Tisa (România-Ucraina).

Bazinul hidrografic superior al Tisei se află în partea de nord-vest a României, în Județul Maramureş, suprapunându-se practic peste Depresiunea Maramureşului şi respectiv în partea de sud-est a Ucrainei, Regiunea Transcarpatia, în raioanele Rahiv, Tiaciv, Hust şi Mijgiria şi se suprapune peste cea mai mare depresiune din lanțul Munților Carpați.

Suprafața bazinului este de aproximativ 10.354 km², din care 3.381 km² se află în România şi 6.973 km² în Ucraina.

Prezenta lucrare se referă la un teritoriu net individualizat sub aspect fizico-geografic, înconjurat de munți şi caracterizat printr-un relief variat, de la luncile râurilor până la crestele montane. Altitudinea cea mai coborâtă este de 157 m la ieşirea râului Tisa din depresiune, iar cel mai înalt punct se află în Munții Rodnei, Vârful Pietrosu Rodnei 2.303 m.

Această lucrare prezintă o descriere succintă despre amplasarea, delimitarea, relieful, hidrografia, clima şi zonele protejate din zona bazinului superior al râului Tisa.

LOCATION

The Tisa River upper basin (Figs. 1a, b) is located in the north-west of Romania (Maramureş County) in the Maramureş Depression and in the south-east of Ukraine, Transcarpatia Region (Rahiv, Tiaciv, Hust and Mijgiria counties).

Figure 1a: Location of the Upper Tisa River basin.

In the studied area, in the upper Tisa River basin, on the right side of this river, in the Dilove locality of Ukraine, is the geographical center of Europe (Fig. 2).

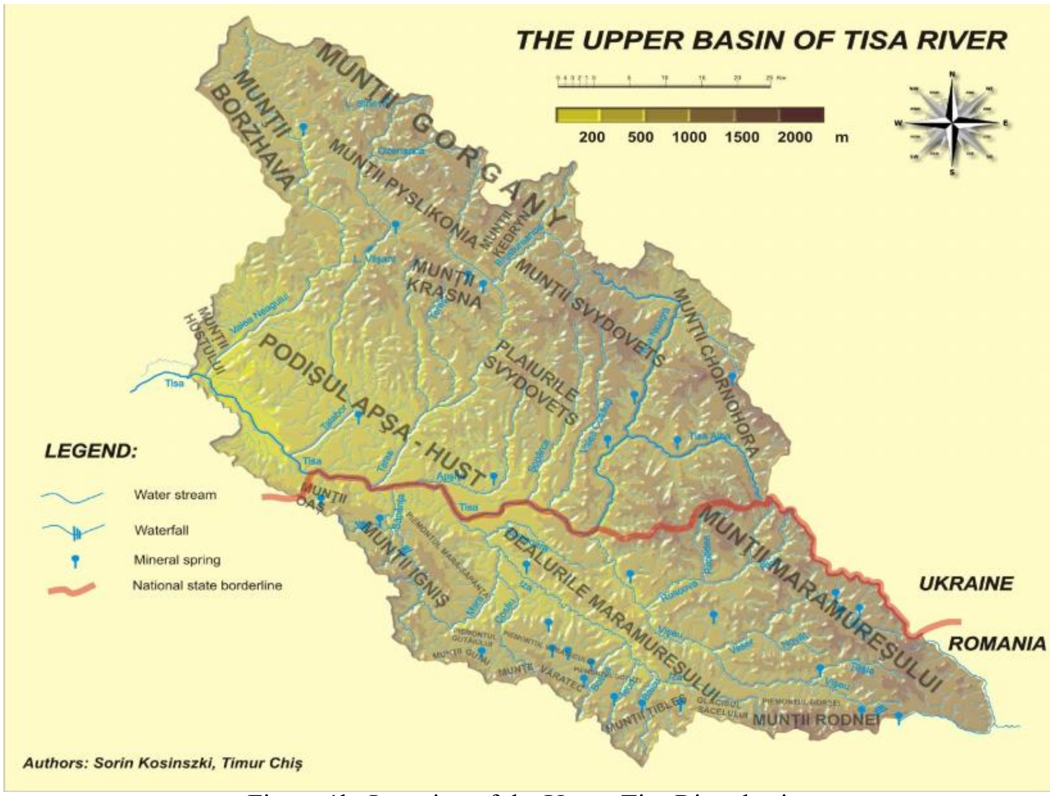

Figure 1b: Location of the Upper Tisa River basin.

Figure 2: The geographical center of Europe.

DEMARCATION

The upper Tisa River basin is bounded from the lowest altitude located on the river Tisa, close to the confluence with Rika, respectively the output zone of the Tisa River from the depression of the Tisa River upper basin, respectively 157 m a.s.l., on the Ukrainian territory. From this point the basin limit follow the watershed limit on the Ukraine territory and climbs in Hustului Mountains (Fig. 3) (Tovsta Peak of 819 m, Tupyi Peak of 878 m), goes down in Lipețk Pass (320 m), here it goes up in Borzhava Mountains (Vodytsia Peak of 1,027 m, Kuk Peak of 1,361 m, Verkh Peak 1,598 m), and goes down in the Volovets'kyi Pass of 974 m, from here the limit rises in the Gorgany Mountains (Hnyla Peak of 981 m, Chorna Ripa Peak of 1,285 m, Vyshkivs'kyi (Toruns'kyi) Pass of 930 m, Mahura Peak of 1,107 m, Vushkivs'kyi Gorgan Peak of 1,439 m, Popadia Peak of 1,740 m, Bert Peak of 1,666 m, Kinets' Gorganu Peak of 1,580 m, Bratkivs'ka Peak of 1,788 m), and goes down in the Yablunyts'kyi Pass of 931 m, from here goes in the Chornohora Mountains (Kukul Peak of 1,539 m, Hoverla Peak of 2,061 m (the highest Ukrainian peak), Turkul Peak of 1,933 m, Chorna Hora Peak of 2,020 m, Vykhid Peak 1,471 m, Stogu/Stih Peak 1,651 m. From Stogu Peak the limit of the basin is separated by the Romanian-Ukrainian actual border and follow the main peak line of the Maramureş Mountains (Fig. 4) and of the Civcin/Chyvchyny Mountains through Budescu Mare/Velyca Budyiovs'ka Peak of 1,678 m, Şuligu Peak of 1,688 m, Lăstun Peak of 1,595 m, Comanu Peak of 1,723 m, Ignăteasa Peak of 1,759 m, and from here the basin limit enters completely on the Romanian national territory, Jupania Peak of 1,853 m, Fântâna Stanchi Peak of 1,725 m, Cornu Nedeii Peak of 1,763 m, Prislop Pass of 1,416 m. From Prislop Pass the basin limit rises on the main crest of the Rodna Mountains (Fig. 5), Ştiol Peak of 1,611 m, Şaua Gărgălău of 1,907 m, Galațiu Peak of 2,048 m, Laptele Mare Peak of 2,172 m, Negoiasa Mare Peak of 2,041 m, Repede Peak of 2,074 m, Cormaia Peak of 2,033 m, Rebra Peak of 2,119 m, Gropilor Peak of 2,063 m, Bătrâna Peak of 1,710 m, Pietrei Pass of 1,196 m, Muncelul Râios Peak of 1,703 m, Şetref Pass of 818 m. From the Şetref Pass the limit of the basin is separated by the main crest of the Țibleş Mountains (Fig. 6), Fântânele Peak of 934 m, Ştefăniței Peak of 1,181 m, Pleşcuț Peak of 1,039 m, Țibleş Peak of 1,839 m, Arcer Peak of 1,834 m, Stregilor Peak of 1,472 m, Covetelor Peak of 1,227 m, Botiza Pass 980 m, from here the limit follow the main crest of the Lăpuşului Mountains - Măgura Porcului of 1,221 m, Secului Peak of 1,311 m, Văratecului Peak of 1,357 m, Prislop Peak of 1,332 m, Neteda Peak of 1,321 m, Neteda Pass of 1,049 m, from here climb on the main crest of the Gutâi Mountains - Gutâiul Mic Peak of 1,400 m, Gutâi Peak of 1,443 m, Secătura Peak of 1,391 m, Măgura Peak of 1,125 m, Gutâi Pass of 987 m. From the Gutâi Peak the limit follow the main crest of the Igniş Mountains (Fig. 7) - Iezuri Peak of 1,091 m, Vârful lui Ilie Peak of 1,198 m, La Cruce Pass, Breze Peak of 1,253 m, Ştedia Pass, Pleşca Mare Peak 1,292 m, Stânelor Peak of 1,162 m, Rotunda Peak of 1,240 m, Tribşor Peak of 976 m, Vezeu Peak of 1,027 m, Vârful Mare Peak of 1,044 m, Huta Pass 586 m. From Huta Pass the limit is on the main crest of the Oaşului Mountains, respectively on the national border - Corolea Peak, Piatra Vâscului Peak of 823 m, Geamăna Mare Peak and go down on the Ukrainian territory to Tisa River downstream the confluence with the Rika tributary. (Boar N., 2005; Chiş V. T., 2008, 2010)

Figure 3: The Hustului Mountains.

Figure 4: The Maramureşului Mountains; Mihailecu ridge.

Figure 5: The Rodna Mountains; Piatra Albă Peak and Iezer Lake.

Figure 6: The Țibleş Mountains.

Figure 7: The Igniş Mountains; Brazilor Peak.

RELIEF

The Upper Tisa Basin depression is a clearly individualized territory from the geographical point of view, characterized by a diverse relief, ranging from river meadows to mountain ridges; the lowest altitude is 157 m a.s.l. at the exit of Tisa River from the depression, while the highest lies in the Rodna Mountains, on the Pietrosu Rodnei Peak of 2,303 m (Boar, 2005; Posea et al., 1980; Ardelean et al., 2000). The characteristic relief to the Upper Tisa Basin is extremely diverse, being represented by:

1. Mountains - Maramureş Mountains, Rodna Mountains, Țibleş Mountains, Lăpuş Mountains, Igniş Mountains, Gutâi Mountains, Oaş Mountains, Hust Mountains, Borzhava Mountains, Gorgany Mountains, Chornohora Mountains, Svydovets Mountains, Krdryn Mountains, Krasna Mountains and Pyslikonia Mountains;

2. Foothills - Borşa Piedmont, Văratec Piedmont, Gutâi Piedmont and Mara-Săpânța Piedmont;

3. Glacises - Săcel Glacis and Vişeu Glacis;

4. Hills - Maramureş Hills (Fig. 8);

5. Plateau - Hust-Apşa;

6. Depressions - Borşa, Vişeu, Ruscova, Bârsana, Vadu Izei, Mara, Rona, Sighet, Yasynia, Chorna, Synevyr Kolochava and Studeniy Mizhgiria;

7. Corridors (Fig. 9) - Vişeu Corridor, Izei Corridor, Tisa Corridor, Shopurka Corridor, Apshytsia Corridor, Teresna Corridor, Tereblia Corridor and Rika Corridor;

Figure 8: Maramureşului Hills.

Figure 9: Tisa Corridor, Plateau - Hust-Apşa, Svydovets Mountains, Gorgany Mountains.

8. Gorges – Vişeu Gorge, Surduc Gorge and Tisa Gorge;

9. Meadows - Tisei Meadow. (Boar, 2005; Chiş, 2008, 2010; Pop, 2000; Posea, Moldovan and Posea, 1980).

HYDROGRAPHY

The Tisa River (Fig. 10) is the main collector and is formed from the union of two rivers - Black Tysa (Chorna Tysa) and White Tysa (Bila Tysa) close to the Rakhiv locality - and drain all the tributaries of the upper Tisa Basin. The most important tributaries of the right side are: Kisva, Shopurka, Apshytsia, Teresva, Tereblia and Rika, and the left side tributaries are Vişeu, Iza and Săpânța (Ujvári, 1972; Bashta and Potish, 2007).

Figure 10: Tisa River.

Figure 11: Tăul Morărenilor Reserve.

The lakes are numerous and are of complex origin.

Glacial: Rodnei Mountains (Iezer Lake, Buhăiescu I, II, III and IV lakes, Repedea Lake); Maramureş Mountains (Tăul Roşu), Chornohora Mountains (Verhne, Mariceika, Nesamovâte, Brebenescul and Breskul), Svydovets Mountains (Apşineț - the bigest (1.2 ha) glacial lake of the area, Dragobratske and Voroseska).

Periglacial: Maramureş Mountains (Vinderel Lake of 0.9 ha), Gutâi Mountains (Tăul Chendroaiei).

Landslide: Tăul Morărenilor (Gutâi Piedmont), Hoteni Lake. (Fig. 11)

Natural dam lake: Gorgany Mountains (Synevyr Lake of 7 ha, is the bigest in the Tisa River upper basin).

Volcanic: Igniş Mountains (Tăul Iezerul Mare).

Anthropical saline lakes: at Ocna Şugatag (Gavrilă, Tăul fără Fund, Roşu), Coştiui and Solotvino.

Carstosaline lakes: at Ocna Şugatag (Vorsing Lake, Alb Lake).

Artificial dam lakes: Runcu Lake, Tereblia Lake.

Lakes formed in place of old meanders or watercourses: are also present on the river Tisa (e.g. Paviscu Pool).

CLIMATE

The climate from the Upper Tisa River Basin is enframed in the moderate temperate continental type, and the relief determines some climate subtypes (mountainous, hilly, depressionary). High mountains protect the region from the cold northern winds, the humid temperate continental climate determining warm summers and mild winters. On winters, thermal inversions may appear, the colder air masses remaining inside the depressions, while on the mountain ridges, the temperature values being slightly more elevated.

The mean annual temperature decreases constantly along with the altitude: Hust (164 m altitude, 8.8°C), Sighetu Marmației (272 m altitude, 8.8°C), Ocna Şugatag (482 m altitude, 6°C), Iasinia (645 m altitude 6.1°C), Borşa (603 m altitude, 6°C), the mountains (up to 1,800 m altitude, 2-0°C, and over 1,800 m altitude, -2°C, on Pietrosul Rodnei).

Rainfall values are high and grow higher with the altitude: in the depressions, multiannual means are 700 mm, increasing to 1,200 mm in Rodna Mountains, Țibleş Mountains, Igniş Mountains, Gutâi Mountains, Oaş Mountains, Hustului Mountains, Borzhava Mountains, Krdryn Mountains, Krasna Mountains or Pyslikoniaiar Mountains, reaching up to 1,400 mm in Maramureş Mountains, Chornohora Mountains, Svydovets Mountains or Gorgany Mountains.

PROTECTED AREAS

Romania - Maramureş, Maramureş Depression

Parks:

Rodna Mountains National Park - Reservation of the Biosphere - 46,339 ha, overlaps a part of the Rodna Mountains. Rodna Mountains National Park belong to Maramureş County (9,798 ha) and Bistrița-Năsăud County (36,541 ha).

Maramureş Mountains Nature Park - 148,850 ha.

Reserves of national interest:

Pietrosul Mare Reserve (Rodna Mountains National Park) - code 2563, mixed, scientific reservation, 3,300 ha, locality Moisei, Borşa, Maramureş County.

Piatra Rea Reserve (Rodna Mountains National Park) - code 2,589, mixed, scientific reservation, 409 ha (in the Law 5/2000 -50 ha), Maramureş County.

Ponorul Izei Reserve (Izvorul Bătrâna) (Rodna Mountains National Park) - code 2562, hydro-geologic, 0.5 ha, locality Moisei, Maramureş County.

Peştera and Izbucul Izei Reserve (Rodna Mountains National Park) - code 2582, speleological, 100 ha, locality Moisei, Săcel.

Vlăşinescu Swamp, code 2571, botanical, 3 ha, locality Mara.

Tăul lui Dumitru, code 2572, botanical, 3 ha, locality Baia Mare.

Creasta Cocoşului, code 2577, mixed, 50 ha, locality Mara.

Tătarului Gorges, code 2578, hydro-geological, 15 ha, locality Mara.

Iezerul Mare Swamp, code 2590, botanical, 5 ha, locality Deseşti.

Cave from Dealul Solovan, code 2593, mixed, 1.02 ha, locality Sighetu Marmaţiei.

Morărenilor Lake, code 2568, mixed, 20 ha, locality Breb-Ocna Şugatag.

Poiana Brazilor Swamp, code 2570, mixed, 3 ha, locality Giuleşti.

Ronişoara Forest, code 2573, forest, 62 ha, locality Rona de Sus.

Pădurea Crăiască, code 2574, forest, 44 ha, locality Ocna Şugatag.

Pădurea de larice Coştiui, code 2576, forest, 0.71 ha, locality Coştiui.

Cornu Nedeii-Ciungii Bălăsânii, code 2580, mixed, 800 ha, locality Borşa.

Arcer - Ţibleş code 2585, mixed, 150 ha, locality Groşii Tibleşului, Dragomireşti.

Farcău Peak - Vinderel Lake - Mihailecu Peak, code 2586, mixed, 100 ha, locality Repedea, Poienile de Sub Munte.

Poiana cu narcise Tomnatec - Sehleanu, code 2588, mixed, 100 ha, locality Repedea.

Reserves of local interest:

Tăurile and peat bogs from Hoteni - botanical, 2.51 ha, locality Ocna Şugatag.

Dumbrava Swamp - botanical, 4 ha, locality Dragomireşti.

Tăurile Chendroaiei - botanical, 2.46 ha, locality Deseşti.

Ursoi - geological reservation, locality Vadul Izei.

Mara River - total length 37.6 km, locality Vadu Izei - length 2.4 km, Ocna Şugatag - length 2.9 km, Giuleşti - length 9.4 km, Deseşti - length 22.9 km.

Natura 2000 Sites:

*Sites of Community Importance **(SCI)** – later, will be special areas of conservation (SAC);*

Gutâi - Creasta Cocoşului, code ROSCI0089, surface of 693 ha.

Igniş Plateau, code ROSCI0092, surface of 19,602 ha.

Maramureş Mountains, code ROSCI0124, surface of 103,391 ha.

Upper Tisa, code ROSCI0251, surface of 6,392 ha.

Rodna Mountains, code ROSCI0125, surface of 47,965 ha out of which 9,798 ha in the territory of Maramureş County.

Iza Valley and Solovan Hill, code ROSCI0264, surface of 47,684 ha.

*Avifaunal Special Protection Area **(SPA)***

Rodna Mountains, code ROSPA0085, surface of 47,965 ha, out of which 9,798 ha in the territory of Maramureş County.

Ukraine - Transcarpathia Region, Upper Tisa Basin, Rakhiv, Tiachiv, Khust and Mizhgiria counties.

Biosphere Reserves:

Karpats'kyi (Carpathian) Biosphere Reserve, 57,880 ha, consist of the following scattered parts:

- Chornohirs'kyi Masyv
- Svydovets'kyi Masyv
- Marmoros'kyi Masyv
- Kuziys'kyi Masyv
- Uhol's'ko - Shyrokoluzhans'kyi Masyv
- Dolyna Nartsysiv (Narcissus Valley)

National Nature Park:

Synevyr National Nature Park, 40,400 ha

Regional Landscape Park:

"Prytysianskyi" Regional Landscape Park (10,331 ha, but only few hundreds hectares within upper Tisa River basin)

Small-scalled Reserve of National Importance:

Apshynets'kyi, 105 ha, hydrological
Bradul's'kyi, 1,026 ha, landscape
Dibrova, 712 ha, forest
Gorgany and Tavpishyrka, 248 ha, botanical
Hladyns'kyi, 130 ha, botanical
Kamianka
Kedryns'kyi, 166 ha, botanical
Kernychnyi, 107 ha, botanical
Richans'kyi, 2,408 ha, general zoological
Stranzul, Zadnia, and Kedryn, 510, botanical
Zatinky and Teresianka, 13 ha, botanical

Small-scalled Reserve of Local Importance

Arnika, 9,5 ha, botanical
Arshychna, 24.5 ha, botanical
Bertianyk, 53.5 ha, botanical
Black Tysa (Chorna Tysa), 39 km, ichtiological
Chornianskyi derenkovach, 260 ha, botanical
Hoverlianka, 2.5 ha, botanical
Kantyna
Mlaky, 58 ha, botanical
Ozirtse
Radianski Karpaty, 649 ha, forest
Stanislav, 5.3 ha, botanical
Ust-Chorna, 13 km, ichtiological
Veimutova sosna, 5 ha, forest

Protected Tracts ("zapovidne urochusche")
Dubrovy, 10 ha
Mochar, 8 ha

Nature Monuments of National Importance
Dovhyi Potik, 25 ha, botanical
Holiatyn
Velykyi Yavorets and Obnoha.

Nature Monuments of Local Importance
Andromeda, 6 ha, botanical
Apshynets Lake, 2.6 ha, hydrological
Big Stone Hill, 5 ha, geological
Cave Chertezh, 3 ha, geological
Cercis, botanical
Gerasheska Lake, 1.35 ha, hydrological
Gorodyliv Waterfall, 0.12 ha, hydrological
Lypovetske Marime Lake, 0.3 ha, hydrological
Menchul-Kvasivskyi, 1.81 ha, botanical
Naked Rocks on Tereblia river bank, 5 ha, geological
Red Rock, 2 ha, geological
Rocks Trostynets, 1.5 ha, geological
Rocks, 0,7 ha, geological
Rododendron, 2.5 ha, botanical
Salty Lakes, 2 ha, hydrological
Salty Lakes, 5.2 ha, hydrological
Shypit Waterfall
Skelia-strimchak, 2.2 ha, geological
Stone Salt place, 3 ha, geological
Svydovets Rocks, 5 ha, geological
Vorozheska Lake, 0.75 ha, hydrological
Waterfall Truphanets, 0.37 ha, geological

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THE GEOLOGICAL STRUCTURE OF THE MARAMUREŞ DEPRESSION (MARAMUREŞ, ROMANIA)

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ABSTRACT

This article includes a detailed description of the geological structure of the Maramureş Depression, which is situated in the northern part of the Oriental Carpathians and the first in the depression series forming "The Great Longitudinal Depressionary Alignement" (Sârcu, 1971).

The data in the present work refer to the southern part of the Maramureş Depression (Pienid Unit, Middle Dacides, External Dacides), the post-tectogenetic layer of the Middle Dacides, Miocene molasse deposits (Badenian, Sarmatian, Pannonian) and Miocene volcanic rocks.

ZUSAMMENFASSUNG: Geologische Struktur der Maramuresch Senke (Maramuresch, Rumänien).

Die Arbeit umfasst eine genaue Beschreibung der geologischen Struktur der im nördlichen Teil der Ostkarpaten gelegenen Maramureşch Senke. Sie ist die erste in der Reihe der Senken, im großen, langegestreckten innerkarpatischen Senkengebiet der Ostkarpaten bekannt als "Marele Uluc Depresionar Longitudinal" (Sârcu, 1971).

Die Ausführungen dieser Arbeit befassen sich mit dem südlichen und zwar dem in Rumänien gelegenen Teil der Maramureşch Senke (etwa 30% ihrer Gesamtfläche). Bezug genommen wird dabei auf das Fundament der Maramuresch Senke (Einheit der Pieniden, der mittleren und äußeren Daciden), die posttektonisch-genetische Decke der mittleren Daciden, auf Miocäne Molasse Ablagerungen (Baden, Sarmat, Pannon) sowie die Miocänen, vulkanischen Gesteine.

REZUMAT: Structura geologică a Depresiunii Maramureşului (Maramureş, România).

Lucrarea prezintă o descriere amanunțită a structurii geologice a Depresiunii Maramureşului care este situată în partea de nord a Carpaților Orientali şi este prima din seria de depresiuni care alcătuiesc „Marele Uluc Depresionar Longitudinal" (Sârcu, 1971).

Datele din aceasta lucrare se referă la partea sudică a Depresiunii Maramureşului, cea de pe teritoriul României (cca 30% din întreaga suprafață a depresiunii). Aceasta lucrare face referire la fundamentul depresiunii Maramureşului (Unitatea Pienidelor, Dacitele mediane, Dacitele externe), cuvertura post-tectogenetică a Dacitelor mediane, depozite de molasă Miocene (Badenianul, Sarmațianul, Pannonianul) şi a rocilor vulcanice Miocene.

INTRODUCTION

The Maramureş Depression, located in the northern part of the Eastern Romanian Carpathians (Sârcu, 1971; Chiş 2008, 2010), is the first of the series of depressions composing „The Great Longitudinal Depressionary Alignement" (Sârcu, 1971).

The data presented deals with the southern part of the Maramureş Depression, on the Romanian territory (around 30% of the entire depression).

The Maramureş Depression is a structural unit that functioned as a active retroarc foreland basin in Upper Cretaceous – Lower Miocene, when the transcarpathic flysch deposits were formed (Zincenco, 1998). Afterwards, Neogene calcareous sandstones were deposited, and then a Neogene island ark calco-alkaline volcanism took place.

MATERIALS AND METHODS

This paper represents the result of over 40 years of geological survey, and it is also based on several papers published on this topic.

RESULTS

1. The basement of the Maramureş Depression

The basement consists of various formations, sometimes outcropping either in the hills and mountains on the border of the depression, or in the neighbouring areas. The Maramureş Depression is crossed by the Tethys Major Suture, which delimits the Internal and the External Carpathians (Săndulescu et al., 1993). The Pienid units are associated with this major suture.

1.1. Pienid Units

The Pienid units include several units assigned to the internal Dacites (Săndulescu et al., 1993).

The Pienid Klippe Belt – the most representative Pienid element, extending from Wien through Slovakia, Poland and Ukraine. In Maramureş the Pienid Klippe Belt passes north of Tisa River to the area north of Sighetu Marmației, where it supposedly leaves Maramureş, crossing south-west on the western ridge of Gutâi Mountains and then south of the mountains, to Poiana Botizii - Strâmbu Băiuț, occurring in the frontal part of the frontal scales of the Botiza Nappe.

The Botiza Nappe – crops out in the southern part of the Maramureş Depression, in the Botiza - Dragomireşti area. Two subunits were delimited:

- the frontal scales, with the following complexes individualized: the Puchov Red Marl (Senonian-Paleocene), the Purple Clays (Paleocene - Eocene), the Stripped Clays (Ypresian) and the Secătura Sandstone (Oligocene);
- the main body, containing the Tocila Flysch (Ypresian - Lutetian), the „Hieroglyph Layer" Flysch and the Secu Sandstone (Lutetian - Priabonian). Inside the internal scales of the Botiza Nappe (the Ieud Scale), the stripped clay deposits are also present in the Middle Eocene.

The Kricevo Nappe – is internal to Botiza Nappe and consists of gray clay deposits and interbedded sandstones, marls and limestones of Cretaceous age (Albian - Senonian). It is mostly extended north from Tisa, the only occurrences south from the river being identified by the drilling 4001 at Sarasău (at the depth of 2250 - 2740 m), where it is similar to the findings from drills 4 and 5 from Solotvino (Ukraine) (Săndulescu et al, 1993).

The Băbeşti - Tiacovo (Teceu) Nappe consists of Triassic and Jurassic limestone sequences associated with ophiolitic alkaline and basic igneous rocks. These rocks are also supposed to occur under the Săpânța - Teceul Mic area (immediately south of Tiacovo (Ukraine)). These deposits have a more internal position to the Kricevo Nappe and, together with it, are overlapping the metamorphic and sedimentary cover formations assigned to the Bihor unit of the internal Dacites.

The Petrova Nappe is considered the most external unit of the Pienids, corresponding to the Măgura Nappe from the Polish and Slovakian Carpathians (Săndulescu et al., 1993). For a long period it was considered the equivalent of the Botiza Nappe. It consists of three series of flysch deposits:

- *the black flysch* (Cretaceous-Paleocene) - outcrops at Izvorul Negru (Budeşti);

- *the Petrova flysch* - "hieroglyph layers" - type flysch with intercalations of red clay (Lutetian - Priabonian) developed between the localities Rona de Sus and Petrova.

- *the Strâmtura sandstone* – sandstone flysch with fluxoturbidity, Priabonian - Lower Oligocene in age, outcropping in the Iza valley and on the ridge separating the Iza and Ronişoara valleys.

The Leordina scale, consisting of the Rozavlea formation (shaly flysch with marls and red clays and black shales (Priabonian - Lower Oligocene)) and of the Voroniciu sandstone (sandstone flysch) of Lower Oligocene age, forms the front of the Petrova Nappe.

1.2. Median Dacites

The Median Dacites are represented by Cretaceous overthrust nappes and basement nappes consisting of several overthrusted units. They occur in large areas in Maramureş and Rodna Mountains and form the basement of the Maramureş depression in the Vişeu valley. From bottom to top, the following units were separated:

1.2.1. The Maramureş nappes comprise the following formations:

- Pop Ivan Group (Lower and Middle Precambrian) – consisting of paragneisses, mica and amphibolites, occurs in the Frumuşaua Valley (Crasna Vişeului).

- Bretila Group (Upper Precambrian) – consisting of paragneisses and amphibolites, is known to occur in the Peştilor Valley, Vaser Valley and in the Rodna Mountains (Repedea Valley, Galați Summit, Bistricioara Valley).

- Repedea Group (Ordovician - Lower Carboniferous) – consists of phyllitic and graphite schists with intercalations of black quartzites and crystalline limestone. Includes the epimetamorphic formations from the Rodna Mountains and the Vaser basin.

- Bistra Group (Devonian - Lower Carboniferous) – terrigenous carbonate rocks (dolomites, limestones), sericite - chlorite schists with acidic metatuff intercalations, occurring in the Bistra Valley basin.

- Cimpoiasa Group (Devonian - Lower Carboniferous) consists of sericite - chlorite schists, limestones and dolomites, and occurs in the northern part of Rodna Mountains. It includes several formations (Buhăiescu, Prislopaş, Negoiescu, Gura Fântânii).

- The Permian consists of conglomerates, sandstones and acidic eruptive rocks, and is present on the Repedea Valley (Poleanca) and Mount Pietriceaua (Repedea, Maramureş Mountains).

- The Mesozoic consists of conglomerates, limestones and Triassic dolomites (Pentaia Valley - Repedea, Botizu Valley).

1.2.2. The Sub-Bucovinic nappe consists of the following rock complexes:

- The Vaser Complex (Upper Precambrian - Lower Cambrian) – consisting of micaschists, Gliganu quartzites, manganese quartzites, and intercalations of acidic metavolcanites. It corresponds to the lower part (TG 1) of Tulgheş group and crops out on the median course of the Vaser Valley, downstream of Făina.
- The Cârlibaba - Ţibău Group (Lower Carboniferous) – consists of chlorite schists covered by a carbonate complex (limestones and dolomites). It extends from the Ţibău Valley through the Vaser source area to Peştilor Valley (Vişeu de Sus).
- The Rebra Unit (Upper Precambrian) – occurs in the Pietrosul Rodnei - Buhăescu Peak area (Rodna mountains), where two formations are separated: *the Inău formation* (at the upper part), consisting of quartz micaschists, graphite quartzites and amphibolites, overlying *the Voşlăbeni formation* (micaschists, quartzites and layers of metamorphic limestones and dolomites).
- The Mesozoic rocks consist of Triassic breccias of Hăghimaş type, sandstones and dolomites (Piciorul Comanului, Piciorul Babei).

1.2.3. The Bucovinic nappe consists of the following structural levels:

- The Tulgheş Group (Cambrian) – composed of three formations: Lower (TG 1) – sericite - chlorite schists; Median (TG 2) – graphitous, with black quartzites, and Upper (TG 3) – vulcanogene - sedimentary, with sulphides. It extends from the upper Ţibău basin to the Ţâşla Valley (Baia Borşa), Vaser Valley, Bardiu Valley (Poienile de sub Munte).
- Upper Paleozoic – red Permian deposits - purple Verrucano-type quartzitic conglomerates (Repedea Valley, Şuligu de Sus Valley).
- Mesozoic – represented by the Lower - Medium Triassic, and possibly Callovian – Oxfordian rocks.

1.3. External Dacites

The external dacites are represented by overthrust nappes consisting of sedimentary formations, mostly flysch-type, associated with alkaline igneous rocks in varying amounts. The External Dacites represent the second suture in the Carpathian area, in addition to the Pienid Unit.

1.3.1. The Black flysch nappe consists of binary black Tithonian - Neocomian flysch (argillaceous shales, sandstone shales, sandstones, limestone breccias, overlying massive ophiolite rocks (pillow basalts, tuffs, dolerites). Two separate formations are associated with the igneous rocks: *the Mihailecu formation* (a sequence of basalts, limestones, jaspers, tuffs and red shales) and *the Vârtop formation* (limestones, limestone breccias, limestones with chlorite intercalations). The Obnuj formation, basically consisting of clays and silts rich in organic matter, was also pointed out.

1.3.2. The Ceahlău nappe has as a characteristic element the Sinaia flysch, the oldest sequence of its kind in the Carpathians. The Ceahlău nappe occurs in the Socol Valley (Poienile de sub Munte) and consists of ternary alternations (sandstones, shales and marls), rarely with intercalations of clays and black marly limestones.

1.3.3. The Corbu formation (Aptian - Albian) consists of sandstones in thick banks and conglomerates with intercalations of marly - argillaceous rocks. At the top of the succession lies a coarse calcareous sandstone with uncharred plant remains (Copilaşu sandstone). The Corbu formation occurs on the slopes of Socol Valley (Corbu, Stogu, Copilaşu) in the Maramureş Mountains.

2. The post - tectogenetic cover of the Median Dacites

The Central - Eastern Carpathian nappes (Median Dacites) are covered in the Maramureş depression by a thick blanket of Paleogene formations which, in some places, overly also the Cretaceous formations.

The Bardău Formation (Vraconian - Cenomanian), is composed of sandstones, marls, conglomerates and limestone with orbitolines. It occurs in the Pietrosul Bardăului area and along the border with Ukraine, between the upper part of Ştevioara Valley and the upper part of Vaser Valley (Şuligu Mountain, Lostun, Comanu, Ignăteasa).

The Marls with Inoceramus (Turonian - Coniacian) occur in small areas (Zănoaga Hill between Peştilor Valley (Vişeu de Sus) and Cvaşniţa Valley (Poienile de sub Munte)).

The Vinderelu formation (Barremian - Aptian) is formed by flysch sandstones (feldspathic sandstones, conglomerates, shales) and a characteristic level of conglomerates with Triassic limestones and rocks from the black flysch.

The Cretaceous sandstones and conglomerates (Senonian) are represented by detrital deposits present in the gorges from the lower part of the Vişeu Valley, between Bistra and Valea Vişeului.

The Puchov red marls (Senonian) have a regional extension, from Poland through Slovakia and Ukraine until the Prahova Valley, all along the North - Western and Eastern Carpathians. They occur both in the Carpathian flysch fosse (in the Botiza and Petrova Nappes) and in the post-tectogenetic cover of the Median Dacites (Baia Borşa, between the Novăț and Vişeu valleys, and between the Tâşla and Novăț valleys).

The Paleocene marls are a gray marl and calcareous marl rocks complex with Paleocene microfauna located at the base of the Prislop conglomerates. They occur in the upper part of Vişeu Valley, in the Peştilor Valley (Vişeu de Sus) and Cvaşniţa Valley (Poienile de sub Munte).

The Prislop conglomerates (Lutetian) are conglomerates consisting of metamorphic quartz clasts, micas, limestones and dolomites and even nummulitic limestone blocks. Cretaceous limestone blocks with *Exogyra columba* may also occur. They extend from Vişeu to Poienile de sub Munte (Cvaşniţa Valley).

The Vişeu formation (Lutetian - Priabonian) consists of marls and gray marly silts with intercalations of nummulitic limestones and microconglomerates. They occur between Vişeu de Sus and Vinului Valley (Vişeu de Mijloc).

The Vaser formation (Priabonian) consists of gray marly silts with rare intercalations of thin calcareous sandstones. Red clays may occur localy. They are located in the area Vişeu de Sus - Bătoaia Valley - Vişeu de Mijloc - Vinului Valley - Cvaşniţa Valley - Bardiu Valley (Poienile de sub Munte). Previously, the Vişeu and Vaser formations were included in a formation called "*The Vaser marls*".

The Valea Carelor formation (Lower Rupelian) consists of clays and clay silts with layers of menilites, disodilic shales, thin sandstones, limestones and calcareous marls. Red clays occur localy. In its northern sector (north of Cvaşniţa Valley), a sandstone complex also occurs in this formation (*The Mentalisa sandstone*). The Valea Carelor formation represents a local and characteristic facies of the Lower Oligocene, its outcrop areas being on the northern Maramureş fosse (the area between Luhei, Bistra and Scorodnei rivers, where poorly laminated black marls occur), in the Poienile de sub Munte - Vişeu area (Cvaşniţa Stream, Peştilor Stream , Vinului Stream, Scrada Stream), and, respectively, in the Baia Borşa – Birțu area (Fântâna stream and Valea Rea Valley from the Cisla basin).

The most typical occurrence of the Valea Carelor formation occupies the upper part of the Iza River (Işcioara Stream, Repedea Stream, Teilor Stream) and the upper basin of the Bistriţa, Valea Largă Valley and Băleasa, left tributaries of the Iza River, with outcrops of black marly clays and disodilic clays, strongly brecciated.

The Birţu Sandstone (Rupelian), overlaying the Valea Carelor formation, is a sequence of approx. 200 - 600 m thick curbicortical micaceous sandstones and limestones in 0.2 to 2.0 m thick beds, with thin intercalations of clays and marls. It occurs in the upper part of Vişeu Valley, at Borşa, and on the lower part of Valea Morii Valley (Vişeu de Jos).

The Valea Morii formation (Rupelian) is located between the Birţu sandstones and Borşa sandstones and is composed of gray clays and marls, brown or blackish limestones with menilite intercalations and micaceous or calcareous sandstones. It covers large areas in both the Vişeu and Iza river basins.

The Borşa Sandstones (Upper Oligocene - Lower Miocene) consists of a stack of 1,000 - 1,500 m thick massive micaceous sandstones and microconglomeratic varieties. It occupies large areas on Iza Valley (the upper part), Vişeu Valley (from Rădeasa Gorge, between Vişeu de Sus and Moisei and between Vişeu de Jos and Leordina). In the northern part of the basin, they cover the marly and marly-sandstone formations from the Vişeu and Iza river basins (right side). The Borşa Sandstones generally have a uniform development and a relatively monotonous appearance all along their area of occurence. They consist of hard gray sandstones with micas in decimetric and often metric layers, with fine, medium and rarely coarse granulation, with argillaceous and calcareous cement.

The sequence of Paleogene deposits ends with the *Upper marly sandstone formation*, in sedimentary continuity over the Borşa Sandstones. Based on nannoplancton studies (Dicea et al., 1980) places this formation in the NN_2 zone with *Discoaster druggi*, in the Lower Miocene.

3. Miocene molasse deposits

3.1. Badenian

The Badenian rocks are discordantly overlying Paleogene deposits. They are strongly folded and consist of a sequence of sandstones and marls with intercalations of finer dacitic tuffs at the top and coarser at the base. Within these deposits Antonescu et al. (1979) separated the following formations: a) tuffs and tuffaceous marls with globigerines; b) the breccia formation with salt rock, c) the marly sandstone formation.

a. The formation of tuffs and tuffaceous marls with globigerines (correlated by Antonescu et al. (1979) with the Dej Tuffs), shows quite large variations in thickness and facies in its various areas of occurrence. In the region north of Iza Valley, the formation has a thickness of around 100 m. Good outcrops of this sequence occur in two of the tributaries of Caselor Valley (Bârsana), in Ţiganului Creek (Coştiui) and in right side of the Coştiui stream.

South of Iza Valley, the formation of tuffs and tuffaceous marls with globigerines shows variation both in thickness and in lithological constitution.

b. The breccia formation with salt rock is composed of a complex of heterogeneous layers, with frequent directional facies changes and deposits with varied lithology: breccias, marls, sands, sandstones, salt rock, gypsum and tuffs. North from the Iza Valley, a complete sequence can be seen in the Coştiui - Rona de Sus area. Over the open tuff on the left side of the Coştiui Stream are a series of brecciated gray marls with white salt efflorescences, with two small salt rock massifs (in drilling 1,011 C.S.G. Vadu Iza, salt rock is 334 m thick) and some lenticular intercalations of fibrous white gypsum and gypsiferous sandstones. The sequence continues with a series of approx. 175 m of plastic purple marls with extremely rare limonitic yellow sands and red tuffs in centimetric layers. Towards the top, the marls are hard and compact, often with conchoidal fractures and contain 3 - 5 cm intercalations of gray calcareous sandstones. All the succession contains white salt efflorescences at various levels. The marls are overlain by 50 - 75m of fine greenish and gray tuffs, outcropping on the ridge between Coştiui and the Ronişoara Stream (*Picuiul Tuff*). On top of this is a series of 150 - 175 m thick gray marls, tuffaceous, sandy and sometimes brecciated, with frequent fragments of red and green clays and calcareous sandstones (Eocene age), lenticular layers of coarse yellow tuffs and two decimetric intercalations of yellow limestones with *Litothammnium*.

In the area delimited by the Porcului Valley, Năneşti and Bârsana (Bradova, Cerbova streams, etc.), the breccia formation with salt rock turns laterally into a marly sandstone series 400 m thick, composed of yellow sandstones, micaceous, brittle, with frequent medium hard millimetric coal levels and with intercalations (or alternations) of gray, yellow and purple marls. This sandstone series is covered by the Picuiul Tuff (50 m), which is directionally correlated with the tuffs intercalated in the breccia formation with salt rock from Coştiui and Rona de Sus, respectively with the tuffs from the Hotarului Valley (Bârsana), which are overlain by gray marls with salt efflorescences.

c. The marly sandstone formation (Sasului Valley - Săliştei Valley formation). The deposits which succeed the last of breccia formations with salt rock do not have the characteristic facies of the shales with radiolarians known in the Carpathian avantfosse area and in the Transylvanian depression. Most authors agree that the shale deposits with radiolarians have their stratigraphical equivalent in the deposits situated immediately above the breccia with salt rocks, in our case the marly sandstone formation.

The base of the marly sandstone formation, studied in very good outcrops, predominantly consists of medium hard yellowish, calcareous and micaceous sandstones in decimetric and rarely in metric banks, with subordinate intercalations of gray - yellow and gray - purple marls in plates. Both marls and especially sandstones often present impressions of uncharred plants, millimetric coal intercalations or even lenses of coal. North from the Iza River, the above described rocks are overlain by a 50 m sequence of fine to medium grained, gray - yellow and greenish tuffs (*the Vârful Ascuțit Tuff*), with lenticular development. The tuffs occur on the left side of the Iza river, at Onceşti, towards west and north through Porcului Valley, Sălişte Creek, Vârful Ascuțit and and from here to the east until the left side of the Sălişte Creek (left tributary of Ronişoara Valley), where it thins out.

The second level of the marly sandstone formation is predominantly marly, consisting of plastic gray marls, with cutting edges and thin sandstone intercalations. On the bottom of this level, in the right side of the Sălişte Creek at the confluence with Iza (at Vad), a sandstone packet, 30 to 40 m thick, can be distinguished.

The marly sandstone formation is the lithostratigraphic equivalent of the shales with radiolarians and marls with *Spiralis* from the Subcarpathian area.

3.2. Sarmatian

Sarmatian deposits have a continuity of sedimentation over the Badenian deposits, usually filling some synclines. Within the Sarmatian, Antonescu et. al. (1980) separate by cartographic methods the following formations: a) the marly formation, b) the conglomerate formation, c) the marly sandstone formation.

a.The marly formation. This formation includes an 80 to 100 m succession of plastic gray and yellow sandy marls in plates, with intercalations of sequences of gray calcareous and micaceous sandstones, occurring in 2 - 3 cm thick slabs. The separation of these subjacent Badenian deposits was based on their microfaunistic content, marked by the presence of *Anomalinoides dividens*; based on this, they were assigned to Lower Sarmatian (Volhinian). In the Remeți area, this formation is intercalated with the Remeți Dacitic Tuff, 40 - 50 m thick, with a significant westward extension.

b. The conglomerate formation (The Crăciuneşti - Văleni conglomerate). With a maximum thickness of 75 m, it has good outcrops in the Sălişte Creek and in a small left tributary of the Tisa River, south of the railway barrier at Crăciuneşti. The deposits consist of a sequence of gray conglomerates, yellow sandy marls and yellow sandstones. Conglomerates with well rounded clasts consist of yellow sandstones and coarse tuff fragments with a sandy matrix. Where they occur, these conglomerates are a good lithologic marker.

c. The marly sandstone formation. In its few outcrops located between Rona de Sus and Crăciuneşti, the formation is composed of soft plastic gray - yellow and yellow marls, with white sulphate efflorescences.

In the area north of the Iza River (Rona de Sus - Crăciuneşti), the marly sandstone formation covers conglomerates, where they occur, or, in their absence, they lie over the sandstones from the top of the marly sandstone formation (Valea Cosăului formation).

In areas south of the Iza river, the marly sandstone formation consist of an alternation of sandy micaceous purple and gray marls, and yellow sandstones. The marly sandstone formation (Valea Cosăului formation) was also separated in this area. Its best outcrops are on the right side of the Cosău Creek, between Fereşti and Călineşti, and it represents the lithostratigraphic equivalent of the marly formations and partly of the conglomerates from the Rona de Sus area. It consists of yellow and purple brittle micaceous sandstones and sands with intercalations of gray and purple marl, with cutting edges, in centimetric layers.

3.3. Pannonian

The Pannonian deposits, the last of the Miocene sedimentary cycle, unconformably cover the Sarmatian formations. These variably thick deposits include mostly grayish marls, but also thin sandstone intercalations with bivalve fragments, and sand intercalations with crossed stratification. These deposits occur especially in the marginal area of the Maramureş Depression (at the springs of Mara Valley, Agriş, Botiza).

4. Miocene volcanic rocks

4.1. Miocene dacitic Tuffs

The dacitic tuffs, named "the Bârsana dacitic pyroclastic complex" have a large extension in the Badenian formations that form the molasse filling of the Maramureş Depresion. They are well developed in the localities Ocna Şugatag, Bârsana, Ieud, Săliştea de Sus, Vadu Izei and Coştiui and consist of pyroclastic tuff deposits, secondary flows of ash and pumice, sedimented in a marine environment which favoured the zeolitisation process - especially of the fine tuffs.

In the Sarmatian, the so called " Remeți dacitic pyroclastic complex" is represented in the Remeți area. It consists of lapillic tuffs, coarse and fine tuffs which include clasts of pumice stones and volcanic glass. This complex is almost 8 km long, and has a a thickness of 5 - 25 m.

4.2. The volcanic rocks from Dragomireşti - Săliştea de Sus

A volcanic-sedimentary formation was identified between these two localities, on the right slope of the Iza Valley, situated at a distance of around 10 km from the magmatic massives of Văratec-Botiza, Ţibleş or Toroiaga. This formation is over 150 m thick in Cetăţelul Hill and consists of pyroclastites (lapillic tuffs) alternating with epiclastic rocks. The andesitic rocks occurring in its upper part seem to be the remains of an extended flow. Its elements (lithic lapilli or clasts) consist of andesites with hornblende and biotite, or andesites with hypersthene and augite.

4.3. The Toroiaga-Ţiganu intrusive structure

According to Zincenco (1998), the intrusive rocks from Baia Borşa belong to the oriental arch of post-collisional Upper Miocene magmatites. The intrusive pack consists of the following rock types:

- quartz andesites with biotite and hornblende from Novicior (the oldest);
- andesites with hornblende and biotite from Toroiaga;
- quartz diorites with hornblende ± pyroxene from Secu-Novăţ;
- quartz andesites with biotite and hornblende from Vertic;
- andesites with hornblende ± biotite ± pyroxene ± quartz from Piciorul Caprei.

The subvolcanic structure Toroiaga-Ţiganu, oriented NW-SE, is 12 kilometers long and has a width of 4 kilometers in its north-western part and up to 1.5 kilometers in its southern part. South of this massif, the intrusions occur as sills, dykes or small isometric intrusions consisting of pyroxenic andesites "of Arşiţa", which are considered the most recent intrusive rocks from the area.

4.4. The intrusive rocks from Ţibleş Mountains

The subvolcanic-plutonic structure from Ţibleş is placed on a NW-SE alignment, 6 kilometers long and 2 kilometers wide. The main body predominantly consists of Ţibleş quartz monzodiorites - monzogabbros with pyroxenes and hornblende. The basaltic pyroxenic andesites from Arcer form the border of the main body. NW from the main intrusive structure lays the dome of Tomnatec dacites and the dacitic bodies from the springs of Biacului Valley. On the main ridge of the massif (Gropii Peak, Stegioara Peak) and towards the Calului Valley (Baicului Valley affluent) intrusive bodies of diorites and porphyry quartz microdiorites also occur.

4.5. The Neogene eruptive rocks from the northern part of the Lăpuş ului Mountains

Between Budeşti - Glod and Botiza, the main ridge of the Lăpuşului Mountains is composed of eruptive rocks belonging to the Cavnic - Jereapăn Pannonian andesitic complex. Inside this effusive complex several rock types were separated: Măgura Mare pyroxenic andesites, Vârfu Dealului pyroxenic andesites, Izvorul Negru microporphyric pyroxenic andesites, Prislop basaltic pyroxenic andesites, Scărişoara Peak - Botiza pyroxenic andesites, Chicera basaltic pyroxenic andesites and Grohote glassy basaltic pyroxenic andesites. In its northern part, the effusive ridge is bordered by numerous intrusions extending from Budeş ti, through Glod and Poienile Izei up to Botiza. The rocks have a large petrographic variety: basalts (Oanşei Valley - Budeşti), diorites, microdiorites, basaltic andesites and andesites (Glod - Botiza), quartzitic andesites (Botiza), quartz monzodiorites (Rugului Spring, Gurguiatu - Botiza), microgranodiorites and dacites (Botiza).

4.6. The Neogene eruptive rocks from the Gutâi Mountains

This is the largest area occupied by Neogene eruptive rocks from Maramureş. The volcanic products are of Pannonian age and are separated in several complexes.

The andesitic complex of Firiza is only represented by the dacites with hornblende and pyroxenes from Breze.

The andesitic complex of Săpânţa occupies the largest surface. This complex includes the petrographic varieties: Valea Rea basaltic pyroxenic andesites (in the Bradului Peak area), Runcu - Tur pyroxenic andesites, Piatra Săpânţei pyroxenic andesites, Vârfu Feţii (Săpânţa) pyroxene ± hornblende and quartz andesites, and Vârfu Văcarului basaltic pyroxenic andesites. The sill intrusions from the Remeţi - Agriş area (basaltic andesites with pyroxene ± olivine), the intrusions of basaltic pyroxene andesites and quartz andesites with pyroxenes and hornblende from Neresen (Remeţi) belong to the same complex

The Rotunda - Vârfu Bradului andesitic complex occupies smaller areas at the springs of Săpânţa Valley and Brazilor Valley and comprises the following petrographic varieties: Mlăci pyroxenic andesites, Brazilor Valley basaltic pyroxenic andesites, Vârfu Stânilor pyroxenic andesites, and Vârfu Bradului pyroxenic andesites with amphiboles.

The Igniş-Mara andesitic complex was formed on the present-day upper course of the Mara river and comprises the following varieties: Pod Cireş basaltic pyroxenic andesites, Vârfu Pietrii andesites with pyroxenes ± hornblende ± quartz, and Igniş-Mara pyroxenic andesites, the most frequent variety.

The volcanic activity ended in this sector with local extrusive manifestations, forming the volcanic domes of Braga (pyroxenic andesites with hornblende, quartz and biotite), Pleşca Mare (dacites with quartz, biotite and pyroxenes) and Gutâi (andesites with pyroxenes, hornblende, biotite and quartz - the youngest eruptive rocks).

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GEOLOGY AND KARST GEOMORPHOLOGY OF THE IZVORUL IZEI AREA (MARAMUREŞ, ROMANIA)

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ABSTRACT

Karst landscape in the Izvorul Izei area (NW Rodnei Mountains) developed on an approximately 40 m thick Upper Eocene limestone succession, which was deposited over the Upper Precambrian crystalline rocks of the Rebra series and is overlain by Oligocene black shales and sandstones. Uplift of the Rodnei Mountains and subsequent erosion have exposed the carbonate rocks over a large part of our study area. However, these extensive exposures of limestone appear to be relatively poor in exokarst landforms, which are restricted to few gorge sectors, cliffs, several isolated occurrences of karren and alignments of karst depressions in the vicinity of lithologic contacts. The presence of impervious rocks above and below the limestones appears to be the main controlling factor behind the distribution of karst landforms in the area. Karst depressions are concentrated along the contact between the carbonate rocks and the overlying Oligocene units and generally drain small allogenic streams. The main underground drainage, the Iza - Izvorul Izei karst system, developed close to the contact between the limestones and the underlying crystalline rocks. It is believed that this underground drainage also collects most of the water drained through the depressions identified at the surface. The upper and lower ends of the Iza - Izvorul Izei system are accessible through two caves that have been the object of intense exploration and surveying during the past 12 years. Their collective length is now over 5 km, however a direct connection between the two caves is yet to be discovered. Izvorul Izei area appears to be a typical contact karst. On one hand, the juxtaposition of permeable and impermeable lithologies has facilitated the development of an extensive underground drainage and corresponding surface landforms, and on the other hand the distribution of karst depressions and the caves themselves provide and ideal opportunity to study tectonic and lithologic features that are otherwise not detectable in the surface outcrops available in the area.

RÉSUMÉ: La géologie et la géomorphologie du karst de la zone Izvorul Izei (Maramureş, NO des Monts Rodnei, Roumanie).

Le terrain karstique de la zone Izvorul Izei (Nord-Ouest Monts Rodnei) a été formé sur une séquence calcaire d'âge Eocène supérieur, d'environ 40 m d'épaisseur. Les calcaires sont déposés sur les roches cristallines du Précambrien supérieur de la série de Rebra et sont partiellement couverts par des argiles noires et des grès Oligocène. Bien que des roches carbonatées sont exposés sur une grande superficie de la zone étudiée, les phénomènes exokarstiques sont relativement rares. Ils sont limités à un secteur de gorges et des murs de calcaire, des apparitions sporadiques de lapiés et des alignements de dolines et ponors le long des contacts lithologiques. La présence de roches imperméables près de calcaires est le principal facteur de contrôle de la distribution des phénomènes karstiques. Les dépressions karstiques sont concentrés le long du contact entre les calcaires et les roches Oligocènes, et ils drainent des petits ruisseaux d'eaux allogéniques. Le drainage souterrain principale de la zone, le système karstique Iza - Izvorul Izei, a été formée principalement au niveau du contact entre les calcaires et les roches cristallines du Précambrien supérieur. Même si les deux grottes, situées à l'extrémités du système karstique, explorées et cartographiées les 12 dernières années, ont une longueur totale de plus 5 km, le lien entre eux n'a pas encore été trouvé. Nous supposons que ce système karstique collecte l'eau de ruisseau Sterpu et aussi l'eau infiltrée a travers les dépressions karstiques (ponors et dolines) de la surface du bassin d'alimentation. La zone Izvorul Izei se caractérise par un karst de contact typique. D'une part, le chevauchement des roches karstifiables et roches imperméables a facilité le développement des formes exokarstiques et d'un important drainage souterrain. D'autre part, la localisation et la distribution de dépressions karstiques et des grottes sont idéales pour l'étude des caractéristiques de la structure, la tectonique et la lithologie, qui ne peuvent pas être observés dans les affleurements de surface.

REZUMAT: Geologia şi geomorfologia carstului din zona Izvorul Izei (jud. Maramureş, NV Munţilor Rodnei, România).

Relieful carstic din zona Izvorul Izei (NV Munţilor Rodnei) s-a format pe o secvenţă calcaroasă de aproximativ 40 m grosime, de vârstă Eocenă superioară. Calcarele sunt depuse peste rocile cristaline de vârstă Precambriană superioară ale seriei de Rebra şi sunt parţial acoperite de argile negre şi gresii Oligocene. Deşi rocile carbonatice sunt expuse la suprafaţă pe arii extinse din zona studiată, aceasta este relativ săracă în fenomene exocarstice, care se restrâng la un sector de chei şi câtiva pereţi calcaroşi, la apariţii sporadice de lapiezuri şi la aliniamente de doline şi ponoare de-a lungul contactelor litologice. Prezenţa rocilor necarstificabile în apropierea calcarelor este principalul factor de control al distribuţiei fenomenelor carstice. Depresiunile carstice se concentrează de-a lungul contactului dintre calcare şi rocile Oligocene şi drenează mici cursuri de apă alogenă. Principalul drenaj subteran al zonei, sistemul carstic Peştera Iza - Peştera Izvorul Izei s-a format în mare parte la contactul dintre calcare şi rocile cristaline. Cu toate că cele două peşteri de la capetele sistemului carstic, explorate şi cartate în ultimii 12 ani, au o lungime cumulată de peste 5 km, legătura dintre ele nu a fost încă găsită. Presupunem că acest sistem carstic colectează, în afară de apele pârâului Sterpu, şi apa infiltrată prin depresiunile carstice (ponoare şi doline) de la suprafaţa bazinului de alimentare. Zona Izvorul Izei se caracterizează printr-un carst de contact tipic. Pe de o parte, suprapunerea rocilor carstificabile şi necarstificabile a facilitat dezvoltarea formelor exocarstice şi a unui important drenaj subteran. Pe de altă parte, localizarea şi distribuţia depresiunilor carstice şi a peşterilor sunt ideale pentru studiul unor caracteristici de structură, tectonică şi litologie care nu pot fi observate în aflorimentele de la suprafaţă.

INTRODUCTION

The Rodnei Mountains National Park is the largest national park in the northern Eastern Carpathians. The main purpose of the park is the conservation of natural habitats and biological diversity (APNMR, 2010), but it also includes several isolated karst areas classified as nature reserves. Two of these, the "*Ponorul Izei Nature Reserve*" and the "*Peştera şi Izbucul Izei Nature Reserve*" (APNMR, 2010) are situated in the NW corner of the Rodnei Mountains and include a significant proportion of the karst landscape in our study area. 33 of the ca. 50 caves discovered so far in the Izvorul Izei karst area are included in the two nature reserves.

The karst rocks from the area, consisting mostly of Upper Eocene (Priabonian) limestones, form a continuous band, approximately 10 km long and up to 3 km wide (Fig. 1), oriented SW - NE, from Săcel (Maramureş county) to the northern slopes of Bătrâna (1710 m) and Tarniţa Bătrânei (1762 m) summits at the western part of the Rodnei Mountains ridge.

Hydrographically, the whole area is tributary to the Tisa River Basin, through two main water courses: the Iza River, draining most of the karst area, and the Dragoş Valley, which collects waters from the south-eastern corner of the study area. (Fig. 1). One of the tributaries of the Dragoş Valley, the Sterpu stream, originates under the Bătrâna summit and is captured underground at "Ponorul Bătrânei", the entrance to the Iza Cave (Fig. 1, 2). The water resurfaces at Izvorul Albastru al Izei (*The Blue Spring of Iza*), or shortly Izvorul Izei (*Iza spring*) in the hydrographic basin of the Iza river.

The Iza - Izvorul Izei system is the main underground drainage of the area. The drainage is about 2.2 km long as the crow flies and collects most of the surface water of the studied perimeter through ponors and caves. Two longest caves in the area belong to this underground drainage: Iza Cave (4.4 km), and Izvorul Izei Cave (0.9 km), near the Izvorul Izei spring. So, it is not surprising that previous studies were mostly concerned with exploration, survey and scientific documentation of these two caves (Viehmann et al., 1979; Sârbu, 1985). However, their possible links with the outside morphology, lithology and hydrology were marginally addressed (Viehmann et al., 1979, 1981; Silvestru and Viehmann, 1982; Iurkiewicz, 2010).

The present paper compiles published and unpublished data obtained in the last 12 years on the Izvorul Izei karst and adds a detailed survey of both karst and lithology at the surface and in the caves. At the beginning of our studies, the only maps we were aware of were the one of Viehmann et al. (1979) and the geologic map 1:50000 (Kräutner et al, 1982). We have mapped all karst features (karren, dolines, ponors, gorges, karst tunnels, caves and potholes), and their possible connections with bedrock lithology.

The surface mapping was done during two summer camps, each one week long (2008-2009). The survey, comprising over 600 stations, was done with a Garmin 60 SX GPS and in parallel, when necessary, with the classic method, using compass and clinometer (Tandem Suunto) and fiberglass tape. GPS data were processed with DNR Garmin 5.03, available online at Minnesota Dept. of Natural Resources (*http://www.dnr.state.mn.us/ mis/gis/tools/arcview/ extensions/DNRGarmin/DNRGarmin.html*). The topographic map of the area was developed using Quantum GIS (*http://www.qgis.org/*) based on topographic charts at scale 1:25000 (1984 edition), and the geologic map 1:50000, Pietrosul Rodnei (Kräutner et al., 1982).

Cave survey is an ongoing process: it took so far over 30 trips from 2001 to present, and involved over 40 people. Underground mapping was done using a Bosch DLE 50 laser telemeter with 0.2 mm/50 m precision and a Tandem Suunto optical instrument which includes a compass and a clinometer, with precisions of 0.5 degrees. Field data (geologic contacts, karst phenomena, cave maps) were drawn using Adobe Illustrator.

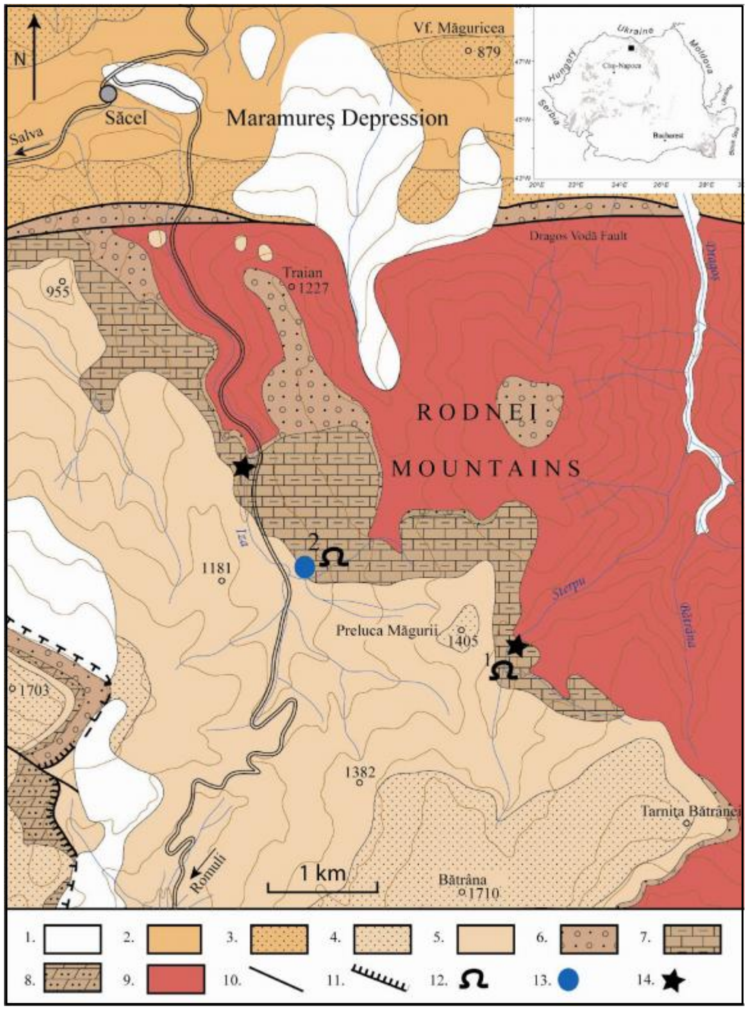

Figure 1: Geological map of the NW part of the Rodnei Mountains (after Kräutner et al., 1982)
1 – Quaternary deposits, 2 – Upper Oligocene flysch, 3 - Borşa sandstone, 4 - Birţu sandstone (Lower Oligocene), 5 - black shales (Valea Carelor Formation, Lower Oligocene, 6 - Lutetian conglomerates, 7 – Priabonian limestone, 8 – Eocene marls, 9 – metamorphic rocks, 10 – fault, 11 – nappe, 12 – entrances to Iza (1) and Izvorul Izei (2) caves, 13 – Izvorul Albastru al Izei, 14 – location of the two limestone profiles studied by Sahy et al (2008).

PREVIOUS WORK

Knowledge of the Iza Cave dates from back in '50s, but the first exploration was done only in 1976 (*Buletin FRTA - CCSS*, 1977; Viehmann *et al*., 1979). The first survey was done in 1977 and the paper describing the cave was published in 1979 by Viehmann *et al*. At that time the explored and mapped length of the cave was 2300 m (-170 m) (Viehmann et al., 1979). Three years later, the cave length reached 2440 m (*Speotelex* 1982). Silvestru and Viehmann (1982) and the Romanian Cave Systematic Catalogue (Goran, 1982) mention a length of 2500 m. A diving trip in 1986 attempted to pass the Iza Cave downstream sump, a feat that was unsuccessful because the underwater passage was blocked by tree trunks (G. Rajka, *pers. comm*.). Later on, the cave was reported closed at ~300 m from the entrance by a dam of tree trunks. A 10-15 m sump formed on the passage upstream and several Montana Caving Club trip reports mention only visits of the Entrance Passage. After the intense summer drought of 2000, a team from Montana Caving Club re-opened the Entrance Passage of the Iza Cave and reached the larger spaces downstream. A thorough re-survey which included longitudinal sections, profiles and geological mapping, was started in 2001 (Tămaş et al., 2009). 4.4 km have been mapped and almost 2 km of new passages have been explored in the Iza Cave until now.

The first attempt to pass the sump at Izvorul Albastru al Izei was made in September 1981 by divers who advanced 7 m until an underwater boulder choke, 4 m below the surface (Nicoară, 1982; Halasi, 1984). In 1984, the sump (30 m long, -5 m deep) was passed and a ca. 500 m long aired active passage was discovered and explored, but not mapped (Sârbu, 1985). The last dive attempt we are aware of was in 1996, when I. Rist (Montana Baia Mare) mapped ca. 10 m down to -6 m. As the water flowing through this passage was heard from a small cave upstream of the Iza spring, there were hopes that it could also be reached by digging. Some mentions of digging in the cave are noted in club reports (Patalita, 1984), but apparently these attempts were unsuccessful. The access to the passage beyond the sump at Izvorul Albastru al Izei was gained in 2004, through a 30 m crawl, of which 9 m were dug in sediments. The cave was then surveyed over 450 m to an upstream sump (now, sump 3). After several dives in 2004 and 2009, the active passage was explored and mapped for some 250 m, until sump 5. At the same time, mineralogical and sedimentological studies on the secondary deposits from the cave (Elekes, 2009) provided new directions for future exploration. Two new digs opened the way to the Fossil Passage and at present, Izvorul Izei Cave is ca. 900 m long (Tămaş, 2011).

GEOLOGY OF THE IZVORUL IZEI KARST AREA

In one of the first informations on the age of the limestones from the Izvorul Izei area published by Kräutner in 1930, all the nummulitic limestones from the Transcarpathian Flysch were considered Lower Eocene (Lutetian) in age. Later on, the limestones were assigned an Upper Eocene age (Priabonian), based on micropalaeontological data and their stratigraphic position (Patrulius et al., 1955, Dicea et al., 1980). The nummulitic limestones have been studied in the Teilor Valley quarry from Săcel by Sylvester (1995), who considered their depositional context, and by Vlad (2003), who was concerned with their economic valorification (as construction materials). The study of Sahy et al. (2008) focused on two complete composite sections of the Upper Eocene limestones (Fig. 1): one in the Iza Valley, just south of Preluca Izei, and the second at the Iza Cave entrance, describing their typical facies and depositional environments.

In the Izvorul Izei area the metamorphic basement of the Rodnei Mountains is overlain by Eocene and Oligocene marine sediments. Endo- and exokarst landforms are hosted by a ~ 40 m thick Upper Eocene limestone succession which is under- and overlain by impermeable crystalline and respectively Oligocene sedimentary rocks. The stratigraphic relationship between individual rock units and their relative distribution on the surface is somewhat difficult to trace due to the relative scarcity of surface outcrops. A combination of outcrop scale observations, regional distribution patterns of certain karst landforms such as dolines and ponors, and extensive geological mapping conducted in the caves from the area was used here to paint a more accurate picture of the local geology.

RESULTS AND DISCUSSIONS

Crystalline rocks

The crystalline rocks from the Izvorul Izei karst area belong to the Rebra series which along with the Bretila series constitutes the metamorphic basement of the Rodnei Mountains (Kräutner et al., 1982). On a larger scale, these units are part of the Central - East Carpathian nappe system (Mutihac, 1990) and are composed of Precambrian rocks metamorphosed to the amphibolite facies (Balintoni, 1997). According to Kräutner et al. (1982), metamorphic rocks cropping out in the north-eastern corner of the Iza area (Fig. 1, 2) belong to the Ineu Formation of the Rebra series, which is dominated by garnet micaschists with subordinate intercalations of crystalline limestone and dolomite, quartzite and amphibolites (Balintoni, 1997). Our observations of the metamorphic rocks come from surface outcrops and the Iza cave.

i) *At the surface*, the contact with the Upper Eocene sedimentary rocks is uncovered in the upper part of Uliţa de Piatră Valley, where micaschists occur in the valley bottom (Fig. 1, 2). The contact with the Priabonian limestones can be followed almost in straight line to Preluca Măgurii and then south to the left side of Sterpu Valley (Fig. 2). The metamorphic rocks (micaschists with quartz bands) also outcrop in the Sterpu Valley bottom, in a small gorge sector 150 m downstream from the Iza Cave entrances, and their contact with the Eocene rocks can be followed to the SE upstream a right hand tributary of Sterpu Valley (Fig. 1, 2). In the northwestern part of the area, metamorphic rocks outcrop in the Iza Valley bottom and then downstream (north) on both sides of the valley. Three dolines identified in an otherwise metamorphic area of the Preluca Măgurii glade may indicate the presence of crystalline limestones, but this could not be verified in surface outcrops.

ii) *Underground*, the passages of the Iza Cave expose micaschists with garnets, quartzites, crystalline limestones and dolomites, and associated mineralization, the latter usually as lenses. Crystalline limestones and dolomites are situated on top of micaschists (Fig. 3, 4). They are either white, forming decimetric “banks” separated by milimetric black stripes, probably graphitic, or consist of alternative centimetric white and gray stripes (Fig. 4). Mineralizations are usually connected with the crystalline carbonate rocks, but were also observed along faults and fractures in the micaschists. They contain pyrite as the main mineral and are probably of Blazna - Guşet type, described by Udubaşa (1981) and Udubaşa et al. (1983) from the southern Rodnei Mountains.

Sedimentary rocks

In the Izvorul Izei karst area, the sedimentary rocks are mostly Upper Eocene (Lutetian conglomerates, Priabonian limestones) and Oligocene (black shales, sandstones) in age. Quaternary deposits occur on small areas at the surface, in the northern part (Fig. 1), and in caves (Elekes, 2009; Tămaş et al., 2011). On the left side of the Iza Valley and to the south, toward the main ridge of the Rodnei Mountains, the Eocene rocks are covered by the Lower Oligocene bituminous shales of the *Valea Carelor* formation. The *Birțu* sandstones are the last unit of the Paleogene sedimentary succession to occur in the area and they outcrop on the Bătrâna summit and at Preluca sub Măguri (Patrulius et al., 1955, Dicea et al., 1980).

Conglomerates

The Lutetian conglomerates form a discontinuous layer up to 1 m thick, separating the metamorphic basement from the overlying carbonate rocks. In surface outcrops they consist mainly of rounded quartz pebbles and subordinately micaschist lithoclasts bound by carbonate cement (Sahy et al., 2008). They occur in two small patches, the first situated north from Preluca sub Măguri, and the second in the southeastern part of the area (Figs. 1 and 2).

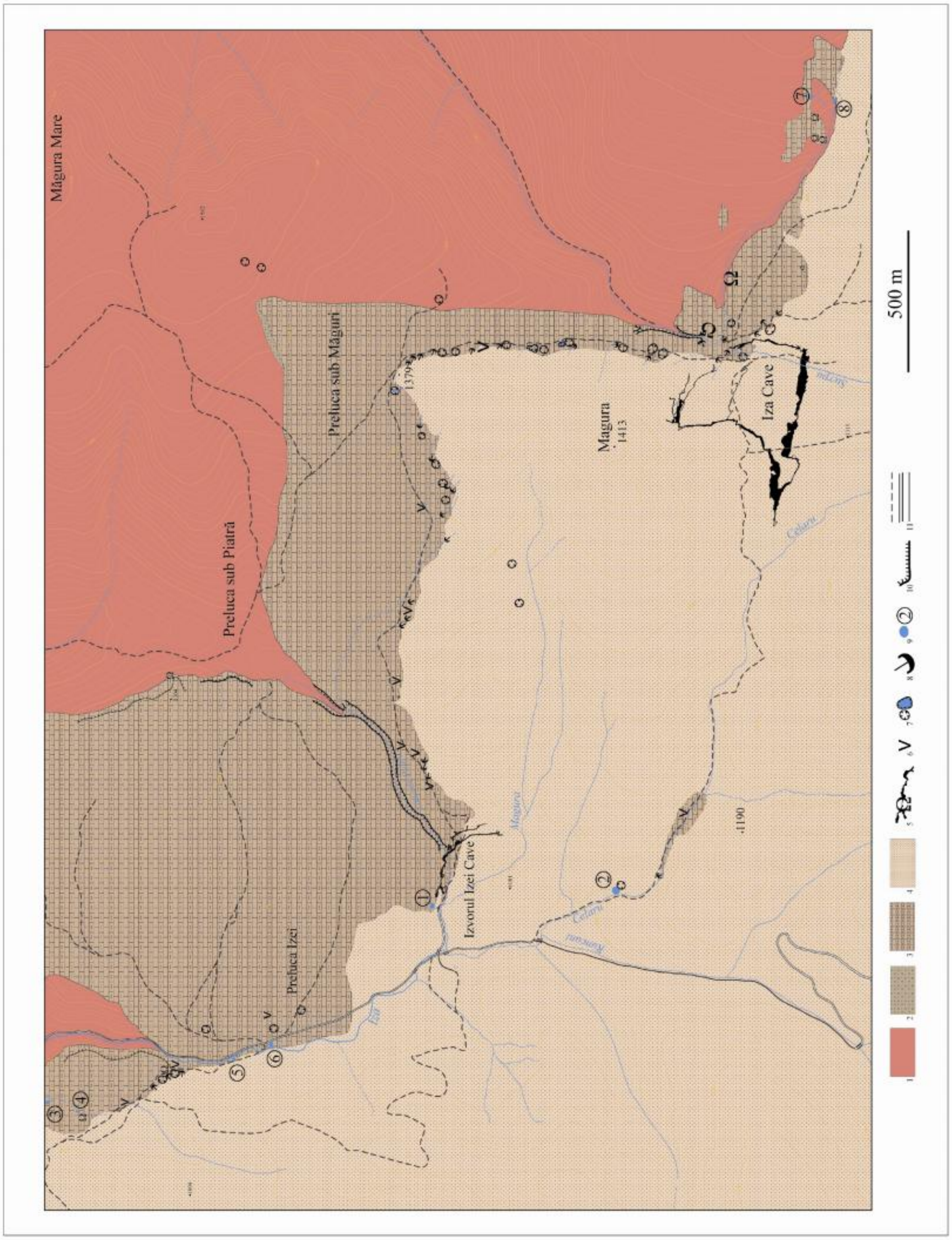

Figure 2: Karst and geologic map of the Izvorul Izei area: 1. crystalline rocks, 2. Lutetian conglomerates, 3. Priabonian limestones, 4. Oligocene rocks, 5. caves, 6. pits, 7. dolines, 8. ponors, 9. springs (1-Izvorul Albastru al Izei, 2-Izvorul Puturos, 3,4-springs in the NW corner, 5,6-springs in Preluca Izei, 7,8-springs on the affluent of the Sterpu Valley), 10. cliffs, gorges, 11. roads.

Figure 3: Contact micaschists - crystalline limestones on the Advancement Passage, Iza Cave.

Figure 4: Mineralized crystalline limestone breccia on the Advancement Passage, Iza Cave.

In the Iza Cave, the contacts between metamorphic rocks, conglomerates and/or limestones can be followed along the walls of the passages for more than 2.5 km. The conglomerates contain varied lithoclasts, sometimes over 30 cm in diameter, consisting of micaschists, quartzites, crystalline limestones, dolomites and oxidized mineralization (Fig. 5). The degree of rounding also varies. It is possible that these conglomerates do not coincide with the base of profile 1 from Sahy et al. (2008), in which the quartz is found in rounded cobbles up to 20 cm in diameter, similar with the ones described by Kräutner (1930), but to represent a lower separate level. When conglomerates are missing from the succession opened by the cave passages, they are replaced by a 0.5 - 1 m level of subangular - subrounded blocks of varying size (up to 1 m long) (Fig. 6) or subrounded or platy decimetric pebbles bound by carbonate cement.

Figure 5: Conglomerate with decimetric micaschist clasts (Iza Cave).

Figure 6: Contact micaschists - Priabonian limestones on the Afluent Passage, Iza Cave; above the contact there is a 0.5 m level of subangular blocks of metamorphic rocks.

Limestones

The Upper Eocene (Priabonian) rocks are nummullitic stratified limestones and massive coral-algal limestones forming a stripe 10 km long and up to 3 km large (Fig. 1). The limestones cover the conglomerates or sometimes directly the crystalline rocks and form a faulted monocline dipping 10-20°W (Kräutner et al, 1982). South from Preluca sub Măguri, the limestones form a band ~150 m large, covered to the west and south by Oligocene formations. From the Iza cave entrance, this band expands towards SE along the right tributary of Sterpu Valley (Fig. 2, 7). On the left slope of the tributary, the limestones are covered by Oligocene formations, while on the right slope two isolated limestone “islands” appear. Another isolated limestone patch occurs in the downstream part of Celaru Valley, uncovered by the erosion of the cover of Oligocene rocks (Fig. 2). The microfacies of these limestones have been studied in detail by Sahy et al. (2008), in two profiles (Fig. 1). Analyzes of these profiles revealed great differences between the southern and the northern area of the ramp where the carbonate rocks had been deposited. The limestones range from open-shelf wackestones and packstones with coral-algal crusts at the cave entrance, to nummulitic sandstones near Izvorul Izei spring (Sahy et al., 2008).

Figure 7: Limestone outcrops in the Izvorul Izei area: a. Cliff in Preluca sub Piatră; b. Isolated limestone tower above the Iza Cave entrance

Oligocene rocks

The Priabonian carbonate deposits are covered by the Valea Carelor Formation (lower Oligocene), consisting of black shales and sandstone intercalations. These rocks occur on the western side of Iza Valley and mostly in the whole northern part of the area (Fig. 1, 2). In the Iza Cave, the black shales have been identified in some lateral passages from the upper part of the Affluent Series (Tămaş et al., 2009, 2011). These rocks consist of a series of thin levels dominated by clay material separated by sequences with a slightly higher amount of quartz grains. The fauna from the black shales is scarce, represented by isolated specimens of planktonic foraminifera whose poor preservation did not allow clear identification (Sahy et al., 2008). The sandstones, last in the succession, forms patches on the topographic heights of Bătrâna peak, Preluca sub Măguri and Muncelul Râios (Fig. 1). These sandstones contain well sorted quartz pebbles with subangular to rounded shapes and mica fragments, as well as feldspars and even carbonates.

KARST

Exokarst

Karren

The most common karren in the Izvorul Izei area are *linear karren* (fracture-controlled) and *rundkarren* (Fig. 8). Other types are *solution pans* (*kamenitze*) and *rinnenkarren* (Fig. 9). Their occurrences are by no means spectacular compared to other karst areas and they are restricted to very few places. All types identified, but especially the former two, are more frequent in the forest road beds and in places where the soil cover was removed by forestry works or torrents (Mureşan, 2010).

Figure 8: Linear karren, initially buried.

Figure 9: a. Kamenitza; b. Rinnenkarren

Dolines and ponors

Surface surveys in the area showed 43 ponors and 42 dolines, of which 90% are less than 15 m from the limit between the Priabonian limestones and non-carbonate rocks. Their survey gives a very good approximation of the lithologic contact, especially in the areas with no obvious outcrops. The ponors (Fig. 10a) and the dissolution dolines (Fig. 10b) are the most representative exokarstic forms from the area. They form two main alignments along the limestones - Oligocene rocks contact, one N-S, parallel with the Sterpu Valley downstream the Iza Cave entrance, and the second W-E, between Preluca de sub Măguri and Uliţa de Piatră

Valley (Fig. 2). In addition to these 2 alignments, a few ponors were mapped on the left side of the Iza Valley, downstream Preluca Izei and in the SE corner of the karst area, on the right-hand side of the Sterpu Valley (Fig. 2). Ponors drain small streams usually less than 100 m long, sourcing from the Oligocene rocks. Dolines are up to 15 m in diameter and generally 5-6 m deep. Most of them are on the Priabonian limestones; three dolines situated NE from Preluca sub Măguri, on crystalline rocks, may mark the presence of metamorphic limestone stripes, whereas two more are developed on Oligocene rocks, probably in an area where these form a thin cover above the Upper Eocene limestones (Mureşan, 2010). Two **collapse dolines** occur at the entrances of the Iza Cave, one being the large entrance normally used by cavers. A third one gives access to a 10 m deep pit, located on the W-E alignment of ponors, parallel to the Uliţa de Piatră Valley (Fig. 2).

Figure 10: a. Ponor on the contact with non-karst rocks at the end of a short blind valley in Preluca sub Măguri; b. Dissolution doline in Preluca sub Măguri.

Tunnels and natural bridges

Four karst tunnels have been identified in the Izvorul Izei area, all of them small parts of old cave sectors, eroded and suspended after the deepening of local base level (Bleahu, 1982). The most impressive are the ones from the right side tributary of Sterpu Valley (Fig. 2, 11). Two other smaller tunnels are located on the left side of Iza, downstream from Preluca Izei, in the NW corner of the area.

Gorges

The only important gorge in the Izvorul Izei area is the so-called "Uliţa de Piatră" (*Stone Alley*) formed along a small stream sourcing from Preluca sub Piatră (Fig. 2, 12). At the downstream end of the gorge, this stream is partly drained underground through diffuse losses in the streambed and reaches the active passage of Izvorul Izei Cave. The gorge sector is ca. 1 km long and ends 100 m upstream from Izvorul Izei spring. It is 15-35 m wide, with walls 5-15 m high and up to 5-6 m of breakdown on the sides due to accentuated limestone fragmentation (Fig. 12). The gorge is generally developed NE – SW. In their uppermost part the metamorphic rocks outcrop in the valley bed and gradually on the slopes. Morphologically, the gorge sector of Uliţa de Piatră continues the limestone cliffs from the eastern side of Preluca sub Piatră (Fig. 2).

Figure 11: Karst tunnel on the affluent of Sterpu Valley, in the SE corner of the karst area.

Figure 12: Uliţa de Piatră Gorge.

Karst springs

Eight karst springs, seven permanent and one temporary, have been identified in the Izvorul Izei area. Izvorul Albastru al Izei is the most important, both in terms of drainage length and flowrate. Their locations are shown in Fig. 2.

Izvorul Albastru al Izei (Fig. 13) has a normal flowrate of probably 30 - 40 l/s (Iurkiewicz, 2010), but can exceed $1m^3/s$ during floods and snowmelt. The spring is separated from Izvorul izei Cave by a sump (see Previous Work). The main collector is the Iza Cave, capturing underground the Sterpu Valley and partially its right side affluent, with a total flowrate of 10-15 l/s (Iurkiewicz, 2010) through its entrances and several other diffuse losses, to which are added the two main ponor alignments described previously.

Izbucul Puturos *(Smelly Spring)* is located on the right side of Celaru Valley (Fig. 2), at the contact between limestones and black shales and represents the exit point of water drained through diffuse losses in the valley ca. 200 m upstream of the spring (visual observation in May 2006). Its name comes from the characteristic sulphur odor, probably due to the oxidation of sulphides from the Oligocene black shales. It has a flowrate of about 1 l/s and was the entrance to a small cave, now blocked by breakdown.

In the NW part of the area, two small karst springs are the exit points for water from the nearby ponors (Fig. 2). On the opposite side of the valley, a third, temporary one, located under the forest road, drains the limestone band of Preluca Izei. South-east from the Iza Cave entrance, an isolated limestone block hosts two small karst springs, both located at the limestones/micaschists contact. The first is fed by a stream flowing on metamorphic rocks and conglomerates and sinking underground at the contact with the limestones, with an underground drainage ca. 50 m long. The second, at 3 l/s, is fed by water flowing on black shales and sinking at their contact with the limestones. Its underground drainage is 150 m long.

Figure 13: The stream flowing from Izvorul Albastru al Izei during a flood.

Endokarst

The 33 caves and potholes discovered and explored so far in the Izvorul Izei area are presented in Tab. 1 (C.S. Montana, 2011). Due to particular hydrological and lithological factors, the Iza - Izvorul Izei karst system is the only long underground drainage in the area and roughly 50% of the smaller caves discovered, and probably more than 80% of the ponors from the area are hydrologically connected to it. The two longest caves in the Izvorul Izei area belong to this underground drainage: Iza Cave (4410 m), and Izvorul Izei Cave (900 m). The total length of the two caves at the ends of the system now exceeds 5300 m. The straight line distance between the Iza Cave entrances and the spring is of about 2.2 km for a dislevelment of 225 m, whereas the distance left between the respective terminal sumps of the two caves is 1.2 km, for only 60 m of vertical elevation. The other caves usually do not pass 100 m in length or 25 m in depth and rarely consist of more than a single shaft or subhorizontal passage.

Table 1. The caves explored and mapped in the Izvorul Izei area (C.S. Montana, 2011)

Code	Name	Length (m)	Depth (m)	Iza karst drainage*	Year of exploration
1029/1	Iza Cave (Peştera Iza)	4410	-181	yes	1976 - present
1029/2	Peştera din Tabără	12	-3	probably	1977
1029/3	Peştera cu Lapte	49	3	no	1977
1029/4	Peştera nr. 2 de la Ponorul Măgurii	45	-15	yes	1977, 2007
1029/5	Peştera nr. 3 de la Ponorul Măgurii	11	2	probably	1977
1029/6	Peştera Izvorul Izei /Peştera de la Izbuc	900	25 (-7;+18)	yes	1984; 2004 - present
1029/7	Avenul din Preluca de sub Bătrâna	11	-11	yes	1977
1029/8	Peştera cu apă din Ponoare	64	-12	no	1977,1996
1029/9	Avenul cu apă din Ponoare	10	-7	no	1977
1029/10	Avenul de sub stâna de la Ponorul Izei	106	-25	probably	1977
1029/22	Avenul cu Fereastră	no data		no	‘80s
1029/23	Peştera cu Săliţă	no data		no	‘80s
1029/24	Peştera Scurtă	no data		no	‘80s
1029/26	Avenul Scoica	57	-15	no	‘80s
1029/27	Peştera de deasupra Avenului Scoica	9	-1	no	‘80s
1029/28	Ponorul Ungurilor	29	-12	no	‘80s
1029/29	Peştera Izvorul Puturos	27	-2	no	‘80s
1029/30	Peştera Roşie	22	-3	probably	‘80s
1029/31	Ponorul din pădure	45	-12	probably	‘80s
1029/37	Peştera Izbucul Izei	10	-6	yes	1984; 1996
1029/38	Peştera Tunel din Ponoare	15	-1	no	1996
1029/39	Peştera Ascunsă din Ponoare	14	1	no	1996
1029/40	Avenul cu Scară	117	-25	yes	1996-1997
1029/41	Peştera Mică din Ponoare	10	-3	no	1996
1029/42	Peştera Diaclazei din Peretele Izei	12	0	no	1996
1029/43	Peştera Cetatea Izei	26	+19	no	1996
1029/44	Avenul Mare de sub Preluca Măgurii	13	-12	probably	2003
1029/45	Avenul cu apa de sub Prelucă	11	-8	probably	2003
1029/49	Avenul cu Ecou	8	-8	probably	2006
1029/50	Ponorul cu Zmeură	18	-11	probably	2008
1029/51	Peştera din Peretele Mare	10	-2	no	2008
1029/52	Avenul fără Ecou	13	-8	probably	2008
1029/53	Avenul de sub Copac	11	-5	probably	2006

*The former or present hydrological connection between the caves and the Iza - Izvorul Izei karst system is assumed based on their location and on surface and underground observations. To our knowledge, no water tracing studies have been done so far (see also Iurkiewicz, 2010).

Iza Cave

The entrances to the Iza Cave are situated in the Sterpu Valley, at the place also known as "Ponorul Bătrânei", at around 1250 m a.s.l. Descriptions of the cave have been published by Viehmann et al. (1979), Tămaş (2009) and Tămaş et al (2009). All 3 entrances are in the Eocene limestones. The main river passage (Entrance Passage - Advancement Passage), about 1.2 km long, crosses the contacts between Priabonian limestones, Lutetian conglomerates, and metamorphic rocks at 50 m from Entrance 2, then deepening into the metamorphic rocks until the Confluence Room (Fig. 14). Shortly after the contact, two waterfalls on micaschists and then a 6 m-high fissure-directed passage lead down to a narrow sector carved between two conglomerate beds, the site of a former sump caused by accumulated tree trunks. After a 90° turn along intersected fissures, the Entrance Passage connects to the Advancement Passage by a 15 m drop where the cave stream falls over an overhanging conglomerate ledge.

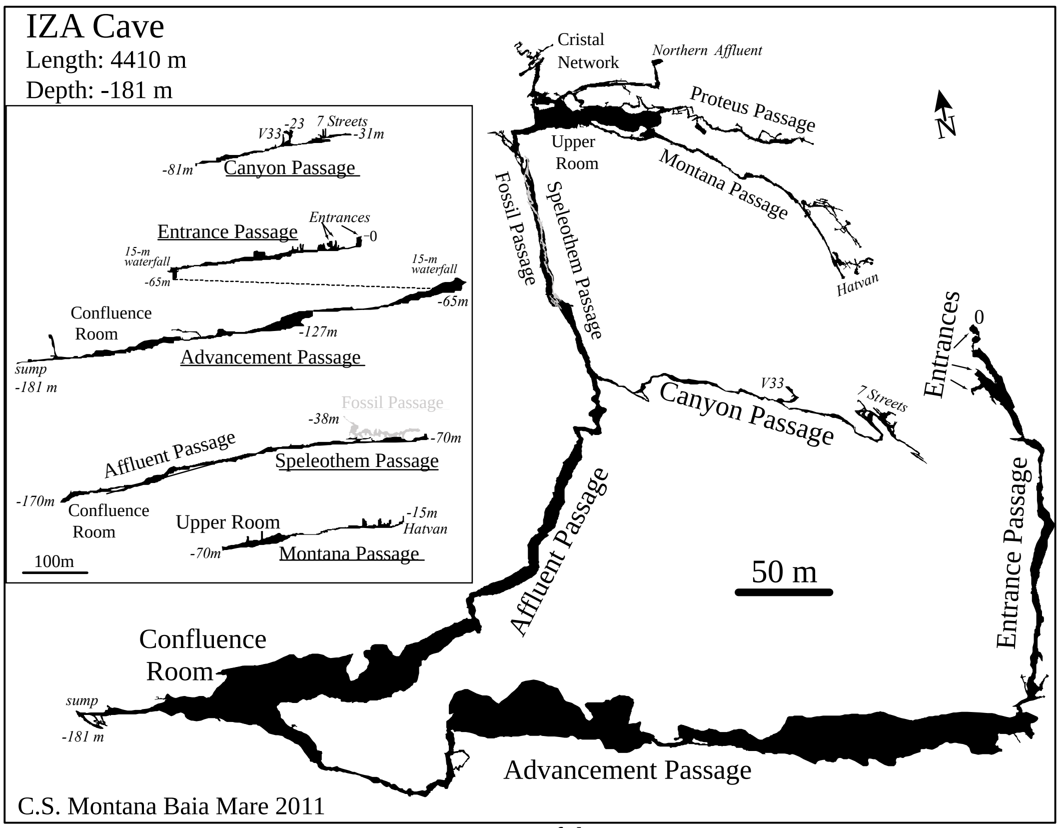

Figure 14: Map of the Iza Cave.

The Advancement Passage (~ 700 m long), has an E-W general direction and three large sectors (up to 15 m high and 50 m width) connected by smaller passages; the floor descends steeply from right to left, following the micaschist dipping. Shifts in the ceiling height along these sectors are caused by SE-NW parallel faults. The first large sector, with the ceiling on conglomerates, ends at -92 m in a narrow hole where the passage crosses the main fault and enters the limestones in its lower left block. After a short canyon carved in limestones, the main fault is reached again. Another large sector on the main fault follows for 120 m, down to -130 m. This ends in a wall of marble breccia and the passage turns S, crossing another fault, and then NE, parallel to the main fault, down to - 160 m, connecting to the Confluence Room, another very large passage along the main fault, with cross sections similar to the previous two; this shape also extends to the first part of the Affluent Passage. Thick clay deposits cover the passage bottom and a large lake forms here during floods. 50 m downstream the confluence, the final, much smaller Sump Passage is developed in limestones once again (possibly after crossing a transversal fault), and after a further 50 m, the final sump is reached at - 181 m.

The Affluent section accounts for three quarters of the cave length so far (Fig. 14). Its first part, oriented E-W, is developed almost entirely in marble and has similar shapes and sizes with the large parts of the Advancement Passage. The passage gets smaller as it turns NE and enters micaschists again, with the Priabonian limestones occurring only in the ceiling and with no conglomerates in-between. This section, about 300 m long, where the affluent forms several waterfalls, ends in a fracture line parallel to the main fault opened by the Advancement Passage. The Affluent makes two turns at right angles, first W then N. Upstream, the passage gets smaller and is oriented N-S again until the Upper Room, developed W-E (Fig. 14).

The Canyon Passage (~400 m long), a narrow canyon parallel to the faults in the Advancement Passage, has formed in limestones, exposing the contact with the micaschists at its bottom. Most of the water from the Affluent section comes from this passage, which ends very close to the cave entrance, under the Sterpu Valley, being probably fed by diffuse losses upstream from the actual entrance (Figs. 2 and 14).

The Speleothem Passage is almost rectilinear, directed N-S, and is nicely decorated, with the limestone - micaschist contact occurring in the lower part of the walls. At its upper end, a short climb up along a canyon leads to the Fossil Level (~300 m), formed by a complex of narrow canyons and pits and some lateral passages. Several restrictions at the upper end of the Speleothem Passage and a 90^{o} turn E lead to the Upper Room, which, together with the side passages surveyed so far, accounts for 1.5 km (Fig. 14). The lower part of the chamber is rectangular and relatively flat-topped (ceiling on limestone bedding plane), while the upper part forms along a great E-W fissure and ends upstream in a large breakdown covered by sediments and several generations of calcite speleothems. Seven side-passages, some of them interconnected, have already been discovered from the Upper Room (Fig. 14). The longest is the Montana Passage, which accounts for ca. 750 m. Three small streams join the affluent in the Upper Room: the Northern Affluent, a second one along the Montana Passage, and the third from the Proteus Passage. The latest discovery in the Iza Cave is the Cristal Network (150 m mapped so far), a maze of small fossil phreatic passages, at the level of the Upper Room ceiling. The Cristal Network contains the first palaeontological discoveries in the Iza Cave: bear remains and clawmarks, which are now being investigated.

The Iza Cave interior deposits are mostly clastic sediments of various sizes. Clay and silt deposits occur only in the Confluence Room, which during floods was may be filled with water. As a peculiar feature, the cave has very few collapse deposits, in contrast with what one would expect to see in a cave where non-karst rocks account for more than half of the passages. Breakdown consisting of micaschists and a few limestone blocks occur in the largest parts of the Advancement Passage and the Affluent Passage. Classic speleothems, such as stalactites, stalagmites and flowstones are quite rare. Most of them are concentrated along the main fault on the Advancement Passage, in the Speleothem Passage and the Upper Room. Extensive weathering deposits formed on the metamorphic rocks, described by Viehmann et al (1979, 1981), have been reinvestigated by Tămaş et al. (2011). They consist of gypsum, secondary iron minerals (goethite, jarosite, hematite), illite, and kaolinite.

The morphology of the cave is mainly influenced by the lithology and fractures. Passages generally following the limestone/micaschist contact descend with the same dipping (9-10°). Most passages are guided by fractures, the Advancement Passage being developed along parallel faults. Passages in limestones are labyrinthic, with smaller cross sections, while larger passages in areas with micaschists and marble are usually rectilinear. Iza Cave genesis is probably largely due to vadose inflow at the contact zone with the overlying Oligocene deposits. Floodwater dams up behind constrictions and follows diverted routes or creates mazes, and flows torrentially in larger sectors ("floodwater cave" - Palmer, 1972).

Izvorul Izei Cave

The first survey of the Izvorul Izei Cave has been done in september 2004 and the first description has been published by Tămaş and Perşoiu, in 2005. All the passages in this cave were discovered through either digging or diving. The entrance is a small pit, less than 2 m deep, at ca. 1030 a.s.l, opened on the right side of Uliţa de Piatră Valley, 30 m upstream from Izvorul Albastru al Izei. The entrance pit is followed by a 30 m horizontal crawl (of which 9 m were dug in sediments), 4-5 m large and 0.4 m high, developed on bedding planes (Fig. 14). Tunnel 1 connects to a fossil sector parallel to the active passage which reaches very close to the surface. From here on, the passage reaches reasonable size (2x3 m) and is connected to the cave river (Old Passage, ~200m long) by a 3 m drop.

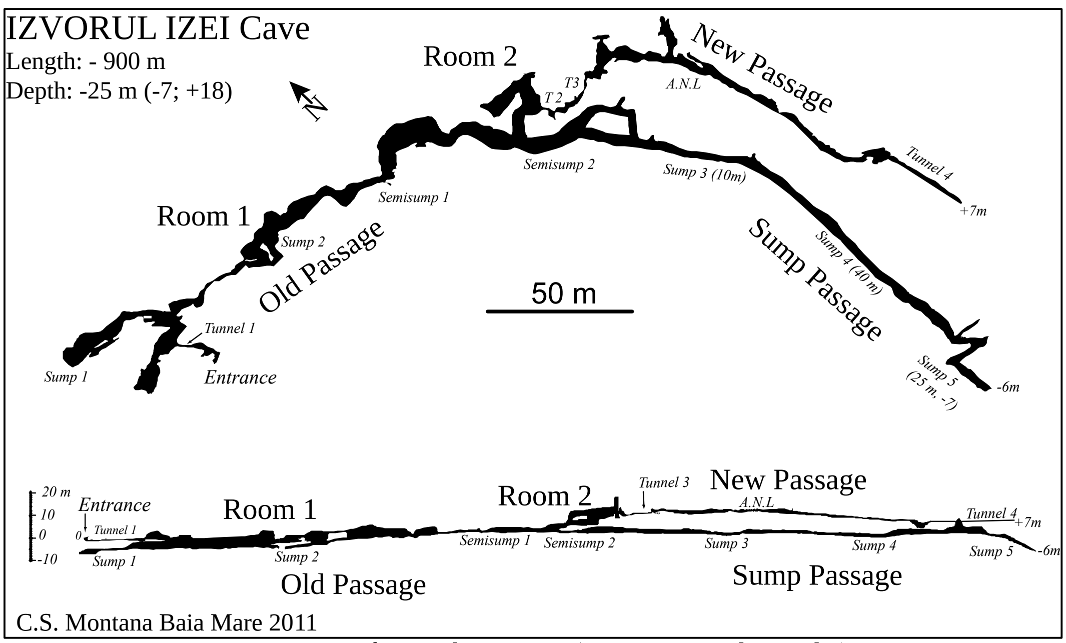

Figure 15. Map of Izvorul Izei Cave (T2, T3 – tunnels 2 and 3)

The active passage has a shape of a flat-topped canyon, between sump 1 and semisump 1 (Fig. 15). The downstream sump (Sump 1), connecting with Izvorul Albastru al Izei, is reached after 40 m. The Old Passage gets larger upstream towards Room 1 (5-6 m x 2 m) and keeps the flat-topped canyon shape until Semisump 1 (Fig. 15). From Semisump 1 to Room 2, the passage is nearly horizontal and the cross-sections are circular to elliptic. Semisump 2 leads upstream to the Sump Passage (~300 m long), explored through several dives between 2004 and 2009 and ending at -6 m in an underwater sediment fill (sump 5).

Goethite nodules found at several levels inside a 3.5 m high sediment filling from Room 2 were thought to originate from the passages of Iza Cave, which hosts pyrite mineralization as well as large amounts of goethite speleothems. After digging Tunnels 2 (6 m) and 3 (8 m) at the top of the sediments, the fossil level (New Passage, ca. 200 m long), was discovered. The New Passage, parallel to the Sump Passage below, is very similar in shape and size: a succession of fossil sumps, ending with a very long one (from A.N.L. to Tunnel 4, over 70 m, see Fig. 15). Originally 4-5 m high and up to 3 m large, it is now almost completely filled with detrital sediments.

CONCLUSIONS

The lithologic succession in the Izvorul Izei area, studied both in surface outcrops and underground, in the Iza Cave, comprises Upper Precambrian crystalline rocks, Eocene conglomerates and limestones, and Oligocene black shales and sandstones. The crystalline rocks belong to the Ineu Formation of the Rebra series and consist of garnet micaschists with subordinate intercalations of crystalline limestone and dolomite, quartzite, and amphibolites, as well as associated mineralization. The Lutetian conglomerates form a discontinuous layer between the metamorphic basement and the Priabonian carbonate rocks. They contain varied lithoclasts, consisting of micaschists, quartzites, crystalline limestones, dolomites and oxidized mineralization. The limestones range from open-shelf wackestones and packstones with coral-algal crusts at the cave entrance, to nummulitic sandstones near Izvorul Izei spring. They form a faulted monocline dipping 10-20°W and are covered by the Lower Oligocene non-karst rocks.

The contacts between these various rocks play an important role in karst landscape development in the area. Oligocene non-karst rocks are the main source of allogenic water for the ponors formed on the Upper Eocene limestones close to the contact. This allogenic water is more agressive, compared with water resulted from precipitations and recharged through dolines, and has a highly variable discharge (Palmer, 2001).

The development of exokarst in the area is influenced by the lithologic contacts between karst and non-karst rocks, by structural and tectonic factors, and by water availability. Ponors and cave entrances follow precisely the map of the contact between limestones and Oligocene rocks. This geometry may be explained by the difference in aggressivity between the allogenic and autogenic water. The lack of karst depressions away from the contacts may also be due to the monoclinal structure, favouring rapid runoff, and to the fragmentation of the limestones. Water from precipitations flows along the dip of the limestone monocline, infiltrating through small cracks and then along bedding planes, producing very little enlargement through corrosion. On the limestone surface, linear karren, rundkarren, solution pans and rinnenkarren are formed, more commonly under the soil cover. The reasons for the reduced presence of karren may also be the thin bedding and fragmentation of the limestones.

The endokarst in the Izvorul Izei area is represented by a major underground drainage, the Iza - Izvorul Izei karst system. The Iza Cave, at present 4410 m long, collects allogenic water from the Sterpu Valley and one of its affluents, as well as most of the surface streams. Once the water reaches underground, another contact, the one between the Upper Eocene limestones and the underlying crystalline rocks plays a major role in the cave development. The main cave river can transport huge loads of trees and debris, and may possibly swell up to several cubic meters per second. The high volume of water entering the cave during floods flows torrentially, eroding the non-karst bedrock and transporting large amounts of sediments, and is dammed behind restrictions, where diversion routes or small phreatic mazes may develop in the limestones. The hydrological regime is therefore very contrasting between low flow and high flow and points to cave enlargement only during major floods. The allogenic inflow and the fracture-guided character make us think that the Iza - Izvorul Izei karst system genesis is largely due to vadose inflow at the contact zone with the overlying Oligocene deposits, and to epiphreatic outflow at the lowermost possible point. Izvorul Izei Cave, at the downstream end of the system, has a morphology showing a combination of epiphreatic and water-table features. This genetic model greatly contributes to the understanding of the typical contact karst from the area.

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HYDROCHEMICAL STATUS OF STREAMS AND RIVERS OF THE UPPER TYSA RIVER BASIN IN THE UKRAINIAN CARPATHIANS

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KEYWORDS: Carpathians, Tisa/Tysa/Tisza River basin, water quality, heavy metals.

ABSTRACT

An ecological evaluation of water quality for streams and rivers of the upper Tysa River basin in the Ukrainian Carpathians is made. Mean monthly data for 2002 – 2010 are provided. Based on the obtained results, it is possible to state that streams and rivers of Carpathian Biosphere Reserve (CBR) can be used as reference models on anthropogenically disturbed areas. Content of toxic contaminants is analyzed within the scope (heavy metals in particular). It is determined that heavy metals concentration is conditioned both by natural and anthropogenic drivers. In order to obtain a more detailed picture of the research area's hydrological status it is crucial to widen the hydrological monitoring not only according to the area, but also according to the qualitative hydrological parameters. These include such as: biogenic elements (N, P), heavy metals, radon and other toxic elements. Parallel hydrochemical soil research and biogeochemical research would make it possible to trace the migration of chemical elements according to the system "atmospheric precipitation –> soil –> plant –> animal –> human". Such investigations would allow the study and the accumulation of a considerable amount of data obtained from continuous measurements, allowing a timely implementation of necessary measures on stabilization and mitigation of probable ecological problems in the local economical development, thus avoiding negative pressure on the biota and on people in particular.

RÉSUMÉ: L'état hydrochimique des ruisseaux et des rivières du bassin supérieur de Tisa dans les Carpates Ukrainiens.

Une évaluation écologique de la qualité de l'eau dans les rivières et les ruisseaux du bassin supérieur de Tisa dans les Carpates Ukrainiens est décrite dans cet article. Sont présentées des données mensuelles moyennes pour la période 2002-2010. En base des résultats obtenus, il est possible d'affirmer que les ruisseaux et les rivières de Réserve de la Biosphère des Carpates (RBC) peuvent être utilisées en tant que modèles de référence pour les régions affectées par des activités anthropiques. Le contenu des contaminants toxiques est analyse a ce but (particulièrement les métaux lourds). Nous avons déterminé que la concentration des métaux lourds est conditionnée par des mécanismes naturels ainsi que des mécanismes anthropiques. Afin d'obtenir une image plus détaillée de l'état hydrochimique de la zone étudiée, l'élargissement du monitoring hydrologique, non seulement concernant la zone quadrillée, mais également les paramètres hydrologiques qualitatifs s'impose. Celles-ci sont: les éléments biogéniques (N, P), métaux lourds, radon et autres éléments toxiques. La recherche hydrochimique du sol ainsi que la recherche biogéochimique pourraient rendre possible le suivi de la migration des éléments chimiques selon le système "précipitations atmosphériques -> sol -> plante -> animal -> homme". Tels investigations permettront l'étude et l'accumulation d'une grande quantité de données obtenues a partir des mesures continues, ce qui permettrait l'implémentation plus rapide des mesures nécessaires sur la stabilisation et le combat des problèmes écologiques probables dans le développement économique local, sans mettre une pression négative sur le vivant et les gens plus particulièrement.

REZUMAT: Starea hidrochimică a pâraielor şi râurilor din bazinul superior al Tisei în Carpații Ucrainieni.

S-a efectuat o evaluare ecologică a calităţii apei din pâraiele şi râurile din bazinul superior al Tisei din Carpaţii Ucrainieni. Sunt furnizate date medii lunare pentru perioada 2002-2010. Pe baza rezultatelor obţinute, este posibil să se afirme că pâraiele şi râurile din Rezervaţia Biosferei Carpaţilor (RBC) pot fi folosite ca modele de referinţă pentru zonele antropizate. În acest scop s-a analizat concentraţia de substanţe toxice (în special metale grele). S-a descoperit că atât factorii naturali, cât şi cei antropogeni influenţează concentraţia metalelor grele. Pentru a obţine o imagine mai detaliată a stării hidrologice a zonei cercetate se impune o lărgire a monitorizării hidrologice, nu numai din punct de vedere al zonei studiate cât şi a parametrilor hidrologici calitativi investigaţi. Aceştia sunt: elemente biogene (N, P), metale grele, radon şi alte elemente toxice. Studii pedologice de hidrochimie şi biogeochimie ar putea de asemenea face posibilă urmărirea migraţiei elementelor chimice în sistemul “precipitaţii atmosferice –> sol –> plantă –> animal –> om”. Asemenea cercetări ar permite studierea şi acumularea unui mare volum de date prin măsurători continue, ceea ce ar duce eventual la o implementare mai rapidă a măsurilor necesare de stabilizare şi abordare a unor probleme ecologice probabile în dezvoltarea economică locală, ceea ce nu ar mai exercita o presiune negativă asupra viului şi a populaţiei în particular.

INTRODUCTION

The Carpathian Biosphere Reserve (CBR) is a nature protection, research and ecoeducation institution, which aims for flora and fauna conservation in general, as well as their particular species and communities, both typical and unique ecosystems. It belongs to the World Network of UNESCO biosphere reserves, thus contributing to the global eco-monitoring, identifying main changes of ecosystems. Hydrochemical indexes (ingredients) of water bodies illustrate these changes in the best way, because they play an important role in physiological, bio- and geochemical processes, which occur is soils, water and plants. They define optimal living conditions for organisms and condition their biological productivity. Research of contaminators’ distribution patterns allows getting a reliable picture of area’s pollution parameters. The hydrochemical investigations, being a part of general monitoring, have been held at CBR since 2002.

The largest tributary of the Danube - the Tysa river - is made by confluence of the Chorna (Black) and the Bila (White) Tysa rivers in 4 km to the north of Rakhiv.

The Chorna Tysa starts on the northeastern slope of the Svydovets ridge at Okoly Mt. on the altitude of 1400 m a.s.l. It is 49 km long, catchment area is 567 km^2; the river’s basin totally lays in mountainous area, which defines its mountain regime and the structure of the valley. The valley is deep and slightly winding. A riverbed’s width elevates from 10 to 25-50 m. Depth in midsummer period is – 0,5-2,0 m; in flood season is raises up to 4-6 m. A stream speed in midsummer time if 1,0-1,5 m/s. Mean water flow is 12,3 m^3/sec (Yatsyk et. al., 1991) (Bilyn village). Close to Yasinia on the left side the Lazeschyna river flows into the Chorna Tysa.

The Bila (White) Tysa starts on the western slope of the Chornohora massif in Korbul tract at around 1600 m a.s.kl. it flows from the east to west, separating the Chronohora range from Rakhiv mountains with its riverbed. This is a typical mountain river with great elevations (10 м/км), and deep, narrow valley, slightly winding, with steep forested slopes, which often hang over the river with their cliffs. The river is 19 km long, catchment area - 489 km^2 (Yatsyk et. al., 1991). Mean speed of flow is 2-3 m/sec, mean runoff – 13,5 m^3/sec (Roztoky village).

Total length of the Tysa river constitutes 966 km, 209 km of which stretches in Ukraine. Partially it flows along the state border with Romania and Hungary. From its well and down the Ukrainian-Romanian border it stretched in the southwestern direction along the narrow valley with high slopes. Starting from the state border it takes a sudden turn westwards. On this section a Romanian river Viseu tributes into it (on the left).

This segment of the catchment area is the most humid in Ukraine with the densest river net (from 2,0 to 2,8 km/km^2). It belongs to the Chornohora zone of the Maramureş crystalline massif of the Carpathian folded region (Paparyha, 2010). The Chornohora zone with a great number of scales is represented by chalk Paleogene deposits. Chalk deposits are mostly concentrated on the north. Here belong Shypot, Yalovets, Chornohora and Stryi overcoats. There are four complexes in the Paleogene flysch: Paleocene massive Yamna sandstones and argillites of Maniave, Vyhoda, Popelska and Bystrytsia overcats; black non-limestone menilite schist; dark limestone argillites and sandstones of Polianytsia overcoat and Krosna series. On the surface along the northeastern edge of the Chornohora there are rocks of Skupicska, Hnyletska, Topilchanska, Probiynenkivska and Veretska overcoats (Paparyha, 2010). The most popular landmark of the area is the Chornohora massif with the highest peak of Ukraine – Hoverla Mt., which raises on the altitude of 2061 m a.s.l. next to it there are five more Carpathian mountain tops reaching over 2000 m.a.s.l.: Petros, Rebra, Brebeneskul, Pip-Ivan, Hutyn-Tomnatyk.

The Maramureş crystalline massif is composed of Ptototersoi-Paleogene formations. Elevation here is 750 – 1940 m a.s.l.; the main mountain here is Pip Ivan of Maramureş (1940 m). The mountain range is made up of hard crystalline rocks, which conditions a characteristic relief and specific soil cover, flora and vegetation (Paparyha, 2010). The Maramureş' relief is characterized by deep mountain valleys, numerous crests and peaks. The Kvasnyi stream catchment is located within the massif, which is the right tributary of the White Tysa. Great part of its area belongs to the Carpathian Biosphere Reserve.

MATERIAL AND METHODS

Water samples are analyzed in a chemical laboratory; we identified content of basic ions of salt composition: SO_4^{2-}, HCO_3^-, CI^-, Ca^{2+}, Mg^{2+}, $Na^+ + K^+$, iron and nitrates in mg/dm^3, overall liquid, and alkalinity in mg-equ/dm^3 according to standard methodologies. The Ph indicator was identifies with an electrometric method by means of a device PH-150. All the devices used for the analysis were correspondingly verified.

To characterize the hydrochemical peculiarities of waters under study we used O. Alyokin classification, where a water class was defined by dominating acid ions, a group – by dominating cations, and a water type – by correlation between ions in equivalents (Kharchenko et. al., 1999).

The ecological evaluation of water quality was made according to the 'Methodology of water quality evaluation for surface waters by corresponding categories" (Kharchenko et. al., 1999).

RESULTS

Results of investigation for the period from 2002 to 2010 are given in the table 1.

Indexes of mineralization and ion water compositions, sums of ions, hydrogen ions concentration and some other ingredients are common for all water ecosystems. Their concentration can vary due to living organisms' and human activities, and natural factors (Paparyha et. al., 2010).

The domination in ion composition is as following: among anions - HCO_3^-, the content of which fluctuates from 13,3 to 159,0 mg/dm^3; among cations – Ca^{2+} (2,6 –46,1 mg/dm^3) depending on the degree of mineralization; within the subalpine-alpine belt (Bilyi strem) Na^+ can sometimes dominate. So, the water was mostly characterized as hydrocarbonate-calcium, and rarely – hydrocarbonate-natrium of the 1st, 2nd and sometimes 3rd types.

Ion SO_4^{2-} takes the second place after HCO_3^-. Its minim content is 2,6 mg/dm^3 (8,9 % of the overall mineralization) registered in water sample taken from Bilyi stream. The same place showed increase of sulphate content to 4,7 mg/dm^3 (15,9 % of the overall mineralization) after heavy rains. It could be caused by acid rains, as feeding of the given stream is done by means of precipitation. In a snow melting period the sulphate content sometimes becomes higher – up to 26,5 mg/dm^3 in the Tysa river close to the CBR headquarters (minimal value – 9,1 mg/dm^3).

By the contamination with components of salt composition all waters belong to category 1 (Cl < 20 mg/dm^3, SO_4^{2-}< 50 mg/dm^3). The water of researched rivers and streams is fresh (ultra-fresh in alpine areas). The sum of ions was 29 – 240 mg/dm^3 correspondingly: minimal – in the alpine areas with gradual increase downstream. Maxim values were found in the rivers: Tysa, Chorna Tysa, Kvasnyi stream. The least mineralization values are observed in snow melting season, and also in warmer period of the year when intensive rainfalls occur.

Table 1. Dynamics of hydrochemical composition of water in the upper Tysa basin (Ukrainian part)* (Rachiv, 2002 – 2010); *- a numerator stands for minimal and maximal meanings for analysis results, and a denominator stands for mean meaning

Ingredient	Bilyi Stream, waterfall, alt. 1550 m	Hoverla river, Ust-Hoverla	Bohdan river, Lavka tract	Kvaskyi stream, Holovach tract	Bila Tysa river, Ust Hoverla	Chorna Tysa, Keveliv tract	Tysa river, Piddil tract
PH	5,84- 7,46 6,49	7,20- 7,52 7,36	6,40-7,70 7,09	6,38-7,75 6,92	7,08- 8,05 7,57	6,17-7,40 6,99	6,69-8,68 7,9
Hardness, mg-equ/dm^3	0,18-0,37 0,26	0,56-1,30 0,93	1,17-1,80 1,54	0,82-0,2,2 1,51	1,14-1,15 1,15	1,44-2,35 2,13	1,37-2,80 2,10
Ca^{2+}, mg/dm^3	2,6 -7,0 4,2	9,4 -18,0 13,7	17,3-28,1 24,1	13,8-38,6 25,8	17,4 -20,7 19,1	21,2-40,1 32,9	24,0-46,1 33,6
Mg^{2+}, mg/dm^3	0,2 -0,9 0,6	1,1 -4,9 3,0	1,3 -7,3 4,1	1,6-3,3 2,7	1,2 –3,4 2,3	1,8-7,9 5,5	2,0-9,8 5,3
Na^++K^+, mg/dm^3	3,0 -5,4 4,5	3,8 -5,9 4,9	2,3-9,3 5,6	4,2-8,4 6,2	4,4 -20,1 12,3	1,5-12,0 5,8	1,0-12,2 7,5
HCO_3^-, mg/dm^3	13,3 -22,2 17,1	34,9 -61,0 48, 0	68,5-110,0 86,6	46,3-126,9 85,4	65,3 -91,5 78,4	76,1-130,0 113,9	73,0-159,0 118,4
Cl^-, mg/dm^3	1,6 -4,3 3,1	3,5 -4,7 4,1	2,2 -3,6 4,0	2,0 -3,2 2,7	3,5 -3,6 3,6	2,1-7,9 4,7	2,1-10,4 4,7
SO_4^{2-}, mg/dm^3	2,6 -4,7 3,4	4,5 -17 10,8	9,3-18,7 12,6	11,3-16,5 13,1	7,0 -17 12,0	11,2-25,0 16,9	9,1-26,5 16,8
Overall mineralization, mg/dm^3	29,0 -39,0 33,0	61 -108 85	108,9-167 136,0	81,1-197,0 135,9	102 -153 128	134-203 180	127 -240 188
NO_3^-, mg/dm^3	1,10	0,75-3,0 1,88	1,5-2,45 1,82	1,80	1,4 – 3,0 2,20	2,95	0,5 – 5,6 2,35
Fe заг, mg/dm^3	0,01-0,02	0,02-0,065 0,042	0,02-0,12 0,07	0,04	0,05	0,008-0,035 0,017	0,01-0,3 0,07
Index	C_{I-II}^{Ca}, C_I^{Ca}, C_I^{Na}, C_{II}^{Ca}	C_{II}^{Ca}	C_{II}^{Ca} ,C_{I-II}^{Ca}	C_{II}^{Ca}	C_{II}^{Ca}	C_{II}^{Ca},C_{III}^{Ca}	C_{II}^{Ca},C_{III}^{Ca}

The overall water hardness is conditioned mainly by availability of dissolving compositions of calcium and magnesium and are changing depending on the soil type composing the watershed, as well as on the season (Kharchenko et. al., 1999). With the hardness around 4 mg-equ/m^3 water is considered to be soft. The research areas are characterized by a gradual hardness raise if we move downstream: from 0.18 (alpine areas) up to 2.40 mg-equ/m^3 (Tysa river). So, the conclusion is that all these waters are soft.

Mean pH of the steams researched testifies to the fact that water is mostly characterized by either neutral or weak alkaline reactions. There were declines to slightly acidic pH in the spring that is related to a large number of admission of melt waters in watercourses. Maximum values of this index (over 8.5) indicates the river pollution, which was defined in the River Tysa during floods. In the highlands the water has a slightly acid reaction in most cases. Minimum value - 5.84 determined in a sample selected after undergoing significant precipitation (increase of the sulfate was observed at the same time). Thus, alpine streams are most vulnerable to acidification, as naturally their pH is already slightly acidic. To helps to promote a cross-border transfer of pollutants from atmospheric currents from the industrialized areas. This confirms previous studies (Paparyha et. al., 2010) held by the researchers of CBR.

The content of soluble iron compounds is depending on pH and redox processes occurring in it. MAC for iron < 0.3 mg/dm3. Some Carpathian rivers are characterized by slightly higher iron content because of purely natural causes. According to the chemical analysis, iron content in the investigated waters elevates from 0.008 to 0.3 mg/dm3.

For NO3-(MAC = 40 mg/dm3) - in all cases there was slight increase downstream (0,75 - 5,6 mg/dm3). This proves a very little nitrate injection downstream of watercourses.

Therefore, we highlighted the environmental assessment of water quality by general indicators. But equally important is the assessment of water quality is detection of specific toxic effect of pollutants such as petroleum products, phenols, organochlorine insecticides used in agriculture, heavy metals, surfactants, etc. According to previous research (Kharchenko et. al., 1999) in 1991 the situation of water quality indicators for specific toxic effect on the Ukrainian part of the upper Tysa basin was rather unfavorable. This particularly applies to water pollution with heavy metals that come in these watercourses (Table 2). The concentration of heavy metals occurs due to their appearance both from anthropogenic sources and from natural ones.

Table 2. Water quality characteristic in the Ukrainian part of the upper Tysa river basin according to toxic elements content dated to 1991 (Kharchenko et. al., 1999).

River	Cu	Zn	Cr	Fe	Mn	Ni	Cd	Pb
Chorna Tysa	7.2-19.3	17.4-171.2	0.0-13.2	30.0-40.0	7.2-4.3	0.0-18.1	1.0-6.0	19.5-40.3
Bila Tysa	1.6-9.2	18.3-224.7	0.0-6.9	20.0-50.0	7.2-23.7	0.0-19.8	0.0-7.5	11.1-36.0
Shopurka	6.4-33.8	52.3-171.4	0.0-4.5	40.0-60.0	3.6-11.4	0.0-14.4	1.3-5.3	12.6-28.9
Tysa	2.6-86.3	29.9-592.1	0.0-20.8	30.0-100.0	3.9-29.2	0.0-37.8	0.0-10.2	12.2-65.9

The concentration of most toxic substances considered in the waters of the mentioned watercourses is higher then general. The main reason for this was definitely a time of intense anthropogenic pressure, which was reinforced by natural factors. It should be noted that the

Carpathians are geochemical provinces with high concentrations of heavy metals (Kharchenko et. al., 1999). The ill-conditioned (too much or lack) content of heavy metals and other toxic elements in soils, waters and plants of the Chornohora massif of CBR and surrounding areas as human-induced and natural genesis indicate studies conducted by CBR researchers in 2005-2009 (Kkriuchenko et. al., 2009; Paparyha, 2010). According to (Kkriuchenko et. al., 2009; Paparyha, 2010) to present data, the situation is much better thanks to polluting enterprises' collapse (factories of artificial fur, pulp and paper plant, condenser plant and its affiliates, and others which dumped waste production in the abovementioned watercourses) and the transfer of large areas within the catchment to the management of CBR.

CONCLUSIONS

Watercourses are major sources of fresh water needed for various human needs and for support plant and animal life. They play a unique role of environmental indicators not only of aquatic ecosystems and the whole area of its water intake from the atmosphere and terrestrial ecosystems. The state of small rivers is defined as the surrounding watershed. In its turn, human health depends on the health of these rivers, as the 80% minerals (calcium, magnesium, sodium, potassium, phosphorus and others) arrive in a living organism with water (Paparyha, 2010). Therefore, especially important is to determine poelementno of chemicals in water.

According to research results, watercourses in the Chornohora massif of CBR can be used as a benchmark during water analysis in anthropogenically-affected areas. It is impportant to expand the hydrochemical monitoring not only in size but also in quantitative hydrochemical parameters such as: nutrient elements (N, P), heavy metals, radon and other toxic elements. Concurrent studies of soil geochemical and biogeochemical studies would enable to trace the migration of chemical elements in the system to rainfall -> soil -> plant -> animal -> man.

This kind of research will help to explore and accumulate a large number of continuous measurement and control observations, allowing time to take necessary measures to stabilize and help resolve environmental problems within the economic development of the national economy that would not have harmful effects on people. Only in this case it is possible to predict ecological state of the environment for timely removal of natural and anthropogenic factors impact on the health and biota in general.

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ECOLOGICAL AND GEOCHEMICAL FEATURES OF THE RAKHIV-TYSIANSKA TECTONIC ZONE OF THE UKRAINIAN CARPATHIANS

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KEYWORDS: tectonic zones, chemical content, mineral springs, human health, Ukrainian Carpathians.

ABSTRACT

The article deals with the ecological and geochemical features of the Rakhiv-Tysianskyi transverse fault, and its probable impact on the health of the residents living in the area it affects. An attempt was made to identify cause and effect relationship between increased sickness rate and non-standard content (low or excessive) of elements in the groundwater, which is widely used by the residents as medicinal and drinking water. Particular emphasis is placed on the results of investigations of mineral water with a small water discharge. These springs have no commercial value, but they are all located in the area affected by the above-mentioned fault. Due to the content of toxic elements in the investigated groundwater springs the water cannot be used as drinking water on a daily basis. This water can be recommended (on condition that more research is carried out by physicians) to be used only as medicinal, i.e. only measured amounts of it should be used.

ZUSAMMENFASSUNG: Ökologische und geochemische Kennzeichen des tektonischen Gebietes Rakhiv-Theiß in den Ukrainischen Karpaten.

Der Artikel befasst sich mit den geochemischen und ökologischen Merkmalen der transversalen Rakhiv-Theiß Verwerfung und ihrem wahrscheinlichen Einfluss auf die Gesundheit der im betroffenen Gebiet ansässigen Bevölkerung. Es wurde ein Versuch gemacht, die Beziehung zwischen Ursachen und Auswirkungen einer steigenden Erkrankungsrate und nicht Standard gemäßem Gehalt (niedrig oder übermäßig hoch) von Elementen im Grundwasser zu identifizieren, das von den Ansässigen als Medizinal- und Trinkwasser in hohem Maße genutzt wird. Besonders Schwerpunkt wird auf die Ergebnisse der Untersuchungen von Mineralwasser mit geringem Abfluss gelegt. Diese Quellen haben keine kommerzielle Bedeutung, liegen jedoch alle in dem Gebiet der genannten Verwerfung. Bedingt durch den Gehalt an toxischen Elementen in den untersuchten Grundwasserquellen, kann das Wasser nicht als tägliches Trinkwasser genutzt werden. Dieses Wasser kann - unter der Bedingung weiterer Forschungen durch Physiker - nur zur medizinischen Verwendung, d.h. nur in dosierter Menge empfohlen werden

REZUMAT: Trăsăturile ecologice şi geochimice ale zonei tectonice Rakiv-Tysianska din Carpaţii ucrainieni.

Lucrarea prezintă caracteristicile ecologice şi geochimice ale faliei transversale Rakhiv-Tysiansky şi posibilul său impact asupra sănătăţii localnicilor din zona afectată de ea. S-a încercat identificarea relaţiei cauză - efect dintre rata crescută de îmbolnăvire şi conţinutul cu dozaj aleatoriu din pânza freatică, a cărei apă este folosită de localnici pe scară largă ca medicament sau apă potabilă. O atenţie deosebită se acordă rezultatelor studiului apelor minerale cu un debit mic. Izvoarele nu au nici o valoare comenrcială, dar ele sunt localizate în zona afectată de falia menţionată mai sus. Din cauza conţinutului de elemente toxice din izvoarele cercetate apa nu poate fi consumată pentru nevoile zilnice. Această apă poate fi recomandată (în condiţiile în care se vor face mai multe cercetări asupra ei de către medici) să fie folosită numai ca medicament, adică numai în anumite doze.

INTRODUCTION

Problems of health and its dependence on the ecological and geochemical environment are considered under the condition that trace elements come from various natural and anthropogenic sources. Special attention has been recently paid to the study of the impact of anthropogenic factors on the population health [1].

However, the study of the impact of natural factors on ecological and geochemical environment is limited, so the problem of the influence of natural factors on the environment remains insufficiently studied, especially in tectonically active areas where people live.

In the era of orogenesis, deep-seated strike-slip fault structures were intensively developing within the geosynclinal areas. Among them, according to the movement of mobile belts, there can be distinguished longitudinal, transverse and diagonal deep-seated faults (Khayin, 1964). However, during the early and middle stages of geosynclines longitudinal and diagonal deep-seated faults dominated, while the transverse ones appeared at the final stage of geosynclines development and may be regarded as deep-seated faults that cross not only the geosynclines, but also the neighboring platform.

Rakhiv-Tysianskyi transverse fault (Fig. 2) is the southern part of such a fault that crosses the Carpathian mountain system along the valley of the river Tysa, it further crosses Gorgany and Precarpathian trough near Nadvirna village in the north and reaches the East European platform in the north-northeast. This fault is well seen on the results of geoindicational aero- and space images decoding implemented by O. M. Colodiy.

It is believed [3, 6] that the upper mantle and deep parts of the crust are connected with the surface of the planet through deep and regional faults. The fluids have been coming from the deep horizons to the ground through deep fault structures, volcanic channels or diffuse along the areas of tiny fractures etc. [3, 6]. During the faults activation, preconditions for geophysical, geochemical, biogeochemical, hydrochemical and other abnormalities are created within their zones and areas affected by them.

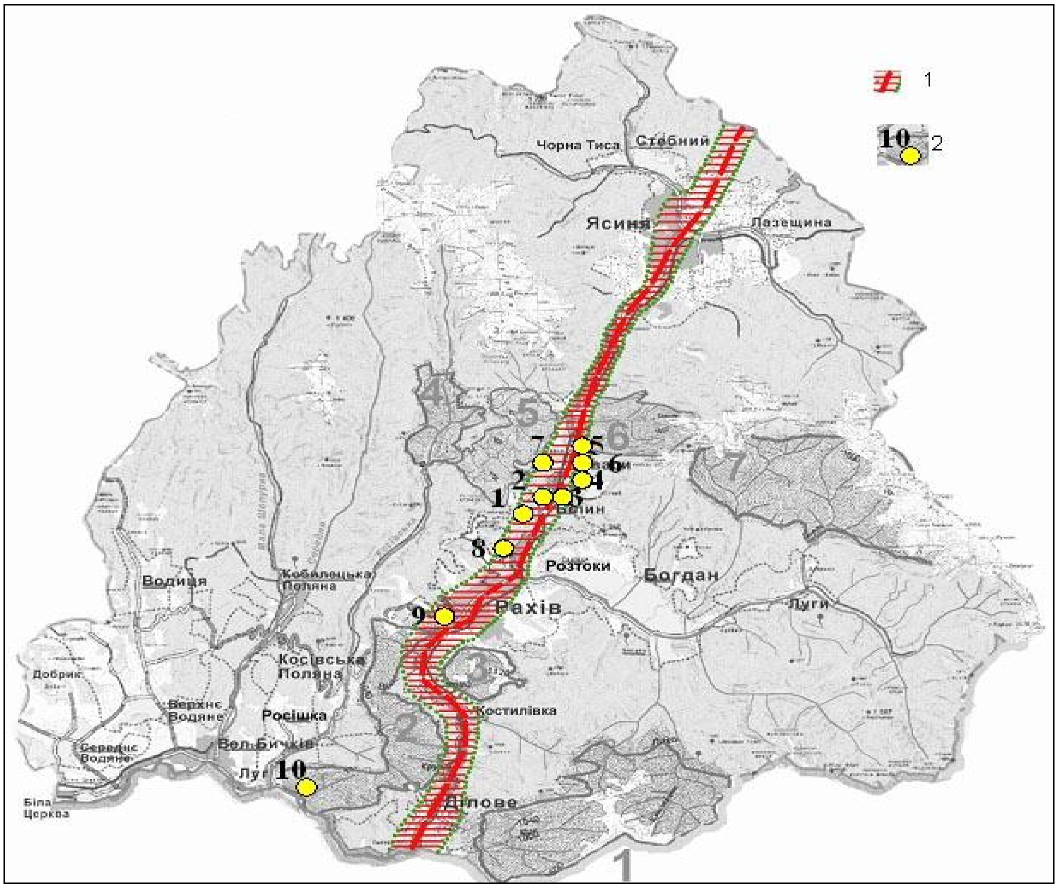
Previous studies [6] have discovered that most settlements are situated along the rivers, whose river beds are controlled by the tectonic faults zones, i.e. are directly situated in the areas affected by deep-seated fault structures.

Such zones of tectonic activation are characterized by a significant intensification of fluids which include chemicals typical for deep hydro geochemical zones. These include heavy metals, radon, fluorine, chlorine, sodium, potassium, lithium, arsenic, mercury and many others [5, 6], which change ecological-geochemical condition of the environment and affect the health of the population.

Some scientific researches which deal with the study of the impact of natural geological factors on the environment [4, 5, 6] directly indicate the presence of such influence. In particular, within the Lviv region, at the junction of the Carpathians, Precarpathian trough and the East European platform there was discovered a direct relationship between residents' health and location of settlements relative to various deep-seated and regional tectonically active faults and fluid permeable faults as well as minerals deposits [6].

Since the human body gets trace elements mainly through drinking water [1], main importance is attached to the study of distribution patterns of heavy metals, lithium, fluorine, arsenic, iodine and other chemical elements in different types of drinking and mineral water.

Heavy metals and other elements appear in groundwater mainly due to "leaching" of the rocks which are enriched with heavy metals [1]. As for lithium, fluorine, iodine, arsenic and some other elements, they come in natural water from deep hydrogeochemical zones in the areas of tectonic activation. This was well illustrated by the study of the fluoride distribution in drinking waters of Ukraine and their impact on endemic disease [1, 2].



Figue 2: Location of the studied mineral springs;
1 - Rakhiv-Tysianskyi transverse fault, 2 - mineral springs and their numbers.

The same dependence of health on a number of natural factors was established in Rakhiv district (Fig. 2), where the impact of Rakhiv-Tysianskyi transverse fault of the Carpathians is of special importance. [4, 5]

On the territory of the investigated area there are ore deposits and many ore and non-metallic minerals, in particular, the area is rich in groundwater. The numerous springs of fresh and mineral water are widespread throughout the area.

A group of researchers [4, 5] has conducted a research on the dependence of residents' health on the location of settlements relative to the tectonically active zone and fluid permeable faults area connected with Rakhiv-Tysianskyi transverse faults of the Carpathians. According to the processed statistical data on sickness rate and mortality for the period of 1992 - 2004 within Rakhiv-Tysianskyi fault and beyond, it has been established that within the area affected by the fault the average sickness rate and mortality indicator in all nosological groups (with the exception of the respiratory system) is significantly higher than that outside the fault area. Mortality rate indicator due to cancer is distinguished especially clearly. (Fig. 1)

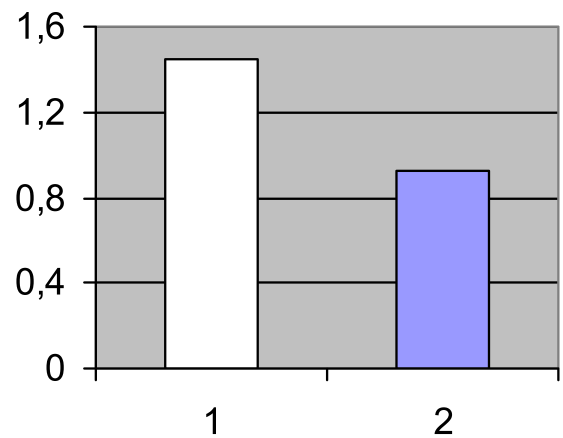


Figure1: Histogram showing the dependence of cancer death rate on the possible impact of the fault; The area affected by Rakhiv-Tysianskyi fault, 2 - outside the area affected by the fault.

In order to establish the cause and effect relationship between increased sickness rate and mortality of the population living in the area affected by Rakhiv-Tysianskyi transverse fault (Fig. 2) and the likely impact of this fault, ecological and geochemical characteristics of mineral water, which is used by the resident as drinking and medicinal water, were identified. The content of trace elements, whose prolonged deficiency or excess leads to metabolic disorders and diseases, was defined with a view to achieving the objective.

MATERIALS AND METHODS

The identification of heavy metals in water was carried out with the help of atomic absorption spectrophotometer C-115 and "Saturn 3"; Li was measured with the help of PAZH-1 using emission flame photometry; nitrates and fluoride, chloride - with the help of potentiometry. Analytical studies were carried out in the laboratory of the M.P. Semenenko Institute of Geochemistry, Mineralogy and Ore Formation, the National Academy of Sciences of Ukraine.

The study covered a total of 10 springs (Fig. 2) used by the residents for drinking. Water temperature in the springs is 6 - 9^0C, except the spring #10 where the water temperature is 23-25^0C (water has specific hydrosulfide smell). All waters have weak mineralization - up to 0.7 g/liter.

RESULTS AND DISCUSSIONS

The water was collected from the springs so that we could identify NO3-, pH, Eh, Ni, Zn, Fe, Li, Co, Cu and other elements. The table shows the data of several elements, the others are within the MPC. Results of the analytical studies are presented in the table 1.

Table 1: The chemical content of water in mineral springs.

Spring no.	Ni	Fe	NO_3	Li	pH	Eh
	mg/dm^3					
1	0.10	0.50	0.30	1.87	5.60	250.00
2	0.10	0.50	0.37	15.14	5.60	230.00
3	0.10	0.50	0.37	13.15	5.70	250.00
4	0.10	0.50	0.15	1.87	5.95	265.00
5	0.10	0.50	0.20	2.97	5.20	260.00
6	0.04	8.61	3.75	21.04	5.80	135.00
7	0.06	4.10	0.50	2.97	6.25	120.00
8	0.04	0.50	0.33	1.56	5.90	220.00
9	0.12	0.11	4.25	25.39	6.35	150.00
10	0.10	0.50	0.10	8.22	7.20	215.00
MPC according to Sanitary Rules and Regulations 2.1.4.559-96	0,.1	0.3	45.0	0.03	6.5 - 8	

The groundwater is characterized by a high content of lithium, nickel and iron. Given the MPC for drinking water it should be noted that the MPC in some springs was exceeded: Li – by 830 times (springs No. 6 and 9), Fe – by 28 times (spring No. 6).

A significant increase in the content of some chemical elements (Li, Ni, Fe) in natural waters of the springs located in the area of Rakhiv-Tysianskyi transverse fault was identified for the first time. The largest concentration of Li was observed in waters found in the areas where fault structures are crossed (Rakhiv, Kvasy, etc.) which may be a geochemical indicator of the presence of intersection knots of faults with different directions.

The intersection zones of multidirectional tectonic faults, where the groundwater with high content of toxic elements used as medicinal and drinking is discharged, are the areas of environmental risk and need special medical and geochemical studies.

The identified features of toxic elements impact on geochemical environment in the area of Rakhiv-Tysianskyi transverse fault is the basis for developing measures for population health improvement and conducting further research.

CONCLUSIONS

The patterns of toxic elements distribution in groundwater were identified during the geochemical study of groundwater in the area of Rakhiv Tysianskyi transverse fault of the Carpathians. It was found out that MPC was exceeded in the water of some springs: Li – by 830 times (springs No. 6 and 9), Fe – by 28 times (spring No. 6). These springs are located in the area of tectonic faults and what is the most important **-** this area is densely populated with people, making it the area of environmental risk. Thus, as to the content of toxic elements, the groundwater from the studied springs is not allowed to be used as drinking on a daily basis. This water can be recommended (on condition that more research is carried out by the physicians) to be used only as medicinal, i.e. only measured amounts of it can be used.

Nonstandard content of trace elements (heavy metals, fluorine, iodine, arsenic, lithium, etc.), entering the groundwater along Rakhiv-Tysianskyi fault, is the basis for further comprehensive geochemical studies. Only in this case the prediction of changes in the environment and timely removal of natural and anthropogenic harmful effects on human health is possible.

Setting up the landscape-geochemical monitoring of settlement areas of the Carpathian region and collection of sufficient statistical data through continuous measurement and control observations in the future would enable us to develop the necessary regulatory measures to stabilize and eliminate environmental problems associated with the negative impact of both natural and anthropogenic factors on environment in general and the health of people in particular.

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INFLUENCE OF ALLUVIAL DEPOSITS ON SOIL PROPERTIES OF THE FLOODPLAIN OF THE FOOTHILL CURRENT OF THE RIVER TYSA

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KEYWORDS: floodplain soils, alluvial deposits, human impact, upper Tysa floodplain, Ukrainian Carpathians.

ABSTRACT

The influence of alluvial deposits on the properties of major floodplain soils of the river Tysa's foothill current was studied. It was found that at the channel banks of the floodplain, where sand and sandy alluvial material have been deposited, alluvial turf soils (Haplic Fluvisols (Eutric Arenic)) were formed. The soils of the same type that have been drained have different structure and properties, which has caused a change in their classification (Haplic Arenosols (Eutric)). In the places where levees are absent or are far away from the riverbed, alluvial meadow-bog soils Gleyic Mollic Fluvisols (Eutric Siltic) are formed. Water-physical and physical-chemical properties of soils have deteriorated due to the influence of land reclamation, which causes changes in the direction and intensity of soil formation process and thus cause the change of the type of soil to Protohistic Umbric Gleysols (Distric Siltic). The processes of soil formation and functioning are restructured at the reclaimed areas, which caused the loss of the alluvial properties of the soils and their change of type.

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ZUSAMMENFASSUNG: Der Einfluss der alluvialen Ablagerungen auf die Eigenschaften des Auenbodens am Fuß der Terrassen des Theiß-Flusses.

In vorliegender Arbeit werden die Ergebnisse der Untersuchungen über den Einfluss der alluvialen Ablagerungen auf die Bodeneigenschaften im Hochwasserbett der Theiß untersucht. Es wurde festgestellt, dass sich in den Auen am Rande des Flussbettes, wo sich Sand sowie sandige Alluvionen ablagern, alluviale Torfböden bilden. Böden vom gleichen Typus, die drainiert wurden, haben andere Strukturen und Eigenschaften, die Änderungen in ihrer Klassifikation erfordern. In Abschnitten, an denen die Dämme fehlen oder in größerer Entfernung vom Fluss liegen, bilden sich sumpfige Schwemmböden, mollische Gley-Auenböden. Die physischen oder die physikalisch-chemischen Eigenschaften des Wassers werden durch die Kulturlandgewinnung zerstört, da diese Veränderungen in Richtung und Intensität der Bodenbildung verursacht und einen Wechsel des Bodentyps zu einem Protohistisch-umbrischen Gleyboden bewirkt. Die Bodenbildungsprozesse und Funktionen werden in den Gebieten mit Landnutzung umstrukturiert und bestimmen den Verlust der alluvialen Eigenschaften im Boden sowie den Wechsel des Bodentyps.

REZUMAT: Influenţa depozitelor aluviale aspura proprietăţilor solului de luncă de la baza teraselor actuale ale râului Tisa.

S-a studiat influenţa depozitelor aluviale asupra proprietăţilor solului din lunca majoră a râului Tisa. S-a constatat că pe malurile albiei din luncă, unde nisipul şi aluviunile nisipoase sunt depozitate se formnează soluri de turf aluvial (Haplic Fluvisols (Eutric Arenic)). Solurile de acelaşi tip care au fost drenate au structuri şi proprietăţi diferite, care generează schimbări în clasificarea lor (Haplic Arenosols (Eutric)). In zonele în care lipsesc digurile sau se află la o distanţă mare de albie, se formează soluri mlăştinoase aluviale, Gleyic Mollic Fluvisols (Eutric Siltic). Proprietăţile fizice ale apei sau cele fizico-chimice ale solurilor sunt deteriorate din cauza influenţei îmbunătăţirilor funciare, care genereaza schimbări în direcţia şi intensitatea formării solului şi deci schimbarea tipului de sol în Protohistic Umbric Gleysols (Distric Siltic). Procesele de formare şi funcţionare a solurilor sunt restructurate în zonele regenerate , determinând pierderea proprietăţilor aluviale în soluri şi schimbarea tipului lor.

INTRODUCTION

The Transcarpathian lowland with its mild warm climate and sufficient humidification has been a suitable area for farming for a long time. More than 150 years ago people found a way to transform wetlands and boggy habitats into farming areas by changing their ecological potential completely. Tysa’s riverbed and its tributaries adjusting began in the middle of XIX century due to the railways construction. At present reclamation is considered very carefully and critically, but due to continuous drainage unique biotope complexes of plains were lost forever. If the impact of drainage on average river flow indicators is still open to question, the statement that this type of economic activity reduces the flooding of floodplain landscapes is undisputable and even axiomatic. It prevents the natural improvement of soil through inclusion of silt, which is rich in nutrients, in soil formation processes.

The researchers have been paying attention to the problems of floodplain soil formation and economic use of alluvial soil (Williams, 1948, Voronova, 1960, Elenevskyy, 1936, Skvortsov, 1959), but because of the dynamic and multidirectional alluvial soil processes the received data is not always possible to interpolate for the soil of certain landscapes, such as the Transcarpathian Lowland. This is especially connected with the impact of flood waters and silt, which is carried by them, on the properties of soils and changes in their properties and functions after hydro melioration measures.

MATERIALS AND METHODS

The research was conducted throughout 2005-2011 within the foothills of the river Tysa (Tisza, Tisa; Tyachiv and Khust districts of the Transcarpathian region). To determine the changes in the soil properties of the floodplain complexes, a number of research areas in natural and drained parts of the floodplain of the Tysa’s upper course were set. Morphological, water-physical and physical-chemical properties of the soils were studied. Laboratory and analytical studies were carried out with the help of conventional methods (Arinushkina, 1970 and Kolos, 1964). Factorial ecological principles developed by O.N. Sokolovsky Research institute for soil science and agrochemistry (Polupan, 1981) and profile-genetic principle adopted for the WRB nomenclature (*, 2007) were used for soils classification.

RESULTS AND DISCUSSIONS

The river Tysa originates in Polonynsko-Chornohorskyi region of the internal anticlinal zone of the Carpathians, which is composed of Cretaceous and Paleogene flysch [9]. However, it crosses the geological structures of all ages on its way - from relict volcanic to the Neogene ones, which determines the diverse composition and properties of alluvium deposited in its floodplain.

The structure of floodplains soil of the main rivers of the Transcarpathian lowland is formed by the soils of three large groups, which differ in terms of genesis and properties, belonging to alluvial, and half-hydromorphic and hydromorphic types (Orlov and Vovk, 2008). However, the specific hydrogeological conditions of the floodplain of the Tysa's foothills caused the dominance of the turf and bog (meadow bog) soil. Actually, these soils are equally prevalent within both natural and drained floodplain.

Due to the high speed of Tysa's current, rubble and sand river deposits are typical for the foothill floodplain of the river. The deposited silt forms channel banks and covers the floodplain with sandy, loamy predeposited rocks. River silt with a high content of physical clay fractions is accumulated only in micro-depressions of central parts and fluvial terraces of the floodplain.

In the channel bank of the floodplain, where sand and sandy alluvial deposits are deposited with weak alkaline soil reaction (pH 6,9-7,0), very low hydrolytic acidity, dominance of absorbing complex of exchange cations Ca and Mg (Vovk and Orlov, 2008), alluvial turf soils (Haplic Fluvisols (Eutric Arenic)) are formed. Alluvial turf soils are azonal soils formed by layers of fresh river alluvium on well drained sandy-pebbles stony deposits. Turf floodplain soils are the only type of alluvial soils with good water filtration. It is facilitated by both alluvium grain size and close location to the riverbed, which is a natural drainage for groundwater, determining the slope of the level of their bedding from the terrace to the riverbed. Given the conditions of formation, alluvial turf soils of the channel banks are heavily layered, but without a clear genetic horizons that are not identified by the majority of morphological characteristics. Definition of the lower limit of the soil profile has always been controversial.

Due to a high content of absorbed bases in the absorbing complex the studied soils are characterized by very low hydrolytic acidity. Its value does not exceed 0.4 mg · equiv per 100 g of soil (Tab. 1) which correlates with the values of this indicator in the silt deposited in the channel banks of the floodplain. Calcium dominates in the absorbing complex of turf soils, due to its significant content in alluvial deposits and lower, compared to Mg and univalent cations, substitution and displacement. Its relative content amounts to 60-70% of the cation exchange capacity and is barely changed in the profile. In general, the studied soils are low in humus, and humin dominates in humus composition, it is the most decomposition resistant group of humus substances.

The drained soils of the same type that are common in the places where there are no dams and have different structure and properties, which changes their classification - Haplic Arenosols (Eutric). The main diagnostic feature that distinguishes drained soils of floodplains from the alluvial ones is the absence of sedimentation. The cumulative balance of the substances, formed by periodic changes of flooding and flood waters dissipation, is replaced by the regime of capillary- soil saturation, and then completes departure of profile from groundwater with the development of flushing (automorphic) soil formation. The soil profile becomes more powerful with better differentiation of genetic horizons. Unlike in alluvial soil the roots run through humus horizons with a distinct shift to lower horizons. However, without annual inflow of big organic-mineral river material the soils become thickened and destructed. The slowed filtration processes cause a lack of air in the layers full of roots. The increase of acidity in the drained soils is accompanied by the decrease in soil bases (Table 1), which provided the flushing regime is intensified can lead to poor access of nutrients to plants.

Table 1: Properties of turf soils of natural reclaimed floodplains of the foothill part of the river Tysa; Note: pH (H2O) - actual acidity, pH (KCl) - exchange acidity H - hydrolytic acidity; V - degree of saturation by the bases.

Indicator and depth (cm) of horizon	pH (H_2O)	Humus , %	H	Ca	Mg	V, %
			mg * ekv /100 g of soil			
Alluvial turf soil (Haplic Fluvisols (Eutric Arenic)) of the natural floodplain						
Hp, 2-8	6.8	2.48	0.35	12.0	4.8	97.96
P, 8-50	6.9	1.88	0.30	10.0	3.2	97.78
Turf soil (Haplic Arenosols (Eutric)) of the reclaimed floodplain						
H, 2-23	6.4	2.41	0.65	9.2	4.1	95.34
HP, 23-42	6.4	0.81	0.45	8.4	3.0	96.20
P, 42-59	6.1	1.68	0.83	11.0	6.2	95.40

In the places where levees are absent or are far away from the riverbed the flood waters carry smaller factions to the heart of the floodplain. Flood water is trapped in the lower places for a longer time compared to other areas of the floodplain, and provides an active accumulation of fine-grained, loamy, and rich in organic and mineral substances river silt on the soil surface. Under these conditions, alluvial meadow-bog soils Gleyic Mollic Fluvisols (Eutric Siltic) are formed. Transformation of plant residues takes place under variable aerobically-anaerobic conditions which intensify humification of organic matter and its accumulation in the form of coarse-grained humus horizon with traces of gleyzation. When it comes to alluvial meadow-bog soils this horizon is well humificated, up to 25 cm with a gradual, not clearly marked transition to lower horizons. According to the grain-size properties the alluvial meadow-bog soils are defined as loamy dusty ones. Similar to other types of alluvial soils, the upper humus horizons of meadow-bog soils are characterized by a correlation of grain-size fractions through participation in river silt soil formation. Among the clay fractions, coarse and fine dust fractions dominate, their share varies from 24% to 32%.

Acidification of the studied soils is a result of intensive development of gleyzation processes when organic compounds with acidic properties are formed. Therefore, humus horizons of alluvial meadow-bog soils are characterized by medium acid reaction of soil solution. Calcium predominates among the cations in the absorbing complex of the studied soil, it accounts for 69-73% of exchange bases (Tab. 2). The dominance of calcium in the absorbing complex is due to the high content of this element in silt and its low ability to leave the absorbed state.

Table 2: Properties of meadow-bog soils of natural and reclaimed floodplains of the foothills of the river Tysa.

Indicator and depth (cm) of horizon	pH (H_2O)	Humus , %	H	Ca	Mg	V, %
			mg * ekv /100 g of soil			
Alluvial meadow-bog soil (Gleyic Mollic Fluvisols (Eutric Siltic)) of natural floodplain						
Hd, 0-6	5.1	6.25	4.56	23.4	8.9	87.63
Hgl, 6-22	5.0	4.62	4.50	23.0	9.0	87.67
Phgl, 22-42	4.3	3.00	5.68	23.0	9.0	84.93
Meadow-bog soil (Protohistic Umbric Gleysols (Distric Siltic)) of reclaimed floodplain						
Hт(gl), 7-19	4.0	4.21	12.46	2.8	2.1	28,23
Hpgl, 19-42	3.8	3.27	15.65	3.0	2.6	26.35
Phgl, 42-68	4.0	0.95	10.61	3.6	3.0	38.35
PGl, 68-85	3.9	0.57	10.76	4.7	3.2	42.34

A significant transformation of soil properties of reclaimed floodplain causes the changes in the direction and intensity of soil formation process and thus the change of the soil type of to Protohistic Umbric Gleysols (Distric Siltic). There is a significant deterioration of water-physical and physical-chemical properties in drained soils due to the cessation of silt flow and gleyzation of entire soil thickness. The processes of primary organic humification are slowed and humus horizons get the traces of turf. Compared with natural floodplain soils, the investigated soils are characterized by significantly higher exchange and hydrolytic acidity, lower content of humus and catastrophic drop in the content of exchange cations in the absorbing complex. Thus, the soils of reclaimed floodplain are characterized by unfavorable conditions for the functioning of most plant communities. High exchange and hydrolytic acidity lead to weakening of microbiological activity, slowing the process of mineralization of organic residues down, worsening of plant nutrients supply. Hence, it has important limitative influence on the development of most vascular plants, because the solubility of aluminum and magnesium compounds to concentrations that are toxic for plants increases under such conditions. Obviously, specific plant communities, where groups of acidophilic species dominate, develop in the studied soils.

On the reclaimed areas, the processes of soil formation and functioning are being changed and sometimes they are irreversible. Investigation of acquired characteristics and diagnostic parameters enable us to talk about the loss of alluvial properties by reclaimed soils and change in their type

CONCLUSIONS

Alluvial deposits (silt) that are annually accumulated in the floodplain of the Tysa river is organic and mineral substance, which is characterized by high heterogeneity, directs the soil formation in the floodplains of rivers and is an important factor in the functioning of floodplain ecosystems. Being sorted by river currents and redeposited in different floodplain areas, they are actively involved in soil formation processes. Optimal and balanced conditions for biota development are formed in such alluvial soils. Large-scale hydro melioration measures violate internal groundwater regimes creating specific obstacles for the soil ecosystem. Soil balance restoration is a long process that is accompanied by the elaboration of adaptive mechanisms to overcome stress in human altered soil environment by certain groups of biota.

Having compared the properties of alluvial and reclaimed soils, we can estimate the depth of indirect anthropogenic transformation of the latter and determine the natural and anthropogenic soil formation.

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THE CONTRIBUTIONS OF THE BOTANISTS ARTUR COMAN AND ADÁM BOROS TO THE KNOWLEDGE OF THE BRYOPHYTES OF THE MARAMUREŞ AREA (ROMANIA) - II

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ABSTRACT

In this paper we continue the results' presentation of the research upon the bryophytes identified by the two botanists, the travels made together and those gathered by A. Coman and sent for determination to Boros A. from the Maramuresului Depression and the surrounding mountains between 1947 and 1970. This paper refines the bryophytes species published by the author in a paper about Rodnei Mountains (2010) and about Vişeului Defile (2011).

This material includes species, subspecies and varieties, some of which are of great scientifical importance, like: *Aloina rigida, Andreaea rupestris, Aulacomnium palustre, Isopterygium elegans, Polytrichum formosum, Polytrichum ştefureachii, Schistostega pennata, Sphagnum magellanicum and Tortella tortuosa*.

ZUSAMMENFASSUNG: Der Beitrag der Botaniker Artur Coman und Ádam Boros zur Kenntnis der Moosflora der Maramuresch (Rumänien) - II.

In vorliegender Arbeit werden die weiteren Forschungsergebnisse zu den Moosen mitgeteilt, die die beiden genannten Botaniker während gemeinsamer Geländearbeiten zwischen 1947-1970 im Gebiet der Maramuresch Senke und den umgebenden Gebirgen gesammelt haben. Hinzu kommen die Moosbelege, die allein von A. Coman gesammelt und an Á. Boros zur Bestimmung eingesandt wurden. Die Arbeit vervollständigt die Angaben zu den von der Verfasserin über das Rodna-Gebirge (2010) und die Klamm von Vişeu (2011) veröffentlichten Moosarten.

Das Material umfasst Arten, Unterarten und Varietäten, von denen einige eine herausragende wissenschaftliche Bedeutung haben. Zu ihnen gehören: *Aloina rigida, Andreaea rupestris, Aulacomnium palustre, Isopterygium elegans, Polytrichum formosum, Polytrichum ştefureachii, Schistostega pennata, Sphagnum magellanicum* und *Tortella tortuosa*.

REZUMAT: Contribuţia botaniştilor Artur Coman şi Boros Ádám la cunoaşterea briofloreі Maramureşului (România) - II.

În această lucrare continuăm prezentarea rezultatelor cercetărilor despre briofitele identificate de cei doi botanişti, din deplasările făcute împreună şi a celor adunate de A. Coman trimise pentru determinare lui Á. Boros, din Depresiunea Maramureşului şi din munţii înconjurători între anii 1947-1970. Lucrarea completează specile de briofite publicate de autoare într-o lucrare despre Munţii Rodnei (2010) şi despre Defileul Vişeului (2011).

Acest material cuprinde specii, subspecii şi varietăţi, unele dintre ele au o împortanţă ştiinţifică deosebită, cum sunt: *Aloina rigida, Andreaea rupestris, Aulacomnium palustre, Isopterygium elegans, Polytrichum formosum, Polytrichum ştefureachii, Schistostega pennata, Sphagnum magellanicum* şi *Tortella tortuosa*.

INTRODUCTION

La învitaţia lui A. Coman, cei doi botanişti au efectuat timp de doi ani consecutiv deplasări în Maramureş. În anul 1962 între datele de 17 – 20 oct. au efectuat cercetări briologice în zona vulcanică, pe platoul vulcanic în împrejurimile locurilor Mara, Crivin, Staţiunea Izvoarele, Poana Brazilor, Cheile Tătarului, Valea Runcului. La data de 29 iul. 1962 au efectuat cercetări şi în Defileul Râului Vişeu, rezultatele acestora se găsesc într-o lucrare publicată (Béres, 2011).

MATERIAL AND METHODS

În cadrul studiului la aceasta lucrare am folosit urmatoarele materialele şi metode dupa cum urmează:

- studierea bibliografiei
- inventarierea briofitelor din Muzeul Maramureşului, Sighetu Marmaţiei
- deplasare la Muzeul Botanic din Budapesta şi studierea Herbarului Boros Ádám
- studierea corespondenţei cu A. Coman şi jurnalul de teren (manuscris) al briologului maghiar Boros Ádám referitor la Maramureş
- elaborarea listei brofitelor în ordinea alfabetică cu nomenclatura originală folosită de Boros Á. şi cu completarea datelor de la A. Coman referitoare la locul, altitudinea, expoziţia văii sau a versantului unde au existat aceste date
- abreviaţiunile folosite la elaborarea lucrării: cu aster, în paranteză cu anul publicării şi paginaţia sunt reprezentate speciile deja publicate de Boros, care au fost colectate în comun de cei doi botanişti, în rest sunt folosite aceleaşi abreviaţiuni ca în prima parte a comunicării noastre.

RESULTS AND DISCUSSIONS

În continuare prezint lista briofitelor:

Acrocladium cuspidatum (Hedw.) Lindb.
- Sălişte, val. Slatinei, 07.06.1961
- Săpânţa, Poiana Săpânţei, 23.05.1963
- Sighetu Marmaţiei, Făget, în loc mlăştinos, 19.05.1961
- Giuleşti – Berbeşti, Bubila, 03.07.1963

Aloina rigida (Hedw.) Kindb.
- Petrova, Chicera, alt. 351 m., 15.11.1959

Amblystegium serpens (Hedw.) Schimp.
- Vişeu de Jos, val. Morii, alt. 505 m., 09.08.1949
  Vişeu de Jos, în comună, alt. 458 m., 05.05.1951

Amblystegium varium (Hedw.) Lindb.
- Sighetu Marmaţiei, Agriş, alt. 800 m., în pădure de fag, 23.08.1963

Andreaea rupestris Hedw. var. *alpestris* (Thed.) Scharp.
- Deseşti - Mara, val. Runcului, 18.10.1962

Anisothecium palustre (Dick.) Hay.
- Giuleşti, mlaştina Poiana Brazilor, 18.10.1962

Anomodon attenuatus (Hedw.) Hüben
- Deseşti - Mara, val. Runcului, în pădure de fag, 17.10.1962
- Săpânţa, mlaştina Jilerescu, pe muşuroaie, 17.10.1961
- Sighetu Marmaţiei, sub Munţii Piatra, în păduri de fag, alt. 850 m., 23.08.1963
  Sighetu Marmaţiei, Agriş, alt. 800 m., 23.08.1963
- Vişeu de Jos, Danova, alt. 441 m., exp. N., 05.05.1951

- Vişeu de Jos, val. Porcului, alt. 475 m., exp. E., 01.08.1952

Anomodon viticulosus (Hedw.) Hook. et Teyl.

- Borşa, val. Ţibăului, în val. Lelici, alt. 1158 m., exp. E., pe calcar, 31.05. – 01.06.1950
- Sighetu Marmaţiei, Agriş, în păduri de fag, alt. 800 m., 23.08.1963
- Vişeu de Jos, val. Liţei, alt. 466 m., exp. E., pe piatră sub carpeni, 12.07.1949

Atrichum angustatum (Bruch) Scimp.

- Săpânţa, în zonă, 23.05.1961

Atrichum undulatum (Hedw.) P. Beuw.

- Sighetu Marmaţiei, Dl. Dobăieşi, pe pământ, 16.06.1962
- Sighetu Marmaţiei, sub Munţii Piatra, în păduri de fag, alt. 850 m., 23.08.1963

Aulacomnium palustre (Hedw.) Schwägr.

- Borşa, val. Ţibăului, în Codreaua, mlaştină, alt. 1096 m., exp. E., 31.05 – 01.06.1950 şi alt. 1097 m., exp. N., 31.05. – 01.06.1950
- Deseşti - Hoteni, Balta- tinov, 20.08.1960 şi 23.05.1961
- Dragomireşti, Dumbrava, alt. 470 m., exp. N., 09.03.1959
- Ieud, val. Slatinei, la grădina Roşanului, alt. 368 m., exp. SE, 03.06.1953
- Săpânţa, mlaştina Jilerescu, 23.05.1961

Barbula convolute Hedw.

- Ruscova, Chernesschii, alt. 456 m., exp. S., 23.04.1955

Barbula fallax Hedw.

- Petrova, Chicera, alt. 351 m., exp. E., 15.11.1958

Barbula hornschiana Schultz.

- Vişeu de Sus, gura văii Rea, alt. 536 m., exp. S., pe stânci, 25.04,1950

Barbula unguiculata Hedw.

- Sălişte, lângă râul Iza, în jos de comună, alt. 452 m., exp. N., 21.12.1952

Bartramia oederi (Gunn.) Sw.

- Borşa, Mt. Cearcănu, alt. 1656 m., exp., S., 25.06.1950
  Borşa, val. Ţibăului, pe mal, alt. 980 – 1008 m., exp. E., 02.-03.07.1960
  Borşa, val. Lelici, Pe stânci calcaroase umede, alt.1101 m., exp. S., 31.05. – 01.06.1950 şi alt. 1090 m., exp. S., 02 – 03.07.1960

Bazzania tricrenata (Wahl.) Trev.

- Borşa, val. Ţibăului, Lelici, pe calcar într-o peşteră umedă, alt. 1097m.,31.05.1950
- Vişeu de Jos, Zăvoiu Mare, alt. 448 m., 15.08.1950

Bazzania trilobata (L.) Gray

- Deseşti - Mara, în sat, 19.10.196

Blasia pusilla L.

- Vişeu de Jos, val. Morii, pe sol argilos, alt. 487 – 500 m., exp. N.,17.10.1957 * (1967, pp.218)
- Vişeu de Sus, Gurguiata, alt. 602 m., exp. NE., 17.10.1957 * (1967, pp.218)

Blepharostoma trichophyllum (L.) Dum.

- Borşa – Baia Borşa, pe piatră, alt. 852 m., exp. N., 26.05.1954

Brachytecium populeum (Hedw.) B.S.G.

- Bistra – Valea Vişeului, lângă tunel, 21.10.1962
- Vişeu de Sus – Vişeu de Mijloc, val. Pupezei, alt. 601 m., exp. NV., 21.09.1948
- Vişeu de Jos, în comună, alt. 458 m., 21.09.1951
- " " val. Cuhei, alt. 443 m., exp. V., 05.05.1951

Brachytecium rivulare (Brach) B.S.G.
- Bocicoiu Mare – Satul Tisa, păşunea comunală în mlaştină, 23.08.1961
- Budeşti, izvorul Călinei, în turbă, alt. 891 m., exp. N., 16.07.1970

Brachytecium rutabulum (Hedw.) B.S.G.
- Ocna Şugatag – Hoteni, Balta, mlaştină alt. 500 m., 18.04.1950
- Rona de Sus – Coştiui, Jidicea, păduri de fag, 25.08.1963
- Ruscova, Vivodni, alt. 956 m., exp. V., 30.04.1955
- Sălişte, val. Găleata, alt. 481 m., exp. N., 21.04.1953
- Vişeu de Sus - Vişeu de Mijloc, val. Pupezei, alt. 601 m., exp. NV., 21.09.1948
  Vişeu de Sus - Vişeu de Mijloc, val. Morii, alt. 501 m., exp. V., 30.10.1947

Bryoerythrophyllum recurvirostrum (Hedw.) Chen
- Vişeu de Jos, val. Liberului, alt. 430 – 455 m., exp. N., 06.07.1949

Bryum argenteum Hedw.
- Dragomireşti, izvorul Baicu, la Lespedea lângă pârâu, 10.12.1947
- Sighetu Marmaţiei, pe piatră, 17.09.1962
- Vişeu de Sus, în oraş, alt. 502 m., 10.12.1947

Bryum Duvalii Voit.
- Vişeu de Sus, Dl. Balmoş, alt. 631 m., exp. S., în mlaştină, 23-25.04.1950

Bryum Weigelii Spreng.
- Vişeu de Sus, Dl. Balmoş, alt. 631 m., exp. S., 23 – 25.04.1950 * (1967, pp.239)

Bryum ventricosum Diks.
- Borşa, Mt. Cearcăn, în apă pe roci calcaroase, alt. 1415 m., exp. S., 25.06.1950
- Budeşti – Breb, La Seci, sfagnet, alt. 800 m., 25.08.1960
- Vişeu de Sus, la malul râului Vişeu, alt. 581 m., exp. N., 13.05.1953

Calliergon cordifolium (Hedw.) Warnst.
- Dragomireşti, Dumbrava, alt. 462 m., exp. N., 17.06.1953

Calliergon cuspidatum (L.) Kindb.
- Borşa, val. Ţibău, Codreaua în turbă, alt. 1100 m., exp. E., 31.05 – 01.06.1950
- Petrova, râturi după dealuri, alt. 397 m., exp. S., 19.05.1953
- Săliște, în comună lângă râul Iza, alt. 451 m., exp. N., 21.12.1952
- Săliște gura văii Basarab, în val. Drăguiasa, alt. 468 m., exp. V., 12.09.1953
- Vişeu de Jos, Mociara Mare, alt. 473 m., pe sol, 04.05.1951
- Vişeu de Jos, Zăvoiu Mare, alt. 443 m., 30.06.1952
- Vişeu de Sus, Făget, 1105 m., exp. S., 10-13.09.1948

Calliergon stramineum (Dicks.) Kindb.
- Deseşti – Mara, Poiana Izvoarelor, alt. 900 m., 17.10.1963 *(1967, pp.243)
- Giuleşti, Poiana Brazilor, pe turbărie, alt. 1100 m., 18.10.1962 *(1967, pp.243)
- Berbeşti, Bubila, *(1967, pp.243)
- Vişeu de Sus – Vişeu de Mijloc, val. Pupezei, alt. 601 m., exp. NV., 21.09.1948

Calypogeia neesiana (Mass. Et Car.) Müll. Frib.
- Deseşti – Cheile Tătarului, până la Staţiunea Izvoarele, alt. 900 m., 19.10.1962 * (1957, pp. 226)
- Giuleşti, Poiana Brazilor, molidet mlăştinos, alt. 1100 m., 18.10.1962 *(1967, pp. 226)

Camptothecium sericeum (L.) Kindb.
- Borşa, Lelici, alt. 1120 m., exp. E., pe stânci calcaroase, 02-03.07.1960
- Petrova, Chicera, E., alt. 351 m., exp. E., 15.11.1958

Catharinea Haussknechtii (Jur. Et Milde) Broth.
- Vişeu de Sus – Vişeu de Mijloc, val. Pupezei, alt.598 m., exp. NV şi 602 m., 21.09.1948

Catharinaea undulata (L.) W. et M.

- Deseşti – Mara, Pod Cireş, 18.10.1962
- Ieud, Muncei, alt. 1056 m., exp. S., 15.05.1958 *(1967, pp. 250)
- Moisei, pădurile din val. Rea, alt. 602 m., exp. N., 31.05.1953
- Sighetu Marmaţiei, Dl. Dobăieşi, lângă pârâul Ronişoara, 13.05.1960
- Vişeu de Jos, Dealuţ, alt. 596 m., exp. N., 05.05.1958 *(1967, pp. 250)
- Vişeu de Sus, în oraş, Str. Cimitirului, sub cimitirul romano – catolic, alt. 543 m., exp. S., 19.10.1953
- Vişeu de Sus, Făget, alt. 1297 m., exp. S., pe gol de munte, 10-13.09.1948
- Vişeu de Sus, Vişeu de Mijloc, val. Pupezei, alt. 501 m., exp. NV., 21.09.1948 *(1967, pp. 250)

Ceratodon purpureus (L.) Brid.

- Borşa, Mt. Cearcănu, alt. 1656 m., exp. S., pe stânci calcaroase, 25.06.1950
- Borşa, Codreaua, alt. 1075 m., exp. E., 02-03.07.1960
- Borşa, Baia Borşa, val. Fătăciunii, alt. 803 m., exp. NC., 13.06.1959
- Borşa, Baia Borşa, Piatra Băiţei, alt.817 m., exp. V., 29.05.1949
- Borşa, Baia Borşa, Sacu, alt., 801 m., exp. SE, 26.05.1954
- Ieud, Muncel, alt. 801 m., exp. NV., 27.06.1955, şi var. *conicus,*
- Moisei, pădurile din val. Rea, alt. 602 m., exp. N., 31.05.1953
- Petrova, Burzucău, alt. 406 m., exp. E., 19.05.1953
- Repedea, Mt. Petriceaua, alt. 1217 m., exp. SV., 17.061957
- Rozavlea, Raşco, alt. 983 m., exp. SV., 21.07.1949
- Ruscova, Dumbrava, alt. 457 m., exp. S., 06.05.1954
- Ruscova, Dealul Lung, alt. 462 m., exp. S., 29.05.1955
- Ruscova, Lujana, alt., 441 m., 23.04.1955
- Sălişte, Buleasa, alt. 562 m., exp. V., 17.04.1953
- Săpânţa, Cascada Şipot, 23.05.1961
- Sighetu Marmaţiei, lângă podul Ronişorii, 16.05.1961
- Vişeu de Jos, în comună pe lemn putred, alt. 458 m. 03.05.1951
- Vişeu de Jos, în comună pe acoperişul unei case, alt. 458 m., 26.03.1951
- Vişeu de Jos, val. Liberului, alt. 430 – 455 m., exp. N., 06.07.1949
- Vişeu de Sus, faţa Alacului, alt. 802 m., exp. S., 15.05.1953
- Vişeu de Sus, în oraş, alt. 501 m., pe piatră, 15.05.1953
- Vişeu de Sus, val. Grebenului, alt. 796 m., exp. SE., 13-17.09.1948

Chyloscyphus pallescens (Ehrh.) Dum.

- Vişeu de Jos, val. Liberului, alt. 430 – 455 m., exp. N., 06.07.1949
- Vişeu de Jos, val. Morii, alt. 501 m., exp. V., 30.10.1947

Chiloscyphus polyanthus (L.) Corda

- Giuleşti, Tăul Negru tinov, alt. 1100 m., în turbrie, 29.07.1961
- Sarasău, Cioatele lui Ştern, mlaştină cu turbă, alt. 450 m., 30.07.1961
- Vişeu de Jos, val. Liţei, alt. 469 m., exp. E., lângă sol pe trunchi de Carpinus sp., 12.07.1949

Chrysohypnum calcareum (Crunw. et Nyholm) Boros

- Vişeu de Jos, val. Liţei, pe piatră de sub un Carpinus sp., alt. 468 m., exp. E., 12.07.1949
- Vişeu de Jos, val. Morii, alt. 499 m., exp. V., 11.10.1949

Chrysohypnum stellatum (Schreb.) Loeske

- Vişeu de Sus – Vişeu de Mijloc, val. Vinului, alt. 538 m., exp. V., în loc mlăştinos, 11.04.1958
- Vişeu de Jos, val. Liţei, alt.466 m., exp. E., pe piatră sub Carpinus sp., 12.07.1949

Cinclidotus minor (L.) Lindb.

- Vişeu de Sus – Valea Vişeului, în apa râului Vişeu abundent mai sus de tunel, 19-21.10.1962. *(1964, pp. 552; 1967, pp. 237)

Cinclidotus nigricans (Brid.) Loeske

- Vişeu de Sus – Valea Vişeului, în apa râului Vişeu lângă tunel, alt. 350 m., 21.10.1962 *
- (1964, pp. 552: 1967, pp. 237)

Climacium dendroides Web. et Mohr.

- Bogdan Vodă, Dl. Raşchii, alt. 613 m., exp. V., 21.11.1952
- Borşa, val. Ţibăului pe Codreaua în turbărie, alt. 1097 m., exp. E., 31.05.10.1962
- Borşa, val. Ţibăului, în pădure, alt. 1002 m., exp. NE., pe stânci umede, 31.05 – 01.06.1950
- Borşa, Mt. Cearcănu, alt. 1256 m., exp. V., 25.06.1950
- Borşa – Baia Borşa, Piatra Băiţei, alt. 817 m., exp. V., 29.05.1950 şi alt.757 -795 m., exp. V. pe stânci umede 20
- Câmpulung la Tisa, Mociara, 14.05.1962
- Dragomireşti, Preluca, alt. 532 m., exp. E., 27.11.1952
- Leordina, la podul C.F.R., alt. 427 m., 01.04.1954
- Sălişte, Păltiniş, alt. 987 m., exp. NE., 17.09.1954
- Vişeu de Jos, val. Preotesei, alt. 453 m., exp. V., 26.10.1955
- Vişeu de Jos, Mt. Maxim, alt. 1131 m., exp.S., pe un fag, 16.09.1949
- Vişeu de Sus, val. Liberului, alt. 430 – 455, exp. N., 06.07.1949
- Vişeu de Sus, val. Venişului, alt. 716 m., exp. N., 30.08.1949
- Vişeu de Sus - Vişeu de Mijloc, Zăvoiu Mare, pe prund lângă râul Vişeu, alt. 479 m., 12.07.1949
- Vişeu de Sus - Vişeu de Mijloc, val. Pupezei, alt. 605 m., exp. NV., 21.09.1948
- Vişeu de Sus - Vişeu de Mijloc, val. Peştilor, alt. 603 - 652 m., exp. N., 22.10.1953

Conocephalum conicum (L.) Lindb.

- Bistra, gura văii Topolău, alt. 633 m., exp. N., 01.12.1958
- Sălişte, val. Găleata, alt. 486 m., exp. N., 21.04.1953 şi alt. 512 m., exp. NV.
- Sighetu Marmaţiei, sub Mţii Piatra la cascadă, 20.08.1960 şi în păduri de fag, alt. 900 m.
- Sighetu Marmaţiei, în oraş în loc umbros, 11.06.1960
- Vişeu de Sus, val. Liberului, alt., 430 – 455 m., exp. N., 06.07.1949
- Vişeu de Sus, Mt. Greben, alt. 1317 m., exp. S., 07-08.07.1947

Cratoneurum commutatum (Hedw.) Moenk.

- Borşa, Mt. Cearcănu, alt. 1415 m., exp. S., în apă pe roci calcaroase, 20.-25.06.1950
- Borşa, val. Chindric în Priseci, alt. 937 m., exp. N, în apă, 10.06.1950
- Borşa, val. Ţibăului, în Lelici, alt. 1158 m., exp. E., pe stânci calcaroase, 31.05 – 01.06.1950
- Dragomireşti, val. Baicu, mai jos de ciuroi, alt. 502 m., exp. S., 14.09.1957
- Poienile de Sub Munte, sub Mt. Paltin în vale, alt. 801 m., exp. S., 07-08.06.1947
- Ruscova, Tătârlaua, alt. 652 m., exp. S., 30.05.1955

Cratoneurum filicinum (Hedw.) Roth.

- Sighetu Marmaţiei, Iapa-Cioncaş, într-un loc mlăştinos, 30.07.1961
- Sighetu Marmaţiei, sub Mţii Piatra, alt. 850 m., în păduri de fag, 23.08.1963

Ctenidium molluscum (Hedw.) Mitt.

- Ruscova, alt. 467 m., exp. N., 02.05.1955

Dichodontium pellucidum (L.) Schimp.
- Moisei, Lazuri, alt. 933-936 m., exp. N., 23-27.07.1948
- Vişeu de Sus – Vişeu de Mijloc, val. Pupezei, alt. 602 m., exp. NV., 21.09.1949

Dicranella cerviculata (Hedw.) Schimp.
- Giuleşti, Poiana Brazilor tinov, alt. 1010 m., 18.10.1962 *(1967, pp. 230)

Dicranella palustris (Dicks.) Crunw.
- Giuleşti, val. Brazilor, alt. 900 – 1000 m., 18.10.1962 *(1967, pp. 229)
- Mara, Poiana Izvoarele, alt. 900 m., 17-19.10.1962 *(1967, pp. 229)

Dicranella rubra Lindb.
- Vişeu de Sus – Vişeu de Mijloc, val. Peştilor, alt. 676 m., exp. E., 22.10.1953

Dicranella rufescens *Dick.(Schimp.
- Deseşti – Mara, val. Runcului, alt. 700 – 800 m., 18-19.10.1962 *(1967, pp.230)
- Vişeu de Sus, Str. Cimitirului, în cimitirul romano-catolic, alt. 545 m., exp. S., 19.10.1953

Dicranella squarrosa (Starke) Schimp.
- Giuleşti, val. Brazilor, sfagnet, 18.10.1962

Dicranoweisia crispula (Hedw.) Lindb.
- Borşa, Mt. Cearcănu, alt. 1500 m., exp. SV., pe stânci calcaroase, 25.06.1950

Dicranum fuscescens Turn.
- Borşa, val. Fătăciunii, Preluca lui Holici, alt. 941 m., exp. E., 16 – 19.05.1950

Dicranum longifolium Ehrh.
- Borşa – Baia Borşa, Piatră Băiţei, alt. 852 m., exp. N., 26.05.1954
- Moisei, Lazuri, alt.927 m., exp. N., 23 – 27.07.1948
- Sighetu Marmaţiei, sub Mţii Piatra, alt.1001 m., exp. NE., 04.08.1958
- Sighetu Marmaţiei, Lespezi, în păduri de fag, 22.06.1962
- Sighetu Marmaţiei, Piatra Ţiganului, alt. 1220 m., exp. N., pe stânci, 30.07.1960
- Vişeu de Sus – Vişeu de Mijloc, val. Pupezei, alt. 601 m., exp. NV., 21.09.1948

Dicranum Starkei W. et M.
- Borşa, Mt. Cearcănu, alt. 1215 m., exp. S., pe stânci calcaroase, 25.06.1950
- Borşa, Lelici, alt. 1100 m., exp.S., printer stânccării calcaroase, 02-03.07.1960
- Ieud, în comună, alt. 360 m., exp. NV., lângă biserica de pe deal, 14.06.1955
- Ruscova, alt. 462., exp.N., 03.05.1955
- Sighetu Marmaţiei, Mţii Piatra, alt. 1001 – 1042 m., exp. NE., 24.08.1958
- Sighetu Marmaţiei, sub Mţii Piatra la Agriş, alt. 786 m., exp. E., 24.08.1958
- Vişeu de Jos, val. Liţei, alt.471 m., exp. E., sub un Carpius sp. în pădure pe sol, 12.07.1949

Distichium inclinatum (Ehrh.) B.S.G.
- Borşa, Val. Ţibăului, în val. Lelici, alt. 1100 m., exp. S., în peşteră umedă, 03.04 – 01.06. 1950. *(1967, pp.228)

Distichum montanum Hagen
- Borşa, val. Ţibăului – val. Lelici, alt.1097 m., exp. S., în peşteră umedă, 31.05 – 01.06. 1950 *(1967, pp. 228)
  Borşa, Mt. Cearcănu, alt. 1660 m., exp. S., pe calcar, 25.06.1952

Ditrichum flexicaule (Schleich.) Hpe.
- Borşa, val. Ţibăului, pe malul stâncos umed, alt. 980 m., exp. E., 02-03.07.1960
  Borşa, val. Lelici, pe stânci calcaroase
  Mt. Cearcănu, alt. 1660 m., exp. S., pe calcar, 25.06.1950

- Sighetu Marmaţiei, sub Mţii Piatra, Agriş, alt. 807 m., exp. E., 24.08.1958

Ditrichum pallidum (Schreb.) Hpe.
- Ruscova, Cherneschii, alt. 456 m., exp. S., 23.04.1955

Dolichotheca silesiaca (Selign.) Fleisch.
- Vişeu de Sus – Vişeu de Mijloc, val. Pupezei, alt. 600 m., exp. V.,NV., 21.09.1948

Drepanocladus aduncus (Hedw.) Moenh.
- Ieud, la Iezer, alt. 368 m., exp. S., 09.06.1955
- Rozavlea, Dumbrava, alt. 458 m., exp. V., în mlaştină, 11.10.1952

Drepanocladus fluitans (L.) Warnst.
- Borşa, Cornedei, alt. 1751 – 1753 m., exp. V., 05.07.1958

Encalypta ciliate (Hedv.) Hoffm.
- Borşa, Coasta Plaiului, alt.1256 m., exp. S., 23.04.1955
- Borşa – Baia Borşa, Piatra Băiţei, alt. 830 m., exp. V., 29.05.1949

Encalypta contorta (Wulf.) Lindb.
- Borşa, val. Ţibăului în Lelici, alt. 1096 m., exp. S., pe stânci, 31.05 – 01.06.1953
- Moisei, pădurile din val. Rea, alt. 603 m., exp. N., 31.05.1953

Encalypta vulgaris (Hedw.) Hoffm.
- Borşa, Mt. Cearcănu, alt. 1568 m., exp. NV., 25.06.1950

Entodon Schreberi (Willd.) Moenk.
- Bogdan Vodă, Dl. Raşchii, alt. 610 m., exp. V., 21.11.1952

Eurhynchium zetterstetii P. Stoermer
- Deseşti – Mara, Pod Cireş, 18.10.1962
- Vişeu de Jos, val. Liberului, alt. 430 – 455 m., exp. N., 06.07.1949

Fissidens dubius P. Beauv.
- Vişeu de Jos, Dl. Hăuşului, alt.596 m., exp. SE., 06.09.1952

Fontinalis antipyretica Hedw.
- Borşa, val. Cisla, în apă, exp. S., 18.09.1947 şi 16.05.1950
- Giuleşti, Poiana Brazilor, 18.10.1962

Frullania dilatata (L.) Dum.
- Vişeu de Jos, Dl. Hăuşului, alt.588 m., exp. V., 06.09.1952

Funaria hygrometrica (L.) Sibth.
- Borşa, Cornedei, alt. 1748 – 1753 m., exp. V., 05.07.1958
- Borşa, val. Ţibăului, pe Codreaua, pe sol, alt. 1000 m., exp. S., 31.05 – 01.06.1950
- Borşa, lângă râul Vişeu pe prundiş, 02.07.1949 şi 02-03.07.1960
- Ocna Şugatag – Hoteni, Pietrele Albe, alt. 576 m., exp. V., 26.06.1961
- Repedea, Mt. Petriceaua – Laba, alt. 1213 m., exp. SV., 17.06.1957
- Rozavlea, Gârbova, alt. 386 m., 15.05.1955
- Rozavlea fundul văii Branoului, alt. 406 m., exp. S., 06.05.1953
- Ruscova, Dumbrava, alt. 453 m., exp. S., 27.04.1955
- Săpânţa, Hordău, 23.05.1961
- Sighetu Marmaţiei, Lazu Şesului, 21.05.1970,
- Vişeu de Jos, val. Liberului, alt. 430 – 455 m., exp. N., 06.07.1949
- Vişeu de Jos, Zăvoiu Mare, alt. 448 m., 15.08.1950
- Vişeu de Sus, fundul văii Boului, alt. 925 m., exp. N., 23 – 27.07.1948
- Vişeu de Jos, Gurguiata, alt. 816 m., exp. E., 15.05.1951

Georgia pellucida (L.) Rabenh.
- Moisei, Lazuri, alt. 927-933 m., exp. N., 23 – 27.07.1948
- Săcel, Plai, alt. 856. 27.08.1951

Grimmia alpicola, Sw.
- Deseşti – Mara, Cheile Tătarului, alt.700 m., 19.10.1962 *(1967, pp. 237)

Grimmia apocarpa (L.) Hedw.
- Ocna Şugatag – Breb, laz la Tău, alt. 600 m., sfagnet, 25.08.1960
- Petrova, Chicera, alt. 351 m., exp. E., 15.09.1958
- Rozavlea, Raşca, alt. 950 m., 21.08.1949

Gymnocolea inflata (Huds.) Dum.
- Vişeu de Sus, Preluca Mejdii, alt. 1350 m., exp. V., în mlaştină în apă, 24.07.1951

Hedwigia albicans (Web.) Lindb.
- Bogdan Voda, val. Preotesei, alt. 702 m., exp. E., pe stânci, 03.08.1949

Homalia trichomanoides (Schreb.) B.E.
- Vişeu de Jos, val. Liberului, alt. 430 – 455 m., exp. N., 06.07.1949

Hygramblystegium irriguum (Wils.) Loeske
- Petrova, Burzucău, alt. 407 m., exp. E., 19.05.1953

Hylocomium proliferum (L.) Lindb.
- Bogdan Vodă, Dl. Raşchii, alt. 613 m., exp. V., 21.11.1952
- Săcel, Măgura Săcelului, alt. 1137 m., exp. V., 21.05.1949

Hypnum cupressiforme Hedw.
- Ocna Şugatag – Breb, în comună, 25.08.1960
- Ocna Şugatag, Hoteni, în comună, 20.08.1960
- Vişeu de Jos, Deluţi, alt. 470 m., exp. V., 26.07.1951
- Sighetu Marmaţiei sub Mţii Piatra la Agriş, alt. 800 m., în păduri de fag, 23.08.1963
- var. filiforme Brid. Deseşti – Mara, Pod Cireş, 26.07.1965

Hypnum fertile Sendtn.
- Vişeu de Sus, Dosu Alacului, alt. 963 m., exp. N., 01 03.07.1948 *(1967, pp. 248)

Isopterygium elegans (Hook.) Lindb.
- Deseşti – Mara, Cheile Tătarului, pe stânci de andetit în molidiş, 19.10.1962 *(1967, pp. 246)

Isothecium myurum Brid.
- Sighetu Marmaţiei, Mţii. Piatra, exp. E., păduri de fag, 30.07.1961 şi pe stânci, 22.06.1962

Lepidozia reptans (L.) Dum.
- Borşa, val. Fătăciunii, Preluca lui Halici, alt.941 m., exp. E., 16-19.05.1950.
- Borşa – Baia Borşa, Piatra Băiţei, alt. 852 m., exp. N., 26.05.1954.

Leskella nervosa (Brid.) Loeske
- Deseşti – Mara, val. Runcului, 18.10.1962.

Leucobryum glaucum (L.) Schimp.
- Săliştea, val. Fătăciunii, alt. 882 m., exp. N., 21.10.1949.

Leucodon sciuroides Schäegr.
- Sălişte, lângă râul Iza în jos de comună, alt. 451 m., exp. N., 21.12.1952.
- Vişeu de Jos, Dl. Hăuşului, alt. 596-602 m., Exp. SE., 06.09.1952.

Lophocolea bidentata (L.) Dum.
- Ieud, Poderei, alt. 383 m., exp. N., 07.04.1955.
- Vişeu de Jos, val. Morii, alt. 487-500 m., exp. N., 09.07.1949.

Madotheca laevigata (Schrad.) Dum.
- Deseşti – Mara, val. Runcului, 18.10.1962,

- Vişeu de Jos, val. Liţei, alt. 469 m., exp. E., pe trunchi de Carpinus betulus, 12.07.1949,
- Vişeu de Jos, Dl. Hăuşului, alt. 596-602 m., exp. SE., 06.09.1952.
- Vişeu de Jos, val. Ţimpurilor, alt. 750 m., exp. S., V., 14.04.1959 *(1967, pp.226)

Madotheca platyphylla (L.) Dum.

- Sighetu Marmaţiei, sub Mţii. Piatra, alt. 890 m., în loc umed, 21., 26.08.1961.
  Sighetu Marmaţiei, Cascada Strunga, în mlaştină, 23.08.1963,
- Sighetu Marmaţiei, Agriş, alt. 800 m., în păduri de fag, 23.08.1963.
- Vişeu de Jos, val. Liţei, alt. 469 m., exp. E., pe trunchi de carpen, 12.07.1949,
- Vişeu de Jos, Dl. Hăuşului, alt. 596 m., exp. SE., 06.09.1952,
- Vişeu de Jos, val. Ţimpurilor, alt. 750 m., exp. V., S., 14.04.1959.

Marchantia polymorpha L.

- Bistra, val. Bistra, la gura Topolăului, alt. 604 m., exp. V., 03.10.1948,
- Borşa, Mt. Cearcănu, alt.m1405 m., exp. S., pe calcar, 25.06.1950,
- Ieud, Alior, alt. 861 m., exp. N., în mlaştină, 13.09.1956,
- Leordina, alt. 398 m., lângă gara C.F.R., în mlaştină, 13.05.1950,
- Moisei Izvorul Negru, exp.NE., 21.05.1949,
- Petrova, alt. 372 m., lângă gara C.F.R., 14.01.1961,
- Vişeu de Jos, Zăvoiu Mare, 15.08.1950.
- Vişeu de Sus – Vişeu de Mijloc, fundul văii Boului, alt.925 m., exp. N., 23-27.07.1948,
- Vişeu de Sus, val. Pupezei, alt. 604 m., exp. NV., 21.09.1948.

var. *aquatica* Nees:

- Borşa, Mt. Cearcănu, alt. 1256 m., exp. V., 25.06.1950,
- Borşa, val. Ţibăului, pe Codreanu, alt. 1096 – 1098 m., exp. E, în turfosis, 31.05. – 01.06.1950
  Borşa, Leordina, alt. 398 m., lângă gara C.F.R., în loc mlăştinos, 23.05.1950,
  Borşa, Săpânţa, mlaştina Jilerescu, în apă, 14. şi 24. 07.1961,
  Borşa, Vişeu de Jos, Zăvoiu Mare, alt. 448 m., 15.08.1950,

subsp. polymorpha:

- Sighetu Marmaţiei, sub Mţii. Piatra, alt. 900 m., în păduri de fag, 23.08.1963,
- Vişeu de Sus, val. Pupezei, alt. 604 m., exp. NV., 21.09.1948,
- Vişeu de Sus, fundul văii Boului, alt. 925 m., exp. N., 23-27.07.1948.

Marsupella emarginata (Ehrh.) Dum.

- Deseşti – Mara, Cheile Tătarului, alt. 700 m., pe stânci de andezit, 19.09.1962

Metzgeria conjugata Lindb.

- Deseşti, - Mara, Cheile Tătarului, alt. 700 m., pe stânci de andezit, 19.09.1962.

Metzgeria furcata (L.) Dum.

- Vişeu de Jos, val. Morii, alt. 517 m., exp. N., 09.07.1949.

Metzgeria pubescens (Schr.) Rodii

- Moisei, alt. 602 m., exp. N., păduri la izvorul pârâului Rea, 31.05.1953.

Mnium cuspidatum Hedw.

- Vişeu de Jos, val. Morii, alt. 487-500 m., exp. N., 09.07.1949.

Mnium medium B.S.G.

- Budeşti, Izvorul Călinei, alt. 891 m., exp. N., în turbărie, 16.07.1970.

Mnium punctatum (L.) weiss

- Borşa, Lelici, alt. 1095 m., exp. S., între stânci calcaroase, 02-03.07.1960,
- Budeşti, Izvorul Călinei, alt. 889 m., exp. N., în turbă, 14-17.07.1961,
- Moisei, Lazuri,, alt.986 m., exp. S., şi 1101 m., exp. NE., 23-27.07.1948,
- Săpânţa, mlaştina Jilerescu, alt. 880 m., 14-19.07.1961,

- Sighetu Marmaţiei, Mţii. Piatra, alt. 950 m., liziera pădurii de fag, 23.08.1962,
- Vişeu de Sus, Glimboaca Mare, alt. 1101 m., exp. NE., 01-02.09.1948.

Mnium pseudopunctatum Bruch et Schimp.

- Sighetu Marmaţiei, Dl. Solovan, 10.07.1961.

Mnium rostratum Schrad.

- Borşa, val. Ţibăului, alt. 980 m., exp. NV., malul râului pe stânci umede, 02-03.07.1960
- Vişeu de Sus, val. Pupezei, alt. 603 m., exp. NV., 02-03.07.1960.

Mnium seligeri Jur.

- Borşa, val. Ţibăului în Codreaua, alt. 1096 m., exp. E., în mlaştină, 31.05-01.06.1050.
- Moisei, val. Rea, alt. 606 m., exp. N., 31.05.1953
- Vişeu de Jos, Mociara Mare, alt. 483 m., pe sol, 04.05.1951.

Mnium undulatum Hedw.

- Giuleşti – Berbeşti, Bubila, alt. 750 m., exp. NE, 17.07.1961,
- Ocna-Şugatag – Hoteni, în sat, 20.08.1960,
- Rona de Sus - Coştiui, Jidicea, păduri de fag, 15.08.1963,
- Ruscova, Str. Mociarului, alt. 455 m., exp. N., 29.04.1955,
- Sighetu Marmaţiei, Dl. Dobăieşi, exp. V., 19.08.1960,
- Sighetu Marmaţiei, sub Mţii. Piatra, în pădure, 27.07.1961,
- Vadul Izei – Valea Stejarului, pe coastă, 27.07.1961,
- Vişeu de Jos, Podinoace, alt. 486 m., exp. N., 05.07.1949,
- Vişeu de Jos, val. Morii, alt. 466 m., exp. V., 11.08.1959.

Nardia scalaris Gray.

- Borşa, Cornedei, alt. 1753 m., exp. V., 05.07.1958.

Neckera complanata (Hedw.) Hüb.

- Vişeu de Jos, val. Liţei, alt. 468 m., exp. E., pe sol în pădure de carpen, 12.07.1949,
- Vişeu de Jos, val. Morii, alt. 508 m., exp. S., loc umbros, pe scoarţa de carpen, 13.07.1949.

Neckera crispa (L.) Hedw.

- Borşa, val. Ţibăului, alt. 1008 m., exp. NE., pe stâncă umedă, 31.09.1950,
- Borşa, Lelici, alt. 1156 m., exp. E., pe roci calcaroase, 31.05. – 01.06.1950,
- Sighetu Marmaţiei, sub Mţii. Piatra, alt. 900 m., în pădure de fag, 23.08.1963.

Neckera pennata Hedw.

- Sighetu Marmaţiei, sub Mţii. Piatra, alt. 900 m., păduri de fag, 23.08.1963.

Oligotrichum montanum (Hedw.) var. *pulvinatum* Pleff.

- Deseşti – Mara, Poarta Roşie, 18.10.1962.

Pellia epiphylla (L.) Lindb.

- Sighetu Marmaţiei, sub Mţii. Piatra, alt. 900 m., păduri de fag, 21.06.1962 şi 23.08.1963

Pellia fabbroniana Roddi

- Breb, La Seci, alt. 800 m., sfagnet, 25.08.1960,
- Deseşti – Hărniceşti, sub Mţii. Piatra, în apă, 21.06.1962,
- Petrova, val. Neadră, alt. 414 m., exp. S., 18.08.1959,
- Săcel, Măgura Săcelului, alt. 1108 m., exp. V., 21.05.1949,
- Săpânţa, mlaştina Jilerescu, 23.05.1961, Vişeu de Jos, val. Porcului, alt. 474 m., exp. E., 01.08.1952,
- Vişeu de Sus, gura văii Rea, alt. 527 m., exp. E., în apă lin curgătoare, 25.04.1950

Philonotis fontana, Brid.

- Săpânţa, Nireş, 23.05.1961.

Plagiochila asplenioides (L.) Dum.
- Sighetu Marmaţiei, sub Mţii. Piatra, alt. 900 m., păduri de fag, 23.08.1963,
- Vişeu de Jos, val. Liberului, alt. 430-455 m., exp. N., 06.07.1949,
- Vişeu de Jos, val. Morii, alt. 487-500 m., exp. N., 09.07.1949.

var. *major* Nees
- Vişeu de Jos, val. Liberului, alt. 430-455 m., exp. N., pe sol la umbră, 13.07.1949.

Plagiothecium laetum B.S.G.
- Petrova, lângă gara C.F.R., 15.03.1957 *(1967, pp. 248)

Plagiothecium platyphyllum Moenk.
- Sighetu Marmaţiei, Mţii. Piatra, exp. E., păduri de fag, 30.07.1961.
- Plagiothecium succulentum (Wils.) Lindb.
- Vişeu de Jos, val. Morii, exp. N., 07.09.1949 *(1967, pp. 247).

Platyhypnidium riparioides (Hedw.) Dixon
- Giuleşti, mlaştina Poiana Brazilor, 18.09.1962,
- Săpânţa, mlaştina Jilerescu, în apă, 14.08.1961.

Plectocolea hyaline (Lyell) Mitt.
- Moisei, Lazuri, alt. 951 m., exp.N., 23-27.07.1948.

Pogonatum urnigerum (Hedw.) P. Beauv..
- Bocicoiu Mare – Satul Tisa, pârâul Tepliţa, 11.07.1960 şi 21.09.1960
- Borşa, Podul Cearcăn, alt, 1410 m., exp. V., 12.06.1959,
- Mosei, Dl. Traian exp. 19.05.1949,
- Vişeu de Jos, Dl. Hăuşului, alt.596 m., exp.SE., 06.09.1952,
- Vişeu de Jos, val. Liţei, alt. 472 m., exp. E., pe sol în pădure de carpen, 12.07.1949,
- Vişeu de Sus, Ascunsu, alt. 1356 m., exp. SE., 12-13.09.1947,
- Vişeu de Jos, Retitiş, alt. 547 m., exp. N., 14.05.1953.

Polytrichum alpinum Hedw.
- Ocna Şugatag – Hoteni, la Baltă, alt. 600 m., 25.07.1963.

Polytrichum attenuatum Menz.
- Bistra, Poduri, alt. 338 m., exp. S., 19.08.1954,
- Borşa, Codreaua, alt. 1071 m., exp. E., 02-03.07.1960,
- Breb, mlaştina Tăciuneasa, alt. 500 m., 25.08.1960,
- Moisei, Tăul Obcioarei (Fântâna Sferdii), alt. 1026 m., 05.08.1953,
- Moisei, pădurile din val. Rea, alt. 603 m., exp. N., 31.05.1053,
- Ruscova, Dumbrava, alt. 462 m., exp. S., 27.04.1958,
- Vişeu de Jos, val. Morii, alt. 487 m., exp. N., 09.07.1949 şi alt. 500 m., exp. V.,

Polytrichum commune Hedw.
- Breb, mlaştina Tăciuneasa, alt. 700 m., 25.08.1960,
- Budeşti, val. Călinei, alt. 950 m., exp. N., turbărie, 02.07.1968,
- Giuleşti, mlaştina Poiana Brazilor, în turbărie, 18.10.1062,
- Moisei, Tăul Obcioarei, alt. 1026 m., 05.08.1953,
- Vişeu de Sus, Dosul Ascunsului, alt. 1265 m., exp. V., 24.07.1951.

var. *perigonal*e (Hedw.) Berg
- Săpânţa, mlaştina Jilerescu, 23.05.1961.

Polytrichum formosum Hedw.
- Câmpulung la Tisa, Busurat, în pădure de carpen, 14.05.1962.

Polytrichum gracile Smith
- Moisei, Tăul Obcioarei, alt. 1026 m., 05.08.1953,
- Ocna Şugatag – Hoteni, la Baltă, alt. 500 m., în mlaştină, 18.04.1961,

- Vişeu de Jos, alt. 417 m., exp. N., pădurile popii, 18.09.1952,
- Vişeu de Sus, Retitiş, alt. 546 m., exp. N., 14.05.1953.

Polytrichum juniperinum Willd.

- Borşa, Codreaua, alt. 1060 m., exp. N., 02-03.07.1960,
- Ruscova, Dumbrava, alt. 486 m., exp. S., 23.04.1955,
- Sighetu Marmaţiei, Mţii. Piatra, alt. 1053 m., exp. N., 24.08.1958.

Polytrichum piliferum Schreb

- Borşa, Mt. Cearcănu, alt. 1056 m., exp. S., pe calcar, 25.06.1950
- Ocna Şugatag, alt. 508 m., exp. N., păşunea comunei pe muşuroaie, 10.06.1948.

Polytrichum strictum Banks.

- Borşa, Cornedei, alt. 1757 m., exp. V., 05.07.1958,
- Breb, Tăul Sărat, 25.08.1960,
- Deseşti – Hărniceşti, Iezerul Mare, în mlaştină cu turbă, 21.06.1962
- Moisei, Fântâna Sferdii, alt. 1026 m., 05.08.1953,
- Moisei, Tăul Obcioarei, alt. 1086 m., exp. S., 17.07.1948, Ocna Şugatag – Hoteni, la Baltă, alt. 500 m., în mlaştină, 18.04.1961, Poienile de Sub Munte, Tăul Băiţei, alt. 1407 m., exp. V., 03.09.1948,
- Sighetu Marmaţiei, Tăul Negru, pe muşuroi, 22.06.1962.

Polytrichum x ştefureachii Plăm.

- Bocicoiu Mare – Satul Tisa, păşunea comunei, 01.05.1961,
- Săpânţa, Cascada Şipot, 14.07.1961.

Pottia intermedia (Turn.) Fürnr.

- Bogdan Vodă, alt. 378 m., în comună, 13.11.1952,
- Petrova, Chicera, alt. 351 m., exp. E., 15.11.1958,
- Săliştea de Sus, alt. 451 m., exp. N., lângă Iza în jos de comună, 21.12.1952,
- Sighetu Marmaţiei, l’ngă r’ul Iza pe o zidărie de piatră, 18.12.1960,
- Vişeu de Sus – Vişeu de Mijloc, alt. 477 m., în comună pe zid de piatră, 31.03.1951

Preissia quadrata (Scop.) Nees.

- Vişeu de Sus, Usoi, alt. 511 m., exp. N., pe piatră umedă, 25.04.1950,
- Vişeu de Sus – Vişeu de Mijloc, val. Peştilor, a602 m., expp. N., 22.10.1953.

Pterygynandrum filiforme (Timm.) Hedw.

- Deseşti – Mara, val. Runcului, 17.10.1962,
- Vişeu de Jos, val. Morii, alt. 496 m., exp. V., 07.11.1947.

Ptilium crista – castrensis (Hedw.) De Not

- Deseşti – Mara, Cheile Tătarului, 19.10.1962.

Pylaiea polyantha (Schreb.) B.S.G.

- Sălişte, alt. 451 m., exp. N., lângă râul Iza în jos de sat, 21.12.1952,
- Vişeu de Jos, val. Morii, alt. 487-505 m., exp. N., pe Sambucus nigra, 06.11.1947; 09.07.1949; 23.05.1951,
  Vişeu de Jos, Dl. Hăuşului, alt. 596-602 m., exp. SE., 06.09.1952,
  Vişeu de Sus – Vişeu de Mijloc, Zăvoiu Mare, alt. 479 m., lângă râu pe Salix fragilis, 12.07.1949.

Rhacomitrium cabescens (Hedw.) Brid.

- Bocicoiu Mare – Satul Tisa, la pârâul Tepliţ, 08.06.1960,
- Bogdan Vodă, Dl. Raşchii, alt. 613 m., 21.101952,
  Bogdan Vodă, fundul văii Mazăre, alt. 511 m., exp. NE., 31.10.1952,

Borşa, val. Cisla, alt. 679 m., pe sol, 29.05.1949,
- Sighetu Marmaţiei, Agriş, alt. 800-807 m., exp. E., 24.08.1958 şi 23.08.1963.

Rhacomitrium heterostichum (Hedw.) Brid. var. *gracilens* B.S.G.
- Deseşti, val. Runcului, alt. 700-800 m., 18-19.10.1962 *(1967, pp. 238)

Rhacomitrium protensum A. Br. var. *gracilens* B.S.G.
- Giuleşti, val. Brazilor, alt. 900-1000 m., pe stânci de andezit, 18.10.1962 *(1967, pp. 238).

Rhytidiadelphus triqueter (L.) Warnst.
- Borşa, val. Ţibăului, în Lelici, alt. 1076 m., exp. S., pe calcar, 31.05-01.06.1950,
- Rozavlea, fundul văii Branoului, alt. 586 m., exp. V., 06.05.1953,
- Ruscova, Dl. Lung, alt. 501 m., exp. V., 23.04.1955,
- Săpânţa, la Borcut, 17.05.1962,
- Sighetu Marmaţiei, Dl. Solovan, val. Scufundoasă, 20.08.1961, Vişeu de Jos, Dl. Hăuşului, alt. 551 m., exp. E., 06.09.1952.

Rhytidium rugosum (Ehrh.) Lindb.
- Borşa, val. Ţibăului în val. Lelici, alt. 1076 m., exp. S., pe stânci calcaroşi, 31.05-01.06.1950,

  Borşa, în Codreaua, alt. 1097 m., exp. E., în loc cu turbă, 31.05 – 01.06.1950.

Schistostega pennata (Hedw.) Hook.
- Deseşti – Mara, Cheile Tătarului, 19.09.1962.

Scleropodium purum (L.) Limpr.
- Sighetu Marmaţiei, Dl. Dobăieşi, exp. V., 15.08.1960
- Vişeu de Jos, val. Morii, alt. 481-510 m., exp. N., 09.07.1949,
- Vişeu de Jos, val. Porcului, alt. 473 m., exp. E., 01.08.1952.

Seligeria setacea (Wulf.) Lindb.
- Petrova, val. Hotarului, alt. 400 m., în apa râului Vişeu *(1967, pp. 228)
- Ruscova, val. Luhei, alt. 389 m., în apă pe piatră, 17.02.1951,
- Vişeu de Jos, val. Liberului, alt. 515 m., exp. N., pe piatră, 09.07.1949 *(1967, pp. 228)
- Vişeu de Jos, val. Morii, alt. 500 m., pe mal abrupt, 09.07.1949 *(1867, pp.228)

Solenostoma sphaerocarpum (Hook.) Steph.
- Săcel, Fundu Izei, alt. 780 – 640 m., exp. NV., pe stâncă metamorfică umedă, 20.05.1950.

Solenostoma triste (Nees.) Müll.
- Deseşti – Hărniceşti, sub Mţii. Piatra, în apă, 21.06.1962.

Sphagnum fuscum (Schimp.) Klingr.
- Deseşti – Hărniceşti, Iezeru Mare, în mlaştină cu turbă, 21.06.1962.

Sphagnum magellanicum Brid.
- Vişeu de Sus, Preluca Mejdii, alt. 1306 m., exp. NV., în mlaştină, 03.09.1948.

Sphagnum nemoreum Scop.
- Giuleşti, Poiana Brazilor, în mlaştină, 18.10.1062,
- Sighetu Marmaţiei, mlaştina Tăul Negru, alt. 1062 m.,

Syntrichia laevipila (Brid.) Schultz.
- Sălişte, lângă râul Iza în comună, alt. 451 m., exp. N., 21.12.1952,
- Vişeu de Jos, Mt. Maxim, alt. 1131 m., exp. S., pe Fagus sylvatica, 16.09.1940.

Syntrichia ruralis (L.) Brid.
- Repedea, Mt. Petriceaua, Laba, alt. 1187 m., exp. SV., 17.06.1987,
- Sighetu Marmaţiei, în oraş pe acoperişul unei casă, 01.08.1960,
- Vişeu de Jos, val. Liţei, alt, 466 m., exp. E., 12.07.1949,

  Vişeu de Jos, alt. 478 m., exp. S., lângă şosea în partea de jos a localităţii, 16.06.1950,

- Vişeu de Sus – Vişeu de Mijloc, alt. 478 m., exp. E., la marginea şoselei aproare de localitate, 16.06.1950.

Syntrichia subulata (L.) W, et M.

- Ruscova, Dumbrava, alt. 453 m., exp. S., 27.04.1955,
  Săcel, Măgura Săcelenească, alt. 1186 m., exp. SV., 20.05.1950.

Thuidium abietinum (Hedw.) Schimp.

- Bogdan Vodă, Dl. Raşchii, alt. 610 m., exp. V., 21.11.1952,
- Vişeu de Jos, val. Hăuşului, alt. 551 m., exp. V., 06.09.1952,

Thuidium delicatulum (Hedw.) Schimp.

- Sighetu Marmaţiei, agriş, alt. 700 m., 22.08.1063.

Thuidium recognitum (Hedw.) Lindb.

- Vişeu de Jos, val. Morii, alt. 519 m., N., 09.07.1949.

Thuidium tamariscifolium (Neck.) Lindb.

- Vişeu de Jos, Dl. Hăuşului, alt. 551 m., exp. V., 06.09.1952.

Timmia bavarica Hessl.

- Borşa, val. Ţibăului, în val. Lelici, alt. 1097 – 1100 m., 31.05-01.06.1950 *(1967, pp. 241)

Tortella cylindrical (Brid.) Loeske

- Vişeu de Jos, val. Porcului, alt. 587 – 590 m., exp. E., 17.09.1952 *(1967, pp. 235).

Tortella tomentella (Ehrh.) Dum.

- Giuleşti – Bubila, alt. 800 – 650 m., 23.08.1963 *(1967, pp. 218)
- Sighetu Marmaţiei, sub Mţii. Piatra, alt. 900 m., 23.08.1963.

Tortella tortuosa (L.) Limpr.

- Borşa, Coasta Plaiului, alt. 1286 m., exp. SE., şi alt. 1276 m., exp. V., 19.05.1951,
  Borşa, Cornedei, alt. 1740 m., exp. V., 05.07.1958,
  Borşa, val. Şibăului, în val. Lelici, alt. 1097 m., exp. S., în peşteră umedă, 31.05-01.06.1950,
- Borşa, val. Ţibăului, pe Piatra, alt. 1057 m., exp. S., pe calcar, 31.05-01.06.1950,
- Vişeu de Jos, val. Porcului, alt.476 m., exp. E., 01.08.1952.

Tortula muralis Hedw.

- Sighetu Marmaţiei, lângă râul Iza, pe zid de piatră, 03.04.1960 şi 18.12.1960,

var. *aestiva* Hedw.

Sighetu Marmaţiei, alt. 272 m., pe case, 26.05.1970.

CONCLUSIONS

In urma cercetărilor efectuate de cei doi botanisti, in aceasta lucrare sunt prezentate 165 de specii, 1 subspecie, 6 varietăţi, 1 hibrid din 452 locuri.

Cele mai insemnate pentru ştiinţă sunt rarităţile şi relicte, dintre care subliniem prezenţa următoarelor specii: *Aloina rigida, Andreaea rupestris, Aulacomnium palustre, Isopterygium elegans, Polytrichum formosum, Polytrichum x ştefureachii, Schistostega pennata, Sphagnum magellanicum, Tortella tortuosa* etc.

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PECULIARITIES OF EX SITU CULTIVATION OF *GENTIANA LUTEA* L. IN THE UKRAINIAN CARPATHIANS

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KEYWORDS: Ukrainian Carpathians, *Gentiana lutea* L., ex situ cultivation.

ABSTRACT

This article presents data on the *Gentiana lutea* L. cultivation. It shows features of early stages of species ontogenesis. Particular emphasis is placed on the patterns of formation of vegetative organs in 1-5 years old plants, grown ex situ. The field and laboratory germination of *G. lutea* seed was analyzed. To stimulate seed germination low-temperatures stratification was used. In general, the cultivation results show that the species can be grown in culture. A monthly growth of leaf blades was identified. The formation of *G. lutea* leaf rosettes was shown during the vegetation period and the dynamics of average height growth of *G. lutea* plants, grown ex situ, was reflected. It was noted that the newly formed pairs of leaf rosettes grow perpendicularly to the previous ones. At the end of the second year of cultivation, the old leaf rosette turns yellow, cracks at the base and is replaced by the new ones - one, two, rarely three leaf rosettes. The highest growth of the overground part during the first-third year of cultivation is observed in May and June. The overground part of *G. lutea* dies at the end of the fourth year of cultivation, only buds of about 2 cm high stay. From the age of two years onwards, 2-3% of plants develop 2-3 leaf rosettes on the caudex, and the other plants develop only one.

RÉSUMÉ: Les particularités de la cultivation ex situ de *Gentiana lutea* L. dans les Carpates Ukrainiens.

L'article présente des données sur la cultivation de *Gentiana lutea* L. Il informe sur les caractéristiques des premiers stages ontogéniques de l'espèce. Un accent particulier est placé sur les modèles de la formation des organes végétaux dans les plantes âgées de 1 à 5 ans cultivées in situ. La germination sur le terrain et dans le laboratoire des graines de *G. lutea* a été également analysée. Afin de stimuler la germination des graines on a utilisé la stratification à basses températures. Généralement, les résultats de la cultivation montrent que l'espèce est cultivable. A été identifiée aussi une croissance mensuelle des feuilles. La formation des rosettes foliacées chez *G. lutea* a été analysée pendant la période de végétation et la dynamique de la croissance moyenne en hauteur des plantes de *G. lutea*, cultivées in situ a été également présentée. On a remarqué le fait que les paires nouvellement formées des rosettes foliacées poussent perpendiculairement sur les précédentes. A la fin de la deuxième année de cultivation, l'ancienne rosette foliacée jaunit, craque à la base et est remplacée par les nouvelles feuilles – une, deux rarement trois rosettes foliacées. La plus grande croissance de la partie supra terraine durant la période comprise entre la première et la troisième année de cultivation a été enregistrée durant les mois de mai à juin. La partie supra terraine de *G. lutea* meurt à la fin de la quatrième année de cultivation, restant uniquement des bourgeons hauts d'environ 2 cm. A partir de l'âge de deux ans, 2-3% des plantes développent 2-3 rosettes foliacées sur le caudex, pendant que les autres plantes ne développent qu'une seule.

REZUMAT: Particularităţi ale cultivării ex situ a *Gentiana lutea* L. în Carpaţii Ucrainieni.

Acest articol prezintă informaţii despre cultivarea *Gentiana lutea* L. Sunt prezentate caracterele stagiilor timpurii din ontogeneza speciei. Un accent important este pus pe tiparele de formare a organelor vegetative la plante de 1-5 ani, crescute ex-situ. A fost analizată germinarea *G. lutea* în laborator şi pe teren. Pentru a stimula germinarea seminţelor a fost utilizată stratificarea temperaturilor scăzute.

În general, rezultatele arată că specia poate fi cultivată în regim de cultură. O creştere lunară a suprafeţei frunzei a fost identificată. A fost prezentată formarea rozetelor de frunze la *G. lutea* în perioada de vegetaţie, precum şi dinamica de creştere medie a înălţimii plantelor de *G. lutea*. A fost stabilit că perechile de frunze din rozetă nou formate cresc perpendicular pe cele anterioare. La sfârşitul celui de-al doilea an de cultivare, vechea rozetă de îngălbeneşte şi se desprinde la bază, fiind înlocuită de cea nouă – una, două, mai rar trei rozete. Cea mai puternică creştere a părţilor subpământene în primii trei ani de cultivare se observă în mai şi iunie. Părţile aeriene ale *G. lutea* mor la sfârşitul celui de-al patrulea an de cultivare, rămânând doar muguri de aproximativ 2 cm. Începând de la doi ani, 2-3% dintre plante formează 2-3 rozete de frunze pe caudex, pe când celelalte plante formează doar una.

INTRODUCTION

Gentiana lutea L. is a valuable medicinal plant which is included into the second edition of the Red Book of Ukraine as a vulnerable species. Due to the constant anthropogenic pressure, in addition to measures aimed at stabilizing the current range and its recovery, we made attempts to introduce the above-mentioned species in order to reintroduce it in natural habitats, facilitating the increase in the number of individuals. This work was carried out on a scientific basis following the principles of population biology.

MATERIAL AND METHODS

The object of the study was alpine species *G. lutea*. Seeds of *G. lutea* were collected on the Rohnyeska meadow (1550 m asl). To stimulate germination of seeds low-temperatures stratification was used. Seed quality sowing was studied in laboratory and field conditions. Our own methodology was used to identify the growth of plants, grown in culture. According to this methodology we selected 25 model plants, labeled them and measured morphoparameters of each pair of leaf rosettes at the beginning and the end of the month during the growth period. The difference between the data obtained at the end and the beginning of the month was the average growth, we calculated the arithmetic mean of the month growth for each pair of leaves. These digital data were processed statistically (Lakin, 1990).

RESULTS AND DISCUSSION

G. lutea is characterized by seed and vegetative reproduction in natural conditions. The seeds of yellow gentian, as well as of other species of *Gentiana* L, have underdeveloped embryo (Izrailson and Halinskaya 1979). Obviously, this feature of the seeds is one of the reasons for depressed seed reproduction in the natural conditions

In 2006, 1000 seeds of *G. lutea* were sowed in the experimental area in the Bohdan village. Soil seed germination amounted to 60% during the autumn sowing. Together with the study in the near-natural conditions, the studies of laboratory germination were conducted. Laboratory germination amounted to 6-8%. Shoots of *G. lutea* appeared in early April, had two cotyledonous leaves, were facing opposite direction, were oval, with a clear central vein and primary root. The average length of the leaf blade was 0.6 cm, width - 0.4 cm. Two months after germination, the plant had a rosette with three pairs of real leaves. Here we have found a pattern: the leaves grow in pairs and each next pair grows perpendicularly to the previous one.

At the end of the first year of cultivation the rosette's leaves begin to turn yellow, only the fourth, fifth and sixth pairs stay green, the seventh pair begins to form. During this period three veins are clearly visible on the leaves, venation is arcuate. The average plant height is 2.4 cm. The plant stays green during the whole winter.

In the spring next year, after the snowmelt there are *G. lutea* rosettes with three pairs of green leaves that have left since the last year. During the second year of *G. lutea's* life new leaves begin to grow rapidly. In early May, a rosette of seven pairs of leaves is clearly visible. Plants care involves hoeing and weeding between rows and regular watering.

The results of the second year of *G. lutea* cultivation show that the first and the second pair of leaf rosette cease to function in early May and the third pair - in early June. The highest growth of morphoparameters of the vegetative shoots of the fourth couple of leaf rosettes was observed during May. Thus, the average length growth of the leaf blade is 2.6 cm, and the leaf blade width - 1.4 cm. At the beginning of August, the fourth pair of leaf rosette ceases to function. As for the fifth, sixth and seventh pair of leaf rosette, the highest growth is observed in May.

In early September, we observed such a phenomenon: the old leaf rosette of all of plants ceases to function, it cracks in its base and is replaced with the new one, two, rarely three leaf rosettes. In late October, the new rosettes of *G. lutea* have four pairs of leaves. The increase in length and width of the leaf blades of the new leaf rosette was very little during September and October: it ranges respectively from 0.2 to 1.6 cm and from 0.1 to 1.0 cm. At the end of the second and third year of *G. lutea's* life the new leaf rosettes remain green during the winter. The over ground part dies at the end of the fourth and fifth year of cultivation, only buds of about 2 cm high stay.

The interdependence of plants height and age is presented in Figure 1. According to the introduction success the species can be grown in culture. Now we continue to observe the dynamics of plants development in culture.

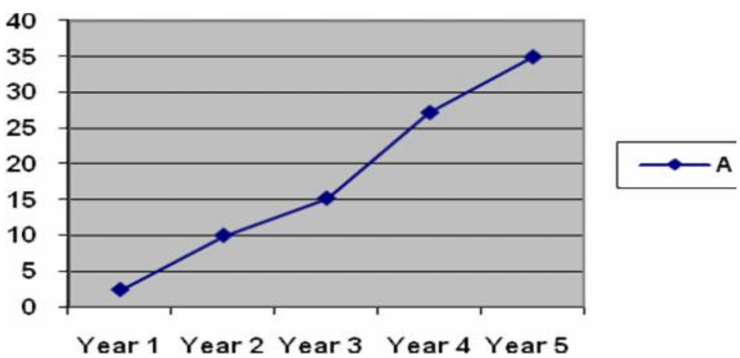

Fig 1. Dynamics of increase in height of *G. lutea* in culture (vertical axis stands for arithmetic mean, cm).

CONCLUSIONS

G. lutea shoots appear in early April. At the end of the first year of cultivation the plant is represented by a rosette of three pairs of leaves, the average height of plant is 2.4 cm.

In early September, the old leaf rosettes of *G. lutea* cease to function; they are replaced by the new ones - one, two, and rarely three leaf rosettes.

At the end of the first, second and third year of *G. lutea* cultivation new leaf rosettes stay green during the winter.

The over ground part of *G. lutea* dies at the end of fourth and fifth year of cultivation, only buds of about 2 cm high stay.

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DISTRIBUTION OF ENDEMIC AND RARE VASCULAR PLANT SPECIES IN THE UPPER TYSA BASIN WITHIN THE CARPATHIAN BIOSPHERE RESERVE (UKRAINE)

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KEYWORDS: plants distribution, endemic and rare plant species, protection status.

ABSTRACT

The paper provides data on distribution, systematic composition and present status of endemic and rare vascular plant species in the Carpathian Biosphere Reserve within the upper Tysa river basin research area. Sixty two endemic species were found within the reserve, and the geographical distribution in the Carpathian region was indicated for each of them. A systematic analysis of their composition is being conducted.

A list of 138 vascular plant species found within the area, listed in the latest edition of The Red Data Book of Ukraine (2009), was presented on the basis of floristic research. In addition to the distribution, the type of rarity was specified for each species according to their conservation status in Ukraine.

RÉSUMÉ: La distribution des espèces végétales endémiques et rares du bassin supérieur de Tisza dans la Réserve de la biosphère des Carpates (Ukraine).

L'article fournit des données sur la distribution, la composition systématique et le statut actuel des plantes vasculaires endémiques et rares de la Reserve de la biosphère des Carpates dans la zone étudiée – le bassin supérieur de Tisza. Dans la biosphère ont été retrouvées 62 espèces endémiques dont la distribution géographique dans la région des Carpates est indiquée individuellement. A été également effectuée une analyse systématique de leur composition.

Une liste de 138 espèces végétales vasculaires trouvées dans la région et mentionnées dans la dernière version du Livre Rouge d'Ukraine (2009) a été présentée, liste basée sur les études floristiques. A part la distribution, le degré de rareté est spécifié pour chaque espèce, en fonction de son statut de conservation en Ukraine.

REZUMAT: Raspandirea speciilor de plante vasculare si endemice in bazinul superior al Tisei din Rezervatia Biosferei Carpatice (Ucraina).

Lucrarea prezinta date referitoare la raspandirea, structura sistematica si statutul actual al speciilor de plante vasculare rare si endemice din Rezervatia Biosferei Carpatice din cadrul zonei de cercetare – bazinul superior al Raului Tisa. Au fost gasite 62 de specii endemice in rezervatie, pentru fiecare din ele fiind indicata distributia geografica in regiunea carpatica. S-a facut o analiza sistematica a compozitiei lor. Este prezentata o lista de 138 de plante vasculare gasite in zona, care este prezentata in ultima editie a Cartii Rosii din Ucraina, pe baza analizelor floristice. In completarea raspandirii am specificat si tipul de raritate pentru fiecare specie in functie de statutul ei de conservare in Ucraina.

INTRODUCTION

The investigated area represents biodiversity of flora, characteristic for the south-western macroslope of the Ukrainian-Carpathians. A significant part of this area belongs to the Carpathian Biosphere Reserve (CBR). The territory of the reserve includes all climate zones of the Ukrainian Carpathians, which are characteristic both for pre-montane planes, and subalpine and alpine zones. The lowest site is located at the altitude of 170 a a.s.l., and the highest – the highest mountain of Ukraine – Hoverla Mt., 2061 m a.s.l.

Over 1200 vascular plant species grow here, which comprises 59 % of the Ukrainian Carpathian flora. There are 7 European red-listed species here: *Astragalus krajinae* Domin, *Heracleum carpaticum* Porc., *Ranunculus malinovskii* A.Jelen. et Derv.-Sokol. (*R. kladni* Schur), *Pulmonaria filarszkyana* Jav., *Primula poloninensis* (Domin) Fed., *Silene dubia* Herbich, *Saussurea porcii* Degen [6], 4 species protected by the Bern Convention: *Narcissus angustifolius* Curt., *Campanula abietina* Griseb. et Schenk, *Poa deylii* Chrtek et Jir., *Botrychium multifidum* (S. G. Gmel.) Rupr., 4 International Red Book species: *Aconitum firmum* Reichenb., *Heracleum carpaticum* Porc., *Plantago atrata* Hoppe, *Ptarmica tenuifolia* (Schur) Schur) [7], 138 belong to the Red Book of Ukraine [5] and 146 – to the Regional Red List [2,3].

RESULTS AND DISCUSSIONS

A prominent place at CBR flora is occupied by endemic species. A complex analysis of rare and endemic Ukrainian Carpathian species was made by K. Malynovskyi, Yo. Tsaryk, V. Kyliak, Yu. Nesteruk. The authors conclusions were based on personal data [4].

62 endemic species are distributed within the represented protected massifs, which is 4,6 % of the total higher vascular plant number of CBR. 14 of them are common for the Carpathians in a whole, 25 – for the East Carpathians, 20 – East and South Carpathians, 2 – West-East Carpathians. The endemic core is made up by the East-Carpathian species. 13 out of which belong to the Red Book of Ukraine [1].

The characteristic feature is that a great number of endemic species is associated to limestone rocks of the subalpine belt. That is why the following mountain ranges are the most rich in terms of endemic species: Chornohora – 40, Svydovets – 38, Marmarosh – 28 species (Tab. 1).

Table 1: Endemic plant species and their distribution within the upper Tysa basin; - red-listed plant species; CBR massifs: K - Kuziy, Sv – Svydovets, Ch – Chornohora, Mr – Maramuresh, U-Sh – Uhlia-Shyrokyi Luh, NV – Narcissi Valley; Endemics: c – all-Carpathian, e-c – East-Carpathian, e-s-c – East-South Carpathian, w-e-c – West-East Carpathian.

NO.	LATIN NAME	DISTRIBUTION IN THE CARPAHTIANS	CBR MASSIFS					
			K	Sv	Ch	Mr	U-Sh	Nv
Salicaceae								
1	*Salix retusa* L. *(S. kitaibeliana* Willd.*)* *	c		+	+			
Caryophyllaceae								
2	*Dianthus carpaticus* Woloszcz.	e-s-c		+	+			
3	*Minuartia zarecznyi* (Zapal.) Klok.	c		+	+			
4	*Silene dubia* Herbich	e-s-c	+	+		+	+	

NO.	LATIN NAME	DISTRIBUTION IN THE CARPAHTIANS	CBR MASSIFS					
			K	Sv	Ch	Mr	U-Sh	Nv
Ranunculaceae								
5	*Aconitum bucovinense* Zapal.	e-c					+	
6	*Aconitum jacquinii* Reichenb. *	e-c			+			
7	*Aconitum hosteanum* Schur	e-c	+		+		+	
8	*Aconitum nanum* Baumg.	e-s-c		+	+			
9	*Aconitum romanicum* Woloszcs.	e-c	+	+	+	+		
10	*Aquilegia transsilvanica* Schur *	e-c		+				
11	*Ranunculus carpaticus* Herbich	e-s-c		+	+			
12	*Ranunculus kladnii* Schur	e-c		+	+			
13	*Trollius transsilvanicus* Schur	c			+			
Brassicaceae								
14	*Cardaminopsis neglecta (Schultes) Hayek*	c	+	+				
Crassulaceae								
15	*Jovibarba pressiana* (Domin) Omelcz. et Czopik*	c	+			+	+	
Saxifragaceae								
16	*Chrysosplenium alpinum* Schur	e-s-c			+	+	+	
Grossulariaceae								
17	*Ribes carpaticum* Schult.	c			+	+		
Rosaceae								
18	*Alchemilla szaferi* Pawl.	e-c			+			
19	*Alchemilla turculensis* Pawl.	e-c			+			
Fabaceaea								
20	*Astragalus krajinae* Domin *	e-s-c		+				
21	*Genista oligosperma* (Andrae.) Simk.*	e-s-c				+		
Euphorbiaceae								
22	*Euphorbia carpatica* Woloszczak	e-c		+				
Violaceae								
23	*Viola declinata* Waldst. et Kit.	e-s-c	+	+	+	+	+	
Hypericaceae								
24	*Hypericum alpigenum* Kit	e-c		+	+	+		
Primulaceae								
25	*Primula poloniensis* (Domin.) Fed.	e-s-c	+	+	+			
Gentianaceae								
26	*Gentiana laciniata* Kit. *	e-c		+	+			
Rubiaceae								
27	*Galium bellatulum* Klok.	e-c		+				
28	*Galium carpaticum* Klok.	e-c	+				+	
29	*Galium transcarpaticum* Stojko et Tasenkevich	e-c	+				+	
Boraginaceae								
30	*Pulmonaria filarszkyana* Jav.	e-c			+	+	+	
31	*Symphytum cordatum* Waldst. et Kit. ex Willd.	c	+	+	+	+	+	
Lamiaceae								
32	*Acinos alpinus* (Simonk.) Klok. (A. baumgartenii)	e-c		+			+	
33	*Melittis carpatica* Klok.	e-c	+			+	+	
34	*Thymus alternans* Klok.	e-c	+	+		+	+	+
35	*Thymus clandestinus (Th. enervius)* Klok.	c			+			

NO.	LATIN NAME	DISTRIBUTION IN THE CARPAHTIANS	CBR MASSIFS					
			K	Sv	Ch	Mr	U-Sh	Nv
Scrophulariaceae								
36	*Melampyrum herbichii* Wolosz.	e-s-c	+	+		+		
37	*Melampyrum saxosum* Baumg.	e-c		+	+	+	+	
Dipsacaceae								
38	*Scabiosa lucida* Vill *(S. opaca)* Klok.	e-s-c		+		+	+	
Campanulaceae								
39	*Campanula carpatica* Jacq. *	c	+			+	+	
40	*Campanula abietina* Griseb. et Schenk	e-s-c	+	+	+	+	+	
41	*Phyteuma vagneri* A. Kerner	e-s-c	+	+	+	+	+	
42	*Phyteuma tetramerum* Schur	e-s-c	+		+		+	
Asteraceae								
43	*Achillea schurii* Sch.Bip.(*Ptarmica tenuifolia)* *	e-s-c			+	+	+	
44	*Carduus kerneri* Simonk.	e-s-c	+	+	+	+		
45	*Centauria carpatica* (Porc.) Porc.	e-c	+	+	+	+	+	
46	*Centaurea marmarosiensis* (Jav.) Czer.	e-c			+			
47	*Centaurea phrygia* L.	e-c	+	+		+	+	+
48	*Doronicum carpaticum* (Griseb. et Schenk) Nyman	e-s-c		+	+	+	+	
49	*Hieracium caesiogenum* Woloszc. et Zahn	e-c					+	
50	*Leontodon pseudotaraxaci* Schur	C		+				
51	*Leontodon repens* Schur	e-c	+		+	+		
52	*Leontodon schischkinii* V. Vassil.	w-e-c		+	+			
53	*Leucanthemum subalpinum* (Simonk.) Tzvel. *(L. raciborskii* Pop. et Chrshan*.)*	e-s-c		+	+	+		
54	*Leucanthemum waldsteinii* (Sch.Bip) Pouzar (*L. rotundifolia* Waldst. et Kit.)	C	+	+	+	+	+	
55	*Senecio carpaticus* Herbich*	C		+	+			
56	*Saussurea porcii* Degen *	e-c			+			
Poaceaea								
57	*Dactylis glomerata* L. *(D. slovenica* Domin)	w-e-c			+	+		+
58	*Festuca carpatica* F. Dietr.	C		+				
59	*Festuca porcii* Hackel *	e-s-c	+		+			
60	*Festuca versicolor* Tausch	C		+	+			
61	*Poa deylii* Chrtek et Jiras *(P.granitica* auct.*)*	e-s-c		+		+		
62	*Trisetum ciliare* (Kit.) Domin	c		+	+			
	Total	62	23	38	40	28	25	3

The structure of the endemic flora of the Carpathian Biosphere Reserve consists of 22 families and 43 genera. The largest number of endemic species contains Asteraceae family listed with 14 plant species, Ranunculaceae - 9 species, Poaceae - 6 species. The dominant genera by few endemic species are *Aconitum, Galium, Thymus, Campanula, Leontodon*; * protection status.

Table 2: Systematic list of higher vascular plants listed to the Red Book of Ukraine; ° – European Red List. ® – Regional Red List. ^ – endemics. © – sub-endemics. ■ – data according to RBU; * –data based on CBR herbarium samples. R – rare; En – endangered; Vu – vulnerable; Ex – extint taxon; No identification – No id.

NO.	Latin name (synonim)	Genus	CBR Massif						*
			K	Sv	Ch	Mr	U-Sh	NV	
1	*Diphasiastrum alpinum* Holub (*Lycopodium alpinum* L.) ®	*Lycopodiaceae*			+		+		R
2	*Lycopodium annotinum* L.	*Lycopodiaceae*		+	+	+	+		Vu
3	*Huperzia selago* (L.) Bernh. ex Schrank et Mart. (*Lycopodium selago* L.)	*Huperziaceae*	+	+	+	+	+		No id
4	*Selaginella selaginoides* (L.) P. Beauv. ex Mart. et Schrank	*Selaginellaceae*		+	+				Vu
5	*Botrychium lunaria* (L.) Sw. ®	*Ophioglossaceae*		+	+		+		Vu
6	*Botrychium matricariifolium* (A. Braun ex Döll) W.D.J. Koch ®	*Ophioglossaceae*		■	■				En
7	*Botrychium multifidum* (S. G. Gmel.) Rupr. ®*	*Ophioglossaceae*				+			R
8	*Cystopteris alpina* (Lam.) Desv. (C. regia) ®*	*Cystopteridaceae*	+						R
9	*Cystopteris montana* (Lam.) Bernh. ex Desv. ®*	*Cystopteridaceae*		+	+	+			R
10	*Cystopteris sudetica* A. Braun et Milde®*	*Cystopteridaceae*			+		+		No id
11	*Taxus baccata* L.	*Taxaceae*	+			+	+		Vu
12	*Pinus cembra* L.	*Pinaceae*	IN	+	+				Vu
13	*Aconitum jacquinii* Rchb. ^	*Ranunculaceae*		■	+				R
14	*Anemone narcissiflora* L. ®	*Ranunculaceae*		+	+	+	+		Vu
15	*Aquilegia nigricans* Baumg.	*Ranunculaceae*		+		■			En
16	*Aquilegia transsilvanica* Schur ^*	*Ranunculaceae*		+					En
17	*Pulsatilla scherfelii* (Ullep.) Skalicky (*P. alba* auct. non Rchb.)	*Ranunculaceae*		+	+	+			R
18	*Ranunculus thora* L. (*R. tatrae* Borbàs)	*Ranunculaceae*		+	+	+			R
19	*Dichodon cerastioides* (L.) Rchb. (*Cerastium cerastoides* (L.) Britt.) ®	*Caryophyllaceae*		■	■	+	+		R
20	*Minuartia pauciflora* (Kit. ex Kanitz) Dvořakovà (*M. zarecznyi* (Zapal.) Klokov ^ ®	*Caryophyllaceae*		+	+				R
21	*Oxyria digyna* (L.) Hill ®	*Polygonaceae*		+					R
22	*Biscutella laevigata* L. s. I. ®	*Brassicaceae*		+					R
23	*Draba aizoides* L. ®	*Brassicaceae*		■					En
24	*Lunaria rediviva* L.	*Brassicaceae*	+			+	+		No id.
25	*Salix alpina* Scop. ®	*Salicaceae*		■					En
26	*Salix herbaceae* L.	*Salicaceae*		■	■	■			R
27	*Salix retusa* L. (*S. kitaibeliana* Willd.) ^	*Salicaceae*		+	+				R
28	*Loiseleuria procumbens* (L.) Desv. ®	*Ericaceae*			+				R

NO.	Latin name (synonim)	Genus	CBR Massif						*
			K	Sv	Ch	Mr	U-Sh	N V	
29	*Rhododendron myrtifolium* Schott et Kotschy *(Rh. kotschyi* Simonk.) ©	*Ericaceae*		+	+	+			No id.
30	*Primula halleri* J. F. Gmel. ®	*Primulaceae*		+	■				R
31	*Primula minima* L.	*Primulaceae*			■	+			R
32	*Jovibarba hirta* (L.) Opiz *(J. preissiana* (Domin) Omelczuk et Czopik)^ ®	*Crassulaceae*	+	■		+	+		R
33	*Rhodiola rosea* L.	*Crassulaceae*		+	+				Vu
34	*Sedum antiquum* Omelcz. et Zaverucha *(S. hispanicum* auct. non L.) ®	*Crassulaceae*	+				+		R
35	*Sempervivum montanum* L. ^	*Crassulaceae*			■	+			R
36	*Saxifraga aizoides* L.*	*Saxifragaceae*			+	+			En
37	*Saxifraga androsacea* L.	*Saxifragaceae*		+	■				R
38	*Saxifraga bryoides* L. ®	*Saxifragaceae*			+				R
39	*Saxifraga carpathica* Sternb. *(S. carpathica* Rchb.) ®^	*Saxifragaceae*		■	+				R
40	*Dryas octopetala* L.	*Rosaceae*		+	■				R
41	*Astragalus krajinae* Domin ° ^	*Fabaceae*		+					R
42	*Chamaecytisus podolicus* (Blocki) Klask. °	*Fabaceae*							Vu
43	*Genista oligosperma* (Andrae) Simonk. ^ ®	*Fabaceae*				+			Ex.
44	*Hedysarum hedysaroides* (L.) Schinz et Thell. *(H. obscurum* L.)	*Fabaceae*		+	+				En
45	*Lathyrus laevigatus* (Waldst. et Kit.) Fritsch ® ^	*Fabaceae*	+					+	R
46	*Securigera elegans (*Pančić) Lassen *(Coronilla elegans* Pančić)	*Fabaceae*					+		Vu
47	*Trifolium badium* Schreb. ®	*Fabaceae*		■					R
48	*Conioselinum vaginatum (*Spreng.) Thell. *(C. tataricum* Hoffm.)®	*Apiaceae*					+		R
49	*Lonicera caerulea* L.® ^	*Caprifoliaceae*			■				R
50	*Succisella inflexa* (Kluk) G. Beck®*	*Dipsacaceae*						+	R
51	*Gentiana acaulis* L.	*Gentianaceae*		+	+	+			R
52	*Gentiana laciniata* Kit. ex Kanitz ^	*Gentianaceae*		+	+				R
53	*Gentiana lutea* L.	*Gentianaceae*			+	+			Vu
54	*Gentiana nivalis* L.®	*Gentianaceae*		■					En
55	*Gentiana punctata* L.	*Gentianaceae*		+	+	+			Vu
56	*Swertia perennis* L. (incl. S.alpestris Baumg. ex Fuss)	*Gentianaceae*		+	+				Vu
57	*Atropa belladonna* L.	*Solanaceae*	+			+	+		Vu
58	*Scopolia carniolica* Jacg.	*Solanaceae*	+	+		+	+		No id.
59	*Pedicularis oederi* Vahl	*Orobanchaceae*			+				En
60	*Veronica aphylla* L.®	*Veronicaceae*		+					R
61	*Veronica bellidioides* L. ®	*Veronicaceae*				■			En

NO.	Latin name (synonim)	Genus	CBR Massif						*
			K	Sv	Ch	Mr	U-Sh	N V	
62	*Veronica fruticans* Jacg. ®	*Veronicaceae*				■			R
63	*Pinguicula alpina* L.	*Lentibulariaceae*		+	+				R
64	*Pinguicula vulgaris* L.*	*Lentibulariaceae*		+					Vu
65	*Campanula carpatica* Jacg. ^	*Campanulaceae*	+			+	+		R
66	*Campanula kladniana* (Schur) Witasek ©	*Campanulaceae*		+	+	■			R
67	*Antennaria carpatica (*Wahlenb.) Bluff et Fingerh. ^	*Asteraceae*		+		+			R
68	*Anthemis carpatica* Waldst. et Kit. ex Willd.®	*Asteraceae*				+			En
69	*Aster alpinus* L. ®	*Asteraceae*		+					R
70	*Erigeron alpinus* L. ®	*Asteraceae*		■		■			R
71	*Doronicum stiriacum (*Vill.) Dalla Torre *(D. clusii* auct. non (All.) Tausch	*Asteraceae*			+				R
72	*Leontopodium alpinum* Cass.	*Asteraceae*		+					En
73	*Ptarmica lingulata* Willd. et Kit. DC. *(Achillea lingulata* Waldst. et Kit.) ©	*Asteraceae*		+	+				R
74	*Ptarmica tenuifolia* (Schur) Schur *(Achillea schurii* Sch. Bip.)^	*Asteraceae*		+	+	+			R
75	*Saussurea alpina* (L.) DC.	*Asteraceae*		■	+				R
76	*Saussurea porcii* Degen ° ^	*Asteraceae*			+				R
77	*Senecio carpathicus* Herbich ^ ®	*Asteraceae*			+				R
78	*Colchicum autumnale* L.	*Liliaceae*					+	+	No id.
79	*Erytronium dens-canis* L.	*Liliaceae*	+				+	+	R
80	*Lilium martagon* L.	*Liliaceae*	+	+	+	+	+	+	No id.
81	*Lloydia serotina* (L.) Rchb. ®	*Liliaceae*		■	■				R
82	*Galanthus nivalis* L.	*Amaryllidaceae*	+	+	+	+	+		No id.
83	*Leucojum vernum* L.	*Amaryllidaceae*					+	+	No id.
84	*Narcissus angustifolius* Curtis	*Amaryllidaceae*		+		+		+	Vu
85	*Crocus banaticus* J. Gay	*Iridaceae*						+	Vu
86	*Crocus heuffelianus* Herb.	*Iridaceae*	+	+	+	+	+	+	No id.
87	*Gladiolus imbricatus* L.	*Iridaceae*	+					+	Vu
88	*Iris sibirica* L. ®	*Iridaceae*						+	Vu
89	*Iris pseudocyperus* Schur	*Iridaceae*	+				+		R
90	*Anacamptis coriophora* (L.) R.M. Bateman, Pridgeon et M.W. Chase s.l. *(Orchis coriophora* L.)	*Orchidaceae*					+	+	Vu
91	*Anacamptis laxiflora (*Lam.) R.M. Bateman, Pridgeon et M.W. Chase *(Orchis laxiflora* Lam.) *	*Orchidaceae*						+	Vu
92	*Anacamptis morio* (L.) R.M. Bareman, Pridgeon et M.W. Chase *(Orchis morio* L.)	*Orchidaceae*			■		+	+	Vu

NO.	LATIN NAME (SYNONIM)	GENUS	CBR MASSIF						*
			K	Sv	Ch	Mr	U-Sh	N V	
93	*Anacamptis palustris* (Jacg.) R.M. Bareman, Pridgeon et M.W. Chase *(Orchis palustris* Jacg.)	*Orchidaceae*					+	+	Vu
94	*Cephalanthera damasonium* (Mill.) Druce	*Orchidaceae*	+				+		R
95	*Cephalanthera longifolia* (L.) Fritsch.	*Orchidaceae*	+				+		R
96	*Cephalanthera rubra* (L.) Rich.	*Orchidaceae*	+						R
97	*Coeloglossum viride* (L.) C. Hartm.	*Orchidaceae*			+				R
98	*Corallorhiza trifida* Chàtel.	*Orchidaceae*			+		+		R
99	*Dactylorhiza cordigera* (Fries) Soó *(Orchis cordigera* Fries)	*Orchidaceae*		+	+	+			Vu
100	*Dactylorhiza fuchsii* (Druce) Soó *(Orchis fuchsii* Druce) ®	*Orchidaceae*			+		+		No id.
101	*Dactylorhiza incarnata* (L.) Soó *(Orchis incarnata* L., *O. latifolia* L. nom. rej.) ®	*Orchidaceae*						+	Vu
102	*Dactylorhiza maculata* (L.) Soó *(Orchis maculata* L.)	*Orchidaceae*	+		+		+	+	Vu
103	*Dactylorhiza majalis* (Rchb.) P. F. Hunt et Summerhayes, s.l. *(Orchis majalis* Rchb. nom. Conserv.)	*Orchidaceae*	+				+	+	R
104	*Dactylorhiza sambucina* (L.) Soó *(Orchis sambucina* L.)	*Orchidaceae*	+			+	+		Vu
105	*Epipactis atrorubens* (Hoffm. ex Bernh.) Besser	*Orchidaceae*	+			+	+		Vu
106	*Epipactis helleborine* (L.) Crantz	*Orchidaceae*	+		+		+		No id.
107	*Epipactis palustris* (L.) Crantz	*Orchidaceae*	+				+		Vu
108	*Epipogium aphyllum* Sw.	*Orchidaceae*					+		En
109	*Goodyera repens* (L.) R. Br.	*Orchidaceae*			+				Vu
110	*Gymnadenia conopsea* (L.) R. Br. ®	*Orchidaceae*	+	+	+	+	+	+	Vu
111	*Herminium monorchis* (L.) R. Br	*Orchidaceae*			■				En
112	*Listera cordata* (L.) R. Br	*Orchidaceae*			+				Vu
113	*Listera ovata* (L.) R. Br	*Orchidaceae*	+		+		+		No id.
114	*Neottia nidus-avis* (L.) Rich.	*Orchidaceae*	+		+	+	+		No id.
115	*Neotinea ustulata* (L.) R.M. Bateman, Pridgeon et M.W. Chase *(Orchis ustulata* L.)	*Orchidaceae*	+				+	+	En
116	*Orchis mascula* (L.) L.	*Orchidaceae*					+	+	Vu
117	*Orchis pallens* L.*	*Orchidaceae*	+						En
118	*Orchis signifera* Vest.	*Orchidaceae*		■	■	■			En
119	*Platanthera bifolia* (L.) Rich.	*Orchidaceae*	+		+	+	+		No id.
120	*Pseudorchis albida* (L.) A. Löve et D. Löve *(Leucorchis albida* (L.) E. Mey)	*Orchidaceae*			+	+			Vu
121	*Traunsteinera globosa* (L.) Rchb.	*Orchidaceae*	+		+		+		Vu
122	*Carex bicolor* All. ®	*Cyperaceae*			■				En

NO.	Latin name (synonim)	Genus	CBR Massif						*
			K	Sv	Ch	Mr	U-Sh	NV	
123	*Carex buxbaumii* Wahlenb.	*Cyperaceae*			+			+	Vu
124	*Carex davalliana* Smith	*Cyperaceae*			+				Vu
125	*Carex fuliginosa* Schkuhr ®	*Cyperaceae*		■	■				R
126	*Carex lachenalii* Schkuhr *(Carex tripartita* auct. non All.) ®	*Cyperaceae*		■					En
127	*Carex pauciflora* Lightf.	*Cyperaceae*		+					Vu
128	*Carex rupestris* All.	*Cyperaceae*			■				R
129	*Carex umbrosa* Host	*Cyperaceae*			■				No id.
130	*Carex vaginata* Tausch ®	*Cyperaceae*			■				En
131	*Eleocharis carniolica* W.D.J. Koch ®	*Cyperaceae*						■	Vu
132	*Agrostis rupestris* All. ®	*Poaceae*			■				En
133	*Bellardiochloa violacea* (Bellardi) Chiov.®	*Poaceae*		■	+				R
134	*Festuca drymeja* Mert. et W.D. J. Koch ®	*Poaceae*	+		■	■	+		Vu
135	*Festuca heterophylla* Lam.*	*Poaceae*				+			Vu
136	*Festuca porcii* Hack. ^	*Poaceae*	+		+				Vu
137	*Festuca saxatilis* Schur ®	*Poaceae*		+	■	■			No id.
138	*Oreochloa disticha* (Wulfen) Link	*Poaceae*			+				En
	Total		34	62	78	46	45	23	R B U

CONCLUSIONS

The following factors have a negative impact on endemic and rare flora: unsustainable forestry, intense pasture, particularly in the highlands, and collection of plant raw-material for various goods. Recently, there has been rapid growth of the destructive influence of recreation on natural ecosystems, especially in alpine areas, where the largest number of rare plants including endemics occur. To conserve and restore the populations of these species, the system of protected areas should be expanded, and it is also necessary to monitor the current state of these territories, and to ensure research for future developments.

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HABITATS SUITABILITY OF HIGHLY INVASIVE PLANTS SPECIES IN THE UKRAINIAN PART OF THE UPPER TISA BASIN

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KEYWORDS: invasive plant species, plants distribution, prediction modeling, habitats suitability, Upper Tisa basin, Ukrainian Carpathian.

ABSTRACT

The Ukrainian Carpathians Mts are experiencing increased levels of plant invasion and disturbances to natural ecosystems, and an investigation of the implications of these trends for biodiversity preservation is of paramount importance. The area of upper Tysa (Tisza) river basin is selected for our studies. The eleven most aggressive non-native invasive plant species (NIPS) have been selected for the study: *Acer negundo* L., *Reynoutria japonica* Houtt., *Reynoutria x bohemica* Chrtek. and Chrtková, *Echinocystis lobata* (Michx.) Torr. and Grey, *Impatiens glandulifera* Royle, *Heracleum sosnowskyi* Manden, *Robinia pseudoacacia* L., *Helianthus tuberosus* L., *Solidago canadensis* L., *Solidago gigantean* Aiton and *Ambrosia artemisiifolia* L. Using two types of species distribution modelling software packages, Maxent and BIOMOD, areas suitable for establishment of eleven NIPS already present in the upper part of the Tysa river are predicted based on six covariates representing climatic, topographic, and disturbance gradients. All received models have a high predictive performance. The Maxent generally predicts a larger area to be suitable than BIOMOD, but BIOMOD algorithms predict a slightly greater proportion of the study area to be suitable. Regardless of algorithm, virtually almost all of linear habitats (riparian habitats and major roads) at lower elevations of upper Tysa basin area (up to approximately 400 m) and also for some territories with such habitats (up to 750 m) are currently at risk to become invaded by several aggressive species. Based on dispersal success of the studied invasive species, invasion of protected areas is likely if current trends continue and eradication of species is highly unrealistic. The conservation planning must be changed to include the presence and management of invasive species in protected areas and ecological networks (for most of cases) based on current economic and management situation.

ZUSAMMENFASSUNG: Die Habitat Eignung hoch invasiver Pflanzenarten im ukrainischen Teil des oberen Einzugsgebietes der Theiß (Tysa, Tisza).

Die ukrainischen Karpaten sind in zunehmendem Maße der Ausbreitung invasiver Arten und Störungen der natürlichen Ökosysteme unterworfen, so dass eine Erfassung der Auswirkungen dieser Entwicklungen für die Bewahrung der Biodiversität von höchster Wichtigkeit ist. Für unsere Studien wurde das Einzugsgebiet der oberen Theiß (Tysa/Tisza) ausgewählt, wobei sich die Untersuchungen auf die elf am meisten aggressiven, fremden Arten (NIPS) beziehen: *Acer negundo* L., *Reynoutria japonica* Houtt., *Reynoutria x bohemica* Chrtek. und Chrtková, *Echinocystis lobata* (Michx.) Torr. und Grey, *Impatiens glandulifera* Royle, *Heracleum sosnowskyi* Manden, *Robinia pseudoacacia* L., *Helianthus tuberosus* L., *Solidago canadensis* L., *Solidago gigantean* Aiton and *Ambrosia artemisiifolia* L. Unter Anwendung zwei unterschiedlicher Pakete von Software Modellierungstypen Maxent und BIOMOD zur Darstellung der Artenverteilung, werden die für die Ausbreitung der elf genannten invasiven Arten geeigneten Gebiete auf Grund von sechs Co-variaten ermittelt, die klimatische, topographische und Störungsgradienten betreffen. Alle errechneten Modelle gewährleisten eine hohe Leistung voraussagbarer Möglichkeiten. Maxent sagt im allgemeinen ein größeres Gebiet zur möglichen Ausbreitung voraus als BIOMOD, die Algorhytmen des Letzteren zeigen jedoch eine etwas größere Proportion des Untersuchungsgebietes als geeignet an. Ungeachtet vom Algorhytmus, sind gegenwärtig die meisten der linearen Habitate (Uferhabitate und größere Straßen) niedrigerer Höhenlagen im oberen Einzugsgebiet der Theiß (bis zu 400 m), ebenso einige Gebiete mit solchen Habitaten (bis zu 750 m) durch die Besiedlung mehrerer invasiver Arten gefährdet. Auf Grundlage des Verbreitungserfolgs der untersuchten invasiven Arten, ist die Invasion der Schutzgebiete wahrscheinlich, wenn sich die gegenwärtige Entwicklung fortsetzt und die Ausrottung der Arten in hohem Maße unrealistisch. Die Naturschutzplanung muss dahingehend geändert werden, dass Vorkommen und Management der invasiven Arten in Schutzgebieten und ökologischen Netzwerken (in den meisten Fällen) auf Grund der derzeitigen wirtschaftlichen und Pflegesituation mit eingeschlossen ist.

REZUMAT: Potrivirea habitatelor pentru speciile puternic invazive din partea ucraineană a bazinului superior al Tisei.

Carpaţii Ucraineni se confruntă cu o creştere a nivelului invaziei de plante şi a intervenţiei în ecosistemele naturale, iar investigarea implicaţiilor acestor tendinţe pentru conservarea biodiversităţii este de o importanţă capitală. Bazinul superior al Tisei este selectat pentru studiile noastre. Cele mai agresive 11 specii invazive non-native (NIPS) au fost selectate pentru studiu: *Acer negundo* L., *Reynoutria japonica* Houtt., *Reynoutria x bohemica* Chrtek. and Chrtková, *Echinocystis lobata* (Michx.) Torr. and Grey, *Impatiens glandulifera* Royle, *Heracleum sosnowskyi* Manden, *Robinia pseudoacacia* L., *Helianthus tuberosus* L., *Solidago canadensis* L., *Solidago gigantean* Aiton şi *Ambrosia artemisiifolia* L. Cu ajutorul a două pachete software de modelare a distribuţiei speciilor, Maxent şi BIOMOD, arealele cele mai potrivite pentru răspândirea celor 11 NIPS deja prezente în bazinul superior al Tisei sunt anticipate, bazându-ne pe şase variabile de control care reprezintă gradiente climatice, topografice sau de disturbanţă. Toate modelele realizate au un grad ridicat de performanţă în predicţie. Maxent prezice, în general, un areal mai mare potrivit pentru speciile invazive decât BIOMOD, dar algoritmii BIOMOD prezic o proporţie mai mare a ariei în studiu ca fiind potrivită. Indiferent de algoritm, teoretic aproape toate habitatele liniare (habitate ripariene şi drumuri principale) de la altitudinile joase ale bazinului superior al Tisei (până în jurul a 400 m) şi câteva teritorii cu astfel de habitate (până la 750 m) se află la ora actuală în pericol de a fi invadate de diverse specii agresive. Bazat pe succesul de dispersie al speciilor invazive studiate, invazia ariilor protejate este probabilă dacă tendinţele actuale continuă, iar eradicarea speciilor este profund nerealistă. Planurile de conservare trebuie schimbate pentru a include prezenţa şi managementul speciilor invazive în ariile protejate, precum şi reţele ecologice (pentru majoritatea cazurilor), bazate pe situaţia economică şi de management actuală.

INTRODUCTION

Increasing evidence has emerged demonstrating that invasive plant species negatively impact plant communities in the invaded range and that these impacts will most likely be amplified by climate change and anthropogenic disturbances (Thuiller et al., 2007; Brandes and Nitzsche 2006; Dukes 2000; Broennemann et al., 2007; Dukes and Mooney 1999; Nagel et al., 2004; Drake et al., 1997). The Ukrainian Carpathians (UA Carpathians here forth) are experiencing increased levels of plant invasion and disturbances to natural ecosystems, and an investigation of the implications of these trends for biodiversity preservation is of paramount importance.

The UA Carpathians mirror the ecological and economic importance of the whole Carpathian ecoregion. The mountains are home to virgin beech forests that are among the oldest in Europe, and, according to the WWF Carpathian Programme (2007), "with 2,012 species of vascular plants, the Eastern Carpathians are […], after Crimea, Ukraine's richest area in terms of flora" (Wesolowski 2005). Floristic biodiversity also includes a large number of non-vascular species, among them approximately 500 species of mosses. Around 860 species of lichens are also found in the Eastern Carpathians (Tasienkevych 2008).

The Tysa (Tisza) river is the longest tributary of the Danube (966 km) and drains an area of 157,186 km^2 in five countries (Slovakia, Ukraine, Hungary, Romania, Serbia). Tysa can be divided into three main sections: (1) the mountainous Upper Tisza in Ukraine, upstream of the Ukrainian-Hungarian border; (2) the Middle Tisza in Hungary, which is joined by large tributaries including the Bodrog and the Slaná/Sajó (both fed by water from the Carpathian Mountains in Slovakia and Ukraine), as well as the Someş/Szamos, the Crişul/Körös River system and the Mureş/Maros from Transylvania the Lower Tisza downstream of the Hungarian-Serbian border, fed directly by the Bega/Begej, and indirectly by other tributaries via the Danube – Tisza – Danube Canal System.

The upper part of the Tysa river basin was our study area and delineated in Figs. 2 and 3. The UA Carpathians extend over an area of 24,000 km^2. The upper Tysa basin covers near 1/3 of this area. The area is one of "biodiversity hotspots" for the Carpathians with high number of endemic species, protected areas and unique nature heritage, like primeval beech forests. Upper part of the territory consists of large areas of beach and spruce-beech forests and mountain areas with alpine meadows, bogs and mountain streams with cascades (Hamar and Sarkany-Kiss 1999). Further downstream are lower hills with oak forests, as well as large floodplain of Tysa river, which is substantially transformed starting the XIX century. Within whole Transcarpathian Plain alone, an area of about 20,000 ha of wetlands has been destroyed over the last century. Furthermore, the present Ukrainian economic stagnation adds to the pressure upon these forests. Illegal logging still is a serious economic and environmental problem for the region. The proposed study area is also internationally very important. It is located near the borders with four countries: Romania, Hungary, Slovakia, and Poland.

Highly-invasive, non-native plant species (NIPS here forth) have established thriving populations along rivers and roads at low elevations. Utilizing the Alien Plant Ranking System (APRS) developed by the Northern Prairie Wildlife Research Centre (APRS Implementation Team 2000), Prots (2011) determined the eleven most aggressive NIPS to be: *Acer negundo* L., *Reynoutria japonica* Houtt., *Reynoutria x bohemica* Chrtek. and Chrtková, *Echinocystis lobata* (Michx.) Torr. and Grey, *Impatiens glandulifera* Royle, *Heracleum sosnowskyi* Manden, *Robinia pseudoacacia* L., *Helianthus tuberosus* L., *Solidago canadensis* L., *Solidago gigantean* Aiton, and *Ambrosia artemisiifolia* L. The successful proliferation of the species can be attributed to competitive traits which allow them to exclude native species from a habitat. These traits include high fecundity and recruitment, fast growth rates, tolerance to environmental stressors (e.g., seeds enter dormancy when exposed to environmental stress), vegetative reproduction, and high adaptability to long-distance dispersal. Most importantly, the NIPS exhibit high levels of phenotypic plasticity and can thus adapt to a range of environmental conditions and foremost to relatively high levels of disturbances (Petit et al., 2004; Sakai et al., 2001). All NIPS capitalize on anthropogenic or, albeit to a lesser degree, natural disturbances and function as pioneer species that rapidly colonize habitats after disturbance events. Disturbances in form of unregulated forestry practices, pollution, and habitat fragmentation and destruction as a result of changing land-use and infrastructure development have meanwhile increased in the UA Carpathians (Elbakidze and Angelstam 2007; Nazarov et al., 2001; Kuemmerle et al., 2009; Protopopova et al., 2006; Keeton and Crow 2010).

The impacts of NIPS in the introduced range are evident on several ecological levels of organization. At the genetic level, native species can potentially lose genetic variability and thus viability due to hybridization with non indigenous relatives (Protopopova et al., 2006). At the individual level, the highly aggressive NIPS adversely impact the growth, survival, and migration of components of native plant populations. At the population level, this leads to a decrease in abundance and population growth rates and can cause extinction of entire populations, effects that can be extended to the community (Chornesky and Randall 2003; Hulme et al., 2009). At the ecosystem level, by manipulating biotic or abiotic components of an ecosystem, e.g., changes in nutrient loads in soils due to high rates of biomass production and subsequent decomposition, NIPS change its functions. Most importantly, populations of native species and entire ecosystems in the upper part of the Tysa river basin, like in whole UA Carpathians, are threatened mostly by the cumulative impacts of NIPS. Rarely does one find only one species in an ecosystem; instead, in ecosystems currently highly impacted by NIPS, i.e., riparian and roadside communities, one encounters several of the species competing with each other – having almost completely displaced native herbaceous vegetation. Such trends are alarming and require a quantification of the potential long-term impact of NIPS on biodiversity patterns in the UA Carpathians.

Using two types of species distribution modelling software packages, Maxent and BIOMOD, areas suitable for establishment of eleven NIPS already present in the upper part of the Tysa river basin are predicted based on six covariates representing climatic, topographic, and disturbance gradients. Predictor variables are thus chosen to portray areas at high risk of plant invasion and not the entire ecological niche of the species because the latter cannot be determined easily for these rapidly spreading, highly adaptive species (Dullinger et al., 2009; Austin 2002; Peterson 2006; Evangelista et al., 2008). The reasons is that different models tend to produce different results for a species given the same parameters, and the most accurate model is not the same for all species in one study area (Thuiller, 2003). These inter-model variations are often amplified when models are projected to different regions or climates (Hijmans and Graham, 2006; Phillips, 2010).

Our main research question is: given climatic, topographic, and anthropogenic predictors that limit the distribution of suitable habitats for invasive species establishment in the upper Tysa river basin, what is the potential threat of invasion in protected areas under current values of the predictors?

MATERIAL AND METHODS

Species presence data

Near one thousand presence records of non-native invasive plant species (NIPS) (mentioned above) have been collected by B. Prots from years 1990-2011 and by B. Vykhor (2009-2011) and supplemented with reliable herbaria records of the University of Lviv (LW), the University of Uzhgorod (UU), the State Museum of Natural History in Lviv (LWS), and the University of Chernivtsi (CHER) for upper part of Tysa river basin. Each of the species is modelled individually, with the exception of *Solidago* spp. and *Reynoutria* spp. These two taxa have very similar physiologies and realized niches in their invaded range, and the probability is high that mistakes were made in older datasets (herbarium records and literature data) in identifying the genera as separate species. Therefore, each genus/taxon is modelled as one complex, i.e., the complex of *Reynoutria* spp. (*R. japonica* and *R.* x *bohemica*) and the complex of *Solidago* spp. (*S. canadensis* and *S. gigantea*).

For each species/taxonomic complex, the records are georeferenced to a precision of at least 10 meters. When observation points were taken, all locations were at least 50 m apart in order to avoid spatial autocorrelation. Only locations where permanent populations have become established (occupying a sampling unit of 50 m^2 in consecutive years) have been included in the modelling in order to minimize model inaccuracies due to casual, opportunistic observations.

All data are in a presence-only format. Presence-absence data sets are not available for the species studied here and, even if available, could be potentially misleading for the reasons explained above, i.e., the species are not in equilibrium with their environment. Nevertheless, the algorithms used in this study require a basis for distinguishing between suitable and unsuitable habitat. Maxent does so by sampling 10,000 random background points from the entire study area, and BIOMOD extracts 10,000 random pseudo-absence points from the study area outside a radius of 3 km around each presence point.

Predictor variables

Initially, 20 bioclimatic and 5 topographic/land-cover variables were available for modelling (Table 1). Of the 20 bioclimatic variables, 19 were retrieved as ESRI grids from the WorldClim global database (Hijmans et al., 2005). The climatic layers “were generated through [thin spline] interpolation of average monthly climate data from weather stations on a 30 arc-second (or 1 km^2) resolution grid” (Hijmans et al., 2005). Bioclimatic variables used in this study were derived from the monthly values for a particular region. The 20^{th} bioclimatic variable, sum of active temperatures >10°C, as well as vector maps on hydrology and roads, a digital elevation model (DEM), and land-cover and ecoregion data were provided by I. Kruhlov from the Geography Department of the University of Lviv, with the permission of T. Kuemmerle and P. Hostert (Hostert et al., 2008; Kruhlov 2008; Kuemmerle et al., 2009). Layers relevant to the ecology of the NIPS, proximity to water and to settlements and roads, were derived from these maps using the *simple (Euclidean) distance* function in ArcMap 10. Slope was derived from the DEM.

Initial models were run with all or many of the variables and consistently demonstrated in both Maxent that choosing fewer relevant bioclimatic variables instead of the 20 available ones and particularly including slope and distance to water and human structures as variables significantly improved the performance of the models. In general, environmental variables with a Pearson’s correlation coefficient $r > 0.85$ and that contributed little to model fitting were not included into the models. The final environmental variables are thus: minimum temperature of coldest month (*mintcold*), maximum temperature of warmest month (*maxtwarm*), sum of active temperatures > 10°C (*sat*), proximity to water (*s_dist_water*), proximity to settlements and roads (*s_dist_sett_r*), and slope (*slope*) (Table 1).

The DEM held the finest resolution (30 x 30 m). Therefore, to fit the resolution of slope, the climatic variable were resampled to a resolution of 30 m^2 using the *cubic resampling* function in ArcMap 10. Similarly, the sum of active temperatures was interpreted (by contour interpolation) from the ecoregion map at a resolution of 30 m^2. Lastly, hydrology, infrastructure, and settlement maps were rasterized to the same resolution. This yields a 9460 x 7380 grid, with 23,357,345 pixels containing values for all variables. All layers are projected onto the UTM grid, zone 34 with WGS84 datum.

Table 1: Description of predictor variables used for distribution modeling of NIPS (non-native invasive plant species).

Variable	Abbreviation	Measured in	Original geometric accuracy/ resolution	Description
Minimum temperature of coldest month	mintcold	°C x10	1 km (resampled to 30 m)	Invasive species tolerate a wide range of environmental conditions but are sensitive to extremes; periods of extreme frost diminish survival of these generalists (Ibanez et al., 2009).
Maximum temperature of warmest month	maxtwarm	°C x10	1 km (resampled to 30 m)	The NIPS do not tolerate excessive xerothermic (dry and hot) conditions (Ibanez et al., 2009).
Sum of active temperature s > 10°C	sat	°C	1:100,000 ecoregion map (rasterized to 30 m)	Sat approximates the length of the growing season, and species are sensitive to short seasons at upper altitudes (Pearson et al., 2002).
Proximity to water	s_dist_water	m	1:200,000 hydro map (rasterized to 30 m)	All species become established predominantly along river corridors; water plays a vital role for the soil moisture and water balance of the species and provides the most important vehicle of long-distance dispersal and accessibility of suitable habitat (Evangelista et al., 2008; Herborg et al., 2007; Peterson 2006).

Proximity to settlements and roads	*s_dist_sett_r*	m	1:200,000 roads/settl. map (rasterized to 30 m)	Human settlements and roads provide a measure of disturbance that can be beneficial to the spread of the invasive species, provide corridors to suitable habitat, and approximate propagule pressure (Dullinger et al., 2009; Ibanez et al., 2009; Thuiller et al., 2006).
Slope	*slope*	degrees	30 m	The geographical distribution of all species is limited by steep slopes (to different degrees dependent on species); most species are confined to flat river valleys; slope also determines the distribution of anthropogenic structures (Evangelista et al., 2008).

Modeling approaches

We have used two types of species distribution modelling software packages, Maxent and BIOMOD to get a high prediction level for species distribution.

Maximum entropy – Maxent: Maxent modelling is a general-purpose machine learning method for making inferences from incomplete information (Phillips et al., 2006; Franklin 2009). The application has specifically been developed for presence-only data because it does not make assumptions about absences. Maxent estimates two probability distributions, a probability distribution of predictor variables over presence locations and probability distribution of predictor variables across the study area, and estimates the values for the response variable (suitability of an area for the establishment of NIPS) by finding the most uniform distribution of suitable areas given the constraint "that the expected value of each environmental predictor variable under this estimated distribution matches its empirical average (average values for the set occurrence data)"(Hernandez et al., 2006). Maxent has been shown to outperform other presence-only modelling methods (Phillips et al., 2006; Elith et al., 2011; Dudik et al., 2007).

Each of the nine species/taxa is individually modelled with Maxent. For each species, 80% of the records are used for model fitting and 20% for testing. Because the performance of the models is influenced by the particular partitioning step the software assigns to the data, this effect is minimized by the 5k cross-validation. This method divides the occurrence data into five equal-sized folds, and models are created leaving out each fold in turn. The left-out fold is used for evaluation. A final run is made for each species using all the presence records for model fitting in order to derive the most robust classification for visual interpretation (Hernandez et al., 2006). In order to minimize the dependence of model results on a particular sample of background points, all modelling is done twice, each time choosing a different random seed of background points.

Biodiversity Modelling – BIOMOD: BIOMOD models habitat suitability using nine common techniques in species distribution modeling: Generalized Linear Models (GLM), Generalized Additive Models (GAM), Multivariate Adaptive Regression Splines (MARS), Classification and Regression Tree Analysis (CTA), mixture discriminant analysis (FDA), Artificial Neural Networks (ANN), Generalized Boosted Models (GBM), Random Forests (RF), and a Rectilinear Envelope (SRE) (Thuiller 2003; Thuiller et al., 2009b). All techniques can be characterized as either statistical or machine-learning, although the debate on the exact definition of the methods is ongoing (Franklin 2009). The former includes GLM, GAM, FDA, and ANN, and modelling is based on a predefined relationship between predictor and response variables, which then determines how a regression function is fit to describe the relationship between predictor and response variables. The latter includes CTA, MARS, GBM, RF, and SRE, and modelling requires algorithms to "learn" the response function directly from the species data that is analyzed without assuming a certain distribution (Franklin 2009; Hastie et al., 2009). The greatest advantage of BIOMOD is the ability to model the distribution of species using several methods and thus compare the results of the various techniques.

Unlike Maxent, which does not explicitly regard the background as pseudo absences but rather as potential habitat, the algorithms in BIOMOD are discriminative and rely on binary presence/absence data, and pseudo absences must thus be drawn from the background. This is accomplished with the *NbRepPA* function, which is calibrated to extract 10,000 random background points at a minimum distance of 3 km from each presence location (Thuiller et al., 2009a). The procedure is repeated two times to minimize the dependence of the set of pseudo absences on one particular extraction.

Similar to Maxent, BIOMOD is able to split the distribution data into several groups, leave one group out of model fitting each turn, and cross-validate fitted models with the left-out group. In order to compare the results between models within the BIOMOD framework and between BIOMOD and Maxent, a 5k cross-validation is performed (Thuiller et al., 2009b). Just like in Maxent, a final run is made for each species/taxonomic complex using all the presence records for model fitting to derive the most robust classification for visual interpretation.

Distribution of suitable habitat in protected areas

In order to quantify the impact of invasion in protected areas (in terms of area potentially occupied), predictions for current distributions and future projections calibrated on all presence points are transformed into binary suitable (= 1) unsuitable (= 0) values using an optimized threshold based on the ROC curve which maximizes the percentage of correctly predicted presences and background/pseudo absence points. Areas that are suitable for one or more species within protected areas and ecological networks can then be quantified.

RESULTS AND DISCUSSIONS

Although the distribution of the invasive organisms is not confined to the political borders that separate the Ukrainian area of the Carpathians, the choice of the study area has practical as well as ecological applicability. From the practical point of view, the scope of this study, the lack of data on the predictor and response variables for the entire Carpathians (including upper Tysa basin), and the objective to provide relevant information for regional and local authorities justify the focus on the region. From the ecological point of view, the mountain region present topographic gradients of values of the predictor variables that limit the distribution range of the invasive plants (Guisan and Thuiller 2005). That is, outside the UA Carpathians (including outside delineated upper Tysa basin), excessive summer heat and soil moisture deficit limit the distribution of most of the NIPS, while within the mountains, the shortening of the growing season and cold temperatures at higher elevations do the same.

Comparisons between studied invasive species are best accomplished by overlaying the binary predictions for each species as determined by an optimized threshold. This is because the relative suitability indices vary by species and algorithm in terms of the optimized threshold. For a given species and algorithm, all optimized thresholds are given in the table 2.

Table 2: Optimized thresholds for binary predictions of invasive plant distributions within the Ukrainian Carpathians (included upper Tysa basin); suitable = above the threshold; thresholds based on the final models (calibrated on all presence points) in Maxent and BIOMOD best model algorithms.

Species	Threshold Maxent	Threshold BIOMOD
Acer negundo	0.162	0.644
Ambrosia artemisiifolia	0.063	0.55
Echinocystis lobata	0.124	0.597
Helianthus tuberosus	0.111	0.62
Heracleum sosnowskyi	0.189	0.63
Impatiens glandulifera	0.121	0.62
Reynoutria spp. (*R. japonica* and *R. x bohemica*)	0.174	0.577
Robinia pseudoacacia	0.156	0.585
Solidago spp. (*S. canadensis* and *S. gigantea*)	0.162	0.628

As Figure 1 demonstrates, Maxent generally predicts a larger area to be suitable than BIOMOD, in particular for *Heracleum sosnowskyi* and *Robinia pseudoacacia*. The two exceptions are *Acer negundo* and *Solidago* spp. Here, BIOMOD algorithms predict a slightly greater proportion of the study area to be suitable. In general, all received models have a high predictive performance.

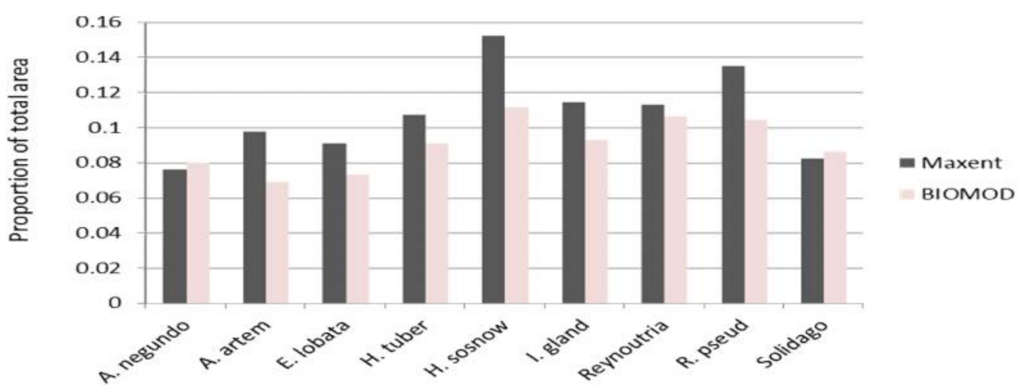

Figure 1: Proportion of total area within the Ukrainian Carpathians (including upper Tysa) predicted as suitable for establishment of invasive species with Maxent and BIOMOD models.

In the figure 2, depicting averages of species presence (9 NIPS/pixel) and of predictor variables (maxtwarm, s_dist_sett_r, slope) within biogeographic regions (Kruhlov, 2008) found in the UA Carpathians, demonstrates the correlation between the aggregation of suitable habitats for all 9 species/taxa modelled and the presence of suitable climatic regimes, high density of anthropogenic structures, and flat slopes in the regions of the upper Tysa basin, like Upper Tysa Depression, Cirokha-Rika Low Mountains and Vyhorlat-Hutyn Volcanic Ridge.

Region	Name	9 NIPS/pixel	maxtwarm (Cx10)	s_dist_sett_r (m)	slope (degree)
23	Upper Tysa Depression	1.05	246.2	554.09	5.62
8	Cirocha-Rika Low Mountains	0.17	237.49	797.99	10.58
14	Vyhorlat-Hutyn Volcanic Ridge	0.13	235.16	1144.26	10.63
0	Marginal Beskydy	0.05	218.84	800.13	8.79
9	Marginal Gorgany	0.05	215.99	727.1	12.38
12	Latorytsia-Rika Verkhovyna	0.04	213.28	481.15	12.88
19	Pokuttia-Bukovyna External Mountain	0.04	220.18	1198.55	13.76
24	Rika-Apshytsia Cliff Mountains	0.04	230.97	843.01	14.61
18	Brdo-Manchul Polonyny	0.03	217.8	2140.58	19.57
28	Apshytsia-Kosivs'ka Low Mountains	0.03	227.43	647.81	12.13
6	Ravka-Runa Polonyny	0.02	210.61	1544.32	15.88
1	Dnister Beskydy	0.02	211.68	742.89	10.58
7	Bukovets' Polonyny	0.02	204.03	734.02	14.22
11	External Gorgany	0.02	204.68	1628.24	15.71
26	Rakhiv Flysch Polonyny	0.01	200.3	2217.09	20.99
21	Hutsul Verkhovyna	0.01	207.6	838.6	12.25
3	Central Gorgany	0.01	210.95	1143.55	13.54
15	Borzhava-Krasna Polonyny	0.01	204.33	2754.11	21.94
30	Rakhiv Crystalline Polonyny	0.01	206.06	2412.2	22.04
16	Internal Gorgany	0.01	189.49	2306.56	21.51
20	Pokuttia Gorgany	3.57E-03	200.18	1253.38	18.69
4	Central Beskydy	2.10E-03	199.53	2026.4	17.75
22	Svydivets' Polonyny	7.61E-04	188.92	3066.2	19.08
27	Bukovyna Internal Mountains	6.06E-04	204.5	1630.08	16.58
29	Hryniava Polonyny	4.59E-04	196.64	1002.12	17.77
2	S'an-Stryi Verkhovyna	3.95E-04	205.68	512.84	8.79
10	Beskydy Verkovyna	2.80E-05	202.15	824.17	10.98
5	Internal Beskydy	2.13E-05	197.77	1083.96	15.52
25	Chornohora Polonyny	1.82E-05	183.36	2783.86	18.03
13	Central Gorgany	6.60E-06	186.94	2800.98	19.62
17	Gorgany Verkhovyna	0	191.3	2698.64	13.6
31	Chyvchyny Flysch Polonyny	0	182.44	1637.59	18.5
32	Chyvchyny Crystalline Polonyny	0	176.36	3339.36	15.28

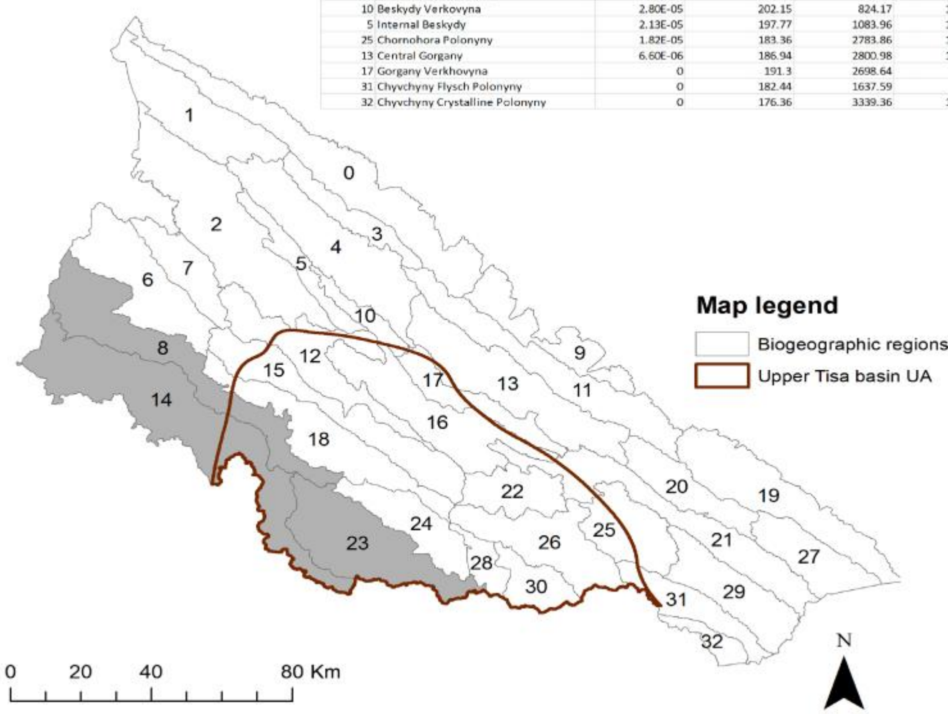

Figure 2: Biogeographic regions within the Ukrainian Carpathians and table (sorted descending based on 9 NIPS/pixel) showing correlation between mean values of maximum temperature of the warmest month (maxtwarm), distance to settlements and roads (s_dist_sett_r), and slope and average number of all 9 study species/taxa (NIPS) per pixel within each region. Regions colored in grey represent the three most invaded regions (highest proportion of 9 NIPS/pixel).

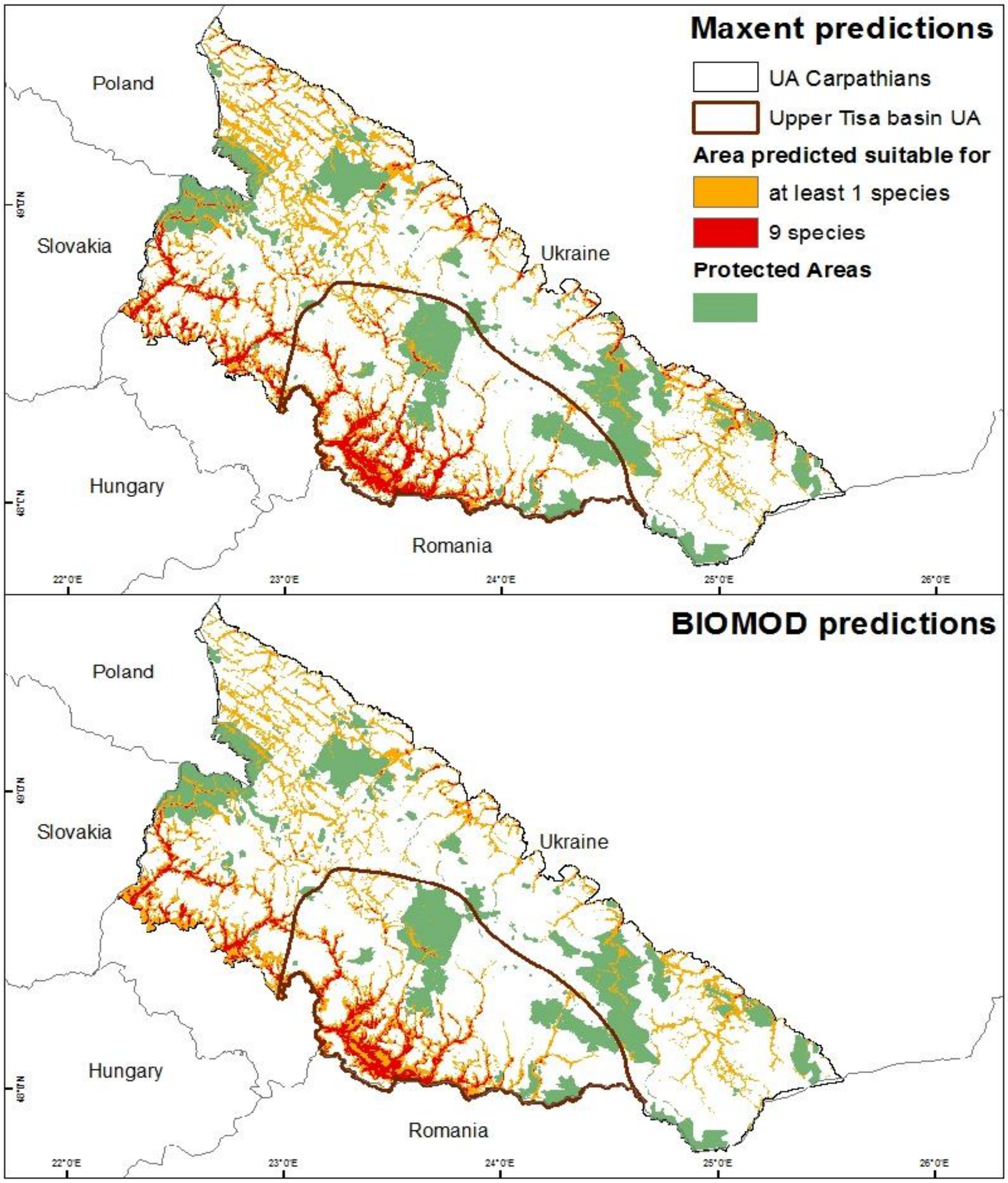

Figure 3: The range of potential impact of non-native invasive plants on biodiversity in the Ukrainian Carpathians (delineated Upper Tysa basin) under current environmental conditions; spatial distribution of suitable habitats for establishment of one or nine invasive plants/taxa within the region and within protected areas as determined by Maxent and BIOMOD algorithms.

Regardless of algorithm, virtually almost all of linear habitats (riparian habitats and major roads) at lower elevations of upper Tysa basin area (up to approximately 400 m) and also for some territories with such habitats (up to 750 m) are currently at risk to become invaded by several aggressive NIPS. In addition, the presence of species in many habitats predicted as suitable means that further spread of the NIPS is imminent if current trends continue. The potential distributions of the eleven NIPS for the study area are identified as highly aggressive. Meanwhile, the results of this study illustrate that the NIPS have the potential to spread far into the mountain range (Fig. 3).

For all NIPS, this migration occurs primarily along rivers and roads and emphasizes the importance of these linear habitats for the spread of invasive species. In areas that are highly suitable for invasion today, future projections suggest a lateral spread of species away from major linear habitats and along small waterways.

The figure 3 demonstrates also the threats protected areas face by the highly adaptive and aggressive NIPS. The Synevyr National Nature Park, edges of the Carpathian Biosphere Reserve and number of small scaled reserves located along rivers need a special conservation management against distribution of invasive species for the area of the upper Tysa basin.

Given the negative impacts the NIPS presented in this study have on biodiversity, the impact of potential invasion of species-rich, protected landscapes is a major concern. Protected areas are landscapes designated and managed with the specific aim to protect biodiversity within them. Therefore, analyses of potential introduction of NIPS into protected areas must be incorporated into strategies or management plans to protect biodiversity. In cooperation, ecologists, conservation biologists, and natural-resource managers can determine the likelihood of invasion based on the modelling results, which species are most likely to invade an area, and where these species are likely to come from. A clear understanding of the Maxent algorithm, comparisons of the contributions of different predictor variables, and expert knowledge on the ecology of the species can be used to prioritize monitoring in order to achieve successful prevention and early detection and quick response to invasion for selected areas if appropriate and possible. In general, given the dispersal success of the studied invasive species, invasion of protected areas is likely if current trends continue and complete eradication of species is highly unrealistic. Therefore, conservation planning must be changed to include the presence and management of invasive species in protected areas and ecological networks (for most of cases) based on current economic and management situtaion, which is different to current views.

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TENDENCIES OF *RHODODENDRON MYRTIFOLIUM* SCHOTT ET KOTSCHY COMMUNITY DINAMICS IN THE UKRAINEAN CARPATHIAN ALPINE AREAS

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KEYWORDS: *Rhododendron myrtifolium*, distribution range, human impact, community dynamics.

ABSTRACT

The paper provides information about the dynamic pattern of a *Rhododendron myrtifolium* community in the Ukranian Carpathians. A field survey and subsequent literature review focused on the impacts of grass burning, grazing intensity and recreational activities on the spatial and temporal distribution of this species. The main anthropogenic factors with a substantial impact on the dynamic of this species were identified as being the excessive grazing and burning. However, at the lower limit of the species' distribution in the subalpine zone (1350-1650 m a.s.l.) we can see the process of woodland succession and the raising of the upper forest line as a result of decline in farming activities. This fact causes the reduction of *Rhododendron myrtifolium* Myrtifolium thickets, which reduces the scope of this species' vertical distribution range in the Ukrainian Carpathians. The greatest current threat for *Rhododendron myrtifolium* was identified as that posed by increasing recreation pressure.

RÉSUMÉ: Tendances dans la dynamique des communautés de *Rhododendron myrtifolium* Schott et Kotschy dans la région des Carpates ukrainiens.

L'article offre des informations sur les schémas de la dynamique des communautés de *Rhododendron myrtifolium* dans les Carpates ukrainiens. Une étude de terrain et la littérature subséquente se sont concentrées sur l'impacte des brûlis, l'intensité du pâturage et des activités récréatives sur la distribution spatiale et temporelle de l'espèce. Les principaux facteurs anthropogéniques ayant un impacte substantiel sur la dynamique de l'espèce investiguée ont été le pâturage excessif ainsi que les brûlis. Néanmoins, à la limite inferieure de distribution de l'espèce dans l'étage sous alpin (1350-1650 m au dessus de la mer) on peut observer le processus de succession et la montée de la limite supérieure de la foret comme résultat du déclin des activités agricoles. Ceci mène à la réduction des fourrés de *Rhododendron myrtifolium* ce qui entraine la réduction de la limite superieure de distribution de l'espèce dans les Carpates ukrainiens. A présent, la plus grande menace pour *Rhododendron myrtifolium* a été identifiée comme la pression récréative.

REZUMAT: Tendinţele de dinamică a comunităţilor de *Rhododendron myrtifolium* Schott et Kotschy din trei regiuni alpine din carpaţii Ucraineni.

Articolul oferă informaţii cu privire la modelele dinamici comunităţii de *Rhododendron myrtifolium* din Carpaţii ucrainieni. Un studiu de teren şi bibliografia subsecventă s-a concentrat pe impactul incendierii vegetaţiei ierboase, al păşunatului intensiv și al activităților recreaționale asupra distribuției spațio-temporale a acestei specii. Principalii factori antropogeni cu impact substanțial asupra dinamicii acestei specii au fost identificați a fi pășunatul excesiv și incendierea vegetației. Dar cu toate acestea, la limita inferioară a arealului speciei în zona subalpină (1350-1650 m de la nivelul mării) putem vedea procesul succesiunii forestiere și urcarea lizierei pădurii ca rezultat al declinului activităților agricole. Acest fapt duce la reducerea desișurilor de *Rhododendron myrtifolium* care reduce perspectiva distribuției verticale a acestei specii în Carpații ucrainieni. S-a concluzionat că cea mai mare amenințare prezentă pentru *Rhododendron myrtifolium* este cea a presiunii recreaționale în creștere.

INTRODUCTION

The alpine vegetation of the Ukrainian Carpathians has suffered changes in the last few centuries as a result of intensive anthropogenic impact. Because of the local economic activity the areas of pristine plant associations decreased substantially [7,8]. Anthropogenic factors affected negatively, in particular, sprawling bush thickets of rare Rhododendron myrtifolium Schott et Kotschyi. This sub-endemic species grows in the Eastern and Southern Carpathians and partly on the Balkan Mountains [7.14]. Rh. myrtifolium listed in both editions of "Red Book of Ukraine" [2.6], and plant communities that form this type are included in the "Green Book of the USSR" [3] and the "Green Book of Ukraine" [4]. Rhododendron thickets are also registered as endangered habitats that require introduction of special measures for their protection, approved by the Standing Committee of the Berne Convention December 6, 1996 [15].

In the Ukrainian Carpathians main areas of Rh. myrtifolium distribution are mainly associated to the Marmarosh massif within the altitudes 1350-2050 m asl. On the Svydovets, Gorgany and Chyvchyny-Hrynyava mountains such localities are found sporadically and occupy small areas. During the last few centuries of intensive anthropogenic impact solid thickets of Rh. myrtifolium broke up into separate isolated fragments and remain mostly on steep slopes, rocky cliffs and scree [8].

The main economic use of natural resources is of traditional highland Polonyny management (grazing, felling, burning), recreational activities and others.

Grazing is one of ancient forms of land use, and it is one of the most significant factors of influence and anthropogenic stress on natural systems. For hundreds of years significant areas of pristine shrub communities have been destroyed, and replaced by secondary meadow communities have appeared, that currently occupy significant areas of alpine zone in the Ukrainian Carpathians [7]. Along with other species, communities of Rh. Myrtifolium suffer from burning and logging. For example, the largest segments of Rh. myrtifolium areas collapsed almost completely due to intensive grazing and recreation activity – slopes between peaks P'yetros and Pip Ivan of Chornohora [8]. There also has been a large population concentrated on the Svydovets in former times, but now only islands on the northern slope Blyznytsia Mt. (Polish Steryshora) survived. According to data from scientific literature, the Borzhavsky meadow population of Rh. myrtifolium has disappeared completely [14]. In the Maramorosh massif there are continuous thickets of Rh. Myrtifolium, which are preserved here quite well on the slopes of Pip Ivan.

MATERIAL AND METHODS

The survey was conducted in 2001-2010 period, to study the dynamics of communities with the participation of Rh. myrtifolium on sotes with different anthropogenic impact (fire, grazing, recreation and in localities with the suspended human impact). There was established a network of permanent plots, where direct and indirect methods of study were applied to trace changes in vegetation cover (E. Aleksandrova, 1). On the basis of detailed geobotanical descriptions a list of plant species was compiled; the quantitative inventary defined the percentage according to the methodical instructions (V.M. Ponyatkovska, 9). The names of all plants are given according to SK Cherepanov guidelines [13], names of associations are given according to the dominant classification [10]. Vegetation dynamics was observed based on changes in coverage by biomorphological groups: tree-shrubs, meadows and moss-lichen.

Investigation of changes after fires which had occurred in areas occupied with Rh. myrtifolium were conducted using the same methods as in normal geobotanical studies [9]. Identification of vegetation cover was carried out before the fire took place using the method of plant residues and "scars" - boundaries, fire power and coverage of Rh. Myrtifolium by the solid or damaged shoots of live trees and shrub species on the methods according to V.D. Alexandrov [1]. To define an exact age of the burnt territories we used archival materials of CBR and also conducted interviews with rangers of the reserve.

Quantitative influence of grazing intensity on a specific area with Rh. myrtifolium was determined according to literature instructions by Yo. Tsarik, et al. [11], in which the density and number of animals on pasture was divided into three categories: a) no grazing, b) low or moderate grazing (defined in the study period from 0,5 to 1,0 livestock per 1 ha; 3.5 sheep per 1 ha) c) intensive grazing (over 2 cows per 1 ha, over 10 sheep per 1 ha). That distinction was valid for all plots throughout the period of study.

To study the impact of recreation on the changes in vegetation communities with the participation of the studied species a special profile was established near the main tourist route to Hoverla from the south-western side by the method of direct observation by V.D. Aleksandrova [1].

RESULTS AND DISCUSSIONS

K.A. Malynovskyi singled out the *Rhodoreta kotschyi* formation with three associations within: *Rhodoretum vacciniosum, Rh. herboso-cetrariosum* та *Rh. sphagnosum*. Analyzing these communities according to the floristic classification, K.A. Malynovskyi and V.V. Krichalushiy [8] refer the *Rh. myrtifolium* communities to *Loiseleurio-Vaccinietea* Eggler 1952 ex Schubert 1960 class, порядку *Rhododendro-Vaccinietalia* Br.-Bl. in Br.-Bl. et Jenny 1926 order, *Rhododendro-Vaccinion* Br.-Bl. 1926 union, and the association of *Rhododendretum myrtifolii* (Puscaru et al. 1956) Kricsfalusy et Malynovski 2002.

According to the descriptions conducted in the Ukrainian Carpathian Alpine areas of associations within the *Rhododendreta myrtifolii* formation according to the dominant classification [10] and 10 associations: I. Group of shrub-motley rhododendron associations, which includes three associations: 1. Rhododendretum (myrtifolii) vacciniosum (myrtilli); 2. Rh. vacciniosum (uliginosi); 3. Rh. purum; II. Group of motley-grass rhododendron associations, which include five associations: 4. Rh. calamagrostidosum (villosae), 5. Rh. caricosum (curvulae), 6. Rh. festucosum (pictae), 7. Rh. juncosum (trifidi), 8. Rh. sesleriosum (heufleriana). III. Group of oligotrophic moss-lichen rhododendron associations: 9. Rh. cetrariosum (islandicae), 10. Rh. sphagnosum.

On its lower range *Rh. myrtifolium* participates in shrub communities. We single out the following associations: 11. *Pinetum (mugi) rhododendroso (myrtifolii)-vacciniosum (myrtilli),* 12. *Duschekietum (viridi) rhododendroso (myrtifolii)- calamagrostidosum (villosa),* 13. *Juniperetum (sibirica) rhododendroso (myrtifolii)- deschampsiosum (caespitosae).* In some places adjacent to the upper forest line we described the association: 14. *Piceetum (abietis)* *juniperoso (sibiricae) – rhododendrosum*. On its upper range in the alpine zone *Rh. myrtifolium* participates in rare shrub communities; the following associations are described: 15. *Salicetum (herbacea) rhododendroso festucosum (supini);* 16. *Salicetum (retusae) caricosum (sempervirentis);* 17. *Loiseleurietum* (*procumbentis) rhododendroso juncosum (trifidi);* 18. *Empetretum (nigri) rhododendroso cetrariosun (islandicae).*

There are 212 localities with vascular plants within the communities described above: 6 species listed to the European Red Lis: *Astragalus krajinae* Domin*, Heracleum carpaticum* Porcius*., Ranunculus malinovskii* R.Jelen. et Derv, *Pulmonaria filarskiana* Javorka*, Primula poloninensis* (Domin) and Fed*, Silene dubia* Herbich.; 3 species under the Bern Convention: *Narcissuc angustifolius* Curt., *Campanula abietina* Griseb*.* et Schenk., *Poa deylii* Chrtek et Jiras*.*; 2 species listed to the IUCN lists: *Ptarmica tenuifolia* (Schur) Schur, *Heracleum carpaticum* Porc. Apart for that, communities with participation of *Rh. myrtifolium* create appropriate conditions for a number of rare, endemic and relict plant species.

In the dynamics of groups involving Rh. myrtifolium are two opposing processes: digression as a result of anthropogenic factors (fires, over-grazing, intensive recreational pressure), climate change at the lower limits of distribution - 1350-1600 masl (shrubs succession, raise of woodland belt and the upper forest line) and demutation because of the direct human impact within the upper subalpine and alpine zones - 1650-2050 masl. We join the opinion of most authors [5, 7, 8, 12], who studied the dynamics of high-mountain vegetation in the Ukrainian Carpathians that under the influence of climatic changes in the Ukrainian Carpathians there is a trend of increasing vegetation zones, and centuries of anthropogenic influence has led to deep digressive transformation of indigenous vegetation of alpine zone.

Anthropogenic changes occur as a result of human activities, such as burning and grazing as a result of traditional poloninsky economy and trampling from heavy recreational pressure.

Impact of fire. Changes appeared within communities with of *Rh. myrtifolium* after fires on four plots which have undergone fire effect in different years: Kostan-Gropa alpine meadow (Pip-Ivan of Maramureş Mt.), alpine meadows Serylivka and Holovcheska (Petros Mt.) and Baltsatul meadow (Pip Ivan of Chornohora). Analyzing the data of the research, we note that fires negatively affect rhododendron thickets and lead to their digression. Natural succession on alpine meadows depends on the intensity of fire and slope steepness. After continuous intense fire there occurs a complete change in vegetation. In some places recovery of Rh. myrtifolium thickets is not observed, and their places are occupied by groups dominated by Calamagrostis arundinacea (L.) Roth., S. villosa (Chaix.) JF Gmel., Agrostis tenuis Sibth., Deschampsia caespitosa (L.) Beauv., Lerchenfeldia flexuosa (L.) Schur. With a weak fire intensity when only the upper part of shoots is damaged, Rh. myrtifolium and shrubs Vaccinium myrtillus L., V. ulliginosum L., Rhodococcum vitis-idea (L.) Avror., Empetrum nigrum L. et al., reach partial recovery. Fire in some places encourages pioneer-plants such as Chamerion angustifolium (L.) Scop. Destruction of herb-shrub cover on steep slopes causes soil erosion and increase the area of stony placers. Continuous periodic burning for few last centuries has led to the destruction of undergrowth of Rh. myrtifolium large areas.

Influence of grazing. Researches of communities involving Rh. myrtifolium influenced by grazing was held on the meadow Lysychyy, located on the northern slope of Mount Pip Ivan Marmaros. Depending on the nature of vegetation, microrelief features, nature, timing and movement of cattle we distinguish between several areas of moderate up to intensive grazing or no grazing. The quantitative impact of grazing (Yo. Tsarik et al., 11) on a specific area is conditionally divided into 3 categories: intensive, low or moderate grazing and no grazing. At this pasture there were laid 3 plots in places with different intensity grazing. In the area of intense grazing the overall plant cover decreased from 92% to 90% of coverage of Rh. myrtifolium decreased from 9 to 7%, and the reduction also referred to other types of shrubs. Instead, we can trace an increased participation of meadow species. Reduction in coverage of Rh. myrtifolium depends on the load and increase in the density of livestock, species of domestic animals, seasons and duration of grazing. The area with little or moderate grazing are characterized by increase of vegetation cover from 92% to 94%. For Rh. myrtifolium there's observed a slight increase in coverage from 12 to 13%. There is also observed an expansion of shrub species. Among pastures there are more remote and difficult to access ones. In areas where grazing is stopped, there is observed an increase in vegetation cover from 96% to 100%. The increase of Rh. myrtifolium coverage constitutes from 15 to 17%. There is an increase in coverage of shrub species, however, there is a reduction in herbaceous species. According to this study, the increas of Rh. myrtifolium coverage is observed in areas where grazing moderate or stop altogether.

Influence of recreational activity. Burning and grazing is reduced within alpine areas of the Ukrainian Carpathians, but there is an increase in recreational pressure (trampling, bonfires, camping, tree cutting, littering, picking flowers etc.). According to our observations, Rh. myrtifolium is extremely vulnerable to trampling. Digression of plant communities with Rh. myrtifolium is observed in the most visited tourist sites – mountain tops section and piedmonts of the highest mountains, banks of mountain lakes and streams, and others. To study the dynamics of plant communities with the participation of this species, which occurs under intense recreational pressure, in 2001 there has been laid a profile (100x1 m) along the tourist trail on the south-western slope near the top of Hoverla Mountain. During the study period we can note polygon the reduction in the overall vegetation cover from 93 to 72%. Coverage of Rh. myrtifolium decreased from 20 to 15%. In plant communities we observe a decrease of Salix herbacea L., Carex sempervirens Vill., C. curvula All. et al. Also, there's a decrease in number of rare herbaceous species, in particular Pulsatilla scherfelii Skalicky, Rhodiola rosea L., Gentiana punctata L., Antennaria carpatica (Wahlenb.) Bluff. Et Fingerh., Huperzia selago (L.) Bernh. ex Mert., Anemone narcissiflora L. et al.

Impact of conservation. An indicator of rhododendron thickets' adaptation to quit of anthropogenic pressure is their ability to demutae. We conducted long observation of vegetation in the Carpathian Biosphere Reserve on the alpine meadows Bretskul and Tsybulnik (1700-2000 m asl) in the upper subalpine and alpine zones, where more than 10-15 years ago the anthropogenic impact had been suspended. It was found, that there was an increase in the number of Rh. Myrtifolium coverage and expansion of its distribution area. Thus, under the condition of minimal or complete absence of anthropogenic pressure on the secondary (derived) meadows there's observed a recovery in Rh. Myrtifolium communities within the upper subalpine and alpine zones.

Impact of climate change. Study of the climate change impact on communities involving Rh. myrtifolium within the lower limits of distribution were conducted on the southeastern slope of Bretskul (1500-1520 m asl) within the association of Pinetum (mugi) rhododendroso (myrtifolii)-vacciniosum (myrtilli), listed into the Green Book of Ukraine [4]. The described association is in the core zone of the Carpathian Biosphere Reserve, so no anthropogenic influence is possible. According to our observations show an increase in coverage of Pinus mugo and therefore reduce the coverage of Rh. myrtifolium. In some places within the lower limit of rhododendron thickets distribution there was observed a raise in the upper forest line and Picea abies (L.) Karst. succession, which is also a consequence of the climate change. Modern climatic changes lead to Rh. myrtifolium communities digression within the lower range of distribution.

CONCLUSIONS

The digression of the communities with participation of *Rh. myrtifolium* occurs as a result of an intensive anthropogenic pressure (fires, over-grazing, and intensive recreation). There's a raise in the upper forest line and woodland caused by the global climate change, which in its turn leads to digression of *Rh. myrtifolium* in its lower range. Secondary meadows undergo succession of *Rh. myrtifolium* phytocoenoses with shrubs after human pressure is stopped within the lower range of its distribution and also brings to their digression. The demutation occurs as a result of stopping the direct human impact within the upper subalpine and alpine zones. Impact of grazing and burning has grately reduced during recent years. The greatest threat today for communities with *Rh. myrtifolium* in the increase of recreational pressure.

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HIGHLAND FORESTS OF THE CARPATHIAN BIOSPHERE RESERVE

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KEYWORDS: Primeval forests, composition, distribution, preservation, beech, spruce, management.

ABSTRACT

The article highlights the condition and deals with the analysis of highland forests for the historical period. The article describes the results of the research of modern highland forests in four massifs of the Carpathian Biosphere Reserve (CBR). In particular, the data on species composition and distribution, as well as their area is provided. The distribution of natural forests and primeval forests according to the CBR massifs were shown. The preservation level of the upper forest limit of beech and spruce forests was shown. A systematic analysis of rare flora and fauna species was outlined. A management plan for the conservation of highland forest ecosystems and for regulatory measures for the restoration of disturbed biotopes was suggested.

ZUSAMMENFASSUNG: Die Bergwälder des Karpaten-Biosphärenreservats (Ukraine).

Der Artikel befasst sich mit Zustand und Analyse der Bergwälder in historischer Zeit. Es werden die Forschungsergebnisse der modernen Forstwirtschaft in Bergwäldern von vier Massiven des Karpaten-Biosphärenreservats der Ukraine vorgestellt. Insbesondere geht es dabei um die Zusammensetzung und Verteilung der Baumarten sowie ihr Areal. Vorgestellt wird auch die Verbreitung natürlicher Wälder sowie der Urwälder in den Bergmassiven des Karpaten-Biosphärenreservats. Der Verfasser geht ferner auf den Erhaltungszustand der oberen Verbreitungsgrenze der Buche und Tanne ein. Diesen Ausführungen folgt auch eine systematische Analyse der seltenen Arten aus Flora und Fauna. Schließlich wird ein Managementplan für die Bewahrung der Bergwaldökosysteme sowie regelnde Maßnahmen für die Renaturierung der gestörten bzw. veränderten Lebensräume vorgeschlagen.

REZUMAT: Paduri montane ale Rezervatiei Biosferei Carpatice.

Lucrarea evidenţiază condiţiile şi prezintă analiza pădurilor montane de-a lungul timpului. Lucrarea prezintă rezultatele cercetărilor asupra pădurilor montane actuale din patru massive din Rezervaţia Biosferei Carpatice (CBR). În particular, se prezintă şi date asupra speciilor existente şi a distribuţiei lor precum şi asupra arealului lor. De asemenea, se arată răspândirea pădurilor naturale şi seculare, în funcţie de masivele CBR. Se evidenţiază nivelul de conservare al limitei superioare a pădurilor de fag şi molid. Se propune un plan de management pentru conservarea ecosistemelor pădurilor montane şi măsuri de refacere a biotopurilor distruse.

INTRODUCTION

In accordance with the applicable regulations in Ukraine, the forests located above 1100 m asl are considered to be highland forests and must be included in the category of protective anti-erosion forests.

The highland forests of the Ukrainian Carpathians play a crucial environmental, protective and climate-regulating role. Being exposed to harsh mountain conditions, forest cover gained unique life forms and is an important factor for creating environment. Hence, a famous Alps researcher (Pockberger, 1958) aptly described a strip where forest vegetation is neighboring with subalpine formations as "battle zone".

Over the last several centuries the highland forests of the Ukrainian Carpathians have undergone significant changes due to intensive human impact. In particular, unsystematic deforestation, burning and uprooting of forests and excessive grazing led to the formation of artificial pastures (meadows), totaling more than 100,000 hectares, changes in altitudinal location and configuration of the upper forest limit as well as structure and productivity of forest and shrub cenosis, etc. The upper limits of highland forests are mainly of anthropogenic origin and sometimes are 200-300 m lower. (Kolishchuk, 1958, 1960; Malynovskyi, 1980, 1984)

Climate or natural upper forest limit is partially preserved only in certain massifs and mostly within protected areas. At present, only their remains can be found in such massifs as Beskyd and Svydivets. The relatively better natural upper forest limit is preserved only in Marmarosh and Chornohirskyi massifs. (Stoyko and Tretyak, 1978; Stojko, 2002; Sukhariuk and Voloshchuk, 2005).

The aim of the research is to asses naturalness of highland forests of the CBR, preservation level of the upper forest limit, define plants and animals species listed in the Red Book of Ukraine and take steps to conserve natural forests and primeval forests as well as to restore disturbed biotopes within the highland forest belt of the Carpathian Biosphere Reserve.

MATERIAL AND METHODS

CBR forest cover an area of 44,107 hectares and are located in Vyhorlat-Hutyn (855 ha), Chornohirskyi (12,261 ha), Svydivets (9503 ha), Marmarosh (7,647 ha) and Uholsko-Shyrokoluzhanskyi (13,841 ha) massifs. The highland forests can be found on the territory of the last four massifs. The assessment of naturalness of the forests was carried out according to the methods of (Stojko, 2002) using mensurational description and maps. The study of the upper forest limit was conducted by the method of (Kolishchuk, 1958, 1960) using topographic maps, respective surveying instruments and tools.

Floral and faunal surveys were carried out through the route observations of forests and forest glades. To learn more about flora and fauna of the reserve’s highlands, information databases and materials of the CBR Nature Chronicles were used.

RESULTS AND DISCUSSIONS

CBR highland forests cover an area of 15425 ha, representing 34.9% of the total area of the reserve’s forests (Tab. 1). Spruce and beech forests are the most common in the highland forest belt (13,928 ha or 90.3%). Natural forests and primeval forests make up 81% of the total area of the highland forests, which indicates a high level of their preservation. 2959 ha of beech primeval forests, which are part of the Ukrainian-Slovak-German site of the UNESCO World Heritage "Primeval Beech Forests of the Carpathians and the Ancient Beech Forests of Germany", is preserved within the CBR highland forests zone. It has also been established that mountain pine, green alder and maple natural forests and primeval forests are preserved and protected only within the highland forest zone.

Table 1: Types and naturalness of highland forests.

Types, the naturalness and area (hectares) of the forests		CBR				
		Uholsko-Shyrokoluzhansky	Chornohirskyi	Svydivets	Marmarosh	CBR Total
Pure and mixed beech						
Total		**1282**	**1047**	**2071**	**258**	**4658**
including	primeval	902	281	1555	221	2959
	natural	380	761	449	27	1617
	secondary	-	5	67	10	82
Pure and mixed spruce						
Total		**-**	**4195**	**1738**	**3337**	**9270**
including	primeval	-	991	352	1799	3142
	natural	-	1915	700	706	3321
	secondary	-	1289	686	832	2807
Mixed juniper						
Total		**13**	**63**	**52**	**104**	**232**
including	primeval	10	63	29	81	183
	natural	3	-	10	11	24
	secondary	-	-	13	12	25
Mixed maple						
Total		**-**	**81**	**-**	**4**	**85**
including	primeval	-	66	-	4	70
	natural	-	15	-	-	15
	secondary	-	-	-	-	-
Mountain pine						
Total		**-**	**572**	**-**	**49**	**621**
including	primeval	-	290	-	37	327
	natural	-	282	-	12	294
	secondary	-	-	-	-	-
Green alder						
Total		**5**	**416**	**82**	**56**	**559**
including	primeval	-	180	75	37	292
	natural	5	236	7	9	257
	secondary	-	-	-	10	10
CBR Total		**1300**	**6374**	**3943**	**3808**	**15425**
including	primeval	912	1871	2011	2179	6973
	natural	388	3209	1166	765	5528
	secondary	-	1294	766	864	2924

Analysis of the upper forest limit research results has shown that anthropogenic impact most significantly affected the deciduous stands of the upper forest limit (Tab. 2). In particular, the lowest location of anthropogenic upper forest limit and the lowest percentage of the natural upper forest limit were identified here. Maximum altitude of the natural forest limits and the largest percentage of its preservation were found in the spruce forests area in Marmarosh massif where their indicators total 1710 m asl and 41.3% respectively.

Table 2: Altitudinal location and naturalness of the upper forest limit.

Massif name	Upper forest limit type	Maximum altitude of the natural forest limit, m asl.	Minimum altitude of the anthropogenic forest limit, m asl.	% of natural forest limit depending on its total length within the massif
Uholsko-Shyrokoluzhansky	deciduous (forest beech)	1370	1060	1.6
Svydivets	pin (spruce), deciduous (forest beech)	1480 1390	1140 1080	3.8 0.7
Marmarosh	pin (spruce)	1710	1270	41.3
Chornohirskyi	pin (spruce), deciduous (forest beech)	1650 1430	1190 1130	35.9 1.4

Rich biodiversity was found in the highland forests of the CBR (Tab. 3). Their flora consists of 17 species of plants listed in the Red Book of Ukraine and presented in 8 families. Such unique rare species as Narcissus angustifolius, Gentiana lutea, Rhododendron myrtifolium and others were found here.

Table 3: Flora's systematic structure of rare species of vascular plants within the highland forests listed in the Red Book of Ukraine.

No.	Family name	Number of species within the CBR	Including massifs			
			Svydivets	Chornohirskyi	Marmarosh	Uholsko-Shyrokoluzhansky
1	Lycopodiaceae	1	1	1	1	1
2	Huperziaceae	1	1	1	1	1
3	Ericaceae	1	1	1	1	
4	Gentianaceae	4	3	4	3	
5	Liliaceae	1	1	1	1	1
6	Amaryllidaceae	3	1	1	2	2
7	Iridaceae	1	1	1	1	1
8	Orchidaceae	5	4	5	4	5
Total:		17	13	15	14	11

Table 4: Fauna's systematic structure of rare species of animals within the highland forests listed in the Red Book of Ukraine

No.	Animals class	Number of species within the CBR	Including massifs			
			Svydivets	Chornohirskyi	Marmarosh	Uholsko-Shyrokoluzhansky
1	Insecta	7	3	5	4	4
2	Amphybia	4	4	4	4	4
3	Avia	16	12	14	7	9
4	Mammalia	16	14	14	15	16
Total:		43	33	37	30	33

CONCLUSIONS

Management plan for highland forest ecosystems

1. Improving of grazing and ecotourism activities.
2. Development of a comprehensive plan to restore the upper forest limit.
3. Mapping of habitats of rare species of animals and plants and their monitoring, as well as database maintenance.
4. Creation of a permanent sample plots network in the natural and secondary forests.
5. On-site marking of the boundaries of all plots of UNESCO World Natural Heritage site.

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PRIMEVAL FORESTS OF THE CARPATHIAN BIOSPHERE RESERVE: DIVERSITY AND ACTION PLAN FOR THEIR CONSERVATION (UKRAINE)

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KEYWORDS: oldgrowth forests, primeval forests, rare plant species, distribution, conservation.

ABSTRACT

In introductory part highlights the importance of primeval forest ecosystems and the history of their research both in the Ukrainian Carpathians and in the territory of the Carpathian Biosphere Reserve (CBR). Based on the results of field researchers in mature and oldgrowth forests of the basic CBR massifs using corresponding criteria, the primeval forest communities have been identifies. 10 forest types were singled out with the total surface of 14 600 ha, among which beech spruce communities dominate. The article provides data on the primeval forests distribution within lads of other land users, and also the number of rare plant species and forest communities. The Action Plan for CBR's primeval forests conservation is presented along with conclusions and the list of references.

ZUSAMMENFASSUNG: Forêts vierges de la Réserve de la Biosphère des Carpates: Diversité et Plan d'Action pour leur conservation (Ukraine).

La partie introductive met en évidence l'importance écosystèmes forestiers vierges et l'historique de leur étude dans les Carpates Ukrainiens ainsi que sur le territoire de la Réserve de la Biosphère des Carpates (CBR). A partir des résultats des recherches sur le terrain dans des forêts matures et âgées des massifs principaux de la CBR et en base des critères correspondantes, ont été identifiées les communautés des forêts vierges. 10 types de forêt ont été mises en évidence couvrant une superficie totale de 14 600 ha, dominées par les communautés de hêtre et d'épicéa. L'article fournit des données sur la distribution des forêts vierges entre les utilisateurs de terres, ainsi que le nombre des espèces rares de plantes et des communautés forestières. Le Plan d'Action pour la conservation des forêts vierges de CBR est présenté ainsi que les conclusions et la liste des références.

REZUMAT: Pădurile virgine din Rezervaţia Biosferei Carpaţi: Diversitate şi Plan de Acţiune pentru conservarea acestora (Ukraina).

Introducerea marchează importanţa ecosistemelor pădurilor virgine şi istoricul cercetărilou acestora atât în Carpaţii Ucraineni cât şi pe teritoriul Rezervaţiei Biosferei Carpaţi (CBR). Pe baza rezultatelor obţinut de cercetători pe teren în pădurile mature şi bătrâne din principalele masive incluse în CBR utilizând criterii adecvate, s-au identificat asociaţiile tipice pentru pădurea virgină. A fost evidenţiate 10 tipuri de asociaţii pe o suprafaţă totală de 14 600 ha, dominate de asociaţia fag-molid. Articolul furnizează date cu privire la distribuţia pădurilor virgine între diferiţii utilizatori de terenuri precum şi numărul de specii rare de plante şi asociaţii forestiere. Sunt prezentate Planul de Acţiune pentru conservarea pădurilor virgine incluse în CBR precum şi concluziile şi bibliografia.

INTRODUCTION

Forests by their functions play an important role in the vegetation of the Earth. In forest ecosystems there's focused a considerable diversity of habitats and many species of terrestrial plants, animals, fungi and microorganisms. Now, the world continues to intensify deforestation and active denaturalization of natural landscapes, so the problem of natural forest conservation becomes especially important. Today, on the European continent, only very small patches of primary forests are left. Their conservation is crucial for Ukraine.

Primeval forests as a unique natural relict have a diverse meaning. They support biological, landscape and phytocoenotic diversity and secure evolutionary processes in fores ecosystems. Primary forest communities serve also as ecological models for re-naturalization secondary forest stands and forest close-to-nature management.

Primeval forest research in the Carpathians were started already early in the 20th century by Alois Zlatnik [13] - in 1930ths there has been established a network of research plots in beech and spruce primeval forests. Later on the following researchers worked in the Ukrianian Carpathians: Stepan Stoiko, Vasyl Parpan, Vasyl Cherniavskyi et al [3-9].

In 2000-2005 the Carpathian Biosphere Reserve (CBR) have been studing the dynamics of natural regeneration and structure and composition of forest stands together with the Swiss Federal Institute of Forest, Snow and Landscape Research WSL at the Uholka-Shyrokyi Luh massif [10,11].

During 2007-2008 there was a Ukrainian-Dutch project held dedicated to mapping of the Transcarpathian primeval forests (BBI-Matra) [1].

Researchers of the Carpathian Biosphere Reserve and the Zvolen University of Forest Ecology (Slovakia) have prepared a dossier for the Ukrainian-Slovak nomination to the UNESCO World Natural Heritage List "Primeval beech Forests of the Carpathians". The nomination was approved on June 28, 2007 and inscribed as a joint property into the List [12].
The aim of other investigations was inspection of mature and overgrowth forests of CBR, primeval forests identification and elaboration a conservation management plan.

MATERIAL AND METHODS

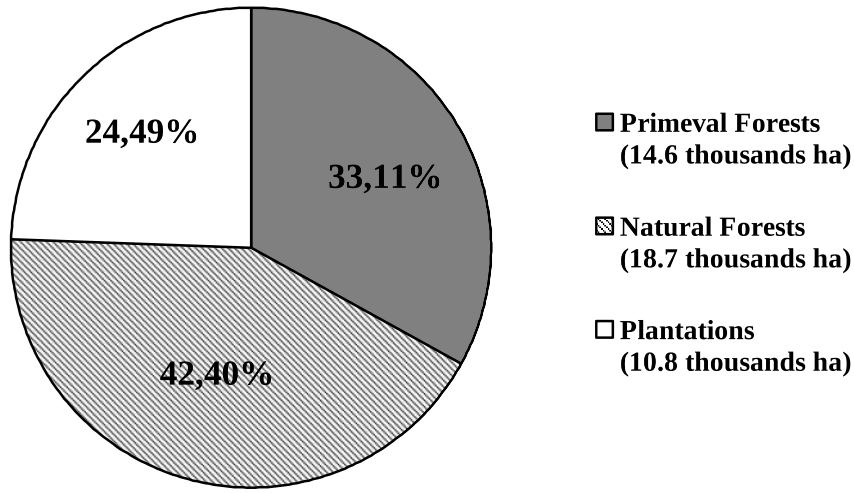
Research targets: CBR forests with surface 44107 ha (82,2% of the overall territory of the reserve), which are located in Rakhiv (29410 ha), Tiachiv (11891 ha), Khust (1951 ha) and Vynohradiv (855 га) administrative districts of Transcarpathia.

Foests of the reserve are distributed in the Chornohora (12261 ha), Svydovets (9503 ha), Krasna (Uholka-Shyrokyi Luh - 13841 ha), Maramureş (7647 ha) and Vyhorlat-Hutyn (855 ha) massifs of the Ukrainian Carpathians. Within CBR forests there dominate beech (22593 ha) and spruce (17813 ha) stands.

Estimation and identification of forest ecosystems' naturalness was held based on field researches using methodology by Stepan Stoiko [4]. In the process of work we used taxation descriptions of forest stands and maps produced as a part of the CBR Management Plan ("Project of territory organization …") [2].

RESULTS AND DISCUSSIONS

Based on data processing it has been identified, that within CBR natural forests dominate (Fig. 1).



Fgure 1: Structure of forests of the Carpathian Biosphere Reserve by naturalness.

The area of natural and primeval forests is correspondingly 18667 and 14600 ha. Artificial plantations cover 10840 ha or 24,5% of the total CBR forest. Spruce monoculures dominate in this case.

According to dominating forest-forming species 10 forest types are described for CBR (Table1).

Table 1 **Forest types and their distribution within CBR**

No	Primeval forest type	Name of the Massif and area (ha)				
		Uholka-Shyrokyi Luh	Svydovets	Chronohora	Maramureş	**Total**
1	Pure beech	7736	989	275	30	**9030**
	Mixed beech	946	441	202	735	**2324**
2	Pure spruce		25	327	895	**1247**
	Mixed spruce		4	288	815	**1107**
3	Mixed fir	185	4	90	115	**394**
4	Mixed sycamore	5	1	3		**9**
5	Mixed oak	10				**10**

6	Mixed ash-tree	2		1		**3**
7	Mixed birch	2				**2**
8	Mixed alder	4				**4**
9	Green alder			180		**180**
10	Pinus mugo			275	15	**290**
Total		***8890***	***1464***	***1641***	***2605***	***14600***

Main primeval forest areas of CBR are mostly concentrated in the Uholka-Shyrokyi Luh massif. The largest cluster of beech primeval forests of Europe is protected here. Second place is occupied by pure and mixed spruce primeval forests. Lesser share belongs to fir, mountain pine, green alder and other primeval communities.

As tyou can see from the Table 2, among the forest sites directly managed by CBR (27191 ha) there are 13770 ha of primeval forests, while other users possess only 830 ha. Thus, over 93% of primeval forest ecosystems is concentrated at CBR.

Table 2: Distribution of primeval forests by landusers

Name of division	Area, ha	Forest area, ha	Primeval forest area, ha
Directly managed by CBR			
Uholka Division	4729,0	4598,0	4080,0
Shyrokyi Luh Division	5654,0	5431,9	4720,0
Kuziy-Svydovets Division	2406,0	2275,6	1195,0
Keveliv Division	4483,0	3278,9	727,0
Bohdan-Petroske Division	2972,0	2489,9	473,0
Maramureş Division	3103,0	2462,9	940,0
Chornohora Division	4296,0	2947,0	985,0
Tybushany Division	4078,0	3707,0	650,0
Narcissi Valley	256,0	-	-
Total:	**31977,0**	**27191,2**	**13770,0**
CBR area managed by other landusers			
Khust Forestry Enterprise			
Vilshanske division	630,0	592,1	60,0
Drahivske division	1427,0	1359,2	30,0
Total:	*2057,0*	*1951,3*	*90,0*
Bushtyno Forestry Enterprise			
Gunykivske division	2126,0	1859,9	-
Vynohradiv Forestry Enterprise			
Vynohradiv division	941,0	854,8	-
Yasinia Forestry Enterprise			
Svydovets division	4195,0	3713,2	80,0
Rakhiv Forestry Enterprise			
Kvasy division	1135,0	1104,9	70,0

Bohdan division	481,0	447,0	-
Hoverla division	1958,0	1795,1	65,0
Rakhiv division	408,0	355,7	-
Ustiriky division	1000,0	950,5	-
Total:	*4982,0*	*4653,2*	*135,0*
Velykyi Bychkiv Forestry Enterprise			
Luh division	299,0	293,9	-
Kostylivka division	420,0	407,2	-
Dilove division	2988,0	2710,6	525,0
Разом:	*3707,0*	*3411,7*	*525,0*
Rakhiv district department for agriculture			
"Nove Zhyttia"	286,0	286,0	-
Land Fund			
Rakhiv District Council	2892,0	185,9	-
Taichiv District Council	467,0	-	-
Total:	*3359,0*	*185,9*	-
Total for lands managed by other users:	**21653,0**	**16916,0**	**830,0**
Total for CBR:	***53630,0***	***44107,2***	***14600,0***

Analysis of the data obtained showed that the primeval forests of the reserve are distributed in Tiachiv (8800 ha), Rakhiv (5710 ha) and Khust (90 ha) administrative districts of Transcarpathia.

There are 42 plant species in primeval forest ecosystems which are listed to the Red Book of Ukraine, and 46 rare phytocoenoses listed to the Green Book of Ukraine.

Action plan for primeval forests conservation

1. Include all primeval forest sites to the core areas.
2. Demarcation in site of all primeval sites.
3. Identify a buffer zone around each of the clusters and define all possible risks.
4. Prepare a long-term research and monitoring program for the primeval forests.
5. Optimize the number of ecological trails which lead through primeval communities.
6. Use primeval forests as education base for training biologists, foresters, ecologists, and other experts.
7. To establish ecoeducation or information centers close to primeval forest sites.
8. Inform public through mass-media and raise their awareness about importnance of primeval forests conservation.
9. Develop contacts with international research institutions.

Due to the fact, that the largest primeval forest sites are concentrated at CBR, there should be established an international capacity building and research ceter based at the reserve.

CONCLUSIONS

Based on multi-year researches in the forests of the Carpathian Biosphere Reserve, there were determined primeval forest types by dominating species, as well as their area, biological and phytocoenotic diversity.

Implementation of the given Action Plan will benefit conservation of these unique primeval forest communities.

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DATA ON THE FRESHWATER MOLLUSCS FROM ROMANIAN TRIBUTARIES OF THE UPPER TISA RIVER BASIN

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KEYWORDS: Gastropods, Bivalves, endemic species, chorology, ecology, aquatic, human impact.

ABSTRACT

In the Romanian tributaries' of the Upper Tisa River basin, 16 species of aquatic molluscs (among them 13 species of Gastropods and three of Bivalves), have been found up to the present. The present paper presents their annotated systematical and chorological check-list, some ecological characteristics and the main environmental issues related to the human impact, of this area. The reduced specific diversity is due to geomorphological and hydrological features, such as: steep slopes, high water velocity, mountain landscapes with few specific habitats, high range of water debits, unstable substratum etc. which are limiting habitats' conditions for most freshwater molluscs, while another issue is the large part of the region, as well as many waters, which were not researched up to the present. However, the area shelters some local endemic species, explained by the presence of some glacial refuges. Both scarce specific habitats, as well as human pressure, shape the structure and distribution of the freshwater mollusc species in the area.

RĖSUMĖ: Données sur les mollusques d'eau douce des affluents roumains du bassin supérieur du Tisa.

Dans les affluents roumains du bassin supérieur du Tisa, 16 espèces de mollusques aquatiques (parmi eux 13 espèces de gastéropodes et trois bivalves) ont été trouvés jusqu'au présent. Cette oeuvre présente leur catalogue systématique et chorologique, certaines caractéristiques écologiques et les principaux problèmes environnementaux liés à l'impact humain, dans cette région. La réduction de la diversité spécifique est due aux caractéristiques géomorphologiques et hydrologiques, tels que: des pentes raides, la vitesse élevée de l'eau, paysages de montagne avec peu des habitats spécifiques, la gamme haute des débits d'eau, le substrat instable etc. Cettes sont des conditions limitatives pour la plupart des mollusques d'eau douce. Toutefois, la zone abrit certaines espèces endémiques locales, fait expliqué par la présence de certains refuges glaciaires. La rarité des habitats spécifiques, ainsi que la pression humaine, façonnent la structure et la distribution des espèces de mollusques d'eau douce dans la région.

REZUMAT: Date privind moluştele acvatice din afluenţii din România ai bazinului Tisei superioare.

În afluenţii din România ai bazinului superior al râului Tisa au fost identificate până în prezent 16 specii de moluşte acvatice (dintre care 13 specii de gastropode şi trei de bivalve). Lucrarea de faţă prezintă lista sistematică şi chorologică actualizată, preferinţe ecologice şi probleme legate de efectele impactului antropic în această zonă. Diversitatea specifică redusă se datorează pe de o parte caracteristicilor reliefului, cum ar fi prezenţa extinsă a ariilor montane, pante mari şi cursuri rapide ale râurilor, variaţii cu amplitudini ridicate ale debitelor, substrat instabil etc., constituind factori limitativi pentru cele mai multe specii de moluşte, precum şi datorită faptului că arii extinse şi numeroase ape nu au fost încă cercetate sub aspect malacologic. Aria studiată adăposteşte câteva specii endemice locale, a căror prezenţă este explicată de existenţa unor refugii glaciare. Atât raritatea habitatelor specifice, cât şi impactul antropic, se reflectă în structura şi distribuţia speciilor de moluşte acvatice în aria de interes.

INTRODUCTION

The freshwater Mollusca fauna from the Romanian tributaries of the Upper Tisa River were scarcely studied up to the first decade of 2000. Some few information date back to the XIXth Century, by the work of E. A. Bielz (1867), M. V. Kimakowicz (1883), their collections being kept mainly in the Natural History Museum from Sibiu. Some data about terrestrial species were published by J. Frivaldszky (1871, ap. Fehér et al., 2008), especially regarding Clausilidae and Helicidae. In the middle XXth Century more data were provided by the work of János Wagner (=H[ans] Wagner) (1941 and others) which also described *Bythinella molcsanyi* as a new species, from the Igniş Mountains. Others dealt mainly with terrestrial species, but some aquatic taxa were also quoted (L. Soós, 1940, 1943. etc.). There was little else done afterwards, until the late 90's. During the month of August 1995 an international transboundary research team investigated the ecological state and the diversity of several aquatic groups in the Upper Tisa Basin, from its two sources (the rivers Bila Tisa and Chorna Tisa) in the Ukrainean Carpathians, down to the confluence with the River Someş/Szamos (the first name being in Romanian, while the second is in Hungarian) in Hungary, covering also the streatch of the Tisa River which is the natural boundary between Ukraine and Romania, in which the main rivers from Maramureş watershed flow: the Iza and the Vişeu rivers. The screening-type research included also a study concerning the freshwater molluscs from the tributaries Teresva, Tereblia and Batar from Ukraine (Sárkány-Kiss, 1999). However in the present paper only the streach down to the Terbelia flow is considered. In this sector the former mentioned author highlighted a very reduced diversity of freshwater mollusc species. Some more data regarding the molluscs from Maramureş were published by K. Bába (1997), Popa et al. (2006) and Gheoca (2010) concerning terrestrial gastropods. Fehér Z. et al. (2008) published a Malaco-faunistical study of Maramureş (as a region, containing both rivers' basins: the Upper Tisa and the Someş River tributaries of different orders), with some taxonomical and conservation notes, established in the framework of the research program "Invertebrate faunistical investigation of the Maramureş", molluscs from many areas being sampled between 2004 and 2008 (Murányi, 2008). During this project a revision of the collection of János Wagner was done, the material being collected and preserved between 1940 and 1944 by the late staff of the Hungarian Natural History Museum in Budapest. The paper presented an annotated check-list of the mollusc fauna of Maramureş county, including literature data, some unpublished material from the Wagner collection, as well as the results of recent samplings. An important outcome of this study was the discovery of *Bythinella molcsanyi* type material, which was believed to be fully destroyed. The study revealed that the mollusc fauna of Maramureş county is relatively poor, considering either the total species richness or the number of endemic and rare taxa, compared to other parts of the Carpathians. Concerning the mollusc fauna from the Romanian Tisa river tributaries, a number of 6 freshwater molluscs species were found or quoted, among them the identity of *Bythinella austriaca* was questioned recently (Falniowski et al., 2009 a, b); they belong to five species of gastropods and one bivalve. The other aquatic species were quoted from the Someş River Basin area included in the Maramureş region. I. and M. Sîrbu have done several malacological sampling trips along the Mara, Iza, Săpânţa and Vişeu Rivers, as well as in the Gutâi, Rodna and Maramureş Mts. during the summer of 1999 and 2007; some data were published (Sîrbu et al., 2008 regarding the Maramureş Mountains Nature Park auquatic and hygrophilous molluscs; Sîrbu and Benedek, 2004 concerning some clams species; Glöer and Sîrbu, 2006 about some new taxa found in the Romanian fauna; Sîrbu 2010 revised the freshwater molluscs from the Natural History Museum in Sibiu). Some more contributions were provided by Falniowski, Szarowska and Sîrbu (2009 a and b) concerning the systematical revision of the genus *Bythinella* in Romania, which confirmed the status of some endemic species, rejected the presence of some others, and described new species for the science, including two from the area of interest. The area and watersheds which are about to be referred here, are the Romanian northern rivers-group basins (Ujvári, 1972), namely the tributaries of the Upper Tisa River: Vişeu River basin (surface of 1606 km^2, length = 80 km), Iza River basin (surface = 1303 km^2, length = 83 km), Săpânţa River (surface = 135 km^2, length = 20 km) as well as the Tisa River sector wich is the natural 62 km border between Romania and Ukraine. These waters drain the central and northern part of the Maramureş Mountains, the northern Rodna and Lăpuş Mts., as well as most northern watersheds of Oaş-Gutâi-Ţibleş Mts.

The available information from collections, papers and references, as well as data and molluscs collected from field research trips, accomplished by the authors, are considered in order to establish a present-day picture about the frehshwater mollusc fauna from the specified area, namely the Romanian watershed of the Upper Tisa River Basin. Lots of areas and freshwater habitats are still not researched, and the available data are scarce and scattered, thus another issue is to identify the future needs and topics in order to improve the knowledge.

METHODS AND RESEARCH AREA

Being a synthesis on all present-day available information concerning this topic, all sources of literature, revised collections and sampled materials were considered. The systematical and chorological check-list of the freshwater molluscs from the Romanian sector of the Upper Tisa River basin is given, together with some critical remarks, discussions on systematical and ecological features, and human impact sources and effects are characterized hereby. Original unpublished data, gathered between 1999 and 2007 are also considered. The systematics is given in accordance to R. Bank (2011) and R. Araujo (2011), respectively considering Fauna Europaea v. 2.4 (2011), than according to P. Glöer and I. Sîrbu (2006), while the newly described species are characterized and presented according to Falniowski et al. (2009 a, b). Most molluscs, sampled between 1999 and 2007, were done in the frame of several screening-type researches; the sampling sites were selected from the mountain areas down to hills, valleys and depressions, according to geomorphologic and hydrologic features, and to the presence of human impact sources. Thus a wide variety of habitats were investigated, like riverbeds, rivulets, brooks, permanent or temporary ponds and pools, springs, high altitude glacial lakes, etc. The main areas investigated were the Mara, Iza, Vişeu and Săpânţa rivers' valleys and some parts of their basins.

RESULTS

The systematical and chorological annotated check-list of the freshwater molluscs species found up to the present in the Romanian Upper Tisa River Basin, is given below.

Classis Gastropoda Cuvier, 1795

Ordo Neotaenioglossa Haller, 1892

Fam. Hydrobiidae Troschel, 1857; Subfam. Amnicolinae Tryon, 1862

(according to Fauna Europaea v. 2.4)

(Grossu, 1986) ascribed the genus to **Fam. Bythinellidae Radoman, 1976**

1. *Bythinella molcsanyi* H. Wagner, 1941

Taxonomic identifier (fauna europaea, v. 2.4): urn:lsid:faunaeur.org:taxname:427982

Observation: Fauna Europea incorrectly lists this species as *B. molcsany*, however, the correct name is *B. molcsanyi.*

Endemic species, described in literature from "Rozsály-tömb [Muntii Igniş], Izvora-fennsík [Statiunea Izvoare], springs near Molcsány-tanya (forester's hut) (ca. 1000 m) [= type locality]" (Wagner, 1941; ap. Fehér et al., 2008). Four lots (39 specimens altogether) were found in the Wagner collection, which are indicated as "*B. Molcsányi*" or "*Bythinella n.sp*." by Wagner's handwriting (Fehér et al., 2008). Since no holotype was designated originally, all of them are syntypes. Three of the lots are housed now in the Mollusca Collection of the Hungarian National History Museum, Budapest, and one in the Mollusca Collection of the Mátra Museum, Gyöngyös; this taxon is still known only from the type locality (idem). J. Wagner (1941) mentioned the occurrence of "*Bythinella austriaca* (Frauenfeld, 1857)" at several localities around the locus typicus of *B. molcsanyi*, which later proved to be another species. In the same type locality it was found again by Sîrbu I. and Sîrbu M. (leg. 1999), Fehér et al. (2008, leg. 2004-2008), Falniowski et al. (2009; found in rivulets springing from on oligotrophic marsh, helocrenic brooks). Within the type locality it lives sympatrically with *Bythinella grossui* Falniowski, Szarowska & Sîrbu, 2009. At present, all the known localities of *B. molcsanyi* are situated in the Igniş Mountains (springs and flowing waters belonging both to the Mara-Iza as well to the Lăpuş-Someş rivers basins). Benke et al. (2009) also mention this species in their paper. However, the material, that they assigned to this species, was originated from the Cimpoieş valley near Staţiunea Borşa. This is one of the populations, which was referred as "*Bythinella cf. austriaca*" in Fehér et al. (2008) and its systematic position is still unclear; possibly belongs to *B. viseuiana* or an undescribed species.

2. *Bythinella grossui* Falniowski, Szarowska & Sîrbu, 2009

Taxonomic identifier (fauna europaea, v. 2.4): urn:lsid:faunaeur.org:taxname: 427961

Endemic species; locus typicus: in the Izvoare Resort (Igniş Mountains), rivulets springing from an oligotrophic marsh (helocrenic brooks), Mara River Basin; 47°44'50.8"N, 23°43'02.7"E, 909 m a.s.l. (Falniowski et al., 2009 a,b). The holotype, as well as paratypes are deposited at the Museum of Natural History, Wrocław University. Its present known distribution, apart from the type locality, comprises three other localities in the Igniş Mountains. The species occurs sympatrically with *Bythinella molcsanyi*.

3. *Bythinella viseuiana* Falniowski, Szarowska & Sîrbu, 2009

Taxonomic identifier (fauna europaea, v. 2.4): urn:lsid:faunaeur.org:taxname: 428041

Endemic, recently described species. Its locus typicus is the Vişeu River Valley, downstream from the village of Bistra, a helocrenic brooklet close to the main road, a tributary of the Vişeu (first sampled by Monica Sîrbu in 2007); 47°52'14" N, 24°11'23" E, 362 m a.s.l (Falniowski et al., 2009 a,b). The holotype, as well as paratypes are deposited at the Museum of Natural History, Wrocław University. In present it is still known only from the type locality (but see notes at *B. molcsanyi*).

Six more endemic *Bythinella* species, collected by Z. Fehér, D. Murányi and A. Varga, occur in this region which can be distinguished by morphological as well as by anatomical features. We cannot mention the names or sampling sites here, because the new descriptions have not been published yet. However, it shows that mountainous regions like the Carpathians provide good habitats for spring-snails, possibly like the mountains of Bulgaria (Glöer & Georgiev 2011).

Ordo Basommatophora Keferstein, 1864

Fam. Lymnaeidae Lamarck, 1812

4. *Galba truncatula* (O.F. Müller, 1774)

Literature data: Sighetu Marmaţiei (M. Kimakowicz, 1883), Gutâi Mountains (J. Wagner, ap. Fehér et al., 2008), Rodnei Mountains, Borşa - Staţiunea Borşa resort, Cimpoies valley, beech forest, wet grassland and brooks in the vicinity of the mineral water spring (Fehér et al., 2008).

Original data: brooks and marshes covered with vegetation at the northern edge of the Bistra Village in the Vişeu River Valley (Sîrbu et al., 2008); puddles and brooks close to the dam, upstream CFF Crivina (Mara River Valley; leg.1999); in the Lăpuş Mountains near Slătioara (leg. 2009) and on the Igniş plateau, 3 km N of Pleaşca (leg. 2009).

5. *Stagnicola palustris* (O.F. Müller, 1774)

Literature data: E.A. Bielz (1867)**-** (*Stagnicola palustris* agg.) Rodna; "Mauritius and Richard Winnicki von Kimakowicz" collection in the Natural History Museum from Sibiu **-** labeled as "*Lymnaea palustris"* and "*Lymnophysa palustris*" from Sighetu Marmaţiei.

Original data: brooks and marshes covered with vegetation at the northern edge of the Bistra Village in the Vişeu River Valley (Sîrbu et al., 2008).

6. *Stagnicola turricula* (Held, 1836)

Literature data: M. Kimakowicz (1883) **-** Sighetu Marmaţiei

7. *Radix labiata* (Rossmässler, 1835) syn. *Radix peregra* (O.F. Müller, 1774)

Literature data: Wagner (1942, ap. Fehér et al., 2008) vicinity of the Băile Borşa resort, up to Pietrosu Rodnei Mt., 1200 - 1900 m and in the Gutâi Mountains. Fehér et al. (2008) make the remark that "these records refer probably to the following species" (i.e. *Radix ovata*).

Original data: brooks and marshes covered with vegetation at the northern edge of the Bistra Village in the Vişeu River Valley; Rica Valley upstream Coşnea, both in ponds and brooks; in the same habitats in Coşnea Valley; Culic Valley; Bistra Valley, here also in temporary pools in the flood area; marshes along Valea Neagră, in the Bistra village; ponds in the flood area of the Vişeu River at Leordina (Sîrbu et al., 2008); brooks in Mara River Valley, upstream the dam, close to the Cheile Tătarului narrows, in the Mara River close to Vadu Izei village, in the Vişeu River Basin, Pietrosu rivulet, upstream of the Baia Borşa resort (leg. 1999).

8. *Radix balthica* (Linnaeus, 1758) syn. *Radix ovata* (Draparnaud, 1805)

Literature data: Fehér et al. (2008) - quoted *Radix ovata* from Maramureş Mountains, Poienile de Sub Munte locality, Rica Valley in artificial ponds, at 763 m (leg. 2007); and Bocicoiu Mare village in Tisa (leg. 2004).

Fam. Planorbidae Rafinesque, 1815

9. *Planorbarius corneus* (Linnaeus, 1758)

Literature data: M. Kimakowicz (1883) **-** Sighetu Marmaţiei.

10. *Anisus spirorbis* (Linnaeus, 1758)

Original data: brooks and marshes covered with vegetation at the northern edge of the Bistra Village in the Vişeu River Valley (Sîrbu et al., 2008).

11. *Anisus leucostoma* (Millet, 1813)

Original data: This species has been found in 2009 in the Lăpuş Mountains, in the Morii valley, 7 km south of Bârsana, in a sidestream.

12. *Gyraulus rossmaessleri* (Auerswald, 1852)

Original data: helocrenic pond with clear water, invaded by aquatic and paludal vegetation, in the Izvoare resort, Gutâi Mountains, Mara River basin, here living together with *Pisidium casertanum*, upstream and close to the brooks where *Bythinella molcsanyi* was sampled, in sectors with faster flowing water. When it was sampled by the authors, in 1999, it was the first encounter of this species in the Romanian fauna (Glöer and Sîrbu, 2006).

13. *Ancylus fluviatilis* O.F. Müller, 1774

Literature data: It was quoted by M.v. Kimakowicz from the Vişeu area in the XIXth Century (collection kept in the Natural History Museum in Sibiu) without specific location. Bába (1997, ap. Fehér et al., 2008) sampled it from Igniş Mts., without definite locality; Sárkány-Kiss (1999) considers it as the single living freshwater mollusc species along the upper Tisa River, from the sources area, down to the flow of Tereblia tributary (including the sector which borders Romania and Ukraine); Fehér et al. (2008) Igniş Mountains, Deseşti - Izvoare Resort, Roşie Valley, river in a beech forest, forest edge and grasslands; Munţii Pietrii, Săpânţa, Brazi river in a pine forest at the Brazi valley, rocks and grassland patches (841 m); Runc river on the Runcului meadow (937 m); Săpânţa River in a beech forest at the Şipot waterfall and a sidespring in a meadow (663m; leg. 2005); Munţii Pietrii, Săpânţa river in a beech forest (500 m), Gutâi Mts., SW Mara, Rîuşor; Remeţi NW, Tisa. According to Curtean-Bănăduc (2008 and in. verbis) it lives in high numbers in Socolău River 50 m downstream the confluence with Rica; in Ruscova River 50 m upstream the confluence with Bardi; Cvaşniţa River 3.6 km upstream the confluence with Ruscova; in Repede River 50 m upstream the omonimous locality; Ruscova River 50 m upstream the flow in the Vişeu River; Frumuşeaua River 2 km downstream the confluence of the rivulets Tomnatec and Pop Ivan; Vişeu River in its Defile.

Original data: During our researches it was found in 2007 in the Bistra River upstream the omonimous village, in Rica River (upstream the confluence in exceptionally large numbers, i.e. hundreds of individuals on square meter) and Coşnea rivers. It is worth mentioning that in 1999 it was not found in any station along the Vişeu River, from downstream Borşa to Petrova, upstream the defile (Sîrbu et al., 2008). In 1999 the authors sampled it from the Mara River and tributaries upstream the dam from the Tătarului narrows, downstream to CFF Crivina; in the Săpânţa River upstream the village.

Clasis Bivalvia Linnaeus, 1758

Ordo Veneroida H. & A. Adams, 1856

Fam. Sphaeriidae Deshayes, 1855 (1820)

14. *Pisidium casertanum* (Poli, 1791)

Literature data: J. Wagner (1941 ap. Fehér et al., 2008) **-** from the Igniş Mts., spring at ca. 1000 m; Bába (1997, ap. Fehér et al., 2008) **-** Igniş Mts. (without definite locality).

Original data: brooks and marshes close to the northern edge of the Bistra village, in the Vişeu River Valley; ponds and rivulets in Rica Valley, in Coşnea, Culic and Bistra rivers valley; marshes in Valea Neagră (Sîrbu et al., 2008); in the Gutâi Mts., brooks close to Izvoare resort; rivulets downstream the spring Izvorul Albastru al Izei, upstream of Săcele village; in the Săpânţa River, downstream the fishery (leg. 1999); on the Igniş plateau, 3 km N of Pleaşca; in the Ţibleş Mts. near Botiza (leg. 2009).

15. *Pisidium personatum* Malm, 1855

Original data: brooks and puddles in the Bistra village, along several km upstream the locality (Sîrbu et al., 2008); in the Săpânţa River, downstream the fishery (leg. 1999).

16. *Pisidium nitidum* Jenyns, 1832

Original data: lakes and pools above the upper mountain level in the Mihăilecu - Farcău mountains area, and in Vinderelu Lake (Sîrbu et al., 2008); in the Pietrosul Rodnei glacial lake (leg. M.&I. Sîrbu, 1999; leg. A.M. Benedek, 2009); from the Tăurile Buhăescu glacial lakes (leg. A.M. Benedek, 2009).

DISCUSSION

Regarding the Hydrobiidae s.lat. (or the Bythinellidae), this family was supposed (J. Wagner, 1941; Grossu, 1986; Sîrbu et al., 2008 etc.) to be represented by two species in the Romanian watershed of the Upper Tisa River Basin, namely by *Bythinella austriaca* (v. Frauenfeld, 1857), and a local endemic species *Bythinella molcsanyi* H. Wagner, 1941. Fehér et al. (2008) quoted or sampled more spring-snails from Igniş Mts., Rodna Mts. (Borşa resort, Cimpoies valley), Lăpuş Mts. etc. Molecular studies on this material (see also: Benke et al. 2009) suggested that "although resembles morphologically to the *B. austriaca* populations of the Northern Carpathians, Maramureş material seems to be very different from them by the sequence of the mitochondrial COI gene (Benke et al., 2009). This might be an indication of a cryptic species, but can also be explained by an extreme intraspecific molecular diversity. Until this is not clarified, we treat this species tentatively as *B. cf. austriaca*". Later, Falniowski et al. (2009 a), verified that there is, in fact, no *B. austriaca* in Romania. In the frame of a several-years research (2005 - 2009), according to Falniowski et al. (2009, a, b) "mitochondrial cytochrome oxidase I (COI) and ribosomal internal transcribed spacer 1 (ITS-1) sequences were analysed in 12 Romanian *Bythinella* populations. Phylogenetic relationships were inferred using maximum parsimony, maximum likelihood and Bayesian techniques. For COI, the Kimura two-parameter (K2P) distances and haplotype networks were computed. Two sympatric and four allopatric groups were distinguished. The K2P distances are similar to those for congeneric rissooids, so each of the six groups represents a species. Two are identified as *Bythinella molcsanyi* H. Wagner, 1941, and *Bythinella dacica* Grossu, 1946." The other four groups were ascribed to four new species. "The occurrence of six species, each with a low haplotype number and high interspecific differences between haplotypes, is explained by: (1) a relatively long history of *Bythinella* in the territory of a Pleistocene glacial refugium; (2) the discontinuous character of the northernmost refugium, promoting speciation, but local extinction and subsequent recolonization; (3) unstable, post-glacial microhabitat conditions; and (4) the fragmented distribution of Romanian *Bythinella*." (according to Falniowski et al., 2009 a, p. 2955). Thus, in Maramureş, inclusively in the Romanian tributaries' basins of the Tisa River, up to the present three endemic species have been recognized, based on biomolecular, morpho-anatomical and biogeographical evidence, namely *Bythinella molcsanyi* H. Wagner, 1941, *Bythinella grossui* Falniowski, Szarowska & Sîrbu, 2009, which occurs sympatrically with the former species, and *Bythinella viseuiana* Falniowski, Szarowska & Sîrbu, 2009. The molecular distinctness of the studied species is not reflected in their morphology, the morphological differences are poorly marked, their variability ranges overlapping. However, in *Bythinella* molecular differences are usually not well reflected in morphology, which confirms the morphostatic model of evolution, with numerous cryptic species within the genus (idem). There are still several samples of *Bythinella* from the whole region, which have to be checked out before they should be ascribed to the mentioned, and possibly also to some other, new taxa. The authors of the present paper have sampled (1999 - 2007) spring-snails also from the Mara River Valley, in the Cheile Tătarului narrows, in the Runcului Valley, from springs in the Dealul Herii hill, Ronişoara river basin, tributary of the Iza River, than springs and brooks beneath the Prislop Pass, close to the Rodna Mountains, brook in the Culic Valley on the mountain slope, in the Nadoşa valley over Săpânţa, in the Morii valley over Bârsana and in the Ţibleş Mts. near Botiza. Future research will possibly bring new evidence regarding these spring-snails systematics and their evolutionary biology.

It should be noted that from the Ukrainean part of the Upper Tisa watershed (more precisely from Ugolsky forestry of the Karpatsky Reserve in Tyachev district), some related taxa were described, namely *Terrestribythinella baidashnikovi* Sitnokova, Starobogatov & V. Anistratenko 1992, *T. amphibiotica* V. Anistratenko 1995 and *T. carpathica* Sitnikova, Starobogatov & V. Anistratenko 1992. According to Sitnikova et al. (1992), these are terrestrial animals but conchologically resemble to *Bythinella*. In the Fauna Europaea check-list, the latter two are treated as the synonyms of the former taxon. It would be desirable to clarify its systematic relationship to Romanian *Bythinella* species and to delimit its range more precisely (including its possible occurrence in Romania).

Another problems regarding the hydrobiids is *Paladilhiopsis carpathica* Soós, 1940 which was described on the basis of one individual from a cave close to Hoverla (in Ukrainean) or Hovârla (in Romanian) Mountain, in Ukraine close to the border with Romania. It is a troglobiont aquatic species with uncertain systematical status, which has to be taxonomically investigated by means of biomolecular criteria in the future. Its presence in Romania is still possible, thus it is mentioned here, but not included in the check-list.

During the screening-type research accomplished by the international team in August 1995, A. Sárkány-Kiss (published in 1999) found along the Tisa river, except for the sampling stations placed close to the sources, on both Bila Tisa and Chorna Tisa, downstream to the Tereblia confluence, only the species *Ancylus fluviatilis.* This segment covers the Ukarinean sector, as well as the sector which marks the natural border between Romania and the former country. Some few other species, namely *Radix labiata* and *Radix auricularia*, were quoted by the same source form the Teresva tributary, and *Radix labiata, Stagnicola palustris* and *Galba truncatula* were found in the Tereblia tributary, in both cases near their confluences with the Tisa river, because they shelter habitats of stagnant waters and rich algal periphyton, due to nutrients enrichment from fertilizers used in mountains pastures (idem). A higher diversity of aquatic molluscs species was found only beginning with the vicinity of Vinogradiv. The reduced diversity was explained by Sárkány-Kiss (1999) due "... first of all the steep slopes of the riverbed. The high speed of the stream results in strong erosion. For the same reason large quantities of boulders are carried by the river. From the sources of the river, down to (...) the Hungarian border, the riverbed consists of large sized boulders, which become more and more rounded going downstream". The mentiond author considers a high quality of the water in the upper Tisa River sector (idem). These features are in a broader sense valid for the whole area of interest, and explain the poor specific diversity (only 15 species of freshwater species). The mountainous landscape shape the riverscapes and limit the molluscan specific habitats.

According to the annual report of environmental quality state of the Maramureş county agency (2010), in the upper Tisa river basin 329 km of running waters are monitorized. Most sectors lie within the I - II quality classes according to all parameters, but the Ţâşla (Cisla) tributary of the Vişeu River is qualified as III -IV because of the Cu, Zn and Mn contents, originating from the Borşa mining indutry. Below the flow of this tributary, the Vişeu River falls accordingly in a lower quality class, but downstream, at the level of the Bistra locality, due to natural cleaning processes, it recovers again.

Sîrbu et al. (2008) wrote: "*Ancylus fluviatilis* in some respect is witness of a certain rivers' and brooks' ecological state, and even when such kind of habitats are somehow organic loaded, it clearly proves a sound degree of oxygenation and self-cleaning capacity of the aquatic habitat. It's absence is equally significant, being the other side of the coin.(...) It's absence from a whole riverbed, as it is the case of Ţâşla River, supports a conclusion of severe debasement of river's system quality. Along the Vişeu River it is almost not to be found (as it was revealed by the researches done by I. and M. Sîrbu in 1999 and A. Curtean-Bănăduc in 2007), at least not downstream of Baia Borşa as far as Petrova, despite the fact that this river offers the specific conditions of its habitat. The remnant pollution caused by mining, related to heavy metals discharges, acidification, cianide spills etc., and other sources, are still the main causes of its absence. Although it is generally considered that the remnant pollution belongs to the past, its effects are still present, and will be also in the future a certain timespan". The natural, self-cleaning capacity of the Vişeu River was proved by several papers, like those published by Staicu et al. (1997), Curtean-Bănăduc (2008, which found *A. fluviatilis* in the Vişeu River almost in the lowest sector, namely in its final defile, downstream Petrova), and Sîrbu et al. (2008).

In the Romanian area of the Upper Tisa River Basin, most rivers' ecological systems are of high quality in their upper sectors, but prove certain effects in their middle and lower sectors, due to human impact sources. The main threats and problems are linked to: mining and other industrial wastewater discharges, enforced deforestation, saw mills wastes, household wastes and discharges, improper hydrotechnical works, and others.

CONCLUSIONS

In the Romanian tributaries of the Upper Tisa River, 16 species of freshwater molluscs were identified, among them three are endemic taxa: *Bythinella molcsanyi, Bythinella grossui* and *Bythinella viseuiana.* The possible presence of some other new taxa belonging to this group (new taxa of *Bythinella* or *Paladilhiopsis carpathica*) has still to be investigated. 13 species are gastropods and three bivalves (clams). The reduced number and specific composition is due to the landscapes' characteristics: mostly a mountain region, with steep slopes and fast-flowing waters, hig seasonal ranges of waterlevels, coarse unstable substratum etc., while another reason is that the largest part of the region, and most waters, were not yet researched as far as molluscs are concerned. Human impact is also a limiting factor, especially linked to mining industry as well as other wastewater discharges, however the rivers from this area prove a certain self-cleaning capacity.

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DATA ON TERRESTRIAL GASTROPODS FROM THE VIŞEU RIVER BASIN (UPPER TISSA RIVER BASIN, ROMANIA)

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KEYWORDS: Romania, Maramureș , Viș eu River basin, Upper Tisa, terrestrial gastropods.

ABSTRACT

The paper presents some data on terrestrial gastropod fauna from the Vişeu River (Upper Tisa, Romania). The biological material was collected from eight sampling points located in the subcarpathian area of Tisa, Vişeu, Bistra, Frumuşeaua, and Ruscova river valleys. Samplings were made between 2008-2010. 53 land snail species were identified, belonging to 18 families. The terrestrial gastropod fauna in the investigated area is dominated by Oxychilidae (10 species) and Clausiliidae (10 species). Among the most common species are *Punctum pygmaeum, Ruthenica filograna, Oxychilus orientalis, Fruticicola fruticum, Perforatela dibothryon, Monachoides vicinus, Faustina faustina, Helix pomatia.* Two endemic (*Oxychilus orientalis, Schystophallus oscari)* and five Carpathian (*Macrogastra tumida, Vestia gulo, Vestia turgida, Carpathica calophana, Perforatella dibothryon)* species were found. We highlight the importance of riparian habitats in the dispersion of terrestrial gastropod species.

RĖSUMĖ: Considération sur la faune de gastropodes terrestres du bassin de la Rivière Viș eu (Tissa supérieure, Roumanie).

L'article présente certaines aspectes de la faune des gastropodes terrestres de la Tisza supérieure. Le matériel provient des huit points de prélèvement situés dans les collines des Carpates dans les vallées des rivières Tisza, Vişeu, Bistra, Frumuşeaua et Ruscova. Les prélèvement ont été réalises entre 2008-2010. Apres l'analyse du matériel ont été identifiés 53 espèces de gastropodes terrestres, appartenant à 18 familles. La faune de gastropodes terrestres dans la région est dominée par Oxychilidae (10 espèces) et Clausiliidae (10 espèces). Parmi les espèces les plus communes sont *Punctum pygmaeum, Ruthenica filograna, Oxychilus orientalis, Fruticicola fruticum, Perforatela dibothryon, Monachoides vicinus, Faustina faustina, Helix pomatia.* Deux espèces endémiques (*Oxychilus orientalis, Schystophallus oscari)* et cinq carpatiques (*Macrogastra tumida, Vestia gulo, Vestia turgida, Carpathica calophana, Perforatella dibothryon)* ont été identifiées. On souligne l'importance des habitâtes riveraine pour la dispersion des espèces de gastropodes terrestres.

REZUMAT: Consideratii privind gastropodele terestre din Bazinul Vişeului (Tisa superioară, România).

Lucrarea prezintă aspecte ale faunei de gastropode terestre din bazinul Tisei superioare. Materialul analizat provine din opt puncte de colectare localizate în zona dealurilor subcarpatice pe văile râurilor Tisa, Vişeu, Bistra, Frumuşeaua şi Ruscova, colectările fiind realizate în intervalul 2008-2010. În urma analizei materialului au fost identificate 53 de specii de gastropode terestre, aparţinând la 18 familii. Fauna de gastropode terestre din zona investigată este dominată de către Oxychiliidae (10 specii) şi Clausiliidae (10 specii). Dintre cele mai comune specii menţionăm *Punctum pygmaeum, Ruthenica filograna, Oxychilus orientalis, Fruticicola fruticum, Perforatela dibothryon, Monachoides vicinus, Faustina faustina, Helix pomatia.* Două specii sunt endemice *Oxychilus orientalis* şi *Schystophallus oscari*, iar cinci carpatice *Macrogastra tumida, Vestia gulo, Vestia turgida, Carpathica calophana, Perforatella dibothryon*. Subliniem importanţa conservării habitatelor ripariene în dispersia speciilor de gastropode terestre.

INTRODUCTION

The Vişeu River is one of the main tributaries of Upper Tisa, and a significant part of its course is located in Maramureş Mountains Nature Park. Vişeu River streams from Rodna Mountains and flows after 80 km in Upper Tisa. The area is featured by beach and mixed forests. Earlier reports about the land snails of this area were made by E.A. Bielz (1867), M v. Kimakowicz (1883, 1890, 1894), Frivaldszky (1871), Al. V. Grossu (1981, 1983, 1987). Recent studies in the area have been achieved by Andrei (1997), Popa et al. (2006), Fehér et al. (2008), Gheoca et al. (2008), Sîrbu et al. (2008), V. Gheoca (2010), Cameron et al. (2011). These studies cover some areas of Maramureş Mountains, or are part of a larger study regarding the Carpathians. The present study focuses of the land snail fauna of subcarpathian area of Vişeu River basin.

MATERIAL AND METHODS

Samples were taken from eight sampling points, located in forests of the subcarpathian area, at altitudes ranging from 380 to 650 m. The sampling points are represented in the figure number 1.

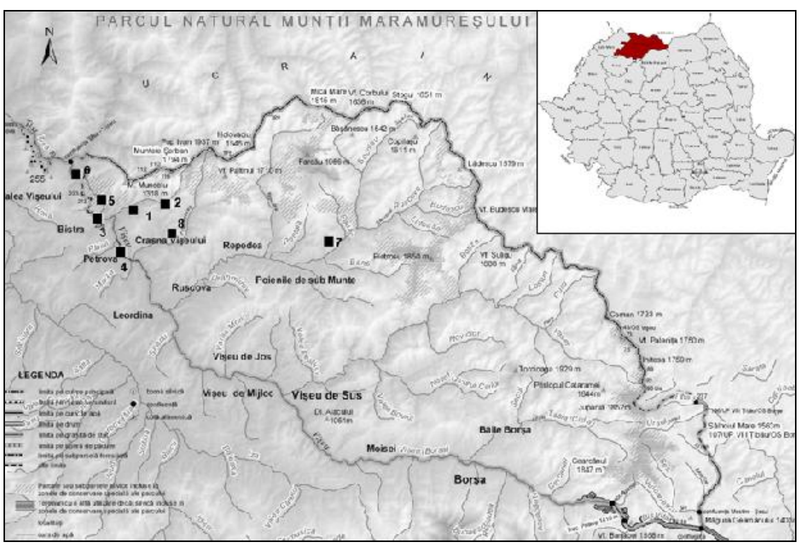

Fig. 1. The location of sampling points.
(map source: Administration of Maramureş Mountains Nature Park, modified).

Qualitative samples were taken. All the living snails and fresh shells were considered. The biologic material was identified using Grossu (1981, 1983, 1987). The results were used to build the list of land snail species. Nomenclature follows Fauna Europaea v. 2.4 (Bank, 2011).

RESULTS AND DISCUSSIONS

A number of 59 land snails species belonging to 19 families were recorded in the area, as shown in table 1.

Table 1. The distribution in the area, ecolgy, and zoogeography of the terrestrial gastropods of Vişeu River bassin. Abbreviation: data source (recently recorded species in Maramureş Mountains): C: Cameron et al, 2011, G: Gheoca et al, 2008, S: Sîrbu et al, 2008, F: Fehér et al, 2008; OR – original data; humidity preferences: H – hygrophylous, MH – mesohygrophylous, M – mesophylous.

species	**sampling stations**	**date source**	**hum. pref.**	**geo- phy**
ACICULIDAE (3)				
Acicula parcelineata (Clessin, 1911)	1,5	C	M.	Eur.
Platyla polita (W. Hartmann, 1840)	1,5,7	C, OR	M	opean
Platyla perpusilla (Reinhardt, 1880)	1,2,7	C	M	pend.
CARYCHIIDAE (1)				
Carychium tridentatum (Risso, 1826)	1,2,3, 5,7,8	C, OR	H	opean
SUCCINEIDAE (1)				
Succinea putris (Linnaeus, 1758)	7,3	C,S,OR	H	opean
COCHLICOPIDAE (1)				
Cochlicopa lubrica (O. F. Müller, 1774)	3,8	C,G,	H	larctic
VALLONIIDAE (3)				
Vallonia costata (O.F. Müller, 1774)	3	G, OR	MH	larctic
Vallonia excentrica Sterki, 1893	3	G, OR	M	larctic
Acanthinula aculeata (O. F. Müller, 1774)	2,3,4,5,7	C,G, OR	M.	opean
GASTRODONTIDAE (1)				
Zonitoides nitidus (O. F. Müller, 1774)	3	S, OR	MH	larctic
VERTIGINIDAE (4)				
Truncatellina cylindrica (A. Férussac, 1807)	1,2	C	M.	opean
Vertigo pusilla O.F. Müller, 1774	1,2,6,8	C	MH	European
Vertigo alpestris Adler, 1838.	1	C	M	European
Vertigo pygmaea (Draparnaud, 1801)	3	G, OR	M	larctic
PUNCTIDAE (1)				
Punctum pygmaeum (Draparnaud, 1801)	1,2,3,5,6,7,8	C,G, OR	M	opean
CLAUSILIIDAE (10)				
Cochlodina laminata (Montagu, 1803)	1,2,5,6	C,F	MH.	opean
Cochlodina orthostoma (Menke, 1828)	1,2,4,5,7,8	C,G,F, OR	MH	opean
Ruthenica filograna (Rossmässler, 1836)	1,2,4,5,6,7,8	C,G, OR	MH	Eur.
Macrogastra tumida (Rossmässler, 1836)	7	C	MH	pathic
Macrogastra borealis (Boettger, 1878)	7	F	MH	E Eur.
Clausilia dubia Draparnaud, 1805	1	C	MH	opean
Balea stabilis (L. Pfeiffer, 1847)	1,2,5,6,7,8	C,F	MH	opean
Vestia gulo (E.A. Bielz, 1859)	1,5	C	MH	pathic
Vestia turgida (Rossmässler, 1836)	2,3,7,8	C,G,F, OR	MH	pathic
Bulgarica (Strigilecula) cana (Held, 1836)	1,4,5	C,G, OR	M	N. Eur.

ARIONIDAE (2)				
Arion (Mesarion) subfuscus Draparnaud 1805	1,2,4	F	MH	ean
Arion (Carinarion) circumscriptus Johnston 1828	2,4,7,8	F	MH	W. Eur.
VITRINIDAE (2)				
Vitrina pellucida (O. F. Müller, 1774)	7	C	M	larctic.
Semilimax semilimax (Ferussac, 1802)	2,5,7	C	H	).-Carp.
PRISTILOMATIDAE (2)				
Vitrea transsylvanica (Clessin, 1877)	1,2,6,7,8	C	MH	E Eur.
Vitrea diaphana (Studer, 1820)	2,5,6,7,8	C,F	MH	opean
OXYCHILIDAE (10)				
Nesovitrea hammonis (Ström, 1765)	1,7	C	M	earctic
Aegopinella pura (Alder, 1830).	2,5,6,7	C	M	opean
Aegopinella minor (Stabile, 1864)	2,5,6	C,F	M	S Eur.
Aegopinella epipedostoma (Fagot, 1879)	2,3,5,7,8	C,G	H	opean
Oxychilus glaber (Rossmässler, 1835)	3	OR	MH	opean
Oxychilus depressus (Sterki, 1880)	2,5,7,8	C	MH	S Eur.
Oxychilus orientalis (Clessin, 1877)	1,2,3,5,6,7,8	C,G, OR	.M	Endemic
Oxychilus draparnaudi (Beck, 1837)	3	OR	H.	V Eur.
Schystophallus oscari (Kimakowicz, 1883)	8	C, OR	MH	lemic
Carpathica calophana (Westerlund, 1881)	1,5,6	C,F	MH	pathic
LIMACIDAE (3)				
Lehmannia marginata (Muller, 1774)	7	F, OR	MH	V Eur.
Limax cinereoniger Wolf, 1803	1,2,7,8	OR	MH	opean
Bielzia coerulans (M. Bielz, 1851)	1,4,7,8	OR	MH	E Eur.
AGRIOLOMACIDAE (2)				
Deroceras laeve (Muller, 1774)	7	F	MH	earctic
Deroceras moldavicum (Grossu&Lupu, 1961)	7	F	MH	pathic
EUCONULIDAE (1)				
Euconulus fulvus (O. F. Müller, 1774)	4	OR	MH.	larctic
BRADYBAENIDAE (1)				
Fruticicola fruticum (O. F. Müller, 1774)	1,2,3,4,5,6,7,8	C,G, OR	MH.	earctic
HYGROMIIDAE (6)				
Euomphalia strigella Draparnaud, 1801	2	C	M	opean
Lozekia transsylvanica (Westerlund, 1876)	5,7	C	MH.	European
Perforatella dibothrion (M.v.Kimakowicz, 1884)	1,2,3,5,6,7,8	C,G,OR	MH	Carpathic
Monachoides vicinus (Rossmässler, 1842)	1,2,3,5,6,7,8	C,G	M.	Eur.
Petasina bielzi (E.A.Bielz, 1859)	5,6,7	C	MH	V Eur
Trochulus sericeus (Draparnaud, 1801)	4	OR	MH	V Eur
HELICIDAE (5)				
Isognomostoma isognomostomos (Schröter, 1784)	1,2,5,6,7,8	C	M	opean.
Drobacia banatica (Rossmässler, 1838)	1,2,3,5,7	C,G	M	E Eur.
Faustina faustina (Rossmässler, 1835)	1,2,3,5,6,7,8	C,G	M	E Eur.
Cepaea vindobonensis (Pfeiffer, 1828)	3,5	C	M	E Eur.
Helix pomatia Linnaeus, 1758	1,2,3,5,6,7,8	C,G	M.	opean

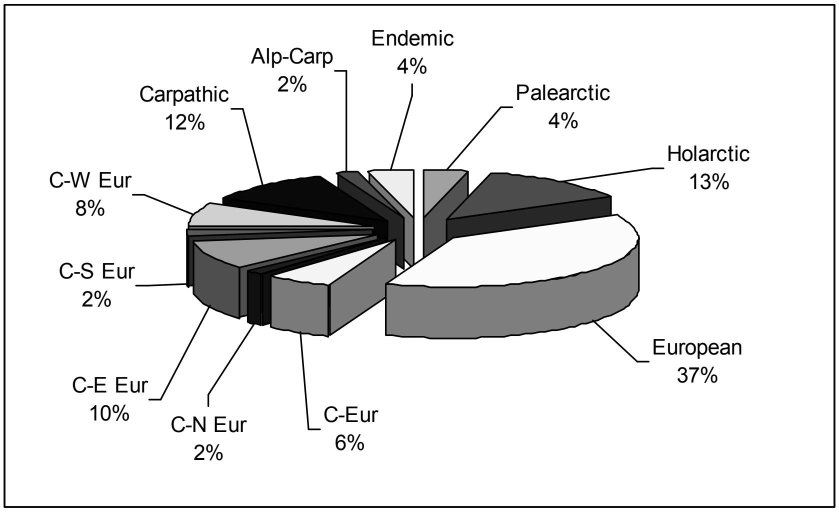

Figure 2: The zoogeographical structure of land snail fauna from Vişeu River Basin.

Among the most wide spread species are *Punctum pygmaeum, Ruthenica filograna, Oxychilus orientalis, Fruticicola fruticum, Perforatela dibothryon, Monachoides vicinus, Faustina faustina, Helix pomatia*, found in six to eight sampling points. Meanwhile *Vallonia costata, V. excentrica, Zonitoides nitidus, Vertigo alpestris, V. pygmaea, Vitrina pellucida, Oxychilus oscari, O. draparnaudi, Lehmannia marginata, Deroceras laeve, Euomphalia strigella* were present in only one sampling station. Twelve percent of recorded species are Carpathian, two species are endemic, *Oxychilus orientalis* and *Schystophallus oscari*, and one subendemic, *Platyla perpusilla*. We underline the presence of *Drobacia banatica*, species from Habitat Directive Annex II. Its populations in this area are very important for the species' conservation at its distribution limit in Romania

CONCLUSIONS

The presence of endemic, subendemic and of European importance species emphasizes the importance of land snails' conservation in the area.

The Tisa River contributes to the dissemination of the land snail species. In this context, Déli and Sümegi (1999) indicate the presence of mountain species as *Vitrea diaphana, Bielzia coerulans, Ruthenica filograna, Balea biplicata Aegopinella minor, Cochlodina laminata, Clausilia pumila*, *Monachoides vicinus* in some spots of the Hungarian Szatmár-Bereg Plain. They conclude that the structure of this region's land snail fauna is due to the connection with the subcarpathic region ensured by Tisa River. Another notable presence is that of *Drobacia banatica* in the Tisa floodplain near Tiszabecs, considered the most important population of *D. banatica* from Hungary (Fintha et al, 1993, Szabó and Fintha, 1999), highlighting the importance of Tisa River for the distribution of land snail species.

The conservation of riparian habitats is crucial for the contribution of rivers to land snail distribution. Due to the relative lack of mobility of this species, they cannot easily escape a disturbance in their environment and presumably are slow to recolonize disturbed sites. Thus, the terrestrial gastropod fauna of a site may be expected to reflect the disturbance history of this site (Strayer et al, 1985).

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ECOGEOGRAPHIC STRUCTURE OF THE MOTH FAUNA (LEPIDOPTERA, DREPANOIDEA, BOMBYCOIDEA, NOCTUOIDEA) IN UPPER TISA RIVER BASIN AND ADJACENT AREAS (UKRAINE)

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KEYWORDS: moth fauna, Upper Tisa River Basin, ecogeographic complexes, habitat groups, biogeography and environment.

ABSTRACT

The results of investigations of the moth fauna in Upper Tisa River Basin as well as some adjacent districts of Czornohora Mts and Transcarpathian Lowland (Ukraine) are given. The research was carrying out during 2007–2010 at 12 investigation points situated in all principal vertical vegetation belts of East Carpathians, within elevation profile from 170 to 1850 m altitudes. There is totally 534 species of *Drepanoidea, Bombycoidea* and *Noctuoidea* found in the area. The analysis of its ecogeographic structure is given and general regularities of species distribution through vegetation belts are determined. There are some variations of species distribution caused by local environmental conditions, mountain biogeographic barriers or inversions revealed and discussed.

RÉSUMÉ: La structure échographique de la faune des hétérocères (Lepidoptera, Drepanoidea, Bombycoidea et Noctuoidea) dans le basin supérieur de la Tisza et des régions avoisinantes (Ukraine).

Sont présentés les résultats des investigations sur la faune des hétérocères du bassin supérieur de la Tisza ainsi que dans quelques-uns des départements avoisinants des Montagnes de Czornohora et de la dépression Transcarpatique (Ukraine). La recherche a été effectuée pendant la période de 2007–2010 sur 12 stations de recherche situées dans les principales étages de végétation des Carpates Orientaux, entre 170 et 1850 m altitude. Nous avons identifie un total de 534 espèces de of *Drepanoidea, Bombycoidea* et *Noctuoidea* dans la zone étudiée. L'analyse de sa structure écogéographique y est présentée ainsi que les modèles de distribution générale de l'espèce dans les étages de vegetation investiguées. Les quelques variations dans la distribution de l'espèce causées par les conditions environnementales locales, par les barrières biogéographiques montagneuses ou par les inversions identifiées sont présentées et discutées.

REZUMAT: Structura ecogeografică a faunei de molii (Lepidoptera: Drepanoidea, Bombycoidea, Noctuoidea) din bazinul superior al Tisei şi arealele adiacente (Ucraina).

Rezultatele investigaţiilor faunei de molii din bazinul superior al Tisei şi din câteva districte adiacente din Munţii Czornohora şi din Depresiunea Transcarpatică (Ucraina) sunt prezentate. Cercetările au fost efectuate în perioada 2007-2012 în 12 puncte de investigare situate în toate principalele centuri de vegetaţie verticală din Carpaţii de Est, în interiorul profilului de altitudine dintre 170 şi 1850 m. În total, 534 de specii de *Drepanoidea, Bombycoidea* şi *Noctuoidea* au fost găsite în zonă. Analiza structurii ecogeografice este oferită şi tiparele de distribuţie a speciilor în raport cu centurile de vegetaţie sunt determinate. Pot fi identificate anumite variaţii în distribuţia speciilor cauzate de condiţii de mediu locale, bariere biogeografice montane sau inversiuni, care au fost prezentate şi discutate.

INTRODUCTION

Superfamily *Noctuoidea* together with much lesser by taxonomical size *Bombycoidea* and *Drepanoidea* is rather well outlined in systematical and ecological aspects *Lepidoptera* group with principally night activity of imago. The group's representatives have a considerable share or predominate in *Lepidoptera* communities by species diversity, number and biomass in almost all world biogeographic regions, as well as in European Nemoral region (Kryzhanovskii, 2002). They are playing great role as herbivores consumers and pollinators, as well as important forage source for numerous insectivores (bats, birds etc.). There are many moth species might cause a serious damage for forestry or agriculture, but there is great number of the rare, threatened and narrow-spread species, which could be good indicators of ecological conditions of natural ecosystems.

High species diversity both with considerable biogeographic and ecological differentiation of the moth fauna allow to use it as a subject of ecological and biogeographic research in the aim to determine regularities of distribution of the living organisms in dependence on environmental conditions of natural landscapes. The Upper Tisa Basin is perfect range for such research because it presents almost of all vertical vegetation belts of Carpathians – from lowland oak woodland up to alpine tundra, and it situated on the distribution limits for many species of Boreal or Mediterranean origin.

MATERIAL AND METHODS

The field research were carrying out during 2007–2010 at 12 investigation points situated (with the single exception) in Ukrainian part of Tisa River Basin and Transcarpathian administrative region. There are 8 points situated within Upper Tisa Basin, above "Khust Gates". The Pozhezhevska point situated near watershed of Tisa and Prut river basins at the border of Transcarpathian and Ivano-Frankivsk regions, and another 3 points (Beregszasz, Akli Hegy, Czorna Hora) belong to Transcarpathian chain of volcanic hills. All investigation points offer the profile through vertical vegetation belts from the lowland up to highest mountain massifs of Ukrainian Carpathians (Czornohora, Marmarosh or Maramures Mts) (Table 1).

Table 1: Geographical situation of investigation points

POINT	COORDINATES	ALTITUDE, m	LANDSCAPE DISTRICT	VEGETATION BELT*
Beregszasz	48^0 11.04' N 22^0 40.88' E	192	Transcarpathian Lowland	Querceta roboris / petraeae
Akli Hegy	48^0 01.02' N 23^0 03.57' E	187	Transcarpathian Lowland	Querceta roboris / petraeae
Czorna Hora	48^0 08.24' N 23^0 04.09' E	232	Volcanic Range	Querceta roboris / petraeae

Kireshi	48^0 10.68' N 23^0 20.96' E	171	Upper Tisa Depression	Querceta roboris / petraeae
Mala Uholka	48^0 15.24' N 23^0 37.37' E	424	Polonyna Range	Fageta sylvaticae
Kuzij	47^0 56.16' N 24^0 06.19' E	380	Marmarosh Mts	Querceto-Fageta
Rakhiv	48^0 01.56' N 24^0 10.03' E	430	Marmarosh Mts	Fageta sylvaticae
Keveliv	48^0 11.57' N 24^0 18.00' E	585	Svydovets Mts Czornohora Mts	Fageta sylvaticae
Ust-Hoverla	48^0 04.06' N 24^0 27.24' E	650	Czornohora Mts	Abieto-Fageta Fageto-Abieta
Czorna Tysa	48^0 18.20' N 24^0 16.87' E	780	Svydovets Mts Gorgany Mts	Fageto-Abieto-Piceeta
Pozhezhevska	48^0 09.26' N 24^0 32.07' E	1430	Czornohora Mts	Piceeta abietis Pineta mugi
Pip Ivan	47^0 55.96' N 24^0 19.39' E	1600 1850	Marmarosh Mts	Prata subalpina Prata alpina

* (Stoyko, 2009)

The principal part of field research carried out on the territory of Carpathian Biosphere Reserve (CBR) by the framework of scientific cooperation between CBR and Institute of Ecology of the Carpathians NAS of Ukraine (IEC), State Museum of Natural History NAS of Ukraine.

The results of research were publishing partially in preceding works (Geryak, Bidychak, 2009; Geryak, Kanarskyi, 2008; Lyashenko, 2009ab). The principal part of original materials concerning present and former occurrence of *Noctuoidea* species within Transcarpathian region as well as references analysis of these data are published in recent faunal work (Geryak, 2010). The aim of present work is to generalize obtained during research time data concerning *recent* regional moth fauna and to consider it from environmental point of view. However, this work contains some unpublished before original data concerning distribution of the moth species through investigated area.

The materials were collecting by standard for the taxonomical group methods (Novak, 1969). The basic collecting method for night active moths was night catching by means of daylight lamps with a share of UV-eradiation in the spectrum (BML250W, BML400W). There were stationary light traps mounted at 6 points on CBR territory (Kireshi, Mala Uholka, Kuzij, Rakhiv (Central Office), Ust-Hoverla) as well as at vicinities of Beregovo (Beregszasz). The traps were working each night during whole vegetation season, and the principal part of materials was collecting there. In the sites Czorna Hora, Akli Hegy, Czorna Tysa as well as in high mountains (Pip Ivan, Pozhezhevska), where stationary traps were unavailable, periodic collecting was carried out with mobile light traps or screen. At the day time moths were collecting by butterfly-net. Also visual observations upon *Lepidoptera* both with collecting of preimaginal stages were pursuing near by investigation points immediately.

The identification and systematic processing of the materials made using modern sources (Carter et al., 1987; Fibiger, 1990, 1993, 1997; Fibiger, Hacker, 2004, 2007; Fibiger et al., 2009, 2010; Goater et al., 2003; Hacker et al., 2002; Macek et al., 2007, 2008; Nowacki, 1998; Ronkay, 1994, 1995; Zilli et al., 2005). There are genitalia preparations produced and investigated for doublet species.

The concept of ecogeographic complex applied in the way to following interpretation of the materials. According to some biogeographic surveys concerning Palaearctic insect fauna (Emelyanov, 1974; Kryzhanovskii, 2002) it looks to be worth to distinguish 9 ecogeographic complexes (ECs) in the regional fauna of *Lepidoptera*.

Alpine (A): contains the species with disjunctive Alpine or Arctic-Alpine distribution ranges restricted to higher altitude levels of European mountain regions above the tree line.

Boreal (B): the species with the principal part of ranges coincided with Eurasian taiga zone (or Euro-Siberian Boreal biogeographic region) and which are not penetrating generally outside southern limits of temperate forest zone.

Boreomontane (BM): the species attracted to higher mountainous regions of Europe and might less or more widely distributed in Boreal taiga zone of Eurasia. They often have an interrupted (disjunctive) ranges.

Boreonemoral or **Temperate (T):** the species with wide Palaearctic, Euro-Siberian or West-Central-Palaearctic ranges generally restricted to temperate (both coniferous and deciduous) forest zone of Eurasia.

Nemoral (N): the species with West-Palaearctic or Ancient-Mediterranean ranges which are generally restricted to the deciduous forest zone of Europe (or European Nemoral biogeographic region).

Nemoral-Montane (NM): the species inherent to European Nemoral region mainly and attracted to *Fageta sylvaticae* forest formations in lower mountainous areas. There are number of Ancient-Mediterranean relics among these species (Kryzhanovskii, 2002).

Steppe (S): the species with Pontic-Mediterranean or Centralasian ranges restricted mainly to continental steppe or forest-steppe zones (from Central and South-Eeast Europe to Kazakhstan, Mongolia or Far East). This area considered separately as the Scythian Steppe biogeographic region (Emelyanov, 1974).

Mediterranean (MT): the species with ranges restricted to Mediterranean or Hesperic (follow Emelyanov, 1974) biogeographic region (including some Palaeotropical migrants), which are penetrating into warmer regions of temperate Europe from south.

Polyzonal (P): eurychoric species without clearly defined bioclimatic preferences. They are able to inhabit permanently or temporarily (as the migrants) most of natural zones of the continent – from tundra to deserts or sclerophylous formations in the wider sense.

Each EC contains species with different habitat preferences which have to be altered depending to local geographical conditions of concrete region. These variations are reflected generally by ecological (habitat) groups of species, which are separated according to their demands of soil and climatic (mesophiles, xerothermophiles, hygrophiles etc.) or spatial and synmorphologic (nemoral, seminemoral, grassland species) conditions of the habitat. According to popular scheme (Kudrna, 1986; Macek et al., 2007, 2008) there are 12 habitat groups of moth species (HGs) separated:

U (ubiquists) – eurytopic and eurychoric species occur in diverse habitats;

M1 (grassland mesophiles) – the species with relatively wide ecological adaptation scale which prefer open meadow habitats generally;

M2 (seminemoral mesophiles) – the species preferring half-open ecotones or succession stages of mesophile forest ecosystems (woodland clearings and margins, cuttings, coppice etc.);

M3 (nemoral mesophiles) – the species preferring mesophile forest ecosystems, which are held up under the tree canopy mainly;

X1 (grassland xerothermophiles) – the species attracted to open xeric habitats such as steppes or dry meadows and heaths;

X2 (seminemoral xerothermophiles) – the species preferring half-open warm and xeric habitats with moderately developed but not closed wood vegetation, such as forest-steppe, bushy steppes or dry woodland margins;

X3 (nemoral xerothermophiles) – the species preferring dry and warm sparse pine woods or thermophile oak woodland;

H1 (grassland hygrophiles) – the species preferring open wet habitats such as eutrophic wetlands, damp or boggy meadows;

H2 (nemoral hygrophiles) – the species preferring wet habitats with developed tree or bush canopy, such as floodplain woodland, bushy alluvia etc;

HT (hygrothermophiles) – the species attracted to warm and wet habitats;

TF (tyrfophiles) – the species restricted to raised or transitional peat bogs and surrounding swamp woodland;

A (alpicols) – the species restricted to high-mountain habitats situated above the tree line generally.

The range characteristics and habitat preferences of the moth species determined by analysis of the surveys concerning Central-European fauna (Macek et al., 2007, 2008; Nowacki, 1998, et al.).

The following original formula applied to the characteristic of ecogeographic structure of the moth fauna in each case:

#P #T #N #S #MT #BM: #U #M #X #H #TF #A,

– the part in species composition, % (a single species with the part < 0.5% marked +); P – Polyzonal, T – Temperate, N – Nemoral (both with Nemoral-Montane), S – Steppe, MT – Mediterranean, BM – Boreomontane (both with Boreal and Alpine) species; U – ubiquists, M – mesophiles, X – xerothermophiles, H – hygrophiles (both with hygrothermophiles), TF – tyrfophiles (if present), A – alpicols (if present).

RESULTS AND DISCUSSIONS

There are 534 moth species belonging to outlined taxa found in investigated area during 2007–2010. The checklist contains 16 species of *Drepanoidea,* 39 – *Bombycoidea* and 479 – *Noctuoidea* species (Table 2). The most richness is characteristic for *Noctuidae* family with its 335 species. It is worth to note that the 42 moth species (*marked with asterisk* *) are found for the first time in the Ukrainian Carpathian region (Geryak, 2010; Geryak, Bidychak, 2009; Lyashenko, 2009a). From other side, there are only about 10 species formerly known from investigated area which have not confirmed at the present (Geryak, 2010; et al.). There are *Saturnia spini* (Denis and Schiffermueller, 1775), *Thaumetopoea processionea* (Linnaeus, 1758), *Hyphantria cunea* (Drury, 1773), *Orgyia recens* (Huebner, 1819), *Grammodes stolida* (Fabricius, 1775), *Cucullia argentea* (Hufnagel, 1766), *Anarta dianthi* (Tauscher, 1809), *Actebia praecox* (Linnaeus, 1758), *Dichagyris candelisequa* (Denis & Schiffermueller, 1775). Another few formerly uncertain species there were found recently but apart from our research (Nowacki, Bidychak, 2009; Nowacki et al., 2010): *Callopistria latreillei* (Duponchel, 1827), *Episema glaucina* (Esper, 1798), *Chersotis multangula* (Huebner, 1803).

Table 2: Checklist of the moth species found in investigated area

#	TAXA	FINDS BY THE POINTS												EC	HG
		Beregszasz	Akli Hegy	Czorna Hora	Kireshi	Mala Uholka	Kuzij	Rakhiv	Keveliv	Ust-Hoverla	Czorna Tysa	Poznezhevska	Pip Ivan		
	DREPANOIDEA														
	THYATIRIDAE														
1	*Thyatira batis*	+	+	+	+	+	+	+	+	+	+			T	M3
2	*Habrosyne pyritoides*	+	+	+	+	+	+	+	+	+	+			T	M2
3	*Tethea ocularis*	+	+	+	+	+	+	+						T	M2
4	*Tethea or*	+	+	+	+	+	+	+	+	+	+			T	M3
5	*Tetheella fluctuosa*				+	+	+	+	+	+	+			T	H2
6	*Ochropacha duplaris*	+		+	+	+	+	+	+	+				T	H2
7	*Cymatophorina diluta*	+	+	+	+		+							N	X3
8	*Polyploca ridens*	+	+	+		+	+							N	X3
9	*Achlya flavicornis*							+	+	+				T	M3
	DREPANIDAE														
10	*Falcaria lacertinaria*			+	+	+	+	+	+	+	+			T	M3
11	*Watsonalla binaria*	+	+	+	+	+	+							N	X2
12	*Watsonalla cultraria*					+	+	+	+	+				NM	M3
13	*Drepana curvatula*	+	+	+	+	+	+	+	+	+	+			T	H2
14	*Drepana falcataria*	+	+	+	+	+	+	+	+	+	+			T	M3
15	*Sabra harpagula*	+	+	+	+	+	+	+	+	+	+			T	M3
16	*Cilix glaucata*	+	+	+	+	+	+	+	+	+	+			N	X2
	BOMBICOIDEA														
	LASIOCAMPIDAE														
17	*Poecilocampa populi*	+	+	+	+	+	+	+	+	+	+			T	M2
18	*Trichiura crataegi*	+	+	+	+	+	+	+	+	+	+	+	+	T	M2
19	*Malacosoma neustria*	+	+	+	+	+	+	+	+					T	M2
20	*Eriogaster lanestris*	+	+	+										T	X2
21	*Eriogaster catax*	+		+	+									N	X2
22	*Lasiocampa trifolii*				+		+	+						N	X1
23	*Lasiocampa quercus*			+				+				+	+	T	M2
24	*Macrothylacia rubi*	+	+	+	+	+	+	+	+	+	+	+	+	T	M2
25	*Euthrix potatoria*			+	+	+	+	+	+					T	H2
26	*Cosmotriche lobulina*							+	+	+	+	+		BM	M3
27	*Gastropacha quercifolia*	+	+	+	+	+	+	+						T	X2
28	*Gastropacha populifolia*	+		+	+		+	+						T	H2
29	*Phyllodesma ilicifolia*							+						T	H2
30	*Phyllodesma tremulifolia*						+	+						N	M2
31	*Dendrolimus pini*						+	+	+	+	+	+		B	M3
32	*Odonestis pruni*	+	+	+	+	+	+	+	+	+	+			T	M2

	LEMONIIDAE														
33	*Lemonia dumi*				+									T	M1
	ENDROMIDIDAE														
34	*Endromis versicolora*					+	+	+	+	+				T	M3
	SATURNIIDAE														
35	*Aglia tau*				+	+	+	+	+	+				NM	M3
36	*Saturnia pyri*	+	+	+	+									MT	X2
37	*Saturnia pavonia*					+						+		T	M2
38	*Saturnia pavoniella* *	+	+	+	+									MT	X2
	SPHINGIDAE														
39	*Agrius convolvuli*	+	+	+	+	+	+	+	+	+	+	+	+	MT	U
40	*Acherontia atropos*			+				+				+		MT	U
41	*Sphinx ligustri*	+	+		+		+							T	M2
42	*Hyloicus pinastri*					+	+	+	+	+	+			T	M3
43	*Marumba quercus* *		+											MT	X3
44	*Mimas tiliae*	+	+	+	+	+	+	+	+	+	+			T	M3
45	*Smerinthus ocellata*	+	+	+	+	+	+	+	+	+	+			T	M2
46	*Laothoe populi*	+	+	+	+	+	+	+	+	+	+			T	M2
47	*Hemaris fuciformis*						+	+	+	+				T	M2
48	*Hemaris tityus*			+	+	+	+	+						T	M1
49	*Macroglossum stellatarum*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
50	*Proserpinus proserpina*	+	+	+	+			+						N	M2
51	*Hyles euphorbiae*	+	+	+	+		+	+						T	X1
52	*Hyles galii*	+	+	+	+	+	+	+	+	+	+	+	+	T	M2
53	*Hyles livornica*	+	+									+		MT	U
54	*Deilephila elpenor*	+	+	+	+	+	+	+	+	+	+	+	+	T	M2
55	*Deilephila porcellus*	+	+	+	+	+	+	+	+					N	M2
	NOCTUOIDEA														
	NOTODONTIDAE														
56	*Clostera curtula*	+	+	+	+	+	+	+	+	+	+			T	H2
57	*Clostera pigra*	+	+	+	+	+	+	+	+	+	+			T	M2
58	*Clostera anachoreta*				+	+	+	+	+	+	+			T	M2
59	*Clostera anastomosis*	+	+	+	+	+	+	+	+	+	+			T	M2
60	*Notodonta dromedarius*	+	+	+	+	+	+	+	+	+	+	+		T	M3
61	*Notodonta torva*					+	+	+	+	+	+	+		B	H2
62	*Notodonta tritophus*	+	+	+	+	+	+	+	+					T	H2
63	*Notodonta ziczac*	+	+	+	+	+	+	+	+	+	+	+		T	H2
64	*Drymonia dodonaea*	+	+	+	+	+	+	+	+	+				N	M3
65	*Drymonia ruficornis*	+			+	+	+	+	+					N	X3
66	*Drymonia obliterata*					+	+	+	+	+				NM	M3
67	*Drymonia velitaris*						+							MT	X2
68	*Drymonia querna*	+	+	+	+		+							MT	X2
69	*Pheosia tremula*	+	+	+	+	+	+	+	+	+	+	+		T	M2

70	*Pheosia gnoma*	+	+	+	+	+	+	+	+	+	+	+		T	M3
71	*Pterostoma palpina*	+	+	+	+	+	+	+	+	+	+	+		T	M2
72	*Ptilophora plumigera*	+	+	+	+	+	+	+	+					T	M3
73	*Leucodonta bicoloria*					+	+	+	+	+	+			B	M3
74	*Ptilodon capucina*	+	+	+	+	+	+	+	+	+	+	+		T	M3
75	*Ptilodon cucullina*	+	+	+	+	+	+	+	+					N	M3
76	*Odontosia carmelita*					+	+	+	+	+				T	M3
77	*Gluphisia crenata*	+	+	+	+	+	+	+						T	H2
78	*Cerura vinula*	+		+	+	+	+	+	+	+	+			T	M2
79	*Cerura erminea*	+			+	+	+	+	+	+				T	M2
80	*Furcula furcula*	+	+	+	+	+	+	+	+	+	+	+		T	M3
81	*Furcula bicuspis*				+	+	+	+	+					T	M3
82	*Furcula bifida*	+	+	+	+	+	+	+	+	+				T	M3
83	*Phalera bucephala*	+	+	+	+	+	+	+	+	+	+			T	M3
84	*Phalera bucephaloides*			+										MT	X2
85	*Peridea anceps*					+	+							N	M3
86	*Stauropus fagi*	+	+	+	+	+	+	+	+	+	+	+		T	M3
87	*Harpyia milhauseri*	+	+	+	+	+	+							N	M2
88	*Dicranura ulmi* *	+		+										MT	M3
89	*Spatalia argentina*	+	+	+	+	+	+							N	M3
	NOLIDAE														
90	*Meganola albula*	+	+	+	+	+	+	+						T	H2
91	*Meganola strigula*	+		+	+		+	+						N	M3
92	*Meganola togatulalis* *	+												N	M2
93	*Nola cucullatella*	+	+	+	+	+	+							N	X2
94	*Nola cicatricalis* *	+												N	M3
95	*Nola confusalis*					+	+	+	+	+	+			T	M2
96	*Nola aerugula*	+		+	+		+							T	H2
97	*Nola cristatula*				+		+							MT	HT
98	*Nola chlamitulalis*	+		+										S	X1
99	*Bena bicolorana*	+	+	+	+	+	+							N	M3
100	*Pseudoips prasinanus*	+	+	+	+	+	+	+	+	+	+	+		T	M3
101	*Nycteola revayana*	+			+	+	+	+				+		T	M3
102	*Nycteola asiatica*	+	+	+	+		+							T	H2
103	*Nycteola siculana* *	+												N	H2
104	*Earias clorana*	+	+	+	+	+	+	+	+	+	+			T	H2
105	*Earias vernana* *	+												N	H2
	ARCTIIDAE														
106	*Chelis maculosa*	+												S	X1
107	*Phragmatobia fuliginosa*	+	+	+	+	+	+	+	+	+	+	+		P	M2
108	*Phragmatobia luctifera* *	+	+											S	M1
109	*Parasemia plantaginis*					+				+	+	+	+	BM	M2
110	*Spilosoma lutea*	+	+	+	+	+	+	+	+	+	+			T	M2
111	*Spilosoma lubricipeda*	+	+	+	+	+	+	+	+	+	+	+		T	M2
112	*Spilosoma urticae*	+	+		+	+	+							T	M2

113	*Cycnia luctuosa* *	+												S	X1
114	*Diaphora mendica*	+	+	+	+	+	+	+						T	M2
115	*Diacrisia sannio*	+	+	+	+	+	+	+	+	+	+	+		T	M2
116	*Rhyparia purpurata*	+	+	+										T	X2
117	*Pericallia matronula*							+						T	M2
118	*Arctia caja*	+	+	+	+	+	+	+	+					T	M2
119	*Arctia villica*	+		+										N	X2
120	*Callimorpha dominula*				+	+	+	+	+	+	+			T	M2
121	*Euplagia quadripunctaria*	+	+	+		+	+	+		+				N	M2
122	*Nudaria mundana*						+		+					NM	M3
123	*Thumatha senex*				+		+	+						T	H1
124	*Miltochrista miniata*	+	+	+	+	+	+	+	+	+	+	+		T	M3
125	*Cybosia mesomella*	+		+	+	+	+	+	+	+	+			T	M2
126	*Pelosia muscerda*	+	+	+	+	+	+	+	+	+	+			T	H2
127	*Pelosia obtusa* *	+												T	H1
128	*Atolmis rubricollis*	+	+	+	+	+	+	+	+	+	+	+		T	M3
129	*Lithosia quadra*	+	+	+	+	+	+	+	+	+	+	+		T	M3
130	*Eilema caniola* *	+												MT	X1
131	*Eilema complana*	+	+	+	+	+	+	+	+	+	+			T	M2
132	*Eilema depressa*	+		+	+	+	+	+	+	+	+	+		T	M3
133	*Eilema griseola*	+			+	+	+	+	+	+	+	+		T	H2
134	*Eilema lurideola*	+		+	+	+	+	+	+	+	+	+		T	M2
135	*Eilema lutarella*	+	+	+										T	X1
136	*Eilema palliatella* *	+	+	+										N	X1
137	*Eilema pygmaeola* *	+	+	+										N	X1
138	*Eilema sororcula*				+	+	+	+	+	+	+	+		T	M3
139	*Setina irrorella*	+												T	M1
140	*Amata phegea*	+	+	+										N	X2
141	*Dysauxes ancilla*	+	+	+	+									N	X2
	LYMANTRIIDAE														
142	*Calliteara pudibunda*	+	+	+	+	+	+	+	+	+	+	+	+	N	M3
143	*Orgyia antiqua*	+	+	+	+	+	+	+	+	+	+	+		T	M2
144	*Euproctis chrysorrhoea*	+	+	+	+	+	+	+	+	+	+			N	M3
145	*Euproctis similis*	+		+	+	+	+	+	+	+	+			T	M3
146	*Arctornis l-nigrum*	+	+	+	+	+	+	+	+	+	+			T	M3
147	*Leucoma salicis*	+		+	+	+	+	+	+	+				P	M2
148	*Lymantria monacha*					+	+	+	+	+	+	+	+	T	M3
149	*Lymantria dispar*	+	+	+	+	+	+	+	+	+	+			T	M3
	EREBIDAE														
150	*Rivula sericealis*	+	+	+	+	+	+	+	+	+	+	+		P	M1
151	*Parascotia fuliginaria*					+	+	+	+	+	+			T	M3
152	*Hypenodes humidalis*				+									T	H1
153	*Schrankia costaestrigalis*	+												P	H2

154	*Schrankia taenialis*	+												N	M2
155	*Eublemma amoena* *	+												S	X1
156	*Eublemma ostrina* *		+											MT	X1
157	*Eublemma parva* *	+												MT	X1
158	*Eublemma purpurina*	+	+	+	+	+	+							N	X2
159	*Calymma communimacula*	+												MT	X2
160	*Idia calvaria*	+			+	+	+	+						N	H2
161	*Simplicia rectalis*	+					+							N	M2
162	*Paracolax tristalis*		+	+	+	+	+	+	+					N	M3
163	*Macrochilo cribrumalis*	+			+									T	H2
164	*Herminia grisealis*	+	+	+	+	+	+	+	+	+	+			T	M2
165	*Herminia tarsicrinalis*	+	+	+	+	+	+	+	+	+	+			T	M3
166	*Herminia tarsipennalis*					+	+	+	+					T	M2
167	*Polypogon strigilata*	+		+	+	+	+	+	+	+	+			T	M3
168	*Polypogon tentacularia*	+		+	+	+	+	+	+	+	+	+		T	H2
169	*Zanclognatha lunalis*	+	+	+	+	+	+	+						T	X2
170	*Pechipogo plumigeralis*		+											S	X1
171	*Hypena proboscidalis*	+	+	+	+	+	+	+	+	+	+	+	+	T	M3
172	*Hypena rostralis*	+	+	+	+	+	+	+	+	+	+	+		T	M2
173	*Hypena crassalis*					+	+	+	+	+	+	+		T	M3
174	*Hypena obesalis*										+	+		BM	H2
175	*Colobohyla salicalis*	+	+	+	+	+	+	+	+	+				T	H2
176	*Phytometra viridaria*	+	+	+	+	+	+	+	+	+	+			T	H1
177	*Trisateles emortualis*	+	+	+	+	+	+	+	+					T	M3
178	*Laspeyria flexula*	+	+	+	+	+	+	+	+	+	+			T	M3
179	*Scoliopteryx libatrix*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
180	*Calyptra thalictri* *				+									N	M2
181	*Lygephila craccae*	+	+	+	+	+	+							N	X2
182	*Lygephila lusoria*				+									S	X1
183	*Lygephila pastinum*	+		+	+									N	X2
184	*Lygephila viciae*					+	+	+	+	+	+			T	X2
185	*Euclidia mi*				+		+	+	+					T	M1
186	*Euclidia glyphica*	+	+	+	+	+	+	+	+	+	+	+		T	M1
187	*Catephia alchymista*	+												N	X2
188	*Minucia lunaris*	+	+	+	+	+	+							N	X3
189	*Dysgonia algira*	+	+	+										MT	X2
190	*Catocala sponsa*	+	+	+		+	+	+						N	M3
191	*Catocala promissa*	+	+	+		+	+	+						N	M3
192	*Catocala conversa* *		+											MT	X2
193	*Catocala nymphagoga* *	+												MT	X2
194	*Catocala fulminea*		+	+	+	+	+	+	+					T	M2
195	*Catocala hymenaea*	+	+	+										S	X2
196	*Catocala fraxini*	+		+	+	+	+	+	+	+	+			T	M3
197	*Catocala nupta*	+	+	+	+	+	+	+	+	+	+			T	H2

198	*Catocala elocata*	+	+	+	+	+	+	+						N	H2
199	*Catocala electa*				+	+	+	+	+	+	+			T	H2
	NOCTUIDAE														
	Plusiinae														
200	*Abrostola asclepiadis*	+	+	+	+	+	+							T	X2
201	*Abrostola tripartita*	+	+	+	+	+	+	+	+	+	+	+	+	T	M2
202	*Abrostola triplasia*	+	+	+	+	+	+	+	+	+	+	+	+	T	M2
203	*Abrostola agnorista* *	+												MT	X2
204	*Trichoplusia ni* *	+												P	X1
205	*Macdunnoughia confusa*	+	+	+	+	+	+	+	+	+	+	+	+	T	U
206	*Diachrysia chrysitis*	+	+	+	+	+	+	+	+	+	+	+	+	T	U
207	*Diachrysia stenochrysis*	+	+	+	+	+	+	+	+	+	+	+	+	T	U
208	*Diachrysia chryson*					+	+	+	+	+	+			BM	H2
209	*Diachrysia zosimi*				+									T	H1
210	*Euchalcia variabilis*						+	+	+	+	+			BM	M2
211	*Euchalcia modestoides*				+						+			BM	M2
212	*Lamprotes c-aureum*		+		+									NM	M2
213	*Polychrysia moneta*						+				+			T	M2
214	*Plusia festucae*	+		+	+	+	+	+	+					T	H1
215	*Plusia putnami*				+									BM	H1
216	*Autographa gamma*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
217	*Autographa pulchrina*					+	+	+	+	+	+	+	+	BM	H2
218	*Autographa buraetica*						+	+	+	+	+			BM	H2
219	*Autographa jota*				+	+	+	+	+	+	+	+		NM	M2
220	*Autographa bractea*						+	+	+	+	+	+		BM	H2
221	*Syngrapha interrogationis*						+	+	+	+	+	+	+	BM	TF
	Eustrotiinae														
222	*Protodeltote pygarga*	+	+	+	+	+	+	+	+	+	+			T	M2
223	*Deltote bankiana*	+	+	+	+	+	+	+	+					T	H1
224	*Deltote deceptoria*	+	+		+		+							T	M2
225	*Deltote uncula*	+		+	+		+							T	H1
	Acontiinae														
226	*Emmelia trabealis*	+	+	+	+	+	+							T	X1
227	*Acontia lucida*	+		+	+									MT	X1
228	*Aedia funesta*	+	+	+	+	+	+	+						MT	HT
229	*Aedia leucomelas*	+	+	+										MT	HT
	Pantheinae														
230	*Panthea coenobita*					+	+	+	+	+	+	+		BM	M3
231	*Calocasia coryli*	+	+	+	+	+	+	+	+	+	+	+		T	M3
	Dilobinae														
232	*Diloba coeruleocephala*	+	+	+	+	+	+	+						N	M2
	Acronictinae														
233	*Moma alpium*	+	+	+	+	+	+	+	+	+	+			T	M3

234	*Acronicta alni*				+	+	+	+	+	+	+	+		T	M3
235	*Acronicta cuspis*	+		+	+	+	+							T	H2
236	*Acronicta psi*	+	+	+	+	+	+	+	+	+	+	+		T	M3
237	*Acronicta tridens*	+	+	+	+	+	+	+	+					T	M2
238	*Acronicta aceris*	+	+	+	+	+	+							N	M3
239	*Acronicta leporina*				+	+	+	+	+	+	+	+		T	H2
240	*Acronicta megacephala*	+	+	+	+	+	+	+	+	+	+			T	M3
241	*Acronicta strigosa*	+	+	+	+	+	+	+						T	M2
242	*Acronicta menyanthidis*										+	+		B	TF
243	*Acronicta auricoma*	+	+	+	+	+	+	+				+		T	M2
244	*Acronicta euphorbiae*	+			+									T	X2
245	*Acronicta rumicis*	+	+	+	+	+	+	+	+	+	+	+		T	M2
246	*Simyra albovenosa*	+		+	+									T	H1
247	*Craniophora ligustri*	+	+	+	+	+	+	+	+	+	+			T	M2
	Metoponiinae														
248	*Panemeria tenebrata*	+		+	+	+	+	+	+					N	M1
249	*Tyta luctuosa*	+	+	+	+	+	+							N	X1
	Cuculliinae														
250	*Cucullia fraudatrix*	+		+	+									S	X1
251	*Cucullia absinthii*	+		+	+									N	X1
252	*Cucullia artemisiae*	+		+	+									T	X1
253	*Cucullia xeranthemi* *	+		+										S	X1
254	*Cucullia asteris*	+												S	X1
255	*Cucullia lactucae*	+		+	+							+		T	X1
256	*Cucullia pustulata* *											+		S	X1
257	*Cucullia lucifuga*					+	+	+	+	+	+	+		BM	X1
258	*Cucullia umbratica*	+	+	+	+	+	+	+	+	+		+		T	M1
259	*Cucullia tanaceti*	+		+	+									N	X1
260	*Cucullia chamomillae*	+		+	+									N	X1
261	*Cucullia scrophulariae*	+			+									N	M2
262	*Cucullia gozmanyi* *	+												S	X1
263	*Cucullia lanceolata*				+									S	X1
264	*Cucullia lychnitis*	+			+									N	X1
265	*Cucullia verbasci*	+		+	+					+				N	X1
266	*Cucullia prenanthis*					+	+	+	+	+				NM	M2
	Oncocnemidinae														
267	*Calophasia lunula*	+	+	+	+	+	+							T	X1
268	*Calliergis ramosa*										+	+		BM	M2
269	*Lamprosticta culta*		+											MT	X2
	Amphipyrinae														
270	*Amphipyra pyramidea*	+	+	+	+	+	+	+	+					T	M3
271	*Amphipyra berbera*				+	+	+	+	+				+	T	M2
272	*Amphipyra perflua*	+		+	+	+	+	+	+	+	+			T	M3
273	*Amphipyra livida*	+			+		+							T	M2
274	*Amphipyra tragopoginis*	+		+	+	+	+	+	+	+	+	+		T	M2

275	*Amphipyra tetra* *	+												S	X2
	Psaphidinae														
276	*Asteroscopus sphinx*	+	+	+	+	+	+	+						N	M2
277	*Asteroscopus syriacus* *	+												S	X2
278	*Brachionycha nubeculosa*	+			+	+	+	+	+	+				T	M2
279	*Valeria oleagina*	+	+	+										MT	X2
280	*Allophyes oxyacanthae*	+		+	+	+	+	+	+					N	M2
	Heliothinae														
281	*Schinia scutosa*	+		+	+		+							MT	X1
282	*Heliothis viriplaca*	+	+	+	+	+	+	+	+	+	+	+		P	X1
283	*Heliothis maritima*	+	+	+	+		+							P	X1
284	*Heliothis peltigera*	+		+	+									MT	X1
285	*Heliothis nubigera*			+										MT	X1
286	*Helicoverpa armigera*	+	+	+	+		+					+	+	MT	U
287	*Periphanes delphinii*		+											MT	X1
288	*Pyrrhia umbra*	+	+	+	+		+	+				+	+	P	U
	Condicinae														
289	*Acosmetia caliginosa*	+	+	+	+									S	HT
290	*Eucarta amethystina*	+	+	+	+	+	+	+						S	HT
291	*Eucarta virgo*	+	+	+	+		+	+						S	HT
	Eriopinae														
292	*Callopistria juventina*	+	+	+	+	+	+	+	+	+				N	M3
	Bryophilinae														
293	*Cryphia fraudatricula*	+	+	+	+		+							S	X2
294	*Cryphia receptricula*	+												MT	X1
295	*Cryphia algae*	+	+	+	+									N	M3
296	*Cryphia felina* *	+												N	X1
	Xyleninae														
297	*Pseudeustrotia candidula*	+	+	+	+	+	+	+	+	+	+			T	M2
298	*Elaphria venustula*	+	+	+	+	+	+	+	+					T	X2
299	*Spodoptera exigua*	+												MT	U
300	*Caradrina morpheus*			+	+	+	+	+	+	+				T	H2
301	*Caradrina kadenii*	+		+										MT	X1
302	*Paradrina clavipalpis*	+		+	+	+	+	+	+	+		+		T	M1
303	*Paradrina selini*										+			N	M2
304	*Hoplodrina ambigua*	+	+	+	+	+	+	+	+			+	+	T	M2
305	*Hoplodrina blanda*	+	+	+	+	+	+	+	+					T	X2
306	*Hoplodrina octogenaria*	+	+	+	+	+	+	+	+	+	+			T	M2
307	*Hoplodrina respersa*						+	+						N	X2
308	*Hoplodrina superstes*	+	+	+										MT	X2
309	*Rusina ferruginea*	+	+	+	+	+	+	+	+	+	+			T	M2
310	*Charanyca trigrammica*	+	+	+	+	+	+	+	+	+	+			N	M2

311	*Chilodes maritimus*				+									T	H1
312	*Athetis gluteosa*	+	+	+	+									S	X1
313	*Athetis furvula*	+	+	+	+									S	X1
314	*Hydrillula pallustris*								+					T	H1
315	*Proxenus lepigone*	+		+	+									S	X1
316	*Enargia paleacea*	+		+	+	+	+	+	+					T	M3
317	*Ipimorpha retusa*	+		+	+	+	+	+	+	+	+			T	H2
318	*Ipimorpha subtusa*	+			+	+	+	+	+					T	H2
319	*Cosmia affinis*	+					+							T	H2
320	*Cosmia diffinis*	+		+										N	H2
321	*Cosmia pyralina*	+	+	+	+	+	+	+	+	+	+			T	M3
322	*Cosmia trapezina*	+	+	+	+	+	+	+	+	+	+	+		T	M3
323	*Dicycla oo* *	+												N	X3
324	*Atethmia centrago* *	+												N	M2
325	*Mesogona acetosellae*	+			+		+	+						N	X2
326	*Mesogona oxalina*				+									T	H2
327	*Dipterygia scabriuscula*	+	+	+	+	+	+	+	+	+	+	+		T	M2
328	*Mormo maura*						+							N	H2
329	*Trachea atriplicis*	+	+	+	+	+	+	+	+	+	+			T	M2
330	*Polyphaenis sericata*	+	+	+										MT	X2
331	*Thalpophila matura*	+		+	+	+	+	+	+	+				N	M2
332	*Actinotia polyodon*	+	+	+	+	+	+	+	+	+	+	+		T	M2
333	*Actinotia radiosa* *		+											MT	X2
334	*Chloantha hyperici*	+	+	+	+									N	X1
335	*Hyppa rectilinea*					+	+	+	+	+	+	+		B	H2
336	*Phlogophora meticulosa*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
337	*Phlogophora scita*					+	+	+	+	+	+			NM	M3
338	*Euplexia lucipara*	+		+	+	+	+	+	+	+	+	+		T	M2
339	*Apamea monoglypha*	+	+	+	+	+	+	+	+	+	+	+	+	T	M1
340	*Apamea syriaca tallosi*	+	+	+										MT	X1
341	*Apamea lithoxylaea*	+			+	+	+	+						T	X1
342	*Apamea crenata*				+	+	+	+	+	+	+	+		T	M2
343	*Apamea epomidion*						+	+						N	M3
344	*Apamea lateritia*					+		+	+	+	+	+		T	M1
345	*Apamea furva* *	+												T	X1
346	*Apamea maillardi*											+		A	A
347	*Apamea rubrirena*										+	+		BM	M2
348	*Apamea illyria* *											+		BM	M2
349	*Apamea remissa*					+	+	+	+	+	+	+		T	M2
350	*Apamea anceps*	+	+	+	+		+							T	X2
351	*Apamea sordens*	+	+	+	+	+	+	+	+	+	+	+		T	M1
352	*Apamea scolopacina*					+	+	+						T	M3
353	*Apamea ophiogramma*	+	+		+	+	+	+				+		B	H2
354	*Oligia strigilis*	+	+	+	+	+	+	+	+	+	+	+		T	M2
355	*Oligia versicolor*				+		+	+	+		+			N	H1

356	*Oligia latruncula*	+	+	+	+	+	+	+	+	+	+	+		T	U
357	*Mesoligia furuncula*	+	+	+	+	+	+	+						T	M2
358	*Mesapamea secalis*	+		+	+	+	+	+	+					N	M2
359	*Mesapamea didyma*	+		+	+	+	+	+	+			+		N	M2
360	*Photedes captiuncula*											+		BM	M2
361	*Photedes minima*	+	+		+									T	H1
362	*Luperina testacea*	+			+	+	+							N	X1
363	*Luperina zollikoferi*	+												S	X1
364	*Amphipoea oculea*	+				+	+	+	+					T	H1
365	*Amphipoea fucosa*	+		+	+	+	+	+	+	+	+			T	H1
366	*Hydraecia micacea*	+		+	+	+	+	+	+					T	H1
367	*Hydraecia ultima*				+		+	+						B	H2
368	*Hydraecia petasitis*					+	+	+	+					BM	H2
369	*Gortyna flavago*	+			+		+							T	H1
370	*Helotropha leucostigma*	+			+		+	+	+					B	H1
371	*Calamia tridens*	+		+										T	X1
372	*Chortodes pygmina*	+			+		+	+						T	H1
373	*Chortodes extrema*	+	+	+										T	X2
374	*Chortodes fluxa*	+	+	+	+		+	+						T	H2
375	*Oria musculosa* *	+												MT	X1
376	*Nonagria typhae*	+			+	+	+	+						T	H1
377	*Rhizedra lutosa*	+			+		+	+						B	H1
378	*Archanara algae*	+												N	H1
379	*Archanara geminipuncta*				+									N	H1
380	*Archanara neurica* *	+												N	H1
381	*Archanara sparganii*	+			+		+	+						T	H1
382	*Arenostola phragmitidis**	+												B	H1
383	*Episema tersa* *	+												S	X1
384	*Brachylomia viminalis*				+	+	+	+	+	+	+	+	+	BM	H2
385	*Parastichtis suspecta*	+		+	+		+							T	M2
386	*Parastichtis ypsillon*	+				+	+	+	+					T	H2
387	*Atypha pulmonaris*	+			+	+	+	+	+			+		N	H2
388	*Xanthia togata*	+		+	+	+	+	+	+	+	+			B	H2
389	*Cirrhia gilvago*	+												N	X3
390	*Cirrhia icteritia*	+	+	+	+	+	+	+	+	+	+	+		T	H2
391	*Cirrhia ocellaris*	+		+	+		+							N	M2
392	*Tiliacea citrago*	+	+	+		+	+	+	+					N	X3
393	*Tiliacea aurago*	+	+	+		+	+	+	+	+				N	M3
394	*Tiliacea sulphurago*					+	+							MT	X2
395	*Agrochola circellaris*	+	+	+	+	+	+	+	+	+	+	+		T	M3
396	*Agrochola lychnidis* *	+	+	+										N	M3
397	*Agrochola macilenta*	+	+	+	+	+	+	+	+	+	+			N	M3
398	*Agrochola lota*				+	+	+	+	+	+	+			T	H2

399	*Agrochola litura*	+	+	+	+	+	+	+	+	+	+	+		N	M2
400	*Agrochola nitida*	+		+			+							N	X3
401	*Agrochola humilis*	+	+	+		+	+							MT	X2
402	*Agrochola helvola*	+	+	+	+	+	+	+	+					T	M3
403	*Agrochola laevis*	+	+	+										N	X3
404	*Conistra erythrocephala*	+		+										N	M2
405	*Conistra ligula*	+		+			+							N	X2
406	*Conistra rubiginea*	+	+	+	+	+	+	+	+					N	M2
407	*Conistra rubiginosa*	+	+	+	+									N	M2
408	*Conistra vaccinii*	+	+	+	+	+	+	+	+	+	+	+		T	M2
409	*Lithophane furcifera*	+			+	+	+							T	H2
410	*Lithophane ornitopus*	+	+	+	+	+	+	+						N	M2
411	*Lithophane socia*	+		+	+	+	+	+	+					T	M2
412	*Lithophane consocia*	+			+	+	+	+	+	+	+	+		BM	H2
413	*Lithomoia solidaginis*										+	+		BM	TF
414	*Xylena exsoleta*	+												T	M2
415	*Xylena vetusta*				+									T	H2
416	*Eupsilia transversa*	+	+	+	+	+	+	+	+	+	+	+		T	M3
417	*Griposia aprilina*	+	+	+		+	+							N	X3
418	*Dichonia aeruginea* *	+												MT	X2
419	*Dichonia convergens*	+	+	+										MT	X3
420	*Dryobotodes eremita*	+		+										N	X3
421	*Antitype chi*	+		+										T	X2
422	*Ammoconia caecimacula*	+		+	+	+	+	+						N	M2
423	*Aporophyla lutulenta*	+		+	+									S	X1
424	*Mniotype adusta*					+	+	+	+	+	+	+	+	BM	H2
425	*Mniotype satura*	+		+	+	+	+	+	+	+	+			T	M3
	Hadeninae														
426	*Panolis flammea*								+					T	M3
427	*Dioszeghyana schmidti* *	+												MT	X2
428	*Orthosia cerasi*	+	+	+	+	+	+	+	+	+	+			N	M3
429	*Orthosia cruda*	+	+	+	+	+	+	+	+	+	+			N	M3
430	*Orthosia gothica*	+	+	+	+	+	+	+	+	+	+	+		P	U
431	*Orthosia gracilis*	+	+	+	+	+	+	+						T	H2
432	*Orthosia incerta*	+	+	+	+	+	+	+	+	+	+	+		T	M3
433	*Orthosia miniosa*	+	+	+										N	M2
434	*Orthosia opima*	+	+	+	+	+								T	M2
435	*Orthosia populeti*	+	+	+	+		+	+	+	+				T	H2
436	*Anorthoa munda*	+	+	+	+	+	+	+	+	+				T	M3
437	*Egira conspicillaris*	+	+	+	+	+	+	+	+	+				N	M2
438	*Tholera cespitis*	+		+	+	+	+	+	+					T	M1
439	*Tholera decimalis*	+	+	+	+	+	+	+	+	+	+			T	M1
440	*Cerapteryx graminis*					+	+	+	+	+	+	+		B	M1
441	*Anarta trifolii*	+	+	+	+	+	+	+	+					T	X1
442	*Polia bombycina*	+			+	+	+	+	+	+	+	+		T	M2

443	*Polia hepatica*							+	+	+	+	+		T	M2
444	*Polia nebulosa*	+	+	+	+	+	+	+	+	+	+	+		T	M2
445	*Pachetra sagittigera*					+	+	+						T	X2
446	*Lacanobia aliena*						+	+						S	X2
447	*Lacanobia contigua*	+	+	+	+	+	+	+	+	+	+			T	M3
448	*Lacanobia oleracea*	+	+	+	+	+	+	+	+	+	+			T	M1
449	*Lacanobia splendens*	+			+		+	+						T	H2
450	*Lacanobia suasa*	+	+	+	+	+	+	+	+	+	+			T	M2
451	*Lacanobia thalassina*	+	+	+	+	+	+	+	+	+	+	+		T	M3
452	*Lacanobia w-latinum*	+	+	+	+	+	+	+	+	+	+	+		T	X2
453	*Melanchra persicariae*	+	+	+	+	+	+	+	+	+	+	+		T	M2
454	*Ceramica pisi*					+	+	+	+	+	+	+		T	M1
455	*Papestra biren*											+		BM	H2
456	*Mamestra brassicae*	+	+	+	+	+	+	+	+	+	+	+	+	T	U
457	*Hada plebeja*	+	+	+	+	+	+	+	+	+	+	+		T	H2
458	*Sideridis reticulatus*	+		+	+		+							N	X2
459	*Sideridis rivularis*	+	+	+	+	+	+	+	+	+		+		T	X1
460	*Sideridis turbida*	+		+										T	X1
461	*Conisania luteago*	+	+	+	+	+	+	+						T	X1
462	*Hecatera bicolorata*	+	+	+	+							+		T	X1
463	*Hecatera dysodea*	+	+	+	+									N	X1
464	*Hadena albimacula* *	+												N	X1
465	*Hadena capsincola*	+		+	+		+							T	M2
466	*Hadena compta*	+		+	+							+		T	X1
467	*Hadena confusa*	+		+	+		+	+						T	M1
468	*Hadena filograna* *	+												N	X1
469	*Hadena irregularis*	+												N	X1
470	*Hadena perplexa*	+	+	+	+		+	+		+				T	X1
471	*Mythimna albipuncta*	+	+	+	+	+	+	+	+	+	+	+	+	T	M1
472	*Mythimna conigera*	+		+	+	+	+	+	+	+	+	+		T	M1
473	*Mythimna ferrago*	+	+	+	+	+	+	+	+	+	+	+	+	T	M1
474	*Mythimna impura*	+			+									T	H1
475	*Mythimna l-album*	+	+	+	+	+	+	+	+	+				N	H1
476	*Mythimna pallens*	+	+	+	+	+	+	+	+	+	+	+		T	M1
477	*Mythimna pudorina*	+	+	+	+									T	H1
478	*Mythimna straminea*	+			+									T	H1
479	*Mythimna turca*	+	+	+	+	+	+	+	+	+	+			T	M2
480	*Mythimna unipuncta* *	+												MT	U
481	*Mythimna vitellina*	+	+	+	+	+	+	+	+	+	+	+	+	MT	U
482	*Leucania comma*					+	+	+	+	+	+	+	+	BM	H1
483	*Leucania obsoleta*	+			+									T	H1
484	*Lasionycta imbecilla*						+	+			+			BM	H2
485	*Lasionycta proxima*											+		BM	X2
486	*Senta flammea*				+									B	H1

	Noctuinae														
487	*Peridroma saucia*												+	P	U
488	*Dichagyris flammatra*							+				+	+	MT	X1
489	*Euxoa birivia*										+			A	A
490	*Euxoa tritici*	+												N	X1
491	*Agrotis bigramma*	+												N	X1
492	*Agrotis cinerea*					+	+	+						N	X1
493	*Agrotis clavis*	+		+	+	+	+							T	X1
494	*Agrotis exclamationis*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
495	*Agrotis ipsilon*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
496	*Agrotis segetum*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
497	*Axylia putris*	+	+	+	+	+	+	+	+	+	+	+		P	M1
498	*Ochropleura plecta*	+	+	+	+	+	+	+	+	+	+	+		P	M1
499	*Diarsia brunnea*	+		+	+	+	+	+	+	+	+	+	+	T	M2
500	*Diarsia dahlii*						+	+				+		B	H2
501	*Diarsia florida*					+	+	+	+	+	+	+		BM	H2
502	*Diarsia mendica*						+	+	+	+	+	+		BM	M2
503	*Diarsia rubi*	+			+	+	+	+	+	+				B	H2
504	*Cerastis rubricosa*	+	+	+	+	+	+	+	+	+	+			T	M1
505	*Cerastis leucographa*	+			+	+	+	+	+					T	M2
506	*Paradiarsia punicea*				+									B	H1
507	*Lycophotia porphyrea*										+			B	TF
508	*Rhyacia simulans*											+		T	X1
509	*Rhyacia lucipeta*												+	MT	X1
510	*Chersotis rectangula*												+	BM	X2
511	*Noctua comes*	+	+	+	+		+							N	M2
512	*Noctua fimbriata*	+	+	+	+	+	+	+	+	+	+	+	+	T	M2
513	*Noctua interposita*	+	+	+	+	+	+	+	+	+	+	+	+	N	M2
514	*Noctua janthe*	+	+	+	+	+	+					+		N	M2
515	*Noctua janthina*	+	+	+	+	+	+					+		N	M2
516	*Noctua orbona*	+	+	+	+									N	M2
517	*Noctua pronuba*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
518	*Epilecta linogrisea*	+		+										N	X1
519	*Spaelotis ravida*	+												T	X1
520	*Opigena polygona*	+												T	X1
521	*Eurois occulta*				+	+	+	+	+	+	+	+		BM	M2
522	*Graphiphora augur*	+			+		+	+			+			B	M2
523	*Anaplectoides prasina*				+	+	+	+	+	+	+	+	+	T	M2
524	*Xestia baja*	+		+	+	+	+	+	+	+	+	+	+	T	M2
525	*Xestia c-nigrum*	+	+	+	+	+	+	+	+	+	+	+	+	P	U
526	*Xestia collina*											+		BM	M2
527	*Xestia ditrapezium*	+		+	+	+	+	+	+	+	+			T	M2
528	*Xestia stigmatica*					+	+	+	+					N	M2
529	*Xestia sexstrigata*	+										+		N	M2
530	*Xestia triangulum*	+			+	+	+	+	+					T	M2

531	*Xestia xanthographa*	+		+	+	+	+	+						N	M2
532	*Eugraphe sigma*	+			+	+	+	+	+	+	+			T	M2
533	*Eugnorisma depuncta*						+	+	+					T	M2
534	*Naenia typica*	+			+		+							T	H1

Ecogeographic structure of regional moth fauna presented further (Table 3). There is Temperate EC dominate with 265 species and a share of about 50% in total species amount. The next dominating Nemoral EC consist 116 species or 22% in total amount. These two complexes are forming “standard” Middle-European ecogeographic block. Following ECs have not exceeding a part of 10%: Mediterranean (46 species, 8.6%), Boreomontane (31, 5.8%), Steppe (27, 5.1%), Polyzonal (21, 3.9%), Boreal (18, 3.4%), Nemoral-Montane (8, 1.5%) and Alpine (2 species, < 1%).

Among HGs seminemoral mesophiles (M2) prevailing with its 138 species and 26% in total amount. There are totally 253 mesophile species or 47% in amount, 144 xerothermophiles with 27%, 107 hygrophiles with 20% and 24 ubiquists with almost 5% accordingly. The strictly specialized and sthenotopic tyrfophiles (TF) or alpicols (A) are presented by few species only.

The general ecogeographic structure of regional moth fauna looks as:

4P 50T 23N 5S 9MT 10BM: 4U 47M 27S 20H 1TF +A.

The species diversity is richest in mixed lowland & hilly terrain of Transcarpathia within *Querceta robori-petraeae* vegetation belts. There are 417 species occur totally at the points situated on volcanic hills of Bereg Uplands (Beregszasz), Czorna Hora and Klenova Hora (Akli Hegy), and 83 of them is found only there.

Table 3: Ecogeographic structure of the moth fauna in investigated area

CATEGORY	SPECIES NUMBER BY THE POINTS												
	Beregszasz	Akli Hegy	Czorna Hora	Kireshi	Mala Uholka	Kuzij	Rakhiv	Keveliv	Ust-Hoverla	Czorna Tysa	Pozhezhevska	Pip Ivan	**Total**
Ecogeographic complexes (ECs)													
A	–	–	–	–	–	–	–	–	–	1	1	–	2
B	7	1	1	9	7	13	13	8	7	9	7	–	18
BM	1	–	–	5	12	17	18	17	17	23	23	7	31
T	214	143	184	223	200	223	209	182	151	136	85	22	265
N	103	55	78	69	54	69	46	28	17	11	8	2	116
NM	–	1	–	3	6	7	6	7	6	2	1	–	8
S	22	9	12	11	1	4	3	–	–	–	1	–	27
MT	32	22	23	11	5	10	5	2	2	2	6	5	46
P	20	17	18	18	16	18	17	16	16	15	16	11	21
Habitat groups (HGs)													
U	22	20	20	19	17	19	19	17	17	17	21	18	24
M1	20	14	19	21	21	22	23	21	18	16	15	3	26

M2	105	72	89	107	100	112	103	87	72	70	50	15	138
M3	64	54	64	64	78	82	79	75	65	54	27	3	89
X1	63	22	40	35	12	17	11	4	5	2	9	2	76
X2	43	30	34	22	15	24	11	5	3	3	2	1	55
X3	12	8	9	3	5	7	2	2	–	–	–	–	13
H1	25	5	9	29	9	18	15	11	4	4	1	1	36
H2	40	18	27	44	42	55	50	37	31	28	19	3	65
HT	5	5	5	5	2	4	3	–	–	–	–	–	6
TF	–	–	–	–	–	1	1	1	1	4	3	1	4
A	–	–	–	–	–	–	–	–	–	1	1	–	2
Total	399	248	316	349	301	361	317	260	216	199	148	47	534

The richest fauna is characteristic to **Beregszasz** point, where 399 species found:

5P 54T 26N 6S 8MT 2BM: 6U 47M 30X 18H.

There is largest amount of Mediterranean and Steppe species (totally 54) among all points as well as Nemoral species (103) revealed. It is associated with location of the point, which situated on xeric stony hill covered by Pannonic oak woods with *Quercus petraea* (Kish et al., 2006) or scrub and dry grassy clearings mosaics, and opened onto Transcarpathian plain. The unexpectedly high part of hygrophiles (70 species) as well as presence of Boreal elements (7 species) here is caused by the proximity of surrounding humid plain with lowland oak woods and damp meadows. There are 45 species found only at this point during our investigations, and most of them are Mediterranean, Steppe or Nemoral xerothermophiles. Also there 35 of 42 newly found in Ukrainian Carpathian region moth species occur.

The species composition found at another points **Akli Hegy** and **Czorna Hora** seems like much poor (248 and 316 species accordingly), but it caused generally by unavailability of stationary catching with light traps there. At the same time, ecogeographic structure of species composition at these points is similar to the previous:

Akli Hegy – 7P 58T 23N 4S 9MT +BM: 8U 56M 24X 11H;

Czorna Hora – 6P 58T 25N 4S 7MT +BM: 6U 54M 26X 13H.

These points have more xeric environments and it marks up on nearly absence of Boreal species as well as lower parts of hygrophiles in the structure in comparison with Beregszasz point.

There are interesting finds at both of points occurred. The Akli Hegy is the only known locality of Mediterranean hawkmoth *Marumba quercus* (Denis and Schiffermueller, 1775) in western region of Ukraine, where it found at the first time at 2009. There are number of rare xerothermophile *Noctuoidea* species found recently: *Eublemma ostrina* (Huebner, 1808), *Pechipogo plumigeralis* (Huebner, 1825), *Catocala conversa* (Esper, 1787), *Lamprosticta culta* (Denis and Schiffermueller, 1775), *Periphanes delphinii* (Linnaeus, 1758), *Actinotia radiosa* (Esper, 1804) at Akli Hegy (Geryak, 2010); *Callopistria latreillei*, *Episema glaucina*, *Chersotis multangula* at Czorna Hora (Nowacki, Bidychak, 2009; Nowacki et al., 2010).

The volcanic hills of Transcarpathian Lowland is famous by its unique as for Ukrainian Carpathians Submediterranean (Pannonic) wood vegetation with participation of *Quercus cerris, Q. dalechampii, Q. polycarpa, Fraxinus ornus, Tilia tomentosa, Staphylea pinnata, Cornus mas, Ligustrum vulgare* etc. (Kish et al., 2006; Stoyko, 2009). There are last plots of Pannonic xeric grasslands in Transcarpathia remained on some these hills. Most of specific Mediterranean or Steppe moth species are associated with its formations, but their future survival both with unique ecosystems here is rather doubtful. Some present kinds of human activity in this area have been causing a serious threat for regional biodiversity at the close perspective. It is concerning to open mining (especially at Bereg Uplands) which has further continue, rapid oak woods cutting, recently activated re-mastering of xeric slopes for commodity vineyards, burnings of dried vegetation etc.

Another investigated point within *Querceta robori-petraeae* vegetation belts is **Kireshi** or famous Valley of Narcissi. There are humid to wet meadows in combination with alluvial *Salix* or other shrubs and remnants of oak woods presented. The humid environmental conditions determine significantly ecogeographic structure of the moth fauna:

5P 64T 21N 3S 3MT 4BM: 5U 55M 17X 22H.

There are rare hygrophile *Noctuoidea* species found, such as *Diachrysia zosimi* (Huebner, 1822), *Plusia putnami* (Grote, 1873), *Archanara geminipuncta* (Haworth, 1809), *Xylena vetusta* (Huebner, 1813), *Senta flammea* (Curtis, 1828), *Paradiarsia punicea* (Huebner, 1803), which not occurred elsewhere in investigated area. It is right also for Nemoral mesophile *Calyptra thalictri* (Borkhausen, 1790). However, there are many xerothermophile moth species characteristic to most dry and warm Transcarpathian localities occur. There are *Eriogaster lanestris* (Linnaeus, 1758), *E. catax* (Linnaeus, 1758), *Saturnia pyri* (Denis & Schiffermueller, 1775), *S. pavoniella* (Scopoli, 1763), *Drymonia querna* (Denis & Schiffermueller, 1775), *Dysauxes ancilla* (Linnaeus, 1767), *Cucullia lychnitis* (Rambur, 1833), *Heliothis peltigera* (Denis & Schiffermueller, 1775) as well as rare Steppe species *Lygephila lusoria* (Linnaeus, 1758), *Cucullia lanceolata* (Villers, 1789). Thus, unique combination of hygrophile and xerothermophile elements of diverse biogeographic origin has result as very rich moth fauna with 349 species found totally.

Following three points are representing lower parts of *Fageta sylvaticae* vegetation belts. **Mala Uholka** point situated closely to famous Uholka massif of virgin beech forest, but the species diversity of its moth fauna is much poor than in almost woodless Kireshi site.

There are 301 species found and ecogeographical structure of its composition is rather "standard":

5P 66T 20N +S 2MT 6BM: 6U 66M 10X 18H.

There are not any species occurred only at this point, but Boreomontane species (12) become to consist a visible part in the structure as well as parts of Mediterranean or Steppe species (totally 6) is decreasing considerably in comparison with localities of *Querceta robori-petraeae* vegetation belts. The low habitat diversity of the site which presented by mesophile beech forest with its clearings and margins at general is rather most important cause of relatively mediocre character of local moth fauna.

Unlike of Mala Uholka the **Kuzij** is most interesting by the moth fauna among the points situated within *Fageta sylvaticae* vegetation belts. It situated near Tisa River Valley at the western foothills of Marmarosh Mts, which are rising rapidly from 350 to 1090 m altitude at this place. It is the zone of sharply defined transition between Upper Tisa Depression with *Querceta robori-petraeae* vegetation and higher mountain massifs of Interior Carpathians with *Fageta sylvaticae* and *Piceeta abietis* vegetation belts. The mountains of Marmarosh built with hard metamorphic rocks and have rapid stony slopes. These features as well as complicated relief with barrens of carbonate rocks cause mosaic pattern of distribution of the habitats and vegetation communities with its rich biodiversity. As an example of that diversity, there is unique fact of occurrence of *Quercetum petraeae* forest community at the Tempa Mt near 1000 m altitude known (Stoyko, 2009).

The Kuzij point surrounded by rapid slopes of the same named stream valley, which covered by plentiful broadleaf forest of *Fagus sylvatica* with participation of *Quercus robur, Carpinus betulus, Acer pseudoplatanus, Fraxinus excelsior* and *Tilia cordata*. There are open mesophile grassy clearings and margins as well as fragments of the damp riverside woods and coppice of *Alnus glutinosa, A. incana* and *Ulmus laevis* in immediate environs.

There are 361 species moth species in species composition, and it is largest amount found among the points within *Fageta sylvaticae* vegetation belts:

5P 62T 21N 1S 3MT 8BM: 5U 60M 13X 21H +TF.

As it seen, the species structure has more diverse character than that it is at Mala Uholka point. This richness and diversity caused, on the one hand, by availability of damp woodland habitats, which attract many hygrophile species. As result, there is largest amount of nemoral hygrophiles among all of investigation points (55) and almost largest – of hygrophiles generally (77). On the other hand, near Tisa River Valley playing a role of ecological corridor by which Mediterranean, Steppe or other xerothermophile species have to penetrate into cooler mountain terrains. Thus there are 10 Mediterranean, 4 Steppe and 48 generally xerothermophile species found at Kuzij in comparison with 5, 1 and 32 such species accordingly at Mala Uholka point. Another characteristic feature of this site is large amount of Boreal and Boreomontane species (totally 30), which is caused both by local environmental conditions (situation in the damp and relatively cool valley) and biogeographic influence of near higher mountain terrains. It is worth to note, that the biogeographic barrier effect also sharply defined at the site. For example, there are few xerothermophile moth species characteristic to Transcarpathian Lowland localities occurred at the near vicinity of Kuzij – the Luh village, which situated at open to Upper Tisa Depression SW foothills of the same mountain massif, but never found at Kuzij: *Saturnia pyri*, *Lamprosticta culta, Agrochola laevis* (Huebner, 1803), *Dryobotodes eremita* (Fabricius, 1775).

The species diversity of moth fauna at the **Rakhiv** point is less rich than at Kuzij. The point has similar environmental surrounding but it situated at 50 m higher vertically by Tisa River and after the series of its sharp meanders within strict and squeezed by mountains valley. The climatic conditions there are also cooler than at Kuzij site.

There are 317 moth species found:

5P 66T 16N 1S 2MT 10BM: 6U 65M 8X 21H +TF.

There is considerable decrease of the parts and amounts both of Nemoral and xerothermophile elements becomes – from 76 and 48 species at Kuzij to 52 and 24 at Rakhiv accordingly. It is associated probably both with climatic condition changes and the lesser availability for the species penetrating from Upper Tisa Depression, which caused by the valley relief. It looks like the next biogeographic barrier becomes through mentioned 50 m altitude rise.

There are two rare in Ukrainian Carpathians Temperate species caught only at this point: *Phyllodesma ilicifolia* (Linnaeus, 1758) and *Pericallia matronula* (Linnaeus, 1758).

Another 2 points **Keveliv** and **Ust-Hoverla** situated also in Tisa or Bila Tisa river valleys within *Fageta sylvaticae* vegetation belts but at much higher altitudes (585 and 650 m accordingly). There are 260 moth species found at Keveliv as well as 216 at Ust-Hoverla points: Keveliv – 6P 70T 13N 1MT 10BM: 7U 70M 4X 18H +TF;

Ust-Hoverla – 7P 70T 11N 1MT 11BM: 8U 72M 4X 16H +TF.

There is seen that the species diversity became decreasing rapidly with altitude rise. The Steppe and hygrothermophile species are absent totally at these points, and single Mediterranean species occur. There are small number of mostly Temperate xerothermophiles penetrates into these mountain terrains, but the parts and amounts of Nemoral elements in species compositions decreased at 1.5-2 times in comparison with Rakhiv point.

The **Czorna Tysa** point presents another qualitative change in the structure of moth species composition. Despite it situated ultimately within *Fageta sylvaticae* vegetation belts by its average altitude intervals (Stoyko, 2009), there are belts descended at this site because of situation in cold and almost closed for warm SW air masses valley in uppers of Tisa River, between Svydovets and Gorgany Mts. Thus, there is vegetation of *Piceeta abietis* belts dominate as well as *Picea abies* in surrounding forest communities. There are also damp meadows and riverside coppice of *Alnus incana* and *Salix spp.* presented near the point.

There are 199 moth species found:

8P 68T 7N 1MT 17BM: 9U 70M 3X 16H 2TF 1A.

There are Nemoral species decreasing naturally, and a few of Mediterranean are widespread migrants, such as *Agrius convolvuli* (Linnaeus, 1758) or *Mythimna vitellina* (Huebner, 1808). But there is largest amount of Boreoalpine, in wider sense (B+BM+A), species (33) among all of investigation points, as well as all 4 tyrfophiles occurring in Upper Tisa River Basin found. There are such specific Boreomontane species as *Cosmotriche lobulina* (Denis & Schiffermueller, 1775), *Parasemia plantaginis* (Linnaeus, 1758), *Syngrapha interrogationis* (Linnaeus, 1758), *Acronicta menyanthidis* (Esper, 1789), *Cucullia lucifuga* (Denis & Schiffermueller, 1775), *Calliergis ramosa* (Esper, 1786), *Apamea rubrirena* (Treitschke, 1825), *Lithomoia solidaginis* (Huebner, 1803) characteristic to *Piceeta abietis* both with Subalpine vegetation belts. The Boreal tyrfophile species *Lycophotia porphyrea* (Denis and Schiffermueller, 1775) both with Alpine *Euxoa birivia* (Denis and Schiffermueller, 1775) found only at this point.

The moth species composition has furthermore decrease through the rising up to the tree line. There are 148 species found at **Pozhezhevska** point, which situated at the border of *Piceeta abietis* and *Pineta mugi / Prata subalpina* vegetation belts:

11P 57T 6N 1S 4MT 21BM: 14U 62M 7X 14H 2TF 1A.

There are largest parts in the species composition both Temperate and Polyzonal ECs consist (101 species or 68% totally), but next richest are Boreal and Boreomontane ECs with its 31 species totally (including single rare Alpine species *Apamea maillardi* (Geyer, 1834). Most of species are characteristic for *Piceeta abietis* belt generally, but there are some interesting finds occur. The continental Steppe species *Cucullia pustulata* (Eversmann, 1848) [= *fraterna* auct.] was found there at 2007 at the first time in Ukrainian Carpathians, as well as Boreomontane *Apamea illyria* (Freyer, 1846) at 2008 (Geryak, Bidychak, 2009).

The point is interesting by its situation on the migratory way through highest chains of Carpathians. There are Mediterranean vagrants such as *Acherontia atropos* (Linnaeus, 1758) or *Hyles livornica* (Esper, 1780) occur during its migrations to north. The last mentioned species observed there in number near 100 individuals during a few night hours in August 2007. There are another Mediterranean migrants or xerothermophiles of other origin registered, which not occurred generally in the lower mountain terrains: *Cucullia lactucae* (Denis and Schiffermueller, 1775), *Heliciverpa armigera* (Huebner, 1808), *Dichagyris flammatra* (Denis and Schiffermueller, 1775), *Rhyacia simulans* (Hufnagel, 1766) etc. (Geryak, Bidychak, 2009). It looks like peculiar biogeographic inversion, where some xerothermophile species occur in the cold high mountain terrains more often than in the lower and warmer areas.

The last considered point is **Pip Ivan** situated near the border of Subalpine and Alpine belt of Marmarosh Mts. Actually, there was not a single point because of investigations were carrying out with mobile light trap and screen within wider vertical scale from 1600 to 1850 m altitude or even higher (Geryak, Bidychak, 2009). There were moth fauna naturally poor with 47 species found only:

23P 47T 4N 11MT 15BM: 38U 45M 6X 9H 2TF.

The most of those species are Polyzonal and Temperate ubiquists or other widespread elements, including few Mediterranean migrants. Most interesting find there was Boreomontane xerophile (or xeromontane) species *Chersotis rectangula* (Denis and Schiffermueller, 1775) which not found in the region elsewhere (Geryak, Bidychak, 2009). At the same time, the absence of Alpine species there is common for Ukrainian Carpathians fact. The question of its potential distribution is still remains opened (Kanarskyi, 2009).

CONCLUSIONS

1. There are 534 moth species found in investigated area during the research, including 16 species of *Drepanoidea,* 39 – *Bombycoidea* and 479 – *Noctuoidea.* The row of recent finds of new for the regional fauna moth species shows that its composition not ascertained completely at present.

2. The species richness of moth fauna is not decreasing gradually with altitude rise. Its amounts by the localities remain near the same (about 300–400 species) within lower parts of *Fageta sylvaticae* vegetation belts as it is in lowland *Querceta robori-petraeae* belts up to 450 m approximately. This limit is evidently coincident with an average upper limit of relatively common forest communities containing *Quercus* sp. in Upper Tisa River Basin. After the species richness decreases rapidly to about 210–260 species in the higher parts of *Fageta sylvaticae* belts and further to 150–200 species within *Piceeta abietis* belts. There are near 100 species for Subalpine and less than 50 species for Alpine belts localities characteristic.

3. The general trend in changes of ecogeographic structure of the moth species composition in the way to rise up by altitude consists in the decrease of the parts and amounts of mostly xerothermophile Mediterranean, Steppe and Nemoral species as well as parts of Boreal or Boreomontane species increase. However, these changes have not strictly determined by altitude, because local environmental conditions such as habitat diversity, microclimate or physical barriers might have much significant role in the species distribution.

4. The most original elements in the moth species composition with large number of rare and locally distributed species are characteristic to the sites within *Querceta robori-petraeae* vegetation belt, where there are lot of Nemoral, Steppe, Mediterranean both xerothermophile and hygrophile species. These elements are more or less gradually diminishing by altitude rise, and the “standard” widespread Temperate or Nemoral mesophiles become prevailing. The original features of the species composition within upper *Fageta sylvaticae* and *Piceeta abietis* vegetation belts are supported by generally not very numerous Boreal or Boreomontane species as well as thermophile species penetrating from the lower terrains. The species composition of high mountain sites situated above the tree line is most “primitive” and it consists of Polyzonal and Temperate ubiquists or other widespread elements mainly, including few Mediterranean migrants.

5. There is not visible impoverishment of the general species diversity within investigated area determined in about 100-year retrospective, but some kinds of human activity, especially open mining or oak woods cutting in Transcarpathian Lowland and its volcanic hills, causing serious threat for regional diversity of moth fauna as well as unique xeric or floodplain woodland and grassland ecosystems. These habitats need protection at the first turn.

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AUTHORITY NOTES

The conception of the paper as well as methodological processing and generalization of presented materials belong principally to Yu.Kanarskyi. The particular interpretations with analysis of diverse ecological and faunal aspects of the species are authorities of Yu. Geryak (*Noctuoidea*) and E.Lyashenko (*Drepanoidea* and *Bombycoidea*) mainly. The materials are collecting in the framework of common field research with all authors. All original zoological materials of *Noctuoidea* are processing by Yu.Geryak.

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AUTUMN DIET AND TROPHIC RELATIONS OF JUVENILE BROWN TROUT (*SALMO TRUTTA*), RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) AND EUROPEAN GRAYLING (*THYMALLUS THYMALLUS*) IN THE SHIPOT RIVER (UKRAINE)

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KEYWORDS: *Salmo trutta*, *Oncorhynchus mykiss*, *Thymallus thymallus*, diet composition, prey selection, diet overlap

ABSTRACT

Native brown trout (*Salmo trutta*), European grayling (*Thymallus thymallus*) and non-native rainbow trout (*Oncorhynchus mykiss*) coexist in some rivers of the Ukrainian Carpathians. Their diet and trophic relationship were studied for the Shipot River, which is located in the Transcarpathian region of Ukraine. All species consumed mainly insect larvae. The most important prey both by number and biomass in brown trout and European grayling diets were Ephemeroptera and Trichoptera larvae, while Chironomidae and Ephemeroptera larvae were more abundant in rainbow trout diet. There is a possibility of competition among these salmonids as biomass of prey invertebrates in the river is relatively low (9.5 g/m^2). The highest Shorygin's diet overlap indices were observed between brown trout and European grayling (65.5%), and they were slightly lower between rainbow trout and European grayling (60.0%), and rainbow and brown trout (58.5%). Ephemeroptera larvae were responsible for the highest diet overlap between brown trout with European grayling (26.7) and brown trout with rainbow trout (21.5).

RESUMEN: La dieta en el otoño y relaciones tróficas de juveniles de la trucha marrón (Salmo trutta), trucha arco iris (Oncorhynchus mykiss), y el tímalo europeo (Thymallus thymallus) en el río Shipot, Ucrania.

La trucha nativa marrón (Salmo trutta), el tímalo europeo (Thymallus thymallus) y la trucha no nativa arco iris (Oncorhynchus mykiss) coexisten en algunos ríos de los Cárpatos ucranianos. Su dieta y sus relaciones tróficas fueron estudiadas para el río Shipot, que se encuentra en la región de Transcarpacia de Ucrania. Todas las especies consumen principalmente larvas de insectos. Las presas más importantes, tanto por el número y la biomasa en las truchas marrones y tímalo europeas fueron las larvas de Ephemeroptera y Trichoptera, mientras que los Chironomidae y las larvas de Ephemeroptera fueron más abundantes en la dieta de la trucha arco iris. Hay la posibilidad de competencia entre los salmónidos, ya que la biomasa de los invertebrados presa en el río es relativamente baja (9,5 g/m2). El mayor traslape de las dietas del índices Shorygin se observó entre la trucha y el tímalo Europeo (65,5%), y fue ligeramente inferior entre la trucha arco iris y el tímalo Europeo (60,0%), y la trucha arco iris y trucha marrón (58,5%). Las larvas de Ephemeroptera fueron los responsables del traslape más alto de la dieta entre la trucha marrón con el tímalo Europeo (26,7) y la trucha marrón con la trucha arco iris (21,5).

REZUMAT: Dieta de toamnă şi relaţiile trofice ale juvenililor de păstrăv indigen (*Salmo trutta*), păstrăv curcubeu (*Oncorhynchus mykiss*) şi lipan (*Thymallus thymallus*) din râul Şipot (Ucraina).

Speciile autohtone păstrăv indigen (*Salmo trutta*) şi lipan (*Thymallus thymallus*) convieţuiesc în câteva râuri carpatice cu păstrăvul curcubeu alohton (*Oncorhynchus mykiss*). Dieta lor şi relaţiile trofice au fost studiate în râul Şipot din regiunea transcarpatică a Ucrainei. Toate speciile se hrănesc cu larve de insecte. Prada principală, atât ca număr cât şi ca biomasă, a păstrăvului indigen şi a lipanului este constituită din larve de Ephemeroptere şi de Trichoptere, pe când Chironomidele şi Ephemeropterele sunt mai abundente în dieta păstrăvului curcubeu. Există posibilitatea unei competiţii între cele trei salmonide, Ţinând cont că biomasa nevertebratelor pradă din râu este relativ mică (9.5 g/m^2). Cele mai mari valori ale indicelui de suprapunere a dietei al lui Shorygin au fost observate între păstrăvul indigen şi lipan (65.5%) şi între păstrăvii indigen şi curcubeu (58.5%). Larvele de Ephemeroptere au fost responsabile pentru cea mai mare parte a suprapunerii dietelor între păstrăvul indigen şi lipan (26.7%) şi între păstrăvii indigeni şi curcubeu (21.5%).

INTRODUCTION

Transcarpathian watercourses within Ukraine include about 9400 rivers and streams of total length of more than 19000 km (Shmidt, 1978). These watercourses, which belong to the Tisza River basin, are unique ecosystems with the highest diversity of fish species in Ukraine, and contain populations of three native salmoniformes (brown trout, *Salmo trutta* L., 1758; Danube salmon, *Hucho hucho* L., 1758; and European grayling, *Thymallus thymallus* L., 1758). Historically, salmonids were abundant in the Transcarpathian region in the beginning of the 20th century, when brown trout were commercially harvested from rivers at rates of 21 to 110 kg/km annually (Protasov, 1948). From the 1940s, stocks of Transcarpathian salmonids catastrophically declined because of negative anthropogenic effects on local ecosystems. These effects included alteration of hydrological, chemical, and hydrobiological regimes through hydrotechnical building, timber rafting, water pollution, and over-fishing; which altered typical salmonid biotopes (Movchan, 2000). Currently, two species (Danube salmon and European grayling) are listed as endangered in the Red Book of Ukraine, which is an official State document established for documenting rare and endangered species of animals and plants that exist within the territory of Ukraine. Brown trout is widespread in many Transcarpathian rivers; however, its stocks are at a very low level in the majority of watercourses.

Rainbow trout, *Oncorhynchus mykiss* (Walbaum, 1792), which are native to North America, were first introduced in Carpathian rivers of Ukraine at the end of the 19th century (Pavlov, 1980). This was followed by several subsequent introductions with the goal of increasing fish productivity. Currently, rainbow trout are the most common cultured species at specialized trout farms, which within Ukraine are traditionally located mainly in the Carpathian region. As these farms usually discharge water into nearby watercourses, cultured fish can escape into the wild, where they can threaten local fish stocks (Oscoz, 2005). Rainbow trout were also artificially stocked in a number of Transcarpathian rivers by local angler organizations for recreational fly fishing. Natural reproduction of rainbow trout has not been observed in streams of the Ukrainian Carpathians but stocked and escaped can affect native fish populations through predation and competition for food or space (Lucas, 2008).

Thus, for effective fisheries management of Carpathian rivers and conservation of native species, knowledge of interactions between native and non-native fishes is important. Factors that significantly affect fish survival and propagation, are feeding conditions and trophic relationships.

Many studies have examined feeding of stream salmonids including brown trout, rainbow trout, and European grayling (Evsin and Ivanov, 1979, Zadorina, 1988, Kara and Alp, 2005, Oscoz et al., 2005, Kukuła and Bylak, 2007). According to these studies, food of these fishes consists of insect larvae and pupae, among which the most important are Trichoptera, Ephemeroptera, Simuliidae, Coleoptera, Plecoptera, Chironomidae, and terrestrial species. Their diet often significantly overlaps, which can result in strained trophic relationships between them at low biomasses of food organisms. No studies have examined feeding and food relationships of salmonids in streams of the Ukrainian Carpathians. The goal of our study was to investigate diet and trophic relationships of co-existing native brown trout and European grayling and non-native rainbow trout in a Transcarpathian river.

MATERIAL AND METHODS

This study was conducted in September 2009 in the Shipot River (48º 44’ N, 25º 50’ E), which is a 18 km long tributary of the Tur’ya River (Tisza River basin, Transcarpathian region, Western Ukraine) (Fig. 1). This is a typical mountain watercourse, containing boulder-cobble substrates and a stream channel with alternate riffle-pool habitats. The investigated stream reach had a mean depth of 36 cm and a mean wetted-width of 5 m. The current velocity was 1.8 m/s, water temperature 10^{o}C. There was a fish farm in the middle stretch of the Shipot River, where farmed fish (mainly rainbow trout of different age groups) frequently escape into the watercourse.

Fish were collected in a 150-m long river reach after a mass kill caused by a high-voltage AC electrofishing device deployed by poachers. This incident occurred during the night and was reported to the local fish protection inspection unit. All seized fish were identified, measured to the nearest mm (fork length), weighed to the nearest g, and stomachs removed and preserved in a 4% formalin solution. Stomach content analysis was performed in the laboratory under stereoscopic microscope (4.8x - 36x magnification). Prey items were sorted and identified to the lowest possible taxonomic level as well as counted and weighed by groups on an electronic analytical balance with an accuracy of 0.001 g.

Simultaneously with fish collection, zoobenthos was sampled for determination of its qualitative and quantitative composition. Invertebrates were collected using a Surber sampler (25 × 25 cm frame size; 0.25 mm mesh size). The sampler was deployed according to requirements of the EU standard (EN 28 265: 1994). Ten samples were collected randomly on the same 150 m reach of the stream and preserved in a 4% formalin solution until examination. Analysis of aquatic invertebrates was performed using the same methods as stomach content analysis.

Mean percent compositions of prey items by number and by weight were calculated for each fish species. In total, 38 stomachs of three species were processed. For characterizing fish feeding intensity, the gut fullness index (GFI ($^{o}/_{ooo}$) = [prey weight / fish weight] × 1000) was used (Windell, 1971). The Fulton condition factor was calculated according to formula: $C = (W/L^3) \times 10,000$ (Anderson, 1996).

Figure 1: Location of the Shipot River and sampling point.

In order to estimate selection of prey organisms by fishes, the Ivlev's selectivity index (Ivlev, 1955) was used:

$$E_i = \frac{r_i - p_i}{r_i + p_i}$$, where

r_i – percent of prey i weight in the stomach contents;
p_i – percent of prey i weight in the sample of invertebrates from the environment.
Diet overlap (DO) was calculated according to the Shorygin (1952) formula:

$$DO = \sum_{i=1}^{n} \min(p_{ij}, p_{ik})$$, where

p – portion of *i* of *n* prey species (by weight) in two compared fish species *j* and *k*. This index ranges from 0% (no overlap) to 100% (complete overlap). Total diet overlap index was considered significant, if DO ≥ 40 % (Ross, 1986).

RESULTS

Five fish species, including three salmonids: brown trout (n=15), European grayling (n=12), and rainbow trout (n=11) were collected on the sampling site. Brown trout (8-13 cm) and rainbow trout (8-11 cm) were represented only by young-of-the-year, while there were several age groups (0+ – 1+) of European grayling (11-16 cm). Other species, which were collected at this location, included Carpathian barbel (*Barbus carpathicus* Kotlik, Tsigenopoulos, Rab et Berrebi, 2002) (n=57) and Siberian sculpin (*Cottus poecilopus* Heckel, 1837) (n=4).

Major prey organisms in the brown trout diet were aquatic insect larvae, which composed 93% by number (range 83% to 100%) and 73% by weight (range 54% to 95%) of the total stomach content.. Terrestrial insects and Gammaridae comprised insignificant portions of the diet. Among insect larvae, Ephemeroptera (52% by number and 42% by weight) and Trichoptera (15% by number and 19% by weight) dominated in the stomach contents. Chironomidae larva (22%) comprised a significant proportion by number of the brown trout stomach content, while they made up a much lower percentage by weight (9%). The portion of other insects in brown trout diets did not exceed 3% by number and 2% by weight (Table 1).

Table 1**:** Diets of brown trout, rainbow trout, and European grayling in the Shipot River. September, 2009 (% by number / % by weight).

Prey organisms	Fish species		
	Brown trout	Rainbow trout	European grayling
Oligochaeta	0 / 0	0 / 0	0.2 / 0.1
All insects:	94.2 / 75.3	99.7 / 95.1	99.3 / 84.8
Aquatic insect larvae	93.3 / 72.7	97.2 / 91.1	95.8 / 80.3
Odonata	0.2 / 0.2	0 / 0	0 / 0
Ephemeroptera	52.4 / 41.6	28.0 / 33.4	40.8 / 28.7
Plecoptera	0.4 / 0.3	0.5 / 2.3	1.4 / 1.8
Coleoptera	0.4 / 0.6	0 / 0	0.8 / 1.0
Trichoptera	15.0 / 19.2	10.0 / 19.6	26.5 / 36.1
Diptera larvae (Simuliidae)	2.9 / 1.8	1.1 / 1.1	1.1 / 0.7
Chironomidae	22.0 / 9.0	57.6 / 34.7	25.2 / 12.0
Terrestrial insects	0.9 / 2.6	2.5 / 4.0	3.5 / 4.5
Plecoptera	0 / 0	0 / 0	1.2 / 0.1
Simuliidae	0.9 / 2.6	2.5 / 4.0	2.3 / 4.4
Crustacea (Gammaridae)	5.8 / 4.4	0.3 / 0.8	1.7 / 1.0
Digested remains	0.0 / 20.3	0.0 / 4.1	0.0 / 14.2

Ephemeroptera larvae in the stomach content by weight were mainly represented by *Centroptilum* sp. (the part of which in the brown trout diet ranged from 0 to 59%, or 27.1% on average), *Ecdyonurus* sp. (0–8%, 2.3% on average), and *Chitonophora* sp. (0–17%, 6.6% on average), while Trichoptera larvae were represented mainly by *Hydropsyche pellucidula* (0–50%, 19.2% on average).

Gut fullness indices of individual specimens ranged from $45.6^{o}/_{ooo}$ to $141.0^{o}/_{ooo}$ ($93,1^{o}/_{ooo}$ on average). The Fulton condition factor was from 1.2 to 1.4. Weight of the stomach contents fluctuated from 41 mg to 266 mg (118 mg on average) and depended on individual fish size and weight.

Rainbow trout also consumed mainly aquatic insect larvae, which on average composed 97% by number (range 92% to 100%) and 91% by weight (range 83% to 98%) in the stomach content. Terrestrial insects and Gammaridae did not contribute significantly to rainbow trout feeding. Among aquatic insect larvae, dominant preys were Chironomidae (58% by number and 35% by weight) and Ephemeroptera (28% by number and 33% by weight), Trichoptera larvae were less important (10% by number and 20% by weight), and other insect larvae contributed only a small portion (Table 1).

Ephemeroptera larvae in the rainbow trout gut content by weight were mainly represented by *Centroptilum* sp. (1–19%, 9.3% on average), *Chitonophora* sp. (4–12%, 8.4% on average), and *Heptagenia* sp. (0–16%, 4.6% on average), while Trichoptera larvae were represented by *Hydropsyche pellucidula* (14–30%, 19.6% on average).

Rainbow trout feeding intensity was significantly higher than that of brown trout. Gut fullness indices ranged from $529.4^{o}/_{ooo}$ to $1244.1^{o}/_{ooo}$ ($876.7^{o}/_{ooo}$ on average). The Fulton condition factor varied from 1.1 to 1.7. The stomach content weight ranged from 450 to 2115 mg (1080 mg on average) and significantly depended on individual fish size and weight.

European grayling consumed mainly aquatic insect larvae, which on average composed 96% by number (range 93% to 100%) and 80% by weight (range 66% to 90%). Terrestrial insects and Gammaridae also were not significant in the diet of this species. Dominant preys of European grayling were Trichoptera larvae (27% by number and 36% by weight) and Ephemeroptera larvae (41% by number and 29% by weight). Chironomidae larvae comprised 12% of the diet by weight, but 25% of the diet by number. Other insects comprised a much lower portion of the diet (Table 1).

Main Trichoptera larvae species in the European grayling stomach content by weight were *Hydropsyche pellucidula* (8–59% by biomass), *Sericostoma* sp. (0–6%, 1.1% on average), *Rhyacophila* sp. (0–8%, 1.5% on average), and *Potamophylax* sp. (0–3%, 0.6% on average). Among Ephemeroptera larvae, *Centroptilum* sp. (2-45%, 20.8% on average), *Chitonophora* sp. (0–2%, 0.2% on average), *Heptagenia* sp. (0–1%, 0.2% on average), and *Ecdyonurus* sp. (0–1%, 0.1% on average) were observed.

Feeding intensity of European grayling was higher than brown trout but significantly lower than rainbow trout. Gut fullness indices ranged from $126.9^{o}/_{ooo}$ to $286.7^{o}/_{ooo}$ and averaged $215.5^{o}/_{ooo}$. The Fulton condition factor was from 0.9 to 1.1. The stomach content weight of European grayling ranged from 197 mg to 1053 mg (451 on average) and depended on individual fish size and weight.

Plecoptera larvae were insignificant in the diet of the studied fishes. In stomach contents of brown trout they were represented by *Leuctra* sp. (0–1% by weight); in rainbow trout by *Perla* sp. (1–8%) and *Leuctra* sp. (0–1%); and in European grayling by *Perla* sp. (0–6%), *Leuctra* sp. (0–1%), and *Perloides* sp. (0–0,4%). Terrestrial insects in stomachs of all studied fishes were represented mainly by Simuliidae, while Crustaceans by Gammaridae (0–6%; 0–2%; 0–5%, respectively for brown trout, rainbow trout, and European grayling by weight). In addition, Coleoptera larvae were observed in insignificant quantities in stomachs of brown trout and European grayling, while Odonata larvae were found in the brown trout stomach content only (Table 1).

In general, percent occurrence of Coleoptera and Trichoptera larvae in stomach contents of the studied fishes by weight was higher than their percent occurrence by number and vice versa for Chironomidae larvae.

The percent occurrence of Ephemeroptera larvae (33%) and Gammaridae (0.8%) in the stomach content of rainbow trout by weight were higher than those by number (28% and 0.3%, respectively) in contrast to the percente occurrence of these prey items in the stomach contents of brown trout and European grayling, where their percent occurrence was lower by weight but higher by number. This indicated that rainbow trout selected larger specimens of these prey organisms than other two fish species.

The biomass of invertebrates in the Shipot River in autumn of 2009 was 9.5 g/m^2 at an abundance of 4430 individuals/m^2. By number, the most abundant were Chironomidae larvae, which composed 38% of all organisms. By biomass, the most important were Diptera larvae and Gammaridae, which composed respectively 33% and 22% of the total invertebrate biomass (Table 2). Diptera larvae included mainly *Atherix* sp. (15%) and Simuliidae species (12%).

Table 2: Biomass and abundance of aquatic invertebrates in the Shipot River. September, 2009.

Biological characteristics	Group of aquatic invertebrates									
	Oligochaeta	All insects	Ephemeroptera larvae	Plecoptera larvae	Coleoptera larvae	Trichoptera larvae	Tipulidae larvae, Simuliidae larvae	Chironomidae larvae	Crustacea (Gammaridae)	Total
Abundance, ind./m^2	64	4048	576	672	64	688	368	1680	320	4432
Biomass, g/m^2	0.032	7.424	0.880	0.688	0.096	1.296	3.120	1.344	2.048	9.504
Abundance, %	1.4	91.4	13.0	15.2	1.5	15.5	8.3	37.9	7.2	100.0
Biomass, %	0.3	78.1	9.3	7.2	1	13.7	32.8	14.1	21.6	100.0

According to the estimated selectivity indices, the most preferred prey were *Centroptilum* sp. (0.90-0.96) and *Hydropsyche pellucidula* larvae (0.85-0.89), which were positively selected by all fishes. Brown and rainbow trout also selected *Chitonophora* sp. (0.63 and 0.70, respectively); rainbow trout also selected *Heptagenia* sp. (0.59) and Chironomidae larvae (0,42); while *Perla* sp. was selected by rainbow trout and European grayling (0.16 and 0.31, respectively) (Table 3). Alternatively, all studied fishes avoided Plecoptera and Simuliidae larvae as well as Gammaridae, while brown trout and European grayling also avoided Chironomidae larvae to some degree (Table 3).

Table 3: Ivlev's selectivity indices of three salmonids in the Shipot River. September 2009.

Prey organisms	Brown trout	Rainbow trout	European grayling
Oligochaeta	-1	-1	-0.63
Ephemeroptera larvae	0.64	0.57	0.51
Centroptilum sp.	0.96	0.90	0.95
Chitonophora sp.	0.63	0.70	-0.70
Heptagenia sp.	-1	0.59	-0.75
Plecoptera larvae	-0.92	-0.52	-0.61
Perla sp.	-1	0.31	0.16
Leuctra sp.	-0.91	-0.90	-0.91

Coleoptera larvae	-0.23	-1	0.01
Trichoptera larvae	0.17	0.18	0.45
Hydropsyche pellucidula	0.85	0.86	0.89
Sericostoma sp.	-1	-1	-0.11
Rhyacophila sp.	-1	-1	-0.92
Potamophylax sp.	-1	-1	-0.84
Simuliidae larvae	-0.75	-0.83	-0.90
Chironomidae larvae	-0.22	0.42	-0.08
Gammaridae	-0.66	-0.93	-0.91

When comparing the stomach content composition of the studied fishes with the composition of available prey in the river, fish diet by weight was significantly dependent on abundance of invertebrates in the habitat (Fig. 2). Only percent occurrence of Plecoptera larvae in the diet of the studied fishes was significantly lower than their abundance in the river. Percent occurrence of individual prey organisms by weight in rainbow trout diet was correlated to their biomass in the river (r=0.76, p=0.028). However, no similar correlation was observed for brown trout and European grayling (r=0.23, p>0.1 and 0.35, p>0.1, respectively).

The correlation was somewhat higher between the percent occurrence of prey organisms in the diet by number and their abundance in the river: r=0.88 (p=0.04) for rainbow trout, r=0.40 (p>0.1) for brown trout, and r=0.55 (p>0.1) for European grayling.

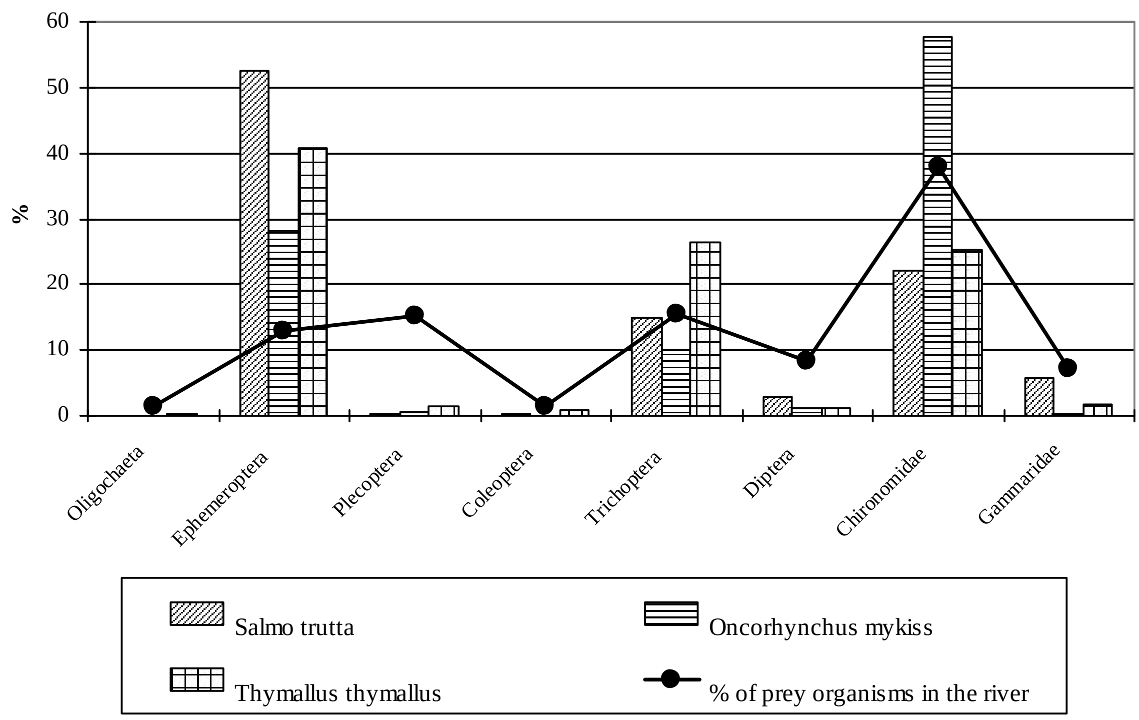

Figure 2: Relationship between the diet composition of three salmonids (% by number) and abundance of prey organisms in the river (ind./m^2).

The highest total diet overlap indices in the Shipot River in autumn were observed between brown trout and European grayling, and they were somewhat lower between rainbow trout and European grayling and between brown and rainbow trout (Table 4). Ephemeroptera larvae were responsible for the highest diet overlap between brown trout with European grayling (26.7) and brown trout with rainbow trout (21.5), and specifically diet overlap of individual Ephemeroptera species were 20.8 and 9.3 for *Centroptilum* sp. and 0.3 and 6.6 for *Chitonophora* sp., respectively. Significant diet overlap of Trichoptera larvae between brown trout and European grayling (19.2); rainbow trout and European grayling (19.6); and brown trout and rainbow trout (19.2) also occurred. Diet overlap of Chironomidae larvae were 9.0 when comparing brown trout with rainbow trout and 12.0 when comparing rainbow trout with European grayling. There was insignificant overlap of diet consisting of terrestrial insects (Similiidae) (2.5 to 4.0). There was also very low overlap in diet consisting of Plecoptera, Simuliidae, and Gammarus sp. (0.3–1.7).

Table 4: Diet overlap indices between three salmonids in the Shipot River. September, 2009.

Parameters	Brown trout × Rainbow trout	Brown trout × European grayling	Rainbow trout × European grayling
Total DO index	58.5	65.5	60.0
DO index by: Ephemeroptera larvae	21.5	26.7	17.2
Trichoptera larvae	19.2	19.2	19.6
Simuliidae	2.5	2.5	4.0
Chironomidae larvae	9.0	9.0	12.0
Digested remains	4.1	6.1	4.1

DISCUSSION

All studied fishes consumed mainly aquatic insect larvae. The most important component in brown trout diet was Ephemeroptera larvae; in European grayling diet, Trichoptera larvae; and in rainbow trout, Chironomidae larvae. The total percent occurrence of aquatic insects in the rainbow trout diet was higher (97% by number and 91% by weight) than that in the other species.

Similar values for brown trout diet were obtained for the Çatak Stream in Turkey (Çetinkaya, 1999), where 58.3% of stomach contents by number were Ephemeroptera larvae. A somewhat different situation was observed in other Turkish rivers (Kara and Alp, 2005), where Ephemeroptera larvae in brown trout diet composed on average 15.8% by weight, while the dominant group was Plecoptera larvae (25.7% by weight); however, Gammaridae were significant prey organisms in September according to the Index of Relative Importance (80%). In New Zealand (McLennan and MacMillan, 1984) and Irish rivers (Lehane et al., 2001), the dominant prey in brown trout diet by number were Trichoptera and Ephemeroptera larvae, followed by Plecoptera, Coleoptera, and Diptera larvae. Percent occurrence of terrestrial insects and Gammaridae was insignificant, which is similar to our results. Differences in the diet of brown trout inhabiting different regions has already shown to be related mainly to the food base composition of rivers, as this fish feeds on the most accessible prey organisms (Lagarrigue et al., 2002).

An important component of the rainbow trout diet in a New Zealand study was Ephemeroptera larvae, which was 28.4% by number on average for the year and from 4% to 20% during autumn (McLennan and MacMillan, 1984). While this finding was similar to our results (i.e., 28% Ephemeroptera), we observed significant differences in Chironomidae larvae number in the rainbow trout stomach content, which in the Shipot River was 58%, while the percent of all Diptera (including Chironomidae) was only 1.9-2.2% in the autumn period in the New Zealand study (McLennan and MacMillan, 1984). However, according to Oscoz et al. (2005), Chironomidae larvae were a relatively significant component of the age-1 rainbow trout stomach contents in the Urederra River in Spain.

The main components of the European grayling diet by number in the Shipot River were Ephemeroptera (41%) and Trichoptera (27%) larvae. This is different from its diet in the Krušnice River, Croatia (Beciraj et al., 2008), where this species fed mainly on Gammarus sp, which composed 33.5% to 61.5% of the stomach content by number. In Croatia, diet of European grayling < 23 cm, consisted of Gammarus (33.6% by number), and Trichoptera and Ephemeroptera larvae (16.1% and 12.2%, respectively by number). The most abundant of the Trichoptera larvae were Leptocerus sp. (8.76%) and Hydropsyche sp. (3.56%), and of the Ephemeroptera larvae, Baetis sp. (6.85%) and Ephemerella sp. (6.39%). In the Shipot River, only Hydropsyche sp. were observed, which represented from 2% to 40% of the total number of prey organisms in the stomach content but only 1% in the river, while Gammarus sp. represented only 1.7% in the stomach content but 21.5% in the river. Plecoptera larva did not play significant role in the European grayling diet: 1.4% in the Shipot River (Ukraine) and 1.5% in the Krušnice River (Croatia).

Significance of terrestrial insects in diets of the studied fishes varies in different studies and different regions (Zadorina, 1988, McLennan and MacMillan, 1984, Lagarrigue et al., 2002, Kara and Alp, 2005, Kukuła and Bylak, 2007). In general, the percent occurrence of these prey organisms did not exceed 9% by number both for the year and for different months, which corresponds to our results. However, in the Pulonga River on the Kola Peninsula (Russia) during summer, terrestrial insects composed from 44% to 89% by number of the brown trout stomach content (Evsin and Ivanov, 1979). This can be explained by a much higher abundance of terrestrial insects (Diptera) in the Russian North in summer in comparison with the Carpathian region. Gut fullness indices (GFI) of brown trout in the Pulonga River were also much higher ($108.5–344.9^{o}/_{ooo}$) (Evsin and Ivanov, 1979) than those in the Shipot River ($45.6–141.0^{o}/_{ooo}$). Similar low GFI values, which varied from $75^{o}/_{ooo}$ (September) to $170^{o}/_{ooo}$ (February), were observed in Turkish rivers where the percentage occurrence of terrestrial insects in brown trout diet was also low (Kara and Alp, 2005). The highest GFI values in the Shipot River were observed for rainbow trout ($529.4–124.1^{o}/_{ooo}$), indicating that this introduced fish fed much more intensively than native brown trout and European grayling.

According to many studies (Hayes and Jowett, 1994; Lagarrigue et al., 2002; Oscoz et al., 2005), stream salmonids consume the most accessible and visible prey organisms, which drift with the current. However, benthic invertebrates can be also found in diets of these fish (Amundsen et al., 1999; Lagarrigue et al., 2002), especially in small trout (Fleituch and Amirowicz, 2005). Based on the estimated Ivlev's selectivity indices, both trout species and European grayling in the Shipot River actively selected Ephemeroptera larvae (0.51–0.64) and Trichoptera larvae (0.2–0.5). In the Wołosaty Stream, which is located in Polish Carpathians, brown trout weighing <80 g also selected Trichoptera larvae (0.11), but did not select Ephemeroptera larvae (-1) (Kukuła and Bylak 2007). Such a difference can be explained by higher abundance of Ephemeroptera larvae in the Shipot River (576 ind./m^2) than in the Wołosaty Stream (242 ind./m^2). Thus, the preferred prey organisms of the studied fishes in the Shipot River were Ephemeroptera and Trichoptera larvae represented mainly by *Centroptilum* sp., *Hydropsyche pellucidula* and others (Table 3), which were actively selected by fishes even at their low abundance and biomass in the river. Rainbow trout also selected Chironomidae larvae (0.42), which were avoided by brown trout and European grayling. Chironmidae larvae were also avoided by brown trout in the Wołosaty Stream in Poland despite their high density in the stream (Kukuła and Bylak, 2007).

According to our results, the studied fishes in the Shipot River avoided Oligochaeta (-1 – -1.63), Plecoptera larvae (-0.52 – -0.92), Coleoptera larvae (-1 – 0.01), and Simuliidae larvae (Diptera) (-0.75 – -0.90), which is consistent with data obtained for brown trout in a Polish stream (Kukuła and Bylak, 2007). Possibly, the small sizes of the above-mentioned organisms, their low energetic value, and the difficulty fish have in accessing these invertebrates, which usually hide under the substratum, make them a less desirable prey (Ware, 1973, Rincón and Lobón-Cerviá, 1999, Oscoz et al., 2005). In general, the presence of either prey organism in the fish diet significantly depends on their presence and abundance in the river (Fig. 2).

Fish growth in Carpathian watercourses occurs mainly during the summer, when biomass of prey organisms in rivers and presence of terrestrial insects largely satisfies dietary needs of fish. But growth also continues during the autumn and a decrease of prey abundance could cause competition among the fishes we studied as a result of significant overlap of their diet. Total diet overlap indices between the studied species were high enough (59-60) for this to be probable. The highest diet overlap values were associated with Ephemeroptera and Trichoptera larvae, the biomass of which in the Shipot River was relatively low (0.88 and 3.12 g/m^2, respectively). At the same time, diet overlap between two native species was somewhat higher than that between the non-native and native salmonids.

Thus, the background of low biomass of prey organisms (9.5 g/m^2), high diet overlap values between the studied fishes, low gut fullness indices and high feeding intensity of rainbow trout indicate the possibility of food competition between this introduced species and native salmonids. However, this may not occur because of low abundance of these fishes in the Shipot River. The density of salmonids in other rivers of the Ukrainian Carpathians is even lower.

Food competition among native salmonids and non-native fishes might affect abundance and wellbeing of native fishes in Carpathian rivers. Therefore, a more detailed study of this matter that can contribute to restoration and conservation of biodiversity in this unique natural complex is vitally needed.

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BROWN BEAR'S PREFERENCES IN USE OF DIFFERENT HABITATS OF THE CARPATHIAN BIOSPHERE RESERVE

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KEYWORDS: brown bear, habitats preferences, forests composition, Carpathian Biosphere Reserve, Ukrainian Carpathians.

ABSTRACT

In the paper analysis of biotopical preferences of the brown bear according to stand composition, age classes and density of forests is made. Bear demonstrates the same commitment to middle dense old forests regardless of seasons and species composition of forests. The deciduous forests are more attractive for a bear than conifers because seeds of deciduous species (especially beech) are an important food that provides bears a successful hibernation. Therefore when the ecological network which meets the needs of a bear is designed, special attention should be given to such forests. Grasslands are also important for bear because herbaceous vegetation is very important part of its diet.

ZUSAMMENFASSUNG: Die Nutzungspräferenz verschiedener Lebensräume des Braunbären im Gebiet des Karpaten Biosphärenreservats (Ukraine).

Die Arbeit umfasst eine Analyse der Lebensraumpräferenzen des Braunbären in Bezug auf Bestandszusammensetzung, Altersklassen und Walddichte. Der Bär zeigt die gleiche Vorliebe zu alten Wäldern mittlerer Dichte unabhängig von Jahreszeit und Artenzusammensetzung des Waldes. Die Laubwälder sind für den Braunbären attraktiver als Nadelwälder dank der Samen der Laubwaldarten (insbesondere Buche), die für ihn eine wichtige Nahrungsquelle darstellen und ihm eine erfolgreiche Überwinterung ermöglichen. Daher muss diesen Wäldern, wenn das geplante ökologische Netzwerk die Ansprüche des Braunbären berücksichtigt, eine spezielle Aufmerksamkeit geschenkt werden. Das Grünland ist ebenfalls wichtig für den Braunbären, da die Krautvegetation einen wichtigen Teil seiner Nahrung darstellt.

REZUMAT: Preferinţele ursului brun pentru habitatele pe care le frecventează.

In aceasta lucrare sunt prezentate preferintele ursului brun in conformitate cu categoriile de varsta si densitatea padurilor. Ursul se comporta la fel in padurile cu densitate medie, indiferent de anotimp si de speciile care compun padurea. Padurile de foioase sunt mult mai atractive pentru urs decat cele de conifere pentru ca semintele speciilor de foioase (in special fagul) sunt o hrana importanta, care asigura ursilor o buna hibernare. De aceea, cand este proiectata o retea ecologica care se confrunta cu necesitatile unui urs, trebuie sa se acorde o atentie speciala acestui tip de padure. Pasunile sunt de asemenea importante pentru urs pentru ca vegetatia erbacee este o parte importanta a dietei sale.

INTRODUCTION

Brown bear it is a species which demands vast areas of relatively good conserved wilderness for its dwelling. The current levels of road construction, the development of tourist centers and human activities in habitats used by brown bear has resulted in the fragmentation of suitable habitats and therefore increased the likelihood of human-animal conflicts. Existing protected areas owing to their relatively small area and disconnection can not ensure preservation of this species. To provide successful migrations from one to another natural plot and decrease likelihood of conflicts with people, ecological corridors which connect protected areas should be created. Such ecological corridors are obligatory element of ecological networks. We must know preferences of brown bear in use of habitats if we want to project ecological network which takes into account its biotopical demands (Довганич, 2004, 2010; Ondrus & Adamec, 2009).

We know publications of I. I. Turyanyn (Турянин, 1975), A. N. Tikhonov (Тихонов, 1987), A. A. Slobodyan (Слободян, 1987, 1993), which contain some information about habitats used by bear during its living cycle in the Ukrainian Carpathians. Most detailed among them is paper of A. A. Slobodyan published in monograph «Медведи» («Bears») in 1993, but this author used classification of habitats which is adopted in forestry. This classification reflects ecological demands of brown bear not so sufficiently.

MATERIAL AND METHODS

This paper considers how bears use the habitats in the territory of the Carpathian Biosphere Reserve. Since the ecological representativeness of the reserve for the Carpathian region is high enough, analysis of environmental preferences of brown bear in its territory, in our opinion, must also be sufficiently representative for the Carpathian region.

The main method used in the paper was to analyze the places where bears residence was registered in different massifs of the Carpathian Biosphere Reserve in different seasons of the year. 576 registrations of bears residence made in 9 years of observations (2003-2011) were analyzed. Places of residence were connected to forest stratums, which were analyzed using the existing forest valuation descriptions.

Location of bears residence we conventionally divided into three groups: according to species composition, age and density (the latter two groups apply only to forests). According stands composition we identified the following habitats:

- Coniferous monodominant forests (one coniferous species is dominated, others form less than 10% in stands);
- Coniferous polydominant forests (several coniferous species are dominant);
- Coniferous forests with a touch of deciduous species (portion of deciduous species is less then 10%);
- Mixed forests with prevalence of coniferous species (portion of coniferous species is more then 50%);
- Mixed forests with prevalence of deciduous species (portion of deciduous species is more then 50%);
- Deciduous monodominant forests (one deciduous species is dominated, others form less than 10% in stands);
- Deciduous polydominant forests (several deciduous species are dominant);

- Deciduous forests with a touch of coniferous species (portion of coniferous species is less then 10%);
- Grasslands.

Forests where bears residence was registered we arbitrarily divided into 3 groups according age:

- Young – age classes 2-3;
- Mature – age classes 4-6;
- Old – age classes 7-8.

Forests where bears residence was registered we arbitrarily divided into 3 groups according density:

- Sparse – density 0,2-0,4;
- Middle dense– density 0,5-0,7;

Dense – density 0,8-1,0.

RESULTS

Below there are the results of the analysis for the places, where bears was registered, according to forest composition, age classes and density for the whole territory of the Carpathian Biosphere Reserve (Figures 1-3), as well as for its separate massifs (Tables 1, 2) and by seasons (Tables 3, 4) for the period of 2003-2011.

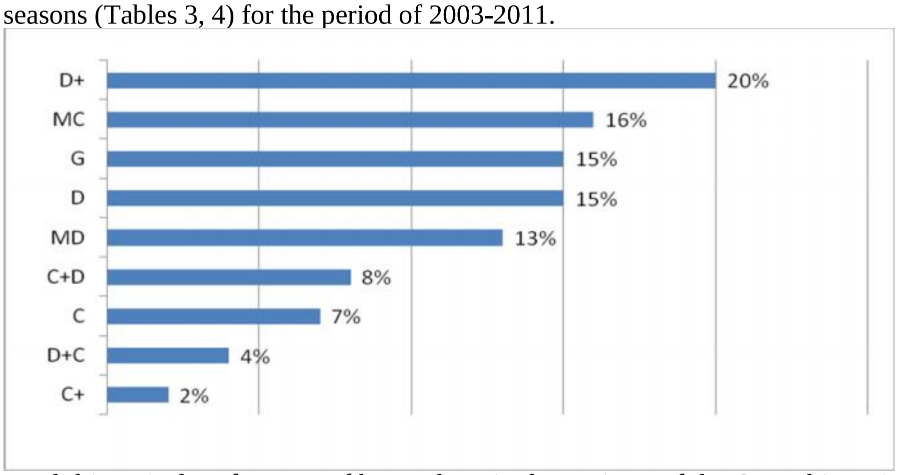

Fig. 1. Total biotopical preferences of brown bear in the territory of the Carpathian Biosphere Reserve (generalized results of 2003-2011) according to the stand composition (% of observations). Convention: **D+** – deciduous polydominant; **MC** – mixed with prevalence of coniferous species; **G** – grasslands; **D** – deciduous monodominant; **MD** – mixed with prevalence of deciduous species; **C+D** – coniferous with a touch of deciduous species; **C** – coniferous monodominant; **D+C** – deciduous with a touch of coniferous species; **C+** – coniferous polydominant.

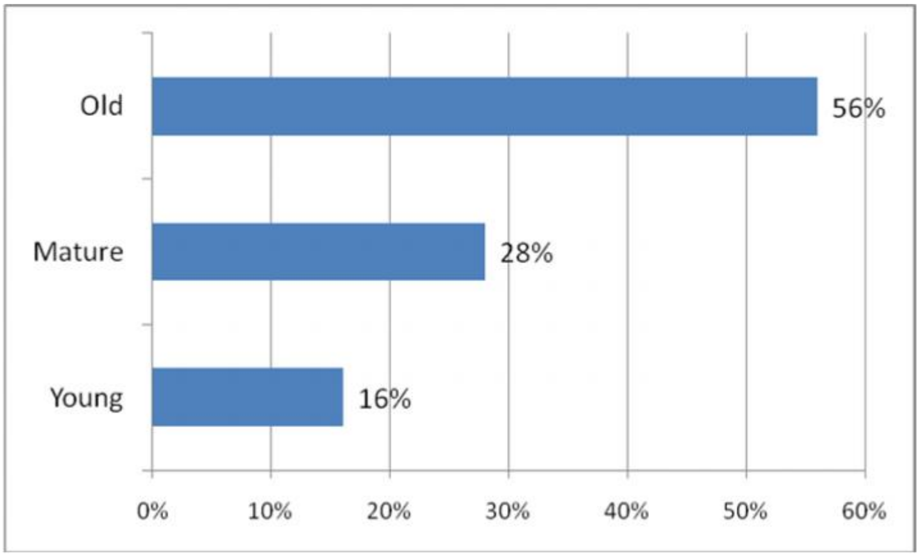

Fig. 2. Total biotopical preferences of brown bear in the territory of the Carpathian Biosphere Reserve (generalized results of 2003-2011) according to the forest age classes (% of observations).
Convention: Young – age classes 2-3; Mature – age classes 4-6; Old – age classes 7-8.

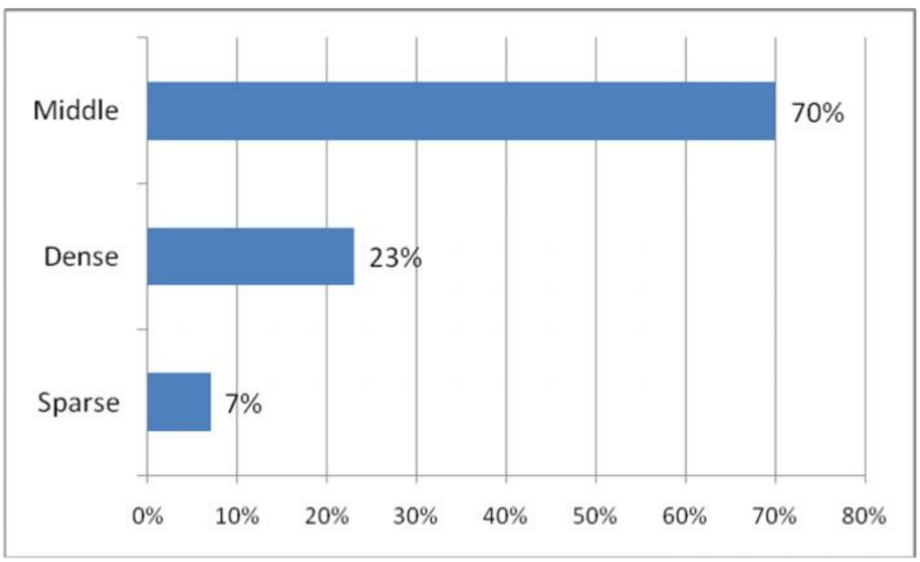

Fig. 3. Total biotopical preferences of brown bear in the territory of the Carpathian Biosphere Reserve (generalized results of 2003-2011) according to the forest density (% of observations).
Convention: Sparse – density 0,2-0,4; Middle dense – density 0,5-0,7; Dense – density 0,8-1,0.

Table 1. Biotopical preferences of brown bear in the separate massifs of the Carpathian Biosphere Reserve according to the stand composition in the period of 2003-2011.

Massifs* of CBR	Stand composition** (%)								
	D	D+	D+C	MD	C	C+	C+D	MC	G
Mr N=136	1	1	2	16	14	1	12	34	19
Ch N=174	5	2	2	17	12	5	17	25	15
Sv N=79	5	34	11	25	1	-	3	6	15
Uh-Sh N=187	38	45	4	2	1	-	-	-	10

***Mr** – Maramorosh; **Sv** – Svydovets; **Ch** – Chornohora; **Uh-Sh** – Uholka-Shyrokyi Luh.
** **D** – deciduous monodominant; **D+** – deciduous polydominant; **D+C** – deciduous with a touch of coniferous species; **MD** – mixed with prevalence of deciduous species; **C** – coniferous monodominant; **C+** – coniferous polydominant; **C+D** – coniferous with a touch of deciduous species; **MC** – mixed with prevalence of coniferous species; **G** – grasslands.

Table 2. Biotopical preferences of brown bear in the separate massifs of the Carpathian Biosphere Reserve according to the age classes and density in the period of 2003-2011.

Massifs* of CBR	Age (%)			Density (%)		
	Young	Mature	Old	Sparse	Middle	Dense
Mr N=136	9	32	59	19	68	13
Ch N=174	37	20	43	1	68	31
Sv N=79	27	35	38	7	59	34
Uh-Sh N=187	2	23	75	1	81	18

***Mr** – Maramorosh; **Sv** – Svydovets; **Ch** – Chornohora; **Uh-Sh** – Uholka-Shyrokyi Luh.
****Young** – age classes 2-3; **Mature** – age classes 4-6; **Old** – age classes 7-8
*** **Sparse** – density 0,2-0,4; **Middle** – density 0,5-0,7; **Dense** – density 0,8-1,0

Table 3. Seasonal biotopical preferences of brown bear in the whole territory of the Carpathian Biosphere Reserve according to the stand composition in the period of 2003-2011.

Seasons	Stand composition* (%)								
	D	D+	D+C	MD	C	C+	C+D	MC	G
Winter N=131	15	20	3	14	10	2	9	16	11
Spring N=104	10	15	4	16	9	3	3	18	12
Summer N=111	2	11	3	13	10	1	9	22	19
Autumn N=230	19	28	5	10	4	1	5	2	16

* **D** – deciduous monoprepotent; **D+** – deciduous polydominant; **D+C** – deciduous with a touch of coniferous species; **MD** – mixed with prevalence of deciduous species; **C** – coniferous monodominant; **C+** – coniferous polydominant; **C+D** – coniferous with a touch of deciduous species; **MC** – mixed with prevalence of coniferous species; **G** – grasslands.

Table 4. Seasonal biotopical preferences of brown bear in the whole territory of the Carpathian Biosphere Reserve according to the age classes and forest density in the period of 2003-2011

Seasons	Age* (%)			Density** (%)		
	Young	Mature	Old	Sparse	Middle	Dense
Winter N=117	21	27	52	6	65	29
Spring N=92	13	36	51	12	61	27
Summer N=90	16	34	50	9	64	27
Autumn N=195	13	23	64	4	79	17

***Young** – age classes 2-3; **Mature** – age classes 4-6; **Old** – age classes 7-8
** **Sparse** – density 0,2-0,4; **Middle** – density 0,5-0,7; **Dense** – density 0,8-1,0

DISCUSSIONS

If you take the whole territory of the Carpathian Biosphere Reserve with all its environmental diversity, the most visited bear habitats were old deciduous polydominant forests (Fig. 1). A little bit less frequently visited are mixed forests with prevalence of conifers, monodominant deciduous (beech) forests and mixed forests with prevalence of deciduous species, and also grasslands. The least attractive for bears were coniferous forests. The low percentage of bear residence in deciduous forests with touch of conifers is due not so much of their attractiveness for this species, but their small share in the woodlands of the reserve.

In old forests bears residence was recorded twice as often as in the mature forests and as 4 times more often than in young woodlands (Fig. 2). As for density, the bears residence was much often registered in middle dense forests, less - in the dense and very rare - in sparse forests (Fig. 3).

Analysis of habitat use of bears in different massifs of the reserve showed (Table 1), that the higher proportion of conifers in the massif the more important for bear are grasslands. In massifs where conifers are dominated (Maramorosh and Chornohora) most of the meetings of bears was recorded in mixed forests. In massifs dominated by deciduous forests (Uholka-Shyrokyi Luh and Svydovets), the largest share of registrations of bears residence accounted for polydominant deciduous forests.

In all massifs bears were most often recorded in old forests and rarely - in the young stands (Table 2). Similarly, in all massifs bears preferred middle dense forests; rarely are they recorded in dense forests and least likely - in sparse woodlands (Table 2).

Seasonal analysis of biotopical preferences of the bear showed (Table 3), that in winter, spring and summer seasons the greatest importance for the bear are mixed forests with predominance of deciduous species and polydominant deciduous forests. Mixed forests with predominance of conifers are important in spring and summer as habitats adjacent to the mountain meadows which are important pastures for the bear during this period. In autumn importance of deciduous forests is markedly increasing for bear. This is due to fruiting of deciduous species; their seeds are an important food for bears before hibernation.

In all seasons the residence of the bears in the old forests recorded significantly more often than in mature forests and much more frequently than in young stands (Table 4). As for density, the bears residence in all seasons most often recorded in middle dense forests, much less - in dense and considerably less - in sparse woodlands (Table 4).

CONCLUSIONS

Bear demonstrates the same commitment to middle dense old forests regardless of seasons and species composition of forests. These forests are main habitat where this species lives.

As for species composition of forests, the deciduous forests are more attractive for a bear than conifers because seeds of deciduous species (especially beech) are an important food that provides bears a successful hibernation. Therefore when the ecological network which meets the needs of a bear is designed, special attention should be given to such forests.

Grasslands are also important for bear because herbaceous vegetation is very important part of its diet. Therefore, meadows, forest glades and clear cuttings should be a mandatory element of ecological network, which among other functions should also ensure conservation of the bear. Especially large proportion of grasslands should be in the areas where coniferous forests are dominated.

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MARAMURESH/MARAMUREŞ REGION STAKEHOLDERS FOR NATURE CONSERVATION MANAGEMENT: STRATEGIC PLANNING

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KEYWORDS: nature conservation management, stakeholders agreement, Maramuresh transboundary region, Ukrainian and Romanian Carpathians

ABSTRACT

The article presents the results of the UA-RO transboundary Maramuresh region stakeholder meeting (2010), which had a main objective to start strategic planning together for the transboundary wider Maramuresh region and to evaluate what has been done so far and look for future cooperation possibilities between stakeholders. The results of previous transboundary work, conservation targets and threats for the region have been agreed. The Conceptual Model on threats and targets of the Maramuresh transboundary region (UA-RO) has been developed. The future vision and strategic development have been discussed. The stakeholders' evaluation has been presented. In general, since 2010 it was no substantial breakthrough on implementation of strategic planning with involvement of majority of main stakeholders; however certain steps have been realized on protected areas support, small scaled nature conservation efforts and general analysis of transboundary activities. The main obstacles prohibiting substantial improvement of practical cooperation between government authorities and civil society actors (NGOs, local stakeholders) are different approaches to biodiversity management and landscape use and very often a lack of willingness to identify common goals. In some cases it is also a lack of capacity both in governmental as well as non-governmental organizations. Certain improvement on transboundary nature conservation activities in Maramuresh is highly needed due to exceptional value of the region for whole Carpathians and increasing amount of threats, which leading to the degradation of the region's natural heritage.

RÉSUMÉ: Les acteurs dans la gestion de la conservation de la nature dans la région de Maramures: planning stratégique.

L'article présente les résultats de la réunion de 2010 des acteurs de la région transfrontalière UA-RO de Maramures, ayant eu comme objectifs principaux le démarrage du planning stratégique commun pour la région transfrontalière élargie de Maramures, l'évaluation des résultats obtenus jusque là, ainsi que la recherche des possibilités de coopération ultérieure des acteurs impliques. Les résultats des travaux transfrontaliers précédants, les objectifs de conservation et les menaces pour la région ont été établies par le quorum des participants. De même, a été développé un Modèle Conceptuel pour les objectifs et les menaces de la région transfrontalière UA-RO de Maramures. La vision future et le développement stratégique de la région ont été abordes et ont été présentées les évaluations des participants. Généralement, en 2010 il n'y a pas eu de réalisation majeure dans l'implémentation du planning stratégique avec la participation de la majorité des grands acteurs de la région; néanmoins certaines étapes ont été franchies concernant le soutien des zones protégées, des efforts de conservation à petite échelle ainsi qu'une analyse générale des activités transfrontalières. Les principaux obstacles empêchant une amélioration visible des pratiques de coopération entre les autorités gouvernementales et les acteurs de la société civile (ONG et acteurs locaux) sont les approches différentes de la gestion de la biodiversité et de l'usage du paysage mais aussi, un grand nombre des fois, le manque de volonté dans l'identification des objectifs communs. Dans certains cas il s'ajoute le manque de capacité au niveau gouvernemental ainsi qu'au niveau des ONG. Sont particulièrement nécessaires les améliorations des activités de conservation de la nature au niveau transfrontalier en Maramures autant à cause de la valeur exceptionnelle de la région pour les Carpates dans leur ensemble qu'à cause du nombre croissant des menaces pour cette région, menant à la dégradation de plus en plus accentuée du patrimoine naturel régional.

REZUMAT: Actorii managementului conservării naturii din regiunea Maramureșului: planificare strategică.

Articolul prezintă rezultatele reuniunii actorilor din regiunea transfrontalieră româno-ucraininiană a Maramureșului din 2010, care a avut ca obiective principale demararea planificării strategice comune pentru regiunea transfrontalieră lărgită a Maramureșului, evaluarea a ceea ce s-a făcut până în acel moment precum și căutarea de posibilități de cooperare ulterioară între participanți. Rezultatele lucrărilor transfrontaliere precedente, țintele de conservare și amenințările pentru regiune au fost stabilite de comun acord. S-a dezvoltat un Model Conceptual pentru țintele și amenințările din regiunea transfrontalieră (UA-RO) a Maramureșului. S-a discutat viziunea viitoare și dezvoltarea strategică a regiunii și s-au prezentat evaluările părților implicate. În general, din 2010 nu a existat o realizare substanțială asupra implementării planificării strategice cu implicarea majorității actorilor mari din regiune; cu toate acestea s-au realizat anumite etape cu privire la sprijinul ariilor protejate, eforturi conservaționiste la scară mică și o analiză generală a activităților transfrontaliere. Principalele obstacole împiedicând o îmbunătățire substanțială a practicilor de cooperare între autoritățile guvernamentale și actorii societății civile (ONG-uri, actori locali) sunt abordările diferite ale managementului biodiversității și a utilizării peisajului și de multe ori lipsa de voință în identificarea obiectivelor comune. În unele cazuri la acestea se adaugă lipsa de capacitate atât la nivel guvernamental cât și la nivelul organizațiilor neguvernamentale. Se simte acut nevoia pentru anumite îmbunătățiri ale activităților de conservare a naturii la nivel transfrontalier în Maramureș atât din pricina valorii excepționale a regiunii pentru întreg piesajul carpatic cât și din pricina acumulării sporite a amenințărilor la adresa acestei zone ducând la degradarea tot mai accentuată a patrimoniului natural regional.

INTRODUCTION

The Carpathian region is rich in biodiversity and is considered one of the most important global repositories of natural wealth, recognized for example by the Carpathian governments with the signing of the Convention of Biological Diversity (CBD) as well as the Convention for the Protection and Sustainable Development of the Carpathians. WWF has identified the Carpathians as one of 200 ecoregions globally outstanding for their biodiversity.
The Carpathians represent one of Europe's last great wilderness areas – a bastion for large carnivores, with over half of the continent's populations of bears, wolves and lynx, and home to the greatest remaining reserves of old growth forests. Together with extraordinarily rich semi-natural habitats such as mountain pastures and hay meadows, created over centuries of traditional land management, the region's biodiversity is unsurpassed in Europe. However, Carpathian ecosystems and wildlife are under serious threat from a number of pressures resulting from changing land use and unregulated human impact, driven in large part by increasing integration of the region into the global economy. Illegal logging, poaching, uncontrolled livestock grazing, agriculture and infrastructure development are leading to the degradation of the region's exceptional natural heritage. Measures to address these threats, including effective controls as well as efforts to channel socio-economic development in a sustainable manner, are limited and hampered by scarce resources, capacity and technical expertise.

WWF established the WWF Danube-Carpathian Programme Office (WWF-DCPO) in 1998 to coordinate and lead the global conservation organisation's efforts to protect the twin ecoregions. WWF's work is based on solid scientific studies and close cooperation and coordination with relevant institutions. In the late 1990s, WWF-DCPO initiated the Carpathian Ecoregion Initiative, a platform of some 50 NGOs, scientific institutes and protected area managers dedicated to the protection and sustainable use of the Carpathians. With WWF's support and leadership, the Carpathian Ecoregion Initiative published in 2001 "The Status of the Carpathians", a groundbreaking report that for the first time approached the Carpathians as a discrete ecoregion, and covered not only the status of biodiversity in the region but also a range of socioeconomic pressures. The document provided an important basis for the Danube-Carpathian Summit, organised by WWF-DCPO in cooperation with the Romanian government in 2001, which brought together leaders and heads of state from all 18 Danube and Carpathian countries to discuss the protection of and sustainable development of the twin ecoregions. It was at this summit that development of the Carpathian Convention was initiated. WWF-DCPO has been closely involved in development of the Carpathian Convention and has actively supported the establishment of the Carpathian Network of Protected Areas under the Convention's aegis. In 2006, WWF-DCPO initiated a 5-year programme to support Protected Areas across the Carpathians. It also draws on WWF-DCPO's considerable experience promoting effective management of protected areas as well as sustainable forest management across the region. WWF-DCPO has been the leading force for introduction of FSC certification of sustainable forestry in the region, providing support for the development of national FSC standards and working groups in Ukraine, Romania, Slovakia and Poland as well as support e.g. for certification of over 1 million ha of state forests in Romania.

In recent years, WWF-DCPO has begun focusing its work in the Carpathians around the landscapes of the Eastern Carpathians and Upper Tisza river basin, including the area of Maramures in northern Romania and the two Ukrainian focal areas for this project. In Maramures, we have worked with regional and local officials as well as other stakeholders to develop a plan for strategic development of the area, which we are now pushing forward with a range of integrated activities focused on sustainable agriculture and forestry, development of tourism and local products as well as development of payments for ecosystem services.

The current article is based on the report of the UA-RO transboundary Maramuresh stakeholder meeting, which was arranged in Rachiv, Ukraine at 22-24th of March 2010 (organizer: WWF-DCPO).

MEETING OBJECTIVES

Main objective: Start strategic planning together for the transboundary wider Maramuresh region.

Secondary Objective: To evaluate what has been done so far and look for future cooperation possibilities between stakeholders.

ATTENDANCE

The meeting was organized by WWF-DCPO (project UA0004.3.). The total number of participants was 29 covering transboundary protected areas staff, local/international NGOs, government authorities and research institutions.

SCOPE OF THE REGION:

The map of the wider Maramuresh Transboundary region (UA-RO) is presented in Fig.1. The scope of the region has been identified at the meeting with all stakeholders taking into account as historical boundary as well as the modern development of the transboundary areas and the ecological network structure.

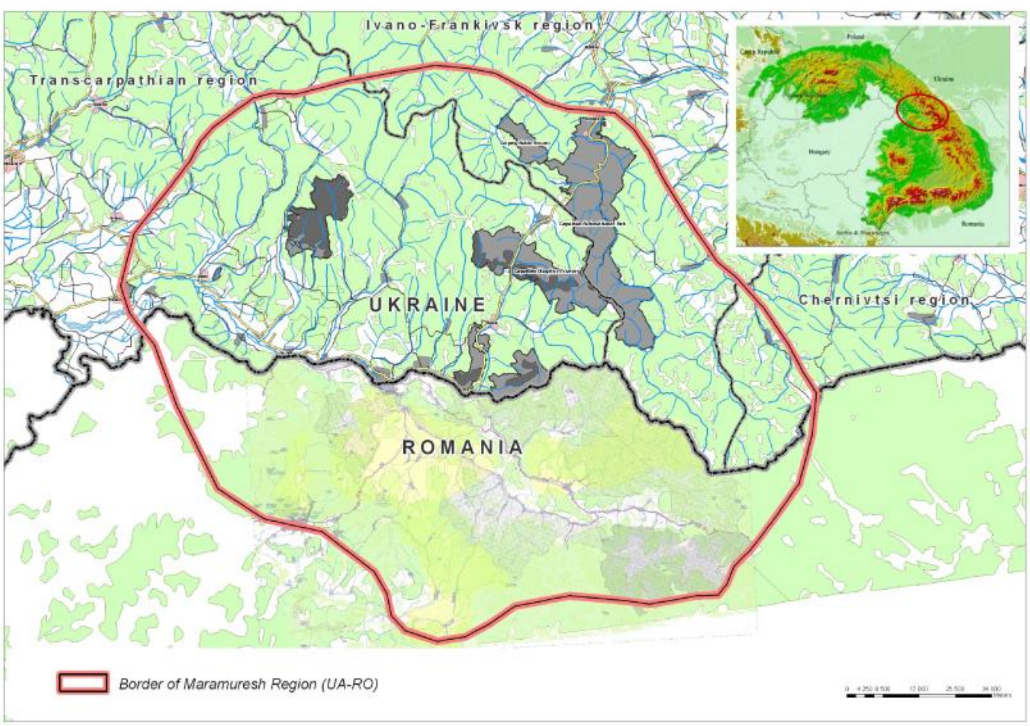

Fig. 1. The map of the Maramuresh Transboundary region (UA-RO).

KEY OUTPUTS:

1. BACKGROUND on WORK DONE so far

Why is this region important?
Because of:

- Biodiversity hotspots
  (UNESCO Heritage sites, endemics and rare species hotspots, large areas of old growth forests, High Conservation Value Forests - HCVFs)
- Untouched landscapes (concentration of protected areas)
- Cultural and historical identity (Ethical and Spiritual Wilderness, European Africa, Hutsul, ethnographic diversity, traditional agriculture)
- Special benefits: Environmental Services (soil, water, air, quietness etc, Tisza and Prut catchments importance (water resource))
- Important resource for environmental education
- Recreation destination

The Region represents the uniqueness of the Carpathians.

Main challenge is to sustain and protect ecological, cultural and social authentic values of the Maramuresh region of the Carpathians.

Work that has been done to date by WWF:

- Collected biodiversity data to use them for establishment of protected areas
- Development of principles of sustainable tourism, sustainable forest management, improving capacity for protected area, strengthening civil society and community development
- Developed High Conservation Value Forests (HCVFs) Toolkits (UA and RO)
- Identified Maramuresh HCV Forests
- Developed model of Ecological Network
- Developed Carpathian Biodiversity System
- Natura 2000/Introduction of EU standards (for Romanian part)
- Maramuresh: economic example of small subsistence farms (for Romanian part)
- Farmers loans (for Romanian part)
- Sustainable forest management: Help with Forest management plans, credible forest certification

What has been done so far - Input Stakeholders:

- Transboundary project by Carpathian Biosphere Reserve,
- Improvement of flood protection in Ukraine and Romanian part of the Tisza,
- Improved local ecological network,
- Project on Chamoix,
- Establishing N2000 Sites on Isar river valley
- Starting small business on ecological tourism
- EU boarder cooperation processes with Ukraine on monitoring water biodiversity
- International exchanges for Greenway project

- Contribution to medicinal tourism
- Development of tourist information centres
- Map of protected areas in the region (incl. RO and UA), tourist guide exists too
- Establishment of resource centre and ecotourism centre in Yaremche town
- Improved ecological/environmental education work

Carpathian Biosphere Reserve working on eco-tourism project

2. WHY TRANSBOUNDARY WORK?

Benefits of transboundary work (as seen by Stakeholders):

- Work together with Romanian stakeholders on transboundary problems such as pollution problems on Tisza and tributaries
- Finding help/exchange of ideas for specific problems (for example, Rakhiv city council need help in solving waste dump- problem)
- Creation of transboundary tourism activities, maybe even concept?
- Exchange ideas for sustainable development
- Sharing data (on biodiversity, nature conservation etc)
- Political pressure for better railway connection and border passes
- Bringing successful projects (combining conservation and economic development) from one side of the border to the other- knowledge exchange of what works well
- To do conservation on Border area and generate income in local communities on both sides
- Improved transboundary cooperation and communication

Ideas for future cooperation developed by Stakeholders during the meeting:

- Carpathian Biosphere Reserve to provide areas of high mountain grassland for possible grassland demonstration project which might be attractive to tourists
- Reforestation on galleries/riverine forests along the Tisza
- Working on protection of valuable forests in transboundary area
- Narcissus valley: sort of festival; to join festival from Romanian side
- 3 days trips for Tisza meetings with Romanian colleagues – eco educational activities, exchange of knowledge
- Beech and Spruce-fur forest has extraordinary international conservation potential. 2 kinds of opportunities for cooperation with University of Vermont:
  - Reforestation projects that could be funded by joint implementation agreements with European nations

- Avoid deforestation process, funded by joint implementation and global carbon market

3. PLANNING for a COMMON TRANSBOUNDARY STRATEGY

Introduction to WWFs Project Management Standards
The scheme of WWF"s Conservation Project/Programme Cycle is presented in Fig.2

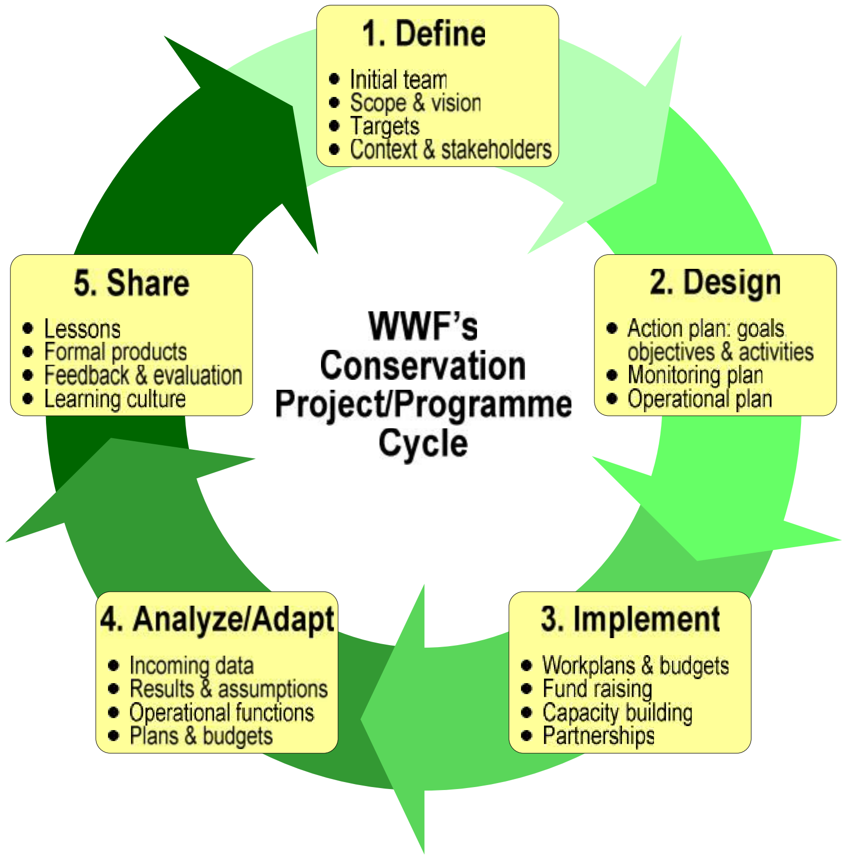

Fig.2. WWF's Conservation Project/Programme Cycle

Defining Conservation targets for the Transboundary Area
Note: Stakeholders were asked to focus on transboundary aspect: either geographically or a target that is relevant for both side because of future cooperation, knowledge or data exchange. A conservation target is, per definition, the key feature of the environment we want to conserve: an ecosystem, species or ecological process

3.1 CONSERVATION TARGETS for the transboundary region
The follow conservation targets for Maramuresh region have been identified:

- **Riverine/Floodplain forests**: endangered for clear cut, Forest ecosystems in river basin (main threats: logging, cutting causing floods), riparian ecosystems
- **HCV grasslands :** Alpine meadows: common values, preservation of endemic species

- **Large Carnivores:** (main threats: habitat fragmentation)
- **HCVForests**: important for ecological functions – includes Old growth forests
- **Endangered species:** golden eagle, black grouse, bats, Danube salmon, European Mink: endangered by poaching
- **Ecological connectivity:** corridors, links between nature protection and other priority sites on both sides of the border
- **Wetlands:** Hydrological network/ Tisza ecosystem, main threat pollution

3.2 THREATS related to Conservation Targets

Tisza ecosystem:
Pollution: Hard waste, nutrients, pollution from mines (heavy metals)
Habitat destruction
Erosion
Gravel extractions
Land use changes, Hydropower infrastructure, bank enforcement – Habitat destruction (hydrology changes, flood regime changes)
Unsustainable/illegal methods of fishing

High Conservation Value Forests (HCVFs):
Logging
Fragmentation
Bark beetle invasions
Historical land use changes
Forest fires
Gaps and disparity in legislation
Landscape scale conversion to secondary spruce and beech plantations

High Conservation Value (HCV) grasslands:
Rich biodiversity of natural meadows
Climate change (temperate forest climbs up)
Destruction of habitat by human (fire, trampling, unsustainable tourism)
-cultural meadows:
-abandonment: lack of grazing, mowing
- Intensification
Historical overgrazing (erosion)

Species/Connectivity:
Landscape Fragmentation/Destruction
Disruption of food web
Human wildlife conflict
Poaching
Pollution
Geopolitical barriers

3.3 CONCEPTUAL MODEL

Conservation Targets and their threats were pulled together in a Draft Conceptual Model, which shows a simplified situational analysis of the regions most important Conservation Priorities. See Conceptual Model in Fig. 3.

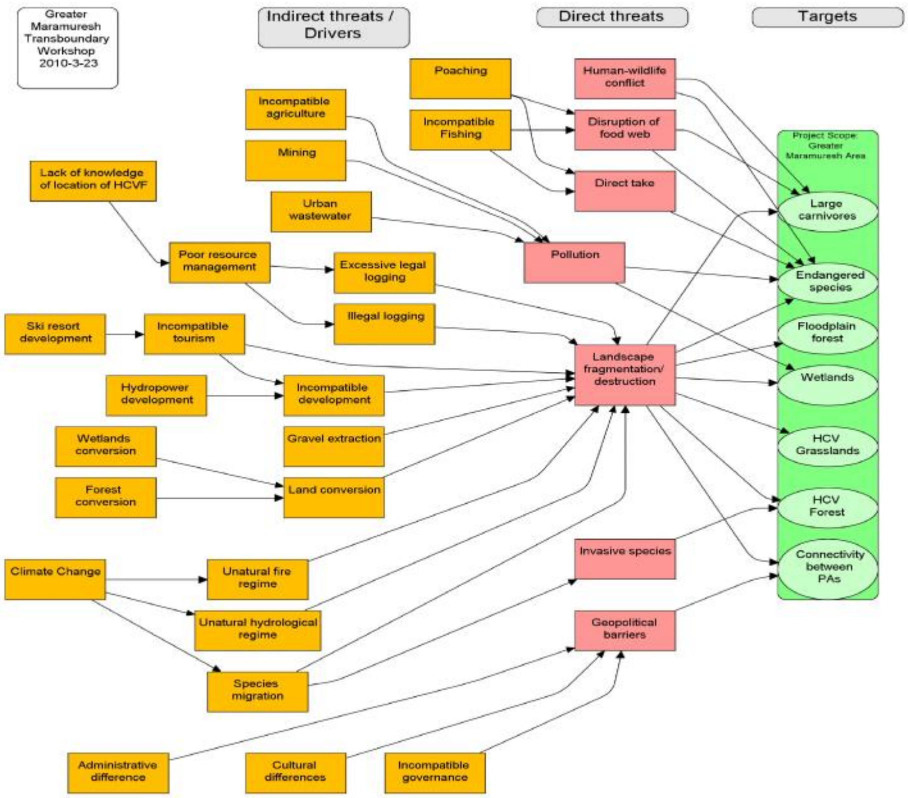

Fig.3. Conceptual Model on threats and targets of the Maramuresh transboundary region (UA-RO)

3.4 VISION

Brainstorm Vision:

- Ecologically pure Tisza river, clean water and abundance of fish
- Effective utilisation (without excessive pressure on nature) and balanced use of natural resources
- Ecological network developed, corridors connected
- Maintaining traditional ways of Livelihoods
- Appropriate legislation and effective enforcement
- Natural dynamics are maintained
- Rich biodiversity
- Living standards

- Resilient to future change
- High level of ecological culture
- Developed agricultural and eco-tourism

Draft Vision statement:
Possible version 1:

- Maramuresh becomes a landscape dominated by nature, a wild matrix in which humans are not exceeding the carrying capacity of the area. Conservation and restoration of ecological processes, species and genetic diversity will produce a level of their situation before the 18th century.

Possible version 2:

- Ecologically sustained Tisza river ecosystem with rich biodiversity, maintained natural processes and resilient to global challenge where humans find their space as part of this ecosystem

3.5 STRATEGIES

Strategies Brainstorm: *Strategies in **Bold** were most voted for*

- Explore participation in Carbon Markets (relates to HCV forest, restoration of floodplain forest)
- Harmonization of the legislation transboundary
- **Ecological Education for local people, starting from schools/children gardens**
- Law enforcement
- Development and stakeholder agreement for local and regional ecological network
- Create green peace affiliates
- Establishment of new protected areas
- Identifying HCV Forest and HCV grasslands
- Restoration of natural floodplain ecosystem to keep natural dynamics (natural water regime)
- **Joint Management plan for the bordering areas - Common understanding of the management**
- **Combined management for water management on the Tisza**
- **Development of transboundary touristic approach?**
- **Strategic Development of a transboundary Network: Action Plan for Upper Tisza: Establish clear map with natural priorities, Gap analysis of existing protected areas, holistic landscape approach and where we need corridors (for ecological network), then management at regional level, vision on how we can work together**
- Preservation of traditional cultural values
- Build water treatment plants in each village/city
- Better control for industrial waste
- Better separate collection of waste in settlements
- **Promote the use of Sustainable forestry practices**

Most Votes:

To create a join management plan for the region
Management plan would address biological and socioeconomic issues, but not all stakeholders can participate in the process. Not enough experts in the room to discuss this. Barrier to good management is that stakeholders are not consulted. For the sake of the meeting, we decided to discuss:

Broad strategy for Nature Conservation for the region/join management for the transboundary region including the following aspects:

- **Biodiversity conservation,**
- Resources management,
- **culture and tradition**
- tourism,
- administrative capacity

3.6 Draft ACTIVITIES
for 2 aspects of the chosen "broad strategy for Nature Conservation for the transboundary region:

A) Broad Strategy for Nature Conservation for Maramuresh Region: Cultural and Traditional Activities :

What: Preserve traditional heritage despite modern traditions
Ethnical- cultural + historical heritage conservation in villages in border zone
Tourism and selling traditional handicrafts as a way to preserve traditions,
Draft (measurable) **Output:** Concept for Ethnical and transboundary cultural tourism as a tool to preserve traditions,

Possible Activities (as brainstormed by participants):

- Festival: more equal distribution of festivals
- Traditional holidays
- Markets
- Joint transboundary Markets
- Master class/schools traditional handicrafts, Atelier, School of crafts to renew all crafts we have: carpets, wood, etc…
- Establish green business support and development: rural tourism, local food, handicrafts. Maramuresh on Romanian side already has a brand in ecotourism- possible development of Maramuresh brand also in Ukraine: transboundary tourism start? Carpathian brand developed at the moment you need to create a demand to be economically sustainable: but you also need education on landscape scale. Train people to do this craft, for development of this work, not to bring tourists to the workshops, but workshops should be placed in the way of the tourists, so e.g. Centre of Europe. Other opinion: If we want promote area as attractive for tourists, we need to develop traditional areas, not just bring traditions into a few tourism centres
- List of Historical monuments- monitor and know the real state
- Promote culture and traditions
- Promotion of multiplication of network of traditional services – Networking:

- Places of tourist attraction
- Transboundary list of ecotourism spots/services for the whole region and in both languages. Develop bigger number of such services, Hutsul tradition
- Produce the crafts locally (schools will help), so it is not “made in china” First teach young people and then produce it too on bigger level and market it, continuation needed, green business will help
- Lobbying for 50 km frontier zone (UA)

Risks/Barriers:

- UA visa for Romania hard to obtain
- Not enough successful models of green business?
- If we just promote traditions we can relate to eco-tourism aren’t we missing out on other traditional lifestyle worth conservation like: highland sheep farming, traditional forest management?

B) Broad Strategy for Nature Conservation in Maramuresh Region: Biodiversity conservation

Output: Map of regional priority areas including existing PAs and areas that should be protected

Activities:

1) Gap analysis (what exists, what doesn’t)- responsible for doing this in RO: park administration, in UA: museum of natural history
2) Compile biodiversity data layers from existing databases – in RO: park admin, in UA: museum of natural history?
3) Collect primary data to address gaps- in RO: park admin, in UA: museum on natural history?
4) Prioritize areas according to desired criteria (e.g through expert workshop) and/or decision support tools)- RO: park admin, UA: museum on natural history?

Risks- Barriers:

Poor data/lack of data

Lack of cooperation + trust in data sharing

Low capacity

Lack of funding: funding with EU Neighbourhood programme, management administration proposal,

Must clarify which biodiversity features are included, what is the working scale.

3. 7. Thoughts on OBJECTIVES

Related to addressing funding issue:

How much does it cost to create Gap Analysis and compile biodiversity data?

You need to consider all the areas to find the important ones

For a gap analysis: get at 2-4 person full time for a year to do this properly to coordinate this, contracting many others: communication and coordination and then one for GIS maps

Coarse filter Gap Analysis: info you have,

Then you can fine filter as you get data and money

We concluded that not the right people were present to discuss further on detailed objectives for the Strategy Output: Map of the priority areas. This has to be done in the future.

3.8 STAKEHOLDER ANALYSIS

Important Stakeholders mentioned by the participants:

- National Forest administration in RO (RNPA): more influence + impacted upon (own park and co finance project)
- State forestry enterprises UA: less influence, less impacted

- Research Institutions: top 2 groups: university, national academy of science, Protected Area (you need to make a group of it).
- Nature conservation office (Government): could provide a complete list of PAs, detailed data, database
- Environmental Agency:
- NGOs: e.g. WWF, Romanian Orthithological Society, Bat research society, Museum of natural science in Bucharest, Natural museum of Sziget,
- Landowners, (public information)
- Hunting and Fishing associations/Hunters
- Farmers
- Touristic structures will be impacted

3.9 RISK ANALYSIS AND RISK MITIGATION

Risk Analysis and Mitigation Strategies for Strategy Output: Map on priority Areas

Risk	*Mitigation Strategy*
Poor data	budget for primary data collection Revalidating data Work with Humboldt University on remote sensing data
Lack of trust and cooperation	involve them in project planning from beginning to build trust and share responsibility Partnerships and agreements with superiors Buy data outright
Low capacity (staff time and skills)	networking and long cooperation to gain all available capacity Adequate funds to pay researchers and data holders#
Lack of funding	EU Neighbourhood programme proposal Maramuresh Nature Park administration proposal
Lack of funds for co financing	Identify NGOs linked to administration offices to get more funds Use WWF network to get matching funds

Unclear project plan clarify the project scope and boundaries, which biodiversity features should be included in gap analysis, and the scale of analysis

CONCLUSIONS

Since 2010 it was no substantial breakthrough on implementation of strategic planning with involvement of majority of main stakeholders, however certain steps have been realized like (1) summarizing previous transboundary work for the UA Carpathians; (2) successful WWF UA-RO project application of CBC Programme on bears migration; (3) several small scaled projects on old growth forests, ecological network and wetlands protection; (4) protected areas support, like for Gorgany NR and Carpathian NNP, on capacity building and tourism/ecological education development. The main obstacles prohibiting substantial improvement of practical cooperation between government authorities and civil society actors (NGOs, local stakeholders) are different approaches to biodiversity management and landscape use and very often a lack of willingness to identify common goals. In some cases it is also a lack of capacity both in governmental as well as non-governmental organizations. Long-term initiatives require stable management structure (coordinating organization and partners), and ensuring financial recourses as well as support at the regional, national and international level. The important role of WWF in the region can be identified in terms of preserving natural and cultural values and requires sufficient capacity and skills on communication, facilitation of a dialogue at different level (including stakeholders, NGOs, businesses, PAs etc) and an elaboration and implementation of projects through which ideas and visions can become reality through involving of all identified main stakeholders. Certain improvement on transboundary nature conservation activities in Maramuresh is highly needed due to exceptional value of the region for whole Carpathians and increasing amount of threats, which leading to the degradation of the region’s natural heritage.