RELIEF DENUDATION ASSESSMENT ON HYDROGRAPHIC BASINS USING THE PERCENTAGE HYPSOMETRIC CURVES METHOD. CASE STUDIES FROM SECAŞUL MARE BASIN (TRANSYLVANIA, ROMANIA)

Marioara COSTEA[1]

KEYWORDS: denudation, percentage hypsometric curve, solid flow, Secaşul Mare.

ABSTRACT

This study presents a method of assessing denudation, one based on geomorphology. Long-term evaluation is achieved by calculating the average rate of denudation and the global percentage hypsometric curve. This method is applied to case studies from Secaşul Mare Basin. The values obtained are compared with solid flow in the same basin. Conjugation in time and space of internal and external factors of genesis and modeling of the landforms has led to significant changes to the geomorphologic landscape. Intensity and size of denudation phenomena depend upon regional tectonic features, and the petrographic nature and climatic conditions over the passage of geological time in the analyzed area. Denudation that has taken place mainly on the interfluves and slopes has resulted in decrease of elevation, changing of interfluve and slope morphology and the creation of new forms of accumulation.

REZUMAT: Evaluarea denudării reliefului pe bazine hidrografice prin metoda curbelor hipsometrice procentuale. Studii de caz din bazinul Secaşului Mare (Transilvania, România).

Studiul de faţă prezintă o modalitate de evaluare a denudării printr-o metodă geomorfologică. Evaluarea se realizează pe termen lung prin calcularea ratei medii de denudare globală şi prin intermediul curbei hipsometrice procentuale. Metoda este aplicată unor studii de caz din Bazinul Secaşului Mare. Valorile obţinute sunt comparate cu scurgerea solidă.

Conjugarea în timp şi spaţiu a factorilor interni şi externi de geneză şi modelare a reliefului au determinat o serie de modificări ale peisajului geomorfologic. Intensitatea şi dimensiunea fenomenului de denudare depind de tectonică, de natura petrografică şi de condiţiile climatice care s-au succedat în timp geologic, în aria analizată.

Denudarea exercitată cu precădere la nivelul interfluviilor şi versanţilor a avut ca rezultat scăderea altitudinală, modificarea morfologiei interfluviilor şi versanţilor şi crearea unor noi forme de acumulare.

ZUSAMMENFASSUNG: Auswertung der Reliefdenudation in Einzugsgebieten durch die Methode der prozentuellen hypsometrischen Kurven. Fallstudien aus dem Einzugsgebiet des Secaşul Mare (Transylvanien, Rumänien).

Diese Studie stellt eine Möglichkeit der Bewertung der Denudation durch eine geomorphologische Methode vor. Die Evaluierung erfolgt langfristig durch die Berechnung der durchschnittlichen globalen Denudationrate und mittels der prozentuellen hypsometrischen Kurve. Die Methode wird auf Fallstudien im Einzugsgebiet des Secaşul Mare angewandt, wobei die erhaltenen Werte mit dem Bodenfließen verglichen werden. Das Zusammenwirken der inneren und äußeren Faktoren der Entstehung und Gestaltung des Reliefs in Zeit und Raum haben zu einer Reihe von Veränderungen der geomorphologischen Landschaft geführt. Intensität und Ausmaß der Denudationserscheinungen sind abhängig von der Tektonik,

den petrographischen Gegebenheiten sowie den Klimabedingungen, die im Laufe geologischer Zeiträume im Untersuchungsgebiet aufeinandergefolgt sind. Die vorwiegend im Gebiet der interfluvialen Höhenzüge und der Hänge stattgefundene Denudation hatte eine Verringerung der Höhen, der morphologischen Veränderung der interfluvialen Höhenzüge und der Hänge sowie die Entstehung neuer Akkumulationsformen zur Folge.

INTRODUCTION

Denudation of the landforms is a complex action exerted by the modeled agents through plucking, displacement and removing of materials, including soil, under certain conditions which contribute to the transformation of the landscape and the development of new forms. The actual configuration of the landforms is the result of the cooperation and action in time and space of several modeling agents.

Even though the geomorphologic processes have a different intensity and frequency in time, assessing the long-term relief denudation can provide us with particularly useful information for interpreting the current dynamics of landform and land management, especially those in the slope. Today, geomorphologic studies are increasingly used in various complementary fields: soil science, ecology, agriculture, forestry, land management and spatial planning, etc. (Antonie et al., 2012). These studies provide the necessary information about the restrictions or favorability imposed by the rock structure, relief morphometry and geomorphologic processes, and the effects of these conditions or processes on productivity and land suitability for specific uses (Iagăru et al., 2012).

The studies of relief dynamics and denudation assessment are best conducted on river basins because they can be clearly defined by watershed and the results can be verified by comparing them with the solid flow at the basin closing section.

Morpho-hydrographic basins are open systems performing continuous exchanges of matter, energy and information with their external environment. System status reflects their functionality at a certain moment and it is defined by certain values of state variables at that time of evolution.

The intensity of matter and energy exchange can be highlighted by a quantitative indicator used in geomorphology, known as the global average rate of denudation (Grecu, 1992; Sandu, 1998; 2003). This expresses the amount of material as an eroded and exported volume from the morpho-hydrographic system during a specified period of time (geological time) in which the basin was under the action of external agents (Grecu, 1992; Sandu, 1998).

Since this indicator is calculated in the long term and appears as homogenized averages, it may or may not be comparable with the solid flow in the past decade. This fact shows the dependence of the morpho-hydrografic system functioning on the tectonics, structure and lithology, the position of local base level, the pace and intensity of the denudation processes, and the resistance of the topographical surface to erosion (Costea, 2006).

METHODS

The calculation of the global average of denudation was performed on the small, inferior order basins of Secaşul Mare Basin. The hypsometric curve method was used considering two phases of basin evolution which highlights two different states of the geomorphological system.

The initial stage was considered during the modeling period of the upper leveled surface of basin, which corresponds to the initial surface and can be restored by erosion shapes and high altitudes. The current phase corresponds to the actual topographical surface, with all the morphological details that characterizes it.

The topographic map with 1:100,000 scale and 20 m equidistance was used to obtain the hypsometric maps. A calculation of the successive actual hypsometric surfaces was made (an equidistance of 200 m was used) for the current area, upstream to downstream, up to the closure of the basin.

The altitudes of erosion shapes were identified for the initial surface. The hypsometric levels were drawn using interpolation and respecting the same equidistance. On this basis, the initial surface was calculated on successive levels between the two initial curves, step by step until it covered the entire basin.

The cumulative surface located above the considered level curve is labeled as **a**. By cumulating the partial surfaces upstream to downstream, the entire area of the basin is obtained (quoted by **A**).

The cumulative altitude, respectively the difference between the altitude of the base level (minimum quota of the basin at the mouth of the river) and the quota of the level curve established for the cumulative surface computed, is labeled with **h**.

The altitudinal development of the basin, respectively the difference between the minimum altitude and the maximum altitude of the basin, is labeled with **H**.

The volume determination is done for each hypsometric step as a product of area and height. The volume corresponding to the two phases (current and initial) is obtained by cumulating the partial volumes from upstream to downstream. The eroded volume (Ve) is the difference between the initial volume (Vi) and the current volume (Va) of the relief.

In order to graphically represent the data and to calculate the percentage hypsometric curves, the surfaces and volume data were transformed in dimensionless data by dividing the partial cumulative values of surface or volume to the total values of the basin (a/A; h/H) (Grecu and Comănescu, 1998; Sandu, 2003).

THE CASE STUDY AREA

Secaşul Mare Basin –morphohydrographical defining elements

Secaşul Mare is a right tributary of Sebeş River, has a length of about 42 km and a basin area of 567 km^2. This basin is located in the southern part of the Transylvanian Depression and includes in its drainage basin the entire Apold Depression and the southern part of Secaşelor Plateau. To the south, the Secaşul Mare Basin extends in the Cindrel Mountains and covers part of the Carpathian border surface near the Poiana and Jina villages. Maximum altitude is of about 1,063 m in Petriceana Hill of Jina Piedmont, which is also the most southern point of the basin; the minimum altitude is recorded in the north-west part of the basin, to the confluence with the Sebeş River. The basin average height is 424 m.

Secaşul Mare River has a relatively symmetrical basin, composed of inferior order basins of small dimensions (10-90 km^2): Netot, Caselor Valley, Câlnic, Pustia, Gârbova, Dobârca, Apoldul, on the left side and Ludoş Valley, Sângătin, Bozul, Doştat with Şpring, Vingard and Daia Valley (Slatina) on the right side.

Adaptation of the valleys to the monoclinal structure of the Secaşelor Plateau is reflected in the geomorphological landscape, characterized by an asymmetrical profile of the subsequent valleys (Secaşul Mare), the symmetrical profile of consequent valleys (left tributary of Secaşul Mare River), obsequent and resequent valleys (right tributaries) and the relief of cuesta with structural surfaces inclined to the north and steep fronts inclined to the south. Secaşul Mare Valley is a subsequent valley with a clear asymmetry on the left marked by a succession (from south to north) of fluvial landforms: glacises, terraces, and floodplains which exert a pushing towards north of the minor riverbed. This pressure exists for a length of over 35 km from east to west, between the Secaşul Mare riverbed and the cuesta steep front of the plateau to be a directly morpho-dynamic report, which influences the intensity of slope processes (Costea, 2006).

Lithological formations more resistant to erosion located at the north border of the Cindrel Mountains, such as crystalline rocks, conglomerates, sandstones, and limestones give the highest landforms of Secaşului Mare Basin, extended spurs and submontainous hills, true buttresses which decrease in elevation to the bottom of the Apold Depression. These formations contrast with the relief generated by clayey and clayey-marly complexes on the bottom of the depression and the plateau which are reflected in the landscape by rounded forms (gentle hills named in Romanian "gruiuri" and "gorgane").

The imbalances occur on the slopes of sub-mountainous hills and plateaus. Current modeling processes contribute to land degradation; torrential erosion, rill erosion, surface erosion, creep, collapses and old and reactivated landslides are dominating on slopes, floods occur in minor and major riverbeds, lateral erosion and meandering, accumulation, redistribution of sediments and alluvial fun formation are present.

Supply and flow regime of the Secaşul Mare Basin are subject to the morpho-climatic conditions. Altitudinal variation reflects the close direct correlation between rainfall and the average of specific flow. Relatively small values are subject to rainwater supply in smaller quantities. The highest leakage is noted in the submontane hills (3 to 6 l/s km^2) and in the plateau (1.8 to 2 l/s km^2) and the lowest in the lower basin, where the values of flow are subunitary (0.2 to 0.9 l/s km^2).

Paleogeographic conditions of landscape evolution and modeling in the studied area

The formation and evolution of landforms from Secaşul Mare Basin is subordinated to two morpho-structural units: the Carpathians and the Transylvanian Depression which is partially included in the basin. Tectonic events that happened between the Paleogene and Quaternary are associated with the nature of the rocks and paleoclimatic conditions and are reflected in the relief genesis and evolution in this area.

Landform evolution took place in two stages: an initial stage of sedimentation according to the base level of the Transylvanian Basin and another of sub-aerial modeling, after the withdrawal of the Pontian Lake and surface exhumation, depending on the subsidence area of Mureş River (Ciupagea et al., 1970).

Obvious changes in the paleogeographic evolution of the entire area (of which the Secaş Basin is part of) are recorded with the differential evolution of the Transylvanian Basin from the Carpathian Mountains mass. The Badenian transgression that favored the deposition of marls, tuffs, etc., is significant (Ciupagea et al., 1969). White, blackish-gray or gray coloration of sedimentary strata in the contact area of sub-mountainous hills (Caselor Valley in Răhău, Gârbova, Deal and Dobârca localities) indicate climate oscillations with alternating wet and dry periods (Lubenescu, 1981).

Depositional processes had been continuing in the Sarmatian, when deposits of gravel and coarse sands alternating with fine deposits have been made at the Sarmatian Sea seashore near Cindrelului Mountains (Sandu, 1998). These Volhinian − Bessarabiene deposits of marl and clay intercalated with sandstones and sand were uncovered at Răhău, Reciu, Gârbova, Dobârca and Apoldu de Sus; to east of Apold, these were covered by Panonian deposits (Lubenescu, 1981).

In the Meotian-Pontian stage, under the Mediterranean climate conditions with different rhythms imposed by an alternation of the seasons, the modeling of the Carpathian border surface was completed − Meotian surface (Posea, 1997) or Transylvanian peripheral surface (Mac, 1972). The movements from Pontian had created the conditions of Gornovița surface suspension with 200 to 250 m from the northern periphery and the formation of erosion aprons.

In the lower compartments, respectively on the line to the north of the Cindrel Mountains, the Pontian transgression favored a marly-clayey complex sedimentation that remains very close to crystalline (Sandu, 1998). The sedimentation phase ended at the end of the Pontian, and was followed by Rhodanian vertical movements of the mountainous area and, consequently, the emersions of the Secaşul Mare Basin area from the Pliocene Lake waters. This marked the opening stage of sub-aerial relief modeling and the shaping of current features of landforms under the action of external agents. Alternation of warm and cool climate and the intensity of climate variations until the present day have led to differential relief denudation and modeling.

Thus, the upper Pliocene is highlighted in the Secaşul Mare Basin through strong erosion due to sediment package ascension, together with the ascension of the mountain frame and because of their low cemented rocks. The Pontian is highlighted in the Secaşelor Plateau at Daia (micaceous sands, sands with some intercalations of clay, gray or yellowish clay deposited in torrential structure), Cunţa (gravel with quartzite elements and gray-purple marls with organic debris), Şpring (quartzite gravel with clay, sand and marls) and Miercurea Sibiului in the Morii Hill (gravel trapped in a mass of ferruginous sands) (Ilie, 1955; Ciupagea et al., 1970).

On the Apold Depression bottom, Pontian deposits are crushed. At Sângătin and Apold small gravels, white micaceous sands and ferruginous sands in torrential structure, with enclaves of gray clay and marls with ferruginous alterations were identified (Ilie, 1955; Ciupagea et al., 1970).

In these petrographic conditions, the erosion was different; it was more intense in the mountain-depression contact area, due to changes in the flow regime of the Carpathian rivers. Thus, in the Dacian – Romanian range, the plateau surface erosion of 550-650 m was concluded (Amnaşului surface, named the Transylvanian surface or the piedmont surface of erosion) (Posea, 2002; Mac, 1972; Josan, 1975; Grecu, 1992).

The Romanian-Villafranchian is marked in the Secaş Basin area by the sculpting of the surface plateau of 450-500 m (Secaş surface), synchronous with the interfluve levels of the sub-mountainous hills or with the lower surfaces of the valley (around 550-600 m) in the Carpathians (Posea, 2002).

Later, the Wallachian movements had raised the Carpathian with 500-1,000 m, and at the same time they provoked the raising of the bordering areas, the depressions and plateau becoming emersion areas. Moreover, the emersion character of this area has been finalized at the end of the Pontian, and the two post-Pontian orogenic movements functioned as a complex (Posea, 2002).

The temperate climate from Villafranchian, with Mediterranean nuances and torrential manifestations of rainfall, favored strong erosion in the Cindrel Mountains and accumulation of eroded material into the depressions from their northern border. Thus, on the southern side of Apold Depression, aprons were created, which have been subsequently subjected to fragmentation, denudating agents and leveling. This was possible only by corroborating tectonic, bio-climatic, hydrological base level conditions for a relatively long period, probably Lower − Middle Pleistocene (Sandu, 1998).

Massive tectonic raises resulted in the deepening of valley courses and the development of epigenetic sectors in the Secaşul Mare basin on Dobârca, Gârbova and Câlnic valleys, where rivers were digging deep into the crystalline schist, extended far to the north and covered by sedimentary rocks.

The geomorphologic landscape aspects began to complete in the Quaternary period. Erosion processes and the deepening of rivers imposed by the Pleistocene climate oscillations (Cârciumaru, 1980) resulted under the coordination of base level changing of Mureş, in the deepening of Secaşul Mare River, the fragmentation and partial covering of the river terraces on its left side, by the glacis of tributaries which descend from the mountain.

RESULTS AND DISCUSSION

Average rate of global denudation

The average rate of global denudation was calculated selectively for three inferior order basins of Secaşul Mare River: Gârbova, Apold and the source basin upstream Apoldu de Jos. The selected tributary basins cover three relief units, in which Secaşul Mare Basin expands: Cindrelului Mountains (Gârbova and Apold, through their source area in the lower mountain level and through the stream Rod tributary of Apold River), Apold Depression (through the middle and lower sector of Gârbova and Apold rivers) and Secaşelor Plateau (by Apold and the source area of Secaşul Mare basin).

The data (Tab. 1) are presented as percentage hypsometric curves (Figs. 1a-d). By providing a dimensionless a/A and h/H, values between 0 and 1 are obtained, proportionate to the growth of cumulative surface and cumulative heights in the basin. The representation of these dimensionless values in a coordinate axis system renders the percentage hypsometric curve following the format: a/A increases from top to bottom, and h/H decreases from top to bottom.

The data using the above methodology allows the assessment of relevant issues aimed at the evolution of landforms and denudation in Secaşul Mare Basin.

Paleogeographical evolution of the studied basin reveals the formation and completion at the end of Pliocene of the initial surface of the main peaks and interfluves. Altitudinal differences of the basin and the petrographic heterogeneity, especially in mountain-depression contact areas, show morphochronological differences on geological levels and different denudation in specific paleoclimatic conditions.

Using the erosion outliers and current altitudes in reconstructing a pre-existing relief contour allowed us an indication of the approximate initial relief surface from which the modeling has started. The initial relief surfaces of the analyzed basins belong to different stages of evolution, being represented generally by Gornoviţa (the lower level of 800-1,000 m) and Amnaş (550-600 m) leveling surfaces.

The eroded material volumes reveal the dependence of the modeling intensity on the physical and chemical features of metamorphic and sedimentary rocks, the petrographic composition and resistance to erosion, differentiated in the contact area, the plateau and the depression area, and also on the local morphological conditions.

Quantitative differences between the mountainous-depression contact and the depression and plateau are highlighted also by the percentage hypsometric curves (Figs. 1a-d). The average rate of denudation values indicates the current stage of evolution of the landscape and the dominant processes.

Assuming that the initial surface of main interfluvial summits in the Gârbova River basin is part of the surface completed in Romania, and considering its age around 1.5 million years, a homogenized average of about 0.17 kg/s during Romanian − Present was obtained, which corresponds to an average eroded volume of 5,260 m^3/year.

Unlike this sub-basin, developed mainly on sedimentary rocks on the same part of Secaşul Mare Basin, the upper interfluvial summits of the Apold River basin belong to the lower level of Carpathian border surfaces, developed on crystalline schists. They were completed in Pontian − Dacian and, considering its age around 12.5 million years, the homogenized average obtained between Pontian − Actual is about 0.026 kg/s, which corresponds to an average eroded volume of 812 m^3/year.

Overall, the values for Apold basin are different from the other sub-basins. This is due to the homogenization of modeling conditions for a period of time (12.5 million years) and the development in elevation of the basin (763 m). On the other hand, given the large weight of surfaces with heights below 800 m (90%), developed on sedimentary deposits in similar conditions to other tributary basins of Secaşul Mare River, we consider that the average of eroded volume is about 3,700 m^3/year, and the homogenized average rate of erosion for the interval Romanian − Actual is 0.12 kg/s.

Table 1: Determination of the Hypsometric Percentage curve and of the relief's volume.

Phase	Features	Altitude				
		< 400	400-600	600-800	800-1,000	> 1,000
Gârbova Basin A = 64.21 km^2						
$H = H_{max} – H_{min}$ = 678 m; H_{max} = 968 m; H_{min} = 290 m						
$V_e = V_i – V_a$ = 7.89 km^3						
Initial	Surfaces (km^2)	5.07	25.05	17	17.09	
	Cumulative surfaces (a) (km^2)	64.21	59.14	34.09	17.09	
	a/A	1	0.92	0.58	0.27	
	Cumulative height (h) (m)	110	310	510	678	
	h/H	0.16	0.46	0.75	1	
	Volume (km^3)	0.56	7.77	8.67	11.59	
	Initial cumulative volum Vi (km^3)	28.59	28.03	20.26	11.59	
Actual	Surfaces (km^2)	18	28.36	12.97	4.88	
	Cumulative surfaces (a) (km^2)	64.21	46.21	17.85	4.88	
	a/A	1	0.72	0.28	0.08	
	Cumulative height (h) (m)	110	310	510	678	
	h/H	0.16	0.46	0.75	1	
	Volume (km^3)	1.98	8.79	6.62	3.31	
	Actual cumulative volume Va (km^3)	20.7	18.72	9.93	3.31	
Phase	Features	Altitude				
		< 400	400-600	600-800	800-1,000	> 1,000
Apold Basin A = 85.17 km^2						
$H = H_{max} – H_{min}$ = 763 m; H_{max} = 1063 m; H_{min} = 300 m						
$V_e = V_i – V_a$ = 10.15 km^3						
Initial	Surfaces (km^2)	4.0	40.75	26.12	10.30	4.00
	Cumulative surfaces (a) (km^2)	85.17	81.17	40.42	14.3	4
	a/A	1	0.95	0.47	0.17	0.05
	Cumulative height (h) (m)	100	300	500	700	763
	h/H	0.13	0.39	0.66	0.92	1
	Volume (km^3)	0.4	12.26	13.06	7.21	3.03
	Initial cumulative volume Vi (km^3)	35.98	35.58	23.32	10.26	3.05
Actual	Surfaces (km^2)	25.66	40.54	11.11	7.19	0.67
	Cumulative surfaces (a) (km^2)	85.17	59.51	18.97	7.86	0.67
	a/A	1	0.70	0.22	0.09	0.008
	Cumulative height (h) (m)	100	300	500	700	763
	h/H	0.13	0.39	0.66	0.92	1
	Volume (km^3)	2.57	12.16	5.56	5.03	0.51
	Actual cumulative volume Va (km^3)	25.83	23.26	11.1	1.54	0.51

Table 1 (continuing): Determination of the Hypsometric Percentage curve and of the relief's volume.

Phase	Features	Altitude				
		< 400	400-600	600-800	800-1,000	> 1,000
Secaşul Mare source basin (upstream Apoldu de Jos) A = 83.26 km^2						
H = H_{max} – H_{min} = 303 m; H_{max} = 603 m; H_{min} = 300 m						
V_e = V_i – V_a = 6.1 km^3						
Initial	Surfaces (km^2)	5.46	73.21	4.59		
	Cumulative surfaces (a) (km^2)	83.26	77.8	4.59		
	a/A	1	0.93	0.06		
	Cumulative height (h) (m)	100	300	303		
	h/H	0.33	0.99	1		
	Volume (km^3)	0.55	21.96	1.39		
	Initial cumulative volume Vi (km^3)	23.9	23.35	1.39		
Actual	Surfaces (km^2)	36.85	46.35	0.06		
	Cumulative surfaces (a) (km^2)	83.26	46.41	0.06		
	a/A	1	0.55	0.0007		
	Cumulative height (h) (m)	100	300	303		
	h/H	0.33	0.99	1		
	Volume (km^3)	3.69	13.91	0.02		
	Actual cumulative volume Va (km^3)	17.8	14.11	0.02		
Phase	Features	Altitude				
		< 400	400-600	> 600		
Daia Basin A = 61 km^2						
H = H_{max} – H_{min} = 366 m; H_{max} = 606 m; H_{min} = 240 m						
V_e = V_i – V_a = 8.08 km^3						
Initial	Surfaces (km^2)	8.5	47.5	5		
	Cumulative surfaces (a) (km^2)	61	52.5	5		
	a/A	1	0.86	0.08		
	Cumulative height (h) (m)	160	360	366		
	h/H	0.43	0.98	1		
	Volume (km^3)	1.36	17.1	1.83		
	Initial cumulative volume Va (km^3)	20.29	18.93	1.83		
Actual	Surfaces (km^2)	48.75	12	0.25		
	Cumulative surfaces (a) (km^2)	61	12.25	0.25		
	a/A	1	0.2	0.04		
	Cumulative height (h) (m)	160	360	366		
	h/H	0.43	0.98	1		
	Volume (km^3)	1.36	17.1	1.83		
	Actual cumulative volume Va (km^3)	20.29	18.93	1.83		
Data calculated based on topographic and hypsometric maps.						

Regarding the higher interfluves of the Secaşelor Plateau, they belong to the Amnaşului Surface (550-600 m).

If we consider that the initial surface of main interfluvial summits in the source area of Secaşul Mare Basin belonging to the Amnaşului surface and the age of this is about 1.5 million years, the homogenized mean values of global average rate of denudation obtained during the Romanian − Actual is 0.13 kg/s, which corresponds to an average eroded volume of 4,067 m^3/year.

In the same conditions of modeling, specific for plateau, for Daia Basin the values are: average eroded volume of 5,386 m^3/year and a denudation rate of 0.17 kg/s.

The homogenized mean values obtained for the average global denudation in geological time are comparable with the values of solid flow in the last decades recorded at Cunţa, in Secaşul Mare Basin. They are similar to the solid flow of neighboring drainage basins developed on the same type of geological substrata and in the same climate and hydrological conditions. Thus, average flow of alluvia in suspension R (kg/s) is about 0.6 kg/s at Cunţa station in the analyzed basin, about 1.34 kg/s at the Cornăţel station in the Hârtibaciu Basin, and about 1.6 kg/s (natural regime) at the Petreşti station in the Sebeş River basin.

Average turbidity (g/cm), which is the amount of alluvia carried in a cubic meter of water, reflects the petrographic composition role in the solid flow and highlights the differences between the two basin sectors. In the sub-mountainous areas, the metamorphic rocks (crystalline schists), hardly eroded, give low average turbidity (30-150 g/m) compared to that recorded in the lower basin. The landform is rugged, with large slopes (15-45°) therefore the power of erosion is accentuated.

In the hilly area, at the northern border of Cindrel Mountains, the substratum is generally composed of coarse material (boulders, gravel and sand), more or less fixed, hard to wash. In this condition, the turbidity increases compared to the mountains, but it remains incomparably lower than in the plateau.

In the plateau area, substrata with a high percentage of fine and impermeable clay and the slope cause a rapid liquid flow which takes over a large amount of solid material (turbidity from 350 to 1,000 g/m^3).

Also, the values of solid flow parameters indicate the type of supply, mostly pluvial, and the torrential character of rainfall in the Secaşului Mare Basin which lead to the appearance of intense hydrological processes and, implicitly, to a strong erosion.

The aggressiveness of rain was greater in the last decades due to the low level of afforestation of the basin; the forest surfaces decrease with altitude. Related to this, we can see the increase in turbidity compared with lower average of afforestation.

The geomorphologic factors with which it can be established a correlation are the average slope of riverbed and of basin and the average height, but these indicators contribute indirectly to changes in the amount of sediments through the environmental conditions they create (spontaneous vegetation coverage, anthropogenic intervention through agriculture, etc.).

The hypsometric curves for the lower order sub-basins of Secaşul Mare also reflect the petrographic and morpho-structural differences and intensity of modeling.

A hypsometric curve almost straight and integral, with values of 50-60%, indicates a maturity stage of landforms; this reveals a dynamic equilibrium between erosion, transport and accumulation, but with relative instability of the balance in the Gârbova Basin, given by the high potential of triggerring slope processes (gullying, torrential erosion and landslides) (integral of actual surface 62%).

Concave hypsometric curves (upper basins of Apold and Gârbova) indicate an equilibrium profile in the contact and depression area, which is subject to changes caused by high potential of triggering and reactivation of mass movements and by active regressive erosion (Apold Basin, integral of actual surface is 52%).

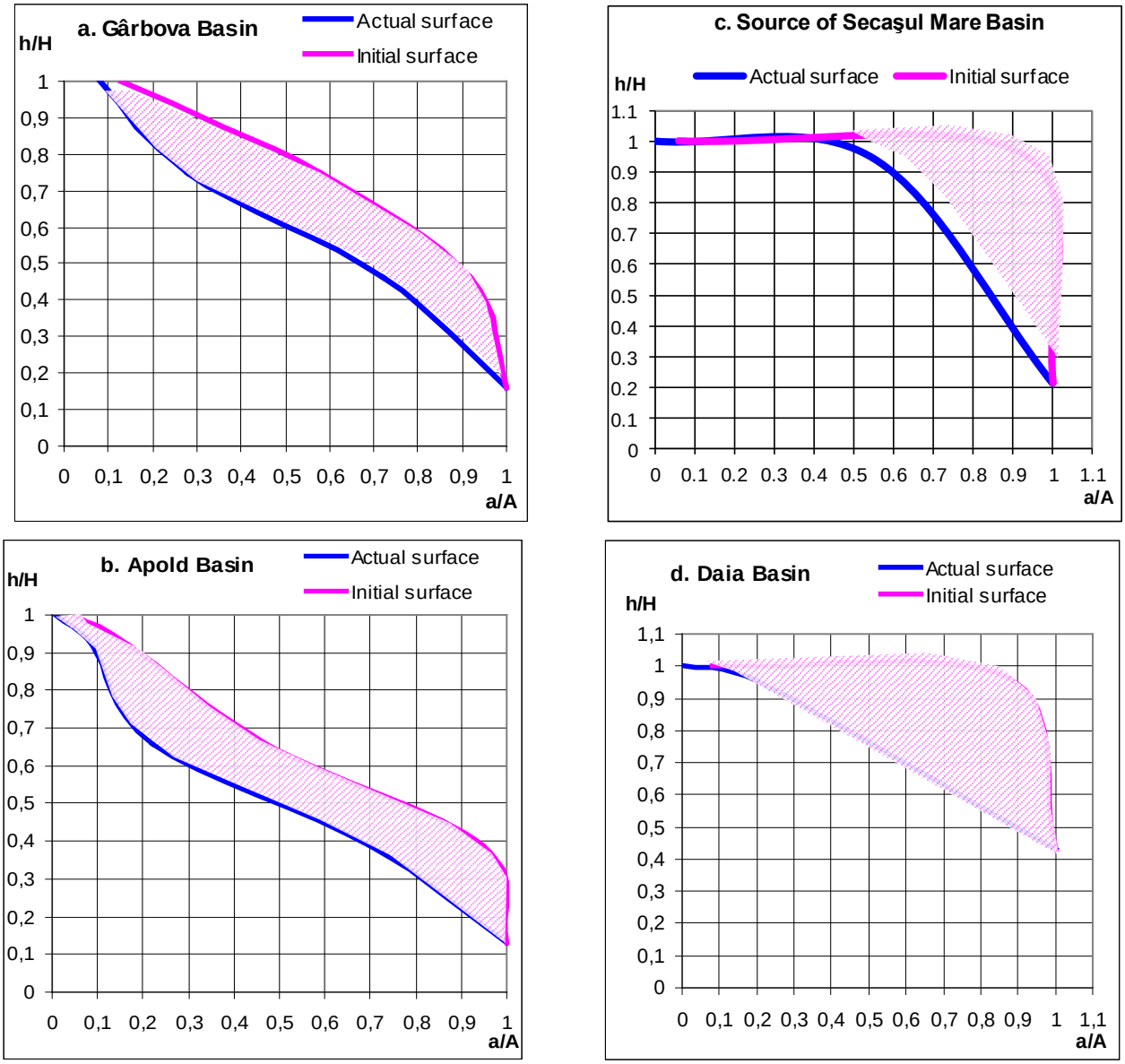

Figure 1a-d: Hypsometric Percentage curves of Secaşul Mare tributaries (shaded area − eroded).

Convex hypsometric curves in the source area of Secaşul Mare Basin and Daia Basin and the high values of hypsometric integral (83%, respectively 76%) indicate a young relief stage, with predominantly deep erosion in the source areas of rivers and frequent disturbances marked by runoff, gullying, torrentiality (contact mountain − depression) and a high potential of modeling and reactivation of erosion in the plateau.

The hypsometric percentage curve for the current landforms surface and its math integral reflects a young relief and predominance of erosion and transport in the upper basins of tributaries, Rod, Gârbova, Câlnic, Reciu; also the accumulation processes are met in the sector of torrential convergence and river confluence. All of these processes are activated and currently reported to local base levels.

For Secaşul Mare Basin, developed mostly in depressionary and plateau area, the hypsometric curves show a tendency for mature landforms, and a domination of accumulation and lateral erosion, processes responsible for enlarging riverbeds and meadows development.

The high rate of slopes denudation show the accentuated dynamic of landscape developed mostly on friable rocks and the mobility of slope line through fragmentation emphasis and through the frequency and intensity of production of slope processes.

CONCLUSIONS

The formation and the evolution of the relief is being carried out of endogenous, exogenous and paleoclimatic conditions, specific to the geological eras and periods.

Sequence and configuration of forms show stages and phases of the evolution of the relief, in which different processes as intensity and typology were recorded: endogenous processes (tectonic activity) and exogenous processes (erosion, material transfer and accumulation).

Thus, the formation of polycyclic modeling complexes, valley corridors, depression basins, piedmonts, alluvial funnels, terraces and floodplains, and the changes occurring within them must be related continuously to the evolution of the hydrographic network, the tectonic activity and geological substratum typology.

The climatic conditions and the use of space are accelerating factors of natural modeling processes and denudation of the landforms.

AKNOWLEDGEMENTS

This work was co-financed from the European Social Fund through Sectorial Operational Programme Human Resources Development 2007-2013, project “Postdoctoral school for zootechnical biodiversity and food biotechnology based on the eco-economy and the bio-economy required by eco-san-genesis” POSDRU 89/1.5/S/63258.

REFERENCES

Antonie I., Pavel P. and Sand C., 2012 – Preliminary consideration on the assessment of the agricultural entomologic fauna dynamics in soil, *Proceedings of AGRI-FOOD*, 20, 25-33.

Cârciumaru M., 1980 – Mediul geografic în pleistocenul superior şi culturile paleolitice din România, Edit. Academiei Române, Bucureşti, 268. (in Romanian)

Ciupagea D., Paucă M. and Ichim T., 1970 – Geologia Depresiunii Transilvaniei, Edit. Academiei R. S. R., Bucureşti, 256. (in Romanian)

Ciupagea D. T., Airinei Ş., Stoenescu S., Popescu M., Popescu C. and Taloş D., 1969 – Nouveaux éléments d'interprétation géologique des résultats géophysiques dans la partie sud-ouest de la dépression de Transylvanie, *Revue Roumaine de Géologie, Géophysique et Géographie*, 13, 1, 87-103. (in French)

Costea M., 2006 – Bazinul Sebeşului. Studiu de peisaj, Edit. Universităţii „Lucian Blaga", Sibiu, 300. (in Romanian)

Grecu F., 1992 – Bazinul Hârtibaciului. Elemente de morfohidrografie, Edit. Academiei, Bucureşti, 167. (in Romanian)

Grecu F. and Comănescu L., 1998 – Studiul reliefului. Îndrumător pentru lucrări practice, Edit. Universităţii, Bucureşti, 179. (in Romanian)

Iagăru P., Sand C., Antofie M. M., Ciortea G. and Spânu S., 2012 – Promoting soil conservation and recovery agricultural techniques for a bio-economic equilibrium, *Proceedings of AGRI-FOOD*, 20, 111-117.

Ilie M. D., 1955 – Cercetări geologice în Bazinul Transilvaniei (regiunea Alba Iulia - Sibiu - Făgăraş - Rupea), *Anuarul Comitetului Geologic*, 28, 251-360. (in Romanian)

Josan N., 1975 – Dealurile Târnavei Mici. Studiu geomorfologic, Edit. Academiei Române, Bucureşti, 142. (in Romanian)

Lubenescu V., 1981 – Studiul biostratigrafic al Neogenului superior din sud-vestul Transilvaniei, *Anuarul Institutului de Geologie şi Geofizică*, 58, 123-202. (in Romanian)

Mac I., 1972 – Subcarpaţii transilvăneni dintre Mureş şi Olt. Studiu geomorfologic, Edit. Academiei Bucureşti, 156. (in Romanian)

Posea G., 1997 – Suprafeţele şi nivelele de eroziune, *Revista de Geomorfologie*, I, 11-30. (in Romanian)

Posea G., 2002 – Geomorfologia României, Edit. Fundaţiei „România de Mâine", Bucureşti, 444. (in Romanian)

Sandu M., 1998 – Culoarul depresionar Sibiu - Apold. Studiu geomorfologic, Edit. Academiei Române, Bucureşti, 198. (in Romanian)

Sandu M., 2003 – Podişul Secaşelor. Relaţii între parametrii morfometrici şi procesele de denudare în bazine reprezentative, *Revue de Géographie*, IX, 62-69. (in Romanian)

AUTHOR:

[1] *Marioara COSTEA*
marioara_costea@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Applied Ecology Research Center,
Dr. Ioan Raţiu Street 5-7, Sibiu,
Sibiu County, Romania,
RO-550012.

THE PLUVIOMETRIC REGIME IN THE CIBIN RIVER HYDROGRAPHIC BASIN (TRANSYLVANIA, ROMANIA)

Simona SPÂNU [1] and *Nicuşor UDREA* [2]

KEYWORDS: climate, pluviometric regime, baric centers, dynamic climatogene factors, precipitations surplus or deficit.

ABSTRACT

This paper aims to analyse the periods of precipitation surplus and deficit in the Cibin hydrographic basin, in a causal liaison with the synoptic situations that generate floods or droughts.

The periods of precipitation surplus represent a risk that usually has local impact, unlike the periods of precipitation deficit, where the areal spread is large, and the onset and development are slow. The perception in the case of periods with pluviometric surplus is that of a major hydrological risk, because of their violent and progressive manner of manifestation; while droughts are perceived as being a less dangerous phenomena.

REZUMAT: Regimul pluviometric din bazinul hidrografic Cibin (Transilvania, România).

Lucrarea de faţă îşi propune o analiză a perioadelor cu excedent şi a celor cu deficit de precipitaţii din bazinul hidrografic Cibin, în legătură cauzală cu situaţiile sinoptice generatoare de inundaţii sau secete.

Perioadele cu excedent de precipitaţii reprezintă un risc cu extindere adesea locală, spre deosebire de cele cu deficit de precipitaţii, unde extinderea areală este mare, iar declanşarea şi evoluţia se petrec lent. Percepţia în cazul perioadelor cu excedent pluviometric este aceea a unui risc hidrologic major, datorat modului violent şi progresiv de manifestare, pe când secetele sunt percepute ca fenomene mai puţin periculoase.

ZUSAMMENFASSUNG: Das Niederschlagsregime im Einzugsgebiet des Zibin-Flusses (Transylvanien, Rumänien).

Vorliegende Arbeit befasst sich mit einer Analyse der Zeitspannen mit Überschuss und solchen mit einem Defizit an Regenfällen im Einzugsgebiet des Zibin-Flusses, mit einer ursächlichen Gesamtschau der Ereignisse, die zu Überschwemmungen oder Dürre führen.

Die Perioden mit einem Überschuss an Niederschlägen stellen ein Risiko von öfters lokaler Ausdehnung dar, im Gegensatz zu jenen mit einem Defizit an Niederschlägen, die größere Areale umfassen, wobei Auslösung und Entwicklung langsam verlaufen. Die Wahrnehmung im Falle eines Überschusses an Regenfällen ist, bedingt durch das gewaltige und sich fortschreitend aufbauende Ereignis, die eines großen hydrologischen Risikos, während die Trockenzeiten, bzw. Dürreperioden als weniger gefährliche Phänomene aufgenommen werden.

INTRODUCTION

As with most other areal on the globe, the climate of the Cibin River hydrographic basin is determined by three main climatogene factors: radiative, dynamic and physico-geographical. The territorial differentiations in solar energy parameters are caused by lattitude, the general orientation of the great relief forms, and by altitude. The Carpathians, through their spatial positioning and the versants' exposure, different reception and transformation of solar energy, and their orientation against the general circulation of the air masses, represent barriers that are considered difficult to overcome.

The dynamic climatogene factors are represented by the general circulation of the air masses and the baric centres that operate over Europe. The analyses of the synoptic situations allow the identification of atmospheric characteristics that are favourable for the accumulation of the precipitations surplus or deficit. In the analysis of the precipitations regime, a determinant role is played by the normal synoptic conditions, respectively by the atmospheric circumstances that favor the dry or rainy regime.

The most important baric centres that generate large quantities of precipitation in the area of interest are the Icelandic cyclone and the Mediterranean cyclone, but other baric centres help determine concrete synoptic conditions. Added to these are the advections of air masses that modify the general circulation of the atmosphere in a complex way, and implicitly the apparition and evolution of meteorological phenomena of risk. The role of barrage played by the Carpathian chain is manifested through both its position and stretch, and through its altitude, influencing the precipitations' regime in the Cibin hydrographic basin.

The geographical factors are represented by the particulare configurations of relief, hydrographic network, and vegetation. Their great diversity in the Cibin hydrographic basin also determines a great variety of manifestations of the meteorological elements and phenomena. In relation to the altitude of the relief, and as consequence of the role of orographic barrage played by the Carpathians, precipitations are unequally distributed and decreases are noticed in the quantity of precipitations towards the Hârtibaciu Plateau area, from west to east, in the sense of the intensification of the degree of continentalism. If the altitude, the exposure and slope of the versants, together with the relief configuration, determine the quantitative modification and that of the type of precipitations, the lithology generates geomorphological hazards that are based on pluviometric phenomena. Landslides, the washing out of versants, the surface erosion processes and the formation of cloughs and torrents are the direct or indirect result of the excessive soil wetting with precipitations' water.

The Cibin hydrographic basin is an area exposed to deluges and floodings due to the excess of precipitation. The greatest deluges occur in the spring, when on the background of the increase in the quantity of precipitations, temperature escalation also intervenes, and the triggering of the melting of the snow layer. Still, most of the deluges occur at the end of spring and the beginning of summer. The Cibin hydrographic basin is not sheltered from deluges and floodings during the winter, these being determined by the amplification of the circulation of cyclonic air masses of oceanic and Mediterranean nature. Except for the autumn months, when the air circulation is predominantly anticyclonic, deluges and floodings might occur throughout the rest of the year, generated by the excessive precipitations.

Among the vegetation forms, the forest is one that influences most of the climatic elements and phenomena. The forest is a complex ecological system, between which the elements of interdependence reports are being created. The forest influences the precipitations that fall over it throughout the duration of retention and drainage and the regime of humidity created inside the forest.

MATERIAL AND METHODS

The analyses of the long data ranges offer an image regarding the succession of periods with pluviometric surpluses and deficits for the Cibin Basin. This approach allows the identification of a possible cyclicity of the episodes with floodings and droughts. Statistical data comes from hydrometric and meteorological local stations and pluviometric posts that have been selected on the basis of the homogeneity and representativeness of the data range. For Sibiu, we used the annual

(Fig. 1) and monthly precipitations values from the interval 1851-2010 and the daily precipitation data between 1970-2010. For Păltiniş, the daily data have been recorded for the same interval as for Sibiu, but the monthly values refer to the interval 1961-2010, a common period for all the selected points. This period benefits of coherent observations, in which the meteorological instruments and apparatus, as well as the locations of the points of measurement, have remained almost the same.

RESULTS AND DISCUSSION

In the temporal and spatial analysis of the periods with the pluviometric surplus and deficit, there are difficulties associated with the establishment of the control variables and the threshold used and induced by the complexity of the phenomena of interest. Precipitations influence the geographic environment, both in space and in time. In a system that is continuously changing the spatial distribution denotes the interdependence and inter-conditioning of precipitations with each of the elements of the geographic environment and with all of them together.

The map of annual isohyets shows the entirely of factors that influence the territorial distribution of the quantities of precipitations during a year, from the atmospheric circulation imposed by the distribution of the baric centres, to the effect of local conditions, primarily that of the relief. Overlapping three distinct relief units (mountain, depression, and plateau), the Cibin hydrographic basin has an altitude difference of over 1,700 m between its spring and its mouth. This aspect is obvious in the repartition of precipitations.

The analysis of the annual regime of precipitations in Cibin hydrographic basin for the interval 1961-2010 and that of the frequency with which precipitations have been registered on different risk classes denote that in Sibiu only a low risk of surplus and deficit is manifested, in Agnita the extreme values with medium and major risk are not present, and in Păltiniş the extremes of medium and major risk are characteristic of the surplus quantities.

The quantity of precipitation that has fallen in the area of the Cibin hydrographic basin has been grouped according to deviation classes (one normal class and five classes for each of the quantities that are higher and lower than the normal) and to pluviometric domains (where the values of all the classes with positive and negative deviations have been gathered, comparing them to the normal domain). Then there have been established groups of pluviometric risk through the surplus and deficit, to these being added the group with no pluviometric risk. The frequency of the years with pluviometric risk through surplus is low in the depression and plateau area, but it is worth mentioning that in the mountains the risk through the surplus reaches 20%, and the one through the deficit 15.6%. The risk through surplus signalled in the mountain region also spreads in the rest of the area, especially in Sibiu Depression, generating a hydrologic risk (Tab. 1).

The risk through surplus or deficit in February shows an almost equal distribution between the groups of risk and the ones pluviometrically normal (Tab. 2). February in Păltiniş shows the group of risk through the deficit is higher than the one through the surplus, in Sibiu the one with risk through surplus is higher, and in Agnita the two groups of risk have equal proportions.

Table 1: Frequency (%) according to groups with and without pluviometric risk in Sibiu, Păltiniş and Agnita in the interval 1961-2010.

Weather station	Group of pluviometric risk		
	Risk through deficit	No pluviometric risk	Risk through surplus
Sibiu	8.9	86.7	4.4
Păltiniş	15.6	64.4	20.0
Agnita	4.4	93.3	2.3

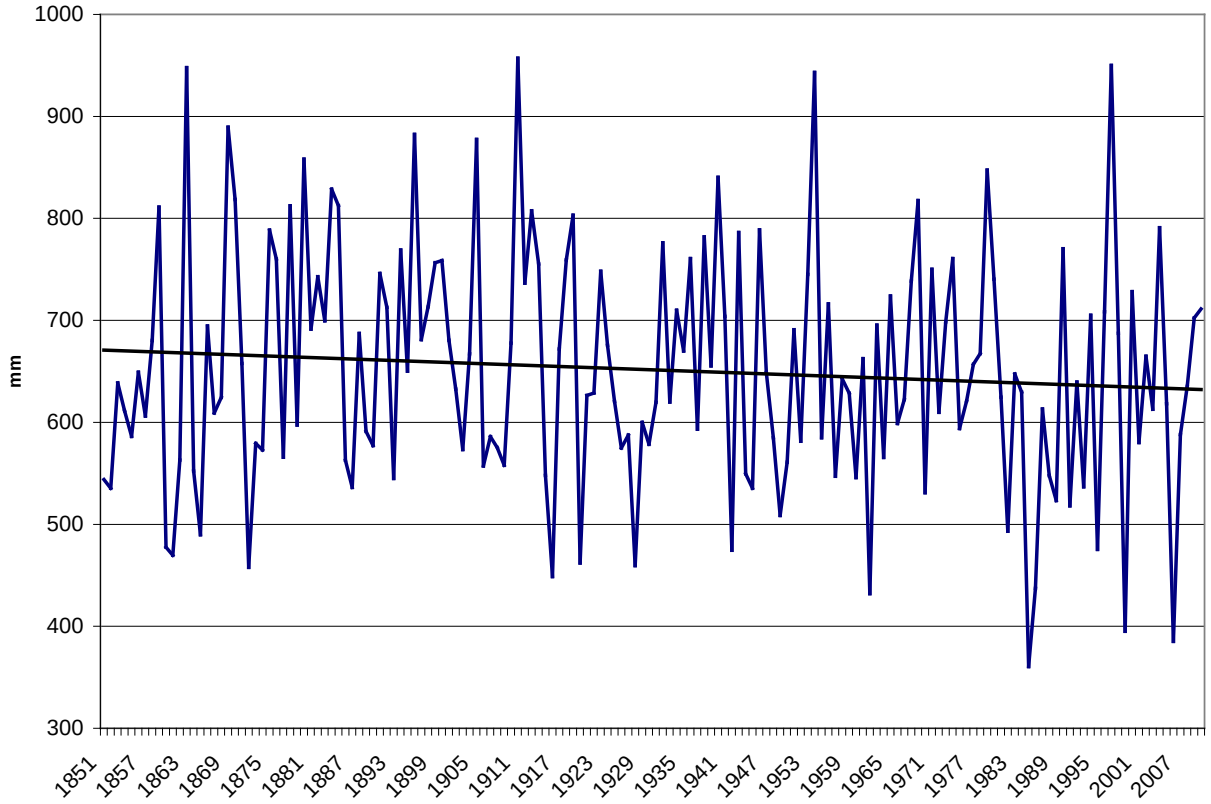

Figure 1: The annual quantities of precipitations (mm\m^2) in Sibiu (1871-2010).

Table 2: Frequency according to groups with and without pluviometric risk in Sibiu, Păltiniş and Agnita in February (1961-2010).

Weather station	Group of pluviometric risk		
	Risk through deficit	No pluviometric risk	Risk through surplus
Sibiu	31.1	35.6	33.3
Păltiniş	35.6	35.6	28.8
Agnita	31.1	37.8	31.1

The group with no pluviometric risk represents 42.3-48.9% of the total months of June that have been analyzed in the depression and the plateau area, and over half in Păltiniş (55.6%). In all the three units of relief, the risk through deficit reaches higher values than the one through surplus (Tab. 3).

In the case of February, the average quantity of precipitations to which the monthly values were compared was low, the deficit would be even more severe, since the rainiest month of the year had been the reference.

Table 3: Frequency according to groups with and without pluviometric risk Sibiu, Păltiniş and Agnita in June (1961-2010).

Weather station	Group of pluviometric risk		
	Risk through deficit	No pluviometric risk	Risk through surplus
Sibiu	26.7	48.9	24.4
Păltiniş	24.4	55.6	20.0
Agnita	33.3	42.3	24.4

Among the pluviometric parameters that visibly influence the precipitations regime and the components of the geographical landscape, whose evolution has to be taken into consideration in the environmental protection, there is the maximum precipitation quantity registered in 24 hours. This can cause a drench which may, in turn, cause severe erosion of the soil, the displacements of boulders and of altered rock fragments from the slopes, and sometimes even the collapse on the highly inclined versants. Floods in the rivers' everglades and valleys, destroyed roads, bridges and vegetation.

The highest quantities fallen in 24 hours are registered in the May-August period, when 60 mm in a month are exceeded. On the crests of the alpine and subalpine level, this quantity exceeds on average 80 mm.

The distribution of the duration of rains on the studied territory highlights both the movement direction of the air masses with the characteristic fronts, and the effects they suffer when they go over the Carpathians. The rains with the longest duration, of over 190 minutes, are produced in the areas of the Cindrel Mountains that are under the influence of the western circulation. The rains with the shortest duration, of under 150 minutes, are produced in the sectors where the descendence of air in the summer predominates, respectively in the Sibiu Depression and Hârtibaciu Plateau.

The rains with the highest quantity of precipitation (over 7-8 mm) are produced in the mountain region. In the depression and plateau areas, rains with lower quantities, of under 6 mm, are produced.

The intensity of rain registers, on average, 0.04 mm/min. On the Hârtibaciu Plateau, where the descendent air currents predominate, as well as insular in the Cindrel Mountains, in the lower areas with reduced humidity, the average intensity of rains is of less than 0.03 mm/min. The absolute maximal intensities have no territorial ordering, being dependent of the nature of the atmospheric front, the intensity of the thermal convection and the particularities of the active surface.

The Carpathian's position in the north-western circulation context and the intensification of the frontal activity and the forming of orographic clouds at the crossing of the mountains determines the increase in the rains intensity.

The frequency variation of Cumulus and Cumulonimbus clouds highlights the accentuation of convective processes. During winter, on the background of thermal inversions, Cumulus and Cumulonimbus clouds are less frequent in lower areas and their frequency increases up to the altitude of 1,500 m. During summer, when convection is strong, the frequency of these clouds is considerably increased.

From a spatial point of view, for the Cibin Basin, a classification of precipitation that falls during 24 hours cannot be established (Tab. 4). From a temporal point of view, the highest quantities of precipitation in 24 hours occur in May-August. From the analysis of the precipitations in 24 hours for 1961-2010, it has been noticed that the highest quantities were produced in the interval 1971-1980, followed by 1961-1970 and 1991-2006.

Table 4: The occurrence probability of the maximal quantities in 24 hours.

Meteo station	Probability (%)				
	20	10	5	2	1
Sibiu	50.3	56.8	62.3	71.8	78.3
Păltiniş	68.4	84.5	96.2	110.1	123.4

CONCLUSIONS

Various calculation methods have been used for establishing the regime of precipitations at different temporal scales, as well as indexes, based on which the characteristics of precipitations have been determined. The methods used in analysing the pluviometric regime of the Cibin Basin are the statistic and mathematical ones, and the ones based on the use of modern meteorological surveillance apparatus.

The purpose of all the specified methods and indices are to identify the periods with pluviometric surplus or deficit, which represents phenomena with climatic risk. At the same time, the finding of a possible cyclicity of such situations, of the frequency with which they manifest and of their tendency in the studied area, has been taken into consideration.

The way in which the environment responds to the action of precipitations, either through pluviometric surplus or deficit, has allowed the introduction of some categories of vulnerability for precipitations in the analysed area, necessary in elaborating a risk management.

AKNOWLEDGEMENTS

This paper was co-financed by the European Social Fund through the Sectorial Operational Program Human Resources Development 2007-2013, project number POSDRU/89/1.5/S/63258 "Postdoctoral school for zootechnical biodiversity and food biotechnology based on the eco-economy and the bio-economy required by eco-san-genesis".

SELECTIVE REFERENCES

Sorocovschi V., 2002 – Riscuri şi catastrofe, Casa cărţii de ştiinţă, Cluj-Napoca, 55-65. (in Romanian)

Sorocovschi V., Moldovan F. and Croitoru A. E., 2002 – Perioade excedentare pluviometric în Depresiunea Transilvaniei, *Studia Universitatis „Babeş-Bolyai"*, 2, 33-38. (in Romanian)

Spânu S., 1999 – The Carpathians orographic barrage role for the air masses crossing the upper and middle Olt River, *Transylvanian Review of Systematical and Ecological Research*, 1, The Upper and Middle Olt River Basin, Sîrbu et al. (eds), Sibiu, 1-12.

Spânu S., 2008a – Adapting the climatic methods of rainfall analysis to the demand of environmental risk management, Proceeding of The First Conference with International Participation - Modern Technologies and Biotechnologies for Environmental Protection, Sibiu, 81-90.

Spânu S., 2008b – Drought and floods in Sibiu area - risk management, The Proceedings of the 14th International Scientific Conference "The knowledge - based organization", Sibiu, 313-320.

Spânu S. and Udrea N. M., 2011 – The identification and evaluation of some natural risks covered by insurance in a rural ecosystem, Proceeding of The 7th International Conference "Integrated Systems for agri-food production - SIPA'11", 349-353.

Udrea N. M., 2011 – The possibilities of utilizing and adapting the insurance of the rural ecosystems for the insurance of the urban ecosystems, Proceeding of the International Symposium Alma Mater, Sibiu, 1-4.

AUTHORS:

[1] *Simona SPÂNU*

simona_spanu@yahoo.com

"Lucian Blaga" University of Sibiu, Oituz Street 31, Sibiu, Romania, RO-550012.

[2] *Nicuşor UDREA*

nmudrea@yahoo.com

"Alma Mater" University of Sibiu, Someşului Street 57, Sibiu, Romania, RO-550164.

MACROMYCETE SPECIES INCLUDED IN BERNE CONVENTION APPENDIX I, IN THE RED LIST FOR ROMANIA, AND RARE PRESENCE IN HISTORICAL MARAMUREŞ AREA (ROMANIA)

Marta BÉRES [1]

KEYWORDS: Romanian Red List, new and rare macromycetes, Maramureş.

ABSTRACT

The research area lies in the north of Romania, named Historical Maramureş, on the south bank of the Tisa River. It is 3375.16 km^2 in area.

From the geographical point of view, it encloses the Maramureş Depression and surrounding mountains, with altitudes between 204 m and 2,305 m.

The protection of macromycetes has become a vital issue nowadays. Based on the criteria of the International Union of Nature Conservation (IUCN), 33 species of endangered European macromycetes have been included into the Berne Convention Annex, of which 11 species are to be found in Romania, and two species in the Historical Maramureş.

Based on their own studies, Tănase and Pop (2005) have made up a Red List of rare macromycetes, endangered and very vulnerable in Romania. Out of the 179 species to be found on the list, 22 species have been also identified in our research area.

A list of very rarely found species is also presented (13 species) as well as a list containing the very first findings (six species) in this studied Maramureş area.

The presented naturalized mushrooms are deposited in the collection of the Maramureşului Museum in Sighetu Marmaţiei Section of Natural Sciences.

Causes of the imminent endangering are shown, together with our suggestions for the protection of macromycetes in the studied territory.

REZUMAT: Specii de macromicete incluse în Convenţia de la Berna Anexa I, pe lista roşie propusă pentru România şi cu prezenţă rară în Maramureşul istoric (România).

Terenul cercetat se află în Nordul României, numit Maramureşul istoric, este situat la sud de râul Tisa şi are o suprafaţă de 3375,16 km².

Din punct de vedere geografic cuprinde Depresiunea Maramureşului şi munţii înconjurători, între 204 şi 2.305 m altitudine.

Pe baza criteriilor UICN au fost incluse în Anexa I a Convenţiei de la Berna 33 de specii de macromicete periclitate în Europa, dintre care 11 specii sunt semnalate şi în România, iar dintre ele, două specii se întâlnesc şi în Maramureşul istoric. Pe baza unui studiu amănunţit, Tănase şi Pop (2005) au întocmit Lista Roşie a macromicetelor din România. Dintre cele 179 de specii din această listă, până în prezent am identificat 22 de specii şi pe terenul cercetat de noi.

Se mai prezintă tabelul speciilor rar întâlnite (13 specii), precum şi cele de primă semnalare în ţară (şase specii) din zona cercetată a Maramureşului.

Ciupercile naturalizate sunt păstrate în colecţia Muzeului Maramureşului Sighetu Marmaţiei secţia Ştinţele Naturii.

În lucrare se mai arată cauzele periclitării ciupercilor şi propuneri pentru ocrotirea macromicetelor din teritoriul studiat.

ZUSAMMENFASSUNG: Großpilze gelistet in Anhang I der Berner Konvention und erfasst in der für Rumänien vorgeschlagenen Roten Liste, die in der historischen Maramuresch selten vorkommen.

Das untersuchte Gebiet liegt im Norden Rumäniens, in der historischen Provinz Maramureșch, südlich des Tisa/Theiß Flusses und umfasst eine Fläche von 3375,16 km².

Verwaltungsmäßig gehört es zum nördlichen Teil des Kreises Maramureșch, von seiner geographischen Lage her umfasst es die Senke der Maramureșch/Depresiunea Maramureșului und die umliegenden Berge in Höhenlagen von 204-2.305 m.

Unter Berücksichtigung der IUCN-Kriterien wurden 33 in Europa gefährdete Arten von Makromyzeten in die Anhang I Liste der Berner Konvention aufgenommen, von denen 11 Arten auch in Rumänien vorkommen. Zwei davon wurden auch in der historischen Maramureșch festgestellt. Aufgrund einer umfassenden Untersuchung stellten Tănase und Pop (2005) eine Rote Liste der Makromyzeten/Großpilze Rumäniens zusammen. Von den 179 darin erfassten Arten wurden 22 auch in unserem Untersuchungegebiet festgestellt.

Hinzu kommen weitere 13, im Gebiet seltene Arten sowie sex zum erstenmal für Rumänien aus der Maramureșch gemeldete Arten.

Die präparierten Pilze werden in den Sammlungen des Museums der Maramureșch in Sighetul Marmaţiei, Naturwissenschaftliche Abteilung aufbewahrt.

Weitere Ausführungen betreffen die Ursachen der Gefährdung von Pilzen sowie auch Vorschläge für den Schutz der Makromyzeten im Untersuchungsgebiet.

INTRODUCTION

The studied area is in the northern Romania, called the historical Maramureş and it is situated south of the Tisa River, having a 3375.16 km² area. From an administrative point of view, it occupies the northern Maramureş county. Geographically, it includes the Maramureş Depression and the surrounding mountains, respectively the mountains of Maramureş, Rodnei, Ţibleş, Gutâi, Igniş with the Maramureş volcanic plateau and lower formations: hills, along the valleys, and strips of fields. The geological substrate is composed of sedimentary, metamorphic and volcanic rocks, which formed different types of soils. The historical Maramureş belongs to a moderate-continental climate, the weather too, varies by altitudinal relief. The average annual temperature in the low depression is 8°C, and respectively 2°C in the high mountainous area. Annual rainfall is between 800 mm and 1,400 mm (in the high mountains). (Chiş, 2008; Iştvan and Chiş, 2011) Local vegetation varies with altitude: alpine, with dwarf bushes, short grassland, taller bushes in the subalpine level, glade of spruce limit, the boreal forest floor of *Picea abies* or associated with *Fagus sylvatica*, the nemoral forest floor of *Fagus sylvatica* and *Quercus petraea* in the undergrowth below, within the forest there are secondary grasslands formed by deforestation. Occasionally, there are plant species belonging to azonal vegetation (wetlands, salty, rocky, limestone, acid vegetation). Maramureş has optimal habitats for the formation and development of macromycetes in diverse species.

MATERIAL AND METHODS

The present material is based on observations, field collections and macromycetes preparations carried out by the author between 1977-2009 in the researched area in historical Maramureş. The collected macromycetes were determined macroscopically and microscopically in laboratory by using different chemical substances. Some critical species were revised or determined by famous mycologists, their initials being included in the text in each case. The following abbreviations were used: N = North, S = South, E = East, W = West, alt. = altitude,

val. = valley, m. = meter, exp. = exposure, inv. no. = inventory number, obs. = observed, det. = determined, rev = revised, R. B. P. R. = Biological Reserve Pietrosul Rodnei, P. N. M. M. = Natural Park of Maramureş Mountains, L. A. = L. Albert, M. B. = M. Béres, K. L. = K. László, D. P. = D. Pázmány.

For fungi-documentary material preparation, the Herpell method improved by Bohus was primarily used and at times the dehydration method was used as well. The prepared macromycetes are kept in the Maramureş Museum, Department of Natural Sciences in Sighetu Marmației. Most of the rare specimens were photographed in situ and also from preparations. For the macromycetes determination the author used the special determination keys published by following authors: Alessio, 1969; Bellu, 1982; Cetto, I-IV 1979; Hollós L., 1904, 1911; Michael/Hennig/Kreisel I and VI 1971 and 1975; Moser, 1978; Pázmány, 1985a, b, 1998; Rimóczi and Vetter, 1990; Sălăgeanu and Sălăgeanu, 1985.

The macromycetes from historical Maramureş area presented in this paper are listed to the alphabeticaly on scientific denominations. The lists contain the following data: scientific denomination of the species, endangered category, location, habitat, altitude, exposure, sampling date, inventory number and initials of the person who determined or revised the species.

RESULTS AND DISCUSSION

Suitable ecological conditions in the study area have ensured the development of various and rich species of macromycetes, according to our knowledge so far. Protecting the fungi means protecting biodiversity and vice versa.

On the basis of International Union of Conservation Nature (IUCN), studied categories were established in terms of threat to fungi in Europe, with the aim of determining priority to their protection. The categories are: Critically Endangered – CR; Endangered – EN, Vulnerable – VU, Near threatened – NT, Data Deficiencies – SD.

According to Berne Convention, Appendix I., 33 endangered species of macromycetes of Europe were included, 11 species being reported in Romania, two of them were recorded in historical Maramureş area:

1. *Gomphus clavatus* (Pers.: Fr.) Gray – NT – Sighetu Marmaţiei, Chişdâmb Forest, mixed forest of beech and spruce planted, 740 m alt., W exp., 24.IX.1977, inv. n. 1731/31, leg. M. B., det. K. L.

2. *Hygrocybe calyptriformis* (Fig. 1). (Berk. and Broome) Fayod. They are included in the National Red List, and therefore are included in the list below.

– Sighetu Marmaţiei, Bârlan, grassland, 800 m alt., N exp., 21.IX.1985, inv. n. 3911-8913/1211-1213.
– Bocicoiu Mare, Dealul Dobăieşi, among grassland, 300 m alt., S exp., 08.IX.2005, obs/det: M. B.

Figure 1: *Hygrocybe calyptriformis*.

Based on a detailed review of the data regarding the macromycetes known in Romania according to the criteria established by the IUCN, Mr. Tănase C. and Mrs. Pop A., in 2005, prepared and submitted to regulation the Red List of macromycetes in Romania. Out of a total of 179 species found on this list, we have identified so far the existence of 24 species in the land researched in the historical area of Maramureş.

The following species of macromycetes from the list that have been identified in Historical Maramureş area, and the localities where them were found, are listed below:

1. *Albatrellus cristatus* (Fig. 2) (Pers.: Fr.) Kotl. and Pouz. – CR −

Figure 2: *Albatrellus cristatus.*

– Strâmtura, Carpino-fagetum, on the ground, 400 m alt., NW exp., 07.VIII.1979, inv. n. 1705/5, leg/det. M. B.
– Bârsana – Secătura, oakwood, on soil, alt. 450 m., exp. S, 14.VIII.1981, inv. n., 2109/409, leg/det. M. B.
– Săpânţa, Nireş Valley, in a beech forest, on wet soil, 600 m. alt., leg/det. M. B.
– Munţii Rodnei, R. B. P. R., mixed forest (beech and spruce), 800 m. alt., N exp., 01.IX.1993, leg/det. M. B.

2. *Amanita caesarea* (Fig. 3) (Scop.: Fr.) Pers. − VU −

Figure 3: *Amanita caesarea*.

− Rona de Sus – Coştiui, Dealul Cugli, *Quercus petraea* woods with *Quercus cerris*, on the ground, 500 m alt., S exp., 18.VIII.1981, inv. n. 2142/442, leg/det. M. B.

− Bârsana-Secătura, Dealul Măgura in Valea Morii, oak with hornbeam forest, on the soil, 350-400 m alt., E exp., 21.VIII.1986, inv. n. 2144/444; and observed in: 16.VIII.1987; 13.VIII.1995; 01.VIII.1997; 17.X.2001, leg/det. M. B.

− Bârsana-Năneşti, was originally a forest of *Quercus petraea*, after deforestation it was planted with *Pinus sylvestris* and *Robinia pseudacacia*, 500 m alt., S exp., steep slopes, 17.VII.1992, inv. n. 2145/445, leg/det. M. B.

− Bârsana-Valea Muntelui, the edge of the forest of *Quercus petraea*, 500 m alt., S exp., inv. n. 2146/446, leg/det: M. B.

3. *Amanita regalis* (Fig. 4) (Fr.) Michael − NT –

Figure 4: *Amanita regalis*.

− R. B. P. R. − Izvorul Dragoş Valley, spruce forest, under an alone *Picea abies* in the pasture above the laboratory house, 1,300 m alt., W exp., 16.VII.1985, inv. 3960/1260; 3961/1261, leg. M. B. rev. K. L.

4**.** *Boletus appendiculatus* Sch. − NT − Sighetu Marmaţiei - Bârlan, grassland with scattered beeches, 700 m alt., NE exp., 24.VIII.1982, inv. n. 2297-2298/597-598, leg. M. B. rev. K. L.

5**.** *Boletus quélétii* Schulz – VU − − Ocna Şugatag − Pădurea Crăiască, forest with sessile and oak, 500 m alt., NE exp., 24.VIII.1984, inv. n. 2589-2590/889-890, leg. M. B., det. K. L.

− Bârsana, Valea Morii, forest of oak with hornbeam, 400 m alt., exp., 31.VII.1986, inv. n. 3979/1279, leg/det. M. B.
− Săpânţa − Livada, forest of oak with sessile, 300 m alt., N exp., 26.IX.1994, inv. n. 20,043/1343, leg/det: M. B.

6. *Catathelasma imperiale* (Fig. 5) (Quél.) Sing. – VU −

Figure 5: *Catathelasma imperiale.*

− Sighetu Marmaţiei − Strunga Ţiganului, mixed forest, 830 m alt., N exp., 24.IX.1977, inv. no. 1785/85, and also there in 13.IX.1980, no. inv. 1976/276, leg/det: M. B.

7. *Choiromyces venosus* (Fig. 6) (Fr.) Th. M. Fr. – VU –

Figure 6: *Choiromyces venosus.*

− Sighetu Marmaţiei, Piatra Şărămpoului, forest floor, after *Fagus sylvatica*, young plantation of *Picea abies*, forest road, 950 m alt., VW exp., 12.IX.1980, inv. no. 2118/418, leg/det: M. B.

− Vadul Izei, valley of brook Şugău, glade with *Quercus petraea*, clay soil, 600 m alt., S exp., 12.IX.1982, obs./det. M. B.

8. *Cortinarius praestans* (Fig. 7) (Cordier) Gill. – NT –

Figure 7: *Cortinarius praestans.*

− Bistra, Mocnaţi, sessile forest, 800 m alt., S exp., 25.VIII.1979, inv. n. 1874/174, leg/det. M. B.

− Rona de Sus-Coştiui, Seneş, beech and oak mixed forest, 600 m alt., E exp., 20.VIII.1981, inv. n. 2186/486, led/det: M. B.

9. *Grifola frondosa* (Fig. 8) (Dicks.: Fr.) Gray – NT –

Figure 8: *Grifola frondosa*.

− Rona de Sus, Dealul Hera, evergreen on oak, 600 m alt., S exp., 17.IX.1981, inv. n. 2213/513, leg/det: M. B.

− Ocna Şugatag, Pădurea Crăiască, oak grove and hornbeam, 500 m alt., SW exp., 28.08.1981, obs/det: M. B.

10. *Gyromitra infula* (Fig. 9) (Schaeff.: Fr.) Quél. – NT –

Figure 9: *Gyromitra infula.*

− Săpânţa, Colibi, mixed forest, on rotten trunk of spruce, 900 m alt., E exp., 12.X.1984, inv. n. 2698/998, leg/det: M. B.
− R. B. P. R.:
a./ Moisei, spruce forest, 1,300 m alt., SE exp., 03.IX.1983, inv. n. 2570/870
b./ Săcel Muntele Celaru near Tăul Muced, spruce area, on the wood in the ground, 1,400 m alt., SE exp., obs/det: M. B.
− Sighetu Marmaţiei, Strunga Ţiganului Forest, under planted spruce, 850 m alt., N exp., 07.VIII.1992, obs/det: M. B.

11. *Hydnellum suaveolens* (Fig. 10) (Scop.: Fr.) Karst. – NT –

Figure 10: *Hydnellum suaveolens*.

− Sighetu Marmaţiei, Strunga Ţiganului mixed forest, on soil under young spruce, 850 m alt., NW exp., inv. n. 20.05/1315, leg/det: M. B.

12. *Hygrophorus russula* (Schaeff.: Fr.) Quél. – NT −

− Sighetu Marmaţiei, Dealul Solovan, *Quercus petraea* forest, 400 m alt., N., 04.IX.1978, inv. n. 1752/52, leg/det: M. B.

− Rona de Sus − Coştiui, Dealul Cugli, forest with hornbeam and oak, 450 m., E exp., 05.IX.1980, obs/det: M. B.

− Bistra-Tocarnea, hardwood forest on the ground, 800 m alt., W exp., 15.VIII.1981, obs/det: M. B.

13. *Mutinus caninus* (Fig. 11) (Huds.: Pers.) Fr. – NT –

Figure 11: *Mutinus caninus*.

− Bistra, Mocnaţi, beech and hornbeam forest, on the ground, 800 m alt., W exp., 27.IX.1984, inv. n. 3892/1192, leg/det: M. B.

− Deseşti, Muntele Ştedea, beech forest, 1,000 m alt., SE exp., 27.VIII.1984, obs: M. B.

14. *Nyctalis asterophora* (Fig. 12) FR. – NT –

Figure 12: *Nyctalis asterophora*.

− Bistra, Toştei Forest, on a decaying mushroom hat, 800 m alt., W exp., 24.VIII.1979, inv. n. 1782/82, leg/det: M. B.:

− Ocna Şugatag, Pădurea Crăiască, on rotten *Russula* sp., 500 m alt., SW exp., 18.IX.1980, obs./det. M. B.

15. *Strobilomyces strobilaceus* (Scop.: Fr.) Berk. - NT
− Onceşti, Creasta Văratec, meadow, under *Corylus avellana*, 1 specimen, 500 m alt., SE exp., 18.VIII.1979, inv. n. 1875/175, leg/det. M. B.

16. *Suillus grevillei* (Klotsch in Fr.) Sing. − VU − in larch plantation:
− Sighetu Marmaţiei: Câmpu Negru, 300 m alt., exp., 05.IX.1977, no. inv. 1878/178; Dealul Dobăieş, 500 m alt., E exp., 22.VIII.1983, no. inv. 2433/733, leg/det: M. B.
− Rona de Sus-Coştiui, 300-500 m alt., NE exp., 09.IX.1978, no. inv. 1881/181, leg/det. M. B.
− Ocna Şugatag, Pădurea Crăiască, 500 m alt., SW exp., 05.VIII.1978, obs/det: M. B.

17. *Suillus plorans* (Roll.) Sing. – VU –
− R. B. P. R., La Gropi, under *Pinus cembra*, 1,700 m alt., E., exp., 05.VIII.1982,

18. *Tremiscus helvelloides* (DC.: Fr.) Donk. – NT

19. *Tricholoma orirubens* Quél. – N. T.

− Săpânţa, valley of tream Săpânţa, beech forest, 400 m alt., exp., 02.IX.1990, inv. n. 3941/1241, leg. C. Albu, det. B. M.
− Bistra, Dealul Hera, beech forest, 500 m alt., SE exp., 06.IX.1991, inv. n. 3983/1283, leg/det. M. B.

− Mara, Munţii Gutâi, near national highway 18, 1,000 m alt., N exp., 12.IX.1983, inv. n. 2432/732, leg. L. Varga, det. M. B.
− Vadul Izei-Valea Stejarului, 400 m alt., S., exp. 18.IX.1984, inv. n. 2431/731, leg/det: M. B.
− Moisei, R. B. P. R., Dragoş Valley, 780 m alt., N exp., near the forest planted in *Larix decidua*, near the forestier´s cabin, 26.IX.1993, obs/det. M. B.

inv. n. 2235-2236/535-536, leg/det: M. B., rev. K. L.

− R. B. P. R., Izvorul Fântânii Valley, 830 m alt., W exp., on the ground among *Petasites* sp., in groups, 01.IX.1993, obs/det. M. B.
− Bistra, Dealul Hera, beech forest, on the soil, 650 m alt., N exp., 18.X.1984, inv. n. 3751/1051, leg/det. M. B.

20. *Volvariella bombycina* (Fig. 13) (Schff.: Fr.) Sing. – VU –

Figure 13: *Volvariella bombycina*.

− Ieud, Idişor Brook valley, on *Salix* sp. in hollow on the banks, 15.VII.2004, obs/foto/leg. M. B.

21. *Xerocomus parasiticus* (Fig. 14) (Bull.: Fr.) Quél – VU –

Figure 14: *Xerocomus parasiticus*.

− Călineşti-Văleni, Măgura Vălenilor, on *Scleroderma citrinum* on the soil clay, 400 m alt., 08.X.1996, foto, leg/det: M. B.

Besides the macromycetes mentioned above, other species which were **firstly signaled** in the country over the collecting period and others that were rarely observed untill now in the studied territory and stocked in collections are also listed below.

All the first mentioned macromycetes in the country are gathered in the historical Maramureş area:

1. *Limacella furnacea* (Fig. 15) (Let.) R. Mre

Figure 15: *Limacella furnace*.

− Sighetu Marmaţiei, in art gallery, near the wall of beech parquet, 04.VIII.1987, inv. n. 20.033/1331, leg. M. B. det. D. P. (in Not. Bot. Agrobot., 1988-1989).

2. *Omphalina discorosea* (Fig. 16) (Pilát) Herink and Kotl.

Figure 16: *Omphalina discorosea*.

− Bârsana, Dealul Hera, 600 m alt., S exp., on rotten beech trunk, numerous linear specimens, 05.X.1981, inv. n. 2396-2398/696-698, and was also there in 19.IX.1982, inv. n. 2399/699. After that date it was no longer found. Leg. M. B. det. K. L.

3. *Pluteus variabilicolor* Babos (Fig. 17)

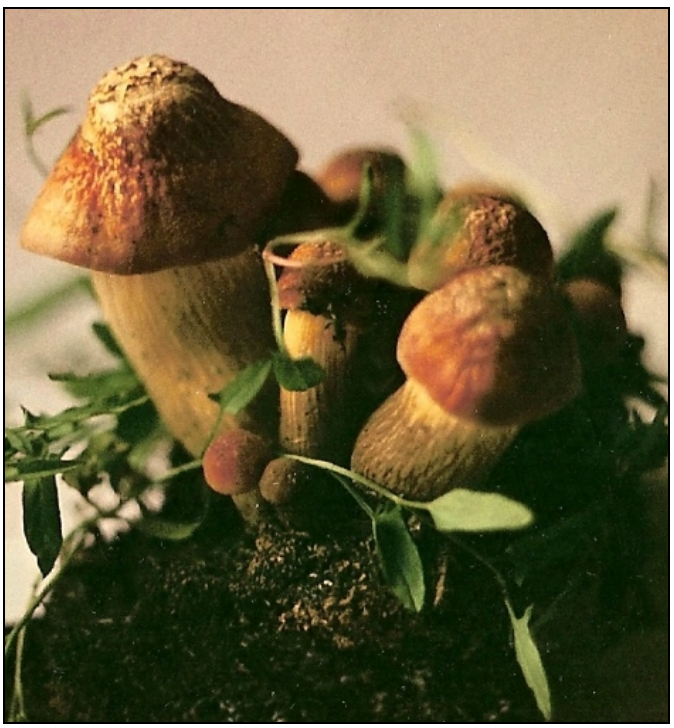

Figure 17: *Pluteus variabilicolor*.

− Sighetu Marmaţiei, near Tisa River dam, ruderal place much sawdust on the floor, 272 m alt., 20.VIII.1980, inv. n. 2011/311; 703 – 706/2403 – 2406, leg. M. B., det. Margit, Babos.

4. *Pulveroboletus lignicola* (Kallenb.) Pilát (Fig. 18),

Figure 18: *Pulveroboletus lignicola*.

− Moisei, R. B. P. R., Dragoş Valley, 1,300 m alt., W exp., spruce wood, on rotting conifer stumps, 2 specimens, 17.VIII.1985, inv. n. 3908/1208., leg. M. B. rev. L. K.

5. *Pholiota nana* E. Horak (Fig. 19)

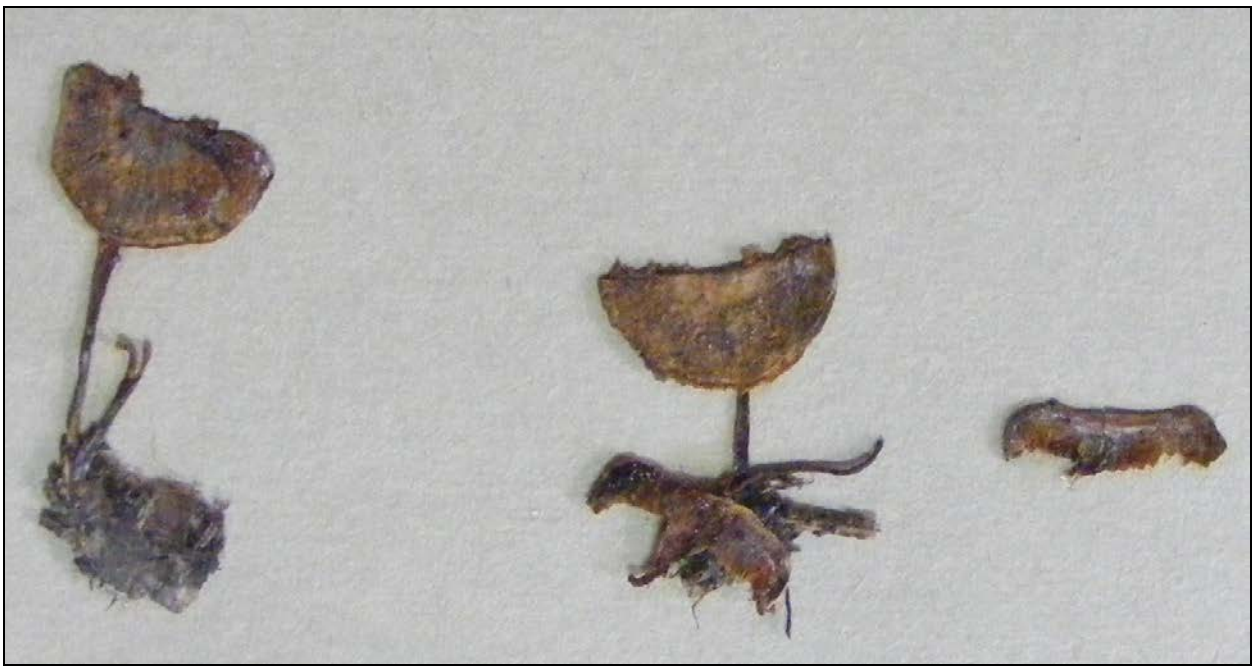

Figure 19: *Pholiota nana*.

− Borşa, R. B. P. M., Zănoaga Mare, 1,700 m alt., WE exp., coniferous wood-edge, 27.VIII.1984, inv. n. 3977/1277, leg. M. B. det. Margit. Babos.

6. *Anthurus archeri* (Berk.) Fischer – NT – (Fig. 20)

Figure 20: *Anthurus archeri*.

− Sighetu Marmaţiei, Iapa District, among the grassland, 400 m alt., NE exp., 23.VIII.1993, inv. n. 20.041, leg/det. M. B. - Săpânţa - Jilerescu, swamp, on the anthill with *Vaccinium vitis-idaea, Carex* sp., 800 m alt., 28.VII.1993, obs/det. M. B.

− Sighetu Marmaţiei: Dealul Solovan, among of *Scirpus sylvaticus*, 600 m alt., S exp., 01.X.1996, and in forest of *Quercus petraea* with *Carpinus betulus*, 550 m alt., N exp., 01.X.1996;

− Bârsana-Secătura, Preluca Mejdii, pasture hygromesophil, among moss and *Colchicum autumnale*. 900 m alt., E exp., 08.X.1996, obs/det. M. B.

− Vadul Izei-Valea Şugău, wet meadow, 400 m alt., NW exp., 30.IX.2001, leg. I. Măran det. M. B.

− Bocicoi, fruit-garden, in grassy place, 2006.X., leg. Huzum, Magdalena, det. B. M.

− Sighetu Marmaţiei, Mociar, Ronişoara Valley, underbrush of oak with hornbeam, 300 m alt., 29.VII.2008, obs/det. M. B.

Other **macromycetes with rare presence** in the historical Maramureş area:

1. *Boletus rhodopurpureus* Smotl. (Fig. 21)

Figure 21: *Boletus rhodopurpureus*.

− Bârsana, Dealul Măgura in valley of Morii Brook, 350 m alt., E exp., *Quercus petraea* forest, on steep slope and oak wood, on soil, 21.VIII.1986, inv. n. 3980/1280, leg. M. B. det. L. A.

2. *Caloscypha fulgens* (Pers.) Boud. (Fig. 22)

Figure 22: *Caloscypha fulgens*.

− Sighetu Marmaţiei, Strunga Ţiganului, 900 m alt., N exp., on the ground among fallen needles, 25.V.1980, inv. n. 2162/462, leg/det. M. B. rev. K. L.

− Moisei, R. B. P. R., 1,100 m alt., N exp., on the ground among conifer needles, 27.V.1987, inv. n. 20.033/1333, leg. S. Horj, det. M. B.

3. *Clavariadelphus pistillaris* (Fr.) Donk

− Sighetu Marmaţiei, Strunga Ţiganului Forest, 800 m alt., NE exp., 13.IX.1980, inv. n. 263, leg/det. M. B.

4. *Macrolepiota fuligineosquarrosa* sensu Pázmány non Malençon (Fig. 23).

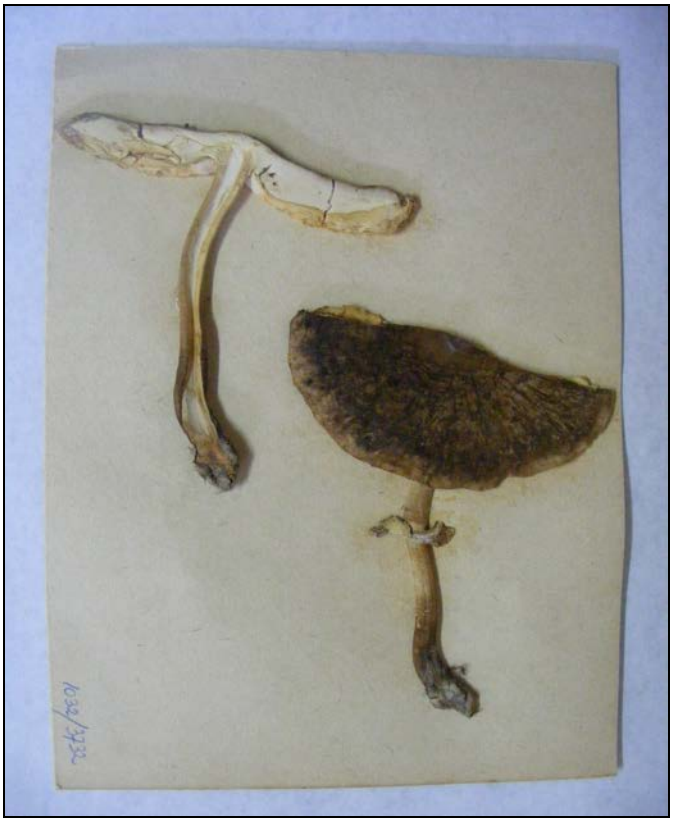

Figure 23: *Macrolepiota fuligineosquarrosa*.

− Vadul Izei, Valea Stejarului, 300 m alt., NW exp., grassland, 02.XI.1984, inv. n. 3732/1032, leg/det. M. B., rev. D. P.

5. *Macrolepiota subsquarrosa* ss. non Pázmány (Lasq.) Bon. (Fig. 24)

Figure 24: *Macrolepiota subsquarrosa*.

− Bârsana, Valea Caselor, 550 m alt., N exp., glade, among grassland, 12.IX.1985, inv. n. 3740/1040, leg. M. B., det. D. P.

6. *Melanogaster broomeanus* Berk. (Fig. 25)

Figure 25: *Melanogaster broomeanus*.

− Sighetu Marmaţiei, Dealul Solovan, 600 m alt., S exp., valley of brook Someş, under mosses and herbaceous laver under *Corylus avellana*, 10.IX.1981, inv. n. 3928/1228, leg. R. Szálka and M. B., det. D. P.

7. *Melanoleuca brevipes* sensu Lange (Fig. 26)

Figure 26: *Melanoleuca brevipes*.

− Sighetu Marmaţiei, 260 m alt., at the outskirts of the town, ruderal place, much sawdust, large groups, 24.IV.1983, inv. n. 2511-2522/811-822, leg. M. B., det. K. L.

8. *Mitrula paludosa* Fr. (Fig. 27)

Figure 27: *Mitrula paludosa*.

− Moisei, R. B. P. R., Izvorul Verde Forest, 1,400 m alt., SW exp., spruce forest, on fallen needles and cones in smoothly flowing water, 20.VII.1986, and observed in a backyard laboratory in a watery area, 1,300 m alt., 17.VII.1988, inv. n. 3943/1243, leg /det: M. B.

9. *Omphalotus olearius* (DC.) Singer (Fig. 28)

Figure 28: *Omphalotus olearius*.

− Sighetu Marmaţiei, Dealul Bagna, Urdea's garden, 300 m alt., NW exp., orchard, on rotten wood, 17.VIII.1980, inv. n. 2004/304, leg/det. M. B.

10. *Pseudoplectania nigrella* (Pers.: Fr.) Fuck

− Sighetu Marmaţiei, Agriş, 680 m alt., N exp., among moss under planted *Picea abies*, 17.IV.1983, inv. n. 2458/758, leg/det. M. B., rev. K. L.

11. *Spathularia flavida* Pers.

− Rona de Sus − Coştiui, Dealul Cugli, 430-570 m alt., NE exp., under *Larix decidua*, 05.VIII.1979, inv. n. 1702-1703/2-3, leg/det: M. B.

− Moisei, R. B. P. R., 800 m. alt., N exp., beech forest mixed with spruce needles fallen among some specimens, 01.IX.1989, inv. n. 2070/370, leg/det. M. B.

12. *Urnula craterium* (Schw.) Fr.

− Ocna Şugatag, Pădurea Crăiască, 450 m alt., SW exp., oak forest, on fallen branches covered with soil, inv. n. 2034/334, leg. M. B., det. K. L.

− Rona de Sus, Pădurea Ronişoara, 500 m alt., SE exp., *Quercus petraea* forest, a rotten branch on ground, 12.V.1984, inv. n. 2455/755, leg/det: M. B. rev. K. L.

13. *Phaeolepiota aurea* (Matt.: Fr.) Mre. is a species more frequently met in the mountainous regions in historical Maramureş, however we consider its inventory is necessary, being proposed for the mapping of this species in Europe. In the studied territory it was signaled in the following places:

− Bistra, Luhei Valley, 400 m alt., NW exp., near and among *Alnus glutinosa*, *Urtica dioica*, 22.VIII.1976, inv. n. 1828/128, and 01.IX.1989, inv. n. 3936/1236, leg/det: M. B.

− Bistra, Polonenca Mountain, 1,300 m alt., S exp., pasture, including *Urtica dioica*, 20.IX.1986, inv. n. 3933-3935/1233-1235, leg/det. M. B.

− Remeţi, Cărbunăreşti Valley, 300 m alt., NW exp., under alder trees near the creek, 17.X.1984, inv. n. 2691/991, leg/det. M. B.
− Săpânţa, valley of stream Săpânţa, 700 m alt., N., *Fagus sylvatica* forest, near shore, 01.IX.1990, inv. n. 3937-3938/1237-1238, leg/det. M. B.

− Vişeu de Sus, P. N. M. M., Bardău Valley, 900 m alt., V exp., in grass roadsides making up linear groups, 07.VI.2007, obs. M. B.
− Poienile de sub Munte, P. N. M. M., Rica Valley, 900 m alt., W exp., near the forest road, leg. I. Pop, det. M. B.

The macromycetes from Maramureş area are exposed to different types of hazard caused by humans and nature, which are largely identical to those in the other countries. The Maramureş's macromycetes threats are: conversion and habitat destruction; deforestation; disappearance of old trees; increasing land settlements and infrastructure development; excessive and improper collection of macromycetes; lack of information materials on the macromycetes role in biodiversity.

We underline some proposals to conserve the macromycetes: publication of information materials for understanding the macromycetes; prohibiting the collection of mascromycetes in the natural reserves; promoting good forestry practices to protect areas of threatened or rare species with vigorous populations, for example: Bârsana − Dealul Măgura for *Amanita caesarea*; restriction of collecting in qualitative terms (after the release of the spores) and recommendation of ways of collection; educating local communities, and the youth, introducing topics in the curriculum with the purpose of protecting macromycetes.

CONCLUSIONS

The purpose of this study was to complete the national inventory and database of macromycetes species considered threatered and those requiring urgent protection at national and local levels and also to contribute to the ongoing knowledge and supplement to the National Red List Macromycetes.

In this paper two species of macromycetes considered endangered in Europe included in the Bern Convention Appendix I were reported, also 24 species listed in the National Red List as well, 5 species were first documented in Maramureş and 13 species of rare macromycetes in Maramureş were mentioned until now.

It is necessary to take measures to protect the habitats where dense populations of endangered mushrooms are reported and to limit the collecting activities in order to assure the preservation of biodiversity.

ACKNOWLEDGEMENTS

With all due respect, the author transmits a great deal of gratitude and expresses thanks for the help with the material's review and in some cases, with the determination of macromycetes to Albert L., Babos M., László K. and Pázmány D., for the review work of Negrean G., and photographing fungi of Béres I. and Manole M. G.

SELECTIVE REFERENCES

Alessio C. L., 1969 – Boletus Dill. ex L. Fungi Europaei, Libreria Edit. Biella Giovanna, Saronno, 705. (in Italian)

Bellu F., 1982 – Contributo al genere Macrolepiota Singer 1, in *Bolletino del Gruppo micologico G. Bresadola*, trento, 100-121. (in Italian)

Cetto B., 1979 – Der Grosse Pilzführer, Band I-IV, München-Bern-Wien. (in German)

Chiş T., 2008 – Geographical background elements of the Vişeu River Basin (Maramureş, Romania), *Transylvanian Review of Systematical and Ecological Research*, 5, The Maramureş Mountains Nature Park, Curtean-Bănăduc et al. (eds), Sibiu, 1-4.

Hollós L., 1904 – Die Gasteromyceten Ungarn, Leipzig: O. Wiegel Komm., fol., 278. (in German)

Hollós L., 1911 – Magyarország földalatti gombái, szarvasgombaféléi, A. K. M. Termtud, Társulat, 247. (in Hungarian)

Iştvan D. and Chiş V. T., 2011 – Gutâi Mountains (Maramureş-Transylvania, Romania), *Acta Oecologica Carpatica*, IV, Curtean-Bănăduc (ed.) Sibiu, 1-6.

László K. and Pázmány D., 1976 – Seltene Pilze aus Rumänien, *Zeitschrift für Pilzkunde*, 42, B, 179-184. (in German)

Hennig Kreisel M., 1971-1975 – Handbuch für Pilzfreunde, I-VI. VEB. Gustav Fischer Verlag, Jena. (in German)

Pázmány D., 1985a – Die Macrolepiota-Arten in Transsilvanien (Rumänien), *Zeitschrift für Mykologie*, 51, 1, 51-60. (in German)

Pázmány D., 1985b – A Macrolepiota nemzetség európai fajainak határozókulcsa, *Clusiana. Mikol. Közl.*, 3, 115-134. (in Hungarian)

Pázmány D., 1998 – Gombahatározó, *Bon Mi Kiadó*, Sepsiszentgyörgy. (in Hungarian)

Pázmány D. and László K., 1979 – Seltene Pilze aus Rumänien II, *Notulae Boanicae Horti Agrobotanicae*, Cluj-Napoca, 10, 59-67. (in German)

Rimóczi J. and Vetter J., 1990 – Gombahatározó, I-II, *Országos Erdészeti Egyesület Mikológiai Társasága*, Budapest, I, 238, II, 473. (in Hungarian)

Sălăgeanu G. and Sălăgeanu A., 1985 – Determinator pentru recunoaşterea ciupercilor comestibile şi otrăvitoare din România, Edit. Ceres, Bucureşti, 330. (in Romanian)

Tănase C. and Pop A., 2005 – Red List of Romanian macrofungi species, Bioplatform – Romanian National Platform for Biodiversity, Bucureşti, Edit. Academiei Române, 101-107.

AUTHOR:

[1] *Marta BÉRES*

martaberes@yahoo.com

Maramureş Museum,
Nature Sciences Department,
Piaţa Libertăţii Street 15,
Sighetu Marmaţiei,
Maramureş County,
Romania,
RO-435500.

MORPHOLOGICAL VARIATION OF *CENTAUREA ATROPURPUREA* WALDST. ET KIT. SPECIES (SUBGENUS *LOPHOLOMA*) FROM TRANSYLVANIA (ROMANIA)

Ghizela VONICA[1], *Andreea TODORUŢ*[2] and *Alexandru BĂDĂRĂU*[3]

KEYWORDS: Romania, Transylvania, *Centaurea atropurpurea* species, differences.

ABSTRACT

Centaurea atropurpurea is a xeromesophyte species encountered increasingly rarely in the SW of the Transylvanian depression. The species prefers rocky areas or meadows with southern exposure and substrate rich in $CaCO_3$.

Morphological studies have revelead the existence of two different groups. One morphological group is characterized by vigour and the second morphological group presents certain characteristics different from the type of the plant.

Morphological differentiation of this species in the habitat upon which it develops highlights the adaptability of this species to certain soil conditions. This adaptation has been described by some botanists as a form of the species *Centaurea atropurpurea*. Actually morphological differentiation is given by the $CaCO_3$ content of soil, moisture and the habitat in which the species is encountered.

REZUMAT: Variaţii morfologice ale speciei *Centaurea atropurpurea* Waldst. and Kit. (Subgenul *Lopholoma*) din Transilvania.

Centaurea atropurpurea este o specie xeromezofită întâlnită tot mai rar în partea de SV a depresiunii Transilvaniei. Specia preferă zonele stâncoase sau pajiştile cu expoziţie sudică cu un substrat bogat în $CaCO_3$.

Studiile morfologice au scos în evidenţă existenţa a două grupări diferite. O grupă este caracterizată prin vigurozitate, iar cea de-a doua grupă prezintă anumite caractere diferite faţă de tipul plantei.

Diferenţierea morfologică a acestei specii, în funcţie de habitatul în care se dezvoltă, aduce în evidenţă adaptarea la anumite condiţii de sol. Această adaptare a fost descrisă de unii botanişti ca o formă a speciei *Centaurea atropurpurea*. De fapt, diferenţierea morfologică este dată de conţinutul în $CaCO_3$ al solului, umiditate şi habitatul în care este întâlnită specia.

ZUSAMMENFASSUNG: Morphologische Variationen von *Centaurea atropurpurea* Waldst. und Kit. (Untergattung *Lopholoma*) aus Transsilvanien/Siebenbürgen.

Centaurea atropurpurea ist eine xeromesophile Art, die im Südwesten der Siebenbürgischen Senke immer seltener anzutreffen ist. Die Art zieht felsige Standorte vor oder Wiesen in südlicher Hanglage auf $CaCO_3$ reichem Substrat.

Bei den morphologischen Untersuchungen wurden zwei unterschiedliche Gruppen festgestellt. Die eine Gruppe kennzeichnet sich durch kräftigen Wuchs, während die andere morphologische Gruppe einige vom Typus abweichende Charaktere aufweist.

Die morphologische Differenzierung der Art in Abhängigkeit von ihrem Lebensraum weist auf eine Anpassung an bestimmte Bodenbedingungen hin. Diese Anpassung wurde von einigen Botanikern als Form der Art *Centaurea atropurpurea* beschrieben. Tatsächlich ist die morphologische Differenzierung durch den Gehalt des Bodens an Kalziumcarbonat, eine bestimmte Feuchtigkeit und den Lebensraum gegeben, in dem die Art anzutreffen ist.

INTRODUCTION

Centaurea atropurpurea is a widespread mesoxeric species found throughout rocky places, scrubs, cracks of calcareous rocks, and on soils rich in $CaCO_3$ (5-25%), and with pH = 7.5-8.5 from the hilly areas in the mountains. It can also be seen in mesoxeric meadows with southern exposure, without the rocky substrate preferences.

It prefers *Festucetalia valesiacae* habitats Br.-Bl. and Tx. 1931 (all. Stipion lessingianae Soó 1947, assoc. Stipetum pulcherrimae Soó 1942 subassoc. Transsilvanicum Soó 1959), but is also found in limestone rockeries of *Seslerietalia rigidae* Gergely 1967 (all. Seslerion rigidae Zolyomi 1939, assoc. Seslerietum rigidae Borza 1934).

A large area with this species is in Transylvania on the SW meadows and W rocky area (Bădărău, 2011; Borza 1959; Boşcaiu and Täuber, 1985; Ciocârlan, 2009; Prodan, 1930; Prodan and Nyárády, 1964; Schneider, 1975; Vonica and Cantor, 2011, 2012; HSB) (Fig. 1).

Centaurea atropurpurea belongs to *Lopholoma* subgenus containing robust plants with few and large capitulas and pinnate-leaf side.

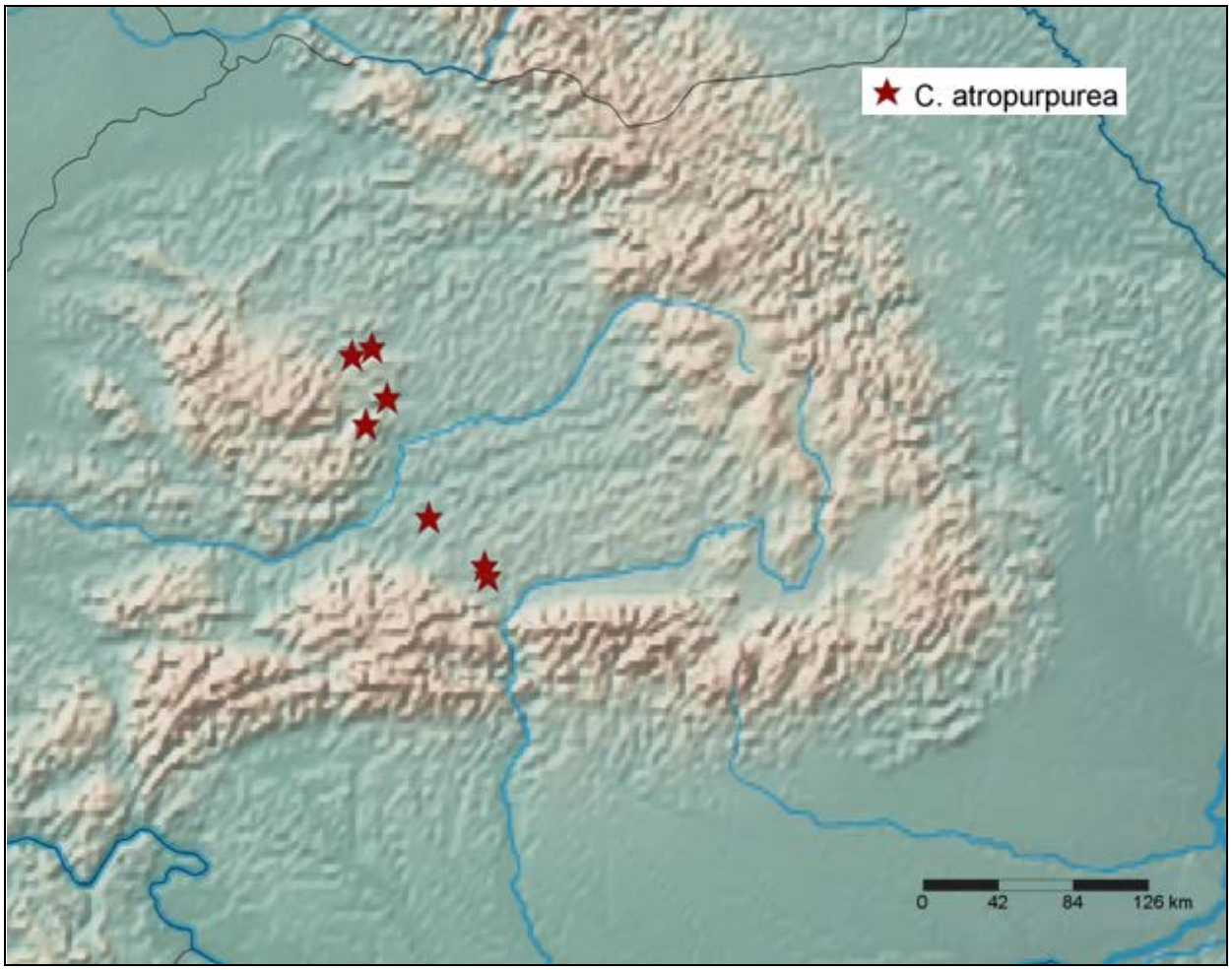

Figure 1: *Centaurea atropurpurea* distribution in Transilvania (Romania).

The subtaxons of this species are: *Centaurea atropurpurea* var. *atropurpurea* with rigid leaves, scabrous, 1-3 pinnate-section, with various forms, *Centaurea atropurpurea subalpina* form (Schur) Gugl., *Centaurea atropurpurea minima* form Borza, *Centaurea atropurpurea latisecta* form (Schur) Gugl., *Centaurea atropurpurea tenuisecta* form (Schur) Gugl., *Centaurea atropurpurea flava* form (Maly) Gugl., *Centaurea atropurpurea mixta* form Gugl. and *Centaurea atropurpurea carnea* form Gugl. (Pop, 1976).

Figure 2: Bracteal appendage of *Centaurea atropurpurea* (*Lopholoma* subgenus).

Centaurea atropurpurea var. *crassifolia* Pop and Hodişan has fleshy, smooth, shiny simple pinnate-section leaves with a single form - *integrifolia* Pop and Hodişan.

Different from other species of this genus, *Centaurea atropurpurea* makes few hybrids due to its relatively early blooming period (May-June period). The species hybridizes with *Centaurea scabiosa* ssp. *spinulosa* (*C.* X *csatói* Borb., *C.* X *atropurpurata* Prod.).

The hybrids can easily be distinguished by the shape of burrs dolls along with observations made on *Lopholoma* subgenus by Garcia-Jacas (1998).

MATERIAL AND METHODS

The morphological diversity of the *Centaurea atropurpurea* species was based on two complementary observations taken from the field and pressed plants in herbarium collections.

Morphological characteristics of this species are: floriferous stem height (FS), number of branches (NB), leafs number on the floriferous stem (LN), leaf size (LL, LW), lacinia dimensions of a measured leaf (LcL, LcW), inflorescence number (IN), inflorescence size (IL, IW), appendage size leaflets bracts (ML, MW), and achenae size (AL, AW, AP). Only one strain from each mother plant (cluster) was collected. To avoid cross-contamination of vegetative material from the same individual, 1 m was kept between individual plants. The *Centaurea atropurpurea* shows loose clusters arranged in clumps with multiple stems, each corresponding to a strain "genet".

The stem height and its branching were measured in the field or immediately after harvest if the environmental conditions were favorable. Stem height was measured from the soil surface to the first flowering branch.

The measured leaves in the study were collected from the mid-stem, measuring their length (from their point of strain insertion until their peak) and their width (the widest part of the collected leaf, including lobes). In some of the cases, some short branches were not considered because small inflorescences developed in the armpit leaves. The width and height of the inflorescence measurements were made only from the bottom of the capital to the top of the internal bracts (last series) for morphological interpretations.

If burrs (achenae) were present, they were collected too, and if they were undeveloped or with closed inflorescence, they would need to be collected from another strain of the same mother plant.

All characters were measured on plants with full development and terminal inflorescence that was undamaged or attacked by insects. Plants were then labeled, numbered, dried and used for other morphological measurements. Studied specimens are preserved in the Natural History Museum herbarium from Sibiu and will be placed in an inventory warehouse for consultation of other specialists.

Centaurea atropurpurea was collected from Turzii Gorge (Cluj County) on both sides, as well as the gorge, Lomb Mountain (Cluj County) near Cluj-Napoca, from Roşia de Secaş (Alba County) and from Guşteriţa, near Fântâna Rece (Sibiu County).

In the laboratory, morphological micro-measurements were continued (at the involucres leaflets, appendage and burrs). Involucres bracts of leaflets are placed on 4-5 rows, the most representative being the third row (the middle row). "Appendage" of involucres leaflets refers to the longest appendage of the involucres leaflets from the middle floor of the inflorescence. In the appendix width was measured only the whole part in the middle of the appendix without including the length of sidewise fimbriae (Fig. 2). On the burrs were several registered characters, width-AW, length-AL and the length doll-AP. The laboratory observations were made with the USB Digital Microscope (400X magnification), trinocular optical microscope B4 OPTECH, binocular stereo microscope (40X) and the electronic caliper.

Statistical analyses for this study were made using the PAST program - Paleontological Statistics 2.15 (Hammer, 1999-2012).

The page with the final data matrix included 12 to 15 quantitative characters and three reports with the characters' number differing depending on the burrs presence.

In the laboratory, the accuracy of measurements was rounded to two decimal places.

RESULTS AND DISCUSSION

For the statistical processing of morphometric data, multivariate analysis was used.

Basic statistical measurements (mean, median, minimum and maximum values, quartiles and standard deviation) were calculated using the PAST package that was offered. FS, LW, LL character values were transformed logarithmically in order to make their distribution more accurate.

Pearson and Spearman correlation coefficients were calculated for all pairs of character and no significant value proving correlations between characters (≥), which is why all the characters were kept in a matrix.

Morphological characters were compared using two types of analysis, the ordination method-PCA (Principal Component Analysis) and PCO (Principal Coordinates Analysis) and using the classification method-UPGMA (Unweighted Pair Group Method with Arithmetic Mean) and Wards Method.

To complete the morphological characterization of *Centaurea atropurpurea* individuals, the species was analyzed by ordination and ranking.

PCA analysis of variant-covariance matrix was calculated using PAST package.

In this analysis, the significance index Jolliffe cut-off is 0.74, which is why the first six main components are significant: (PC1-55.96, PC2-18.59, PC3-16.83, PC4-3.66, PC5-2.90, PC6-1.57) (Fig. 3).

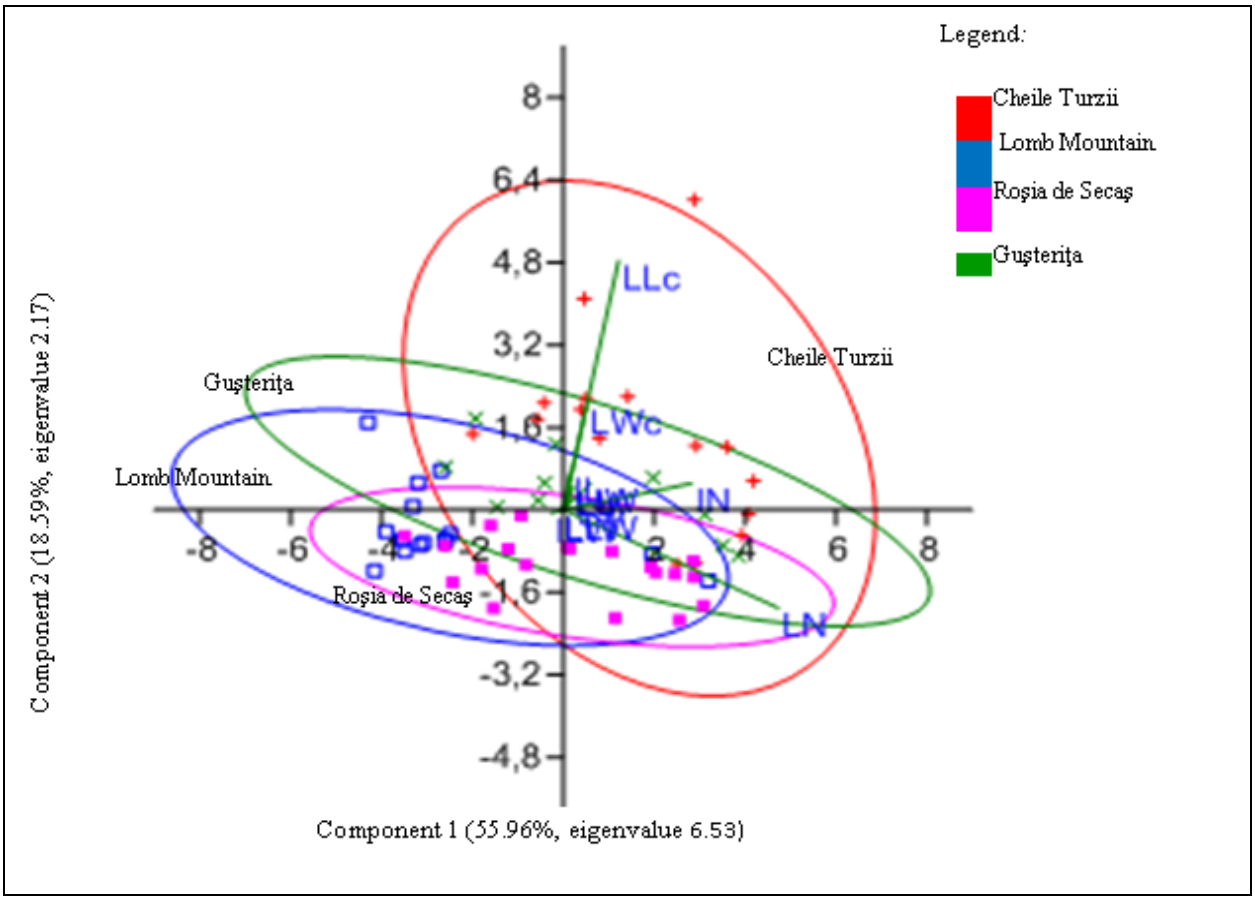

Figure 3: PCA Map computed with var-covar matrix on *Centaurea atropurpurea* species (Joliffe cut-off significance index = 0.74; confidence interval = 95%).

From the PCA analysis it can be seen that populations of *Centaurea atropurpurea* are very similar to each other with regards to the way they morph, with the exception that the population of Turzii Gorge is slightly different from the rest of the populations.

The morphological characteristics that differentiate this population from the other populations are: number of leafs per stem (LN), the number of inflorescences (IN) and the laciniae size (LLC, LWC). All these morphological characteristics are positively related along the PC1 component. If we look along the PC2 component, it can be deduced that the LN is inversely proportional to IN, LLC and LWc, and this correlation is representative for approximately 19% of individuals. The first two main components account for about 75% of the total monitored individuals. Analysis in term of PC3, PC4, PC5 and PC6 represents approximately 25% of cases and differs by about the same characters.

The other three populations are relatively similar, forming a compact group with the population of Turzii Gorges area.

We have no clue which can show us how representative this analysis is, so the morphology of this species is supplemented by other ranking analyses.

UPGMA analysis calculated by the Wards method divides all individuals of *Centaurea atropurpurea* in two groups (Fig. 4).

The two formed groups do not overlap the geographical distribution of the population of *Centaurea atropurpurea*, them being mixed groups.

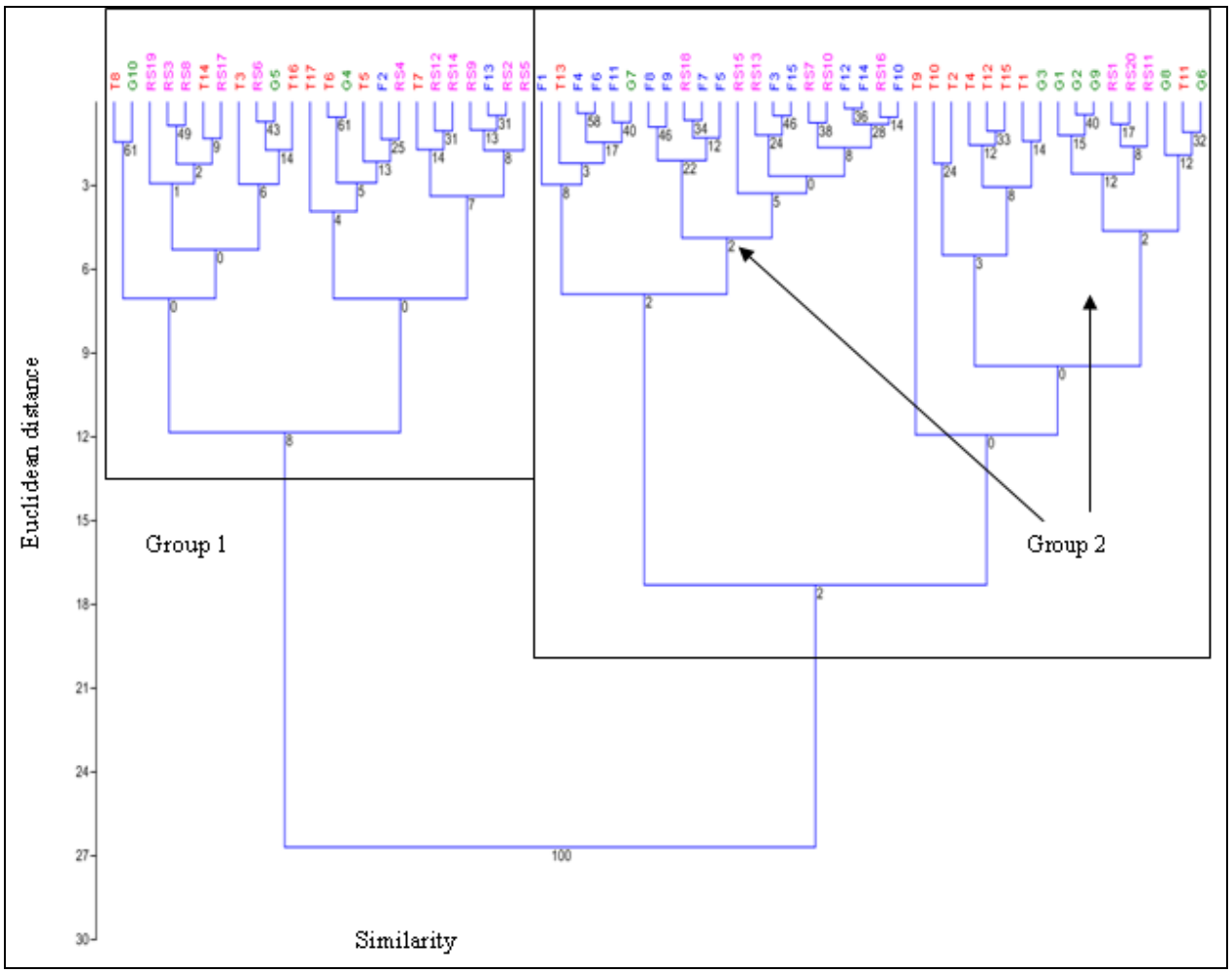

Figure 4: Ordination diagram UPGMA computed with Wards method on Euclidean distance for *Centaurea atropurpurea* (coph. corr 0.61)
(RS − Roşia de Secaş, T − Turzii Gorge, F − Lomb Mt., G − Guşteriţa).

Group 1 consists of a lower number of individuals and contains an equal amount of individuals of the four populations studied.

Group 2, clearly separated from the first group, also consists of two groups: one subgroup comprised mostly of individuals on the Lomb Hill population (F), but also from Roşia de Secaş (RS) and the second subgroup comprised mostly of individuals from Turzii Gorge (T) and to a lesser extent from individuals from Guşteriţa (G) and Roşia de Secaş (RS).

UPGMA analyses grouped individuals based on the average distance of the minimal variations between groups, but it is not known whether either of these groups are of different taxa or are only morphologically different individuals.

NJ cluster analyses group individuals of *C. atropurpurea* on lesser distances (Euclidean) of similarity (Fig. 5).

The two morphological groups formed in UPGMA analysis, are more difficult to separate by this type of analysis. Group 1 is the best defined grouping comprised mostly of individuals from Lomb Hill. This analysis shows that the population of Lomb Hill is different from the rest of the *Centaurea atropurpurea* individuals.

Both rank analyses (UPGMA, NJ) revealed a group of individuals of the Lomb Mountain, which is why, it is going to be verified with the K-means Clustering (KmC) method.

K-means clustering (KmC) checks if the *Centaurea atropurpurea* species fall into two morphological groups and whether the groups overlap the geographical area of the monitored populations (Fig. 6).

PCO chart shows that approximately 75% of the studied individuals are grouped into two morphological groups easily differentiated between them. Newly formed groups partially overlap the geographical area.

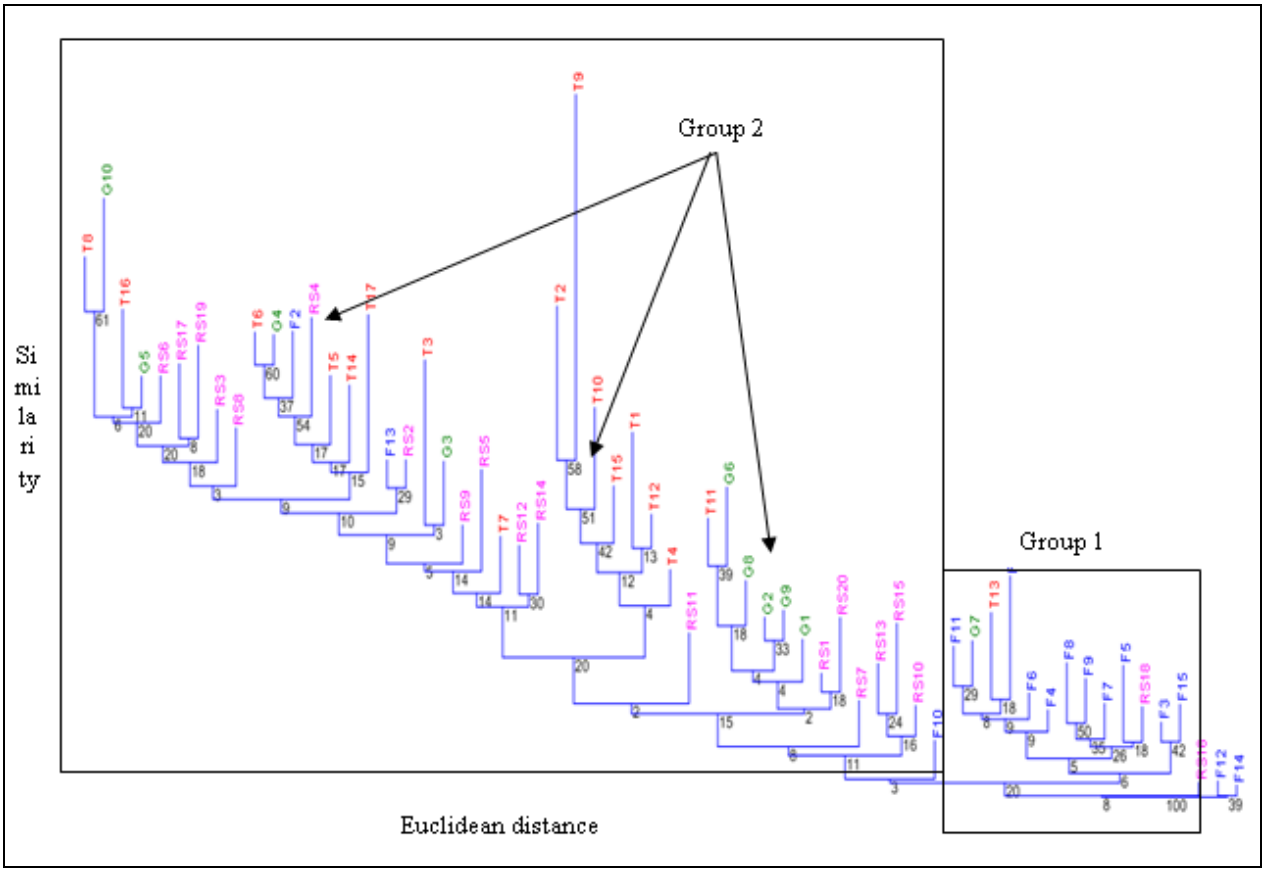

Figure 5: NJ clustering of morphological characters computed with euclidean distance similarity for *C. atropurpurea* (RS − Roşia de Secaş, T − Turzii Gorge, F − Lomb Mt., G − Guşteriţa).

Group 1 consists of individuals from Lomb Mountain and individuals from other populations, forming a mixed group.

Group 2 consists on equal distribution of individuals from Turzii Gorge, Guşteriţa and Roşia de Secaş.

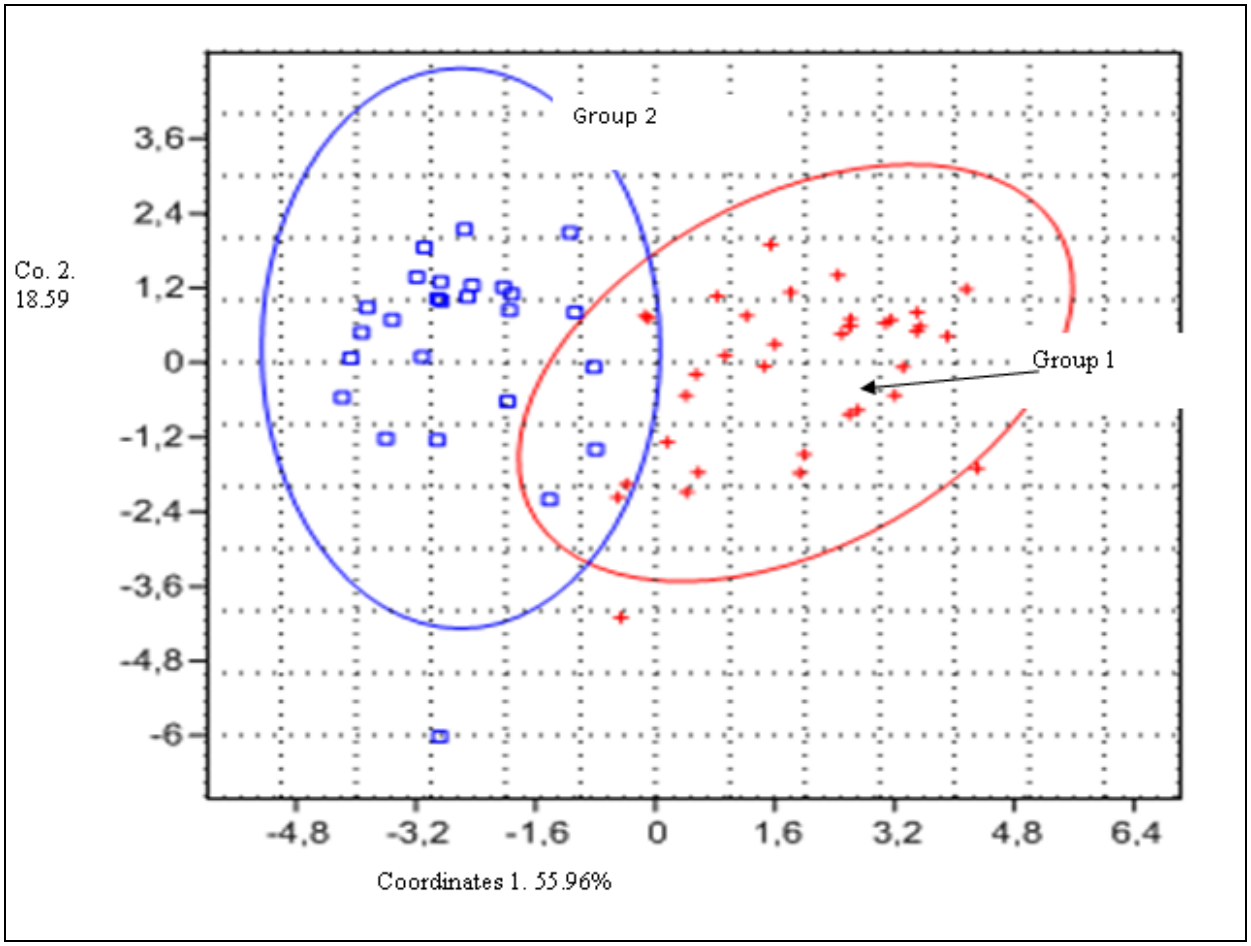

Figure 6: PCO scatter diagram computed with KmC (Cluster-2) for *Centaurea atropurpurea* species.

Ordination and classification analyses showed, in this study, that there are two morphological groups, but they are mixed with a composition of individuals of the four populations.

To make a comparison between the two studied morphological groups, the average of each morphological characteristic were calculated by the PAST package. These averages were plotted for comparison.

Morphological differences between the two formed groups can be seen on the chart of "box plot" type (Fig. 7).

It seems that the two groups differ in the number of leaves (LN), size of leaf stems laciniae (LcL, LcW) and number of inflorescences.

Note that the second group shows the values of these characters much larger and the number of leaves and inflorescences depends on the sturdiness of the plant.

Other morphological characters are similar in both groups.

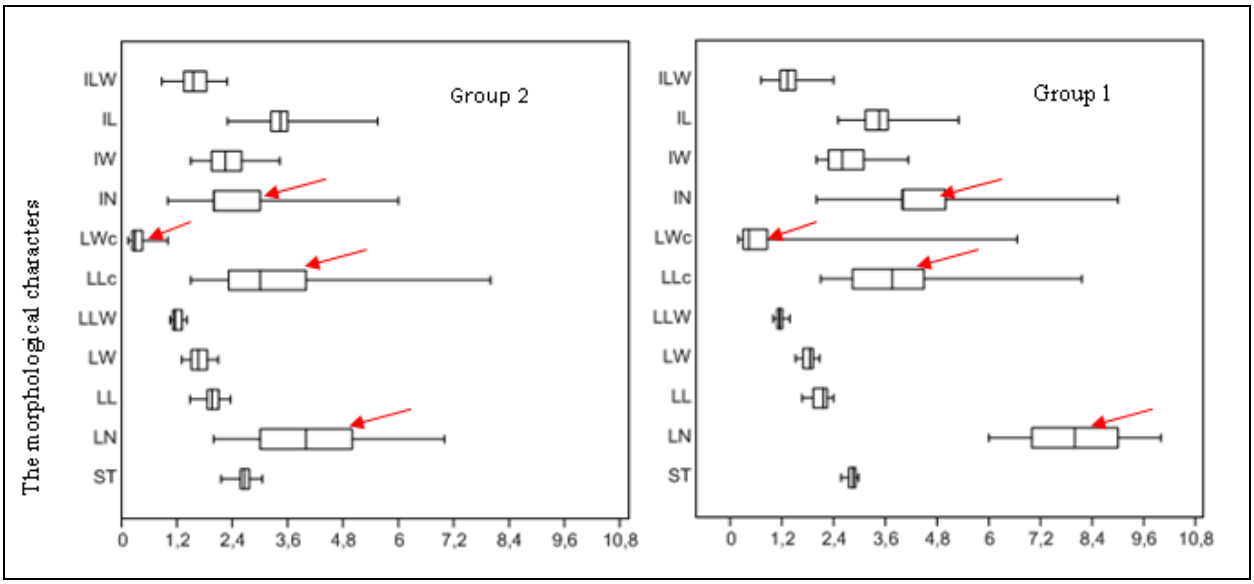

Figure 7: Box plots computed for *Centaurea atropurpurea*
(median, outliers, extrem values, minimum and maximum interval).

CONCLUSIONS

Ordination analysis (PCA, PCO with KmC) and the ranking (UPGMA with WM and JN) showed the existence of two morphological groups of the species *Centaurea atropurpurea*. These morphological groups partially overlap the distribution areas of identified populations. Each morphological group contains individuals from four populations, forming mixed groups. This evidence shows that populations contain the same taxon and differentiation cause based on systematic criteria excluded.

Morphological characters that distinguish the groups among themselves are: number of leaves on the stem (LN), the number of inflorescences (IN) and dimensions laciniata (LcL, LcW).

It was noted that a morphological group presents much higher values of these characteristics, indicating the existence of vigorous plants in this group. The number of leaves and inflorescences are directly dependent on plants sturdiness.

Perhaps the existence of this morphotype is closely related to abiotic factors on which the development of the plant depends.

It is known that this species is calciphile and its development is directly related to $CaCO_3$ in the soil, which is soluble when in contact with rain water, releasing molecules of Ca necessary for its development. With their numerous flowers, field observations have confirmed that populations from Turzii Gorge are more robust.

In contrast, Lomb Mountain population have a lower vigor and lower values of differential characters. Perhaps the soil of this area is lower in Ca.

It must be taken into account in describing species and morphological variations which are closely related to the substrate on which it grows. Analysis of a large number of the monitored morphological characters in several populations helps in accurate description of this taxon.

By following these analysis we conclude that *Centaurea atropurpurea* is a species with an average height of 57.66 cm, reaching heights of 112 cm. The leaves are pinnate-segmented, spear-shaped or linear leaves laciniae 3.54 cm long and 0.54 cm wide. Laciniae sizes are smaller in individuals that develop on a substrate with a smaller amount of Ca. Capitulas are solitary (rarely 2-3) in individuals with a deficiency in Ca and numerous (average of 5) in individuals from a substrate rich in Ca. Flowers are globular in shape, 2.5 mm

wide and 3.48 mm high. Unstriated leaflets bracts are covered by appendages, triangular-spear-shaped, black or dark brown, at the bottom broad 3-4 mm and 8-9 mm long. The appendages are triangular-spear-shaped, about 10 mm long, fimbriae are glossy white, 3-6 mm long, with spiny apical fimbriae. Flowers are red-purple to black, without radial flowers on the edges. The burrs are soot, 4-5 mm long and joined-puberule. The achenae hair is 5 mm long.

Centaurea atropurpurea populations declined in recent years due to land degradation through intensive grazing, especially by sheep grazing. Soil compaction decreased permeability of the upper substrate and the solubility of $CaCO_3$ becomes impossible.

For this species it is proposed to take conservation measures by collecting and sowing seeds from safe habitats and sowing them into botanical gardens from favorable areas and protect it in its habitat. It is recommended for areas where this species grows to introduce some rules of use. For example, grasslands have a high natural value because it is associated with many other protected species.

ACKNOWLEDGEMENTS

The authors are very grateful to Mrs. Schneider-Binder E. for her indication of *Centaurea atropurpurea* population on Guşteriţa area (Sibiu County). We want to thank Mrs. Bănăduc A., the editor in chief of *Acta Oecologica Carpatica*, for her patience, understanding and support during the preparation of this scientific article.

REFERENCES

Bădărău A., 2011 – http://www.floraofromania.transsilvanica.net/flora%20of%20Romania/ac%20XII%201101-1200/Copy%20(109)%20of%20species.htm (accessed in 2.05.2012).

Borza A., 1959 – Flora şi vegetaţia văii Sebeşului, Edit. Academiei Române, Bucureşti, 326. (in Romanian)

Boşcaiu N. and Täuber F., 1985 – Die Zönologischen Verhältnisse der dazischen und dazisch- balkanischen Arten aus dem rumänischen Karpatenraum, *Vegetatio*, Dr. W. J. Publishers, Netherlands, 55, 185-192. (in German)

Ciocârlan V., 2009 – Flora ilustrată a României, Pteridophyta et Spermatophyta, Edit. Ceres, Bucureşti, 833-847. (in Romanian)

Euro+Med, 2006 – Euro+Med PlantBase - the information resource for Euro-Mediterranean plant diversity. http://ww2.bgbm.org/EuroPlusMed/ (20.09.2012).

Garcia-Jacas N., 1998 – Centaurea kunkelii (Asteraceae, Cardueae) a new hybridogenic endecaploid species of sect. Acrocentron from Spain, *Annales Botanici Fennici*, Helsinki, 35, 159-167.

Hammer Ø., 1999-2012 – Reference manual of PAST-Paleontological Statistics, version 2.15, Natural History Museum and University of Oslo.

HSB-Herbarium of Natural History Museum Sibiu.

Pop I., 1976 – Studiu comparativ asupra taxonomiei corologiei şi cenologiei speciilor de Centaurea atropurpurea W. şi K. şi C. kotschyana Heuff. *Studii şi Cercetări de Biologie, Seria Biologie Vegetală*, Bucureşti, 28, 1, 29-34. (in Romanian)

Prodan I., 1930 – Centaureele României. Monografie, Institutul de arte grafice „Ardealul", Cluj, 256. (in Romanian)

Prodan I. and Nyárády E. I., 1964 – Genul Centaurea, Nyárády et al. (eds), 785-977, in Nyárády et al. (eds), 1964, Flora Republicii Populare Române, IX, 785-977. (in Romanian)

Schneider E, 1975 – Pajişti xeroterme din ord. Festucetalia valesiacae Br.-Bl. et Tx. 1943 în zona colinelor marginale ale Depresiunii Sibiului, *Studii şi Comunicări, Ştiinţe Naturale, Muzeul de Istorie Naturală Sibiu*, 19, 95-120. (in Romanian)

Vonica G. and Cantor M., 2011 – Problems and conflicts in the identification of Centaurea species, *Brukenthal Acta Musei*, VI, 3, 541-548.

Vonica G. and Cantor M., 2012 – Centaurea species attractive Transylvania (Romania) endemic and rare plants with high potential as flowering gardening plant, *Bulletin UASVM Floriculture*, Cluj, 69, 1-2, 354-362.

AUTHORS:

Ghizela VONICA [1]
aghizela@yahoo.com
Natural History Museum of Sibiu,
Cetăţii Street 1,
Sibiu, Sibiu County,
Romania,
RO-550160.
Andreea TODORUŢ [2]
deadut2303@yahoo.com
"Babeş-Boliay" University of Cluj-Napoca,
Environment Science and Engineering Faculty, Fântânele Street 30,
Cluj-Napoca, Cluj County,
Romania,
RO-400327.
Alexandru BĂDĂRĂU [3]
sabin.badarau@ubbcluj.ro
"Babeş-Boliay" University of Cluj-Napoca,
Environment Science and Engineering Faculty, Fântânele Street 30,
Cluj-Napoca, Cluj County,
Romania,
RO-400327

RARE PLANT SPECIES FROM LĂPUŞ COUNTY (NORTH-WEST ROMANIA)

Amalia ARDELEAN [1], *Aurel ARDELEAN* [2] and *Radu HOTEA* [3]

KEYWORDS: Lăpuş County, Maramureş, natural reservation, endemic species, rare species, Red List.

ABSTRACT

Lăpuşului County has a remarkable natural heritage, characterized by high richness, variety and diversity. It has three protected areas of high scientific, touristic and scenic value: "Pasul Babei/Babei Pass" Natural Monument, "Arcer - Ţibleş" Nature Reservation, and "Lăpuş Gorge" Natural Reservation.

Field investigations have been based on the following premises: serious damage to the environment, nature degradation, the need to preserve the integrity and diversity of nature, and using natural resources in an equitable and sustainable manner.

The interactions between man and nature are present, and have always existed, but they have changed in time, causing a loss or degradation of the value of nature in people's perception.

The floristic investigation has been completed, with the identification and inventory of the species of vascular plants on the territory of Ţara Lăpuşului. This inventory comprises 746 species belonging to 92 families and 411 genera. The floristic list contains 1,212 vegetal taxa of cormophytes.

Of the species mentioned for the first time by us, from the study area, seven are relict species, rare, endemic plants or in danger of disappearing: *Dryopteris cristata* and *Aconitum tauricum* are glacial relicts; *Potentilla pusilla* and *Juncus minutulus* are critically endangered species; *Centaurea mollis* f. *maramarosiensis*/*C. maramarosiensis* is a taxon endemic to the Carpathians; and *Nigritella nigra* and *N. rubra* are in danger of extinction.

REZUMAT: Specii rare de plante din Ţara Lăpuşului (nord-vestul României).

Patrimoniul natural deosebit din Ţara Lăpuşului, caracterizat printr-o mare bogăţie, varietate şi diversitate, este marcat de prezenţa a trei arii protejate, prezentând o certă valoare ştiinţifică, peisagistică şi turistică: Monumentul natural „Cheile Babei/Babei Gorge", Rezervaţia naturală „Arcer - Ţibleş" şi Rezervaţia naturală „Defileul Lăpuşului".

Investigaţiile efectuate în teren au pornit de la următoarele premise: deteriorarea gravă a mediului înconjurător, degradarea naturii, necesitatea conservării integrităţii şi diversităţii naturii, precum şi utilizarea resurselor naturale într-un mod echitabil şi durabil.

Interacţiunile dintre om şi natură sunt şi au fost prezente, doar felul lor s-a schimbat, având loc o involuţie şi o degradare a valorii naturii în percepţia oamenilor.

Investigaţiile floristice au fost finalizate prin identificarea şi inventarierea speciilor de plante vasculare de pe teritoriul Ţării Lăpuşului. Acest inventar cuprinde 746 specii, aparţinând la 92 familii şi 411 genuri. Lista floristică conţine 1.212 taxoni vegetali aparţinând cormofitelor.

Dintre speciile menţionate pentru prima dată de către noi, pentru zona de studiu, un număr de şapte specii sunt plante relictare, rare, endemice sau pe cale de dispariţie: *Dryopteris cristata, Aconitum tauricum* relicte glaciare, *Potentilla pusilla, Juncus minutulus* specii critic periclitate, *Centaurea mollis* f. *Maramarosiensis/C. maramarosiensis* specie endemică, *Nigritella nigra, N. rubra* aflate în pericol de extincţie.

ZUSAMMENFASSUNG: Seltene Pflanzenarten im Lăpuş-Gebiet (Ţara Lăpuşului), Nordwest-Rumänien.

Das außergewöhnliche Naturerbe des Lăpuş Gebietes, das sich durch großen Reichtum und Vielfalt auszeichnet, ist bestimmt durch drei Schutzgebiete mit einem bedeutenden wissenschaftlichem, landschaftlichen und touristischen Wert: das Naturdenkmal "Cheile Babei", das Naturschutzgebiet "Arcer - Ţibleş" sowie das Naturschutzgebiet "Defileul Lăpuşului" (Lăpuş - Klamm).

Die Geländeuntersuchungen gingen von folgenden Voraussetzungen aus: schwerwiegende Zerstörungen der Umwelt und Verminderung von Naturwerten, Notwendigkeit zum Schutz der Integrität und Diversität der Natur sowie die gerechte Verteilung und nachhaltige Nutzung der natürlichen Resourcen.

Die Wechselbeziehungen von Mensch und Natur waren immer vorhanden, bloß hat sich ihre Art und Weise im Laufe der Zeit verändert. Dabei hat eine Involution oder ein Werteverfall der Natur in der Wahrnehmung des Menschen stattgefunden.

Das Ergebnis der floristischen Untersuchungen war eine Auflistung der Gefäßpflanzen aus dem Gebiet des Lăpuş Gebietes/Ţara Lăpuşului. Dabei wurden 746 Arten festgestellt, die zu 92 Familien und 411 gehören. Insgesamt umfasst die Florenliste 1212 Taxa von Gefäßpflanzen.

Zu den zum ersten Mal im Untersuchungsgebiet erwähnten Arten, gehören sieben, bei denen es sich um Relikte, seltene, endemische oder vom Aussterben bedrohte Arten handelt. Dabei geht es um die Eiszeitrelikte *Dryopteris cristata* und *Aconitum tauricum*, die stark gefährdeten Arten *Potentilla pusilla* und *Juncus minutulus*, die für die Maramureşch endemische *Centaurea mollis* f. *Maramarosiensis/C. maramarosiensis* sowie um die vom Aussterben bedrohte Kohlröschenarten *Nigritella nigra* und *Nigritella rubra*.

INTRODUCTION

The opportunity of phytosociological and ecological research in nature reserves of the Lăpuş County is supported by the following considerations.

The first aspect is that in terms of geobotanical, phytosociological and ecological vegetation of Lăpuş County, there is still little known and the existing scattered data in the speciality literature are wholly insufficient to provide a complete description of flora and vegetation in this area.

The second aspect concerns the fact that zonal plant associations characteristic for the areas of mountains, hills, hollows and valleys, are missing from the bibliography, the fitocenotic analytical tables show their floristic composition and structure.

The third aspect, but not the least, is the fact that there is an updated scientific database, providing precise information regarding the inventory of rare species and the actual populations of rare and imperiled taxons.

The achievement of such a database will streamline the actions of limiting human pressures, and will allow the establishment of effective conservation and restoration of habitats already affected by anthropogenic activities.

Conservation of natural habitats from Lăpuş County, valuable in terms of biodiversity, with endemic, rare and imperiled species, is made in protected areas. Represented by the Natural Monument "Cheile Babei/Babei Gorge" - was included in the list of protected natural areas by the decision of The County Popular Council no. 204/1977, the Natural Reserve "Arcer - Ţibleş" and the Natural Reserve "Lăpuş Gorge", for which the first measures of conservation were established by the Decree no. 37/1994 of Maramureş County Council, these areas were later confirmed by Law no. 152/2000.

MATERIALS AND METHODS

During 2006-2011 a series of ecological expeditions were made to assess biodiversity and habitat conditions of the three protected areas from Lăpuş County. Through field and laboratory analysis, the diversity of natural habitats and main pedo-climatic conditions in which they are located have been established. In 2006-2009 period we made a list of vascular plant species, which have shown major associations and performed an initial assessment of rare plants.

RESULTS AND DISCUSSION

The Natural Reserve "Arcer - Ţibleş" is administratively located on the territory of commune Groşii Ţibleşului (Lăpuş County) and on territory of the town Dragomireşti (Maramureş County). It has an area of 150 hectares and is located at an altitude of 1,650 m in the Ţibleş Mountains.

Ţibleş Mountains belong to Central-European floristic province, southeast of the Carpathian Euro-Siberian region, and are situated in the nemoral area of Central Europe underwoods forests and subarea of mesophilic forests.

Protected areas include a specific gap with subalpine vegetation, located at the upper limit of spruce forest, which is not guarded and is not removed from grazing.

Specific vegetation is characterized by the subalpine meadows and underwoods. Woody vegetation is represented by the underwoods of: *Pinus mugo, Juniperus communis, Vaccinium myrtyllus.* Meadows including: *Festuca ametystina, Festuca rubra, Deschampsia flexuosa, Nardus stricta, Anthoxanthum odoratum, Scorzonera rosea, Arnica montana, Dactylorhiza fuchsii, Orchis ustulata, Lotus corniculatus, Viola declinata, Hypericum perforatum, Melampyrum saxosum, Lilium martagon, Oxyria digyna, Rosa pendulina, Pimpinella major, Ligusticum mutellina, Veratrum album, Prunella vulgaris, Phyteuma tetramerum, Polygala amara*.

The reserve has an important floristic and geological landscape. The main purpose of the declaration as protected area is the conservation of natural habitats, wild flora and fauna, and the biological diversity characteristic.

The Natural Reserve "Lăpuş Gorge" has a geomorphological, geological, landscape and touristic special value. Lăpuş Gorge is situated at the boundary between county of Lăpuş and county of Chioar. It has a length of about 25 km, on the upper and middle flow of Lăpuş River, between the village Răzoare and the village Remecioara.

The Natural Reserve "Lăpuş Gorge" is administrated by mayor houses: Târgu Lăpuş, Vima Mică, Boiu Mare, Şomcuta Mare, Remetea Chioarului and Coaş under the provisions of Government Emergency Ordinance no. 236/2000 regarding the system of natural protected areas, the preservation of natural habitats, flora and fauna.

The purpose of establishing the reserve is the preservation of natural habitats, wild flora and fauna, and biodiversity. In this reserve is an epigenetic gorge considered unique in Romania because of its size and rocks which develop (crystalline shales with levels of metamorphosed limestone and dolomite). This includes sectors like canyon (Vima Mică - Salniţa, Buteasa River) and has rocky slope walls and spurs, waterfalls and caves.

One side of the valley is vast in deciduous forests and dominated by *Carpinus betulus*, with *Fagus silvatica* and *Quercus cerris*.

Natural Monument "Cheile Babei/Babei Gorge" is a geological fossil and its formation has a scientific and landscape value. Cheile Babei/Babei Gorge are located in the township Coroieni, Baba village with an area of 15 ha and a length of 1 km at an average altitude of 250 m, close to the road connecting the city of Târgu Lăpuş with the commune of Gâlgău (Sălaj County). The main purpose of Cheile Babei/Babei Gorge natural area is the preservation of biological diversity.

In the Lăpuş County 34 plant associations were identified, cenotaxonomic assigned to 11 classes of vegetation, 15 order and 24 alliances.

For species identification and infrataxons plants, the authors used Romanian Flora and Flora Europaea and other similar works appeared under the print in Romania. The inventoried plant species have been classified according with current phylogenetic systems.

The floristical list summarizes all taxon plants identified until now, belonging to cormofites, and grouped according to species, subspecies, variety, shape, subshape and hybrids. According to older bibliographic data, but to the recent changes on the ground Lăpuş County flora includes 746 vascular taxons (623 species and 123 subspecies), representing 19.65% of all species and subspecies (3,795 taxons) known in Romania's spontaneous flora.

In a critical situation are vegetal rare and endangered taxons from natural areas which, because of the uncontrolled actions of grazing and deforestation, have suffered in recently years, an intense process that allowed the installation of amfitolerant species with a great competitive ability, compared with typical species of these habitats.

To the category of taxons threatened with extinction belong a number of rare species and subspecies with small populations that require immediate protection, like the followings.

Delphinium simonkaianum Pawl.: rare, forests, rocky places, limey soil. Cheile Babei/Babei Gorge, perennial species, mezoxer. endemite.

Ranunculus millefoliatus Vahl.: rare, through wet meadows. Peteritea, Coroieni, perennial species, central european-mediterranean. Is a species critically endangered (CR).

Ranunculus carpaticus Herbich.: in mountain forests, subalpine forests and edge and glades. Ţibleş Mountains, perennial species, eutr., mezohigr. Carpathian endemite.

Papaver alpinum Borza, ssp. *corona - sancti - stephani* Zapal.: rare, detritus, limestone, rocky places, in the subalpin region. Ţibleş Mountains, perennial species, Carpathian endemite.

Dianthus tenuifolius Schur: rocky, grassy meadows on soils disorders on mountain area. Ţibleş Mountains, perennial species, Carpathian endemite.

Dianthus glacialis Haenke, ssp. *gelidus* Nyman: sporadic, subalpine meadows glades. Ţibleş Mountains, perennial species, hekistoterm, Carpathian endemite.

Rumex thyrsiflorus L: meadow valleys, forest glades and wetlands. Lăpuş Gorge, Cheile Babei/Babei Gorge, Libotin, Stoiceni, Borcut, Lăpuş River, perennial species, euritr., mez. - mezohigr. Is a critically endangered species (CR).

Saxifraga carpathica Stemb: rare and humid rocky places in subalpin area. Ţibleş Mountains, perennial species, Balcanic - Carpathian.

Rubus tereticaulis P. J. Mueller: rare, spruce forests, Băiuţ, Atlantic, Central Europ.

Potentilla pusilla Host.: very rare, meadows, limestone. Peteritea, perennial species, Central European.

Rosa stylosa Desv.: rare, scrubbery, Lăpuş Gorge. Species xeromez., Atlantic.

Medicago polymorpha L.: rare, in meadows and ruderal. Cheile Babei/Babei Gorge. Anual species, mezotr., xeromez., term-subterm., Mediterranean.

Lotus pedunculatus Cav.: rare, in wet meadows and shaded and humid places. Cheile Babei/Babei Gorge. perennial species, mezotr.- eutr., mezohigr.- higr., Subatl.- submedit. Endangered species (EN).

Alyssum wierzbickii Baumg. ssp. *transsilvanicum* (Schur.) Nyman: on the rocks, ribs, rocky mountain, scrubbery and subalpin in the floor, sporadic in Lăpuş Gorge, perennial species, Carp. - Balc. Critically endangered species (CR).

Aethionema saxatile (L.) R. Br.: rare, on steep limestone cliffs, Ţibleş Mountains, perennial species, sax., Central European - Mediterranean. Critically endangered species (CR).

Dentaria glandulosa Waldst. et Kit.: in shadow forests, on land-rich humus of mountain floor until the subalpin. Ţibles Mountains, perennial species, mezotr., scia, mez.- mezohigr. Carpathian endemit.

Salix daphnoides Vill.: sporadic willow, on the edge of the rivers Peteritea, Euras. Critically endangered species (CR).

Linaria alpina (L.) Miller.: rare, on rocks and detritus, on limestone soils. Valea Mare, Ţibleş Mountains. perennial species, Alp. eur. European endemit. Vulnerable species (VU).

Veronica catenata Pennell, Rhodora: sporadic, in rare places full of water in Romania, liable to inundation, water edge, wet meadows. Lăpuş Horge, Peteritea, Borcut, perennial species, higr. Circ. Species with low risk of extinction (LR).

Melampyrum saxosum Baumg: sporadic, in subalpine forests and meadows, rocks with grass. Ţibleş Mountains, Arcer, Hudin, Lăpuş Mountains. Anual species, Carpathian endemit.

Campanula carpatica Jacq.: on steep slopes, rocks, detritus, gritty, on gulches, in the mountain floor until the subalpin area. Groşii Ţibleşului Valley from its source, perennial species, mez., sax., calc. Carpathian endemit.

Campanula alpina Jacq. var. *ciblesii* Prod.: through pastures and meadows, places with rocks in the subalpin area. Ţibleş Mountains, Arcer. Perennial species, mez., oligotr., hekistoterm., Alp. - Carp. endemit.

Phyteuma tetramerum Schur.: sporadic, through forests, clearings, meadows, rocks from mountain and subalpine region. Peteritea, Ţibleş Mountains, Lăpuş Gorge, perennial species, Carpathian endemit.

Phyteuma spicatum L.: rare, in woods, scrubberies, in mountain area. The valley of Strâmbu Băiuţ, Minghet Mountains, perennial species, mez – mezohigr, Eur.

Phyteuma wagneri A. Kerner.: sporadic, subalpine meadows, places with grass, rocks. Ţibleş Mountains, Arcer, perennial species, Carpathian endemit.

Achillea schurii Schultz. Bip.: on rocky places and with grass, in addition to the streams in the subalpine area. Ţibleş Mountains and Arcer, perennial species, Carpathian endemit.

Senecio carniolicus Willd.: rare, in meadows and grows on rocky slopes from subalpine area. Ţibleş Mountain, Arcer, perennial species, oligotr., mez., Alp. - Carp.

Carduus lobulatiformis var. *rodnensis* Csürös and Nyár.: sporadic through meadows, on abrupt versants, on rocks with grass, in subalpine area. Ţibleş Mountains, Hudin, perennial species, Carp. - Balc. Species with low risk of extinction (LR).

Centaurea trinervia Stephan.: sporadic in meadows and the edge of the forests. Cheile Babei/Babei Gorge, perennial species, xeromez., Pont. Species critically endangered (CR).

Festuca filiformis Pourr: meadows in the area of hills and mountains, Lăpuş Gorge, perennial species, xeromez., moderate acid. Species threatened by extinction (EN).

Juncus minutulus Albert and Jahand: in wet places, roads, on the edge of the roads, on wet meadows. Suciu de Sus, annual species, mezohigr. Species critically endangered (CR).

Poa stiriaca Fritsch and Hayek: meadows, forests, edges and cuts of forests, ruderale places, Lăpuş Gorge, Preluca, Peteritea, perennial species, mez. - mezohigr., mezotr. - eutr., Circ. Species with low risk of extinction (LR).

Glyceria declinata (L.) R. Br.: Found near boggy places. Township in Lăpuş Gorge, Ţibleş Mountains, perennial species, higr., Euras. Species threatened by extinction (EN).

Field research conducted to investigate the flora and vegetation of the Lăpuş County led to the following results.

Identification of 47 new species, was not mentioned in the speciality literature for the studied field: *Delphinium simonkaianum, Ranunculus millefoliatus, Gypsophila muralis, Silene heuffelli, Lychnis viscaria, Rumex kerneri, R. pulcher, Rubus tereticaulis, Rubus bifrons, Potentilla*

pussilla, Geum alepicum, Rosa stylosa, Genista tinctoria, Medicago polymorpha, Melilotus altissimus, Trifolium spadiceum, Lotus pedunculatus, Vicia angustifolia, Trinia glauca, Hypericum humifusum, Tamarix ramosissima, Rorippa prolifera, Salix daphnoides, Thymus serpyllum, Digitalis lanata, Rhinanthus borbassi, Melampyrum nemorosum, Campanula transsilvanica, Campanula rapunculoides, Campanula trachelium, Galinsoga ciliata, Achillea crithmifoglia, Centaurea pannonica, Centaurea trinervia, Centaurea mollis, Leontodon crispus, Lactuca perennis, Hieracium rohacsense, Hieracium laevigatum, Narcisus radiiflorus, Orchis mascula, Orchis laxiflora, Orchis purpurea, Dactylorhiza incarnata, Eleocharis ovata, Festuca heteromalla, Lolium multiflorum.

There were identified 33 rare species as being present in the region of study, of which, 13 are endemic species and 20 species are rare or very rare.

Of these 33 rare species, seven species were identified in the field: *Delphinium simonkaianum, Ranunculus millefoliatus, Rubus tereticaulis, Potentilla pussilla, Rosa stylosa, Medicago polymorpha, Lotus pedunculatus*. 25 species were those mentioned in the speciality literature: *Ranunculus carpaticus, Papaver alpinum* ssp. *corona – sancti – stephani, Dianthus tenuifolius, Dianthus glacialis* ssp. *gelidus, Rumex thyrsiflorus, Saxifraga carpathica, Alyssum wierzbickii* ssp. *transsilvanicum, Aethionema saxatile, Dentaria glandulosa, Salix daphnoides, Linaria alpina, Veronica catenata, Melampyrum saxosum, Campanula carpatica, Campanula alpina* var. *ciblesii, Phyteuma tetramerum, Phyteuma spicatum, Phyteuma wagneri, Achillea schurii, Senecio carniolicus, Carduus lobulatiformis* var. *rodnensis, Centaurea trinervia, Festuca filiformis, Juncus minutulus, Poa stiriaca, Glyceria declinata*.

From the total number of taxons inventoried so far in the study area (746 taxons), rare and endangered plants represent 4.42%.

Table 1: Sozological categories.

All species and subspecies identified in Lăpuş County	Species and subspecies endangered	Sozological categories							
		CR	EN	VU	LR	EX	EW	DD	NE
746	14	7	3	1	3	0	0	0	0
100%	1.88%	50.00	21.42	7.14	21.42	0	0	0	0

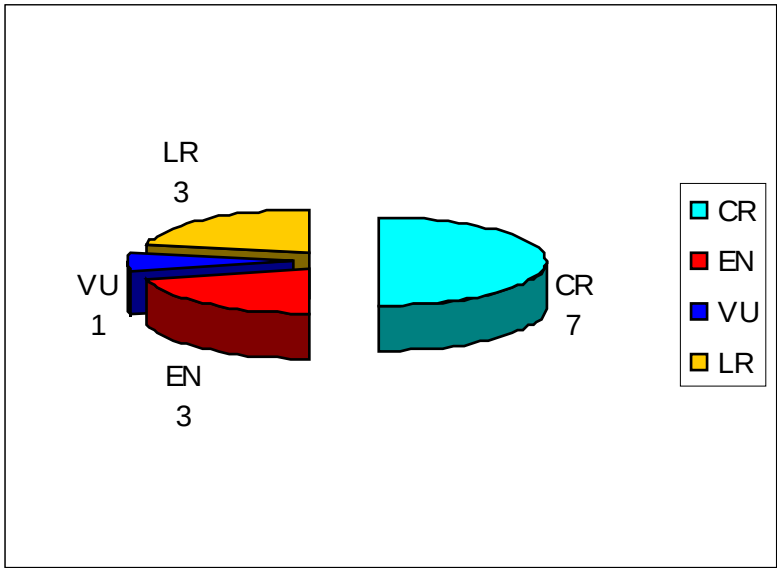

Figure 1: Sozological categories.

Reported to the number of Romanian flora taxons – 3,795, floristic rarities represent 0.87%. In terms of their membership to the IUCN sozological categories set of rare plant has gone step, the situation is as follows: seven species are critically endangered (CR), three species are endangered (EN), one species is vulnerable (VU) and three species are at lower risk of extinction (LR) (Dihoru and Negrean, 2009). Sozological categories: extinct (EX), extinct in the wild (EW), data deficient (DD) and not evaluated (NE) I did not identify vegetal species (Tab. 1, Fig. 1).

CONCLUSIONS

The necessary strategic priorities in the area of sustainable development shall cover the following aspects: the legislative framework in particular situations encountered in Lăpuş County; integration with the conservation of biodiversity in the process of socio-economic development of local communities, taking into account the traditions and the cultural and spiritual features thereof; the conservation of natural and semi-natural habitats in the area; the appropriate management of protected areas, but also other areas with significant accumulations of biodiversity, with substantial local populations of rare and endangered species, lesser known by public opinion, potential special areas of conservation; the development of regional red lists of plant and animal species that are rare and endangered in the area; restoring habitats (where possible) affected by human impact, particularly in the "Cheile Babei/Babei Gorge" and their rare species, as a result of anthropogenic activities development; reducing the effects of anthropogenic impact in areas of interest, other than protected areas; the results of the promotion and popularization of activities within the framework of research projects which have the main aims the protection and conservation of biodiversity; the promotion of tourism, traditional, natural reservations, whilst reducing the impact of mass tourism on these sensitive areas; the intensification of activities relating to information, education and awareness of the general public, but also local authorities on the importance of sustainable development in the context of the safeguarding and protection of biodiversity in general and of biodiversity in the area of Lăpuş Country, in particular.

SELECTIVE REFERENCES

Bavaru A., Godeanu S., Butnaru G. and Bogdan A., 2007 – Biodiversity and nature protection, Romanian Academy Press, Bucharest, 580.

Boşcaiu N., Coldea G. and Horeanu C., 1994 – Red list of vascular plants, endangered, vulnerable, who disappeared and rare flora of Romania, Natural Reservation Magazine, Bucharest, 38, 1, 45-56.

Ciocârlan V., 2000 – Romanian Illustrated Flora. Pteridophyta et Spermatophyta, Ceres Press, Bucharest, 1139-1142.

Dihoru G. and Dihoru A., 1994 – Rare and endangered plants, endemic flora in Romania – red list, *Acta Botanica Horti Bucurestiensis*, Bucharest, 147-152.

Dihoru G. and Negrean G., 2009 – Romanian red list of vascular plants, Romanian Academy Press, Bucharest, 550-630.

Doniță N., Popescu A. and Paucă–Comănescu M., Mihăilescu S. and Biriş A., 2005 – Habitates in Romania, Tehnique and Forestry Press, Bucharest, 407.

Mohan G. and Ardelean A., 2006 – Natural Parks and Reservation from Romania, Victor and Victor Press, Bucharest, 24.

Săvulescu T., (ed.) 1952-1970 – Flora R.P.R. - R.S.R., I - XIII, Academy R.P.R. - R.S.R. Press, Bucharest, 1-660, 1-702, 1-662, 1-952, 1-556, 1-676, 1-662, 1-708, 1-1000, 1-752, 1-876, 1-810, 1-302. (in Romanian)

*** 1997 – Globally threatened plants in Europe, IUCN Red List of Threatened Plants, World Conservation Monitoring Centre.

AUTHORS:

Amalia ARDELEAN
ammaliaam@yahoo.com
"*Vasile Goldiş*" Western University Baia Mare, Culturii Street 5,
Baia Mare, Maramureş County,
Romania,
RO-430191.

Aurel ARDELEAN
ardelean@uvvg.ro
"*Vasile Goldiş*" Western University Arad, Revoluţiei Street 94-96,
Arad, Arad County,
Romania,
RO-430191.

Radu HOTEA
raduhotea@yahoo.com
Baia Mare Sports Highschool
Republicii Street 33-35,
Baia Mare, Maramureş County,
Romania,
RO-430191.

ŞIRNEA LOCALITY CORMOFLORA (BRAŞOV COUNTY, TRANSYLVANIA, ROMANIA)

Constantin DRĂGULESCU[1]

KEYWORDS: mountain area, cormoflora, inventory, phitogeography, ecology, Transylvania, Romania.

ABSTRACT

Şirnea is a mountain village standing at the foot of the Piatra Craiului Mountains, at 1,050 m (ca 3,450 ft) altitude, and 44 km (27.5 mi) south-east of Braşov. As pastures abound here, the main local occupation is animal breeding. The flora of the village has not been studied by other botanists and, as a consequence, the species are named for the first time in the current paper. In the trips made in 1997, 2007, and 2011, I identified 481 cormophyte species. Every one of these species is noted along with the respective bio-form, floristic element, the specific ecological preference for humidity (H), temperature (T), and soil reaction (R), as well as the coenologic preference. The species summary is accompanied by cormoflora analysis in terms of biology, phyto-geography, and ecology.

REZUMAT: Cormoflora localităţii Şirnea (judeţul Braşov, Transilvania, România).

Localitatea Şirnea este un sat de munte de la poalele Munților Piatra Craiului, aflat la 1.050 m altitudine, la o distanță de 44 km sud-est de Brașov. Locuitorii sunt crescători de animale, consecință a faptului că aici predomină pajiștile. Flora satului Șirnea nu a fost cercetată de alți botaniști și în consecință, speciile enumerate în lucrare sunt semnalate pentru prima oară. În deplasările efectuate în anii 1997, 2007 și 2011 au fost identificate 481 cormofite. La fiecare specie s-a notat bioforma, elementul floristic, preferinţele ecologice faţă de umiditate (U), temperatură (T) şi reacţia solului (R) și cele cenologice. Conspectul speciilor este însoțit de analiza cormoflorei sub aspect biologic, fitogeografic și ecologic.

RÉSUMÉ: La cormoflore du village de Şirnea (département de Braşov, Transylvanie, Roumanie).

Le village de Şirnea est un village de montagne situé au pieds des Montagnes Piatra Craiului, à 1.050 m d'altitude et à une distance de 44 km au sud-est de Braşov. Les villageois sont des éleveurs de bétail et les pâturages dominent ainsi cette région. La flore du village de Şirnea n'a pas encore été étudiée par des botanistes auparavant et, en conséquence, les espèces énumérées dans ce papier sont signalées pour la première fois. Dans les déplacements effectués durant les années 1997, 2007 et 2011, 481 cormophytes ont été identifiés. Pour chaque espèce, la bioforme, l'élément floristique, les préférences écologiques concernant l'humidité (U), la température (T) et le type de pH du sol (R) ainsi que les préférences coenologiques ont été identifiés. L'énumération des espèces est accompagnée par l'analyse de la cormoflore d'un point de vue biologique, phytogéographique et écologique.

INTRODUCTION

The village Şirnea (Fig. 1) is included in the commune Fundata and lies on the Bran Plateau, at the foot of the Piatra Craiului Mountains, at 1,050 m (ca 3,450 ft) altitude. It occupies an area on the border between Transylvania and Muntenia, 44 km (27.5 mi) south of Braşov. A typical scattered mountain village, first mentioned in documents in 1729, Şirnea is a picturesque traditional Romanian village (Fig. 2). Its inhabitants raise cattle and sheep on the abundant pastures. The geological substrate consists of Cretaceous and Jurassic sediments and limestone respectively, giving the landscape a unique appearance. (*)

Valea Zbârcioara/Zbârcioara Valley with its tributaries Valea Rogoază/ Rogoază Valley, Valea Turcului/Turcului Valley and Valea Coacăzei/Coacăzei Valley flow on the Şirnea locality. (*)

The average multi-annual temperature is 5ºC (41ºF). Rainfall may exceed 1,000 mm (40 in) p. a. (*)

No studies have yet been published on the vegetation of the village. The only information available acknowledges the association *Poaetum annuae montanum*, by Sanda et al. (1977) (no surveys or species listings given), and Tok (1998) listed plans species at Moeciu de Sus locality limit. Viewing from a general perspective, the vegetation of Şirnea is typically one of meadows and grazing land on the plateau and at hills foot, or forested hilltops. I estimate 50% of the village territory to be meadows (of which most are mesophyle and meso-xerophyle), 30% woods (mixtures, spruce, and beech) and 20% farmsteads (growing vegetables, potatos and fooder plants).

Figure 1: Şirnea locality area (***, www.googleearth.com).

Figure 2: Şirnea locality, with Piatra Craiului Mountains in background (***, Wikipedia).

METHODS

For each particular species, the following particulars have been noted: bio-form; floristic elements; ecological preference for humidity (U), temperature (T), and soil reaction (R), as well as coenological preference (Sanda et al., 2003).

Based on such specific input, we have assembled the biological, phyto-geographic and ecological analysis of the cormophyte flora extant in the village Şirnea.

RESULTS

Flora analysis

The cormoflora of the village Şirnea has never before been studied by botanists, therefore all the species are mentioned below, for the first time. The explorations undertaken in 1997, 2007 and 2011 lead to the identification of 481 cormophyte species.

Bio-analysis

The local flora consists of the following categories of life-forms: hemicryptophytes (57.59%), therophytes (16.42%), geophytes (12.27%), phanerophytes (8.31%), chamaephytes (5.20%) and helo-hydrophyte (Hh 0.21%) (Tab. 1 and Fig. 3). The sheer existence of such plant forms, in the mentioned proportions, are indicative of the expanse of Euro-Asian meadows, a small ratio of aquatic environments, massive anthropic influences exerted in the past (18th-19th centuries), with land clearing and cultivating, and a relatively low impact of tourism at present. The relative altitude and anthropization index, calculated as a ratio of therophytes and hemicryptophytes (Ka = T/H x 100) is 28.52, which is indicative of the altitude of the village and a moderate human impact.

Table 1: Categories of life-forms in cormoflora of Şirnea.

Life forms	Therophytes (T)		Geo-phytes (G)	Helo-hydro-phytes (Hh)	Hemi-Crypto-phytes (H)	Chamae-phytes (Ch)	Phanerophytes (Ph)		
	annual (Th)	biannual (TH)					nano (nPh)	mezo (mPh)	mega (MPh)
Number of species (481)	46	33	59	1	277	25	13	14	13
% (100)	9.56	6.86	12.27	0.21	57.59	5.20	2.70	2.91	2.70

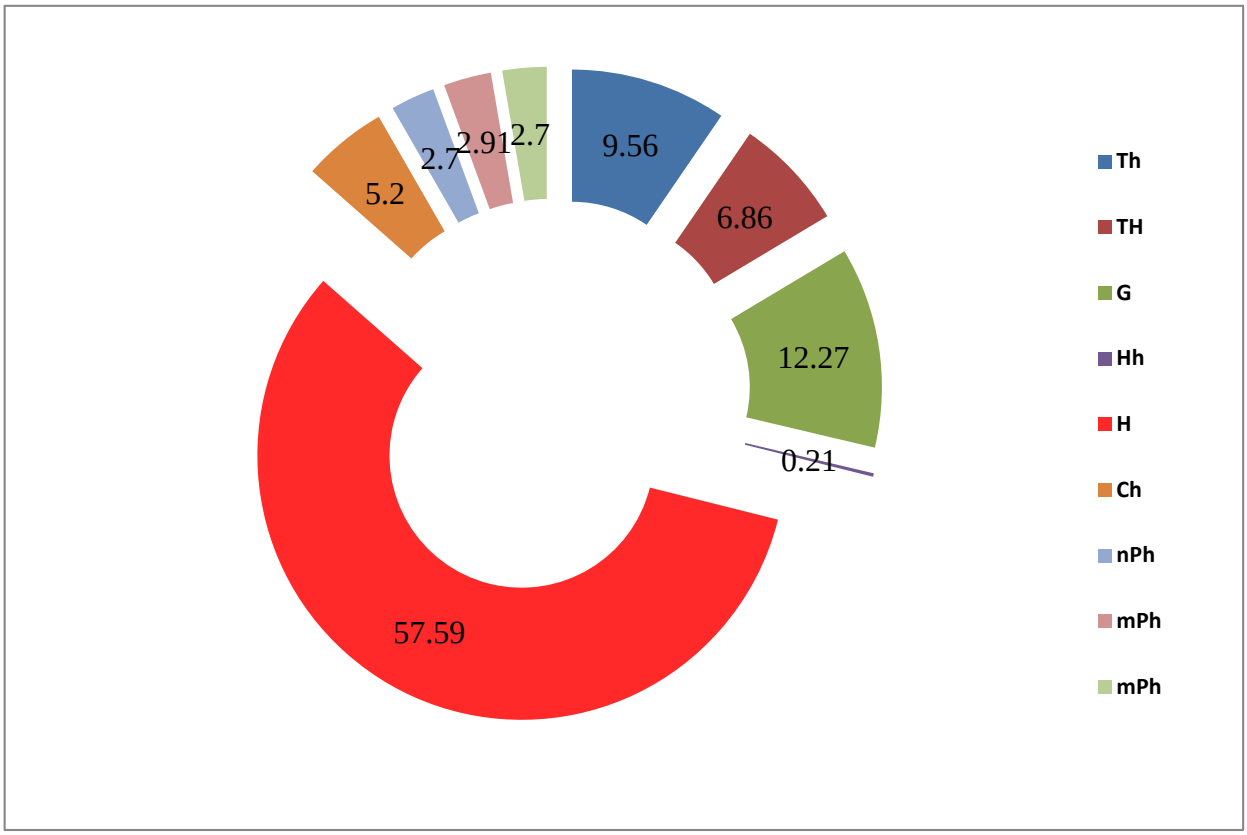

Figure 3: Bioformes spectrum
of the village Şirnea cormoflora.

Phyto-geographical analysis

In terms of phyto-geography (Tab. 2 and Fig. 4), the local cormoflora consists, of Eurasian elements (39.29%), European (19.96%) and central-European (12.06%), which reflect the geographic positioning (latitude and longitude) of the respective area.

Following in weight are circumpolar species (12.89%), Carpathian-Balkan (3.95%), Carpathian (1.45%), Alpine-Carpathian-Balkan (1.45%) and Alpine-Carpathian (0.62%), which are the consequence of the altitude of this mountain village area.

Cosmopolitan (5.62%) and adventives elements (1.25%) are the consequence of human involvement in natural environments; elements of Mediterranean, including sub-Mediterranean nature (0.62%), Pontic-Pannonic-Balkan (0.42%), Pontic-Mediterranean-central-European (0.21%) or Dacian (0.21%) are indicative of the warmer spots on limestone substrate extant on sunny slopes.

Table 2: Categories of floristic elements in cormoflora of village Şirnea.

Phloristic element	Cosmo-politan (Cosm)	Adventi-tious (Adv)	Circum-polar (Cp)	Eurasian (Eua)	European (E)	Central-european (Ec)	Mediterra-neean and submedi-terranean (M + sM)
Species number (481)	27	6	62	189	96	58	3
% (100)	5.62	1.25	12.89	39.29	19.96	12.06	0.62

Phloristic element	Ponto-medite-rranean-central-eropean (P-M-Ec)	Ponto-pannonian-balkanian (P-Pn-B)	Alpine-carpathian-balkanian (Alp-Carp-B)	Alpine-carpathian (Alp-Carp)	Carpathian balkanian (Carp-B)	Carpathi-an (Carp)	Dacian (D)
Species number (481)	1	2	7	3	19	7	1
% (100)	0.21	0.42	1.45	0.62	3.95	1.45	0.21

Phloristic element	Cosmo-politan (Cosm)	Adventi-tious (Adv)	Circum-polar (Cp)	Eurasian (Eua)	European (E)	Central-european (Ec)	Mediterra-neean and submedi-teranean (M + sM)
Species number (481)	27	6	62	189	96	58	3
% (100)	5.62	1.25	12.89	39.29	19.96	12.06	0.62
Ponto-medite-raneancentral-eropean (P-M-Ec)	Ponto-pannonian-balkanian (P-Pn-B)	Alpino-carpathianc balkanian (Alp-Carp-	Alpino-carpathian (Alp-Carp)	Carpathian-balkanian (Carp-B)	Carpathian (Carp)	Dacian (D)	
1	2	7	3	19	7	1	
0.21	0.42	1.45	0.62	3.95	1.45	0.21	

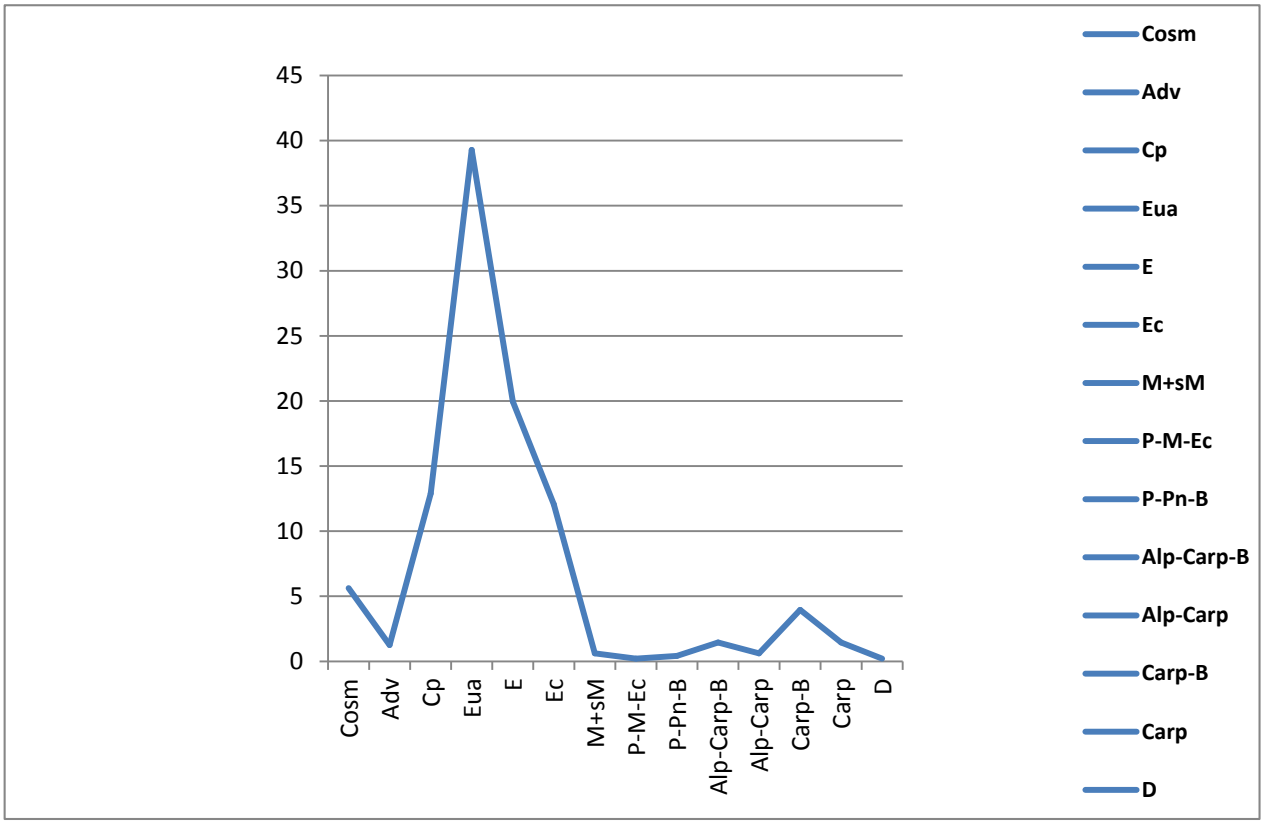

Figure 4: Floristic elements spectrum of Șirnea cormoflora; 0-45 species numbers.

Ecological analysis

The ecological categories of plants identified point out in a high degree the **eco-tope** characteristic features (Fig. 5). Therefore, an analysis of the various species' preference in terms of humidity (Tab. 3) shows the following flora structure: mesophyle species (49.90%), xero-mesophyle (21.41%), meso-hygrophyle (15.18%), euryhydric (5.41%), hygrophilic (3.74%), xerophytic (3.35%), and hydrophytic (0.83%). Indirectly, certain forms stand out, e.g. the extensive meadows and mesophyle forests as well as pasture and saxicole associations on aired slopes or on the other hand, small wet areas with water in excess. The temperature preferences (Tab. 4) of relevant species denote the mountainous-sub-mountainous character of the local climate as well as flora – consisting of 23.70% cryophiles/hechistoterms and microtherms, to which a 51.98% of micro-mesotherms is added. 21.62% of the species present are thermally-amphi-tolerant. Certainly, megatherms are utterly absent, while mesotherms are quasi-inexistent (only 2.70%), taking refuge on warm limestone cliffs, on slopes facing the south or the west. Concerning the adaptability of cormophyte species to the chemical reaction of the soil, (Tab. 5) let us notice the significant spreading of neutro-basiphilic (31.60%) and basiphilic (1.87%) species, totaling one-third of the local flora. They are indicative of the limestone substrate in the respective ground. More than half of the total number of species are euriionic (30.98%), or slightly acido-neutrophilic (24.53%). Acidophilic (8.73%) and highly acidophilic (2.29%) species are spread mainly in coniferous woods and in swamps. The figures given explain both the geological specific characteristics and the relatively high altitude, which implies the acidification of the soils.

Table 3: Ecological categories of plants in Şirnea based on their humidity preferences.

Ecological categories and indexes	Based on humidity preferences (U)						
	Xero-philous U1.5	Xeromeso-philous U2 and U2.5	Meso-philous U3 and U3.5	Mesohigro-philous U4 and U4.5	Higro-Philous U5 and U5.5	Higro-philous U6	Euri-hidous U0
Species number (481)	17	103	240	73	18	4	26
% (100)	3.53	21.41	49.90	15.18	3.74	0.83	5.41

Table 4: Ecological categories of plants in Şirnea based on their temperature preferences.

Ecological categories and indexes	Based on temperature preference (T)					
	Criophilous T1 and T1.5	Micro-therms T2 and T2.5	Micromeso-thermems T3 and T3.5	Meso-therms T4 and T4.5	Mega-therms T5	Euri-therms T0
Species number (481)	13	101	250	13	-	104
% (100)	2.70	21.00	51.98	2.70	-	21.62

Table 5: Ecological categories of plants in Şirnea based on the soil chemical reaction.

Ecological categories and indexes	Based on soil chemical reaction (R)					
	Strong acidophilous R1 and R1.5	Acido-philous R2 and R2.5	Acido-neutro-philous R3 and R3.5	Neutro-bazifile R4 and R4.5	Bazifile R5	Euriionice R0
Species number (481)	11	42	118	152	9	149
% (100)	2.29	8.73	24.53	31.60	1.87	30.98

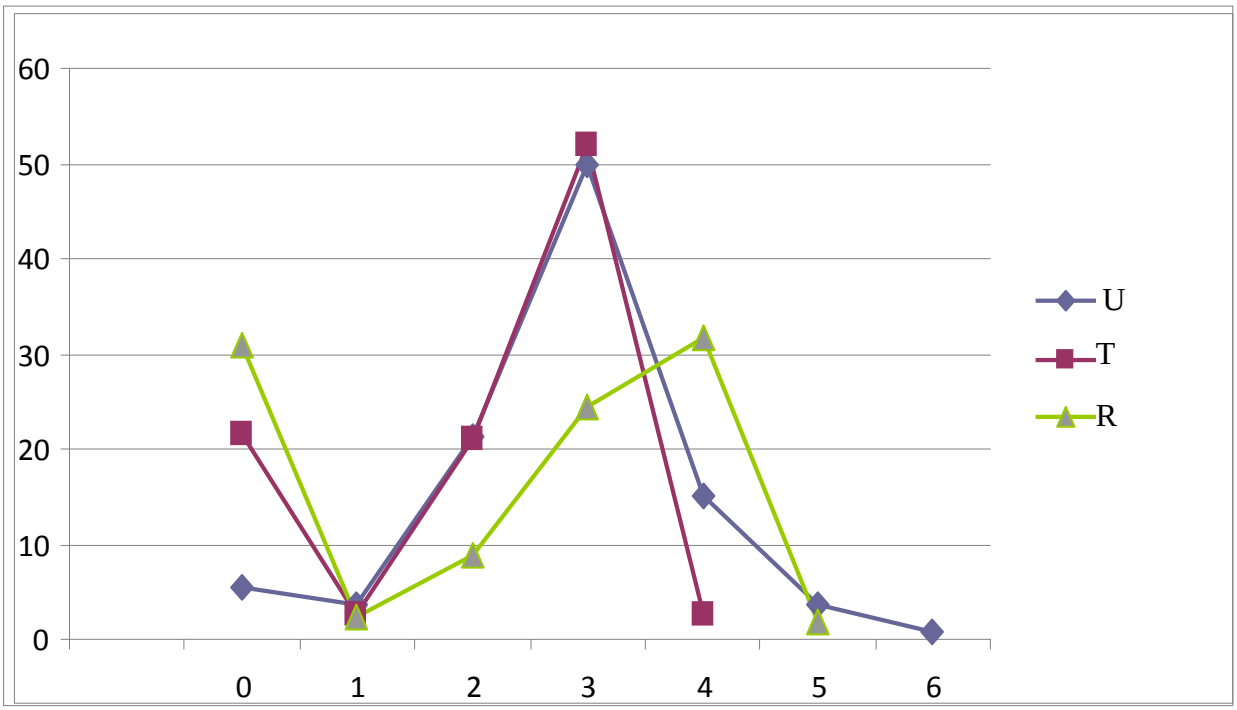

Figure 5: Village Şirnea cormoflora ecological indexes.

The local flora has a remarkable economic value, over 70% of the existent species being useful ones (applications: as fodder, human food, melliferous, medicinal, industrial, domestic and decorative). Out of the 481 cormophyte species, 230 (47%) are medicinal.

Cormoflora

Lycopodiaceae

Huperzia selago (L.) Martins (Lycopodium selago (L.) Bernh.): Ch, Cosm; U3.5T2R2, Vaccinio-Piceetalia

Lycopodium clavatum L.: Ch, Cosm; U3T3R1, Vaccinio-Piceetalia

Equisetaceae

Equisetum arvense L.: G, Cosm; U3T3R0, Artemisietea, Filipendulo-Petasition

Equisetum palustre L.: G, Cp; U5T2R0, Molinietalia

Equisetum telmateia Ehrh. (E. maximum Lam.): G, Cp; U3.5T2R0, Alno-Padion, Eriophorion latifolii, Filipendulo-Petasition

Polypodiaceae

Polypodium vulgare L.: G, Cp; U3.5T3R4, Asplenietea rupestris, Querco-Fagetea

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn: G, Cosm; U3T3R0, Quercetea robori-petraeae

Aspleniaceae

Asplenium ramosum L. (A. viride Hudson): H, Cp; U4T2R4, Asplenion rutae-murariae, Vaccinio-Piceion

Asplenium ruta-muraria L.: H, Eua; U1.5T3R5, Asplenion rutae-murariae

Asplenium scolopendrium L. (Phyllitis scolopendrium (L.) Newman): G, Cp; U3.5T3R5, Acerion pseudoplatani, Fagion

Asplenium septentrionale (L.) Hoffm.: H, Cp; U1T3R2, Asplenietalia septentrionalis

Asplenium trichomanes L. ssp. ***trichomanes*** (ssp. bivalens D. E. Meyer): H, Cosm; U3T0R4, Asplenietea rupestris

Athyriaceae

Athyrium filix-femina (L.) Roth: H, Cosm; U4T2.5R0, Alno-Padion, Fagetalia silvaticae

Cystopteris fragilis (L.) Bernh.: H, Cosm; U3.5T0R0, Asplenietea rupestris

Matteuccia struthiopteris (L.) Todaro (Struthiopteris filicastrum All.): H, Cp; U4T2R0, Alno-Padion

Aspidiaceae

Dryopteris carthusiana (Vill.) H. P. Fuchs (D. spinulosa Watt.): H, Cp; U4T3R0, Alnion glutinosae, Alno-Padion, Querco-Fagetea

Dryopteris dilatata (Hoffm.) A. Gray (D. austriaca (Jacq.) Woynar): H, Cp; U3.5T0R0, Adenostylion alliariae, Vaccinio-Piceion

Dryopteris filix-mas (L.) Schott: H, Eua; U4T3R0, Fagetalia silvaticae, Querco-Fagetea

Gymnocarpium dryopteris (L.) Newman (Phegopteris dryopteris Fee, Dryopteris disjuncta (Rupr.) V. Morton): G, Cp; U3T2.5R2, Fagion, Vaccinio-Piceion

Polystichum aculeatum (L.) Roth (P. lobatum (Hudson) Bast.): H, Eua; U3.5T3.5R3.5, Acerion pseudoplatani, Fagion

Polystichum braunii (Spenner) Fée: H, Cp; U3,5T2,5R43, Acerion pseudoplatani, Fagion

Thelypteridaceae

Phegopteris connectilis (Michx.) Watt (Ph. polypodioides Fee, Dryopteris phegopteris (L.) Christens., Thelypteris phegopteris (L.) Slosson): G, Cp; U3.5T2R2, Adenostylion alliariae, Fagetalia silvaticae, Pino-Quercetalia, Vaccinio-Piceion

Pinaceae

Abies alba Miller.: MPh, Ec; U3T3R0, Symphyto-Fagion

Picea abies (L.) Karsten (P. excelsa Link): Mph, E; U0T0R0, Vaccinio-Piceion

Cupressaceae

Juniperus communis L. var. ***communis***: mPh, Cp; U2T0R0, Junipero-Bruckenthalion, Junipero-Pinetalia mugi

Aristolochiaceae

Asarum europaeum L.: H, Eua; U3.5T3R4, Fagetalia silvaticae

Ranunculaceae

Aconitum moldavicum Hacq. ssp. ***moldavicum***: H, Carp; U3T2R3, Adenostyletalia, Quercetea robori-petraeae, Symphyto-Fagion

Actaea spicata L.: H, Eua; U3.5T3R3, Acerion pseudoplatani, Symphyto-Fagion

Anemone nemorosa L. ssp. ***nemorosa***: G, E; U3.5T3R0, Fagetalia silvaticae, Querco-Fagetea

Anemone ranunculoides L.: G, E; U3.5T3R4, Fagetalia silvaticae, Querco-Fagetea;

Caltha palustris L. (C. laeta Schott, Nyman et Kotschy): H, Cp; U4.5T0R0, Calthion palustris, Cardamini-Montion, Molinietalia

Clematis alpina (L.) Miller (Atragene alpina L.): nPh-L, Eua; U3T2R2, Symphyto-Fagion, Vaccinio-Piceion

Clematis vitalba L.: nPh-L, Ec-M; U3T3R3, Prunetalia, Querco-Fagetea

Helleborus purpurascens Waldst. et Kit.: H, Carp-B-Pn; U2.5T3R4, Fagetalia silvaticae

Isopyrum thalictroides L.: G, Ec; U3T3.5R3, Acerion pseudoplatani, Fagion

Ranunculus acris L. ssp. ***acris***: H, Eua; U3.5T0R0, Molinio-Arrhenatheretea; ssp. ***strigulosus*** (Schur) Hyl. (Ranunculus strigulosus Schur): H(G), P-M; U3.5T3R3, Molinio-Arrhenatheretea

Ranunculus auricomus L. ssp. ***auricomus***: H, Eua; U3.5T3R3, Molinio-Arrhenatheretea, Querco-Fagetea

Ranunculus bulbosus L. ssp. ***bulbosus***: H(G), E; U2.5T3R3, Cynosurion cristati

Ranunculus nemorosus DC. (R. serpens Schrank ssp. nemorosus (DC.) G. Lopez): H, E; U3T0R3.5, Cynosurion cristati, Triseto-Polygonion

Ranunculus repens L.: H, Eua; U4T0R0, Agropyro-Rumicion, Alno-Padion, Bidentetalia tripartiti, Calystegion, Molinio-Arrhenatheretea, Plantaginetea majoris, Salicetea purpureae

Thalictrum aquilegifolium L.: H, E; U2.5T2.5R4, Adenostylion alliariae, Alno-Padion, Filipendulo-Petasition

Trollius europaeus L. ssp. ***europaeus***: H, E; U4T2R4, Calthion palustris, Molinietalia

Papaveraceae

Chelidonium majus L.: H, Eua; U3T3R4, Alliarion petiolatae, Arction lappae, Epilobietea angustifolii

Corydalis solida (L.) Clairv.: G, E; U3T3R0, Fagetalia silvaticae

Ulmaceae

Ulmus glabra Hudson (U. montana Stokes, U. scabra Miller): mPh-MPh, Eua; U4T3R3, Alno-Padion, Fagetalia silvaticae

Urticaceae

Urtica dioica L.: H(G), Cosm; U3T3R4, Alno-Padion, Artemisietea, Epilobietalia angustifolii, Fagetalia silvaticae

Fagaceae

Fagus sylvatica L. ssp. ***sylvatica***: Mph-mPh, E; U3T3R0, Fagetalia silvaticae

Quercus petraea (Mattuschka) Liebl.: Mph-mPh, E; U2.5T3R0, Quercetea pubescenti-petraeae, Veronico officinalis-Quercion

Betulaceae

Alnus incana (L.) Moench: Mph-mPh, Eua; U4T2R4, Alno-Padion

Betula pendula Roth (B. verrucosa Ehrh.): Mph-mPh, Eua; U3T2R2, Carpinion betuli, Symphyto-Fagion, Vaccinio-Piceion

Corylaceae

Carpinus betulus L.: Mph-mPh, E; U3T3R3, Carpinion betuli, Fagion

Corylus avellana L.: mPh, E; U3T3R3, Querco-Fagetea

Caryophyllaceae

Arenaria serpyllifolia L.: Th, Cp; U2T2.5R0, Alysso-Sedion

Cerastium arvense L. ssp. ***arvense***: Ch, Cp; U2.5T0R3.5, Elyno-Seslerietea, Thlaspietea rotundifolii

Cerastium holosteoides Fries ssp. ***holosteoides*** (C. caespitosum Gilib., C. triviale Link., C. fontanum Baumg. ssp. vulgare (Hartm.) Graebner et Burdet): Ch-H, Cosm; U3T0R0, Molinio-Arrhenatheretea, Potentillo ternatae-Nardion, Rumicion alpini

Dianthus carthusianorum L. ssp. ***carthusianorum***: H, E; U2T4R4.5, Festuco-Brometea

Lychnis flos-cuculi L.: H, Eua; U3.5T2.5R0, Magnocaricion elatae, Molinietalia, Molinio-Arrhenatheretea

Lychnis viscaria L. (Viscaria vulgaris Bernh.) ssp. ***viscaria***: Ch-H, Eua; U3T4R0, Festucion rupicolae, Sedo-Scleranthetea

Moehringia trinervia (L.) Clairv.: Th-TH, Eua; U2.5T3R3, Querco-Fagetea

Silene alba (Miller) E.H.L. Krause (Melandrium album (Miller) Garke): Th-TH, Eua; U3.5T2R3, Chenopodio-Scleranthetea, Onopordion acanthii, Origanetalia

Silene dioica (L.) Clairv. (Melandrium rubrum (Weig.) Garcke): H, Eua; U3.5T0R4, Acerion pseudoplatani, Fagetalia silvaticae, Filipendulo-Petasition, Triseto-Polygonion, Vaccinio-Piceetea

Silene heufelii Soó: Th(TH), Carp-B; U3,5T2R0, Fagion, Adenostilion

Silene nutans L. ssp. ***dubia*** (Herbich) Zapal.: H, Carp; U2T3R0, Asplenietea rupestris

Silene pusilla Waldst. et Kit. (Heliosperma quadrifidum (L.) Reichenb.) ssp. ***pusilla***: Ch, E-alp; U3.5T2R0, Cratoneurion commutati

Silene vulgaris *(Moench) Garcke (Behen vulgaris Moench)* ssp. **vulgaris**: H, Eua; U3T3R4, *Festuco-Brometea, Molinio-Arrhenatheretea*

Stellaria graminea L.: H, Eua; U2.5T3R3, Arrhenatheretalia, Molinio-Arrhenatheretea

Stellaria holostea L.: H, Eua; U3T3R0, Carpinion betuli, Querco-Fagetea

Stellaria media (L.) Vill.: Th-TH, Cosm; U3T0R0, Chenopodietea

Stellaria neglecta Weihe S. media ssp. neglecta (Weihe) Gremli: Th-TH, Ec; U3.5T3R3, Querco-Fagetea

Stellaria nemorum L.: H, E; U3.5T3R3, Acerion pseudoplatani, Adenostylion alliariae, Alno-Padion

Chenopodiaceae

Chenopodium album L. ssp. ***album*** (incl ssp. ***spicatum*** (Koch) Nyar.): Th, Cosm; U3T3R0, Chenopodietea

Chenopodium bonus-henricus L.: H, E; U3.5T2R3, Rumicion alpini, Arction, Plantaginetea

Polygonaceae

Polygonum aviculare L.: Th, Cosm; U2.5T0R3, Polygonion avicularis

Polygonum bistorta L.: G, Eua; U4T2.5R3, Calthion palustris, Molinietalia, Triseto-Polygonion

Rumex acetosa L.: H, Cosm; U3T0R0, Molinio-Arrhenatheretea

Rumex acetosella L. ssp. ***acetosella***: H, Cosm; U2T3R2, Festuco-Sedetalia

Rumex alpinus L.: H, E (alp); U3.5T2R0, Adenostylion alliariae, Rumicion alpini

Rumex crispus L.: H, Eua; U4T3R0, Agropyro-Rumicion

Rumex obtusifolius L. ssp. ***obtusifolius***: H, E; U4T0R3, Arction lappae, Artemisietea, Epilobietalia angustifolii

Grossulariaceae

Ribes uva-crispa L. (R. grossularia L.) ssp. ***uva-crispa***: mPh, E; U0T3R0, Acerion pseudoplatani, Alno-Padion, Fagetalia silvaticae

Crassulaceae

Jovibarba globifera (L.) Parnel (Sempervivum globiferum L.) ssp. ***sobolifera*** (J. sobolifera (J. Sims.) Opiz): Ch, E; U1.5T2R4.5, Seslerio-Festucion pallentis

Rhodiola rosea L. (Sedum rosea (L.) Scop. incl. R. scopolii A. Kern.) H, Cp (arct-alp); U2T1.5R0, Papavero-Thymion pulcherrimae

Sedum hispanicum L.: Th-TH, M; U1T3.5R4, Asplenio-Festucion pallentis

Sedum maximum (L.) Hoffm.: H, E; U2T3R4, Festucetalia valesiacae, Querco-Fagetea

Sedum vulgare (Haw.) Link. (S. fabaria Koch, S. telephium L. ssp. fabaria (Koch) Kirschl.): H, Ec; U3,5T2,5R0, Adenostyletalia

Saxifragaceae

Chrysosplenium alternifolium L.: H, Cp; U4T2R4, Alno-Padion, Fagetalia silvaticae

Saxifraga cuneifolia L. ssp. ***robusta*** D. A. Webb.: Ch, E (alp); U3.5T2R0, Fagion

Saxifraga paniculata Miller (S. aizoon Jacq.): Ch, Eua (arct-alp); U1.5T1.5R4.5, Caricetalia curvulae, Seslerietalia coeruleae, Thlaspietea rotundifolii

Saxifraga stellaris L. ssp. ***robusta*** (Engler) Gremli: Ch, Eua (arct-alp); U5T1.5R3, Cardamini-Montion

Parnassiaceae

Parnassia palustris L.: H, Cp; U4.5T2R4.5, Caricetalia davallianae, Molinion coeruleae

Rosaceae

Alchemilla micans Buser (A. vulgaris L. ssp. micans (Buser) Palitz., A. gracilis auct. non Opiz): H, E; U3T2R0, Potentillo ternatae-Nardion, Polygono-Trisetion

Alchemilla vulgaris L. emend. Frohner ssp. ***vulgaris***: H, E; U3.5T2R2, Caricion curvulae, Cynosurion cristati, Potentillo ternatae-Nardion

Crataegus monogyna Jacq. ssp. ***monogyna***: mPh, Eua; U2.5T3R3, Prunetalia, Querco-Fagetea

Filipendula ulmaria (L.) Maxim.: H, Eua; U4.5T2R0, Alno-Padion, Filipendulo-Petasition, Molinietalia

Fragaria vesca L.: H, Eua; U3T2.5R0, Cynosurion cristati, Epilobietalia angustifolii, Querco-Fagetea

Geum montanum L.: H, E (alp); U2.5T1.5R1.5, Caricion curvulae, Potentillo ternatae-Nardion, Salicion herbaceae

Geum rivale L.: H, Cp; U4.5T0R4.5, Adenostylion alliariae, Calthion palustris, Filipendulo-Petasition

Geum urbanum L.: H, Eua; U3T3R4, Alno-Padion, Carpinion betuli, Querco-Fagetea

Potentilla anserina L.: H, Cosm; U4T3R4, Bidentetalia tripartiti, Molinietalia, Nanocyperetalia, Plantaginetalia majoris

Potentilla argentea L. ssp. ***argentea***: H, Eua; U2T4R2, Festuco-Brometea, Onopordetalia, Sedo-Scleranthetea

Potentilla chrysantha Trev.: H, P-B; U2T0R3, Symphyto-Fagion

Potentilla erecta (L.) Rauschel: H, Eua; U0T0R0, Molinio-Arrhenatheretea, Nardetalia

Potentilla reptans L.: H, Eua; U3.5T0R4, Agropyro-Rumicion, Molinio-Arrhenatheretea, Plantaginetea majoris

Potentilla ternata C. Koch (P. aurea L. ssp. chrysocraspeda (Lehm.) Nyman): H, Carp-B; U0T1.5R2, Caricetalia curvulae, Potentillo ternatae-Nardion

Rosa canina L.: nPh, E; U2T3R3, Prunion spinosae, Querco-Fagetea

Rosa pendulina L.: nPh, Ec; U3T2.5R3, Adenostyletalia, Fagion

Rosa squarrosa (Rau) Boreau (R. dumalis Bechst.): nPh, E; U2.5T3R4, Prunetalia

Rubus caesius L.: nPh, E; U4T3R4, Alno-Padion, Convolvuletalia, Fagetalia silvaticae

Rubus hirtus Waldst. et Kit. ssp. ***hirtus***: nPh, E; U3T2.5R3, Fagion, Querco-Fagetea, Sambuco-Salicion capreae

Rubus idaeus L.: nPh, Cp; U3T3R3, Epilobietalia angustifolii, Fagetalia silvaticae

Rubus plicatus Wheihe et Nees ssp. ***plicatus*** (R. fruticosus auct. rom. non L.): nPh, E; U3.5T3.5R2, Querco-Fagetea

Sorbus aucuparia L. ssp. ***aucuparia***: Mph-mPh, E; U3T2.5R2, Querco-Fagetea, Vaccinio-Piceetea

Spiraea chamaedryfolia L. (S. ulmifolia Scop.): nPh-mPh, Eua; U3T2.5R0, Asplenietea rupestris

Fabaceae

Anthyllis vulneraria L. ssp. ***vulneraria***: H, E; U2T0R4, Cynosurion cristati, Festuco-Brometea

Astragalus glycyphyllos L.: H, Eua (sM); U3T3R4, Origanetalia, Querco-Fagetea

Chamaecytisus hirsutus (L.) Link. (Cytisus hirsutus L. incl. C. leucotrichus Schur): nPh, Ec; U2T3.5R4, Festucetalia valesiacae, Quercetea pubescenti-petraeae

Coronilla varia L.: H, Ec-M; U2T3R4, Festuco-Brometea, Quercetea robori-petraeae

Genista tinctoria L. ssp. ***tinctoria***: Ch(-nPh), E; U2.5T3R2, Molinion coeruleae, Nardetalia Quercetea pubescenti-petraeae

Genistella sagittalis (L.) Gams (Genista sagittalis L., Chamaespartium sagittale (L.) P. Gibbs.): Ch, Atl-Ec; U3T3R3, Nardetalia

Lathyrus vernus (L.) Bernh.: H, Eua; U3T3R3, Fagetalia silvaticae

Lotus corniculatus L. ssp. ***corniculatus***: H, Eua; U2.5T0R0, Festucetalia valesiacae, Festucion vaginatae, Molinio-Arrhenatheretea, Plantaginetea majoris

Medicago lupulina L.: Th-TH, Eua; U2.5T3R4, Alysso-Sedion, Chenopodietea, Festuco-Brometea, Molinio-Arrhenatheretea, Plantaginetea majoris

Ononis arvensis L. (O. hircina Jacq.) ssp. ***arvensis***: H, Eua-C; U3T4R0, Molinio-Arrhenatheretea

Trifolium alpestre L.: H, E; U2.5T3R4, Geranion sanguinei, Quercetea pubescenti-petraeae

Trifolium campestre Schreber: Th, E; U3T3R0, Arrhenatheretalia, Festuco-Brometea, Plantaginetea majoris

Trifolium dubium Sm.: Th, E; U3.5T2.5R0, Arrhenatheretalia, Arrhenatherion elatioris, Nanocyperion flavescentis

Trifolium montanum L.: H, Eua-C; U2.5T3.5R4, Arrhenatheretalia

Trifolium pratense L. ssp. ***pratense***: H, Eua; U3T0R0, Molinio-Arrhenatheretea, Plantaginetea majoris

Trifolium repens L. ssp. ***repens***: H, Eua; U3.5T0R0, Cynosurion cristati, Molinio-Arrhenatheretea, Plantaginetea majoris

Vicia cracca L.: H, Eua; U3T0R3, Molinio-Arrhenatheretea

Vicia sepium L.: H, Eua; U3T3R3, Quercetea robori-petraeae, Querco-Fagetea, Trifolion medii; var. *montana* Koch

Onagraceae

Chamerion (Chamaenerion) angustifolium (L.) Holub (Epilobium angustifolium L.): H, Cp; U4T1.5R0, Epilobietalia angustifolii

Circaea lutetiana L.: G, Eua-M; U3.5T3R4, Alno-Padion, Fagetalia silvaticae

Epilobium montanum L.: H, Eua; U3T0R3.5, Fagetalia silvaticae

Thymelaeaceae

Daphne mezereum L.: nPh, Eua; U3.5T3R3, Fagetalia silvaticae

Cornaceae

Cornus sanguinea L.: mPh, Ec; U3T3R4, Prunetalia, Querco-Fagetea

Euphorbiaceae

Euphorbia amygdaloides L.: Ch, Ec-sM; U3T3.5R4, Querco-Fagetea

Euphorbia carniolica Jacq.: H, Alp-Carp-B; U3T3R4, Fagion, Vaccinio-Piceetalia

Mercurialis perennis L.: G (H), E; U3.5T3R4, Fagetalia silvaticae

Aceraceae

Acer platanoides L.: MPh, E; U3T3R3, Acerion pseudoplatani, Fagetalia silvaticae, Querco-Fagetea

Acer pseudoplatanus L.: MPh, Ec; U3.5T3R3, Acerion pseudoplatani, Querco-Fagetea

Oxalidaceae

Oxalis acetosella L.: H(G), Cp; U4T3R3, Betulo-Adenostyletea, Fagetalia silvaticae, Vaccinio-Piceetea

Geraniceae

Geranium phaeum L.: H, Ec; U4T3R3, Adenostylion alliariae, Alno-Padion, Fagetalia silvaticae, Filipendulo-Petasition

Geranium pratense L.: H, Eua; U3.5T3R5, Arrhenatheretalia, Arrhenatherion elatioris

Geranium robertianum L. ssp. ***robertianum***: Th-TH, Cosm; U3.5T3R3, Acerion pseudoplatani, Alno-Padion, Fagetalia silvaticae

Geranium sylvaticum L.: H, Eua; U3T2R0, Betulo-Adenostyletea, Triseto-Polygonion

Balsaminaceae

Impatiens glandulifera Royle (I. roylei Walp.): Th, Adv; U4T3R4, Calystegion

Impatiens noli-tangere L.: Th, Eua; U4T3R4, Alno-Padion, Fagetalia silvaticae

Linaceae

Linum catharticum L. ssp. ***catharticum***: Th, E; U3T2R4, Molinio-Arrhenatheretea

Polygalaceae

Polygala amara L. ssp. ***amara***: H(-Ch), Ec; U0T3R4.5, Seslerio-Festucion pallentis

Polygala vulgaris L. ssp. ***vulgaris***: H, E; U3T3R3, Arrhenatheretalia, Nardetalia

Apiaceae

Aegopodium podagraria L.: H(G), Eua; U3.5T3R3, Alno-Padion, Querco-Fagetea

Angelica archangelica L.: TH-H, Eua (bor); U4.5T2.5R0, Adenostyletalia, Filipendulo-Petasition

Anthriscus nitida (Wahlbg.) Garcke: TH-H, Alp-Carp-B; U3T2.5R4, Acerion pseudoplatani

Anthriscus sylvestris (L.) Hoffm.: TH-H, Eua; U3T3R4, Alno-Padion, Arrhenatheretalia

Astrantia major L. ssp. ***major***: H, Ec; U3.5T2.5R4, Fagetalia silvaticae, Trifolion medii, Triseto-Polygonion

Bupleurum falcatum L. ssp. ***falcatum***: H, E; U2T3.5R4, Festucetalia valesiacae, Geranion sanguinei, Seslerion rigidae

Carum carvi L.: TH-H, Eua; U3.5T3R3, Agrostion stoloniferae, Arrhenatheretalia

Chaerophyllum aromaticum L.: H, Ec; U3.5T3R3, Fagetalia silvaticae

Chaerophyllum hirsutum L. (C. cicutaria Vill.): H, Ec; U4.5T2R0, Filipendulo-Petasition

Chaerophyllum temulum L.: TH, E; U3T3R4, Alliarion petiolatae, Fagetalia silvaticae

Conium maculatum L.: TH, Eua; U3T3R3, Arction lappae, Chenopodietea

Heracleum sphondylium L. ssp. ***sphondylium***: TH-H, Eua; U3T2.5R0, Arrhenatheretalia, Filipendulo-Petasition, Querco-Fagetea

Laserpitium latifolium L.: H, E; U0T0R4, Origanetalia, Quercetea pubescenti-petraeae

Ligusticum mutellina (L.) Crantz ssp. ***mutellina***: H, E (alp); U3.5T1.5R3, Caricetalia curvulae, Nardetalia

Peucedanum carvifolia Vill. (P. chabraei (Jacq.) Reichenb.): H, Ec; U3T3R4, Geranion sanguinei, Mesobromion

Pimpinella saxifraga L. ssp. ***saxifraga***: H, Eua-sM; U2.5T0R3, Elyno-Seslerietea, Festuco-Brometea

Pleurospermum austriacum (L.) Hoffm.: TH-H, Ec; U3T2R4, Acerion pseudoplatani, Adenostyletalia

Sanicula europaea L.: H, Eua; U3.5T3R4, Fagetalia silvaticae

Seseli libanotis (L.) Koch (Libanotis montana Crantz) ssp. ***libanotis***: TH-H, Eua-C; U3T0R4, Geranion sanguinei, Quercetea pubescenti-petraeae

Torilis arvensis (Hudson) Link. ssp. ***arvensis***: Th, Ec; U2.5T3.5R4, Caucalidion, Onopordion acanthii

Hypericaceae

Hypericum hirsutum L.: H, Eua; U3T3R3, Querco-Fagetea

Hypericum maculatum Crantz ssp. ***maculatum*** (H. quadrangulum auct.): H, Eua; U4T3R2, Molinion coeruleae, Nardetalia, Pino-Quercetalia

Hypericum montanum L.: H, E; U3T3R4, Carpinion betuli, Fagion

Hypericum perforatum L.: H, Eua; U3T3R0, Festuco-Brometea, Origanetalia, Sedo-Scleranthetea

Hypericum tetrapterum Fries. (H. quadrangulum L. nom. Ambig.): H, E; U4T3R4, Filipendulo-Petasition, Glycerio-Sparganion, Magnocaricion elatae

Malvaceae

Malva sylvestris L. ssp. ***sylvestris***: Th-TH, Eua; U3T3R0, Onopordetalia, Sisymbrietalia

Violaceae

Viola biflora L.: H, Cp; U3.5T2R4, Adenostyletalia

Viola canina L. ssp. ***canina***: H, Eua; U2.5T0R2, Asplenion septentrionalis, Molinio-Arrhenatheretea, Molinion coeruleae, Nardetalia, Sedo-Scleranthetalia

Viola declinata Waldst. et Kit.: H, Carp-B; U3.5T2R2, Cynosurion cristati, Nardetalia, Potentillo ternatae-Nardion, Triseto-Polygonion

Viola reichenbachiana Jordan (V. sylvestris Lam.): H, Eua; U3T3R3.5, Fagetalia silvaticae, Querco-Fagetea

Viola tricolor L. ssp. ***tricolor***: TH-H, Eua; U2.5T3R0, Asplenio-Festucion pallentis, Molinio-Arrhenatheretea, Sedo-Scleranthetea, Seslerio-Festucion pallentis; ssp. ***subalpina*** Gaudin (V. saxatilis F. W. Schmidt, V. luteola (Schur) Gayer, V. bielziana Schur): H, E; U3T2.5R3

Cistaceae

Helianthemum nummularium (L.) Miller ssp. ***obscurum*** (Celak.) Holub (ssp. ovatum (Viv.) Schinz et Thell., H. hirsutum (Thuill.) Merat): Ch, E; U2,5T3R4, Seslerietalia

Brassicaceae

Alliaria petiolata (Bieb.) Cavara et Grande (A. officinalis Andrz.): Th-TH, Eua; U3T3R4, Alliarion petiolatae, Arction lappae, Epilobietea angustifolii, Querco-Fagetea

Arabis alpina L.: H, Eua (arct-alp); U3.5T1.5R5, Thlaspietea

Arabis hirsuta (L.) Scop.: TH-H, Eua-M; U1.5T3R4, Festuco-Brometea, Quercetea pubescenti-petraeae

Arabis procurrens Waldst. et Kit.: H, Carp-B; U3T3R3, Thlaspietea rotundifolii

Barbaraea vulgaris R. Br. ssp. ***vulgaris***: H, Eua; U3.5T3R3, Agropyro-Rumicion, Calystegion, Senecion fluviatilis

Bunias orientalis L.: TH-H, Eua-C; U3T3.5R3, Artemisietalia, Chenopodietea

Capsella bursa-pastoris (L.) Medik.: Th-TH, Cosm; U3T0R0, Chenopodietea, Chenopodio-Scleranthetea

Cardamine amara L. ssp. ***amara***: H, Eua; U5T0R0, Alno-Padion, Cardamini-Montion

Cardamine impatiens L.: TH, Eua; U4T3R3, Fagetalia silvaticae

Cardamine pratensis L. ssp. ***pratensis***: H, Cp; U5T3R0, Molinio-Arrhenatheretea

Cardaminopsis arenosa (L.) Hayek ssp. ***arenosa***: Th-H, Ec; U2.5T3R4, Asplenion rutae-murariae, Sedo-Scleranthetea, Thlaspion rotundifolii

Dentaria bulbifera L. (Cardamine bulbifera (L.) Crantz): G, Ec; U3T3R4, Fagetalia silvaticae, Fagion

Descurainia sophia (L.) Webb (Sisymbrium sophia L.): Th-TH, Eua; U2.5T4R4, Onopordion acanthii, Sisymbrion officinalis

Erysimum witmannii Zawadzki ssp. ***transsilvanicum*** (Schur) P. W. Ball: TH, Carp; U1.5T3.5R4.5, Seslerio-Festucion pallentis

Lunaria rediviva L.: H, E; U4T3R4, Acerion pseudoplatani

Rorippa pyrenaica (L.) Reichenb.: H, E; U2.5T3R3, Arrhenatheretalia

Rorippa sylvestris (L.) Besser ssp. ***sylvestris***: H, Eua; U4T3R4, Agropyro-Rumicion

Salicaceae

Populus tremula L.: Mph-mPh, Eua; U3T2R2, Querco-Fagetea

Salix alba L. ssp. ***alba***: Mph-mPh, Eua; U5T3R4, Alno-Padion, Salicion albae

Salix caprea L.: mPh, Eua; U3T3R3, Sambuco-Salicion capreae, Alno-Padion

Salix cinerea L.: mPh, Eua; U5T3R3, Alnetea glutinosae, Alno-Padion

Salix triandra L. emend. Ser. (S. amygdalina L.) ssp. ***triandra***: mPh, Eua; U5T3R0, Salicion triandrae

Ericaceae

Bruckenthalia spiculifolia (Salisb.) Reichenb.: nPh, Carp-B; U2.5T2.5R1.5, Junipero-Bruckenthalion

Vaccinium gaultherioides Bigelow (V. uliginosum L. ssp. microphyllum Lange, V. uliginosum auct. rom. p.p.): Ch, Cp (arct-alp); U3.5T0R1, Cetrario-Loiseleurion

Vaccinium myrtillus L.: Ch (nPh), Cp; U0T2R1, Pino-Quercetalia, Vaccinio-Piceetalia

Vaccinium vitis-idaea L.: Ch-nPh, Cp; U3T2R1, Pino-Quercetalia, Vaccinio-Piceetalia

Pyrolaceae

Moneses uniflora (L.) A. Gray (Pyrola uniflora L.): H(G), Cp; U3T2R2.5, Dicrano-Pinion, Vaccinio-Piceetalia

Primulaceae

Lysimachia nummularia L.: Ch, Eua; U4T3R0, Alnetea glutinosae, Alno-Padion, Bidentetea tripartiti, Calthion palustris, Filipendulo-Petasition, Molinietalia, Plantaginetea majoris, Querco-Fagetea

Lysimachia vulgaris L.: H(-Hh), Eua; U5T0R0, Alnetea glutinosae, Molinietalia, Salicetea purpureae, Scheuchzerio-Caricetea nigrae

Primula veris L. em. Huds. (P. officinalis Hill.) ssp. ***veris***: H, Eua; U3T2R5, Arrhenatheretalia, Querco-Fagetea

Soldanella hungarica Simonkai ssp. ***major*** (Neilr.) S. Pawl.: H, Alp-Carp-B, U4T2R1.5, Vaccinio-Piceion

Gentianaceae

Centaurium erythraea Rafin (C. umbellatum auct., C. minus Moench, Erythraea centaurium Pers.) ssp. ***erythraea***: Th-TH, Ec; U3T3R2, Molinio-Arrhenatheretea

Gentiana asclepiadea L.: H, Ec; U4T2R4, Adenostyletalia, Fagion, Origanetalia, Pino-Quercetalia

Gentiana cruciata L.: H, Eua; U3T3R4, Cynosurion cristati, Festuco-Brometea, Mesobromion

Gentiana lutea L.: H, E (alp); U3T2R0, Calamagrostidion villosae, Elyno-Seslerietea

Gentiana utriculosa L.: Th, E (alp); U2.5T2.5R4, Cynosurion cristati, Seslerion rigidae

Gentiana verna L.: H, Eua (arct-alp); U2.5T0R4, Arabidetalia coeruleae, Salicion herbaceae, Seslerietalia coeruleae

Gentianella austriaca (A. et J. Kerner) J. Holub (Gentiana austriaca A. et J. Kerner, G. praecox A. et J. Kerner): TH, Alp-Carp-B; U3T3R3, Cynosurion cristati, Potentillo ternatae-Nardion

Asclepiadaceae

Vincetoxicum hirundinaria Medikus ssp. ***hirundinaria*** (Vincetoxicum officinale Moench, Cynanchum vincetoxicum (L.) Pers.): H, Eua-C; U2T4R4, Geranion sanguinei, Quercetea pubescenti-petraeae

Oleaceae

Fraxinus excelsior L.: MPh, E; U3T3R4, Acerion pseudoplatani, Alno-Padion

Fraxinus ornus L.: mPh-MPh, sM; U1.5T3.5R5, Quercetea pubescenti-petraeae

Ligustrum vulgare L.: mPh, E-sM; U2.5T3R3, Carpinion betuli, Quercetalia pubescentis, Querco-Fagetea

Solanaceae

Atropa belladonna L.: H, E-Atl-M; U3T3R3, Atropion belladonnae, Fagion

Convolvulaceae

Convolvulus arvensis L.: H(G), Cosm; U0T0R0, Arction lappae, Caucalidion, Chenopodio-Scleranthetea, Festuco-Brometea, Sisymbrion officinalis

Cuscutaceae

Cuscuta epithymum (L.) L. ssp. ***epithymum***: Th, Eua; U0T3R0, Festuco-Brometea, Nardetalia, Polygono-Chenopodion polyspermi

Cuscuta europaea L. ssp. ***europaea***: Th, Eua; U4T0R0, Arction lappae, Artemisietalia

Boraginaceae

Echium vulgare L.: TH, Eua; U2T3R4, Festuco-Brometea, Onopordion acanthi, Sedo-Scleranthetea

Myosotis scorpioides L. (M. palustris (L.) Hill): H(Hh), Eua; U5T3R0, Alnetea glutinosae, Calthion palustris, Molinietalia

Myosotis sylvatica Ehrh.: TH, E; U3.5T3R3, Betulo-Adenostyletea, Querco-Fagetea

Pulmonaria mollis Wulfen (P. montana auct. non Lej.) ssp. ***mollis***: H, Ec; U2.5T3R4, Origanetalia, Querco-Fagetea); ssp. ***mollissima*** (Kerner) Nyman: H, E

Pulmonaria obscura Dumort. (P. officinalis L. ssp. obscura (Dumort.) Murb.): H, Ec; U3,5T3R4,5, Fagetalia

Pulmonaria officinalis L. ssp. ***officinalis*** (P. officinalis L. ssp. maculosa (Hayne) Gams): H, E; U3,5T3R3, Acerion pseudoplatani, Carpinion betuli, Fagetalia silvaticae

Pulmonaria rubra Schott: H, Carp-B; U3.5T2R3, Alno-Padion, Fagion, Vaccinio-Piceion

Symphytum cordatum Waldst. et Kit.: H, Carp; U3T2R3, Fagion

Symphytum officinale L. ssp. ***officinale***: H, Eua; U4T3R0, Molinietalia

Lamiaceae

Acinos alpinus (L.) Moench (Calamintha alpina (L.) Lam.) ssp. ***alpinus*** (C. alpina ssp. baumgarteni (Simonkai) Borza): H, Alp-Carp; U3T0R5, Seslerietalia rigidae

Acinos arvensis (Lam.) Dandy (Calamintha acinos (L.) Clairv.) ssp. ***arvensis***: Th-TH, E; U1.5T3.5R4, Festuco-Brometea, Sedo-Scleranthetea

Ajuga genevensis L.: H, Eua; U2.5T3R4, Cynosurion cristati, Festuco-Brometea

Ajuga reptans L.: H-Ch, E; U3.5T0R0, Arrhenatheretalia, Fagetalia silvaticae

Ballota nigra L. ssp. ***nigra***: H, E; U2T3.5R4, Arction lappae, Chenopodietea

Calamintha vulgare L. (C. clinopodium Bentham, Clinopodium vulgare L.).: H, Eua; U2T3R3, Origanetalia, Querco-Fagetea

Galeopsis ladanum L.: Th, Eua; U2T0R4.5, Caucalidion, Secalietea, Sisymbrion officinalis

Galeopsis speciosa Miller: Th, Eua; U3T2R0, Alno-Padion, Epilobietalia angustifolii, Fagetalia silvaticae, Polygono-Chenopodion polyspermi

Galeopsis tetrahit L.: Th, E; U3T3R0, Chenopodietea, Epilobietea angustifolii, Secalietea

Glechoma hederacea L.: H-Ch, Eua; U3T3R0, Agropyro-Rumicion, Alliarion petiolatae, Alno-Padion, Querco-Fagetea, Trifolion medii

Glechoma hirsuta Waldst. et Kit.: H-Ch, P-M-Ec; U2.5T3R4, Querco-Fagetea

Lamium album L.: H, Eua; U3T3R0, Alliarion petiolatae, Arction lappae

Lamium amplexicaule L.: Th, Eua; U2.5T3.5R0, Chenopodio-Scleranthetea, Polygono-Chenopodietalia

Lamium galeobdolon (L.) L. (Galeobdolon luteum Hudson) ssp. ***galeobdolon***: H-Ch, Ec; U3T0R4, Fagetalia silvaticae

Lamium maculatum L. ssp. ***maculatum***: H-Ch, Eua; U3.5T0R4, Alno-Padion, Carpinion betuli, Fagetalia silvaticae

Lycopus europaeus L.: H-Hh, Eua; U5T3R0, Bidentetea tripartiti, Phragmitetea, Salicetea purpureae

Melissa officinalis L.: H, M; U2T4R0, Arction lappae, Quercetea pubescenti-petraeae, Quercetea robori-petraeae

Mentha arvensis L. ssp. ***arvensis*** (ssp. agrestis (Sole) Briq.): H(G), Cp; U4T3R0, Calthion palustris, Molinietalia, Phragmitetea

Mentha longifolia (L.) Hudson ssp. ***longifolia***: H(G), Eua; U4,5T3R0, Agropyro-Rumicion, Bidentetea tripartiti, Chenopodietea, Filipendulo-Petasition, Glycerio-Sparganion, Molinietalia

Origanum vulgare L.: H, Eua-M; U2.5T3R3, Origanetalia, Prunetalia, Quercetea pubescenti-petraeae

Prunella vulgaris L.: H, Cosm; U3T3R0, Alnetea glutinosae, Bidentetea tripartiti, Plantaginetea majoris, Querco-Fagetea

Salvia glutinosa L.: H, Eua; U3.5T3R4, Fagetalia silvaticae

Salvia verticillata L.: H, Ec-M; U2T4R0, Chenopodietea, Festuco-Brometea, Onopordion acanthii, Plantaginetea majoris

Stachys alpina L.: H, Ec; U3T2R0, Epilobietea angustifolii, Sambuco-Salicion capreae

Stachys officinalis (L.) Trev. (Betonica officinalis L.): H, Eua; U3T3R0, Molinion coeruleae, Nardetalia, Origanetalia

Stachys sylvatica L.: H, Eua; U3.5T0R0, Alno-Padion, Fagetalia silvaticae, Filipendulo-Petasition

Teucrium chamaedrys L.: Ch, Ec-sM; U2T3.5R4, Festuco-Brometea, Quercetea pubescenti-petraeae, Sedo-Scleranthetea

Thymus comosus Heuffel: Ch, Carp; U2T3.5R4.5, Asplenietea rupestris, Seslerio-Festucion pallentis, Teucrion montani

Thymus balcanus Borbas (T. praecox Opiz ssp. polytrichus (A. Kerner) Jalas): Ch, Carp-B; U1.5T3.5R2.5, Elyno-Seslerietea, Festucion rupicolae

Thymus pannonicus All. ssp. ***auctus*** (Lyka) Soo (T. marschallianus Willd. ssp. marschallianus): Ch, Eua-C; U1.5T3.5R4, Festucetalia valesiacae, Festuco-Brometea

Thymus pulegioides L. ssp. ***pulegioides***: Ch, E; U2.5T3R3, Festuco-Brometea, Sedo-Scleranthetea, Seslerion bielzii; ssp. ***montanus*** (Bentham) Ronniger

Callitrichaceae

Callitriche cophocarpa Sendtner (C. polymorpha Lonnr.): Th-H (Hh), Eua; U6T3R0, Nanocyperion flavescentis

Plantaginaceae

Plantago lanceolata L.: H, Eua; U0T0R0, Festuco-Brometea, Molinio-Arrhenatheretea

Plantago major L. ssp. ***major***: H, Eua; U3T0R0, Plantaginetea majoris

Plantago media L.: H, Eua; U2.5T0R4, Festuco-Brometea, Molinio-Arrhenatheretea

Scrophulariaceae

Digitalis grandiflora Miller: H, E; U3T3R3, Carpinion betuli, Fagion, Geranion sanguinei

Euphrasia officinalis L. ssp. ***pratensis*** Schubler et Martens (E. rostkoviana Hayne): Th, E; U3T3R3, Molinio-Arrhenatheretea

Euphrasia salisburgensis Funck: Th, E (alp); U3T1.5R4.5, Elyno-Seslerietea

Euphrasia stricta Host ssp. ***stricta***: Th, E; U3T3R0, Arrhenatheretalia, Festuco-Brometea, Nardetalia, Sedo-Scleranthetea

Linaria vulgaris Miller: H, Eua; U2T3R4, Chenopodio-Scleranthetea, Epilobietea angustifolii, Onopordion acanthii, Secalietea

Melampyrum bihariense A. Kerner (M. nemorosum auct. transs. non L.): Th, D; U2.5T3R3, Carpinion betuli, Quercetalia pubescentis

Melampyrum sylvaticum L.: Th, Eua; U3T0R1.5, Vaccinio-Piceetea

Pedicularis verticillata L.: H, Cp (arct-alp); U0T2R4.5, Caricion curvulae, Potentillo ternatae-Nardion

Rhinanthus angustifolius C. C. Gmelin (R. serotinus (Schonheit) Oborny, R. glaber Lam., R. major Ehrh.) ssp. ***angustifolius***: Th, Eua; U0T0R0, Molinietalia, Molinio-Arrhenatheretea

Rhinanthus minor L.: Th, Eua; U3T0R0, Molinio-Arrhenatheretea

Scrophularia nodosa L.: H, Eua; U3.5T3R0, Alliarion petiolatae, Epilobietea angustifolii, Fagetalia silvaticae, Querco-Fagetea

Scrophularia scopolii Hoppe: H, P-Pn-B; U4T3R0, Alliarion petiolatae, Fagetalia silvaticae, Onopordion acanthii

Tozzia alpina L. ssp. ***carpatica*** (Woloszczak) Hayek: H, Carp-B; U3.5T2R4.5, Adenostyletalia, Cardamini-Montion

Verbascum chaixii Vill. ssp. ***austriacum*** (Schott) Hayek: H, E; U2T3R4, Festucetalia valesiacae

Verbascum lychnitis L.: TH, E; U1T3R4, Festuco-Brometea, Trifolio-Geranietea

Verbascum nigrum L. ssp. ***nigrum***: H, Eua; U2T3R4, Epilobietalia angustifolii, Quercetea pubescenti-petraeae

Veronica arvensis L.: Th, Eua; U2.5T3R3, Arrhenatheretalia, Secalietea

Veronica beccabunga L.: H-Hh, Eua; U5T3R4, Bidentetea tripartiti, Glycerio-Sparganion

Veronica chamaedrys L. ssp. ***chamaedrys***: H-Ch, Eua; U3T0R0, Arrhenatheretalia, Prunetalia, Rumicion alpini, Trifolion medii

Veronica officinalis L.: Ch, Eua; U2T2R2, Deschampsio-Fagion, Nardetalia, Pino-Quercetalia, Potentillo ternatae-Nardion, Vaccinio-Piceion, Veronico officinalis-Quercion

Veronica persica Poiret: Th, Adv; U3T0R4, Polygono-Chenopodietalia

Veronica serpyllifolia L. ssp. ***serpyllifolia***: H, Cosm; U3T3R0, Agropyro-Rumicion, Agrostion stoloniferae, Arrhenatheretalia, Cynosurion cristati, Rumicion alpini

Veronica urticifolia Jacq. (V. latifolia Lam. non L.): H, Ec; U3T2.5R4, Acerion pseudoplatani, Fagion

Orobanchaceae

Orobanche flava C. F. P. Mart.: G, E; U3T2.5R0, Filipendulo-Petasition

Campanulaceae

Campanula abietina Griseb. (C. patula L. ssp. abietina (Griseb.) Simk.): H, Carp-B; U3.5T2R2, Junipero-Bruckenthalion, Potentillo ternatae-Nardion

Campanula glomerata L. ssp. ***glomerata***: H, Eua; U2.5T3R4, Arrhenatherion elatioris, Festuco-Brometea, Origanetalia, Quercetea robori-petraeae

Campanula patula L.: TH, E; U3T2.5R3, Arrhenatheretalia

Campanula persicifolia L.: H, Eua; U3T3R0, Quercetalia pubescentis, Querco-Fagetea

Campanula rapunculoides L.: H, Eua; U3T2R0, Fagetalia silvaticae, Geranion sanguinei, Querco-Fagetea

Campanula serrata (Kit.) Hendrych (C. napuligera Schur): H, Carp; U0T2.5R0, Junipero-Bruckenthalion, Potentillo ternatae-Nardion

Campanula trachelium L.: H, Eua (sM); U3T3R3, Carpinion betuli, Querco-Fagetea

Phyteuma orbiculare L.: H, Ec; U0T2R4.5, Asplenietea rupestris, Elyno-Seslerietea, Cynosurion cristati

Rubiaceae

Asperula capitata Kit.: H, Carp-B; U2T2R4, Seslerion rigidae

Asperula cynanchica L.: H, Ec-M; U2T3.5R4.5, Festucetalia valesiacae, Festuco-Brometea

Cruciata glabra (L.) Ehrend. (Galium vernum Scop.) ssp. ***glabra***: H, Eua; U3T2R2, Alno-Padion, Artemisietea, Junipero-Bruckenthalion, Potentillo ternatae-Nardion, Quercetea robori-petraeae, Querco-Fagetea

Cruciata laevipes Opiz (Galium cruciata (L.) Scop.): H, Eua; U2.5T3R3, Alno-Padion, Artemisietalia, Convolvuletalia

Galium aparine L.: Th, Cp; U3T3R3, Convolvuletalia

Galium mollugo L.: H, Eua; U3T0R3, Arrhenatheretalia, Festuco-Brometea, Seslerio-Festucion pallentis, Teucrion montani

Galium odoratum (L.) Scop. (Asperula odorata L.): G, Eua; U3T3R3, Fagetalia silvaticae, Symphyto-Fagion

Galium palustre L. ssp. ***palustre***: H, Cp; U5T3R0, Magnocaricion elatae, Molinietalia

Galium schultesii Vest: G, Ec; U2.5T3R3, Carpinion betuli, Querco-Fagetea

Galium verum L.: H, Eua; U2.5T3.5R0, Festuco-Brometea, Origanetalia

Caprifoliaceae

Lonicera xylosteum L.: mPh, Eua; U3T3R4, Querco-Fagetea

Sambucus ebulus L.: H, Eua (sM); U3T3R4.5, Arction lappae, Artemisietea, Epilobietea angustifolii

Sambucus nigra L.: mPh, E; U3T3R3, Alno-Padion, Epilobietea angustifolii, Prunetalia

Sambucus racemosa L.: mPh, Cp; U3T2R3, Sambuco-Salicion capreae

Adoxaceae

Adoxa moschatellina L.: G, Cp; U4T3R3.5, Alno-Padion, Fagetalia silvaticae, Pinion mugi

Valerianaceae

Valeriana officinalis L.: H, Eua(sM); U4T3R4, Alnetea glutinosae, Alno-Padion, Filipendulo-Petasition, Magnocaricion elatae, Molinietalia

Valeriana sambucifolia Mikan fil. (V. officinalis L. ssp. sambucifolia (Mikan fil.) Celak.): H, Ec; U4T2R3.5, Adenostyletalia, Fagion, Filipendulo-Petasition

Valeriana tripteris L.: H, Ec; U3T0R4.5, Acerion pseudoplatani, Asplenietea rupestris

Dipsacaceae

Knautia arvensis (L.) Coulter ssp. ***arvensis***: H, E; U2.5T3R0, Arrhenatheretalia, Festucion rupicolae

Knautia dipsacifolia Kreutzer (K. sylvatica (L.) Duby) ssp. ***dipsacifolia***: H, Ec; U3.5T2.5R0, Adenostyletalia

Scabiosa ochroleuca L.: H, Eua-C; U2T4R4, Cirsio-Brachypodion, Festucetalia valesiacae

Asteraceae

Achillea collina J. Becker: H, E-C; U2T3R3, Chenopodio-Scleranthetea, Festuco-Brometea

Achillea distans Waldst. et Kit. ssp. ***distans***: H, Alp-Carp-B; U2.5T3R4, Adenostylion alliariae, Junipero-Bruckenthalion, Potentillo ternatae-Nardion, Quercetalia pubescentis, Trifolion medii

Achillea millefolium L. ssp. ***millefolium***: H, Eua; U3T0R0, Agropyro-Rumicion, Artemisietea, Molinio-Arrhenatheretea, Polygonion avicularis

Achillea stricta (Koch) Schleicher: H, Alp-Carp; U2.5T2R3, Junipero-Pinetalia mugi, Nardetalia, Trifolion medii

Antennaria dioica (L.) Gaertner: Ch (H), Eua; U3T1R2.5, Caricion curvulae, Cetrario- Loiseleurion, Nardetalia

Anthemis tinctoria L. ssp. ***fussii*** (Griseb.) Beldie: H, Carp-B; U2T2R3: Festucetalia valesiacae

Arctium lappa L.: TH, Eua; U3T3R4.5, Arction lappae

Arctium tomentosum Miller: TH, Eua; U3T0R5, Onopordetalia

Arnica montana L.: H, E; U3T2.5R3, Triseto-Polygonion

Artemisia vulgaris L.: H, Cp; U3T3R4, Arction lappae, Artemisietea

Bellis perennis L.: H, E; U3T2.5R0, Cynosurion cristati, Molinio-Arrhenatheretea

Bidens tripartita L.: Th, Eua; U4.5T3R0, Bidentetea tripartiti, Chenopodio-Scleranthetea, Nanocyperion flavescentis

Carduus personatus (L.) Jacq. ssp. ***personatus***: H, Ec; U4.5T2.5R4.5, Adenostylion alliariae, Alno-Padion, Filipendulo-Petasition

Carlina acaulis L. ssp. ***acaulis***: H, Ec-M (mont); U2.5T0R0, Arrhenatheretalia, Mesobromion, Potentillo ternatae-Nardion

Carlina vulgaris L. ssp. ***vulgaris***: TH, Eua; U2.5T3.5R0, Festuco-Brometea

Centaurea biebersteinii DC. (C. micranthos S. G. Gmelin): TH-H, P-Pn-B; U2T3.5R4, Festucetalia valesiacae, Festucion vaginatae, Sedo-Scleranthetalia, Sisymbrion officinalis

Centaurea nervosa Wild. (C. Uniflora Turra ssp. Nervosa (Wild.) Bonnier et Layens): H, E (alp); U3T2R2.5, Calamagrostidion villosae, Potentillo ternatae-Nardion

Centaurea phrygia L. (C. austriaca Willd.): H, E; U3T2.5R3, Arrhenatheretalia

Centaurea stoebe L. (C. rhenana Boreau): TH, Ec-B; U2T3.5R4.5, Festucetalia valesiacae, Festucion vaginatae

Cirsium erisithales (Jacq.) Scop.: H, Ec (mont); U3T3R4.5, Fagetalia silvaticae, Filipendulo-Petasition

Cirsium oleraceum (L.) Scop.: H, Eua; U4T3R4, Alno-Padion, Calthion palustris, Filipendulo-Petasition, Molinietalia

Cirsium palustre (L.) Scop.: TH, Eua; U4.5T3R2.5, Alnetea glutinosae, Epilobietalia angustifolii, Molinietalia, Phragmitetea

Cirsium rivulare (Jacq.) Link.: H, Ec (mont); U4T3.5R0, Alnetea glutinosae, Calthion palustris, Magnocaricion elatae, Molinietalia

Cirsium vulgare (Savi) Ten. (C. lanceolatum (L.) Scop. non Hill): TH, Eua; U3T3R0, Artemisietea, Epilobietea angustifolii, Onopordion acanthii

Conyza canadensis (L.) Cronq. (Erigeron canadensis L.): Th-TH, Adv; U2.5T0R0, Chenopodietea, Festucion vaginatae, Sisymbrion officinalis

Crepis biennis L.: TH, E; U3T3R4, Agrostion stoloniferae, Arrhenatheretalia, Sisymbrion officinalis

Crepis paludosa (L.) Moench: H, E (mont); U4.5T0R4.5, Adenostyletalia, Alnetea glutinosae, Alno-Padion, Calthion palustris, Montio-Cardaminetea

Doronicum austriacum Jacq.: G, E (mont); U3.5T2R3, Acerion pseudoplatani, Adenostylion alliariae, Alnion glutinosae-incanae, Filipendulo-Petasition

Erigeron acris L. ssp. ***acris***: TH-H, Cp; U2.5T3R0, Festuco-Brometea, Mesobromion

Erigeron annuus (L.) Pers. (Stenactis annua (L.) Less.) ssp. ***annuus***: Th-TH-H, Adv; U4T0R4, Alno-Padion, Arction lappae, Calystegion, Salicetea purpureae, Sisymbrion officinalis

Eupatorium cannabinum L.: H, Eua; U4T3R0, Alnion glutinosae, Epilobietea angustifolii, Filipendulo-Petasition, Phragmitetea,

Gnaphalium sylvaticum L.: H, Cp; U3T3R3, Epilobietea angustifolii

Hieracium aurantiacum L. ssp. ***aurantiacum***: H, Eua (arct-alp); U3T2R2, Potentillo ternatae-Nardion; ssp. ***carpathicola*** Naegeli et Peter

Hieracium bauhini Besser ssp. ***bauhini***: H, E; U1.5T3R3.5, Cirsio-Brachypodion, Festucetalia valesiacae, Quercetalia pubescentis

Hieracium bifidum Kit. ssp. ***bifidum***: H, Ec; U2.5T2R4.5, Asplenietea rupestris, Cephalanthero-Fagion, Elyno-Seslerietea

Hieracium lachenalii C. C. Gmelin (H. vulgatum Fries, H. acuminatum Jordan incl. ***H. x levicaule*** Jordan) ssp. ***lachenalii***: H, E; U3T0R0, Querco-Fagetea, Fagetalia silvaticae

Hieracium lactucella Wallr. (H. auricula auct. non L.): H, E; U3T0R3, Arrhenatherion elatioris, Potentillo ternatae-Nardion

Hieracium levigatum Willd. ssp. ***levigatum*** (H. rigidum Hartman): H, Eua; U3T3R2, Nardetalia, Pino-Quercetalia, Querco-Fagetea

Hieracium murorum L. (H. sylvaticum (L.) L.): H, E; U3T0R3, Querco-Fagetea, Vaccinio-Piceetalia

Hieracium pilosella L.: H, Eua; U2.5T0R0, Arrhenatheretalia, Festuco-Brometea, Nardetalia, Sedo-Scleranthetea

Hieracium racemosum Waldst. et Kit.: H, Ec-M; U2.5T3R3, Fagetalia silvaticae, Pino-Quercetalia

Hieracium sabaudum L. ssp. ***sabaudum***: H, E; U2.5T3.5R2.5, Deschampsio-Fagion, Origanetalia, Pino-Quercetalia, Quercetalia pubescentis

Hieracium transsilvanicum Heuffel (H. rotundatum auct. non Kit.).: H, Carp-B; U3T0R0, Fagetalia silvaticae, Vaccinio-Piceetea

Hieracium umbellatum L.: H, Cp; U2.5T3R2.5, Deschampsio-Fagion, Nardetalia, Origanetalia, Pino-Quercetalia

Homogyne alpina (L.) Cass.: H, E (alp); U3.5T2.5R2.5, Junipero-Bruckenthalion, Potentillo ternatae-Nardion, Vaccinio-Piceion

Hypochoeris maculata L.: H, Eua; U0T3.5R3.5, Cynosurion cristati, Danthonio-Brachypodion, Festucetalia valesiacae, Festuco-Brometea, Quercetalia pubescentis

Hypochoeris radicata L.: H, E; U3T3R2.5, Cynosurion cristati, Nardetalia

Lactuca serriola Torner: TH, Eua; U1.5T3.5R0, Artemisietea, Chenopodietea, Sisymbrietalia

Lapsana communis L. ssp. ***communis***: Th-TH-H, Eua; U2.5T3R3, Alliarion petiolatae, Arction lappae, Querco-Fagetea

Leontodon autumnalis L. ssp. ***autumnalis***: H, Eua; U3T0R0, Cynosurion cristati, Molinio-Arrhenatheretea, Plantaginetalia majoris

Leontodon hispidus L. ssp. ***hispidus***: H, Eua; U2.5T0R0, Mesobromion, Molinio-Arrhenatheretea

Leucanthemum vulgare Lam. (Chrysanthemum leucanthemum L.) ssp. ***vulgare***: H, Eua; U3T0R0, Molinio-Arrhenatheretea

Leucanthemum waldsteinii (Schultz-Bip.) Pouzar (Chrysanthemum rotundifolium (Waldst. et Kit.) DC.): H, Carp; U4T2R3, Adenostylion alliariae, Chrysanthemo-Piceion, Fagion

Matricaria discoidea DC. (M. matricarioides (Less.) Porter p.p., Chamomila suaveolens (Pursh) Rydb.): Th, Adv; U3T0R0, Bidentetea tripartiti, Polygonion avicularis

Mycelis muralis (L.) Dumort.: H, E; U3T3R0, Asplenietea rupestris, Epilobietea angustifolii, Querco-Fagetea

Petasites albus (L.) Gaertner: G, Eua; U3.5T0R0, Alno-Padion, Fagion

Petasites hybridus (L.) P. Gaertner, B. Meyer et Scherb.: G, Eua; U5T3R3, Adenostyletalia, Alno-Padion, Filipendulo-Petasition

Prenanthes purpurea L.: G, Ec (mont); U3T2.5R0, Adenostylion alliariae, Epilobietea angustifolii, Fagetalia silvaticae, Vaccinio-Piceion

Scorzonera rosea Waldst. et Kit.: G, Alp-Carp-B; U2T0R4, Potentillo ternatae-Nardion

Senecio ovatus (P. Gaertner, B. Meyer et Scherb.) Willd. (S. nemorensis L. ssp. fuchsii (C. C. Gmelin) Celak., S. fuchsii C.C. Gmelin): H, Ec; U3,5T2R3, Fagetalia

Senecio squalidus L. (S. rupestris Waldst. et Kit.): TH-H, Alp-Carp-B; U2T0R2.5, Rumicion alpini, Thlaspietea rotundifolii

Senecio subalpinus Koch: H, Alp-Carp-B; U3.5T2R3, Adenostylion alliariae, Montio-Cardaminetalia, Rumicion alpini

Senecio sylvaticus L.: Th, E; U3T3R3, Epilobietea angustifolii

Solidago virgaurea L. ssp. ***virgaurea***: H, Cp; U2.5T3R3, Epilobietalia angustifolii, Origanetalia

Tanacetum corymbosum (L.) Schultz-Bip. ssp. ***corymbosum***: H, Eua; U2.5T3.5R3, Festucetalia valesiaceae, Geranion sanguinei, Quercetalia pubescentis, Querco-Fagetea

Taraxacum officinale Weber: H, Eua; U3T0R0, Arrhenatheretalia, Artemisietea, Plantaginetea majoris

Telekia speciosa (Schreber) Baumg.: H, Carp-B-Cauc-Anat; U4T2R0, Alnion glutinosae-incanae, Filipendulo-Petasition, Telekion

Tragopogon pratensis L. ssp. ***orientalis*** (L.) Celak. (Tragopogon orientalis L.): TH-H, E; U3T3R4, Agrostion stoloniferae, Arrhenatheretalia

Tussilago farfara L.: G-H, Eua; U3.5T0R4.5, Filipendulo-Petasition, Tussilaginion

Trilliaceae

Paris quadrifolia L.: G, Eua; U3.5T0R4, Fagetalia silvaticae, Pinion mugi

Alliaceae

Allium lusitanicum Lam. (Allium senescens L. ssp. montanum (Fries) Holub (A. montanum Schmidt): G, Ec-sM; U1.5T3.5R4, Festucetalia valesiacae, Seslerietalia coeruleae

Liliaceae

Colchicum autumnale L.: G, Ec; U3.5T3R4, Molinietalia

Erythronium dens-canis L. ssp. ***dens-canis***: G, Ec-sM; U3.5T3.5R4, Carpinion betuli, Quercetea robori-petraeae

Gagea lutea (L.) Ker.-Gawl.: G, Eua; U3.5T0R3, Alno-Padion, Fagetalia silvaticae

Lilium martagon L.: G, Eua; U3T0R4, Betulo-Adenostyletea, Fagetalia silvaticae

Maianthemum bifolium (L.) F.W. Schmidt: G, Eua; U3T3R0, Fagetalia silvaticae, Vaccinio-Piceetalia

Polygonatum verticillatum (L.) All.: G, Eua; U3T2.5R2.5, Betulo-Adenostyletea, Fagion

Scilla bifolia L. ssp. ***bifolia***: G, E; U3.5T3R4, Alno-Padion, Carpinion betuli, Querco-Fagetea

Veratrum album L. ssp. ***album***: H, Eua; U4T2.5R4, Adenostyletalia, Molinion coeruleae, Rumicion alpini

Iridaceae

Crocus vernus (L.) Hill. (C. heuffelianus Herbert): G, Carp-B; U3T1R2, Fagion, Potentillo ternatae-Nardion, Triseto-Polygonion, Vaccinio-Piceion

Orchidaceae

Cephalanthera longifolia (Huds.) Fritsch: G, E; U2.5T3R4, Querco-Fagetea

Coeloglossum viride (L.) Hartman: G, Cp; U2.5T0R3, Nardetalia

Dactylorhiza cordigera (Fries) Soo (Orchis cordigera Fries) ssp. ***cordigera***: G, Carp-B; U4.5T2R2, Montio-Cardaminetalia, Scheuchzerio-Caricetalia nigrae

Dactylorhiza fuchsii (Druce) Soo (Dactylorhiza maculata ssp. fuchsii (Druce) Christens.) ssp. ***fuchsii***: G, Eua; U3T0R0, Fagetalia silvaticae, Molinietalia

Dactylorhiza incarnata (L.) Soo (Orchis incarnata L.) ssp. ***incarnata***: G, Eua; U4.5T0R4, Calthion palustris, Molinion coeruleae

Dactylorhiza maculata (L.) Soo (Orchis maculata L.) ssp. ***maculata***: G, E; U0T0R0, Caricion canescenti-nigrae, Molinietalia

Dactylorhiza sambucina (L.) Soo (Orchis sambucina L.): G, E; U3T2R3, Nardetalia, Querco-Fagetea

Epipactis atrorubens (Hoffm.) Besser: G, Eua; U2T0R4.5, Fagion, Quercetea pubescenti-petraeae

Epipactis helleborine (L.) Crantz: G, Eua; U3T3R3, Fagetalia silvaticae, Quercetea pubescenti-petraeae

Gymnadenia conopsea (L.) R. Br. ssp. ***conopsea***: G, E; U4T0R4.5, Molinietalia

Listera ovata (L.) R. Br.: G, Eua; U3.5T0R4, Alno-Padion, Carpinion betuli, Fagion

Neottia nidus-avis (L.) L.C.M. Richard: G, Eua; U3.5T3R3, Fagetalia silvaticae

Nigritella rubra (Wettst.) K. Richter: G, Alp-Carp; U3T0R4.5, Nardetalia

Orchis coryophora L. ssp. ***coryophora***: G, Ec; U4T0R4.5, Arrhenatherion elatioris, Molinion coeruleae

Orchis morio L. ssp. ***morio***: G, E; U2.5T3R4, Arrhenatheretalia, Festuco-Brometea, Mesobromion

Platanthera bifolia (L.) L.C.M. Richard: G, Eua; U3.5T0R3, Molinietalia, Querco-Fagetea

Juncaceae

Juncus articulatus L. (J. lampocarpus Ehrh.): H, Cp; U5T2R0, Agropyro-Rumicion, Calthion palustris, Nanocyperion flavescentis

Juncus bufonius L.: Th, Cosm; U4.5T0R3, Bidentetea tripartiti, Nanocyperetalia, Plantaginetalia majoris

Juncus compressus Jacq.: G, Eua; U4T3R4, Agropyro-Rumicion, Agrostion stoloniferae, Nanocyperion flavescentis, Plantaginetea majoris

Juncus conglomeratus L.: H, Cp; U4.5T3R3, Calthion palustris, Molinietalia, Molinion coeruleae, Scheuchzerio-Caricetalia nigrae

Juncus effusus L.: H, Cosm; U4.5T3R3, Alnetea glutinosae, Bidentetea tripartiti, Calthion palustris, Molinietalia, Plantaginetea majoris

Juncus inflexus L.: H, Eua; U4T3.5R4, Agropyro-Rumicion

Juncus tenuis Willd.: G, Adv; U3.5T3R4, Polygonion avicularis

Luzula campestris (L.) DC.: H, Cp; U3T0R3, *Arrhenatheretalia, Molinio-Arrhenatheretea, Nardetalia*

Luzula luzuloides (Lam.) Dandy et Willmott (L. nemorosa (Poll.) E. Meyer, L. albida (Hoffm.) DC.) ssp. ***luzuloides***: H, Ec; U2.5T2.5R2, Betulo-Adenostyletea, Fagetalia silvaticae, Junipero-Bruckenthalion; ssp. ***rubella*** (Hoppe) Holub (ssp. cuprina (Rochel) Chrtek et Krisa)

Luzula sylvatica (Hudson) Gaudin: H, Atl-M-Ec; U3.5T2.5R2, Fagion, Vaccinio-Piceetalia

Cyperaceae

Carex digitata L.: H, Eua; U3T3R3, Fagetalia silvaticae

Carex echinata Murray (C. stelllulata Good.): H, Cp; U5T2R1, Calthion palustris, Caricion canescenti-nigrae, Magnocaricion elatae

Carex flava L.: H, Cp; U4.5T3R0, Calthion palustris, Caricetalia davallianae, Eriophorion latifolii, Tofieldietalia

Carex hirta L.: G, Cp; U0T3R0, Agropyro-Rumicion, Magnocaricion elatae, Plantaginetea majoris

Carex nigra (L.) Reichard (C. fusca All.) ssp. ***nigra***: G, Cp; U4T3R2, Calthion palustris, Caricetalia davallianae, Caricion canescenti-nigrae

Carex ovalis Good. (C. leporina auct. non L.): H, Cp; U4T2.5R3, Caricion canescenti-nigrae, Molinietalia, Nardetalia

Carex pairae F. W. Schultz (C. muricata L. ssp. pairaei (F. W. Schultz) Celak., C. muricata L. ssp. lamprocarpa Celak.): H, E; U3T3R0, Quercetea pubescenti-petraeae, Querco-Fagetea

Carex pallescens L.: H, Cp; U3.5T3R3, Molinio-Arrhenatheretea, Nardetalia

Carex remota L.: H, Cp; U4.5T3R3, Alno-Padion, Fagetalia silvaticae

Carex spicata Hudson (C. contigua Hoppe): H, Eua; U0T3R0, Epilobietalia angustifolii, Origanetalia, Querco-Fagetea

Carex sylvatica Hudson: H, Cp; U3.5T3R4, Fagetalia silvaticae

Carex vulpina L.: H, Eua; U4T3R4, Agropyro-Rumicion, Caricion gracilis, Magnocaricion elatae

Eleocharis palustris (L.) Roemer et Schultes: G (Hh), Cosm; U5T0R4, Molinietalia, Nanocyperetalia, Phragmitetea

Eriophorum latifolium Hoppe: H, Cp; U5T0R4.5, Caricion davallianae, Eriophorion latifolii, Scheuchzerio-Caricetalia nigrae

Scirpus sylvaticus L.: G, Cp; U4.5T3R0, Alno-Padion, Calthion palustris, Molinietalia, Phragmitetea

Poaceae

Agrostis canina L. ssp. ***canina***: H, Eua; U3.5T3R3, Caricion canescenti-nigrae, Molinio-Arrhenatheretea

Agrostis capillaris L. (A. tenuis Sibth.) ssp. ***capillaris***: H(G), Cp; U0T0R0, Festuco-Brometea, Molinio-Arrhenatheretea, Nanocyperetalia, Sedo-Scleranthetea

Agrostis stolonifera L. ssp. ***stolonifera***: H, Cp; U4T0R0, Agropyro-Rumicion, Agrostion stoloniferae, Alno-Padion, Magnocaricion elatae, Molinion coeruleae

Anthoxanthum odoratum L.: H, Eua; U0T0R0, Caricion curvulae, Molinio-Arrhenatheretea, Nardetalia

Arrhenatherum elatius (L.) Beauv. ssp. ***elatius***: H, Eua; U3T3R4, Agrostion stoloniferae, Arrhenatherion elatioris

Avenula planiculmis (Schrader) W. Sauer et Chmelitschek s.l. (Helictotrichon planiculme (Schrader) Pilger): H, Carp-B-Sudet; U3T2,5R0, Festuco-Brometea

Avenula pubescens (Hudson) Dumort. (Helictotrichon pubescens (Hudson) Pilger) ssp. ***pubescens***: H, Eua; U3.5T2.5R4, Arrhenatheretalia

Brachypodium sylvaticum (Hudson) Beauv.: H, Eua (sM); U3T3R4, Alno-Padion, Querco-Fagetea

Briza media L: H, Eua; U0T3R0, Arrhenatheretalia, Molinietalia

Bromus hordeaceus L. (B. mollis L.): Th-TH, Eua (sM); U0T3R0, Arrhenatherion elatioris, Festuco-Brometea, Sisymbrion officinalis

Calamagrostis arundinacea (L.) Roth: H, Eua-C; U2.5T3R2, Calamagrostidion arundinaceae, Epilobion angustifolii

Cynosurus cristatus L.: H, E; U3T3R3, Arrhenatheretalia, Cynosurion cristati

Dactylis glomerata L. ssp. ***glomerata***: H, Eua; U3T0R4, Fagion, Molinio-Arrhenatheretea

Danthonia decumbens (L.) DC. (Sieglingia decumbens (L.) Bernh.): H, E; U0T3R2, Danthonio-Brachypodion, Molinio-Arrhenatheretea, Nardetalia

Deschampsia caespitosa (L.) Beauv. ssp. caespitosa (târsă): H, Cosm; U4T0R0; Betulo-Adenostyletea, Molinietalia.

Deschampsia flexuosa (L.) Trin.: H, Cp; U2T0R1, Caricetalia curvulae, Junipero-Pinetalia mugi, Vaccinio-Piceetalia, Veronico officinalis-Quercion

Elymus repens (L.) Gould (Agropyron repens (L.) Beauv.): G, Cp; U0T0R0, Agropyro-Rumicion, Artemisietea, Molinio-Arrhenatheretea

Festuca arundinacea Schreber ssp. ***arundinacea***: H, Ec; U4T3R4, Agropyro-Rumicion, Agrostion stoloniferae, Molinietalia

Festuca drymeia Mert. et Koch (F. montana Bieb.): H, Ec-Carp-B; U4T2R3, Fagion

Festuca heterophylla Lam.: H, Ec-sM; U2.5T3R3, Carpinion betuli, Fagetalia silvaticae, Quercetea pubescenti-petraeae

Festuca nigrescens Lam. (*Festuca rubra* var. *commutata* Gaudin): H, E; U3T1R2, Cynosurion cristati, Nardetalia

Festuca pratensis Hudson ssp. ***pratensis***: H, Eua; U3.5T0R0, Agrostion stoloniferae, Molinio-Arrhenatheretea

Festuca rubra L. ssp. ***rubra***: H, Cp; U3T0R0, Cynosurion cristati, Molinio-Arrhenatheretea, Nardetalia

Festuca rupicola Heuffel ssp. ***rupicola***: H, Eua-C; U1.5T4R4, Festucion rupicolae, Seslerio-Festucion pallentis

Glyceria notata Chevall. (G. plicata (Fries) Fries): H-Hh, Cp; U6T3R4.5, Glycerio-Sparganion

Holcus lanatus L.: H, Cosm; U3.5T3R0, Molinio-Arrhenatheretea

Koeleria macrantha (Ledeb.) Schultes (K. cristata (L.) Pers. p.p., K. gracilis Pers.) ssp. ***macrantha***: H, Eua; U2T4R5, Festuco-Brometea

Lolium perenne L.: H, Cosm; U2.5T4R4.5, Cynosurion cristati, Plantaginetalia majoris

Milium effusum L.: H, Cp; U3.5T3R3, Fagetalia silvaticae

Nardus stricta L.: H, Eua (Cp); U0T0R1.5, Molinio-Arrhenatheretea, Nardetalia

Phleum alpinum L. (P. commutatum Gaudin): H, Cp (alp); U3T2R0, Poion alpinae, Rumicion alpini

Phleum montanum C. Koch: H, Carp-B-Cauc-Anat; U1.5T4R4, Festucion rupicolae

Poa angustifolia L. (P. pratensis L. ssp. angustifolia (L.) Gaudin): H, Eua; U2T3R0, Festuco-Brometea

Poa annua L.: Th-H, Cosm; U3.5T0R0, Polygonion avicularis

Poa media Schur: H, Carp-B; U3T2R0, Juncetea trifidi, Rhododendro-Vaccinion

Poa nemoralis L.: H, Cp; U3T3R0, Asplenietea rupestris, Quercetea pubescenti-petraeae, Querco-Fagetea

Poa pratensis L.: H, Cp-Cosm; U3T0R0, Molinietalia, Molinion coeruleae

Poa trivialis L.: H, Eua; U4T0R0, Calthion palustris, Filipendulo-Petasition, Molinio-Arrhenatheretea, Rumicion alpini

Lemnaceae

Lemna minor L.: Hh, Cosm; U6T0R0, Lemnion minoris

At the border with neighboring villages other species have been observed such as: *Alopecurus pratensis, Botrychium lunaria, Bruckenthalia spiculifolia, Campanula serrata, Carex caryophyllea, Carex remota, Cirsium palustre, Crepis paludosa, Draba nemorosa, Epilobium palustre, Epipactis atrorubens, Galium uliginosum, Gnaphalium sylvaticum, Hypochoeris uniflora, Lathyrus pratensis, Orchis ustulata, Phleum pratense, Potentilla argentea, Potentilla thuringiaca, Pseudorchis albida, Ranunculus polyanthemos, Salix silesiaca, Silene italica* ssp. *nemoralis, Traunsteinera globosa, Trifolium aureum, Trifolium campestre, Trisetum flavescens* and others.

In the field it is difficult to determine the line between the villages, but we believe that the majority of these are in the flora of Şirnea.

REFERENCES

Sanda V., Popescu A. and Doltu M. I., 1977 – Vegetaţia Masivului Piatra Craiului, *Studii şi Comunicări, Muzeul de Ştiinţele Naturii Sibiu*, 21, 115-212. (in Romanian)

Sanda V., Biță-Nicolae C. D. and Barabaş N., 2003 – Flora cormofitelor spontane şi cultivate din România, Edit. Ion Borcea Bacău, 316. (in Romanian)

Tok N., 1998 – Vegetationsökologische Untersuchungen montaner Wiesen der westlichen Ausläufer des Bucegi-Gebirge, Rumäniens, Diplomarbeit, Westfälische Wilhems-Universität Münster, Institut der Ökologie für Pflanzen AG Geobotanik, 88. (in German)

* www.travelworld.ro

** www.wikipedia.org

*** www.googleearth.com

AUTHOR:

[1] *Constantin DRĂGULESCU*
constantindragulescu@yahoo.ro
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Applied Ecology Research Center,
Dr. Ioan Raţiu Street 5-7, Sibiu,
Sibiu County, Romania,
RO-550012.

CONTRIBUTIONS TO THE STUDY OF THE ASSOCIATION BRUCKENTHALIO-PICEETUM BORHIDI 1964, IN THE UPPER PART OF THE ORĂŞTIE RIVER BASIN (TRANSYLVANIA, ROMANIA)

Valeriu-Ioan VINŢAN [1] and *Petru BURESCU* [2]

KEYWORDS: phytocoenoses, association, floristic elements, ecological indices, *Bruckenthalia spiculifolia*, *Picea abies*, Orăştie River, Şureanu Mountains, Transylvania, Romania.

ABSTRACT

In the present paper we aim at a phytocoenological study of the phytocoenoses of the association *Bruckenthalio-Piceetum* Borhidi 1964, an association found in the upper part of the Orăştie River basin, situated in the Şureanu Mountains (Southern Carpathians), in central-western Romania.

The characterization of the association analysed and the presentation of the synthetic table of the association were achieved by careful selection of the most representative relevées from the upper limits of the spruce forests in the Orăştie River basin.

The phytocoenoses of the association analysed, *Bruckenthalio-Piceetum* Borhidi 1964, present in the upper part of the Orăştie River basin, have poor floristic diversity (24 species) but boast the presence of a Carpathian endemic taxon (*Campanula rotundifolia* ssp. *polymorpha*), which occurs in the Grădiştea Muncelului-Cioclovina Natural Reserve (Natura 2000 site).

This study seeks to analyse the phytocoenoses of the association with respect to physionomy, floristic composition, life forms, floristic elements and ecological indices.

REZUMAT: Contribuţii la studiul asociaţiei *Bruckenthalio-Piceetum* Borhidi 1964, din bazinul superior al râului Orăştie (partea central-vestică a României).

În prezenta lucrare facem un studiu fitocenologic al fitocenozelor asociaţiei *Bruckenthalio-Piceetum* Borhidi 1964 (clasa *Vaccinio-Piceetea* Br.-Bl. in Br. – Bl. et al., 1939), identificate în bazinul superior al râului Orăştie, situat în Munţii Şureanu (Carpaţii Meridionali), partea central-vestică a României.

Caracterizarea asociaţiei studiate şi prezentarea tabelului sintetic al asociaţiei au fost realizate prin selectarea celor mai reprezentative relevee, efectuate la limita superioară a molidişurilor din bazinul râului Orăştie.

Fitocenozele asociaţiei analizate, *Bruckenthalio-Piceetum* Borhidi 1964, prezente în bazinul superior al râului Orăştie, cu o biodiversitate scăzută (24 specii), au în componenţa lor un endemit carpatic (*Campanula rotundifolia* ssp. *polymorfa*) şi fac parte din Parcul Natural Grădiştea Muncelului-Cioclovina (sit Natura 2000).

Acest studiu îşi propune să analizeze fitocenozele asociaţiei sub aspectul fizionomiei şi compoziţiei floristice, bioformelor, elementelor floristice şi indicilor ecologici.

RÉSUMÉ: Contributions à l'étude de l'association *Bruckenthalio-Piceetum* Borhidi 1964, du bassin supérieur de la rivière Orăştie (au centre-ouest de la Roumanie).

Dans cet article nous faisons une étude phytocénologique des phytocénoses de l'association *Bruckenthalio-Piceetum* Borhidi 1964, identifiées dans le bassin supérieur de la rivière Orăştie, situé dans les montagnes Şureanu (les Carpates Méridionales) du centre-ouest de la Roumanie.

La caractérisation de l'association étudiée et la présentation du tableau synthétique de cette association ont été réalisées en sélectionnant les prélèvements les plus effectués à la limite supérieure des forêts d'épicéas du bassin de la rivière Orăştie.

Les phytocénoses de l'association *Bruckenthalio-Piceetum* Borhidi 1964, présentes dans le bassin supérieur de la rivière Orăştie, possèdent une faible biodiversité (24 espèces) et sont composées d'un endémisme carpatique (*Campanula rotundifolia* ssp. *polymorpha*). Ces phytocénoses font partie du Parc Naturel Grădiştea Muncelului-Cioclovina (site Natura 2000).

Cette étude vise à analyser les phytocénoses du point de vue de leur physionomie, leur composition floristique, des bioformes, des éléments floraux et des indices écologiques.

INTRODUCTION

The hydrographic basin of the Orăştie River lies in the central-western part of Romania and the southern part of the historical region of Transylvania (Fig. 1). It is located inbetween the hydrographic basins of the rivers Strei (to the south and west) and Cugir (to the east); to the north of the Orăştie River basin ends in the Mureş River.

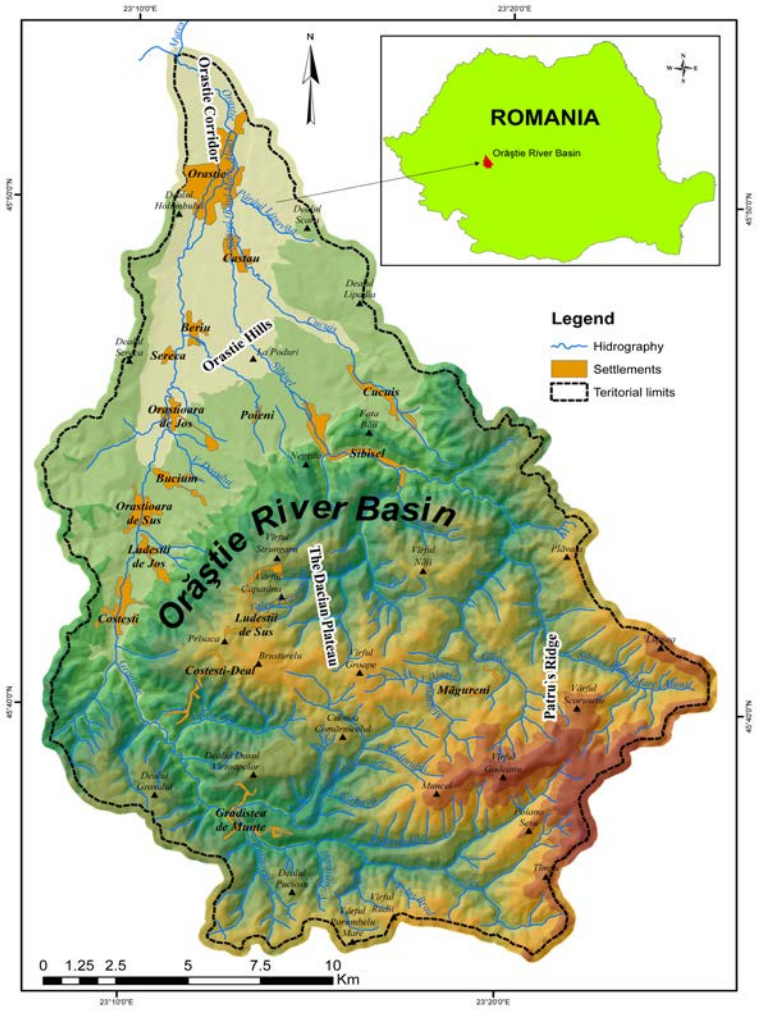

Figure 1: The position of the Orăştie River basin in Romania.

The Şureanu Mountains consist mainly of meso-metamorphic and epi-metamorphic crystalline schists, surrounded peripherically by some areas of sedimentary rocks (sandstones, conglomerates and limestones, etc.). We must add that within the studied territory just a portion of these mountains is included, namely the west-north-western part, commonly known as the Orăştie Mountains.

The territory under analysis is part of the temperate climatic zone, its oceanic influenced climatic sector, its lower mountaineous division, the Southern Carpathians subdivision, the complex topoclimate of the Orăştie lowlands and Parâng highlands (Trufaş, 1986).

The average thermal differences between the outskirts of the mountains and their tops reach around 10°C. Towards their north-western limits, due to the warm air incursions from the Banato-Crişana plains, the yearly average temperatures range from 9 to 10°C. In winter, the multiannual average temperatures vary among -2°C and -7°C, in spring they rise by 6-12°C, in summer they reach 8°C on the mountain tops and over 19°C on the outskirts, while in autumn the average temperatures decrease by 5.5-7°C as compared to those in summer months.

The rainfall amounts in multiannual average to around 550-600 mm in the outskirts and increases to over 1,000 mm in the high altitude central parts (Trufaş, 1986). In the whole of Transylvania the rainfall quantum is 500-700 mm/year (Pătru et al., 2006).

The association *Bruckenthalio-Piceetum* Borhidi 1964 was previously described in the Southern Carpathians (Parâng, Cibin, Cozia, Retezat) and the Apuseni Mountains (Sanda et al., 2008).

Apart from the Oraştie Valley, in a near territory, the Sebeşului Valley (Şureanu Mountains) Borza (1959) researched the phytocoenoses of this association.

MATERIAL AND METHODS

The vegetation studies in the Orăştie River basin (central-western Romania) were conducted throughout 2010 and 2011 targeting all types of sites indicative of the association *Bruckenthalio-Piceetum* Borhidi 1964. The vegetation research deployed the phytocoenologic survey methods drawn up by Braun-Blanquet (1964), adjusted according to the particularities of the region under scrutiny. The sampling technique and the annotations (quantitative appraisals) were observed strictly in accordance with the instructions of the authors Borza and Boşcaiu (1965). The associations were identified using the marker species, without overlooking the differential and dominant species.

In order to thoroughly identify the phytocoenoses of the association, we performed a number of nine phytocoenologic relevées, of which five were included in the synthetic table of the association (Tab. 1).

The sampling sites were chosen within the characteristic patches of the phytocoenoses, their sizes matching 25-400 m^2 each (Cristea et al., 2004).

The phytocoenologic worksheets contain information regarding the habitats' site conditions in which the phytocoenoses evolve: rock, soil, altitude, exposition, slope, vegetation. At the same time when we took down the taxa that define each relevée, we also gave a quantitative appraisal of the participation of each and every species with respect to abundance and dominance, in accordance with the method proposed by Braun-Blanquet and Pavillard (1928), and we pencilled in the overall vegetation coverage using the methods designed by Tüxen (1955) and Ellenberg (1974).

The association phytocoenologic table was designed according to Braun-Blanquet (1964) and Ellenberg (1974). While framing the association into the superior coeno-taxonomic units, suballiance, alliance, order, class, we considered the traditional ecological-floristic systems built by the authors Tüxen (1955), Braun-Blanquet (1964), Borza and Boşcaiu (1965), Soó (1964-1980), as well as the more recent papers by the scientists Mucina et al. (1993), Sanda (2002), Sanda et al. (2008).

The phytocoenologic synoptic table for this association (Tab. 1) consists of information pertaining to the floristic and coenologic composition of the plant population rendering the phytocoenosis, the life form, the floristic (phytogeographic) element, the ecological indices of humidity (U), temperature (T), soil reaction (R), the ordinal numbers of the relevées, the absolute altitude in metres (a.s.l.), the exposition, the slope declination (°), the overall vegetation coverage (%) and the sampled surface (m^2). In the last two columns of the synoptic table we marked the synthetic phytocoenologic indices, namely the constancy of species (K) and the average abundance-dominance (ADm). Constancy (K), whose classes are marked by Roman digits from I to V, stands for the degree of coenotic fidelity of each species towards the ambience of the association's phytocoenoses. The average abundance-dominance (ADm) stands for the percentage of each species' phyto-individual mean coverage within the phytocoenoses. The values of the synthetic phytocoenologic indices, constance (K) and average abundance-dominance (ADm), were calculated using the methods proposed by the scientists Braun-Blanquet and Pavillard (1928), and Cristea et al. (2004).

The nomenclature of taxa was done according to Ciocârlan (2009) and the vegetal association was analysed using the main ecological indices of the component species (Sanda et al., 2005), life forms and floristic elements, the data being displayed graphically through spectra and diagrams (Cristea et al., 2004).

RESULTS AND DISCUSSION

The phytocoenoses of the association under scrutiny, *Bruckenthalio-Piceetum* Borhidi 1964, were found in the upper part of the Orăştie River basin, in the following places: Rudele, Meleia and Godeanu. These phytocoenoses vegetate on slopes of discrete expositions (S, SW, SE, W, E), of 2-28º declinations, at altitudes of 1,320-1,650 m, covering podzols, superficial rankers (Fig. 2).

Figure 2: Association *Bruckenthalio-Piceetum* Borhidi 1964, beneath Godeanu Peak.

Physiognomy and floristic composition. The floristic inventory of the association totals 24 species (21 chormophytes and three bryophytes), thus a poor biodiversity due to the adverse edapho-climatic conditions. The general coverage of the vegetation is between 85% and 95%. The characteristic species, the association's primary one (*Bruckenthalia spiculifolia*), has a significant presence (ADm = 57.50%), when compared to the second characteristic species (*Picea abies*), which has a very reduced coverage (ADm = 3.20%), due to the pedoclimatic conditions and former tree cuttings meant for obtaining the grazing surfaces.

The coenotaxa specific for this association includes a number of seven species (29.16%), which fall under the alliance *Pinion mugi* Pawlowski 1928, order *Junipero-Pinetalia Mugi* Boşcaiu 1971 (*Vaccinum myrtillus, Campanula abietina*) and class *Vaccinio-Piceetea* Br.-Bl. in Br.-Bl. et al. 1939 (*Deschampsia flexuosa, Vaccinum vitis-idaea, Oxalis acetosella*). A number of eight species (33.33%), have migrated from the nards neighboring the association, part of the class *Nardo-Callunetea* (*Nardus stricta, Festuca nigréscens, Danthonia decumbens, Viola declinata, Campanula rotundifolia* ssp. *polymorpha*), four species (16.66%) have transgressed from the class *Querco-Fagetea* (*Luzula luzuloides, Silene nutans* ssp. *nutans*), and five species (20.83%) are accompanying species.

Analysed from a life forms spectrum (Fig. 3) point of view, the association's phytocoenoses result dominated by hemicryptophytes (H = 71.42%; *Deschampsia flexuosa, Nardus stricta, Festuca nigrescens, Potentilla erecta, Danthonia decumbens, Hypericum maculatum, Viola declinata, Luzula luzuloides, Fragaria vesca*), their abundance, due to moderate temperate climate, to natural phenomena (tree falling caused by winds and snows) and to irrational wood exploitation especially in the years following 1990. The chamaephytes (Ch = 14.28%; *Vaccinum myrtillus, Vaccinum vitis-idaea*) are typical for the subalpine zone with glacial winters and snowfalls. Phanerophytes have a poor presence (Ph = 9.52%) that reduces with altitude. The reduced presence of the therophytes (TH = 4.76%) proves a reduced level of human intervention on flora and vegetation as a result of pasturing and wood exploitation.

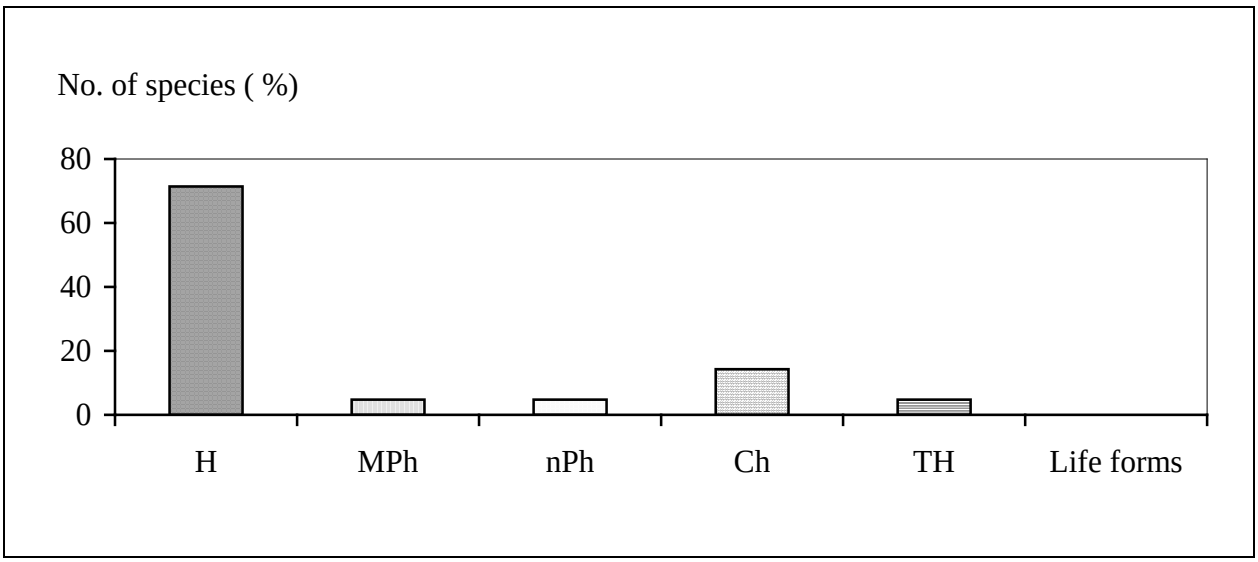

Figure 3: The life forms spectrum of the association *Bruckenthalio-Piceetum* Borhidi 1964; H – Hemicryptophytes; MPh – Megaphanerophytes; nPh – Nanophanerophytes; Ch – Chamaephytes; TH – Biennial therophytes.

The floristic elements spectrum (Fig. 4) highlights that the Circumpolar elements are predominant (Circ = 28.57%; *Vaccinum myrtillus, Deschampsia flexuosa, Oxalis acetosella, Festuca nigrescens*), which shows that a cold climate similar to the boreal one is present in the analysed territory. The Eurasiatic species are present in the same percentages (Eua = 23.80%; *Potentilla erecta, Hieracium pilosella, Hypericum maculatum, Poa nemoralis*), species that have genetically evolved in Europe and Asia, followed by European elements (E = 19.04%; *Picea abies, Nardus stricta, Danthonia decumbens*), with a genetic centre in the moderate temperate climate of Europe, then by Carpatho-Balkanic elements (Carp-B = 9.52%;

Bruckentalia spiculifolia, Viola declinata) with a genetic centre within the Carpathian mountaineous chain and from where a subsequent migration towards south took place or which appeared in the Balkans and migrated towards the Dacian territories, where they've been harmonically integrated in the adoptive stations. The Carpathian endemisms, are also present (End-Carp = 4.76%; *Campanula rotundifolia* ssp. *polymorpha*), as well as Carpathian elements specific for the Carpathian Mountains (Carp = 4.76%; *Campanula abietina*) and Ponto-Panonic ones (P-Pan = 4.76%; *Thymus glabrescens*), linked to the ancestral climate of the Pontian and Panonian lakes during the Pliocene age.

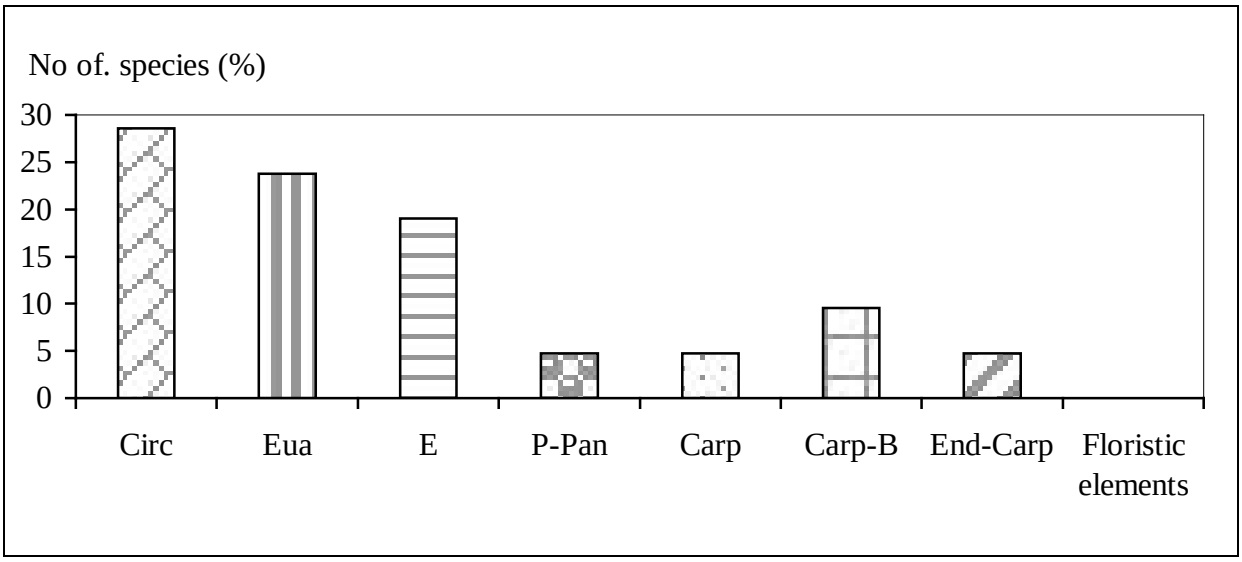

Figure 4: Spectrum of floristic elements of the association *Bruckenthalio-Piceetum* Borhidi 1964; Circ – Circumpolar; Eua – Eurasian; E – European; P-Pan – Ponto-Panonic; Carp – Carpathian; Carp-B – Balkan-Carpathian; End-Carp – Carpathian endemism.

The analysis of the ecological indices diagram (Fig. 5) shows that in terms of humidity the mesophilous species (species that vegetate in conditions of sufficient humidity) are predominant ($U_{3-3.5}$ = 28.57%; *Campanula abietina, Vaccinum vitis-idaea Festuca nigréscens, Viola declinata, Poa nemoralis*), followed by xero-mesophilous ($U_{2-2.5}$ = 28.57%; *Hieracium pilosella, Bruckentalia spiculifolia, Deschampsia flexuosa, Campanula rotundifolia* ssp. *polymorpha, Luzula luzuloides*) growing on dry-wet to wet soils, on spots with a lower and only seasonal water deficit, then followed by eurihydrical species with a large ecological amplitude towards soil humidity (U_0 = 23.80%; *Picea abies, Vaccinum myrtillus Nardus stricta, Danthonia decumbens*), meso-hygrophilous that grow on spots with high humidity ($U_{4-4.5}$ = 14.28%; *Potentilla erecta, Hypericum maculatum, Oxalis acetosella*) and xerophilous ($U_{1-1.5}$ = 3.84%; *Thymus glabrescens*) which grow on spots with seasonal water deficit.

The thermic behaviour puts into evidence the prevalence of the microthermal species which adjusted to low temperature spots ($T_{2-2.5}$ = 33.33%; *Bruckentalia spiculifolia, Vaccinum myrtillus, Campanula abietina, Vaccinum vitis-idaea, Viola declinata, Luzula luzuloides, Fragaria vesca*), followed by eurithermal species that adapted to a high amplitude of thermal variability (T_0 = 28.57%; *Picea abies, Deschampsia flexuosa, Nardus stricta, Hieracium pilosella, Campanula rotundifolia* ssp. *polymorpha*), micro-mesothermal species which need a temperature regime of 6-10ºC ($T_{3-3.5}$ = 23.80%; *Oxalis acetosella, Danthonia decumbens, Hypericum maculatum, Poa nemoralis, Silene nutans* ssp. *nutans*), criophylous ($T_{1-1.5}$ = 9.52%; *Festuca*

nigréscens, Potentilla erecta) and the moderately thermophilous ones, which need a temperature regime of 10-15ºC ($T_{4-4.5}$ = 3.84%; *Thymus glabrescens*).

The chemical reaction of soils is transparent in the higher percentage of euri-ionical species, with high tolerance towards the soil chemistry (R_0 = 33.33%; *Picea abies, Potentilla erecta, Hieracium pilosella, Fragaria vesca, Poa nemoralis, Thymus glabrescens*), followed by highly acidophilous vegetating on high acid soils with a pH varying from 3.5 to 5.0 (R_1 = 23.80; *Bruckentalia spiculifolia, Vaccinum myrtillus, Deschampsia flexuosa, Vaccinum vitis-idaea, Nardus stricta*), acidophilous favouring strongly to moderately acid soils, with a pH ranging between 5.0 and 5.8 (R_2 = 23.80; *Danthonia decumbens, Festuca nigrescens, Hypericum maculatum, Luzula luzuloides*), acido-neutrophilous growing on moderately to weakly acid soils (R_3 = 14.28%; *Viola declinata, Oxalis acetosella, Campanula rotundifolia* ssp. *polymorpha*) and the acid-neutrophilous developing on weakly acid to neutral soils with a pH between 6.5 and 7.0 (R_4 = 4.76%; *Silene nutans* ssp. *nutans*). The great share of the highly acidophilous (R_1 = 23.80%) and acidophilous (R_2 = 23.80%) species in the analysed *Bruckenthalio-Piceetum* Borhidi 1964 association, is determined by the strongly to moderately acid pH of the soil formed on acid rocks (micaschists, quartzites, silica sandstones, quartziferous sands, etc.).

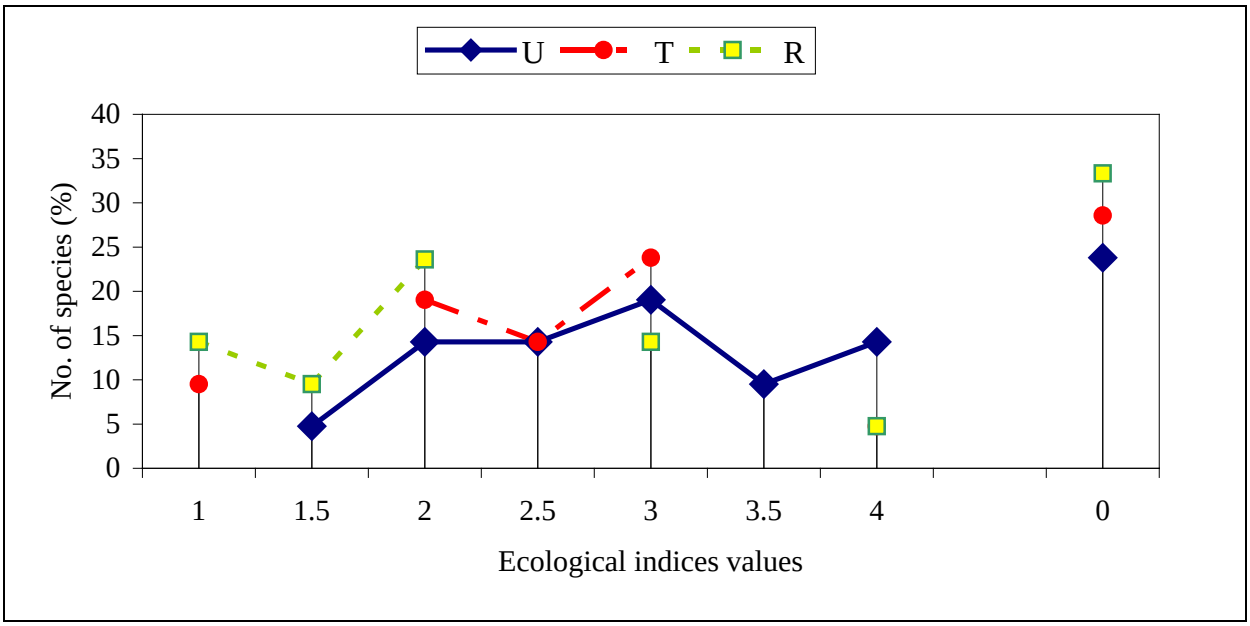

Figure 5: Diagram of ecological indices for the association *Bruckenthalio-Piceetum* Borhidi 1964; U – humidity, T – temperature, R – the chemical reaction of soils.

The research we have performed in the upper catchment basin of the Orăştie River during 2010-2011 revealed that the phytocoenoses of the *Bruckenthalio-Piceetum* Borhidi 1964 association, growing at the upper limits of spruce forests, were little studied in Romania.

When comparing the phytocoenoses of the *Bruckenthalio-Piceetum* Borhidi 1964 association, studied by us in the upper part of the Orăştie Basin (Şureanu Mountains on the west-north-west of South Carpathians) with those in the Cozia Massive (the central-southern part of the Southern Carpathians), described by Coldea and Pop (1988) and studied by Sanda et al. (2007), some similarities and differences come to light.

The phytocoenological table for the reference association (Tab. 1) realised by us (Orăştie Valley, Şureanu Mountains) contains five relevées performed at 1,320-1,650 m, while the phytocoenological table of Coldea and Pop (Cozia Massive), contains six relevées performed at 1,400-1,600 m.

The floristic inventory of the phytocoenoses for the *Bruckenthalio-Piceetum* Borhidi 1964 association, in the upper basin of the Orăştie River (Şureanu Mountains) comprises 24 species, seven of which (29.16%) are part of the coenotaxa subordinating the association, 12 species (49.99%) have transgressed from the *Nardo-Callunetea* and *Querco-Fagetea* classes, five species (20.83%) are accompanying species, while the phytocoenoses of the Cozia Massive reference association have 38 species out of which 18 species (47.36%) are part of the coenotaxa subordinating the association and 20 are accompanying species (52.63%).

In the Orăştie River basin (Şureanu Mountains) the characteristic and edifying species for the *Bruckentalia spiculifolia* association has a high average covering rate (ADm = 57.50%), while the spruce (*Picea abies*) has a low average covering rate (ADm = 3.20%). In the Cozia Massive *Bruckentalia spiculifolia* has a low average covering rate (ADm = 2.66%) and the *Picea abies* species has a high average covering rate (ADm = 79.16%).

We consider that the different percentages regarding the physiognomy and the floristic composition of the phytocoenoses of the *Bruckenthalio-Piceetum* Borhidi 1964 association, in the two regions of the Southern Carpathians (the upper catchment basin of the Orăştie River and the Cozia Massive areas) are due to the different conditions (climate, relief, underground and soil) in which these phytocoenoses develop and to the degree of the human impact on this specific habitat.

CONCLUSIONS

The phytocoenoses of the association researched by us, *Bruckenthalio-Piceetum* Borhidi 1964, in the upper part of the Orăştie River basin (Şureanu Mountains), belongs to the Grădiştea Muncelului-Cioclovina Natural Reserve (Natura 2000 site) and are stable in respect to the ecological dynamics and equilibrium.

These phytocoenoses cover relatively small areas in the territory under scrutiny, being fragmented from natural causes or due to human activities (grazing, spruce tree cutting − *Picea abies*). Nowadays, these activities have greatly diminished due to the reduction of grazing importance in this area of the Orăştie Valley (Şureanu Mountains) (Fig. 6).

The habitat we researched has an important ecological role because it shelters many species of plants and animals; ensures the slope protection against erosion; intercepts the rainfall, releases part of it through perspiration, helps considerable amounts of rain water to permeate the soil; in spring time it buffers the snow thawing; helps maintain the upper natural limits of spruce forests; increases the touristic attractivity of the region by rendering the scenery both diverse and specific (Pop and Florescu, 2008).

In the phytocoenoses of the association studied, *Bruckenthalio-Piceetum* Borhidi 1964, in the upper part of the Orăştie River basin (Şureanu Mountains), we found an endemism (*Campanula rotundifolia* ssp. *polymorpha*) (Ciocârlan, 2009).

The reduced area of an endemic species increases its vulnerability and thus the conservation process of the whole system (species-habitat) suddenly becomes highly important (Pop and Florescu, 2008).

Romania is famous for the beauty and diversity of its Carpathian ecosystems. We believe that the research we conducted on the phytocoenoses of the association *Bruckenthalio-Piceetum* Borhidi 1964 brings about a better understanding of the natural habitats in the Carpathians.

Figure 6: Grazing areas beneath Godeanu Peak (Şureanu Mountains).

Table 1: Association *Bruckenthalio-Piceetum* Borhidi 1964 in the Orăştie River basin.

L.f.	F.e.	U.	T.	R.	No. Land Surveys	1	2	3	4	5	K	*
					Altitude (m.s.m.)	1320	1435	1580	1650	1645		
					Exposition	SV	V	SE	E	S		
					Slope (°)	2	2	20	28	18		
					Coverage (%)	85	95	90	95	90		
					Surface (m^2)	25	100	200	400	200		
0	1	2	3	4	5	6	7	8	9	10	11	12
Car. ass.												
nPh	Carp -Balc	2.5	2.5	1.5	*Bruckenthalia spiculifolia*	4	4	3	4	4	V	57. 50
MPh	E	0	0	0	*Picea abies*	+	1	1	1	+	V	3. 20
Pinion mugi* et *Junipero-Pinetalia												
Ch	Circ	0	2	1	*Vaccinum myrtillus*	1	+	3	2	2	V	15. 60
TH	Carp	3.5	2	2	*Campanula abietina*	+	+	.	.	.	II	0. 20
Vaccinio-Piceetea												
H	Circ	2	0	1	*Deschampsia flexuosa*	1	+	1	1	1	V	4. 10
Ch	Circ	3	2	1	*Vaccinum vitis-idaea*	+	1	+	.	+	IV	1. 30
H	Circ	4	3	3	*Oxalis acetosella*	.	+	.	.	.	I	0. 10

Table 1 (continuing): Association *Bruckenthalio-Piceetum* Borhidi 1964 in the Orăştie River basin.

0	1	2	3	4	5	6	7	8	9	10	11	12
Nardo-Callunetea												
H	E	0	0	1.5	*Nardus stricta*	1	2	.	1	1	IV	6. 50
H	Circ	3	1	2	*Festuca nigréscens*	.	.	1	1	+	III	2. 10
H	Eua	4	1	0	*Potentilla erecta*	+	+	.	.	+	III	0. 30
H	E	0	3	2	*Danthonia decumbens*	+	+	.	.	.	II	0. 20
H	Eua	2.5	0	0	*Hieracium pilosella*	+	+	.	.	.	II	0. 20
H	Eua	4	3	2	*Hypericum maculatum*	+	+	.	.	.	II	0. 20
H	Carp -B	3.5	2	3	*Viola declinata*	+	+	.	.	.	II	0. 20
H	End-Carp	2	0	3	*Campanula rotundifolia polymorpha*	.	+	.	.	.	I	0. 10
Querco-Fagetea												
H	E	2.5	2.5	2	*Luzula luzuloides*	+	+	+	+	+	V	0. 50
H	Eua	3	2.5	0	*Fragaria vesca*	+	+	.	.	.	II	0. 20
H	Eua	3	3	0	*Poa nemoralis*	+	+	.	.	.	II	0. 20
H	Eua	2	3	4	*Silene nutans* ssp. *nutans*	+	+	.	.	.	II	0. 20
Variae syntaxa												
Ch	P-Pan	1.5	4	0	*Thymus glabrescens glabrescens*	+	+	+	.	.	III	0. 30
H	Circ	0	0	0	*Agrostis capillaris*	.	.	+	.	+	II	0. 20
.	.	.	.	.	*Polytrichum commune*	+	+	.	.	.	II	0. 20
.	.	.	.	.	*Polytrichum strictum*	+	+	.	.	.	II	0. 20
.	.	.	.	.	*Dicranium scoparium*	.	+	.	.	.	I	0. 10

Relevées: 1: Rudele, 03.08.2010; 2: Meleia, 03.08.2010; 3, 4, 5: Godeanu, 19.07.2011; L. f. – life forms: nPh – Nanophanerophytes; MPh – Megaphanerophytes; H – Hemycriptofites; Ch – Chamaephytes; TH – Hemiterophytes; F.e. – floristic elements: Eua – Eurasian; Circ – Circumpolar; E – European; Carp – Carpathian; Carp-B – Carpatho-Balkan; P – Pan – Pontic-Pannonian; End-Carp – Carpathian endemism; Ecological indices: U – humidity; T – temperature; R – the chemical reaction of soil, * – ADm (%).

REFERENCES

Borza A., 1959 – Flora şi vegetaţia Văii Sebeşului, Edit. Academiei Republicii Populare Române, Bucureşti, 227-229. (in Romanian)

Borza A. and Boşcaiu N., 1965 – Introducere în studiul covorului vegetal, Edit. Academiei Republicii Populare Române, Bucureşti, 342. (in Romanian)

Braun-Blanqet J., 1964 – Pflanzensoziologie. Springer- Verlag, Wien-New York, 3, Auflage, 12-24. (in German)

Braun-Blanquet J. and Pavillard J., 1928 – Vocabulaire de Sociologie Végétale, Troisième edition, Imprimerie Lemair Ardres, 15-18. (in French)

Ciocârlan V., 2009 – Flora ilustrată a României, Pteridophyta et Spermatophyta, Ceres Publishing House, Bucureşti, 1141. (in Romanian)

Coldea G. and Pop A., 1988 – Cercetări fitocenologice în Muntele Cozia, *Contribuţii Botanice*, Cluj-Napoca, XXVIII, 51-65. (in Romanian)

Cristea V., Gafta D. and Pedrotti F., 2004 – Fitosociologie, Presa Universitară Clujeană Publishing House, Cluj-Napoca, 394. (in Romanian)

Dihoru G. and Negrean G., 2009 – Cartea roşie a plantelor vasculare din România, Edit. Academiei Române, Bucureşti, 630. (in Romanian)

Ellenberg H., 1974 – Zeigerwerte der Gefässpflanzen Mitteleuropas, *Scripta Geobotanica*, Göttingen, 9, 1-97. (in German)

Mucina L., Grabherr G. and Ellmauer T., 1993 – Die Pflanzengesellschaften Österreichs, Teil I, Anthropogene Vegetation, G. Fischer Verlag, Jena-Stuttgart-New-York, 13, 149-169. (in German)

Pătru I., Zaharia L. and Oprea R., 2006 – Geografia fizică a României, climă, ape, vegetaţie, soluri, Edit. Universitară, Bucureşti, 175. (in Romanian)

Pop O. G. and Florescu F., 2008 – Ameninţări potenţiale, recomandări de management şi monitorizare pentru habitatele alpine şi subalpine, Translvania University Publishing House, Braşov, 36-59. (in Romanian)

Sanda V., 2002 – Vademecum ceno-structural privind covorul vegetal din România, Vergiliu Publishing House, Bucharest, 331. (in Romanian)

Sanda V., Barabaş N. and Biţă-Nicolae C., 2005 – Breviar privind parametrii structurali şi caracteristicile ecologice ale fitocenozelor din România, Partea I., Edit. „Ion Borcea", Bacău, 255. (in Romanian)

Sanda V., Răduţoiu D., Burescu P. and Blaj-Irimia I., 2007 – Breviar fitocenologic, Partea a IV-a, Sitech Publishing House, Craiova, 210-211. (in Romanian)

Sanda V., Kinga Ö. and Burescu P., 2008 – Fitocenozele din România, sintaxonomie, structură, dinamică şi evoluţie, Ars Docendi Publishing House, Bucharest, 570. (in Romanian)

Soó R., 1964-1980 – A magyar flora és vegetacio rendszertani, növényföldrajzi kézikönyve, Akadémiai Kiadó, 1-6. (in Hungarian)

Trufaş V., 1986 – Munţii Şureanu, ghid turistic, Sport-Turism Publishing House, Bucharest, 7-46. (in Romanian)

Tüxen R., 1937 – Die Pflanzengesellschaften, Mitteilungen der Floristisch-Soziologischen Arbeitsgemeinschaft Niedersachsen Hannover, 3, 1-70. (in German)

Tüxen R., 1955 – Das System der nordwestdeutschen Pflanzengesell-schaften, Mitteilungen der Floristisch-Soziologischen Arbeitsgemeinschaft, n. Folge, 5, 155-176. (in German)

*** http://www.gradiste.ro

AUTHORS:

[1] *Valeriu-Ioan VINŢAN*
valeriuvintan@yahoo.com
University of Oradea, Faculty of Sciences,
Biology Departament,
Universităţii Street 1,
Oradea, Bihor County,
Romania, RO-410087.
[2] *Petru BURESCU*
pburescu@yahoo.com
University of Oradea,
Faculty of Environmental Protection,
Department of Agriculture-Horticulture,
General Magheru Street 26,
Oradea, Bihor County,
Romania, RO-410087.

THE INTERFERENCE OF TWO TYPES OF XERO-MESOPHILOUS GRASSLAND COMMUNITIES IN THE TRANSYLVANIAN TABLELAND

Erika SCHNEIDER-BINDER [1]

KEYWORDS: site typical biodiversity, adaption capacity, limit of distribution area.

ABSTRACT

The landscape of the southern Transylvanian Tableland is characterized by various geomorphological structures, which determine in their turn the repartition of vegetation, habitats and species. The natural structures are formed and superimposed over the centuries by husbandry, which gives them the special aspect of a traditional cultural landscape. Analysing the site-typical grasslands and their biodiversity, in the group of xero-mesophilous grasslands are a large number of communities, which can be included within two main species rich community groups. Some are identified by *Brachypodium pinnatum* and the others by *Chrysopogon gryllus*. The two groups of communities interact and are sometimes strongly interconnected, which can be observed in many cases in particular in the southern Transylvanian Tableland, in the hilly area around Târnava Mare. The two groups are analysed and compared on the base of phytoceonological samples, and similarities and differences are discussed.

REZUMAT: Întrepătrunderea a două tipuri de pajişti xero-mezofile în Podişul Transilvaniei (România).

Peisajul din Podişul Transilvaniei se caracterizează printr-o mare varietate de structuri geomorfologice, care la rândul lor sunt determinante pentru repartizarea vegetaţiei, a habitatelor şi a speciilor. Structurilor naturale li se suprapun structuri care se datorează influenţei seculare a folosirii extensive a terenului, dând un caracter tipic acestor arii. Analizându-se pajiştile caracteristice ale acestor coline şi biodiversitatea lor, se constată între pajiştile xero-mezofile un şir de comunităţi, între care se diferenţiază clar două grupe principale cu o biodiversitate ridicată. Acestea sunt comunităţile edificate de cele două graminee *Brachypodium pinnatum* şi *Chrysopogon gryllus*. Aceste două grupe de comunităţi se întrepătrund, fiind foarte strâns interconectate, ceea ce este vizibil în special în sudul Transilvaniei, putând fi observat frecvent în Podişul Târnavelor. Cele două grupe de asociaţii sunt analizate comparativ pe bază de ridicări fitocenologice, scoţându-se în evidenţă atât caractere comune cât şi diferenţele între ele.

ZUSAMMENFASSUNG: Interferenz zweier Gesellschaftsgruppen von Halbtrockenrasen im Hochland von Transsilvanien/Siebenbürgen (Rumänien).

Die Landschaft des Hochlands von Siebenbürgen kennzeichnet sich durch eine Vielfalt geomorphologischer Strukturen, die ihrerseits für die Verteilung der Vegetation, der Lebensräume und ihrer Arten bestimmend sind. Die natürlichen Strukturen sind durch die Jahrhunderte lange extensive Bewirtschaftung überlagert und geprägt worden. Analysiert man die Standort typischen Grünlandgesellschaften und ihre Biodiversität, ist unter den *Halbtrockenrasen* eine Reihe von Gesellschaften festzustellen, unter denen sich deutlich zwei artenreiche Hauptgruppen abzeichnen. Dabei geht es um die von Fiederzwenke (*Brachypodium pinnatum*) und die von Goldbart (*Chrysopogon gryllus)* aufgebauten Gesellschaften. Diese beiden Gesellschaftsgruppen greifen ineinander, sind miteinander verzahnt, was insbesondere in Süd-Siebenbürgen, im Kokelhochland häufig der Fall ist. Die beiden Gruppen werden auf Grund pflanzensoziologischer Aufnahmen vergleichend analysiert und dabei Gemeinsamkeiten und Unterschiede hervorgehoben.

INTRODUCTION

The hills of the Transylvanian Tableland, formed from Tertiary deposits, present various geomorphological structures with related microclimatic conditions. They are famous for their flower-rich grasslands and generally high biodiversity. Depending on slope exposure and gradient, as well as the resulting intensity of insolation, a small scale heterogeneity in habitat conditions occurs that is closely linked to the substrate composed of marl and sandstone layers. The steepest front parts of the southern exposed slopes are covered with typical feather grass steppes (*Stipa* ssp.), predominantly consisting of species of the Pontic steppes. The less steep slopes (and former terraces of traditional agriculture) are populated by xero-mesophilic grasslands, which – on the basis of their floristic composition – are related to the eastern meadow steppe (Schneider-Binder, 2013). The xero-mesophilic grasslands are more widespread throughout the tableland and represent the traditional, extensive cultivated lands, replacing former thermophilic oak woods. It is obvious that in the Southern Transylvanian Tableland two different groups of plant communities overlap. These are, on the one hand, the Eastern meadow-steppe-like communities with Pontic, Pontic-Pannonic and Eurasian-continental elements, and, on the other hand communities with sub-Mediterranean xero-thermophilous species. For the first category are representative as characteristic species the xero-mesophilous species *Stipa stenophylla* and Tor-grass *Brachypodium pinnatum* (alliance Cirsio-Brachypodion) and for the second category Golden Barb grass *Chrysopogon gryllus.*

To analyse the grasslands with the interference of communities identified by the two above mentioned abundant and dominant species, associated with other species of similar ecological requirements, it is necessary to analyse the distribution of *Chrysopogon gryllus* and of *Brachypodium pinnatum* as well as the communities in which the species occur and play a major role in the identification of the phytocoenoses.

Chrysopogon gryllus (L.) Trin. is a Southern European–Western Asian species (Kutschera and Lichtenegger, 1982) defined also as Paleomediteranean-south west Asian species (Csürös and Niedermaier, 1966). Its distribution area in Europe extends from southern France, southern Switzerland, Austria, Slovakia to north-eastern Hungary, extending southwards and including some area of the western hills on the border of the Western Romanian Plain, hills on the border of the Apuseni Mountains/Munţii Apuseni and reaching, through the Mureş Valley, the southern part of the Transylvanian Tableland. In the Banat area, as well as south of the Carpathians, the species occurs in Oltenia and Muntenia and in the southern part of the Moldova region, as well as in the Dobrogea (Csürös and Niedermaier, 1966; Drăgulescu and Schumacher, 2006).

In the Transylvanian Tableland the species reaches the northern border of its distribution area, occurring on the hills of Mureş Valley near to Teiuş, on the hills of the Târnava Mare Basin, from those near Sighişoara (Nou Săsesc, Mălâncrav, Roandola) to the hills around Blaj in the downstream part of the Târnava River. In the Southern Transylvanian Tableland *Chrysopogon gryllus* occurs on the hills of Visa Valley and tributaries (Calvasăr/Buia Valley) and reaches in the southern part of the tableland the hills near to Slimnic, at Pădureni.

The xeromorphic, thermophilous, xero-mesophilous species have a large capacity for ecological adaptation. In the Mediterranean, Submediteranean and in the central as well as south-eastern part of the Balkan area *Chrysopogon gryllus* is an euryoecious species (Csürös and Niedermaier, 1966). In general it is growing on different soils from lightly acid and neutral to a lightly alkaline reaction and moderate humus content. Due to the morphological structure of its roots which provide through the enclosure of silicate in the cell wall of endodermis a high protection against drought and medium protection against decomposition, *Chrysopogon gryllus* is able to adapt very well to different site

conditions (Kutschera and Lichtenegger, 1982). This adaption capacity allows it to grow on soils with low groundwater table, but also on soils with high groundwater table including seepage water areas on the hill slopes, as has been reported near Ighişul Vechi and Zlagna in the Hârtibaciu Basin and near to the Motiş/Valea Viilor area (Schneider-Binder, 2011). The indicator value concerning the requirements of humidity/dryness is 1.5 for *Chrysopogon gryllus* (Sanda et al., 1983) corresponding to indicator values two of the system of Ellenberg.

Brachypodium pinnatum (L.) P. Beauv. is a species of Eurasiatic-continental distribution and as a thermophilous species bound to the summer warm continental area (Oberdorfer, 2001; Kutschera and Lichtenegger, 1982). It is a xero-mesophilous species, occurring on calcareous, moderate nutrient and humus-rich, sandy- or stony-loamy soils (Kutschera and Lichtenegger, 1982). Due to the morphological structure of the ramifying roots, with an alternation of numerous narrow lumen and large lumen elements of the protoxylem the species is able to support temporary higher levels of dryness. But the protection against dryness is by a pericambium with only one-two rows of cells lesser as by species with a multilayer pericambium (Kutschera and Lichtenegger, 1982). The indicator value for humidity is 2.5 (Sanda et al., 1983). In the Transylvanian Tableland the species is widespread in xero-mesophilous grasslands on slopes of lower inclination, including former cultivated terraces, but occurs also on slopes with higher inclination.

General coenological data. In its European distribution area *Chrysopogon gryllus* contributes to the identification of different ecological-phytocoenological units. In the Mediterranean area it occurs in the *phrygana* area of the Quercion ilicis zone, edifying the phytocoesnosis of the association of Orchido-Chrysopogonetum, described from Northern Greece (Horvat et al., 1974). On the Adriatic Sea the species occurs as well in the area of Quercion ilicis. In Macedonia the species occurs in the subzone of Ostryo-Carpinion aegeicum, where the communities of the Gold Barb grass (*Chrysopogon gryllus*) are classified as being part of the order Scorzonero-Chrysopogonetalia Horvatic and Horvat 1958, classe Brachypodio-Chrysopogonetea Horvatic 1958. The Bulgarian grasslands characterized by *Chrysopogon gryllus* mostly belong within the order Festucetalia vallesiacae Br.-Bl. and Tx. 1943. The grasslands of *Chrysopogon gryllus* in the Banat province of Romania are classified by Boşcaiu (1972) in the order Brachypodio-Chrysopogonetalia Horvatic 1958 (Boşcaiu, 1972). Due to its large ecological amplitude, *Chrysopogon gryllus* is characteristic of xerophilous and also xero-mesophilous communities. Many associations are described for Romania, but only three, Danthonio-Chrysopogonetum grylli Boşcaiu (1970) 1972, Dauco guttati-Chrysopogonetum grylli Popescu and Sanda (1978) and Chrysopogono-Caricetum humilis Zólyomi (1950) 1958, are valid (Drăgulescu and Schumacher, 2006).

In Transylvania, communities dominated by *Chrysopogon gryllus* are described by Csürös and Niedermaier (1966) as Chrysopogonetum grylli transsilvanicum, a geographical association characterized by features in common with xerophilous *Dichanthium ischaemum* and the xero-mesophilous *Brachypodium pinnatum* communities. This endemic Transylvanian association is characterized by many interfering phytocoenoses of *Brachypodium pinnatum* and *Chrysopogon gryllus*.

Brachypodium pinnatum is characteristic of xero-mesophilous grasslands, with different communities being described (Schneider-Binder, 1971; Sanda et al., 2008) and included in the alliance Cirsio-Brachypodion pinnati Hadac and Klika, in Klika and Hadac 1944. The affiliation to the order Brometalia erecti B.-Bl. 1937 (Sanda et al., 2008) or Festucetalia vallesiacae is discussed with many different opinions (Krausch, 1961; Oberdorfer, 2001).

Considering the strong interlocking of grasslands distinguished by *Chrysopogon gryllus* and *Brachypodium pinnatum* in the Transylvanian Tableland and the difficulty to delineate clearly for some time the phytocoenological units of these two grasses, the objective of this study has been to make a comparison of communities identified by *Chrysopogon gryllus* and *Brachypodium pinnatum*, and to analyse the differences and similarities in a region where the distribution area of the two species overlaps.

MATERIAL AND METHODS

During recent field researches (2005, 2009-2011) on the hills of the Southern Transylvanian Tableland in the area of Sibiu County (Ighişu Vechi, Zlagna, Motiş, Boarta, Mihăileni, Movile, Biertan) as well as earlier unpublished field researches included for comparison (Mihăileni, Cenade), the mosaic pattern of xerophilous and xero-mesophilous phytocoenoses edified by *Chrysopogon gryllus* and *Brachypodium pinnatum* on southern, eastern and western exposed slopes has been studied. Samples were taken following the method of Braun-Blanquet (1964) and included in phytocoenological tables with indication of site conditions (aspect, slope inclination), covering degree, number of species in each sample and locality. Due to the quantity of samples ("relevées") and the presentation possibilities a synthetic table has been worked out with frequency classes from I-V. For the xerotherm variant of phytocoenoses, in which occurs *Chrysopogon gryllus*, a table with samples is presented. For this table the following localities abbreviations where used: Cen = Cenade, Mi = Mihăileni: with CM = Coasta Morii (Morii hillside), CE (Engelmann's hillside), CU (Hungarian hillside). (Tab. 3)

The samples have been analysed following the scale of indicator values for South-Eastern Europe (Sanda et al., 1983; Kovács, 1979; Pop et al., 1978), which corresponds, apart from the transition values, to the values of the scale of Ellenberg et al., (2001), Schneider-Binder (2011). At the same time my own long-term observations were taken into account for indicator value considerations. For the synthetic table are given the indicator values in the system of Ellenberg and the Romanian system (Sanda et al., 1983) as many species are listed only in this system. (Tab. 3)

The species are arranged in the table following the wetness indicator values, to show the existence of species with various indicator values in the communities of *Chrysopogon* and *Brachypodium pinnatum*, being mainly in the range 1–3 (Tab. 1). In the synthetic table (Tab. 3) the species are listed according to the frequency classes and the occurrence in all columns corresponding to the studied sites, or only in three, two or one of them. The nomenclature of the species lists in the included tables follows Ciocârlan (2009) and Drăgulescu (2010).

Table 1: Indicator values according to the Romanian system (Sanda et al., 1983) and Central European system (Ellenberg et al., 2001).

RO		Central Europe	
1	xerophyte	1	Indicator for strong dryness
1.5		2	Transition value between 1 and 2 (Romanian system); Transition value between 1 and 3 (Ellenberg system)
2	xero-mesophyte	3	Indicator for dryness, occurring more frequent on dry soils as on fresh soils, and lacking on wet soils
2.5		4	Transition value between 2 and 3 (Romanian system); Transition value between 3 and 5 (Ellenberg system)
3	mesophyte	5	Indicator for soils with moderate wetness (freshness indicator) lacking on soils with moisture and on soils frequently drying out

RESULTS AND DISCUSSION

Xero-mesophilous grasslands denoted by *Brachypodium pinnatum* and included in the Cirsio-Brachypodion alliance are widespread in the area studied on slopes of southern, south-western or south-eastern aspect. They cover mostly former agricultural terraces on slopes of generally less than 35° to 10°.

In the central part of the Transylvanian Tableland, around Târnava Mare River, in the so-called "Wineland" both types of communities occur, those identified by *Brachypodium pinnatum* and those by *Chrysopogon grryllus*. In this case the *Brachypodium*-rich xero-mesophilous communities are on the slopes with lower gradient and the more xerophilous communities with high abundance-dominance of *Chrysopogon* are mostly located on steeper slopes and exposed to more heat due to its larger tolerance to dryness. This is the case in the Buia/Calvasăr Valley, where *Chrysopogn gryllus* occurs together with *Stipa pulcherrima* and *Stipa stenophylla*, the last a xeromesophilous species (Tab. 2). Remarkably, in one of the phytocoenoses of the Buia Valley near Mihăileni, has been found the very rare Pontic-Balcanic species *Polygala sibirica*, which has been reconfirmed in Transylvania after years in which it had been supposed to be extinct (Schobel, 1973). In these phytocoenoses with xerothermic species there occurs also *Cleistogenes serotina* as a characteristic indicator species for dry sites with pronounced erosion processes. Such type of plant communities have been identified in the Buia Valley area and on the slumping hills of the Motiş/Valea Viilor community area.

Table 2: Xerothermic grassland with *Chrysopogon gryllus* and *Carex humilis* (with wetness indicators U, according to the Romanian system of Sanda et al. (1983).

	Number of samples	1	2	3	4	5	6	7
	Aspect	S	S	S	S	SSE	S	S
	Inclination degree	45	15	15	35	35	40	40
	Coverage degree (%)	80	95	80	70	85	70	80
	Sampling surface (m²)	25	25	25	25	25	25	25
	Number of species	24	25	33	21	28	27	24
	Location	MiCM	MiCM	MiCE	MiCU	Cen	Cen	Cen
U								
1	*Stipa pulcherrima*	2	.	.	.	.	.	.
1	*Festuca valesiaca*	1	1	+	1	+	+	.
1	*Astragalus austriacus*	+	1	.	+	.	+	.
1	*Eryngium campestre*	+	+	1	+	+	.	+
1	*Salvia nutans*	.	+	.	.	.	.	.
1	*Jurinea mollis*	.	.	+	+	+	.	.
1	*Teucrium montanum*	.	.	+	.	+	.	+
1	*Leontodon asper*	.	.	+	.	.	.	+
1	*Cleistogenes serotina*	.	.	.	.	3	1	3
1	*Euphorbia seguieriana*	.	.	.	.	+	.	.
1	*Linaria genistifolia*	.	.	.	.	.	+	.
1.5	*Chrysopogon gryllus*	1	3	3	+	2	1	+
1.5	*Polygala sibirica*	.	.	1	.	.	.	.
1.5	*Stipa stenophylla*	3	+	.	.	+	3	3
1.5	*Dichanthium ischaemum*	1	+	.	.	.	.	.
1.5	*Chondrilla juncea*	+	.	.	+	.	.	.

Table 2 (continuing): Xerothermic grassland with *Chrysopogon gryllus* and *Carex humilis* (with wetness indicators U, according to the Romanian system of Sanda et al. (1983).

	Number of samples	1	2	3	4	5	6	7
	Aspect	S	S	S	S	SSE	S	S
	Inclination degree	45	15	15	35	35	40	40
	Coverage degree (%)	80	95	80	70	85	70	80
	Sampling surface (m²)	25	25	25	25	25	25	25
	Number of species	24	25	33	21	28	27	24
	Location	MiCM	MiCM	MiCE	MiCU	Cen	Cen	Cen
1.5	*Helianthemum nummularium*	+	.	.	1	.	.	+
1.5	*Hypericum elegans*	+	.	.	.	.	+	.
1.5	*Quercus pubescens reg.*	+	.	.	.	.	+	+
1.5	*Achillea setacea*	+	.	+	+	.	.	.
1.5	*Thymus pannonicus*	+	+	+	1	.	.	.
1.5	*Astragalus onobrychis*	+	2	1	+	.	.	.
1.5	*Potentilla incana = aren.*	+	+	+	+	1	.	+
1.5	*Cephalaria uralensis*	.	+	.	.	.	.	+
1.5	*Onobrychis arenaria*	.	+	+	.	.	.	.
1.5	*Scorzonera purpurea*	.	+	+	.	.	.	.
1.5	*Veronica spicata*	.	.	.	.	+	.	.
1.5	*Inula ensifolia*	.	.	.	.	+	+	.
1.5	*Picris hieracioides*	.	.	.	.	+	+	.
1.5	*Vinca herbacea*	.	.	.	.	.	+	.
1.5	*Dictamnus albus*	.	.	.	.	.	+	.
1.5	*Muscari comosum*	.	.	.	.	.	+	.
1.5	*Acinos arvensis*	.	.	.	.	.	+	.
1.5	*Centaurea micranthos*	.	.	.	.	.	+	+
1.5	*Allium flavum*	.	.	.	.	.	+	.
1.5	*Tragopogon dubius*	.	.	.	.	.	.	+
1.5	*Pulsatilla montana*	.	.	.	.	.	.	+
2	*Carex humilis*	2	3	2	3	2	2	2
2	*Dorycnium herbaceum*	2	.	.	.	2	.	1
2	*Fragaria collina*	+	.	.	.	+	+	.
2	*Asperula cynanchica*	+	.	.	.	+	.	.
2	*Verbascum phoeniceum*	+	.	.	.	.	+	+
2	*Koeleria macrantha*	+	.	.	+	-	+	+
2	*Teucrium chamaedrys*	+	.	.	.	+	.	.
2	*Astragalus dasyanthus*	+	.	.	+	.	.	.
2	*Adonis vernalis*	.	+	.	2	+	.	+
2	*Linum tenuifolium*	.	+	.	.	.	.	.
2	*Thesium linophyllum*	.	+	.	+	.	.	.
2	*Nonea pulla*	.	+	.	.	.	.	.
2	*Seseli annuum*	.	+	+	.	.	.	.
2	*Chamaecytisus austriac.*	.	+	1	.	.	.	.
2	*Medicago falcata*	.	+	.	+	+	.	+
2	*Hieracium cymosum*	.	.	+	.	.	.	.
2	*Stachys recta*	.	.	+	.	+	+	.
2	*Euphorbia cyparissias*	.	.	+	+	+	+	+

Table 2 (continuing): Xerothermic grassland with *Chrysopogon gryllus* and *Carex humilis* (with wetness indicators U, according to the Romanian system of Sanda et al. (1983).

2	*Scabiosa ochroleuca*	.	.	+	.	.	.	.
2	*Polygala comosa*	.	.	+	.	.	.	.
2	*Dianthus carthusianorum*	.	.	+	.	+	+	.
2	*Salvia austriaca*	.	.	+	.	+	.	.
2	*Phleum phleoides*	.	.	.	.	.	+	+
2	*Anthyllis vulneraria*	.	.	+	.	.	.	.
2	*Campanula sibirica*	.	.	.	.	+	.	.
2	*Falcaria sioides*	.	.	.	.	+	.	.
2	*Sedum maximum*	.	.	.	.	.	+	.
2.5	*Brachypodium pinnatum*	.	.	.	1	.	.	.
2.5	*Salvia pratensis*	+	.	+	+	.	+	.
2.5	*Anthericum ramosum*	.	.	.	.	.	+	.
2.5	*Helianthemum hirsutum*	.	.	.	.	.	.	+
2.5	*Plantago lanceolata*	+	.	+	.	+	.	.
2.5	*Agrimonia eupatoria*	.	.	.	.	+	.	+
2.5	*Lembotropis nigricans*	.	.	+	.	.	.	.
2.5	*Senecio jacobaea*	.	.	.	.	+	.	.
2.5	*Medicago lupulina*	.	.	+	.	.	.	.
2.5	*Centaurea scabiosa*	.	+	+	.	.	.	.
2.5	*Plantago media*							
2.5	*Polygala major*	.	+	+	.	.	.	.
2.5	*Hieracium umbellatum*	.	+	.	.	.	.	+
3	*Rhinanthus rumelicus*	.	.	2	.	.	.	.
0	*Briza media*	.	.	+	+	.	.	.

Note (place and data of sampling): 1. Mihăileni, Sibiu County, on "Coasta Morii", CM (Morii hillside), 18.06.1976; 2. Mihăileni, Sibiu County, on "Coasta Morii", CM (Morii hillside), 18.06.1976; 3. Mihăileni, Sibiu County, on "Coasta lui Engelmann" CE (on Engelmann's hillside), 18.06.1976; 4. Mihăileni, Sibiu County, on "Coasta ungurească" CU (on the Hungarian hillside), 18.96.1976; 5-8. Cenade (Ce), Alba County, 16.07.1976. The sampling has been carried out together with Mr. Drăgulescu C.

Much interference of the phytoceonoses dominated by the two species exists on slopes of lower gradient, so that sometimes it is difficult to clarify the community affiliation.

Chrysopogon gryllus communities are more widespread in the western and central part of the Southern Transylvanian Tableland, in particular in the area of the so-called "Wineland" of the Târnava Mare River and its right and left tributaries (Csürös and Niedermaier, 1966; Drăgulescu and Schumacher, 2006). Going further eastwards, *Chrysopogon gryllus* becomes rare, replaced in the more eastern part of the tableland by communities of *Brachypodium pinnatum*. This is clearly visible on the distribution maps of *Chrysopogon gryllus* and *Brachypodium pinnatum* (Niedermaier, 1970). According to Niedermaier (1970) a geographical differentiation of xerothermic vegetation in Romania is possible merely on the basis of the distribution of *Danthonia provincialis* as well as *Chrysopogon gryllus* and *Brachypodium pinnatum*.

At high frequency there occurs in the xero-mesophilous grasslands of *Brachypodium pinnatum* and *Chrysopogon gryllus* the sedge *Carex humilis* (Tab. 3) identifying the communities described as Carici-Brachypodietum pinnati as well as Chrysopogono-Caricetum humilis. (Drăgulescu and Schumacher, 2006; Sanda et al., 2008; Schneider-Binder, 1971, 2007).

Table 3: Synthetic overview of the studied xero-mesophilous grasslands.

		Current number of column	**1**	**2**	**3**	**4**
		Number of samples included	8	10	5	12
Ua	Ub		F	F	F	F
2.5	4	*Brachypodium pinnatum CB**	**V**	III	III	**V**
1.5	3	*Chrysopogon gryllus*	II	**V**	**V**	**IV**
2	2	*Carex humilis*	II	IV	II	V
2	3	*Dorycnium herbaceum CB*	V	IV	V	V
1.5	-	*Thymus pannonicus (= Th. marschallianus)*	III	III	II	III
2	3	*Asperula cynanchica*	IV	V	IV	II
2.5	3	*Centaurea scabiosa*	IV	I	IV	II
1.5	-	*Chamaecytisus albus*	IV	II	IV	III
1	3	*Eryngium campestre*	II	III	V	IV
2.5	3	*Anthericum ramosum CB**	II	III	V	I
0	x	*Briza media*	IV	I	III	II
2.5	3~	*Filipendula vulgaris CB**	III	II	III	IV
2	3	*Dianthus carthusianorum*	III	II	IV	III
2	3	*Medicago falcata*	II	IV	II	I
2.5	-	*Campanula sibirica*	III	III	II	I
3	4	*Rhinanthus rumelicus*	III	II	I	II
2	3	*Onobrychis viciaefolia CB*	III	III	I	I
1	-	*Jurinea mollis*	I	II	III	III
2	2	*Teucrium chamaedrys*	II	III	II	II
2	3	*Euphorbia cyparissias*	II	III	II	II
2	-	*Onobrychis arenaria*	II	II	III	I
2	3	*Prunella grandiflora CB**	II	I	III	I
2	3	*Stachys recta*	II	II	III	I
1	3	*Veronica spicata*	II	II	III	I
2.5	4	*Knautia arvensis*	I	I	III	I
2	2	*Thesium linophyllum CB*	I	I	III	I
1.5	2	*Festuca valesiaca*	I	I	II	III
2.5	4~	*Galium verum*	II	II	I	I
2	3	*Fragaria viridis (= F. collina) CB**	II	I	II	I
2	3	*Nonea pulla*	II	I	I	I
1.5	3	*Linum hirsutum*	I	I	I	I
2	-	*Asyneuma canescens diff.*	II	-	-	-
1.5	3	*Dichantium ischaemum (= Andropogon i.)*	-	IV	-	-
2	3	*Anemone sylvestris CB**	-	-	III	-
2.5	4	*Orchis ustulata*	-	-	II	-
1.5	2	*Scorzonera purpurea*	-	-	-	IV
1	2	*Pulsatilla montana*	-	-	-	II
2	3	*Adonis vernalis*	-	-	III	III
2	-	*Echium russicum*	-	-	III	III
2	3	*Peucedanum cervaria CB**	-	-	IV	I
2	4~	*Peucedanum officinale*	-	-	II	II
2.5	3~	*Trifolium montanum CB*	-	-	III	II
2.5	3	*Salvia pratensis*	II	II	-	V
2	4	*Salvia verticillata*	IV	II	II	-
2	4	*Coronilla varia*	IV	II	III	-
3.5	3	*Phleum phleoides*	I	II	IV	-
2.5	4	*Lembotropis nigricans (= Cytisus nigricans)*	II	I	IV	-
2	3	*Thalictrum minus*	I	II	III	-
2	-	*Polygala major CB*	II	-	IV	II

Table 3 (continuing): Synthetic overview of the studied xero-mesophilous grasslands.

		Current number of column	1	2	3	4
		Number of samples included	8	10	5	12
Ua	Ub		F	F	F	F
1.5	-	*Inula ensifolia CB*	II	-	V	III
2.5	4	*Agrimonia eupatoria*	IV	II	-	I
2	3	*Koeleria macrantha*	II	II	-	IV
1.5	-	*Astragalus austriacus*	-	II	II	III
2	3	*Scabiosa ochroleuca*	III	III	-	I
2.5	4	*Crataegus monogyna*	III	I	-	II
2	3	*Bupleurum falcatum CB**	I	I	III	-
2.5	-	*Centaurea biebersteinii (= C. micranthos)*	II	II	I	-
2.5	3	*Pimpinella saxifraga*	II	II	-	I
2	2	*Artemisia campestris*	I	II	-	I
3	4	*Leucanthemum vulgare*	II	I	-	I
2	-	*Potentilla incana (= P. arenaria)*	-	II	II	II
0	x	*Centaurea jacea*	-	II	I	I
2.5	3	*Peucedanum oreoselinum*	-	I	I	II
2	2	*Achillea setacea*	I	II	I	-
1.5	3	*Dictamnus albus*	-	I	I	II
3	5	*Dactylis glomerata*	II	I	-	II
3	5	*Tragopogon pratensis* ssp. *orientalis*	II	-	I	I
2.5	4	*Plantago media CB*	I	-	II	I
3	x ~	*Stachys officinalis (= Betonica officinalis)*	-	I	II	I
3	4	*Achillea millefolium*	III	II	-	-
4	6	*Erigeron annuus*	II	III	-	-
2	4~	*Linum flavum*	II	-	III	-
3	4~	*Ononis arvensis*	II	II	-	-
2.5	4	*Lotus corniculatus*	II	I	-	-
2.5	3	*Pimpinella saxifraga*	II	I	-	-
2.5	4	*Campanula glomerata CB**	II	I	-	-
2	4	*Echium vulgare*	II	I	-	-
2.5	4	*Cichorium intybus*	II	I	-	-
3	4	*Galium mollugo*	II	-	II	-
1.5	3	*Falcaria sioides*	-	II	-	II
2.5	4~	*Senecio jacobaea*	II	II	-	-
0	x ~	*Elymus repens (= Agropyron repens)*	II	II	-	-
3	5	*Prunella vulgaris*	II	II	-	-
2.5	-	*Centaurea apiculata* ssp. *spinulosa*	II	II	-	-
1.5	3~	*Hypericum elegans*	II	I	-	-
1.5	3	*Linum austriacum CB*	I	II	-	-
1.5	2	*Astragalus onobrychis*	I	II	-	-
1.5	3	*Helianthemum nummularium*	I	II	-	-
2	x	*Poa angustifolia*	II	-	-	II
3	5	*Arrhenatherum elatius*	II	-	-	I
1.5	-	*Astragalus monspessulanus*	-	II	-	II
1.5	-	*Allium fuscum*	-	II	-	-
2	3	*Campanula bononiensis*	II	-	I	-
3	4~	*Silene vulgaris*	-	II	-	-
2	-	*Eryngium planum*	II	-	-	-
2	3	*Origanum vulgare*	II	-	-	-
3	6	*Artemisia vulgaris*	II	-	-	-
2.5	4	*Carlina vulgaris*	II	-	-	-

Note: CB = characteristic species of the alliance Cirsio-Brachypodion, CB* = species of the alliance Cirsio-Brachypodion, occurring also in Mesonbromion and Brometalia associations. Species with frequency I in column 1 and 2: *Elymus hispidus* (= *Agropyron intermedium*), *Hypericum perforatum, Inula britannica, Sanguisorba minor, Seseli annuum CB, Tragopogon dubius, Trifolium campestre, Trifolium pratense, Veronica orchidea, Viola hirta*; column 1 and 4: *Leontodon asper, Seseli varium*; column 2 and 4: *Medicago lupulina, Vinca herbacea*; column 3 and 4: *Muscari tenuiflorum*.

Species with frequency I in column 1: *Adenophora liliifolia, Cephalaria radiata, Cirsium pannonicum* CB, *Clematis recta, Clinopodium vulgare, Daucus carota, Laserpitium latifolium, Lavathera thringiaca, Odontites serotina, Sisymbirum sophia, Solidago virgaurea, Stipa capillata, Verbena officinalis*; in column 2: *Agrostis capillaris, Aster amellus, Campanula rotundifolia, Chamaecytisus hirsutus, Cleistogenes serotina, Crepis setosa, Diplotaxis muralis, Euphorbia seguieriana, Gentiana cruciata CB*, Leontodon autumnalis, Linum tenuifolium, Plantago lanceolata, Potentilla recta, Ranunculus polyanthemos* CB, *Quercus pubescens regeneration, Salvia nutans, Silene bupleuroides*; in column 3: *Genista tinctoria, Salvia transsilyvanica, Stellaria graminea*; in column 4: *Anthoxanthum odoratum, Anthyllis vulneraria, Bromus erectus, Carex praecox, Carlina aculis, Cephalaria uralensis, Equisetum arvense, Hieracium cymosum, Hieracium pilosella, Hypericum maculatum, Hypochoeris maculata, Inula hirta, Linum catharticum, Potentilla argentea, Ranunculus acris, Salvia austriaca*.

Carex humilis occurs in extremely dry grassland variants, but in this area, however, it mainly forms xero-mesophilous grasslands together with *Brachypodium pinnatum*, identifying an association of the Cirsio-Brachypodion alliance (Schneider-Binder, 2007). The association with high abundance-dominance values of spring sedge *Carex humilis* occurs on wide areas of the Southern Transylvanian hills. The moisture requirements of *Chrysopogon gryllus* are similar to those of *Carex humilis*, even though it prefers dryer area (U = 1.5). Its temperature requirements are higher compared to those of *Carex humilis*, which generally has slightly broader ecological amplitude for the heat factor.

The species composition of the xero-mesophilous grasslands with *Carex humilis* and *Chrysopogon gryllus* included in the association Chrysopogono-Caricetum humilis Zolyomi (1950) 1958, are altogether very similar to those of *Brachypodium pinnatum* and *Carex humilis*, ass. Carici humilis-Brachypodietum pinnati Soo (1942) 1947 and Dorycnio-Brachypodietum, as described by Csürös and Kovács (1962), and justifies their uniting within the same alliance. However, in the Southern Transylvanian Tableland Chrysopogon-characterized grasslands may only be regarded as an edge effect of the *Chrysopogon* associations of their main distribution area.

In both communities' species of the Cirsion-Brachypodion alliance – *Dorycnium herbaceum, Polygala major, Seseli annuum, Thesium linophyllum, Onobrychis viciaefolia, Inula ensifolia* occurs. *Anthericum ramosum, Anemone sylvestris, Filipendula vulgaris, Fragaria viridis, Peucedanum cervaria Plantago media* – are as well species of the alliance Cirsio-Brachypodion (Krausch, 1961), but they occur also in communities of Brometalia, being considered in West Europe as species of the Mesobromion alliance.

The synthetic table 3 presents a typical xero-mesophilous *Brachypodium pinnatum* community (column 1) realised on the basis of eight samples from the years 2009 and 2010 near to Ighişu Vechi, Motiş, both Sibiu county, Apold/Sighişoara/Mureş County, Curciu and Biertan, both in Sibiu county, with low frequency values of *Chrysopogon gryllus* and also with low abundance-dominance values (Tab. 4). The second column represents a typical community of *Chrysopogon gryllus* realised on the basis of 10 samples from 2009 near to Ighişu Vechi, Zlagna, Motiş, Boarta and Curciu. The third column represents a

typical community identified by *Chrysopogon gryllus* realised as a synthesis of 5 samples from Păucea/Sibiu County in the year 2005 and the fourth column is representative for a transition situation, with *Brachypodium pinnatum* and *Chrysopogon gryllus* from the area of slumping hills near Păucea (2011).

One question is as to whether a clear differentiation of communities identified by *Brachypodium pinnatum* and *Chrysopogon gryllus* is possible in an area of strong overlap of these two communities. *Brachypodium pinnatum* (Tab. 3, column 1) as well as *Chrysopogon gryllus* (Tab. 3, column 2 and 3) distinguishes different communities, but there are also communities in which both species occur and without differential species, or with a very small number of such species which can help to delineate the association (Tab. 3). In this case they take part in the same association, identifying transition stages from a Chrysopogon type association to the Brachypodium type association depending on the inclination and aspect of the slope (Tab. 3, column 4). The frequency in a synthetic table cannot alone explain the situation of differentiation and overlapping of the two types of communities. This is possible on the base of frequency and abundance-dominance values of the single tables which rests on the basis of such a synthesis. A clear differentiation is visible between columns I and II, as in the first are more xero-mesophilous species and in the second more xerophilous species, in the last the abundance-dominance value of *Dichanthium ischaemum* is very high.

The frequency in a synthetic table cannot explain alone the situation of differentiation and overlap of the two types of communities. This is possible on the basis of frequency and abundance-dominance values of the single tables which stay on the base of such a synthesis. (Tab. 4)

Table 4: Frequency and abundance-dominance values of characteristic species “name giving species” of described xero-mesophilous grassland associations of the alliance Cirsio-Brachypodion (Chrysopogono-Caricetum humilis Zolyomi (1950) 1958, Thymo pannonici-Chrysopogonetum grylli Doniță et al., 1962, Carici humilis-Brachypodietum pinnati Soó (1942) 1947, Dorycnio-Brachypodietum Csürös and Kovács 1962); the number of each group is corresponding to column 4 of the synthetic table number 3.

No.	Species	Frequency	Abundance-dominance values
1	Chrysopogon gryllus	II	+ - 2
	Brachypodium pinnatum	V	3 - 4
	Carex humilis	II	+ - 2
	Dorycnium herbaceum	V	+ - 3
	Thymus pannonicus	III	+
2	Chrysopogon gryllus	V	2 - 4
	Brachypodium pinnatum	III	+ - 2
	Carex humilis	IV	+ - 3
	Dorycnium herbaceum	IV	+ - 3
	Thymus pannonicus	III	+ - 2
3	Chrysopogon gryllus	V	3 - 4
	Brachypodium pinnatum	III	+ - 1
	Carex humilis	II	1 - 2
	Dorycnium herbaceum	V	+ - 1
	Thymus pannonicus	II	+ - 1
4	Chrysopogon gryllus	IV	+ - 3
	Brachypodium pinnatum	V	+ - 3
	Carex humilis	V	+ - 4
	Dorycnium herbaceum	V	+ - 3
	Thymus pannonicus	III	+ - 2

The Cirsio-Brachypodion alliance associations are famous for floral richness, which depends on traditional management of the grasslands denoted by them in each case. All changes of use or intensification or abandonment leads to changes in the phytocoenoses and to a loss of characteristic biodiversity. This is a problem for the xero-mesophilous grasslands, as the tendency is for a change in use from hay-meadow to pasture land, the mixed manner of use – in spring until April as pasture and later only as hay meadows – being disregarded. But such grassland types were consistently used as meadow (Schneider-Binder, 2010). At least in early springtime an extensive graze was allowed, but only until Saint George's day (23 April), after which the sole use as mown grassland was traditional. This explains the high biodiversity. If no mowing had taken place in the traditional manner, such species richness would have never been possible (Niedermaier, 1977; Schneider-Binder, 2010).

Chrysopogon gryllus is frequently present in grasslands without grazing as a pioneer on abandoned agricultural lands as well as in abandoned vineyards (as has been reported near Curciu, Biertan and other places in the "Wineland"). In the succession process of grassland evolution *Chrysopogon gryllus* constitutes the final stage (Csürös and Niedermaier, 1966). Depending upon the management of the grasslands dominated by *Chrysopogon gryllus*, the most flower-rich grasslands develop by mowing and very extensive grazing. Mowing without grazing is leading to grasslands of high density (Csürös and Niedermaier, 1966). Without applying management the *Chrysopogon gryllus* communities reach the final phase of grassland succession and develop into thermophilous forests of the order Quercetalia pubescenti. *Brachypodium pinnatum* is as well present in the area of former field terraces and vineyards, but more on slopes of lower inclination. The species is fire-resistant and at an advantage in the concurrence with other species (Oberdorfer, 2001). This is a possible explanation for the occurrence in recent times of large areas of *Brachypodium pinnatum* in places where unfortunately uncontrolled burning has been applied. But these phytocoenoses of *Brachypodium* occuring after burning are not as species-rich as sites with traditional management by mowing, or by early pasturing and later mowing as mentioned above.

CONCLUSIONS

In the study areas of Transylvanian Tableland, xero-mesophilous grasslands are represented near others in particular by communities denoted by *Brachypodium pinnatum* and *Chrysopogon gryllus*. As the ecological amplitude of Gold barb grass is larger than that of Tor-grass, in the area where both species occur, *Chrysopogon gryllus* occupies more xerothermic sites, which are slopes with high inclination, but develps as well on slopes of lower inclination and varied aspect stands together with *Brachypodium pinnatum*. This last species is an important indicator of less accentuated slopes, being an important indicator on low slopes and former cultivated terraces of the hills. In the more easterly part of the tableland, *Chrysopogon gryllus* disappears and *Brachypodium pinnatum* identifies without participation of the Gold barb grass diverse species-rich phytocoenoses. The accompanying species are mostly common to both types of communities, apart from a small number of differential species. To clarify the phytocoenological classification and the affiliation on higher phytoceonological units, a large comparison study should be carried out for the whole distribution area of both species in the Transylvanian Tableland as well as the types of grasslands with *Danthonia provincialis*, also a species of xero-mesophilous grasslands in the Transylvanian hills area.

The conservation of such an area of high biodiversity, rich in species from the eastern meadow steppe can be maintained only by use of traditional management. This is the guarantee for the perpetuation of such high value grasslands.

REFERENCES

Braun-Blanquet J., 1964 – Pflanzensoziologie 3, Auflage, Wien, 865. (in German)

Ciocârlan V., 2009 – Flora ilustrată a României, Pteridophyta et Spermatophyta, Edit. Ceres, Bucureşti, 1141. (in Romanian)

Csürös S. and Kovács A., 1962 – Cercetări fitocenologice în raioanele Sighişoara şi Agnita, *Contribuţii Botanice*, III, 205-232, Cluj. (in Romanian)

Csürös S. and Niedermaier K., 1966 – Phytozönologische Untersuchungen über die Chrysopogon-Gesellschaften des Tirnava Hochlandes S. R. Rumänien, Vegetatio, *Acta Geobotanica*, XIII, 6, 302-318, Den Haag. (in German)

Drăgulescu C., 2010 – Cormoflora judeţului Sibiu, Edit. Universităţii „Lucian Blaga" of Sibiu, 831. (in Romanian)

Drăgulescu C. and Schumacher B., 2006 – Wiesen mit Chrysopogon gryllus in Süd-Siebenbürgen, *Contribuţii Botanice*, XLI, 2, 53-59, Grădina Botanică „Alexandru Borza" Cluj-Napoca. (in German)

Ellenberg H., Weber H. E., Düll R., Wirth V. and Werner W., 2001 – Indicator values of plants in Central Europe, *Scripta Geobotanica*, Erich Goltze K. G., Göttingen, 18, 1-264. (in German)

Horvat I., Glavac V. and Ellenberg H., 1974 – Vegetation Südosteuropas, VEB Gustav Fischer Verlag Jena, 768. (in German)

Kovács J. A., 1979 – Biological, ecological and economical indicators of grasslands flora. M.A.I.A., Acad. St. Agricole şi Silvice, Staţ. Centr. de Cercet. pt. Cultura Pajiştilor, Măgurele Braşov. Edit. Centrul de mat. didactice şi prop. agr., Red. de prop. tehnică agricolă, Bucureşti, 50. (in Romanian)

Krausch H.-D., 1961 – Die kontinentalen Steppenrasen (Festucetalia vallesiacae) in Brandenburg, *Feddes Repertorium*, Beiheft 139, 167-227, Berlin. (in German)

Kutschera L. and Lichtenegger E., 1982 – Wurzelatlas mitteleuropäischer Grünlandpflanzen. Band I Monocotyledoneae, Gustav Fischer Verlag Stuttgart, New York, 515. (in German)

Niedermaier K., 1970 – Zur Ökologie und Chorologie der Trocken-rasenvegetation Rumäniens, *Feddes Repertorium*, 81, 1-5, 243-260. (in German)

Niedermaier K. 1977 – Geheimnisvolle siebenbürgische Landschaft. NaturwissenschaftlicheWanderungen zwischen Alt und Großer Kokel. Siebenbürgisch-sächsischer Hauskalender, 23, Jahrgang, Jahrbuch 1978, München, 137-158. (in German)

Oberdorfer E., 2001 – Pflanzensoziologische Exkursionsflora für Deutschland und die angrenzenden Gebiete, 8, Auflage, Ulmer Stuttgart, 1051. (in German)

Pop I., Csürös S., Raţiu O., Cristea V., Ghişa E., Bechet M., Crişan A., Szász E., Csürös M., Codoreanu V., Ardelean A. and Hodişan I., 1978 – Flora şi vegetaţia Munţilor Zarand. *Contribuţii Botanice*, XVIII, Cluj-Napoca, 215. (in Romanian)

Sanda V., Popescu A. and Doltu M. I., Doniţă N., 1983 – Caracterizarea ecologică şi fitocenologică a speciilor spontane din flora României, *Studii şi Comunicări, Ştiinţe Naturale*, 25, supliment, Muzeul Brukenthal Sibiu, 126. (in Romanian)

Sanda V., Öllerer K. and Burescu P., 2008 – Fitocenozele din România. Sintaxonomie, structură, dinamică şi evoluţie, Ars docendi, Universitatea Bucureşti, 570. (in Romanian)

Schneider-Binder E., 1971 – Die Halbtrockenrasen der Zibinssenke und ihrer Randgebiete, *Studii şi Comunicări, Muzeul de Ştiinţe Naturale Sibiu*, 16, 135-172. (in Romanian; German abstract)

Schneider-Binder E., 1975 – Die Trockenrasen der Festucetalia valesiacae Br.-Bl. Et Tx. 1943 im Hügelgebiet um die Zibinssenke in Südsiebenbürgen, *Studii şi Comunicări, Muzeul de Ştiinţe Naturale Sibiu*, 19, 95-120. (in Romanian; German abstract)

Schneider-Binder E., 2007 – Xerophilous and xero-mesophilous grasslands on slumping hills around the Saxon villages Apold and Saschiz (Transylvania, Romania), *Transylvanian Review of Systematical and Ecological Research* 4, The Saxon Villages Region of southeast Transylvania, Curtean-Bănăduc et al. (eds), 55-64.

Schneider-Binder E., 2010 – Traditional management knowledge of grasslands in the southern part of the Transylvanian Tableland (Romania) as basis for conservation measures, *Acta Oecologica Carpatica* III, Curtean-Bănăduc (ed.), Sibiu, 73-82.

Schneider-Binder E., 2011 – Wet habitats in mosaic patches with dry habitats on hill slopes of Southern Transylvanian Tableland, *Acta Oecologica Carpatica*, IV, Curtean-Bănăduc (ed.), Sibiu, 77-86.

Schneider-Binder E., 2013 – Steppic and dry grasslands in the Transylvanian tableland and their importance for the Natura 2000 network, in Thüringer Ministerium für Landwirtschaft, Forsten, Umwelt und Naturschutz (TMLFUN), Steppe habitats of Europe. Threats, conservation measures and protection, *Proceedings of the International Conference Erfurt*, Germany, 3-6 June 2012, 177-189.

Schobel H., 1973 – Polygala sibirica L. - aus Siebenbürgen nicht verschwunden, *Studii şi Comunicări, Muzeul de Ştiinţe Naturale Sibiu*, Sibiu, 18, 23-312. (in German)

AUTHOR:

[1] *Erika SCHNEIDER-BINDER*
erika.schneider@iwg.uka.de, erika.schb@t-online.de
KIT-University of Land Baden-Württemberg and National Research Association,
of the Helmholtz Society Institute for Geography and Geoecology,
Division WWF-Institute for floodplains ecology,
Josefstrasse 1, Rastatt,
Germany,
D-76437.

ORĂŞTIE RIVER (MUREŞ WATERSHED, ROMANIA) ECOLOGICAL STATUS, BASED ON THE STRUCTURE OF BENTHIC MACROINVERTEBRATE COMMUNITIES

Angela CURTEAN-BĂNĂDUC [1]

KEYWORDS: river ecological assessment, macroinvertebrate communities, Hilsenhoff Biotic Index, EPT/C Index, Transylvania, Romania.

ABSTRACT

The ecological status of the Orăștie River was evaluated based on the structure of benthic macroinvertebrate communities and analysis of its dynamics from data collected along the length of the river.

On the upper course of the river the communities are dominated by stoneflies, mayflies and caddisflies and descending the river course the ratio of these groups decreases in favor of the chyronomids that become dominant on the lower course (15 km upstream the Mureș River confluence).

The benthic macroinvertebrate communities present a structure characterizing the natural state of the Carpathian rivers, indicating that the human impact on the river is insignificant, this sector being included in the Grădiștea Muncelului Cioclovina Nature Park.

The benthic macroinvertebrate communities' structure and the values of the Hilsenhoff and EPT/C indices indicate that the lower river course, especially the sector downstream of Orăștie, is subjected to human pressure – river course straightening, dyke building, organic-charged waste water pollution. In this river sector pollution prevention methods should be applied by correctly managing the industrial, animal rearing and city waste waters.

REZUMAT: Starea ecologică a râului Orăștie (bazinul hidrografic Mureș, România), pe baza structurii comunităților de macronevertebrate bentonice.

Starea ecologică a râului Orăștie a fost evaluată pe baza analizei structurii comunităților de macronevertebrate bentonice și a dinamicii structurii acestor comunități de-a lungul râului.

În cursul superior al râului dominante numeric sunt plecopterele, efemeropterele și trichopterele, în aval scade treptat ponderea acestor grupe, chironomidele devenind dominante în cursul inferior (15 km amonte de confluența cu Mureșul).

În cursul superior al râului, comunitățile de macronevertebrate bentonice prezintă o structură caracteristică râurilor carpatice în condiții naturale, ceea ce indică faptul că impactul antropic asupra râului este nesemnificativ, acest sector este inclus în Parcul Natural Grădiștea Muncelului Cioclovina.

Structura comunităților de macronevertebrate bentonice și valorile indicilor biotici Hilsenhoff și EPT/C relevă faptul că sectorul inferior al râului, în special aval de municipiul Orăștie, este supus presiunii antropice – modificarea liniei malului prin tăierea meandrelor, îndiguiri, poluare cu ape reziduale cu încărcare organică. În acest sector se impun măsuri de prevenire a poluării prin gestionarea corectă a apelor reziduale menajere, zootehnice și industriale.

RÉSUMÉ: Etat écologique de la Rivière d'Orăștie (bassin hydrographique de Mureș, Roumanie) évalué à partir de la structure de la communauté des macro-invertébrés benthiques.

L'état écologique de la Rivière d'Orăștie a été évalué à partir de l'analyse de la structure de la communauté des macro-invertébrés benthiques et de l'analyse de la dynamique de cette structure tout le long de la rivière étudiée.

Dans le cours supérieur de la rivière, la communauté est dominée par les éphéméroptères, les trichoptères et les plécoptères. En aval de la rivière, le pourcentage de ces espèces baisse, étant peu à peu remplacées par des chironomidés qui dominent le cours inferieur de la rivière (à partir de 15 km de la confluence avec la rivière de Mureș).

La communauté des macro-invertébrés benthiques du secteur supérieur de la rivière possèdent une structure similaire à celle d'une rivière carpatique en état naturel, ce qui indique que l'impact anthropique sur la rivière est insignifiant, ce secteur étant compris dans le Parc Naturel Grădiștea Muncelului Cioclovina.

La structure de la communauté des macro-invertébrés benthoniques ainsi que les valeurs des indicateurs Hilsenhoff et EPT/C montrent que le secteur inférieur de la rivière, tout particulièrement le secteur après la ville d'Orăștie, étant soumise à des pressions anthropiques importantes – l'élimination des méandres par la rectification de la ligne des berges, la construction des digues, la pollution par les eaux usées fortement chargées en matière organique. Des mesures de prévention de la pollution devraient être appliquées dans ce secteur de la rivière notamment la gestion convenable des eaux usées ménagères, industrielles et agricoles.

INTRODUCTION

The rivers benthic macroinvertebrate communities present the most adequate structure for the available environmental resource use (Ward and Stanford, 1983; Clements et al., 1989; Wright et al., 2000; Park et al., 2007; Lücke and Johnson, 2009; Resende et al., 2010; Sánchez-Montoya et al., 2010), lending these particular comunities structure as a good indicator for the ecological status of rivers (Rosenberg and Resh, 1993; Cao et al., 1997; Péru and Dolédec, 2010; Couceiro et al., 2012; Monaghan and Soares, 2012; Jiang et al., 2013).

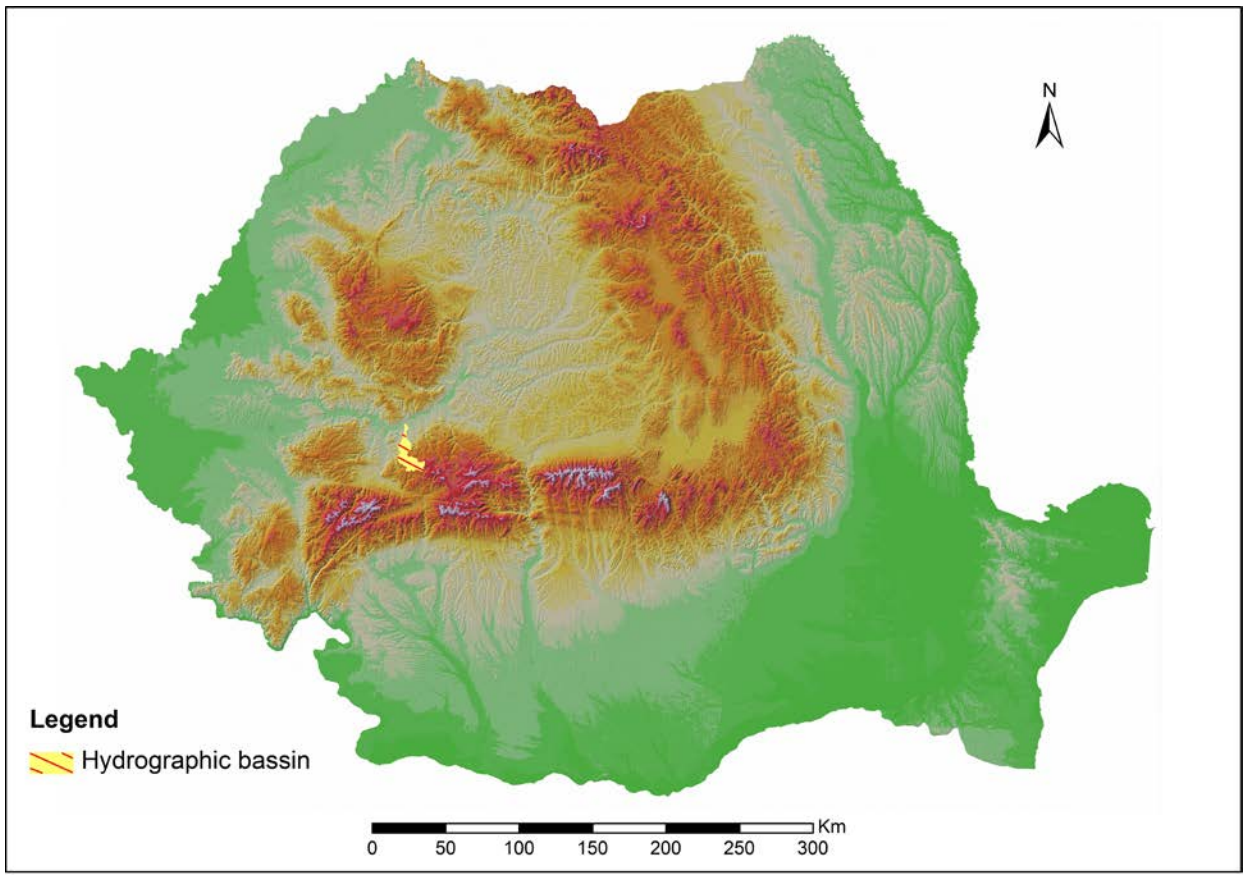

Figure 1: The Orăștie River Watershed location.

This scientific paper presents an analysis of the Orăștie River macroinvertebrate communities' structure, focusing on the spatial dynamic aspects (along the river) and the river ecological status assessment.

Orăștie River is a first order tributary of the Mureș River. Located in the Central-South-West part of the Romanian national territory (Fig. 1).

The largest part of the Orăștie River basin is included in the Grădiștea Muncelului Cioclovina Nature Park protected area.

The river is locally known as, Godeanu, Grădiște, Beriu, Apa Orașului.

The river headwaters start at 1,659 m in the Orăștiei Mountains – a subdivision of Șureanu Mountains, Central Meridional Carpathians, is 51 km in length and has a basin area of 399 km^2. The average annual flow at the confluence with Mureș River is 2.00 m^3/s (195 m altitude) (Agenția Națională Apele Române – Cadastrul Apelor). Orăștie River is a Carpathian river characterized by a steep slope and a predominant lithologic substrate.

MATERIAL AND METHODS

The results of this scientific study are based on quantitative samples of benthic macroinvertebrates (a total of 165 samples), taken in August 2011 from 33 stations situated along the studied river from the headwaters to within 500 m of the confluence with the Mureș River. (Fig. 2)

At each location quantitative samples were taken from five different points. The sampling was carried out with an 887 cm^2 surface Surber Sampler, with a 250 µm mesh net. The sampled biological material was fixed in 4% formaldehyde solution ($NaHCO_3$ was added) and was analyzed in the laboratory with an Olympus (150X) stereomicroscope. The macroinvertebrates belonging to each systematic group were counted and preserved in 70% alcohol, introduced in the collections of the Aquatic Biology Laboratory, Faculty of Sciences, Department of Ecology and Environment Protection and Physics, "Lucian Blaga" University of Sibiu.

The assessed biotope variables were: altitude, slope, riverbed width, depth, substratum types (based on visual evaluation), presence of pools, riffles, runs and bends, bank vegetation, channel modification and riverine land use. For the quantitative structure description of the benthic macroinvertebrate communities we used the relative abundance (A%).

The synthetic indexes used for the Orăștie River ecological state assessment was the EPT/C Index, calculated as the sum of the abundences of the Ephemeroptera, Plecoptera, Trichoptera divided by abundance of the Chironomidae (Plafkin et al., 1989) and Hilsenhoff Biotic Index (HBI) (Hilsenhoff, 1981, 1987), determined for all considered river sectors.

In streams the EPT/C index supraunitary values reveal good biotic conditions (Plafkin et al., 1989). In relation with the Hilsenhoff Biotic Index (HBI) values, seven water quality classes can be distinguished (Tab. 1 - Hilsenhoff, 1987).

Table 1: The water quality classes in relation with the Hilsenhoff Index values.

HBI	Water quality	Organic pollution degree
< 3.75	excellent	no organic pollution
3.76-4.25	very good	very low organic pollution
4.26-5.0	good	low organic pollution
5.01-5.75	acceptable	moderate organic pollution
5.76-6.50	unsatisfying	substantial organic pollution
6.51-7.25	low	critical organic pollution
7.26-10.0	very low	severe organic pollution

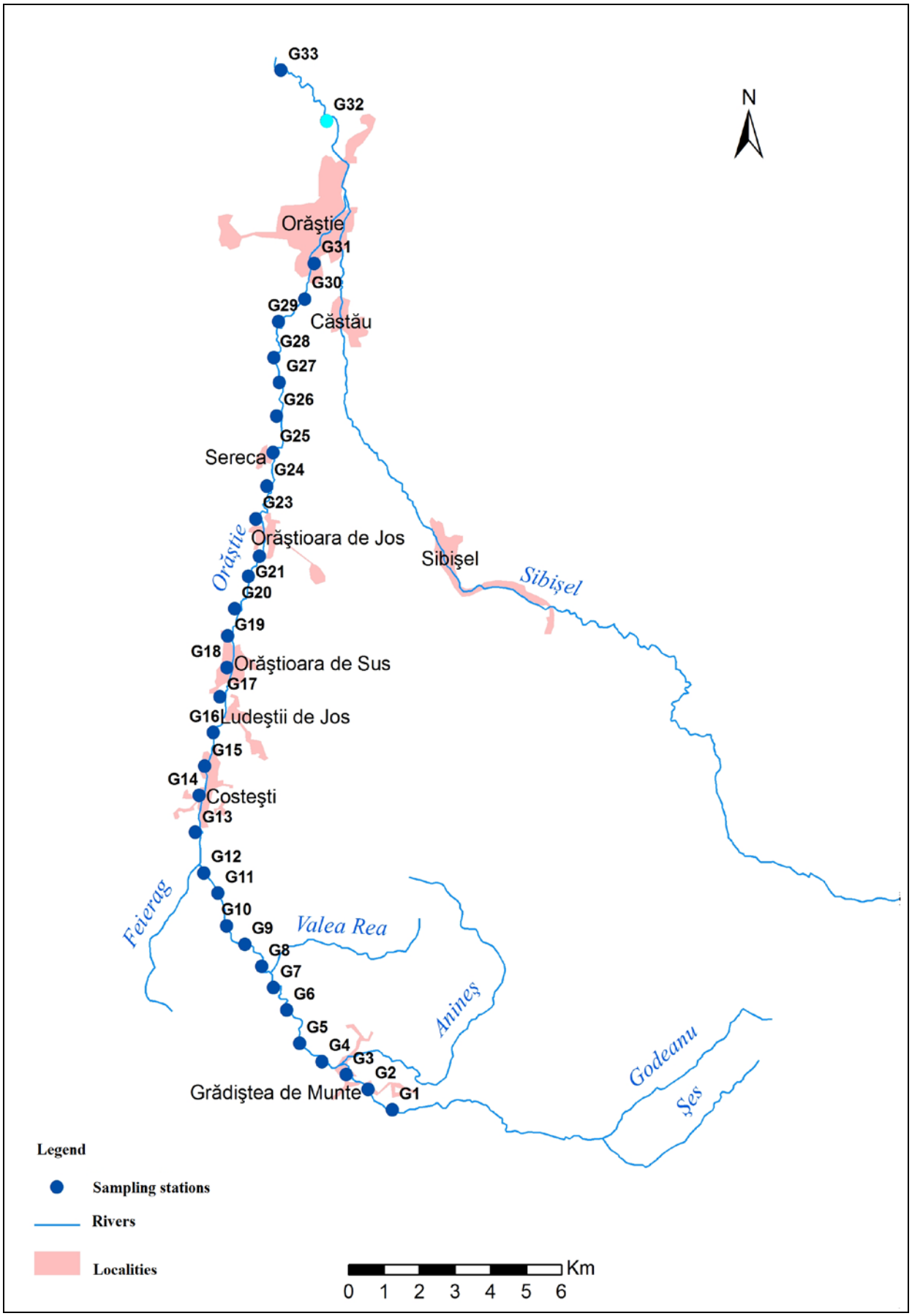

Figure 2: The Orăştie River sampling stations (G1 – G33) layout.

RESULTS AND DISCUSSION

Regarding the benthic macroinvertebrate communities was analyzed the similarity of the 33 considered river sample locations, based on the relative abundance of the taxonomic groups. It was revealed that these groups can be catergorized into three major classes (Fig. 3):

1. Comunities in which numerical codominants are Ephemeroptera, Plecoptera and Trichoptera, present in the river sectors G1, G2, G3, G4, G5, G6, G8, G13, G14, G15, G17;

2. Comunities in which numerical co-dominants are Ephemeroptera and Chironomidae, present in the river sectors G7, G9, G10, G11, G12, G16, G19;

3. Comunities in which numerical dominant are Chironomidae, present in the river sectors G18, G20, G21, G22, G23, G24, G25, G26, G27, G29, G30, G31, G32, G33.

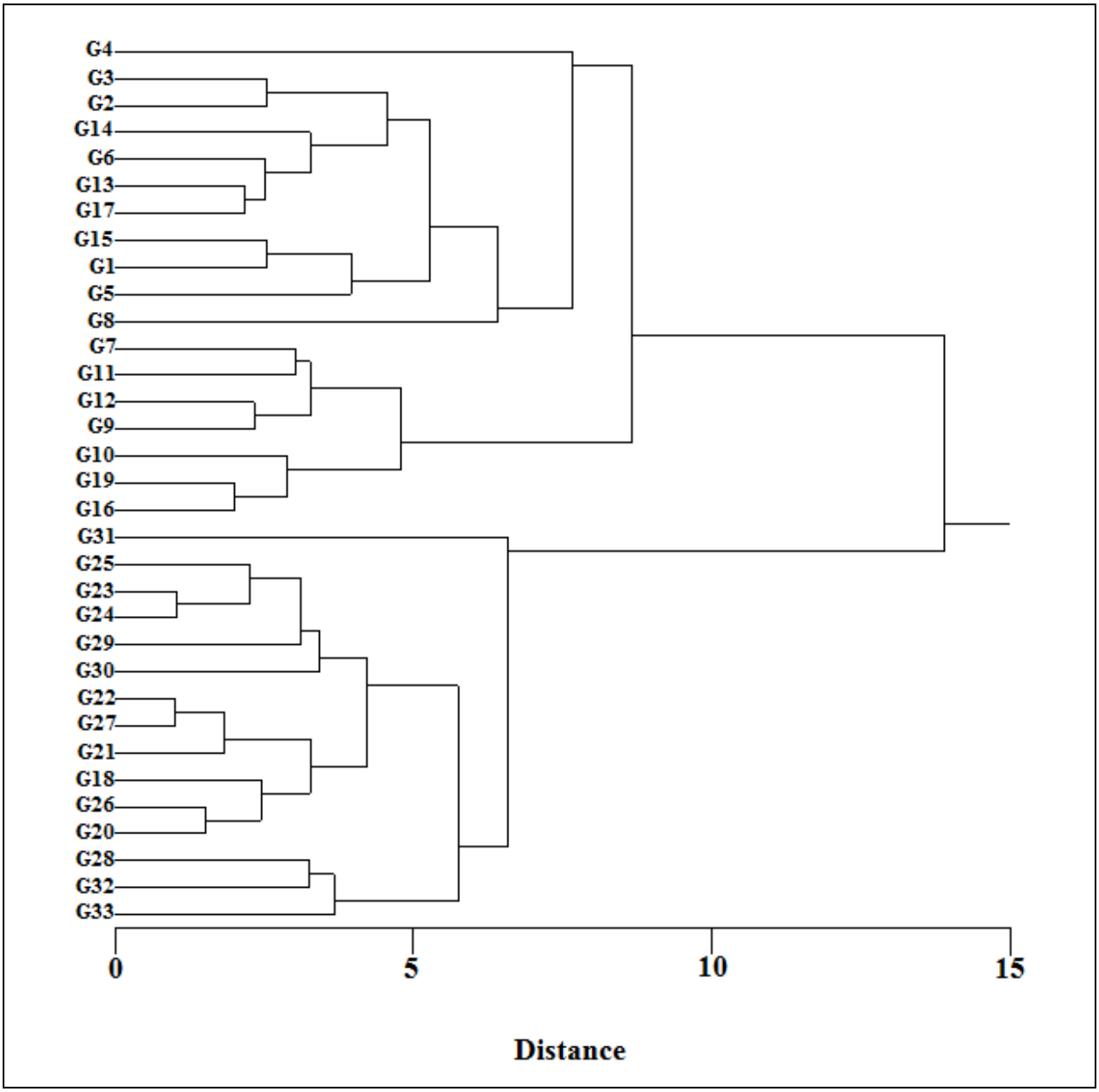

Figure 3: Cluster analysis based on relative abundance of macroinvertebarte taxonomic groups from each of 33 sampling stations along the Orăștie River
(G1 – G33 sampling stations, euclidian distance, average linkage method).

Analyzing the longitudinal dynamics of the benthic macroinvertebrate communities structure, it was found that the upper reaches of the river (upstream G9) numerical dominants are stoneflies, mayflies and caddisflies, downstream the dominance of these groups gradually decreases, and downstream G18 the chironomids are dominant (Tab. 2).

In the reference area, the benthic macroinvertebrates present a lower density than in the upper sector (G1 – G5) characterized by typical biotope conditions for small mountainous stream – narrow width of the minor riverbed, sharp slope, high speed flow, substrate made of rocks and boulders, shallow water, and in the sectors G28 – G32 in which the shore line was modified by cutting the bends, missing arboreal riparian vegetation or the minor riverbed was dammed/embanked (G10, G22, G28 – G32), located near residential areas. The benthic macroinvertebrates present a high density in the G6 – G28 sector, where the lotic habitats are in natural conditition and the diversity of the microhabitats (presence of riffles, runs, pools, and bends), is higher than upstream (Tab. 2).

The macroinvetebrate communities structure and the values of the EPT/C and HBI indices (Tab. 2) reveal that the Orăștie River presents a good ecological status from the source to upstream Beriu locality (G1 – G28), downstream of this locality for a distance of 1 km there is moderate organic pollution, in the sector G29 – G30 the river presents a good ecological status, and downstream (G31) the river is characterized by a moderate ecological status, the sector G32 – G33, is in a unsatisfied ecological state due to the impacts generated by Orăștie locality (17,255 inhabitants).

Table 2: Orăștie River macroinvertebrate communities structure and the Biotic Index values (w – medium riverbed width, d – medium riverbed depth, D – average density, A – relativ abundance, HBI – Hilsenhoff Biotic Index).

Sampling stations	Benthic macroinvertebrate communities structure			Biotic Indices EPT/C and HBI
	Taxonomic groups	D (ind./887cm^2)	A (%)	
G1 w = 1.5 m d = 0.25 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Simuliidae	3.25 0.50 43.00 17.50 10.25 0.25 6.25 1.50	3.94 0.61 52.12 21.21 12.42 0.30 7.58 1.82	EPT/C = 11.8 HBI = 4.09
G2 w = 1.75 m d = 0.35 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Simuliidae	1.75 3.70 20.50 13.25 7.25 3.00 0.50	3.50 7.41 41.04 26.53 14.51 6.01 1.00	EPT/C = 13.67 HBI = 2.90
G3 w = 2.5 m d = 0.25 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Simuliidae	2.60 0.40 16.00 12.60 8.40 0.40 2.60 1.00	5.91 0.91 36.36 28.64 19.09 0.91 5.91 2.27	EPT/C = 14.23 HBI = 2.82

Sampling stations	Benthic macroinvertebrate communities structure			Biotic Indices EPT/C and HBI
	Taxonomic groups	D (ind./887cm^2)	A (%)	
G4 w = 2 m d = 0.30 m	Oligochaeta Planaridae Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Blepharoceridae	0.97 0.97 1.45 15.40 13.40 16.50 0.97 6.79 2.42	1.65 1.65 2.46 26.16 22.76 28.03 1.65 11.53 4.11	EPT/C = 6.68 HBI = 2.69
G5 w = 6 m d = 0.40 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Blepharoceridae	0.40 0.60 33.40 6.60 5.60 0.80 7.20 0.60	0.72 1.09 60.51 11.96 10.14 1.45 13.04 1.09	EPT/C = 6.52 HBI = 3.28
G6 w = 5 m d = 0.45 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Blepharoceridae	8.40 0.40 63.60 52.20 10.00 0.80 31.80 4.20	5.82 0.23 36.30 30.00 5.83 0.47 18.9 2.45	EPT/C = 3.96 HBI = 3.08
G7 w = 7 m d = 0.30 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Blepharoceridae	11.00 0.60 70.00 17.80 13.40 0.20 51.80 4.80	6.49 0.35 41.27 10.50 7.90 0.12 30.54 2.83	EPT/C = 1.99 HBI = 3.87
G8 w = 7 m d = 0.40 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Simuliidae	22.20 1.20 51.40 11.60 11.60 0.20 20.80 3.00	18.20 0.98 42.13 9.51 9.51 0.16 17.05 2.46	EPT/C = 3.59 HBI = 4.46
G9 w = 6 m d = 0.40 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Simuliidae	9.80 0.80 80.80 18.80 0.60 0.60 78.60 5.80	5.01 0.41 41.26 9.60 0.31 0.31 40.14 2.96	EPT/C = 1.28 HBI = 4.11

Sampling stations	Benthic macroinvertebrate communities structure			Biotic Indices EPT/C and HBI
	Taxonomic groups	D (ind./887cm^2)	A (%)	
G10 w = 4 m d = 0.45 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Tipulidae	2.20 0.60 31.00 13.00 4.80 34.80 6.20	2.38 0.65 33.48 14.04 5.18 37.57 6.70	EPT/C = 1.41 HBI = 3.76
G11 w = 8 m d = 0.25 m	Oligochaeta Hidracarina Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	11.00 0.20 95.40 16.20 5.00 0.80 55.20 10.20	5.67 0.10 49.18 8.35 2.58 0.41 28.45 5.26	EPT/C = 2.12 HBI = 3.96
G12 w = 7 m d = 0.35 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	11.2 0.80 0.20 79.80 10.00 6.60 0.20 68.80 10.20	5.96 0.43 0.11 42.49 5.33 3.51 0.11 36.63 5.43	EPT/C = 1.41 HBI = 4.17
G13 w = 11 m d = 0.45 m	Oligochaeta Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Tipulidae	7.60 3.60 82.40 51.80 17.00 26.60 5.60	3.91 1.85 42.34 26.62 8.74 13.66 2.88	EPT/C = 5.69 HBI = 2.97
G14 w = 14 m d = 0.25 m	Oligochaeta Gastropoda (*A. fluviatilis*) Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae	8.00 7.80 3.00 67.00 51.20 3.80 15.40	5.12 4.99 1.92 42.89 32.78 2.43 9.87	EPT/C = 7.93 HBI = 3.08
G15 w = 13 m d = 0.30 m	Oligochaeta Gastropoda (*A. fluviatilis*) Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	16.80 2.80 1.40 117.40 49.80 11.60 0.80 28.60 2.80	7.24 1.21 0.60 50.60 21.47 5.00 0.34 12.34 1.20	EPT/C = 6.26 HBI = 2.82

Sampling stations	Benthic macroinvertebrate communities structure			Biotic Indices EPT/C and HBI
	Taxonomic groups	D (ind./887cm^2)	A (%)	
G16 w = 8 m d = 0.35 m	Oligochaeta Hirudinea Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	28.40 0.60 1.20 2.00 67.80 24.80 12.80 1.60 101.60 15.40	11.09 0.23 0.47 0.78 26.46 9.68 5.00 0.62 39.66 6.01	EPT/C = 1.04 HBI = 4.35
G17 w = 7.5 m d = 0.30 m	Oligochaeta Hirudinea Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Tipulidae	5.60 0.60 0.20 1.40 82.20 47.0 7.40 37.40 4.60	3.00 0.32 0.11 0.75 44.10 25.21 3.97 20.06 2.48	EPT/C = 3.66 HBI = 3.25
G18 w = 10 m d = 0.40 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Tipulidae	8.20 2.60 2.60 28.60 33.00 17.00 144.80 7.60	3.36 1.06 1.06 11.70 13.50 6.96 59.25 3.11	EPT/C = 0.55 HBI = 4.12
G19 w = 10 m d = 0.30 m	Oligochaeta Hirudinea Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	20.6 0.40 0.80 5.00 89.20 43.60 25.20 2.00 138.00 7.40	6.20 0.12 0.24 1.51 26.85 13.12 7.59 0.60 41.54 2.23	EPT/C = 1.15 HBI = 3.98
G20 w = 11 m d = 0.45 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Tipulidae	7.20 0.20 0.40 23.80 23.60 22.00 172.20 5.00	2.83 0.08 0.16 9.36 9.28 8.64 67.68 1.97	EPT/C = 0.41 HBI = 4.28

Sampling stations	Benthic macroinvertebrate communities structure			Biotic Indices EPT/C and HBI
	Taxonomic groups	D (ind./887cm^2)	A (%)	
G21 w = 9 m d = 0.40 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Tipulidae	4.60 0.60 1.00 17.00 24.60 33.40 137.80 7.20	2.03 0.27 0.44 7.52 10.88 14.76 60.92 3.18	EPT/C = 0.55 HBI = 3.81
G22 w = 9 m d = 0.25 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Tipulidae	5.60 1.00 0.40 10.00 6.00 23.40 73.40 3.20	4.55 0.81 0.33 8.13 4.88 19.02 59.68 2.60	EPT/C = 0.54 HBI = 4.41
G23 w = 10 m d = 0.30 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	23.40 1.80 0.40 18.40 18.20 23.40 0.80 101.40 5.40	12.11 0.93 0.21 9.52 9.42 12.11 0.41 52.48 2.81	EPT/C = 0.60 HBI = 4.49
G24 w = 12 m d = 0.40 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Chironomidae Tipulidae	25.40 3.80 0.80 21.20 13.80 20.40 93.40 4.60	13.85 2.07 0.44 11.56 7.52 11.12 50.93 2.51	EPT/C = 0.59 HBI = 4.63
G25 w = 7 m d = 0.25 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	21.80 1.40 1.20 37.20 33.00 20.60 0.20 132.60 4.20	8.64 0.56 0.48 14.75 13.08 8.17 0.08 52.58 1.66	EPT/C = 0.69 HBI = 4.24

Sampling stations	Benthic macroinvertebrate communities structure			Biotic Indices EPT/C and HBI
	Taxonomic groups	D (ind./887cm^2)	A (%)	
G26 w = 7 m d = 0.30 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	5.40 1.20 0.20 19.80 11.20 8.60 0.20 96.20 4.00	3.68 0.82 0.14 13.49 7.63 5.86 0.14 65.53 2.71	EPT/C = 0.42 HBI = 4.47
G27 w = 6 m d = 0.35 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	2.80 0.80 0.20 9.80 6.40 20.00 0.60 72.20 3.00	2.42 0.69 0.17 8.46 5.53 17.27 0.52 62.35 2.59	EPT/C = 0.51 HBI = 4.24
G28 w = 5 m d = 0.30 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	8.00 2.20 0.20 7.60 0.80 2.00 0.20 54.00 2.40	10.34 2.84 0.26 9.82 1.03 2.58 0.26 69.77 3.10	EPT/C = 0.20 HBI = 5.40
G29 w = 9 m d = 0.40 m	Oligochaeta Hidracarina Amphipoda Ephemeroptera Plecoptera Trichoptera Odonata Coleoptera Chironomidae Tipulidae	8.20 2.60 0.20 11.40 5.00 17.80 2.00 0.40 45.20 3.60	8.51 2.70 0.21 11.83 5.19 18.46 2.07 0.41 46.89 3.73	EPT/C = 0.76 HBI = 4.40
G30 w = 5 m d = 0.35 m	Oligochaeta Hidracarina Ephemeroptera Plecoptera Trichoptera Coleoptera Chironomidae Tipulidae	6.60 4.00 8.60 0.40 8.40 0.40 43.80 5.00	8.55 5.18 11.14 0.52 10.88 0.52 56.74 6.47	EPT/C = 0.40 HBI = 4.97

Sampling stations	Benthic macroinvertebrate communities structure			Biotic Indices EPT/C and HBI
	Taxonomic groups	D (ind./887cm^2)	A (%)	
G31 w = 7 m d = 0.30 m	Oligochaeta Hidracarina Ephemeroptera Trichoptera Chironomidae Tipulidae	0.60 1.20 5.40 0.40 12.40 3.00	2.61 5.22 23.48 1.74 53.91 13.04	EPT/C = 0.47 HBI = 5.01
G32 w = 10 m d = 0.40 m	Oligochaeta Ephemeroptera Trichoptera Chironomidae	10.20 3.60 8.60 47.20	14.66 5.17 12.36 67.82	EPT/C = 0.26 HBI = 5.77
G33 w = 8 m d = 0.30 m	Oligochaeta Ephemeroptera Trichoptera Chironomidae	17.20 1.20 7.20 98.40	13.87 0.97 5.81 79.35	EPT/C = 0.09 HBI = 6.00

CONCLUSIONS

In the upper river course (G1 – G15), the benthic macroinvertebrates communities have a characteristic structure for the Carpathian streams in natural conditions, which indicates that the human impact on the river is insignificant, this section was mentioned as being included in Grădiștea Muncelului Cioclovina Nature Park.

The midle river course G15 – G28 presents a favorable ecological status.

The lower Orăştie River course, especially downstream of the Orăştie locality is subjected to anthropogenic pressure – banks line change by cutting the bends, damming, wastewater organic pollution.

Therefore measures are needed to prevent pollution through proper management of domestic, livestock and industrial wastewaters.

AKNOWLEDGEMENTS

The present study was accomplished with the support of Grădiştea Muncelului-Cioclovina Nature Park administration and Faculty of Sciences, "Lucian Blaga" University of Sibiu.

REFERENCES

Cao Y., Bark A. W. and Williams W. P., 1997 – Analysing benthic macroinvertebrate community change along a pollution gradient: A framework for the development of biotic indices, *Water Research*, 31, 4, 884-892.

Clements W. H., Farris J. L., Cherry D. S. and Cairns Jr. J., 1989 – The influence of water quality on macroinvertebrate community responses to copper in outdoor experimental streams, *Aquatic Tixicology*, 14, 3, 249-262.

Couceiro S. R. M., Hamada N., Forsberg B. R., Pimentel T. P. and Luz S. L. B., 2012 – A macroinvertebrate multimetric index to evaluate the biological condition of streams in the Central Amazon region of Brazil, *Ecological Indicators*, 18, 118-125.

Hilsenhoff W. L., 1981 – Use of arthropods to evaluate water quality of streams, *Technical Bulletin*, 100, Department of Natural Resources, Madison, WI.

Hilsenhoff W. L., 1987 – An improved biotic index of organic stream pollution, *Great Lakes Entomologist*, 20, 31-39.

Jiang X., Xie Z. and Chen Y., 2013 – Longitudinal patterns of macroinvertebrate communities in relation to environmental factors in a Tibetan-Plateau river system, *Quaternary International*, 304, 107-114.

Lücke J. D. and Johnson R. K., 2009 – Detection of ecological change in stream macroinvertebrate assemblages using single metric, multimetric or multivariate approaches, *Ecological Indicators*, 9, 4, 659-669.

Monaghan K. A. and Soares A. M. V. M., 2012 – Bringing new knowledge to an old problem: Building a biotic index from lotic macroinvertebrate traits, *Ecological Indicators*, 20, 213-220.

Park Y., Song M., Park Y. and Oh K., 2007 – Community patterns of benthic macroinvertebrates collected on the national scale in Korea, *Ecological modelling*, 203, 26-33.

Péru N. and Dolédec S., 2010 – From compositional to functional biodiversity metrics in bioassessment: A case study using stream macroinvertebrate communities, *Ecological Indicators*, 10, 5, 1025-1036.

Plafkin J. L., Barbour M. T., Porte K. D., Gross S. K. and Hughes R. M., 1989 – Rapid bio-assessment protocols for use in streams and rivers: benthic macroinvertebrates and fish, US EPA/444/4-89-001.

Resende P. C., Resende P., Pardal M., Almeida S. and Azeiteiro U., 2010 – Use of biological indicators to assess water quality of the Ul River (Portugal), *Environmental Monitoring and Assessment*, 170, 535-544.

Sánchez-Montoya M. M., Vidal-Abarca M. R. and Suárez M. L., 2010 – Comparing the sensitivity of diverse macroinvertebrate metrics to a multiple stressor gradient in Mediterranean streams and its influence on the assessment of ecological status, *Ecological Indicators*, 10, 4, 896-904.

Ward J. V. and Stanford J. A., 1983 – The serial discontinuity concept of lotic ecosystems, in Fontaine T. D. I. and Bartell S. M. (eds.), Dynamics of lotic ecosystsm, Ann Arbor Science, 29-41.

Wright J. F., Sutcliffe D. W. and Furse M. T. (eds.), 2000 – Assessing the Biological Quality of Fresh Waters: RIVPACS and Other Techniques. Freshwater Biological Association, Ambleside.

*** Romanian Waters National Agency/Agenția Națională Apele Române - Cadastrul Apelor.

AUTHOR:

Angela CURTEAN-BĂNĂDUC
ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Applied Ecology Research Center,
Dr. Ioan Raţiu Street 5-7, Sibiu,
Sibiu County, Romania,
RO-550012.

AQUATIC INVERTEBRATES IN OLŠAVA RIVER (SLOVAKIA): WHAT THEY TELL US ABOUT THE RIVER CATCHMENT?

Peter MANKO [1], *Ján KOŠČO* [1], *Lenka KOŠUTHOVÁ* [2], *Dušan BARABAS* [2] and *Jarmila LEŠKOVÁ* [3]

KEYWORDS: Slovakia, Hornad River basin, benthic invertebrates, metrics, land use, water quality.

ABSTRACT

Asterics assessment software offers a wide variety of metrics and indices as a result of analysis of benthic invertebrate communities. In this paper we use these data to describe the Olšava River catchment and we compare and discuss the results with data obtained from Geographical Information System (GIS) and with exact data obtained at five study sites representing characteristic sections of the river. We can say that ecological groups (guilds) reflect better changes in water quality, land use, anthropogenic impacts and natural variables. The relative abundance of stoneflies, mayflies and dipterans reflect better anthropogenic impact than relative abundance of another taxa groups (e.g. amphipods and Oligochaeta) in this river catchment. Also, relative abundance of oligosaprobic and polysaprobic species, Slovakian saprobic index, Evenness, EPT-taxa ratio and EP-taxa ratio express increasing human impact (organic pollution) better than another indices and metrics calculated for this stream.

REZUMAT: Nevertebratele acvatice din râul Olšava (Slovacia): ce informații oferă despre bazinul hidrografic?

Programul de evaluare Asterics oferă o varietate mare de măsurători și indicatori ca rezultat al analizei comunităților de nevertebrate bentonice. În acest articol, folosim această informație pentru a descrie bazinul hidrografic al Olšavei, comparăm și discutăm rezultatele cu date GIS, precum și cu date exacte, obținute în cinci stații de studiu, reprezentând secțiuni caracteristice ale râului. Putem afirma că grupurile (ghildele) reflectă mai bine modificările în calitatea apei, utilizarea terenurilor, impacturile antropice și variabilele naturale. Abundența relativă a plecopterelor, efemeropterelor și dipterelor reflectă mai bine impactul antropic decât abundența relativă a altor grupe taxonomice (ex. amfipode și oligochete), în acest bazin hidrografic. De asemenea, abundența relativă a speciilor oligosaprobe și polisaprobe, indicele slovac de saprobitate, echitabilitatea, indicii EPT și EP exprimă impactul antropic în creștere (poluare organică) mai bine decât alți indicatori și indici care s-au calculat pentru acest curs de apă.

ZUSAMMENFASSUNG: Aquatische Invertebaten des Flusses Olšava (Slowakei): Was sagen sie uns über das Einzugsgebiet?

Das Asterics Software Programm enthält eine Menge metrischer Maße und Indikatoren, die sich bei der Analyse der bentischen Invertebraten ergeben. Diese Ergebnisse werden in vorliegender Arbeit zur Beschreibung des Olšava Flusses verwendet, wobei die Daten aus den fünf Probestellen im Olšava Fluss mit denen aus dem Geographischen InformationSsystem (GIS) verglichen und diskutiert werden. Es ist festzustellen, das die ökologischen Gruppen Veränderungen der Wasserqualität, der Landnutzung, der anthropogenen Belastung und der natürlichen Variablen

besser reflektieren. Die relative Abundanz der Steinfliegen, Eintagsfliegen und der Dipteren reagiert empfindlicher auf die anthropischen Störungen als die relative Abundanz anderer Gruppen (Zb. Amphipoden oder Oligochaeten) im Einzugsgebiet dieses Flusses. Außerdem reflektiert die relative Abundanz der oligosaproben und polysaproben Arten, Slowakischer Saprobienindex, die Gleichmäßigkeit sowie das EPT-Taxa und EP-Taxa Verhältniss den steigenden anthropischen Einfluss (organische Belastung) besser, als die anderen für diesen Fluss berechneten metrischen Maße und Indikatoren.

INTRODUCTION

Macrozoobenthos is traditionally used to assess the quality of water and the impacts of human activities on aquatic environments (Rosenberg and Resh, 1993; Hodkinson and Jackson, 2005; Manko, 2008; Lešková, 2009). Many systems of bioindication are known, from simple assessments (Cairn and Dickson, 1971) to highly sophisticated multi-metric systems and programs, or neural networks (Schleiter et al., 1999; Segnini, 2003). Many specialists work on new and performed methods, indexes and approaches regarding biomonitoring. The pros and cons of the older and traditional methods in contrast to the new approaches are discussed (Rico et al., 1992), to which some of these methods have been standardized and included in official monitoring programs (De Pauw et al., 2006; Hering et al., 2003). The Asterics assessment software (AQEM Consortium, 2006) offers a wide variety of metrics and indexes as a result of the benthic invertebrates communities analysis. The data offers us the opportunity to know the water quality, the studied stream characteristics and the impact of human activities in the water catchment basin. The focus of this paper is to use this information to describe the Olšava River catchment basin to compare and discuss the results against data obtained by Geographical Information System (GIS) and the data obtained at study sites.

MATERIALS AND METHODS

Study area

The Olšava River begins as a spring in the Slanske Vrchy Mountains, at an altitude of about 670 m. It is a left tributary of the Hornad River (mouth in 174 m a.s.l.). The Olšava River is 52 km long and its river catchment basin is of 340 km^2. Andesites of Slanské Vrchy Mountains and neogene sediments in Kosice basin are the basis for the formation of the two types of areas in the terms of utilization, typically agricultural and typical forest. It also plays an important role in the runoff formation (Barabas and Dzurdzenik, 2002). Five sampling sites (O1-O5) are situated along the Olšava River (Fig. 1). These sampling sites represent characteristic sections of the river. Individual sections were studied from the hydromorphological point of view, and some details of this analysis and measurements are presented in table 1. Different sites have different characteristics. O1-O3 and O4-O5 sites are in different climate zones (O1-O3 moderately warm, moderately humid; O4-O5 warm, moderately humid climate zone with cold winters) and geochemical types of minerals (O1-O3 andesites and intermediary, subvolcanic, intrusive rocks; O4-O5 claystones and sandstones). On the other hand, there are differences between O1-O2 and O4-O5 sites. The site in the middle of the river combines the composition of the upper and lower part according to geological composition (O1-O2 neogene vulcanites; O3-O4 gray, calcareous neogene clays, siltstones and silt).

Sampling and identification

Seasonal samples were taken five times (site O1 was only sampled twice) from five sites on the Olšava River (Fig. 1, Tab. 1) in 2008-2009. All habitats were sampled at respective localities using the "kick sampling technique" with a hydrobiological net (mesh size was 350 μm). Individual sub-samples taken from habitats 0.25 x 0.25 m square in size were stored in 4% formalin. The biological material was sorted and identified in the laboratory. Ephemeroptera, Plecoptera, Coleoptera and Diptera were identified to the lowest taxonomic level possible. Other taxa were identified only to the family or order level. The full list of the taxa (121 taxa) is shown in table 3.

Analysis

Data was analyzed using statistical software PAST, vers. 2.12 (diversity and equitability indices, diversities comparing cluster analysis) and specialized assessment software ASTERICS, vers. 3.3 (Slovak saprobity index, taxa groups, flow and substrate preferences, zonation, Average score per taxon/Czech version/Evenness, r/K relationship, Life index and water quality classes, trophic guilds) (Tab. 2).

RESULTS AND DISCUSSION

In total, 118 taxa and 79 species of benthic macroinvertebates were identified in the Olšava River. One third of the identified species belong to two insects orders, Ephemeroptera (29 ssp.) and Plecoptera (15 ssp.). Chironomidae represented more than 25% of the acquired specimens, which is probably the taxa group with the highest species diversity. Amphipoda (*Gammarus* ssp.) is also similar to Chironomidae, which is abundant with in Olšava River, with about 25% of the total population, but mayflies (Ephemeroptera) with 40% are clearly the most important order. Other taxa groups presented in Olšava River are Turbellaria, Mollusca, Oligochaeta, Hirudinea, Hydracarina, Isopoda (*Assellus aquaticus*), Odonata, with Diptera, Coleoptera and Trichoptera creating the rest of the community.

Table 1: Study sites characteristics (* according to Hack, 1973).

Study site	O1	O2	O3	O4	O5
GPS (WGS84)	48°54'50''	48°53'48''	48°51'19''	48°43'49''	48°36'37''
	21°23'11''	21°23'6''	21°25'18''	21°25'24''	21°21'23''
Slope (Lt) (%)	3.84	1.17	0.78	0.09	0.05
Torrent. habitats (%)	88	47	30	13	21
Fluv. habitats (%)	12	53	70	87	79
Width (m)	1.59	7.17	5.82	6.81	9.91
Depth (m)	0.08	0.3	0.52	0.78	0.76
Stream gradient (S_L)*	160	120	153	28.14	23.14
Max. velocity ($m.s^{-1}$)	0.2	0.5	1.8	2.2	0.6
Rip. vegetation	W/B	T, B/T, B	T, B/T, B	T, B/G	T/T

Mollusca, Oligochaeta, partly Chironomidae and *Dicranota* sp., some mayfly species (*Caenis luctuosa*, *Caenis macrura*, *Caenis robusta*) and order Diptera show an evident increase in relative abundance downstream. The relative abundance of other species (*Ecdyonurus macani*, *Rhithrogena carpatoalpina*, *Leuctra aurita*, *Leuctra nigra*, *Nemoura cinerea*, *Perla pallid* and *Brachyptera seticornis*), family Limonidae and order Plecoptera decrease downstream (Fig. 2, Tab. 2).

From the groups identified to the species level, only Plecoptera show a clear trend in the taxa richness ~ flow direction relationship, since their diversity declines downstream.

The sharpest difference is evident between sites O1-O3 and O4-O5 in the relative abundance of stoneflies and dipterans (partly mayflies) and between sites O1-O2 and O3-O5 in the case of Oligochaeta and Crustacea (Fig. 2).

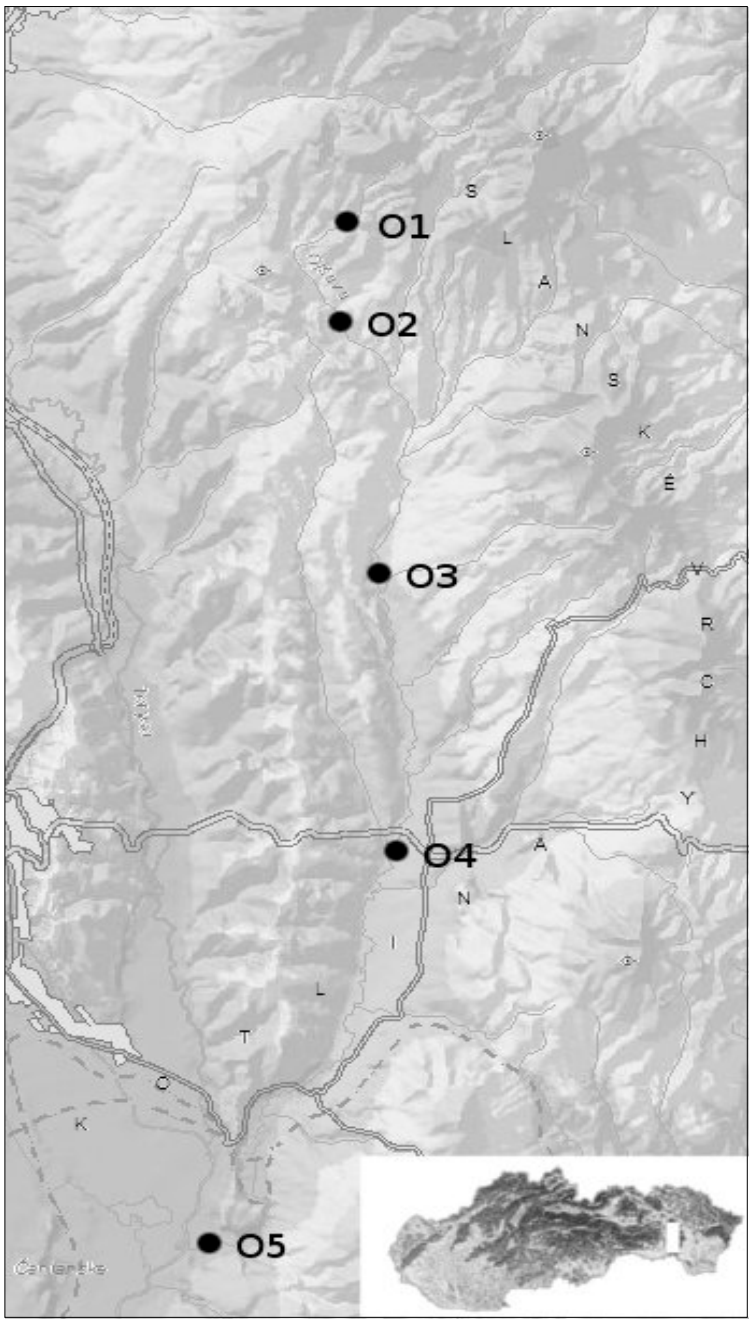

Figure 1: The map of the study area and sampling sites, in Slovakia.

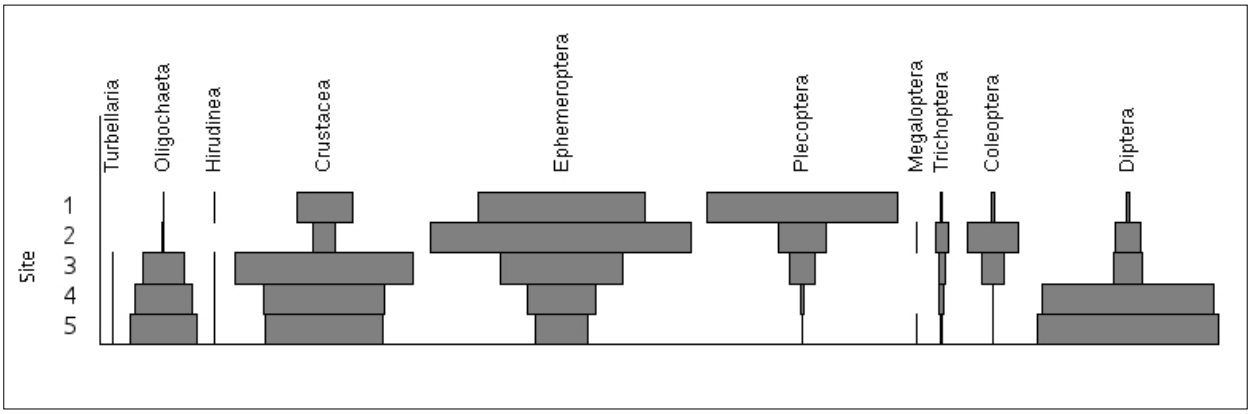

Figure 2: Relative abundance of taxa groups at sampling sites.

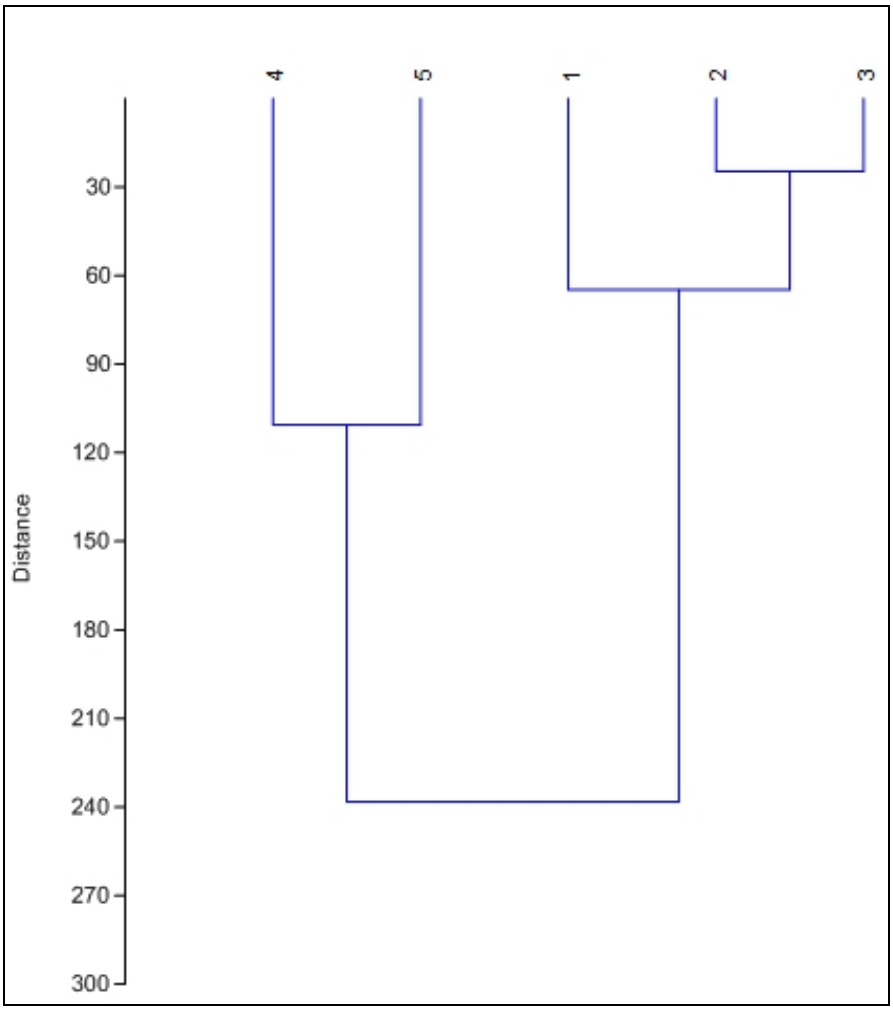

Figure 3: Sampling size simmilarity according to the taxonomical composition (Ward's method).

The upper portion of the river scored a 5 (high) for water quality at sites O1, O2 and O3 and good at sites O4 and O5 by the Asterics software. This is the result of different benthic macroinvertebrates assemblages structure in the two parts of the river divided by the cluster (Fig. 3).

Several other metrics and indexes (Saprobity, taxa groups, flow and substrate preferences, zonation, Average score per taxon/Czech version, Evenness, r/K relationship) express the alternation of conditions from spring to mouth (Tab. 2). The importance of xeno-, oligo and β-mesosaprobic organisms decreases downstream in contrast to α-meso and poly-saprobic organisms. The value of the Slovakian saprobic index also increases downstream. These changes and differences support the ratio of organisms preferring a particular zone of the Olšava River. According to this, we can say that the upper part belongs to the rhithral zone (O1, O2 epirhithral; O3 metarhithral) and the lower part (O4 and O5) to the epipotamal zone. The substrate in the rhithral zone contains a higher ratio of a rough, stony substrate and more species which prefer lithal and belong to grazers and scrapers. Potamal (the lower part) is characterized by the presence of fine organic and inorganic particles. Naturally, more gatherers and collectors preferring particular organic matter (partly pelal and argylal) occur on this stretch of the river (Tab. 3). Clear differences between sites O1-O3 and O4-O5 are noticed due to the relative abundance of oligosaprobic and polysaprobic species, Slovakian saprobic index, Evenness, EPT-taxa ratio and EP-taxa ratio (Tab. 3). The situation in which there is a relative abundance of grazers-scrapers and gatherers-collectors is different, a noticeable step is visible in values between sites O1-O2 and O3-O5.

Table 2: Selected metrics at individual sampling sites (calculated with specialized assessment software ASTERICS, vers. 3.3).

Metrics		Sampling sites				
		O1	O2	O3	O4	O5
Slovakian Saprobic Index		1.27	1.68	1.77	2.29	2.20
Evenness		0.80	0.80	0.61	0.52	0.46
Average score per Taxon (Czech version)		7.59	7.10	6.69	6.54	6.46
r/K relationship		0.06	0.05	0.05	0.04	0.04
zonation	(%) hypocrenal	11.92	9.69	8.47	2.13	1.08
	(%) epirhithral	34.54	24.56	20.95	9.35	9.38
	(%) metarhithral	28.15	23.51	25.31	12.58	12.12
	(%) hyporhithral	14.22	19.81	19.55	14.07	13.33
	(%) epipotamal	6.00	10.84	11.17	14.44	13.40
	(%) metapotamal	2.12	3.67	5.02	10.38	10.00
	(%) littoral	0.87	5.40	5.79	17.64	18.75
microhab. preference	(%) Type Pelal	0.97	5.92	7.68	28.73	31.05
	(%) Type Psamal	3.68	3.97	12.20	10.79	11.74
	(%) Type Akal	7.17	10.44	13.96	9.20	10.03
	(%) Type Lithal	63.62	58.23	33.86	15.56	13.09
	(%) Type Phytal	18.14	15.92	15.78	16.60	14.95
	(%) Type Aka + Lit + Psa	74.46	72.64	60.70	36.09	34.85
current preference	(%) Type Limnophil	-	0.12	-	0.57	0.62
	(%) Type Limno to rheophil	-	-	-	0.03	0.16
	(%) Type Rheo to limnophil	1.73	12.10	6.45	7.26	5.12
	(%) Type Rheophil	40.31	57.37	25.18	8.24	4.65
	(%) Type Rheobiont	24.09	7.19	6.23	0.41	0.21
	(%) Type Indifferent	1.10	4.20	4.99	44.80	48.15
saprobic valence	xeno (%)	8.95	2.53	2.04	0.34	0.32
	oligo (%)	39.62	36.41	30.32	8.40	7.87
	alpha-meso (%)	8.42	14.72	20.06	36.27	34.79
EPT-Taxa (%)		84.57	76.05	36.09	17.71	13.32
EP (%)		84.25	72.81	34.72	16.55	12.20

The community structure, and consequently the structure of autecological groups, correspond with stream characteristics which change from spring to mouth.

These changes are relatively continuous except the middle stretch of the river (site O3). This part is similar to the upper zone in relative abundance of oligosaprobic and polysaprobic species, Slovakian saprobic index, Evenness, EPT-taxa ratio and EP-taxa ratio, relative abundance of stoneflies and dipterans (partly mayflies) (Tab. 2). It is partly a result of the local geomorphological characteristics.

The average slope and stream gradient is higher in the upper portion (Tab. 1) and the climate and geochemical types of minerals are different at the selected site groups (O1-O3 vs. O4-O5). On the other hand, sites O4 and O5 are more affected by anthropogenic impacts (agriculture, pond). So, the difference in the benthic invertebrate communities and ecological groups in these two parts of the river, is the result of the cummulative effect of natural and anthropogenic factors. Relative abundance of grazers-scrapers, gatherers-collectors and Oligochaeta and Crustacea is similar within the lower portions (sites O4-O5). We postulate that it is due to the consequence of lower stream gradient, lower ratio of torrential/fluviatile habitats and naturally higher levels of fine particle deposition.

We found, that traditional indexes like the saprobic index, EPT-taxa ratio, EP-taxa ratio and relative abundance of stoneflies worked better than most of the

new metrics like BMWP and ASPT. Similar findings were published by Sandin and Hering (2004) in Austrian and Czech rivers, where macroinvertebrates are generally identified to lower (species) as opposed to a higher (genus or family) level of identification. Simple "richness measures" (EPT, EP) based on species belonging to the insect orders Ephemeroptera, Plecoptera and Trichoptera (generally regarded as sensitive) are very good, because the loss of taxa richness within this group indicates perturbation (Wallace et al., 1996; Ofenböck et al., 2004). Richness measures and presence/absence of these sensitive taxa contribute to many of the new, modern and more complicated measurements (metrics) which can reflect other stressor types which are absent (or have a very low impact) in the Olšava River. So, the variance of these metrics is a result of the distinctness of natural environmental parameters. The advantage of old, traditional approaches (indexes) can disappear in rivers affected by many different strong stressors. Where new, modern multimetric approaches can exhibit greater accuracy in information (Rico et al., 1992; Ofenböck et al., 2004).

Table 3: The list of taxa found in Olšava River with relative abundance (%) at sampling sites.

Taxon/Study site	O1	O2	O3	O4	O5
Turbellaria	0.00	0.00	0.04	0.02	0.10
Mollusca	0.00	0.00	0.08	1.12	1.44
Oligochaeta	0.16	0.36	8.12	12.64	14.76
Hirudinea	0.16	0.00	0.04	0.10	0.14
Hydracarina	0.00	0.00	0.00	0.22	0.21
Asellus aquaticus (Linnaeus, 1758)	0.00	0.00	0.00	3.37	2.69
Gammarus sp.	13.07	5.00	36.03	23.72	23.64
Baetis ssp. juv.	0.47	3.57	1.43	2.79	1.36
Baetis buceratus Eaton, 1870	0.00	0.00	0.04	1.64	0.19
Baetis fuscatus (Linnaeus, 1761)	0.00	0.12	0.19	1.91	0.97
Baetis muticus Linnaeus, 1758	4.25	1.90	0.34	0.22	0.18
Baetis rhodani (Pictet, 1843-1845)	8.82	3.69	7.03	0.61	0.84
Baetis scambus Eaton, 1870	0.00	0.00	0.04	0.00	0.00
Baetis vernus Curtis, 1834	0.00	0.00	0.00	0.37	0.49
Centroptilum sp. juv.	0.00	0.71	0.00	0.00	0.00
Centroptillum luteolum (Muler, 1776)	0.00	0.24	0.26	0.46	0.41
Centroptillum pennulatum Eaton, 1870	0.00	0.36	0.11	0.00	0.00
Procloeon bifidum (Bengtsson, 1912)	0.00	0.00	0.00	0.00	0.04
Caenis ssp. juv. Stephens, 1835	0.00	0.00	0.08	0.02	0.06
Caenis horaria (Linnaeus, 1758)	0.00	0.00	0.00	0.17	0.14
Caenis luctuosa Burmeister, 1917	0.00	0.12	0.45	3.84	4.93
Caenis macrura Stephens, 1835	0.00	0.00	0.08	0.10	0.23
Caenis robusta Eaton, 1884	0.00	0.00	0.00	0.02	0.04
Ephemera danica Muller, 1764	0.00	2.98	0.41	0.10	0.08
Ephemerellidae indet. juv.	0.00	0.00	0.04	0.00	0.00
Serratella ignita (Poda, 1761)	0.79	0.00	0.64	0.44	0.16
Torleya major (Klapalek, 1905)	0.00	0.60	2.71	0.00	0.00
Ephemerella notata Eaton, 1887	0.00	0.00	0.00	0.05	0.04
Ecdyonurus sp. juv.	3.78	7.26	1.02	0.44	0.14
Ecdyonurus aurantiacus (Burmeister, 1839)	0.00	0.95	0.23	0.02	0.02
Ecdyonurus macani Thomas and Sowa, 1970	0.94	0.36	0.19	0.10	0.04
Ecdyonurus starmachi Sowa, 1971	0.31	1.07	0.30	0.17	0.00

Table 3 (continuing): The list of taxa found in Olšava River with relative abundance (%) at sampling sites.

Taxon/Study site	O1	O2	O3	O4	O5
Ecdyonurus torrentis Kimmins, 1942	0.00	0.00	0.11	0.10	0.02
*Ecdyonurus venosus (*Fabricius, 1775)	0.16	0.12	0.00	0.02	0.10
Electrogena affinis (Eaton, 1884)	0.00	0.00	0.08	0.00	0.00
Electrogena sp. juv.	0.00	4.05	0.75	0.07	0.10
Epeorus assimilis Eaton, 1885	0.63	0.12	0.23	0.00	0.00
Heptagenia sp. juv.	0.00	0.83	0.45	0.12	0.10
Rhitrogena sp. juv.	2.36	15.24	1.47	0.00	0.02
Rhithrogena carpatoalpina Klonowska, Olechowska, Sartori and Wwichelbaumer, 1987	11.18	2.98	0.90	0.00	0.00
Habroleptoides confusa Sartori and Jacob, 1986	4.57	9.52	2.44	0.39	0.27
Habrophlebia fusca (Curtis, 1834)	0.00	0.00	0.00	0.27	0.21
Habrophlebia lauta Eaton, 1884	0.63	4.05	2.71	0.88	0.72
Paraleptophlebia submarginata (Stephens, 1835)	0.63	0.36	0.00	0.00	0.00
Siphonoperla neglecta (Rostock, 1881)	0.79	0.00	0.00	0.00	0.00
Leuctra indet. juv.	0.47	0.36	0.26	0.07	0.06
Leuctra albida Kempny, 1899	2.05	0.00	0.04	0.22	0.18
Leuctra aurita Navas, 1919	0.31	0.24	0.15	0.00	0.00
Leuctra nigra (Olivier, 1811)	1.42	0.36	0.04	0.00	0.00
Nemoura sp. juv.	0.31	2.62	0.11	0.02	0.02
Nemoura cambrica (Stephens, 1835)	0.16	0.00	0.00	0.00	0.00
Nemoura cinerea (Retzius, 1793)	7.24	2.02	0.04	0.02	0.02
Nemoura dubitans Morton, 1894	0.00	0.12	0.19	0.00	0.00
Nemoura marginata Pictet, 1836	0.00	0.12	0.00	0.00	0.00
Nemoura uncinata Despax, 1934	0.00	0.36	0.00	0.00	0.00
Protonemura sp. juv.	0.31	0.36	0.04	0.00	0.00
Protonemura intricata (Ris, 1902)	8.03	0.12	0.94	0.00	0.00
Perla indet. juv.	0.00	0.12	0.04	0.00	0.00
Perla abdominalis	0.00	0.00	0.04	0.00	0.00
Perla marginata (Panzer, 1799)	0.16	0.36	0.11	0.00	0.00
Perla pallida Guerin, 1838	2.20	1.07	0.53	0.00	0.00
Isoperla Banks, 1906	0.47	0.24	0.00	0.02	0.02
Brachyptera Newport, 1849	0.16	0.00	0.00	0.02	0.02
Brachyptera risi (Morton, 1896)	9.76	1.79	1.81	0.00	0.00
Brachyptera seticornis (Klapálek, 1902)	10.87	0.95	0.53	0.00	0.00
Atherix ibis (Fabricius, 1798)	0.00	0.00	0.00	0.05	0.04
Chironomidae indet. juv.	0.31	4.40	3.57	35.22	37.85
Ceratopogonidae	0.00	0.24	1.02	0.02	0.02
Chelifera flavella (Zetterstedt, 1838)	0.00	0.48	0.00	0.00	0.00
Wiedemannia sp.	0.00	0.00	0.00	0.02	0.02
Limonidae	0.79	0.12	0.08	0.07	0.06
Eloeophila maculata (Meigen, 1804)	0.00	0.24	0.00	0.00	0.00
Eloeophila submarmorata (Verral, 1887)	0.00	0.00	0.04	0.00	0.00
Antocha vitripennis (Meigen, 1830)	0.00	0.00	0.04	0.00	0.00
Dicranota sp. juv.	0.00	0.48	0.75	2.47	2.08
Psychoda gemina (Eaton, 1904)	0.00	0.00	0.00	0.02	0.02
Bazarella subneglecta (Tonnoir, 1922)	0.00	0.00	0.08	0.00	0.00

Table 3 (continuing): The list of taxa found in Olšava River with relative abundance (%) at sampling sites.

Satchelliella stammeri (Jung, 1954)	0.00	0.12	0.00	0.00	0.00
Ptychoptera handlirschi (Czizek, 1919)	0.00	0.24	0.00	0.00	0.00
Taxon/Study site	O1	O2	O3	O4	O5
Chrysops caecutiens/relictus	0.00	0.00	0.00	0.07	0.06
Tipula couckei Goetghebuer and Tonnoir, 1921	0.00	0.00	0.00	0.22	0.18
Tipula lateralis Meigen, 1804	0.00	0.00	0.00	0.07	0.21
Tipula montium Egger, 1863	0.00	0.12	0.00	0.00	0.00
Sialis sp.	0.00	0.12	0.00	0.00	0.04
Platambus maculatus (Linnaeus, 1758)	0.00	0.83	0.08	0.00	0.00
Orectochilus villosus (Müller, 1776)	0.00	0.00	0.08	0.00	0.00
Elmis maugetii Latreille, 1798	0.16	0.95	0.49	0.00	0.00
Elmis sp. - larvae	0.16	0.00	0.34	0.00	0.16
Esolus angustatus (Müller, 1821)	0.00	0.00	0.04	0.00	0.00
Esolus sp. - larvae	0.00	0.48	0.15	0.02	0.02
Limnius volckmari (Panzer, 1793)	0.00	0.24	0.11	0.00	0.00
Limnius sp. - larvae	0.00	2.02	0.68	0.00	0.00
Hydraena excisa Kiesenwetter, 1849	0.00	0.24	0.08	0.00	0.00
Hydraena gracilis German, 1824	0.00	1.07	0.94	0.00	0.00
Hydraena riparia Kugelann, 1794	0.00	0.71	0.11	0.00	0.00
Hydraena sp.	0.63	5.60	1.05	0.02	0.02
Hydrocyphon deflexicollis (Müller, 1821) - larvae	0.00	0.00	0.53	0.00	0.00
Rhyacophila tristis Pictet, 1835	0.00	0.36	0.08	0.00	0.00
Rhyacophila s. str. sp. juv.	0.00	0.12	0.08	0.00	0.00
Hydropsyche instabilis (Curtis, 1834)	0.00	0.60	0.11	0.00	0.00
Hydropsyche pellucidula (Curtis, 1834)	0.00	0.00	0.00	0.02	0.02
Hydropsyche saxonica Mclachlan, 1884	0.00	0.24	0.23	0.02	0.02
Hydropsyche sp. juv.	0.31	1.07	0.49	0.98	0.18
Cyrnus trimaculatus (Curtis, 1834)	0.00	0.00	0.00	0.00	0.08
Plectrocnemia sp. juv.	0.00	0.00	0.04	0.00	0.00
Polycentropodidae g. sp. juv.	0.00	0.12	0.00	0.00	0.00
Psychomyiidae	0.00	0.00	0.00	0.00	0.00
Psychomyia pusilla (Fabricius, 1781)	0.00	0.00	0.00	0.02	0.02
Tinodes sp. juv.	0.00	0.12	0.00	0.00	0.00
Goeridae g. sp. juv.	0.00	0.12	0.00	0.00	0.00
Athripsodes cf. *bilineatus* (Linnaeus, 1758)	0.00	0.00	0.08	0.02	0.02
Mystacides sp. juv.	0.00	0.00	0.00	0.02	0.06
Mystacides azurea (Linnaeus, 1761)	0.00	0.00	0.00	0.00	0.04
Oecismus monedula (Hagen, 1859)	0.00	0.12	0.00	0.00	0.00
Sericostomatidae g. sp. juv.	0.00	0.12	0.00	0.00	0.00
Limnephilidae g. sp. juv.	0.00	0.00	0.04	0.00	0.00
Simuliidae indet. juv.	0.00	0.12	12.79	1.30	1.56
Others Diptera	0.00	0.48	1.99	2.37	2.08

CONCLUSIONS

If we compare changes in the relative abundance of species with changes in ecological groups composition, we can say that ecological groups (guilds) represent better the changes in water quality, land use, anthropogenic impacts and natural variables.

The relative abundance of stoneflies, mayflies and dipterans represent better anthropogenic impact than the relative abundance of other taxa groups (e.g. Amphipods and Oligochaeta) in the Olšava River catchment.

The relative abundance of oligosaprobic and polysaprobic species, Slovakian saprobic index, Evenness, EPT-taxa ratio and EP-taxa ratio express the increasing human impact (organic pollution) better than other indexes and metrics calculated for this stream.

AKNOWLEDGEMENTS

This study was supported by the projects KEGA 012PU-4/2012 and OP R & D ITMS: 26220120041. The authors also wish to thank Mrs. Čiamporová-Zaťovičová Z. for helping out with Trichoptera and Coleoptera identification and Mr. Kaňuk J. for his help with GIS.

REFERENCES

Barabas D. and Dzurdženík J., 2002 – Vplyv intenzity využívania povodia Olšavy na odtokové pomery, *Geografické informácie*, 7, Slovensko a integrujúca sa Európa: zborník z XIII, kongresu SGS, II, diel. - Nitra: Univerzita Konštantína Filozofa, 13-17. (in Slovak)

Cairns J. Jr. and Dickson K. L., 1971 – A simple method for the biological assesment of the effects of waste discharges on aquatic bottom-dwelling organisms, *Journal (Water Pollution Control Federation)*, 43, 5, 755-772.

De Pauw N., Gabriels W. E. and Goethals P. L. M., 2006 – River monitoring and assessment methods based on macroinvertebrates, in Biological Monitoring of Rivers: Applications and Perspectives, Ziglio et al. (eds), Chichester, 113-13.

Hering D., Buffagni A., Moog O., Sandin L., Sommerhäuser M., Stubauer I., Feld C., Johnson R., Pinto P., Skoulikidis N., Verdonschot P. and Zahrádková S., 2003 – The development of a system to assess the ecological quality of streams based on macroinvertebrates - design of the sampling programme within the AQEM project, *International Review of Hydrobilogy*, 88, 345-361.

Hodkinson I. D. and Jackson J. K., 2005 – Terrestrial and aquatic invertebrates as bioindicators for environmental monitoring, with particular reference to mountain ecosystems, *Environmental Management*, 35, 5, 649-666.

Lešková J., 2009 – Differences in taxonomical composition of aquatic Diptera (excl. Chironomidae, Simuliidae) in two Carpathian streams in East Slovakia, *Lauterbornia*, 68.

Manko P., 2008 – Aquatic macroinvertebrate communities in River Torysa across the Javorina military training area in the Levočske Vrchy Mountains (Slovakia), *Transylvanian Review of Systematical and Ecological Research*, 6, The Wetlands Diversity, Curtean-Bănăduc et al. (eds), 41-50.

Ofenböck T., Moog T., Gerritsen J. and Barbour M., 2004 – A Stressor Specific Multimetric Approach for Monitoring Running Waters in Austria Using Benthic Macro-Invertebrates. Integrated Assessment of Running Waters in Europe, *Developments in Hydrobiology*, 175, 251-268.

Rico E., Rallo A., Sevillano M. A. and Arretxe M. A., 1992 – Comparison of several biological indices based on river macroinvertebrate benthic community for assessment of running water quality, *Annales de Limnologie*, 28, 2, 147-156.

Rosenberg D. M. and Resh V. H., 1993 (eds) – Freshwater biomonitoring and benthic macroinvertebrates, Chapman and Hall, New York, 488.

Sandin L. and Hering D., 2004 – Comparing Macroinvertebrate Indices to Detect Organic Pollution across Europe: A Contribution to the EC Water Framework Directive Intercalibration, Integrated Assessment of Running Waters in Europe, *Developments in Hydrobiology*, 175, 55-68.

Schleiter I. M., Borchardt D., Wagner R., Dapper T., Schmidt K. D., Schmidt H. H. and Werner H., 1999 – Modelling water quality, bioindication and population dynamicsin lotic ecosystems using neural networks, *Ecological Modelling*, 120, 2-3, 271-286.

Segnini S., 2003 – El uso de los macroinverdebrados bentónicos como indicadores de le condición ecológica de los cuerpos de agua corrriente, *Ecotropicos*, 16, 2, 45-63. (in Spanish)

Wallace J. B., Grubaugh J. W. and Whiles M. R., 1996 − Biotic indices and stream ecosystem processes: results from an experimental study, *Ecological Applications*, 6, 140-151.

AUTHORS:

[1] *Peter MANKO*
peter.manko@gmail.com
[1] *Ján KOŠČO*
jan.kosco@unipo.sk
Department of Ecology
University of Prešov
Novembra Street 1,
Prešov, Slovakia,
SK-08116.
[2] *Lenka KOŠUTHOVÁ*
kosuthova@uvl.sk
Department of Breeding and Diseases of Game and Fish,
University of Veterinary Medicine and Pharmacy,
Komenského Street 73,
Košice, Slovakia,
SK-04181.
[3] *Dušan BARABAS*
dusan.barabas@upjs.sk
Institute of Geography,
"Pavol Jozef Šafárik" University,
Jesenná Street 5,
Košice, Slovakia, SK-04001.
[4] *Jarmila LEŠKOVÁ*
jarmila250284@gmail.com
Department of ecology and water management laboratories,
Slovak Water Management Enterprise,
Vlčie hrdlo, 5672,
Bratislava, Slovakia,
SK-82419.

COMPARATIVE ANALYSIS OF PITFALL TRAPS WITH DIFFERENT LIQUIDS FOR STUDYING GROUND-DWELLING INSECTS WITH SPECIAL REFERENCE TO ANT COMMUNITIES (HYMENOPTERA, FORMICIDAE)

Ioan TĂUŞAN [1], *Alexandru Ioan TATU* [2] and *Adriana-Valentina CRAVĂ* [3]

KEYWORDS: alcohol, brine, vinegar, glycol, Kruskall-Wallis, Transylvania, Romania.

ABSTRACT

In the present paper we examined whether the liquid used in pitfall traps has any effect on ground-dwelling insects, especially on ant communities, in terms of species richness and abundance. Four liquids were tested in order to answer our hypothesis: brine, alcohol, glycol and vinegar. A total of 1,136 insect specimens were collected during August 2010 in grassland habitat in Southern Transylvania. Coleoptera and Hymenoptera were the predominant taxa, as expected. Almost 70% of the specimens consisted of ants. Fourteen species were identified, most of them common, with the exception of *Myrmica specioides* Bondroit, 1918 which is a rare species.

Although vinegar and brine yielded the highest number of ant specimens and individuals, Kruskal–Wallis test showed that there are no significant differences between the tested liquids.

REZUMAT: Analiza comparativă a capcanelor Barber cu diferite lichide pentru studiul insectelor de pământ cu referire specială la comunităţile de furnici.

În prezenta lucrare, am analizat dacă utilizarea unui anumit tip de lichid folosit în capcanele Barber influenţează în vreun fel bogăţia în specii şi abundenţa indivizilor. Pentru a răspunde acestei întrebări, am testat patru tipuri de lichide: oţet, alcool etilic, glicol (antigel) şi saramură. Un număr de 1136 specimene de insecte au fost colectate în urma unei campanii de teren, în august 2010, în sudul Transilvaniei. Cum era de aşteptat, cel mai bine reprezentate au fost Coleoptera şi Hymenoptera. Aproape 70% dintre specimene au fost reprezentate de către furnici. Paisprezece specii au fost identificate, majoritatea fiind specii comune, cu excepţia speciei *Myrmica specioides* Bondroit, 1918, care este rară pentru România.

Deşi capcanele cu oţet şi saramură au înregistrat cele mai multe specii şi cei mai mulţi indivizi, testul Kruskal–Wallis a arătat faptul că nu există diferenţe semnificative între cele patru lichide testate.

RÉSUMÉ: Analyse comparative des pièges à fosse avec différents liquides pour l'étude des insectes du sol et plus particulièrement des communautés de fourmis.

Dans le présent document, nous avons examiné si le liquide utilisé dans les pièges à fosse a un effet sur les insectes fouisseurs, en particulier sur les communautés de fourmis, en termes de richesse en espèces et d'abondance. Quatre liquides ont été testés afin de répondre à notre hypothèse: la saumure, l'alcool, le glycol et le vinaigre.

Un total de 1136 spécimens d'insectes a été recueilli, au cours du mois d'août 2010, dans les prairies du Sud de la Transylvanie. Comme attendu, les taxons dominants sont les coléoptères et hyménoptères. Près de 70% des échantillons se composent de fourmis; Quatorze espèces ont été identifiées. La plupart d'entre elles sont communes à l'exception de *Myrmica specioides* Bondroit, 1918, qui est une espèce rare en Roumanie.

Bien que les pièges à fosse remplis de vinaigre et de saumure capturent un plus grand nombre de spécimens de fourmis, le test de Kruskal–Wallis n'a montré aucune différence significative entre les liquides employés.

INTRODUCTION

Although it has been described more than 80 years ago, the pitfall trap is one of the most widespread sampling method because of its simplicity (Greenslade and Greenslade, 1971), revealing a high number of specimens and a wide range of taxa, particularly spiders (Araneae), ground beetles (Coleoptera, Carabidae) and ants (Hymenoptera, Formicidae) (Weeks and McIntyre, 1997; Ward et al., 2001).

Regarding ant assemblages, there are more than 20 methods of quantification (Schlick-Steiner et al., 2006), but the most used method is pitfall trapping.

Increasingly criticised (Topping and Sunderland, 1992; Topping, 1993; Majer, 1997), pitfall trapping still remains one of the best methods in estimating ant species richness (Andersen, 1997; Bestelmeyer et al., 2000; Steiner et al., 2005).

Pitfall trapping is superior, for example, to bait trapping in the characterisation of relative species abundance, and is capturing most ant species, especially for epigaeic ant community studies (Wang et al., 2001), though cryptic species are usually under sampled (Majer, 1997).

This self-sampling method is time-efficient, easy to use and inexpensive. Results are often rich in catches, both in species and in individuals (Spence and Niemelä, 1994). Nonetheless, pitfall trapping is important in the ALL Protocol for assessing ant diversity (Agosti et al., 2000).

The efficiency of pitfall traps is influenced by several aspects of construction, such as the shape, size and materials (Luf, 1975; Brennan et al., 1999; Koivula et al., 2003), spacing and transect design (Luf, 1975; Ward et al., 2001; Perner and Schueler, 2004; Larsen and Forsyth, 2005; Sabu and Shiju, 2010) and the use of various baits, killing agents, and preservatives (Greenslade and Greenslade, 1971; Weeks and McIntyre, 1997; Pekar, 2002; Koivula et al., 2003; Schmidt et al., 2006; Jud and Schmidt-Entling, 2008; Chen et al., 2011).

Two types of pitfall traps are known: dry pitfall traps (which do not contain any liquids) and wet pitfall traps (which contain a preservative liquid). The last traps have been reported to be more efficient (Santos et al., 2007).

Usually non-attractant liquids are used. Commonly, entomologists use brine, formalin (5-10% formaldehyde), ethylene glycol, ethyl alcohol, vinegar, etc.

We have tested if the liquid used in traps has any effect on the diversity and abundance of ants and other insects.

The sampling was carried out in xero-mesophilous grassland in a hilly area at Cisnădioara, Sibiu County (Transylvania) (45°41’51.76” N and 24°5’23.70” E) in August, 2010. The characteristic association was *Agrosteto-Festucetum sulcatae (rupicolae)* Csűrös-Káptalan 1964 (Schneider-Binder, 1976) (Fig. 1).

MATERIAL AND METHODS

Four blocks consisting of 16 pitfall traps each were set in Latin square structures (Fig. 2) so that any discrimination was ruled out. The traps (175 ml plastic cups) were separated by one meter and every block by five meters. Four types of liquids were tested, in all four plots: glycol, vinegar, alcohol and brine. All of the liquids were diluted to 1:1 parts with water.

The pitfall traps were checked during a field campaign after ten days. The entomological material was reared out and the identification of ant species was carried out on the basis of several available identification keys (Seifert, 1996, 2007; Czechowski et al., 2002; Radchenko and Elmes, 2010), while the rest of the insects were grouped in higher taxa.

Regarding the statistics, Shannon-Wiener general entropy values and their evenness were calculated. We tested the liquids using the Kruskal-Wallis one-way analysis of variance by ranks with PAST software (Hammer et al., 2001).

Figure 1: Meso-hygrophilous grassland of Cisnădioara surroundings (Mesaroş A.-M.).

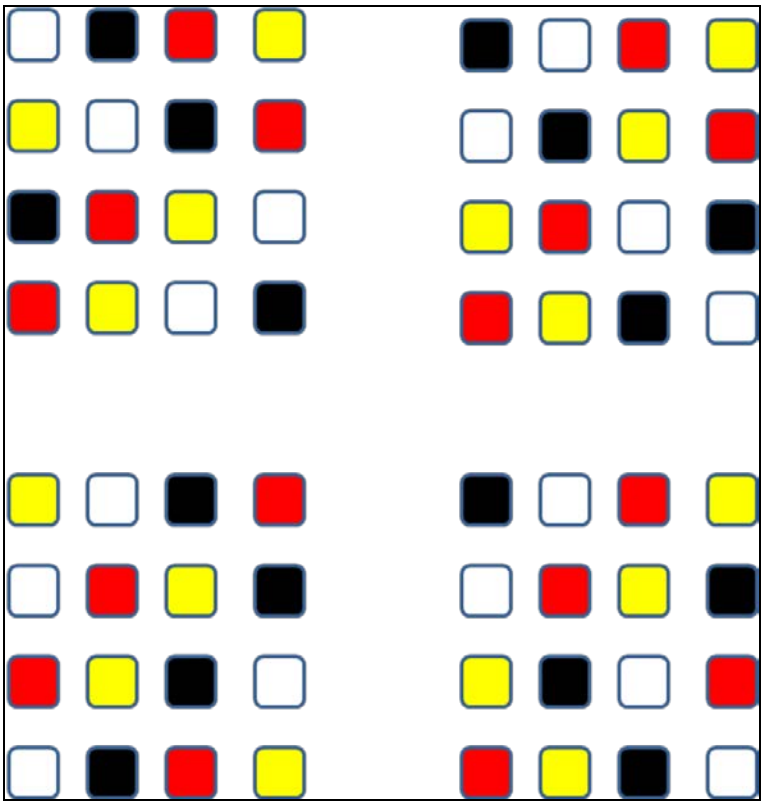

Figure 2: Latin square set up of pitfall traps filled with different liquids (white squares – brine; yellow squares – glycol; red squares – alcohol; black squares – vinegar).

RESULTS AND DISCUSSION

As expected, two important groups of insects were identified: beetles (Coleoptera) and ants (Hymenoptera, Formicidae). The field study yielded 1,136 insect specimens, more than 69% consisting of ants (Tab. 1). Other insects were present, but in quite low abundances: true bugs (Hemiptera, Heteroptera), flies (Diptera), crits and grasshoppers (Orthoptera).

There is no significant difference between the insect communities in all four liquids. The Hymenoptera order is the most abundant in all analysed liquids, especially represented by ants. A small number of dipterans are also present (Fig. 3). Vinegar hosted the highest number of specimens, while glycol the lowest.

Table 1: List of insect taxa identified in pitfall traps in terms of number of individuals (G – glycol; V – vinegar; B – brine; A – alcohol).

Taxa	G	V	B	A
Coleoptera				
Staphilinidae	15	47	16	10
Silphidae	1	-	1	1
Carabidae	38	67	34	59
Cleridae	-	1	-	-
Curculionidae	-	1	-	-
Total number of coleopterans	54	116	51	70
Hymenoptera				
Formicidae	105	324	254	94
Other hymenopterans	-	7	1	-
Total number of hymenopterans	105	331	255	94
Diptera	3	21	6	13
Hemiptera				
Scutelleridae	2	-	1	-
Rhopalidae	1	1	-	-
Cicadellidae	-	4	-	-
Nabidae	-	1	-	-
Aphidae	-	1	-	-
Total number of hemipterans	3	7	1	-
Orthoptera				
Gryllidae	1	-	2	-
Acrididae	-	1	1	-
Total number of orthopterans	1	1	3	1
Total number of specimens	**166**	**476**	**316**	**178**

Regarding the ant communities, 14 species were identified during this study (Tab. 2). The majority of the species are common for the myrmecofauna of Romania (Markó et al., 2006), except for *Myrmica specioides*. The most abundant species is *Myrmica scabrinodis*, a typical grassland species alongside *Formica cinerea, Formica cunicularia, Lasius flavus* and *Lasius niger*.

The presence of several forest species such as *Camponotus ligniperdus, Myrmica ruginodis, Myrmecina graminicola* and *Temnothorax crassispinus* can be explained by foraging and by the surrounding forest habitats.

An interesting surprise is the presence of *Lasius paralienus*, which prefers disturbed habitats (Seifert, 1996).

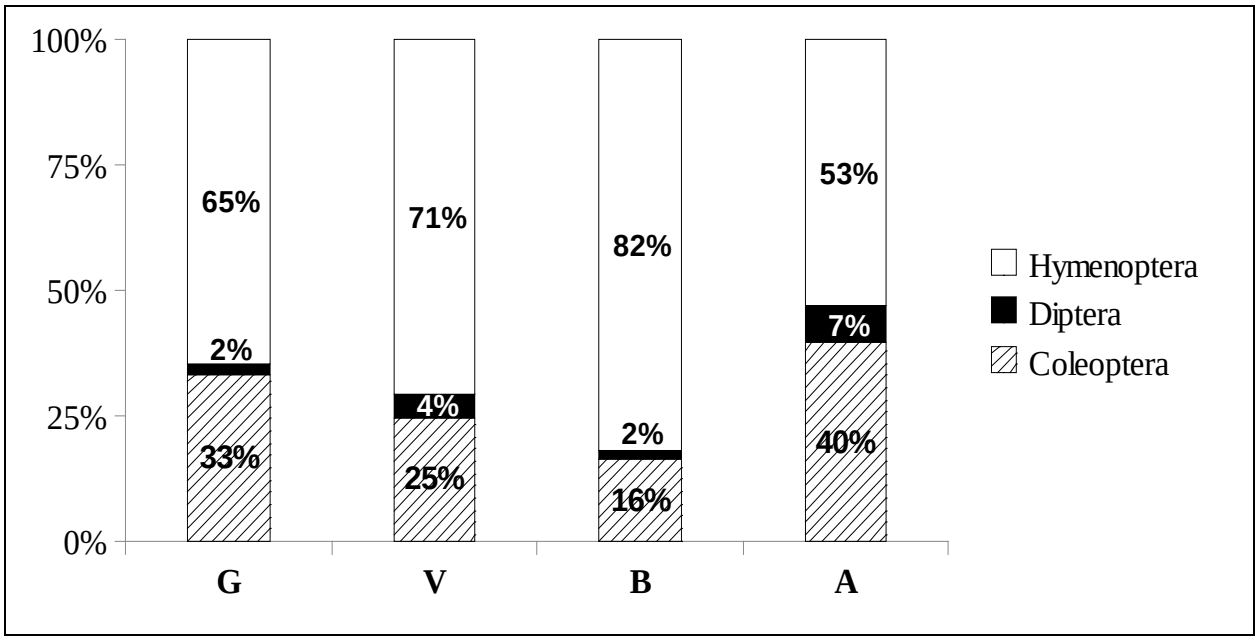

Figure 3: Insect community structure in terms of relative abundance (%) in each of the tested liquids (V − vinegar; A − alcohol; B − brine; G − glycol).

Vinegar and brine revealed the highest number of species, while alcohol and glycol the lowest. The same situation is reflected in terms of numerical abundance (Tab. 2).

However, looking beyond the raw data, the Shannon-Wiener diversity reveals the fact that there are no differences between the four liquids (Fig. 4).

Morever, the non-parametric test, Kruskal–Wallis, suggested that there are no significant differences between the tested liquids ($p = 0.399$). The Bonferroni corrections are given in table 3.

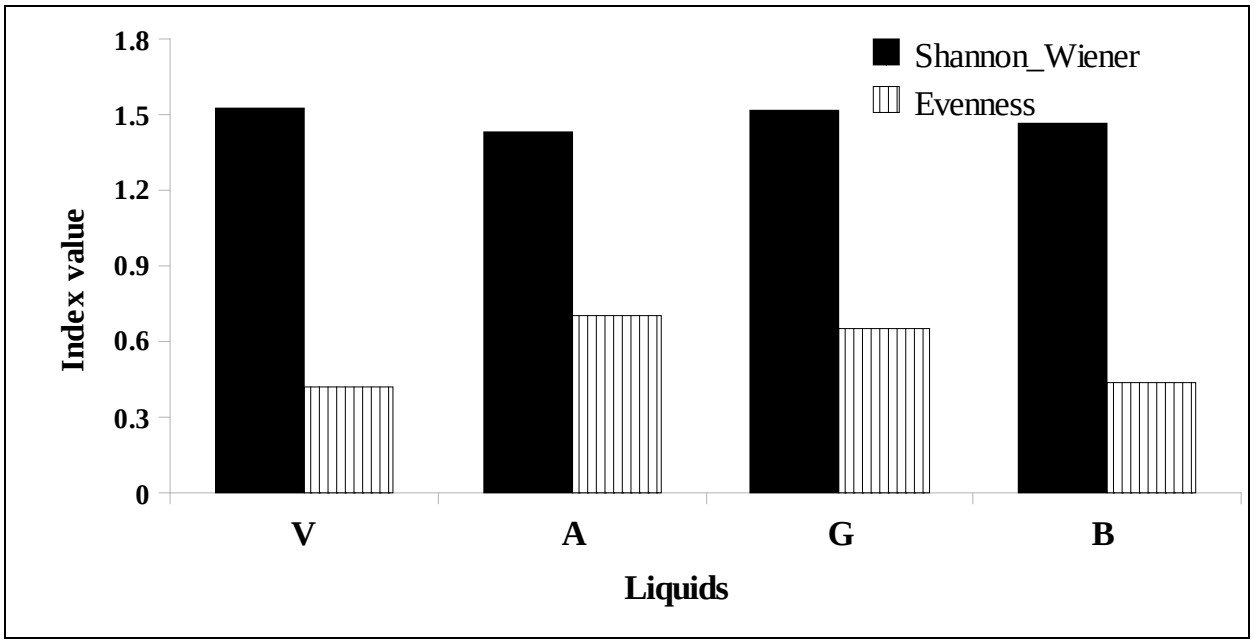

Figure 4: Shannon-Wiener diversity and Evenness of the studied ant communities in Cisnădioara (V − vinegar; A − alcohol; B − brine; G − glycol).

Table 2: List of ant taxa identified in pitfall traps in terms of number of individuals (G – glycol; V – vinegar; B – brine; A – alcohol).

Species	**V**	**A**	**G**	**B**
Dolichoderinae Forel, 187				
Tapinoma sp.	-	-	-	1
Formicinae Lepeletier, 1836				
Camponotus ligniperdus (Latreille, 1802)	-	1	-	1
Formica cinerea Mayr, 1853	7	-	-	2
Formica cunicularia Latreille, 1798	39	22	7	34
Lasius flavus (Fabricius, 1781)	63	5	26	27
Lasius niger (Linnaeus, 1758)	3	9	3	3
Lasius paralienus Seifert, 1992	43	16	18	81
Myrmicinae Lepeletier, 1836				
Myrmecina graminicola (Latreille, 1802)	1	-	-	-
Myrmica ruginodis Nylander, 1846	1	-	-	-
Myrmica scabrinodis Nylander, 1846	153	41	44	100
Myrmica specioides Bondroit, 1918	2	-	-	-
Temnothorax crassispinus (Karavaiev, 1926)	1	-	-	-
Tetramorium cf. *caespitum*	11	-	2	3
Solenopsis fugax (Latreille, 1798)	-	-	5	2
Total number of species: 14	**11**	**6**	**7**	**10**

Table 3: Mann-Whitney pair wise comparison, Bonferroni corrected/uncorrected.

	V	**A**	**G**	**B**
V		0.13	0.26	0.7
A	0.78		0.78	0.26
G	1	1		0.48
B	1	1	1	

CONCLUSIONS

In a previous study of the same habitat, only seven species were identified (Tăuşan and Markó, 2009) using alcohol as trapping liquid, almost the same number as in the present study.

A large number of aspects influence the catch in pitfall traps, such as the selection of pitfall trap size, collecting fluid and habitat type sampled.

Based on this study there is no significant difference in using any non-attractant liquid for pitfall trapping in grasslands. Other studies yielded similar results (Voolma and Sibul, 2006). Still, in some cases, certain liquids can obtain better results. Chen et al. (2011) showed that sugar/vinegar mixture gives reasonably comparable results to ethylene glycol, though the results were reasonably robust.

However, the selected group is extremely important in choosing the correct fluid. Koivula et al. (2003) showed that ethylene-glycol is a more efficient collecting fluid compared to commercial anti-freeze, paraffin and salt water in collecting beetles in a forest patch in South Africa.

Ideally, the liquid should not attract or repel ants, otherwise estimates and comparisons of foragers densities may be biased (Bestelmeyer et al., 2000).

In addition to choosing the efficient liquid for pitfall traps, we recommend using additional methods like nest counting or baiting besides pitfall traps for a better assessment of the ant assemblages in grassland habitats.

REFERENCES

Agosti D., Majer J. D., Alonso L. E. and Schultz T. R., 2000 – Ants: standard methods for measuring and monitoring biodiversity, Washington and London, 80-88.

Andersen A. N., 1997 – Functional groups and patterns of organization in North American ant communities: a comparison with Australia, *Journal of Biogeography*, 24, 433-460.

Bestelmeyer B. T., Agosti D., Alonso L. E., Brandao C. R. F., Brown W. L., Delabie J. H. C. and Silvestre R., 2000 – Field techniques for the study of ground-dwelling ants, in Ants: Standard Methods for Measuring and Monitoring Biodiversity, Agosti et al. (eds), Smithsonian Institution Press, Washington, London, 122-144.

Brennan K. E. C., Majer J. D. and Reygaert N., 1999 – Determination of an optimal pitfall trap size for sampling spiders in Australian Jarrah Forest, *Journal of Insect Conservation*, 3, 297-307.

Chen Y. Q., Li Q., Wang S. and Zhou X. Y., 2011 – A comparison of pitfall traps with different liquids for studying ground-dwelling ants (Formicidae), *Myrmecological News*, 14, 13-19.

Czechowski W., Radchenko A. and Czechowska W., 2002 – The ants (Hymenoptera, Formicidae) of Poland, Museum and Institute of Zoology PAS, Warszawa, 200.

Greenslade P. and Greenslade P. M. J., 1971 – The use of baits and preservatives in pitfall traps, *Journal of the Australian Entomological Society*, 10, 253-260.

Hammer Ø., Harper D. A. T. and Ryan P. D., 2001 – PAST: Paleontological Statistics Software Package for Education and Data Analysis, *Palaeontologia Electronica*, 4, 1, 9.

Jud P. and Schmidt-Entling M. H., 2008 – Fluid type, dilution and bitter agent influence spider preservation in pitfall traps, *Entomologia Experimentalis et Applicata*, 129, 356-359.

Koivula M., Kotze D. J., Hiisivuori L. and Rita H., 2003 – Pitfall trap efficiency: do trap size, collecting fluid and vegetation structure matter? *Entomologica Fennica*, 14, 1-14.

Larsen T. H. and Forsyth A., 2005 – Trap spacing and transect design for dung beetle biodiversity studies, *Biotropica*, 37, 322-325.

Luf M. L., 1975 – Some features influencing the efficiency of pitfall traps, *Oecologia*, 19, 345-357.

Majer J. M., 1997 – The use of pitfall traps for sampling ants - A critique, *Memoirs of the Museum of Victoria*, 56, 2, 323-329.

Markó B., Sipos B., Csősz S., Kiss K., Boros I. and Gallé L., 2006 – A comprehensive list of the ants of Romania (Hymenoptera: Formicidae), *Myrmecological News*, 9, 65-7.

Pekar S., 2002 – Differential effects of formaldehyde concentration and detergent on the catching efficiency of surface active arthropods by pitfall traps, *Pedobiologia*, 46, 539-547.

Perner J. and Schueler S., 2004 – Estimating the density of ground-dwelling arthropods with pitfall traps using a nested-cross array, *Journal of Animal Ecology*, 73, 469-477.

Radchenko A. and Elmes G., 2010 – Myrmica ants (Hymenoptera: Formicidae) of the Old World, Natura Optima Dux, Warsaw, 789.

Sabu T. K. and Shiju R. T., 2010 – Efficacy of pitfall trapping, Winkler and Berlese extraction methods for measuring ground − dwelling arthropods in the Western Ghats, *Journal of Insect Science*, 10, 98, insectscience.org/10.98.

Santos S. A. P., Cabanas J. E and Pereira J. A., 2007 – Abundance and diversity of soil arthropods in olive grove ecosystem (Portugal): Effect of pitfall trap type, *European Journal of Soil Biology*, 43, 77-83.

Schlick-Steiner B. C., Steiner F. M., Moder K., Bruckner A., Fiedler K. and Christian E., 2006 – Assessing ant assemblages: Pitfalls trapping versus nest counting (Hymenoptera, Formicidae), *Insectes Sociaux*, 53, 274-281.

Schmidt M. H., Clough Y., Schulz W., Westphalen A. and Scharntke T., 2006 – Capture efficiency and preservation attributes of different fluids in pitfall traps, *Journal of Arachnology*, 34, 159-162.

Schneider-Binder E., 1976 – Caracterizarea generală a vegetaţiei Depresiunii Sibiului şi a dealurilor marginale, *Studii şi Communicări, Ştiinţe Naturale, Muzeul de Istorie Naturală Sibiu*, 20, 15-45. (in Romanian)

Seifert B., 1996 – Ameisen: beobachten, bestimmen, Naturbuch Verlag, Augsburg, 352. (in German)

Seifert B., 2007 – Die Ameisen Mittel- und Nordeuropas, Lutra, Klitten, 368. (in German)

Spence J. R. and Niemelä J. K., 1994 – Sampling carabid assemblages with pitfall traps: the madness and the method, *Canadian Entomologist*, 126, 881-894.

Steiner F. M., Schlick-Steiner B. C., Moder K., Bruckner A. and Christian E., 2005 – Congruence of data from different trapping periods of ant pitfall catches (Formicidae), *Sociobiology*, 46, 105-116.

Tăuşan I. and Markó B., 2009 – Comparative analysis of ant communities (Formicidae) in the surroundings of Sibiu (Romania), *Brukenthal Acta Musei*, IV.3, 635-644.

Topping C. J., 1993 – Behavioural responses of three linyphiid spiders to pitfall traps, *Entomologia Experimentalis et Applicata*, 68, 287-293.

Topping C. J. and Sunderal K. D., 1992 – Limitations to the use of pitfall traps in ecological studies exemplified by a study of spiders in a field of winter wheat, *Journal of Applied Ecology*, 29, 485-491.

Voolma K. and Sibul I., 2006 – The effect of collecting fluid on the catch results of Hylobius abietis in pitfall traps, *Agronomy Research*, 4, 457-460.

Wang C., Strazanac J. and Butler L., 2001 – A comparison of pitfall traps with bait traps for studying leaf litter ant communities, *Journal of Economic Entomology*, 94, 3, 761-765.

Ward D. F., New T. R. and Yen A. L., 2001 – Effects of pitfall trap spacing on the abundance, richness and composition of invertebrate catches, *Journal of Insect Conservation*, 5, 1, 47-53.

Weeks R. D. and McIntyre N. E., 1997 – A comparison of live versus kill pitfall trapping techniques using various killing agents, *Entomologia Experimentalis et Applicata*, 82, 267-273.

AUTHORS:

[1] *Ioan TĂUŞAN*
ionut_tausan2007@yahoo.com
"Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Raţiu Street 5-7, Sibiu, Sibiu County, Romania, RO-55001,

[2] *Alexandru Ioan TATU*
alex_tatu@yahoo.com
"Babeş-Bolyai" University of Cluj-Napoca, Faculty of Biology and Geology, Department of Taxonomy and Ecology, Clinicilor Street 5-7, Cluj-Napoca, Cluj County, Romania, RO-400006,

[3] *Adriana-Valentina CRAVĂ*
adriana_crava@yahoo.com
"Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Raţiu Street 5-7, Sibiu, Sibiu County, Romania, RO-55001.

NEW SCIS PROPOSAL REGARDING THE ICHTHYOFAUNA AFTER THE CONTINENTAL BIOGEOGRAPHIC SEMINAR FOR ROMANIA, SIBIU (TRANSYLVANIA, ROMANIA), 9-12 JUNE 2008

Doru BĂNĂDUC [1], *Attila NAGY* [2] and *Angela CURTEAN-BĂNĂDUC* [1]

KEYWORDS: Continental Region, Natura 2000, SCIs, Romania, *Alosa pontica/Alosa immaculata, Umbra krameri, Aspius aspius, Barbus meridionalis, Gobio albipinnatus, Gobio kesslerii, Gobio uranoscopus, Pelecus cultratus, Rhodeus sericeus amarus, Cobitis elongata, Cobitis taenia, Misgurnus fossilis, Gymnocephalus schraetzer, Zingel streber* and *Zingel zingel.*

ABSTRACT

The main objectives of the European Community's environmental policy are the protection, conservation and improvement of environment quality. These objectives should be accomplished in the context of the rational use of the resources and in the understanding of the services those ecosystems provide. Over the last few decades the protection of biodiversity has been one of the main goals.

The aim of this paper is to give some data and related arguments for the proposal of new Natura 2000 sites for 15 fish species. At the Continental Biogeographical Seminar for the Romanian national territory (held at the "Lucian Blaga" University of Sibiu, Sibiu, 9-12 June 2008) it was determined that the distribution areas of some fish species are not entirely covered within the already proposed and accepted Natura 2000 sites, so additional proposals were requested by the European Union representatives.

Consequently, this article proposes some new Natura 2000 sites, to be considered at future bilateral Continental biogeographic disscussions for Romania (scheduled for the end of 2012).

The suggested European Community sites of interest in this article are based on the authors' field survey data using specific criteria (well preserved fish populations; stable fish populations; healthy fish populations; typical natural habitats; relatively low human impact; favorable geographical position). The following fish species of conservation interest were included: *Alosa pontica/Alosa immaculata, Umbra krameri, Aspius aspius, Barbus meridionalis, Gobio albipinnatus, Gobio kesslerii, Gobio uranoscopus, Pelecus cultratus, Rhodeus sericeus amarus, Cobitis elongata, Cobitis taenia, Misgurnus fossilis, Gymnocephalus schraetzer, Zingel streber* and *Zingel zingel*.

REZUMAT: Noi propuneri de SCI-uri pentru ihtiofaună, după Seminarul Biogeografic Continental pentru România, Sibiu (Transylvania, România) 9-12 iunie 2008.

Principalele obiective ale Comunităţii Europene în domeniul mediului sunt protecţia, conservarea şi îmbunătăţirea calităţii mediului, în contextul utilizării raţionale a resurselor şi serviciilor ecosistemelor. În ultimele decenii, protecţia biodiversităţii a fost unul dintre principalele obiective în această privinţă.

Scopul principal al acestei lucrări este acela de a oferi date şi argumente în favoarea propunerii unor noi situri Natura 2000 pentru 15 specii de peşti. La Seminarul Biogeografic pentru regiunea Continentală, pentru teritoriul naţional al României (care s-a desfăşurat la Universitatea „Lucian Blaga" din Sibiu, în 9-12 iunie 2008) s-a decis faptul că arealele unor specii de peşti sunt insuficient acoperite de situri Natura 2000, propuse şi acceptate, astfel propuneri suplimentare au fost solicitate de reprezentanţi ai Uniuniunii Europene.

Ca o reacţie la această situaţie, prezenta lucrare propune unele situri Natura 2000 noi, pentru a fi luate în considerare la viitoare potenţiale discuţii bilaterale biogeografice pentru regiunea Continentală a României.

Propunerile de situri de interes comunitar, prezentate în această lucrare, se

bazează pe date de teren ale autorilor şi criterii specifice (populaţii de peşti bine menţinute, stabile şi sănătoase, habitate naturale tipice, impact antropic relativ scăzut, poziţie geografică favorabilă). Au fost incluse următoarele specii de peşti de interes conservativ: *Alosa pontica/Alosa immaculata, Umbra krameri, Aspius aspius, Barbus meridionalis, Gobio albipinnatus, Gobio kesslerii, Gobio uranoscopus, Pelecus cultratus, Rhodeus sericeus amarus, Cobitis elongata, Cobitis taenia, Misgurnus fossilis, Gymnocephalus schraetzer, Zingel streber* şi *Zingel zingel*.

RÉSUMÉ: Nouveaux Sites d'Importance Communautaire (SIC) proposées pour l'ichtyofaune suite au Séminaire Biogéographique Continental concernant la Roumanie, Sibiu (Transylvanie, Roumanie) 9-12 juin 2008.

Les objectifs principaux de la Communauté Européenne dans le domaine de l'environnement concernent la protection, la conservation et l'amélioration de la qualité de l'environnement dans le contexte de l'utilisation rationnelle des ressources ainsi que des services écosystémiques. Durant ces dernières dizaines d'années, la protection de la biodiversité a été un des principaux objectifs à cet regard.

L'article ci-dessous a pour but de présenter des données et des arguments en faveur de la proposition de nouveaux sites Natura 2000 pour 15 espèces de poissons. Durant le Séminaire Biogéographique pour la région Continentale – territoire national de la Roumanie (ayant eu lieu a l'Université "Lucian Blaga" de Sibiu, les 9-12 juin 2008), il a été convenu que les aires occupées par certaines espèces de poissons sont insuffisamment recouvertes par les sites Natura 2000 proposées et acceptées. De ce faite, les représentants de l'Union Européenne ont sollicité des propositions supplémentaires.

En réponse à cette situation, cet article propose la création de nouveaux sites Natura 2000 qui seront examinés lors du prochain Séminaire Biogéographique pour la région Continentale de la Roumanie.

Les sites d'intérêt communautaire proposés dans cet article sont basés sur des données de terrain accumulées par les auteurs ainsi que sur des critères spécifiques (des populations de poissons bien maintenues, stables et en bonne santé, des habitats naturels typiques, un impact anthropique relativement faible ainsi qu'une position géographique favorable). Des espèces de poissons présentant un intérêt conservationnel y sont comprises: *Alosa pontica/Alosa immaculata, Umbra krameri, Aspius aspius, Barbus meridionalis, Gobio albipinnatus, Gobio kesslerii, Gobio uranoscopus, Pelecus cultratus, Rhodeus sericeus amarus, Cobitis elongata, Cobitis taenia, Misgurnus fossilis, Gymnocephalus schraetzer, Zingel streber* et *Zingel zingel*.

INTRODUCTION

The primary aims of the European Community administration representatives in the environmental field are the protection, conservation and improvement of the environment as well as structural quality, for a better use of the natural resources and services of those ecosystems, including the aquatic ecosystems.

During the last decades, biodiversity was one of the main issues in this respect.

To achieve this approach regarding the European Community environmental strategies and policies, the most up to date scientific and technical information was considered.

The action plan at the European Community level to handle the biodiversity issue was established based on the Habitats Directive (92/43/EEC) and Birds Directive (79/409/EEC). These two highly important European Directives have the main objective to conserve the biodiversity in the European Union based on a protected areas network, namely the Natura 2000 network, to protect essential habitats and species characteristic of all the European biogeographic regions: Arctic, Boreal, Atlantic, Continental, Alpine, Pannonian Mediterranean, Macaronesian, Steppic, Black Sea and Anatolian (Fig. 1).

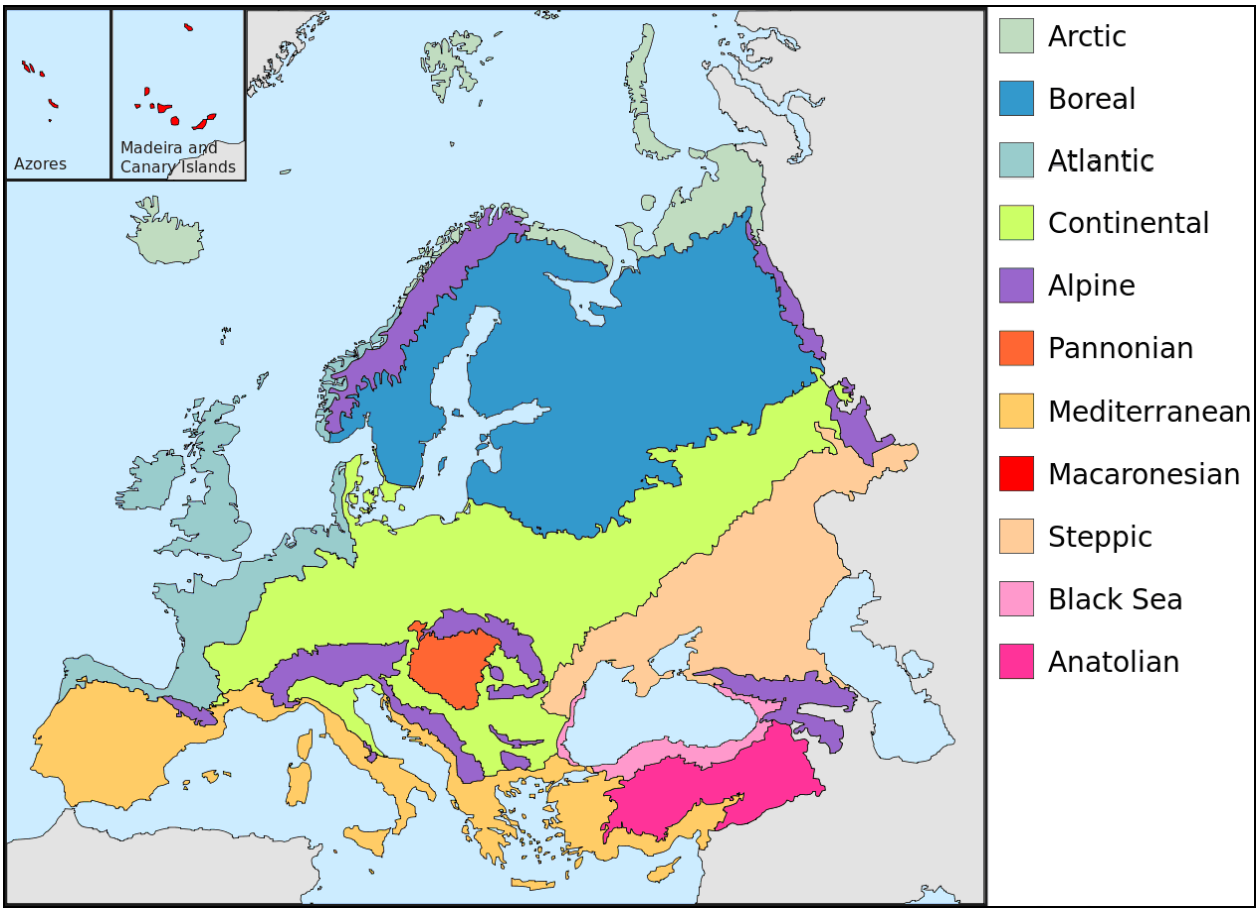

Figure 1: European biogeographic regions; European Environment Agency - www.eea.eu.in

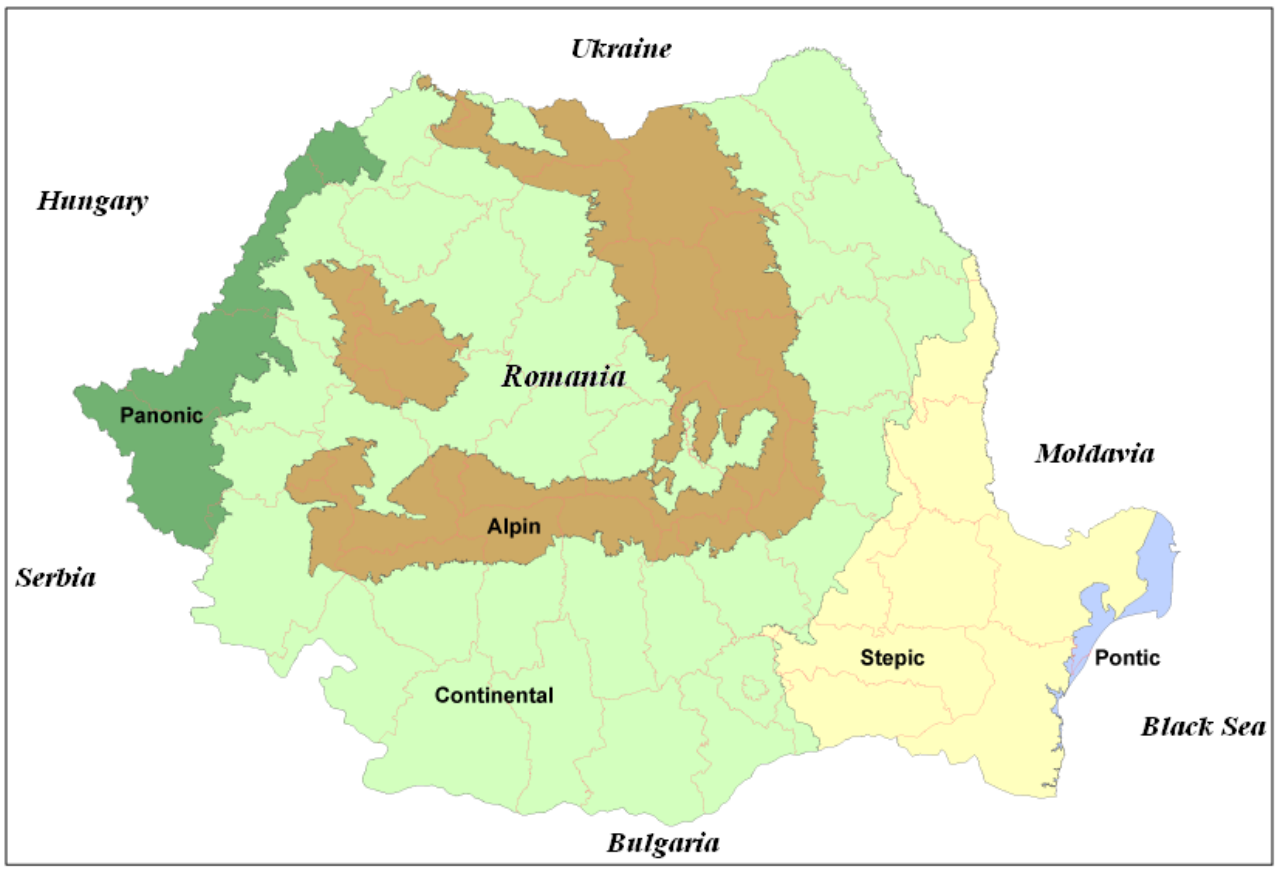

Figure 2: Biogeographic regions of Romania; according to the Ministry Order 776/2007, Annex 2.

Romania, with highest biogeographic diversity among all the European Union countries comprises a total of five biogeographic regions: Continental, Alpine, Pannonian, Pontic and Stepic (Fig. 2). Romania contributes to the European natural heritage as follows: 47% of the national territory is covered by natural and semi natural ecosystems, 780 types of habitats, 3,700 superior plant species, 33,085 invertebrate species and 717 vertebrate species. (Bănăduc, 2001, 2006, 2007a, b)

The Continental biogeographic region is very extensive, ranging from western to eastern Europe, starting in central France and continuing to the eastern edge of Poland and then descending all the way down to Romania and Bulgaria. A total of 13 European Union countries have all or part of their territory in the Continental Region. The region covers major areas of France, Germany, Italy, Poland, Romania, Bulgaria and the Czech Republic, as well as significant parts of Denmark, Belgium, Austria and Slovenia. Only Luxembourg is entirely within the Continental Region. Sweden, has just 3% of the country in this region. (Sundseth and Creed, 2008)

In Romania, the Continental region is the best represented region in terms of surface percentage of the national territory (Fig. 2).

The Natura 2000 net initiative offers few directives on how Romania can protect its natural environment in the areas of expansion of the natural areas surface and the realization and implementation of optimum management plans for all these protected areas including governmental, nongovernmental institutional capacity building, general and specific awareness raising.

One principal element of the implementation of these Directives is the establishment of an optimum Natura 2000 network of sites on the Romanian national territory.

Despite the fact that the Biogeographic Seminars for the Romanian territory were done (helded at the "Lucian Blaga" University of Sibiu, on 9-12 June 2008), it was concluded at the end of this highly important official technical meeting, that the areals of some fish species of conservative interest were not sufficiently covered by Natura 2000 sites, so new sites proposal were requested by the European Union representatives.

As a result, this scientific article deals with the proposal of some new such potential Natura 2000 sites to be accepted at a potential second Continental Biogeographic Seminar for the Romanian territory or at bilateral (EU – Romanian Ministry of Environment) future negotiations.

The suggested sites of European Community interest in this scientific paper are based on data gathered from several field campaigns and based on specific criteria (well preserved fish populations, stable fish populations, healthy fish populations, typical natural habitats, relatively low human impact, favorable geographical position), regarding the following protected fish species: *Alosa pontica/Alosa immaculata, Umbra krameri, Aspius aspius, Barbus meridionalis, Gobio albipinnatus, Gobio kesslerii, Gobio uranoscopus, Pelecus cultratus, Rhodeus sericeus amarus, Cobitis elongata, Cobitis taenia, Misgurnus fossilis, Gymnocephalus schraetzer, Zingel streber* and *Zingel zingel.*

MATERIAL AND METHODS

In the European Natura 2000 initiative context the following site selection criteria were used for this specific study: well preserved fish (of Community interest – oCi) populations; stable fish (oCi) populations; healthy fish (oCi) populations; typical natural habitats (oCi); lowest (as possible) human impact presence; favorable geographical position (possibility of species spreading in more than one hydrographic watershed); best option for species/habitat (oCi) in relation with the needed future Natura 2000 areas specific management.

This paper is based on data gathered during the last seven years and was focused on the following fish species of Natura 2000 initiative conservative interest: *Alosa pontica/Alosa immaculata, Umbra krameri, Aspius aspius, Barbus meridionalis, Gobio albipinnatus, Gobio kesslerii, Gobio uranoscopus, Pelecus cultratus, Rhodeus sericeus amarus, Cobitis elongata, Cobitis taenia, Misgurnus fossilis, Gymnocephalus schraetzer, Zingel streber* and *Zingel zingel*; Annex II fish species.

RESULTS AND DISCUSSION

Alosa pontica (Eichwald) 1838***/Alosa immaculata*** Bennet, 1835 – Natura 2000 code 2491/4125 (RO-Scrumbie de Dunăre, GB-Pontic shad, Black Sea shad; Kerch Black Sea shad, Kerch shad; DE-Donauhering, Schwarzmeer-Hering, FR-Alose de la Mer Noire, ES-Sábalo del Mar Negro; BG-Dunavska skumriya, Karagyoz; RU-Chernomorskaia sel'd, HU-dunai nagy hering, UA-Chernomorskaia seld).

A general descriptive fact sheet is presented here due to the fact that some of the Natura 2000 area administration members are not in the position to identify all these species for the needed associated ecological and biological assessment, monitoring and management activities. This species can be relatively easily confused with other species of the genus *Alosa*.

General descriptive fact sheet. The body of this fish species is elongated and laterally compressed. The dorsal profile smooth and almost regularly advances from the snout to the pectoral fin, after which it goes almost horizontally. Gill rakers are rather thin, usually equal to or a little shorter than the gill filaments. The mouth is big and terminal, a little oblique upward. The jaw is very big, broadened and rounded at its posterior edge. The mandible teeth are obvious. The teeth are well developed in both jaws. The well developed eyelids often cover the biggest part of the eye. The interorbital space is plain or a little stuck out. Lofty and laterally obtuse compressed snout. Rounded back. Laterally compressed abdomen. The dorsal fin is situated approximately at the middle of the body, its origin is situated closer to the snout than the caudal fin base or at equal distance. The dorsal fin is short and low, its edge is plain or slightly concave. The pectoral and ventral fins are short and edgy. The ventral fins are lesser at the back of the dorsal fin. The anal fin is more at the back of the dorsal fin, long and low, its edge is almost plain. The caudal fin is deeply intrusive. Its back is intense green-bluish, its flanks silvery with an accentuated gloss. The head is sometimes hoary, or darkened. This species fins are colourless. (Bănărescu and Bănăduc, 2007)

It should be stated that no complete data was available in order to definitively and comprehensively establish a border for different local stable fish populations. Further multiannual fish population field studies are still needed for the required specific quantitative aspects fulfilment.

Individual fish were caught with specific fishing nets (active or/and passive fishing nets) or through electrofishing followed by in situ identification at the species level. They were released unharmed immediately afterwards in their natural habitats for obvious conservative reasons.

Concerning the *Alosa pontica/Alosa immaculata* species, at the Continental Biogeographic Seminar helded in Sibiu, Transylvania, Romania, in 9-12 June 2008, some conclusions were raised about its proposed sites status as being insufficient minor. One new enlarged site and a new site are proposed below.

Proposed sites. One of the proposed new enlarged site is at the confluence between Olt and Danube rivers, minimum 10-15 km on the Danube upstream of the confluence with the Olt River and minimum 10-15 km downstream of the confluence with this river. The second proposed site is at the Jiu and Danube rivers confluence, minimum 10-15 km on the Danube upstream of the confluence with the Jiu River and at minimum 10-15 km downstream of the confluence with this river.

Umbra krameri Walbaum, 1792 – Natura 2000 code 2011 (RO-ţigănuş bătrân, ţigănuş; GB-Mudminnow; DE-Hundfisch; HU-lápi póc).

A general descriptive fact sheet is presented below due to the fact that some of the Natura 2000 area administration members are not able to identify all these species for the needed associated ecological and biological assessment, monitoring and management activities.

General descriptive fact sheet. The head of this fish species is laterally compressed. The body is moderately laterally compressed. The interorbital space is slightly convex. The mouth is small, terminal and a little oblique. Large gill openings. The caudal peduncule is laterally compressed. The pectorals are rounded. The anal and caudal fins edges are rounded as well. The whole body is covered with big scales. No lateral line. The body is brown with dark shadows. The ventral side is yellowish. A series of dark spots of variable shapes on the body flanks form two longitudinal parallel irregular lines. At the middle of the body there is a light colored line. The fins are yellowish-greyish or brown. At the base of the dorsal fin and the caudal fin is a dark transversal line. It can reach over 15 cm in total length. (Bănărescu and Bănăduc, 2007)

About the *Umbra krameri* species, at the Continental Biogeographic Seminar at Sibiu, 9-12 June 2008, final conclusions were underlined about its proposed site's status as a scientific reserve especially for the southern wetland areas of Romania. Few additional sites were required for these species on the Romanian national territory. In this respect new sites are proposed in this paper.

Proposed sites. The new or enlarged proposed sites are: the Comana Lake and its tributary Gurbanu Rivulet; the Neajlov River in the proximity of the Comana Lake; the wetland near the Comana Locality railway station (Giurgiu County); and Tânganu Rivulet in Cernica Forest (Ilfov County) (Bănăduc, 2008). Of course there may be other wetland areas where this elusive species may still be present with good status of conservation populations.

Aspius aspius (Linnaeus, 1758) – Natura 2000 code 1130 (RO-avat, haut, aun, gonaci, peşte-lup, buţoi, guran; DE-Raapf, Rapen, FR-Aspe; GB-Asp, RU-Zherekh, UA-Bilyzna, HU-balin, CS-Bolen).

A general descriptive fact sheet is presented below due to the fact that this species can be misidentified with other species (*Rutilus rutilus, Leuciscus idus, Leuciscus cephalus* or *Vimba vimba*) by the European Natura 2000 site administration members.

General descriptive fact sheet. The body of this fish species is elongated and slightly laterally compressed. The head dorsal profile smoothly rises up until the end of the head, where it suddenly forms a kind of humpback. The head length represents 22-27% of the body (excluding the caudal fin) length. The eyes are small and are placed laterally and ahead. The forehead is almost flat. The snout length represents 25-31% of the head length. The mouth is big, terminal and upward oblique, it ends under the eye. Thin and continuous lips. The inferior jaw has a protuberance which is fitting in a cavity of the superior jaw, this morphological adaptation helps the fish to grab its prey. The dorsal fin insertion is situated closer to the caudal fin base than to the top of the snout. The dorsal fin extremity is concave. The pectoral fins did not touch the base of the ventral fins; their length represents 17-20% of the body length. The ventral fins represent 13-17% of the body length. The anal fin extremity is strong concave. The caudal is deep holed. The scales are thin, but well fixed. The back is dark-olive, silvery flanks, the ventral part white. The dorsal and the caudal fins are dull greyish brown, the ventral and anal fins are colourless or pale reddish, the pectoral fins colourless. The lips are hoary. Usually this species can reach a length of 30-40 cm and a maximum of 80 cm. (Bănărescu and Bănăduc, 2007)

Regarding *Aspius aspius*, at the Continental Biogeographic Seminar for Romania, at Sibiu 9-12 June 2008, there were underlined conclusions about its proposed sites as insufficient moderate status. More sites were required for this species on the Romanian national territory. New sites in this respect are proposed below.

Proposed sites. The proposed sites comprise several areas as follows: Mureş River (from Deda to Reghin), Mureş River (from Reghin to Târgu Mureş), Mureş River (from Ungheni to Luduş), Mureş River (from Gheja to Mihalţ), Mureş River (three km upstream the confluence with the Târnava River to two km downstream the confluence with the Ampoi River), Mureş River (from Băcăinţi to Şoimuş), Someş River (from Benesat to Tămaia), Someş River (from Ardusat to the Romanian-Hungarian border), Someş River between Someş-Odorhei and Sălsig, Râul Negru River from Lemnia to the confluence with the Olt River; Vedea River between Barza (Pădurea Berzei) and downstream to the confluence with Teleorman River (to Bujoru locality); Teleorman River between Măgura and the confluence with the Vedea River, Claniţa River between Merişani and the confluence with the Teleorman River, Şieu River from Sărata to the confluence with Someşul Mare River, Neajlov River from Vadu-Lat to Singureni, Siret River upstream from the Răcăciuni Lake to the Ion Creangă locality.

More scientific research can improve this proposal with new sites.

Barbus meridionalis Riso, 1827 – Natura 2000 code 1138 (RO-moioagă, moiţă, cîrcuşă, jumugă, jamlă, jamnă, mreană pătată, mreană vânătă, mreană de munte, mreană de vale; BG-Cherna, DE-Forellenbarbe, Semling, Afterbarbe; FR-Barbeau truite, Truitat, Turquan; GB-Mediterranean barbell; HU-peténYi márna, CS-Potocna mrena).

A general descriptive fact sheet is presented below, due to the fact that this species can be misidentified with other species of the genus *Barbus* by some of the European Natura 2000 site administration members and the needed management activities are not possible in this circumstance.

General descriptive fact sheet. Elongated body. The superior profile of the body is an ascendant curveline from the snout to the dorsal fin, without reaching the dorsal fin. The last simple radia of the dorsal fin is thin, flexible and not jagged. The ventral fins are inserted backward to the dorsal fin insertion. The dorsal fin edge is flat or slightly fluted. The lips are more fleshy and developed in comparison with the species *Barbus barbus*. The posterior whiskers are sometimes long, exceeding the back of the eye. The back of the body is dark brown-rust colored, with darker and lighter spots, the flanks are yellow-rusty with spots, the ventral side is light yellow. The dorsal and caudal fins with accentuated spots, the rest of the fins are yellowish. The whiskers are yellowish with no red axis. It can reach a maximum length of 28-30 cm. (Bănărescu and Bănăduc, 2007)

Regarding the *Barbus meridionalis* species, at the Continental Biogeographic Seminar meeting from Sibiu, 9-12 June 2008, there were revealed some conclusions about its proposed sites as insufficient moderate status, extension of the existing sites and adding of new sites being necessary on the Romanian territory. Some new sites in this respect are proposed below.

Proposed sites. Crişul Alb River (from Gurahonţ to Ineu), Mara River (from Mara locality to the confluence with Iza River), Şieu River from Sărata to the confluence with Someşul Mare River, Budac River from Jelna to the confluence with the Şieu River, Mureş River from Deda to Târgu Mureş, Târnava Mare River from Sighişoara to Mediaş, Niraj River from Miercurea Nirajului to the confluence with the Mureş River, Timiş River (downstream of the confluence with Teregova River to Constantin Daicoviciu locality), Sebeş River/Caraş-Severin County, from the half

of the distance between Turnu Ruieni and Borlova localities to the Carbonifera neighborhood of the town of Caransebeş, Nera River (downstream Sasca Montană to the Romanian-Serbian frontier), Vâlsan River (its middle and lower sectors to the confluence with Argeş River), Râul Doamnei River from Slatina to Domnești locality, Putna River between Garoafa and Vânători, Cerna River (Olt Basin) between Roeşti and Măciuca, Gilort River (Jiu Basin) at least between Baia de Fier and Frasin locality, Jiu River from Bumbeşti-Jiu to Turcineşti, Bistriţa River (Jiu Basin) from Peştişani to the confluence with the Jiu River, Motru River from Negoieşti to Cătunele and from Cernaia to the confluence with the Jiu River, Moldova River between Gura Humorului and Roman, Suceava River from Dorneşti to Suceava locality.

More scientific research can improve this proposal with new sites.

Gobio albipinnatus (Lukasch, 1933) − Natura 2000 code 1124 (RO-porcuşor de şes; DE-Weißsflossiger Gründling; GB-White-finned gudgeon; HU-halványfoltú küllő; UA-Pinchkur svitloplavtsovyi; RU-Peskar svetloplavnikovyi).

A general descriptive fact sheet is also presented here for this species due to the fact that this species can be misidentified with other species of the genus *Gobio*, by the European Natura 2000 site administration members. These wrong identifications should be avoided.

Descriptive elements. The body and the caudal peduncle of this fish species are relatively high and laterally compressed. The peduncle height is a little higher in comparison with the thickness at the level of the anal fin posteriour edge. Seven exceptional eight divided rays in the dorsal fin. There are four scales between the lateral line and the ventral fins. In Romania can be found *Gobio albipinnatus vladykovi* Fang 1943. Convex dorsal profile. The maximum height of the body is situated at the dorsal fin insertion. The snout is short and obtuse. The eyes are big and close, looking more upward. The whiskers reach, in general, the posterior edge of the eye. The caudal peduncule is slightly laterally compressed. The caudal fin is profound holed, its superior lobe being longer than the inferior one. The pectoral fins do not reach the ventral fins insertion, the ventral fins outgrow the anus but do not reach the anal fin. The anus is more closer to the ventral fins than the anal fin. The superior part is light yellowish-greenish. The dorsal side of the head is darker greyish, with even darker spots and lines. On flanks, there are in general seven - eight round spots. The lateral line scales have two black spots not very well marked. The ventral face is white. On the dorsal and caudal fins rays are two rows of black spots, also not very well marked. It can reach 13 cm in length. (Bănărescu and Bănăduc, 2007)

Regarding the *Gobio albipinnatus* species, at the Continental Biogeographic Seminar meeting for Romania, at Sibiu (Transylvania, Romania), 9-12 June 2008, there were underlined some specific conclusions about the proposed and accepted sites as insufficient moderate status. More sites were required and also extensions of existing sites were required on the Romanian national territory, especially in the Mureş River basin and on the Danube River. Some new sites are proposed below.

Proposed sites. Caraş River, from downstream of the locality Grădinari to the national border between Romania and Serbia; the confluence of the Olt River with the Danube River, from Scărişoara; Someş River (from Benesat to Tămaia); Someş River between Ardusat and the national border between Romania and Hungary; Mureş River from downstream of Ungheni locality to 5 km downstream of Luduş locality; Mureş River from 5 km upstream of the confluence with Târnava River to 3 km downstream of the confluence with the Ampoi River; Mureş River from Vinţu de Jos downstream to Dobra locality; Târnava River from downstream of Copşa Mică locality and the confluence with the Mureş River in the proximity of Mihalţ locality;

Niraj River from Ceuaşu de Câmpie to the confluence with the Mureş River; Crişul Alb River from Almaş to 3 km downstream of Buteni locality; Gilort River (Jiu River watershed) at least 3 km upstream of the Mirosloveni locality and 5 km downstream to Frasin locality; Milcov River between Broşteni and Câmpineanca localities; Şieu River from Sărata locality to the confluence with the Someşul Mare River; Budac River from Jelna to the confluence with the Şieu River; Vedea River from Cucueţi locality to the proximity of Alexandria locality.

More scientific research can improve this proposal with new sites.

Gobio kesslerii (Dybowsky, 1862) – Natura 2000 code 1124 (RO-porcuşor de nisip; DE-Sandgressling, Kessler Gründling; GB-Kessler's gudgeon; RU-Dnestrovskii dlinnuosyi peskar; HU-homoki küllő; UA-Pichkur dunaiskyi dovgousyi).

A descriptive general fact sheet is presented here due to the fact that this species can be wrongly identified with other species of the genus *Gobio* by the European Natura 2000 site administration members. This species populations assessment, monitoring and management are impossible without their accurate identification.

Descriptive elements. The body has a low profile and is thick or relatively high and slightly laterally compressed. The caudal peduncule is thick and cylindrical, its thickness is in general bigger than the minimum height. The eyes are variable in dimensions, usually smaller than the interorbital space. The lateral scales are more higher than longer. The whiskers have variable length. The caudal lobes are almost equal (excepting *Gobio kesslerii banaticus*). (Bănărescu and Bănăduc, 2007)

Regarding the *Gobio kesslerii* species, at the Continental Biogeographic Seminar meeting in Sibiu, 9-12 June 2008, there were underlined some final conclusions about its proposed sites as insufficient moderate status. More sites were required and also an extension of the existing sites was required on the Romanian national territory. Some new sites are proposed below.

Proposed sites. Mureş River from Deda to Târgu Mureş; Mureş River, 6 km downstream of Ungheni to Luduş; Mureş River 5 km from the confluence with Târnava River to 3 km downstream with the confluence with the Ampoi River; Şieu River from Sărata locality to the confluence with the Someşul Mare River; Budac River from Jelna to the confluence with the Şieu River; Târnava Mare River between Sighişoara and Mediaş localities; Târnava River between Blaj locality and the confluence with the Mureş River in the proximity of Mihalţ locality; Someş River (from Benesat to Tămaia); Someş River (from Ardusat to the Romanian - Hungarian border); Someş River between Someş-Odorhei and Sălsig; Motru River between Cernaia and Glogova localities; Putna River between Baloteşti and Vânători localities; Cerna River (Olt River basin) from the Roeşti locality to the locality Măciuca; Crişul Alb River from Almaş locality to downstream of Buteni locality.

More scientific research can improve this proposal with new sites.

Gobio uranoscopus (Agassiz, 1828) – Natura 2000 code 1122 (RO-porcuşor de vad, chetrar; DE-Steingressling, Steinkresse; GB-Danube Gudgeon; RU-Peskar-verkhoglyad; HU-felpillantó küllő; UA-Dunaiskii dlinnousyi peskar).

A general descriptive fact sheet is presented here in the context in which this fish species can be easily misidentified with other species of the genus *Gobio* by some of the European Natura 2000 site administration members and the needed biological assessment, monitoring and management activities are impossible without accurate identification.

Descriptive elements. The body and the caudal peduncle of this species are thick and cylindrical. At the lips joining points there is a posteriour extension which seems like a second pair of whiskers. The anal

orifice is much closer to the anal fin than to the ventral fins. The chest is completely covered with scales. In Romania lives the subspecies *Gobio uranoscopus friči* Vladykov 1925. The dorsal profile of this subspecies is slightly convex, the ventral profile is horizontal. The snout is relatively sharp. The eyes look much upward. The ventral fins are inserted under the dorsal fin insertion or a little backwards. The caudal fin is deeply holed, the lobes are rounded and equal or almost equal (the inferior lobe a little longer). The edge of the dorsal fin is slightly holed. The dorsal side is greyish-greenish or brown-redish. The back scales have black edges. Behind the dorsal fin there are 2-3 big dark spots. On the flanks are 7-10 big rounded spots. The ventral side is white-yellowish. At the caudal fin base there are two white spots. On the lateral line scales are two small black spots. On the dorsal and caudal fins there are two rows of blak spots. It can reach 13 cm in length. (Bănărescu and Bănăduc, 2007)

Regarding the *Gobio uranoscopus* species, at the Continental Biogeographic Seminar meeting in Sibiu, 9-12 June 2008, there were underlined some final specific conclusions about its proposed and accepted sites as being insufficient minor and scientific reserve in the Someş River watershed. It was underlined the fact that more sites for this species are needed and also an extension of the already proposed sites are required on the Romanian territory.

Proposed sites. Crişul Alb River from 3 km upstream of Gurahonţ locality to Ineu locality; Şieu River (Someşul Mare River watershed) from the confluence with Someşul Mare River to the confluence with Budac River and upstream to the Jelna locality; Mureş River from the proximity of Târgu Mureş locality to the locality Deda; Doamnei River (Argeş River watershed) the main course between 470 m altitude (Domneşti locality) and 700 m altitude (the confluence from upstream of the Nucşoara locality); Someşul Mare River from the proximity of Dej locality to upstream of Năsăud locality; Bistriţa River (Jiu River watershed) from 5 km upstream of the Peştişani locality to the proximity of Teleşti locality; Gurghiu River (Mureş River basin) from the confluence with the Mureş River to the proximity of Ibăneşti locality; Moldova River from upstream the locality Drăguşeni to Tupilaţi.

More scientific research can improve this proposal with new sites identification.

Pelecus cultratus (Linnaeus, 1758) – Natura 2000 code 2522 (RO-sabiţă; GB-Sichel; DE-Sichling; HU-garda, UA-Tschékhon; BG-Sabitza; RU-Chekhon; CS-Sabljarka).

A general descriptive fact sheet is presented here in order to allow the identification of this species by some of the European Natura 2000 site administration members for the needed biological assessment, monitoring and management activities.

Descriptive elements. Elongated streamlined body, much compressed on laterals. The body dorsal profile is at the majority of the exemplars, an almost horizontal line, from the snout to the caudal fin insertion. The eyes are very large, situated in the anterior half of the head. The mouth is superior and almost vertical, small, did not reach the inferior edge of the eye. The inferior jaw is prominent in comparison with the superior one. The dorsal fin is situated more at the posterior. The dorsal fin edge is slightly concave. The anal fin is very long, much higher in its anterior part than in its posterior part, with a concave edge. The caudal fin is strong, deep fluted, the inferior lobe is longer than the superior one. The scales are small, thin, cover all the body including the dorsal part of the till, the eyes and the chest. The lateral line is very sinuous, especially at the anterior part of the body. The superior side is dark blue or grey-bluish with a strong metallic shine, the flanks are shining silvery, the ventral side is white. The pectoral, dorsal and caudal fins are grey, the other fins are yellowish. It can reach 50 cm and one kg. (Bănărescu and Bănăduc, 2007)

Regarding the *Pelecus cultratus* species, at the Continental Biogeographic Seminar meeting in Sibiu on 9-12 June 2008, there were underlined conclusions about its proposed sites as being insufficient moderate.

Rhodeus sericeus amarus (Bloch, 1782) – Natura 2000 code 1134 (RO-boarţă, boarcă, blehniţă; GB-Bitterling; DE-Bitterfish; FR-Bouvière; HU-szivárványos ökle; UA-Gorchak).

A general descriptive fact sheet is presented here to allow the identification of this species by some of the European Natura 2000 site administration members for the assessment, monitoring and management activities.

Descriptive elements. Accentuated and high laterally compressed body. Convex dorsal profile, drawing up from the tip of the snout to the dorsal fin insertion; behind the dorsal fin the profile descent accentuated. Laterally compressed head. The eyes are situated in the anterior half of the head. Small, subterminal, crescent shaped with thin lips mouth. The dorsal fin is inserted in general at equal distances from the tip of the snout and the caudal fin base. The edge of the dorsal fin is slightly convex. The pectoral fins are short, rounded at the top. The ventral fins insertion are situated under the dorsal fin insertion or very little before it; their tops reach or almost reach the anterior edge of the anal fin. The anal fin insertion is under the middle of the dorsal fin; its edge is slightly concave. The scales are big, more higher than longer, persistent. The chest is covered with smaller scales. The lateral line is short. The dorsal part of the body and of the head are greyish-yellowish, the flanks are white, the dorsal and caudal fins are grey, the other fins with a reddish shade. Along the body's posterior half part and of the caudal peduncule there is a greenish line. It can reach 7.9 cm in length. (Bănărescu and Bănăduc, 2007)

Proposed sites. Mureş River about 5 km upstream of the confluence with Târnava River to 3 km downstream to the confluence with Ampoi River; Mureş River in the proximity of Ungheni locality.

More scientific research can improve this proposal with new sites.

Regarding the *Rhodeus sericeus amarus* species, at the Continental Biogeographic Seminar meeting from Sibiu, 9-12 June 2008, there were underlined some final conclusions about its proposed sites as insufficient moderate status. More sites were required and also extensions of existing sites were required on the Romanian national territory, especially in the Mureş River basin and on the Danube. In this respect new sites for this species are proposed.

Proposed sites. A few lakes from the middle of Transylvania (near Geaca and Cătina localities, near Zau de Câmpie and Şăulia localities) Mureş River 3 km upstream of Ungheni locality to 5 km downstream Luduş locality; Mureş River from Gheja to Mihalţ; Mureş River from 5 km upstream its confluence with Târnava River to 3 km downstream its confluence with Ampoi River; Mureş River (from Băcăinţi to Şoimuş); Niraj River from Ceauşu de Câmpie to the confluence with the Mureş River; Şieu River from Sărata locality to the confluence with the Someşul Mare River; Budac River from Jelna to the confluence with the Şieu River; Râul Negru River from Lemnia to the confluence with the Olt River; Moldova River between Oniceni and Tupilaţi localities; Teleorman River between Măgura locality and the confluence with Vedea River; Vedea River between Ghimpeţenii Noi and the confluence with the Danube River; Mureş River from 5 km upstream of its confluence with Târnava River to 3 km downstream of its confluence with Ampoi River; Motru River between Cernaia and the confluence with the Jiu River; Neajlov River between Singureni and Podul Doamnei localities; Siret River between Paşcani and Roman localities; Suceava River between Suceava and Liteni; Suceava River between Dornești

and Mihoveni; Târnava Mare River between Copşa Mică and the confluence with the Mureş River; Târnava Mare River between Sighişoara and Mediaş; Târnava Mare River between Odorheiu Secuiesc and Vânători; Someşul Mic River and its wetlands from Petreşti to Gherla localities; Someş River between Glod and Someş-Odorhei localities; Someş River (from Benesat to Tămaia); Someş River (from Ardusat to the Romanian-Hungarian national border); the limitrophs canals of Crasna River, in the Moftinu Mic, Moftinu Mare and Ghilvaci localities area.

Cobitis elongata Heckel and Kner, 1858 – Natura 2000 code 2533 (RO-fâsă mare; GB-Spotted Big Loach, Balkan Loach).

A general descriptive fact sheet is presented here to allow the identification, without confusion with other species belonging to *Cobitis* and *Sabanejewia* genera species, by some of the European Natura 2000 site administration members for the necessary assessment, monitoring and management activities.

Descriptive elements. The body is much bigger in comparison with the other representatives of the genus reaching a maximum length of 165 mm. The body is elongated and thick. The body height is from the pectoral fins insertion to the anal fin insertion. The interorbital space is almost plain. The mouth is small and inferior. The inferior lip forms a pair of sharp whiskers-like posterior elongations. The longest pair of whiskers is the third one. The caudal peduncle is long, low, laterally compressed, without a dorsal fatty crest, with a thin ventral streamline in its posterior part. The ventral fins insertions are positioned a little in the back of the dorsal fin insertion. The pectorals, ventrals, and the anal fins are rounded, the dorsal fin with a plain edge and rounded corners, the caudal fin with a plain edge. The scales are oviform. The fundamental color is white-yellowish on which exist numerous brown-greyish spots, distributed in regular series. A series of 12-19 spots on the dorsal median line, rounded and relatively closed. On the flanks of the body are 10-13 prolongued spots, rounded at their ends, distributed regularly. Among the dorsal and the lateral spots, the pigmentation is distributed like three longitudinal zones. A black oblique, very intense spot is present at the caudal base, under this one there is a brown spot. On the head there are short winding spots. A broad oblique line exists from the tip of the snout to the eye, rarely prolongued over the eye.

Regarding the *Cobitis elongata* species, at the Continental Biogeographic Seminar meeting in Sibiu, 9-12 June 2008, there were stressed some conclusions about this species sites as insufficient moderate. It was stated the fact that more sites would be needed and also extensions of the already proposed and accepted sites were required on the Romanian national territory. New sites for this species are proposed below.

Proposed sites. Nera River needs to be completely (the Romanian sector) part of the Natura 2000 net, not only its upper part as it was proposed first in the Continental Biogeographic Seminars for Romania. Caraş River, at least 2-3 km downstream of Caraşova locality and at least 2-3 km upstream of Goruia locality, posible upstream and downstream of this sector.

More scientific research can improve this proposal with new sites.

Cobitis taenia Linnaeus, 1758 – Natura 2000 code 1149 (RO-zvârlugă, fîsă, cîră, zmorlă, rîmbiţar; DE-Dorngrundel, Steinbeisser; FR-Loche de rivière; GB-Spined Loach; RU-Shtschipovka; UA-Shtschipovka; HU-Vágó csík; BG-Piskal; CS-Vijun).

A general descriptive fact sheet is presented here to allow the identification, without confusion with other *Cobitis* and *Sabanejewia* genera species, by some of the European Natura 2000 site administration members for the necessary biological and ecological assessment, monitoring and management activities.

Descriptive elements. The dorsal and ventral profiles are almost horizontal. The inter-orbitary space is plain. The two halfs of the inferior lip are subdivided in 3-4 lobes. The third pair of whiskers is the longest. The caudal peduncle in its posterior part has a dorsal and a ventral streamline, the last one being more developed. The ventral fin insertion is situated a little backwards in comparison with the dorsal fin insertion. The caudal fin is truncated or slightly holed. The pectoral and ventral fins are rounded. The lateral line is short, in general, and does not overdraw the pectoral fin. The body background is white-yellowish. The dorsal spots are small, rectangular or rounded, close, in variable number (13-24). The lateral pigmentation of the body consist of four zones. At the caudal fin base in the upper corner, there is a clear vertical black intense spot. On the head there are small spots and an oblique line, from the backhead to the mouth. It can reach 12 centimeters in length. (Bănărescu and Bănăduc, 2007)

Regarding the *Cobitis taenia* species, at the Continental Biogeographic Seminar meeting in Sibiu, 9-12 June 2008, there were stressed some conclusions about this species proposed sites as insufficient minor and scientific reserve in the Olt River. New sites for this species are proposed below.

Proposed sites. The accumulation lake from the Crasna River (between Crasna and Vârşolţ localities); few lakes from the middle of Transylvania (near Geaca and Cătina localities, near Zau de Câmpie and Şăulia localities); Mureş River with its adjacent wetlands, 5 km upstream of the confluence with Târnava River to 3 km downstream of the confluence with Ampoi River; Mureş River (from Băcăinţi to Şoimuş); Siret River between Adjudul Vechi and Burcioasa localities; Siret River between Buhoci and Furnicari localities; Someş River between Bozânţa Mică and Năpradea; Someş River between Pomi locality and the national border between Romania and Hungary; Olt-Cibin-Hârtibaciu confluence area; Râul Negru River from Lemnia to the confluence with the Olt River; Moldova River between Oniceni and Mitești; Moldova River between Tupilaţi and Roman localities; Teleorman River between Măgura and the confluence area with Vedea River. Crişul Alb River, from Ineu to Chişineu-Criş; Someşul Mic River from Petrești to Gherla; Vedea River from Ghimpeţenii Noi to Beiu.

More scientific research can improve this proposal with additional new sites.

Misgurnus fossilis (Linnaeus, 1758) – Natura 2000 code 1145 (RO-ţipar, chişcar, vârlan; GB-Weatherfish; FR-Kerlèche; DE-Wetterfish, Beitzger, Moorgrundel; HU-réti csik, UA-Viun; BG-Zmiorche; CS-Cikov).

A general descriptive fact sheet is presented here to allow the identification of this species by some of the European Natura 2000 site administration members for the necessary assessment, monitoring and management activities.

Descriptive elements. Prolonged and thick body with almost uniform height. The dorsal and the ventral profiles are almost horizontal. The head is thick, slightly compressed laterally. The nostrils are closer to the eyes than to the tip of the snout. The anterior nostril is tubular, round, covered by a skinny operculum. The mouth is inferior and crescent. The upper lip is fleshy and continuous. The lower lip is fleshy with two pairs of fleshy lobes; the anterior pair (and median) short and thick, the posterior pair long and thin and whisker like. The caudal peduncle is lateraly compressed, mostly in its posterior part. The caudal dorsal and ventral peduncule edges are straight and form two fatty streamlines which are looking like an elongation of the caudal fin. The dorsal and ventral fins are situated at the same level. Small scales. Hardly visible lateral line. The dorsal side is dull greyish brown, with small sooty spots. This dull greyish brown area is limited by a narrow longitudinal line, almost black, which lays from the superior corner

of the operculum to the caudal fin; in the posterior part this line is interrupted by isolated spots. Below this line, the body is light dull greyish brown, is following a new sooty line, very broad, continuous from the eye to the caudal fin base. Below this line is yellowish-rusty spotted with brown dots. The head is light-fawn with small dark spots. Smoky fins with dark spots. The females reach 30 cm, the males are smaller. (Bănărescu and Bănăduc, 2007)

Regarding the *Misgurnus fossilis* species, at the Continental Biogeographic Seminar meeting in Sibiu, 9-12 June 2008, there were drawn some conclusions about this species proposed sites as insufficient moderate. More sites were required and also extensions of existing sites were required on the Romanian national territory, especially in the Mureş River basin and also in the Danube. It was concluded also the fact that more sites will be needed and also extensions of the already proposed and accepted sites were required on the Romanian national territory. In this respect, new sites for this species are proposed.

Proposed sites. Someşul Mic River and its lateral dead branches, at Gherla; Mureş River with its dead branches in its adjacent wetlands, from 5 km upstream of the confluence with Târnava River to 3 km downstream of the confluence with Ampoi River; Someş River and the adjacent wetlands between Culciu Mic to Adrian and Dorolt localities. Râul Negru River and its lateral dead branches from Lemnia to the confluence with the Olt River; Siret River between Adjudul Vechi and Burcioasa; Siret River between Buhoci and Furnicari.

Gymnocephalus schraetzer (Linnaeus, 1758) – Natura 2000 code 1157 (RO-răspăr, şpîrliu, bălos, firizar; DE-Schraitzer, Schratz; GB-Schraetzer, Striped Ruffe; HU-Selymes durbincs; UA-Yersh polosatyi).

A general descriptive fact sheet is presented here to allow the identification, without confusion with others species of the *Gymnocephalus* genus, by some of the European Natura 2000 site administration members for the necessary biological and ecological assessment, monitoring and management activities.

Descriptive elements. The body is relatively prolongued. The dorsal profile draws up almost directly from the tip of the snout to the dorsal fin insertion, descending afterwards. Viewing from the lateral sides of the head looks like a triangular shape. The ventral profile is almost horizontal. The eyes are located towards the posterior part of the head, looking more lateraly. The mouth is small and terminal, its opening is situated anterior to the nostrils. The dorsal side and the flanks are yellow and the ventral side almost white. On the dorsal side of the body there are three thin longitudinal black-bluish lines. Two, sometimes three, of them are interrupted. On the hard dorsal fin membrane part exist three rows of round, big and black spots. The soft part of the dorsal fin membrane and the other fins are colorless. The iris is black. It can reach a maximum of 24 cm of the body length. (Bănărescu and Bănăduc, 2007)

Regarding the *Gymnocephalus schraetzer* species, at the Continental Biogeographic Seminar meeting in Sibiu 9-12 June 2008, there were stressed some conclusions about this species proposed sites as insufficient moderate. It was stated that more sites will be needed and also extension of the already proposed and accepted sites were required on the Romanian national territory. In this respect new sites for this species are proposed.

Proposed site. The Olt River at the confluence with Danube River, from 20 km upstream of the confluence.

More scientific research can improve this proposal with new sites.

Zingel streber (Siebold, 1863) − Natura 2000 code 1160 (RO-fusar, fus, prundar, peşte de piatră; GB-Streber, Danube Streber; DE-Streber, Strever, Ströber, Strengkatze, Zagel; HU-kis bucó, német bucó; UA-Chop malyi; SK-Kolok malý).

A general descriptive fact sheet is presented to allow the identification, without confusion with *Zingel zingel* species, by some of the European Natura 2000 site administration members for assessment, monitoring and management activities.

Descriptive elements. Elongated body, skewer-like shape. The dorsal profile of the body ascends slightly, uniform and straight from the tip of the snout to the first dorsal fin insertion. The ventral profile is almost plain. The head is more broader than high, from an above perspective is triangular. The snout is obtuse, wide in the posterior part, narrow in the anterior part. The mouth has inferior crescent-like shape and is small. The caudal peduncle is long and thin, round in section. The dorsal fins are distanced and triangular, high anterior and decreasing gradually to the posterior part. The pectoral fins with truncated edge. The ventral fins are inserted behind the pectoral fins insertions. The scales are small. The lateral line is complete and plain. The superior side of the head and body, and the majority of the flanks are brown-greyish with a green nuance. On this background are five wide sooty lines. The ventral side is white and the fins are colorless. It can reach over 20 cm in length. (Bănărescu and Bănăduc, 2007)

At the Continental Biogeographic Seminar, there were stressed conclusions about its insufficient moderate status and it was stated that more sites will be needed and also extension of the already proposed sites were required on the Romanian territory, especially regarding some stepping stones in Danube and Mureş rivers. New sites for this species are proposed.

Proposed sites. The confluence of the Olt River with Danube River, from Scărişoara, Siret River between Adjudul Vechi and Burcioasa, Siret River between Buhoci and Furnicari, the confluence of the Olt River with Danube River, 20 km upstream of the confluence, Mureş River 5 km upstream of the confluence with Târnava River to 3 km downstream of the confluence with the Ampoi River. More research can add sites and improve this proposal.

Zingel zingel (Linnaeus, 1766) − Natura 2000 code 1159 (RO-fusar mare, pietrar, peşte cu două nume; GB-Zingel; DE-Zingel, Zindel, Zink, Zinne, Zint; CS-Veliki vretenac; HU-nagy bucó; BG-Uretenarka; SK-Kolok velký; UA-Chop).

A descriptive fact sheet is presented here to allow the identification, without confusion with *Zingel streber* species, by some of the European Natura 2000 site administration members for the necessary biological and ecological assessment, monitoring and management activities.

Descriptive elements. Elongated body, skewer-like shape, almost circular in section. The head is oval. The dorsal fins are relatively closely apart. Both dorsal fins are triangular, high anterior and decreasing gradually to the posterior part. The pectoral fins with truncated edge. The ventral fins are inserted behind the pectoral fins insertions. The scales are small, on the ventral side they reach the ventral fins base. The dorsal side and the majority of the flanks are brown-greysh. The ventral side and the abdomen are yellowish. It can reach a maximum body length of 49 cm. (Bănărescu and Bănăduc, 2007)

Regarding the *Zingel zingel* species, at the Continental Biogeographic Seminar meeting from Sibiu, 9-12 June 2008, there were stressed some conclusions about this species proposed sites as insufficient moderate. It was stated that more sites will be needed and also extension of the already proposed and accepted sites were required on the Romanian national territory; especially stepping stones in the Danube and Mureş rivers. New sites for this species are proposed below.

Proposed sites. The confluence of the Olt River with Danube River, from Scărişoara; Siret River between Adjudul Vechi and Burcioasa; Siret River between Buhoci and Furnicari; the confluence of the Olt River with Danube River, 20 km upstream of the confluence; Mureş River 5 km upstream of the confluence with Târnava River to 3 km downstream of the confluence with the Ampoi River; Someş River between Păuleşti locality and the Romanian-Hungarian national border.

More scientific specific research can improve this proposal with new sites identification.

ACKNOWLEDGEMENTS

The authors thank the Faculty of Science of the ”Lucian Blaga” University of Sibiu, NGO Ecotur Sibiu and WWF-DCP for the support during the field campaign. The first author is grateful to the European Committee representatives and Topic Center representatives for the official allowance at the Continental Biogeographic Seminars for Romania and Bulgaria.

REFERENCES

Bănăduc D., 2001 – Specii de peşti dulcicoli şi migratori în mediul dulcicol, de interes comunitar, prezente în România, Conservarea speciilor şi habitatelor acvatice, coordonator Curtean-Bănăduc Angela, Edit. Alma Mater Sibiu, ISBN 973-632-243-2, 72-81. (in Romanian)

Bănăduc D., 2006 – Preinventory for a draft list of Natura 2000 (SCI) sites for fish species, edited by Bureau Waardenburg and Ameco Holand, 62.

Bănăduc D., 2007a – Fish of Natura 2000 network interest in Romania, in Romanian NATURA 2000 NGO Coalition contribution for the SCIs designation, Curtean-Bănăduc and Florescu (eds), Edit. Alma Mater Sibiu, ISBN 978-973-632-402 - 4, 147-182.

Bănăduc D., 2007b – Alosa pontica; A. tanaica; Aspius aspius; Barbus meridionalis; Cobitis tenia; Gobio albipinnatus; Gobio kesslerii; Gobio uranoscopus; Misgurnus fossilis; in Combroux et al. (eds) Caiet de habitate şi specii, Edit. Balcanic. Timişoara, România, ISBN 978-973-85742-6-7, 57-78.

Bănăduc D., 2008 – Umbra krameri Walbaum, 1792 a Natura 2000 protected fish species, in Romania, *Acta Ichtiologica Romanica* III, Bănăduc D. (ed.), 33-44.

Bănărescu M. P. and Bănăduc D., 2007 – Habitats Directive (92/43/EEC) fish species (Osteichthyes) on the Romanian territory, *Acta Ichtiologica Romanica* II, Bănăduc D. (ed.), 43-78.

Sundseth K. and Creed P., 2008 – Natura 2000 Protecting Europe's biodiversity, European Commission, Directorate General for the Enviroment, ISBN 9789279083082, 296.

AUTHORS:

[1] *Doru BĂNĂDUC*
ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu, Faculty of Sciences,
Department of Ecology and Environment Protection,
Applied Ecology Research Center,
Dr. Ioan Raţiu Street 5-7,
Sibiu, Sibiu County,
Romania, RO-550012.

[2] *András Attila NAGY*
andrasattila.nagy@milvus.ro
"Milvus Group" Bird and Nature Protection Association,
Crinului Street 22, Târgu Mureş,
Mureş County,
Romania, RO-540343.

[3] *Angela CURTEAN-BĂNĂDUC*
ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu, Faculty of Sciences,
Department of Ecology and Environment Protection,
Applied Ecology Research Center,
Dr. Ioan Raţiu Street 5-7,
Sibiu, Sibiu County,
Romania, RO-550012.

SUITABILITY OF BROWN BEAR HABITAT IN NORTH-EASTERN MARAMUREŞ (ROMANIA)

Ioan Mihai POP [1], Szilárd SZABÓ [2], Silviu CHIRIAC [3]

KEYWORDS: brown bear, Maramureş, habitat suitability, ecological corridors.

ABSTRACT

This paper presents a theoretical analysis of the suitability of brown bear (*Ursus arctos*) habitat on the left side of the Upper Tisa River basin including the Gutâi, Ţibleş, Rodnei and Maramureş Mountains in Romania. Using GIS methods already used and described by other authors, and geo-spatial information about land use, topography and human infrastructure, we have developed maps of habitat suitability, core areas and connectivity for the target species. Comparing the results with the distribution of the brown bears reported by hunters and the structure of the protected areas network, we have developed an analysis of habitat suitability. Approximately 55% of the study area contains suitable habitats for the brown bear, and over 80% of the surface of the main protected areas can be classified as good or very good habitats for the species.

REZUMAT: Favorabilitatea habitatelor pentru ursul brun în nord-estul Maramureşului (România).

Această lucrare prezintă o analiză a favorabilităţii habitatului ursului brun (*Ursus arctos*), în arealul din partea stângă a Tisei Superioare, inclusiv zona montană reprezentată de munţii Gutâi, Ţibleş, Rodnei şi Maramureşului. Folosind metode GIS, deja utilizate şi descrise în alte lucrări, şi date geo-spaţiale cu privire la utilizarea terenurilor, topografie şi infrastructură, am dezvoltat un set de hărţi, privind habitatul ariei centrale şi de conectivitate a ursului brun. Comparând rezultatele cu distribuţia speciei, raportată de către vânători şi structura reţelei de arii protejate, am realizat o scurtă analiză a habitatului în zona studiată. Aproximativ 55% din suprafaţa de studiu conţine habitate adecvate pentru ursul brun, iar principalele arii protejate au peste 80% din suprafaţa clasificată ca fiind habitate bune şi foarte bune pentru specie.

ZUSAMENFASSUNG: Die Eignung der Lebensräume für den Braunbären im Nordosten der Maramureșch (Rumänien).

Vorliegender Beitrag stellt eine Eignungsanalyse des Lebensraumes für den Braunbären (*Ursus arctos*) im Gebiet links der Oberen Tisa/Theiß einschließlich Gutâi, Ţibleş, Rodna und Maramureșcher Gebirge in Rumänien vor. Mit bereits in anderen Arbeiten beschriebenen und verwendeten GIS-Methoden sowie geographisch-räumlichen Informationen über die Landnutzung, Topografie und Infrastruktur, wurde eine Reihe von Karten betreffend die Eignung als Lebensraum für den Braunbären, die Kernbereiche und Transportkosten für die Zielarten entwickelt. Nach einem Vergleich der Ergebnisse mit jenen aus den Beobachtungen der Jäger über die Verteilung des Braunbären sowie der Struktur des Schutzgebiets-Netzwerks, wurde eine Analyse des Lebensraums im Untersuchungsgebiet durchgeführt. Dabei stellte sich heraus, dass etwa 55% des Gebietes für den Braunbären geeignete Lebensräume umfasst und sich in den wichtigsten Schutzgebieten über 80% der Fläche als gute und sehr gute Lebensräume für den Braunbären darstellen.

INTRODUCTION

Romania still provides natural and seminatural ecosystems supporting a high level of biological diversity, also including the brown bear (*Ursus arctos*), one of the important keystone species (Tardiff and Standford, 1998) for biodiversity and also for the Carpathian Mountains. The mixture of forest habitats, grasslands, pastures, traditional orchards and other conventionally managed lands creates a landscape typical to the Romanian Carpathians, also partially covering the Maramureş County. The conservation status of the brown bear as a keystone species of the Romanian forest ecosystems is directly related to the land use and the suitability of the habitat. In 2003 the estimated brown bear population was approx. 4,350 individuals (Maanen et al., 2006), but the latest estimations suggest that for the Romanian Carpathians Mountains range the population is approximately 6,000 individuals (Linnell et al., 2008) distributed in various habitat conditions. Nevertheless, rapid socio-economic development threatens the wildlife habitat (Maanen et al., 2006) and the danger of habitat loss represents a new negative perspective for brown bear conservation (Şerban-Pârâu, 2010). Most of the recent species loss is directly related to habitat loss or environmental degradation, as a result the wildlife population will probably concentrate on using fewer and smaller patches of habitat (Ratti et al., 1996) or retreat into remote or less accessible areas (Swenson et al., 2000). Considering this, the development of ecological networks represents a solution for wildlife conservation. The structure of an ecological network is built up based on core areas; a buffer zone around each core area and ecological corridors (Predoiu et al., 2003).

The habitat suitability is a tool to evaluate the capacity of certain habitats to support species survival, based on the hypothesis developed around the relationship between the species and the habitat. The development of the geographic information systems (GIS) together with the availability of the geo-spatial data, predicting species occurrence and/or abundance, has become a commonplace (Scott et al., 2001). Application of such models which include conservation gaps or reserve design (Yip et al., 2004). In our study about the theoretical suitability of the habitat, based on Geographic Information System (GIS) modelling, we are using the assumption that animal occurrence and abundance is in direct relation with the habitat quality. This assumption is not always valid, because some sites are considered high quality habitats from an occupancy standpoint and may be low in survival chances, or the so called "sink areas," (Nielsen et al., 2006). All types of habitat could be assessed as being more or less favourable for a species, in our case the brown bear, and the results can offer good information to start a field research or to adopt basic conservation measures.

The results of a habitat mapping are influenced by the quality of the data collected, considering the long-term collection of information regarding occupancy, mortality, food resources etc. At the scale selected for the study, the suitability of the habitat in the north-eastern part of the Maramureş County is not targeting the detailed assessment of the habitat or the level of used habitats by the brown bear. The purpose of this GIS modelling is to map at a large scale the areas with low suitability for bears and the main areas without connection; considering that brown bears conservation actions require their integration with human activities in human-dominated landscapes (Linnel et al., 2008). Also the study targets the identification of the sensitive area from the dispersal of the individual standing point, by signalling the almost closed corridors.

We seized the opportunity to develop a habitat suitability map from the perspective of trans-boundaries conservation of the brown bear and also to produce a technical instrument for species management in the context of unknown dispersal of the bears between Romania and Ukraine.

In the north-eastern part of Maramureş area, according to the assessment made by local hunting associations, the brown bear population is approximately of 170 individuals, representing 3% of the entire population from the Romanian Carpathians and surrounding hill areas.

According to Ardelean and Berés (2000), the brown bear population was assessed in the year 1988 by hunters at 225 individuals, and from that period the population has been significantly decreasing. According to the wildlife management system in Romania, the area is divided into 27 game management units (Tab. 1).

Six of the 27 of total game management units show that the bear does not have a permanent presence in them. The maximum number of bears declared by hunters is 13 bears/unit and the minimum number declared is three bears/unit. The eastern part of the study area (Fig. 1) could be considered the main corridor of trespassing of the brown bear individuals between Romania and Ukraine.

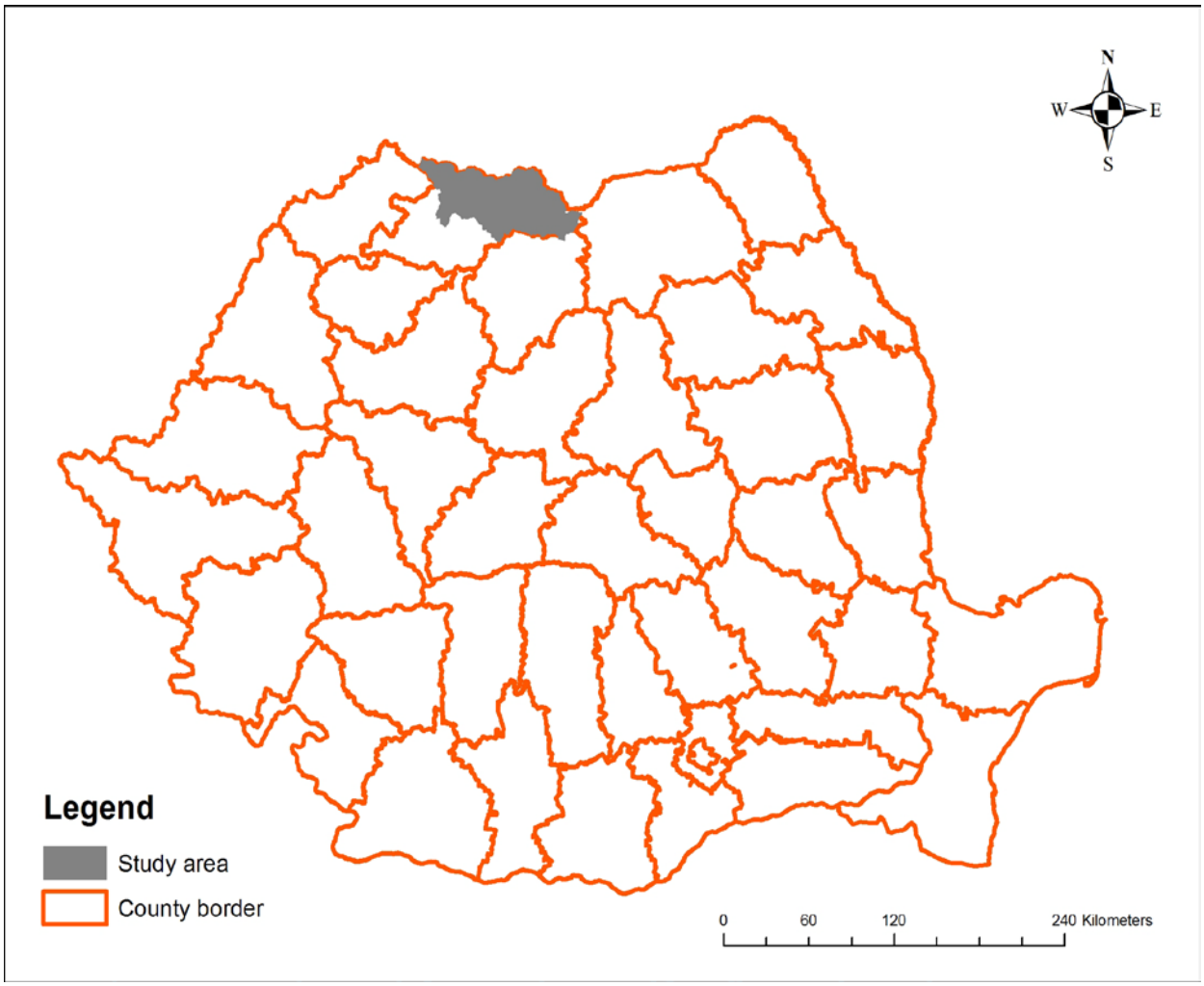

Figure 1: Location of the study area.

Table 1: Game management units and brown bear assessment for 2010 (basic information available at www.mmediu.ro/paduri/vanatoare.htm).

Criteria number	Name of the game unit	Surface km^2	Optimum population	2010 brown bear assessment
1	Bistriţa Ţibău	163.19	13	10
2	Cisla	152.19	7	9
3	Valea Babei/Babei Valley	124.78	10	10
4	Novăţ	147.87	11	10
5	Făina	146.79	11	10
6	Rica	162.02	12	10
7	Socolău	101.21	6	3
8	Vişeu	103.04	0	0
9	Sălişte	104.46	4	7
10	Iza	707.0	0	0
11	Ronişoara	121.35	0	0
12	Bârsana	108.74	0	0
13	Botiza	114.37	5	7
14	Slătioara	166.03	3	5
15	Budeşti	929.3	5	6
16	Agriş	145.41	4	6
17	Câmpulung Tisa	118.66	0	0
18	Săpânţa	946.3	4	6
19	Huta	820.2	5	12
20	Izvoare	114.87	9	10
21	Repedea	116.31	8	8
22	Bistra	173.89	13	14
23	Ruscova	148.56	0	0
24	Baia Sprie-Gutin	195.02	7	8
25	Baicu Ieud	185.51	11	13
26	Prislop	109.96	5	4
27	Pietrosu	104.93	4	4

The protected natural area network is well developed around Rodnei Mountains National Park and Maramureş Mountains Natural Park. Since 2007 the European Natura 2000 network in the study area has been represented by seven sites of community interest (SCI) (Tab. 2).

Each of the protected areas mentioned above covers an area on which the brown bear has a permanent presence, but they are also characterized by different levels of human pressure.

Table 2: Natural protected areas in the study area.

Site code	Site Name	Legal status	Total area – km^2
ROSCI0089	Gutâi - Creasta Cocoşului	Natural reserve, SCI	6.836
ROSCI0251	Tisa Superioară	SCI	63.029
ROSCI0264	Valea Izei and Dealul Solovan	SCI	468.727
ROSCI0092	Igniş	SCI	195.980
ROSCI0124	Munţii Maramureşului	Natural Park, SCI	1.069.087
ROSCI0125	Munţii Rodnei	National Park, SCI	480.616
ROSCI0358	Pricop - Huta - Certeze	SCI	31.620
ROSCI0285	Codrii seculari de la Strâmbu - Băiuţ	SCI	24.974

MATERIAL AND METHODS

The habitat modeling methodology used in our study is based on the existing knowledge on the ecological requirements of the brown bear (*Ursus arctos*) and consists of the collection or generation of spatial data sets with the main environmental factors which can influence the spatial distribution of species. Through various mathematical methods of spatial analysis these data sets can be processed so that the final outcome represents a theoretical model quantifying the habitat quality following the ecological requirements of the species. The results were interpreted using existing information on the spatial distribution of the brown bear in order to increase confidence in this study. In the best conditions such a study can have, a confidence level of approximately 70%, (Ardeleanu and Mircea, 2009) and was considered good enough to conduct this study, with zero level of resources.

To prepare the GIS study we used the method elaborated for the CorridorDesigner extension for ArcGIS, described by Bier et al. (2007) and also used by Ardelean and Mircea (2009) for a Romanian ecological network model. The same guidelines were used for the data analysis and map development. For the GIS analysis we used ArcMap 9.3, ArcInfo software developed by ESRI, with the following extensions: (1) CorridorDesigner for habitat modeling, movement costs and corridor design and (2) DEM Surface Tools by Jeff Jennes, useful for surface analysis.

As basic layers for spatial analysis we have used six types of layers and rasters: (1) Digital Elevation Model – DEM (Shuttle Radar Topography Mission format from http://srtm.csi.cgiar.org/); (2) Digital map of land use type Corine Land Cover version 2006 (http://www.eea.europa.eu/data-and-maps/); (3) Roads and railways network – digital ESRI Shape file; (4) Settlements map – digital ESRI Shape file; (5) Game units maps – digital ESRI Shape file; (6) Natural protected areas – digital ESRI Shape file (www.mmediu.ro). In the first step we proceeded to convert all the layers to raster format with 90x90 m pixels. For the conversion of comunication network and settlements into raster we used the Euclidian Distance ArcGIS Toolbox by giving values to the pixels based on the distance from the lines and polygons of the shape files. Using the "Create topographic position raster" command from CorridorDesigner extension we have generated the field configuration raster.

Following the existing guidelines from literature (Bier et al., 2007; Ardelean et al., 2010) for the transformation of the habitat factors into numerical variables the authors have given different scores from 0 to 100 for each of the factors involved in the analysis. In this system we chose to use the same number of classes presented by other authors: class 1 – antropic areas, non-habitat; class 2 – 1 to 29 – avoided habitats; class 3 – 30 to 59 occasional use, non-breeding; class 4 – 60 to 79 – consistent use with occasional breeding; class 5 – 80 to 100 – best habitat, good reproductive success. We consider the above described system to be suitable for our analysis.

To parameterize the analyzed factors, we followed again the instructions given in the works of Ardeleanu and Mircea (2009) and Bier et al. (2007a), but we have adapted the scores to the specific area of study and ecological characteristics of the target species, using the literature on bear ecology. The factors used for spatial analysis were classified by importance for the brown bear, the highest score being allocated to land use and the smaller one to the road network. At the next step, using the "Create habitat suitability model" tool we obtained the first habitat suitability raster and then we corrected the generated errors using the "Reclassify HSM to accommodate critical habitat factor" tool. The results of all the steps followed are presented in figure number 2.

By identifying Core Areas, our aim was to create a polygon layer of the main areas of potential ecological network. They should be areas of high ecological quality and must also be free of threats that could affect them in the future (change of use). In our case, we have considered Core Areas as the existing network of protected areas (national parks and Natura 2000 sites) that are designed to protect the brown bear, extended to include areas with high favorability around them. Taking into account the major units of relief in the region and that these areas must be large enough to support a viable population of bears, we have generated the following Core Areas: "Maramureş Mountains", "Rodna Mountains", "Igniş-Gutâi" and "Lăpuşu-Ţibleş". Among these areas we have created ecological corridors by using the "Create corridor model" CorridorDesigner. This tool automatically generates also the raster for travel cost (Bier et al., 2007a).

RESULTS AND DISCUSSION

The first results of the GIS data analysis are represented by the suitability of the habitats using the described criteria (Fig. 2). For each habitat suitability class we have obtained the surface percentage of the total surface of the study area: class 1 (non habitat) – 5%, class 2 – 2%, class 3 – 37%, class 4 – 18% and class 5 (Best habitat) – 38%. The mean of the scores calculated for the region is 72.1 with a standard deviation calculated at 13.3727.

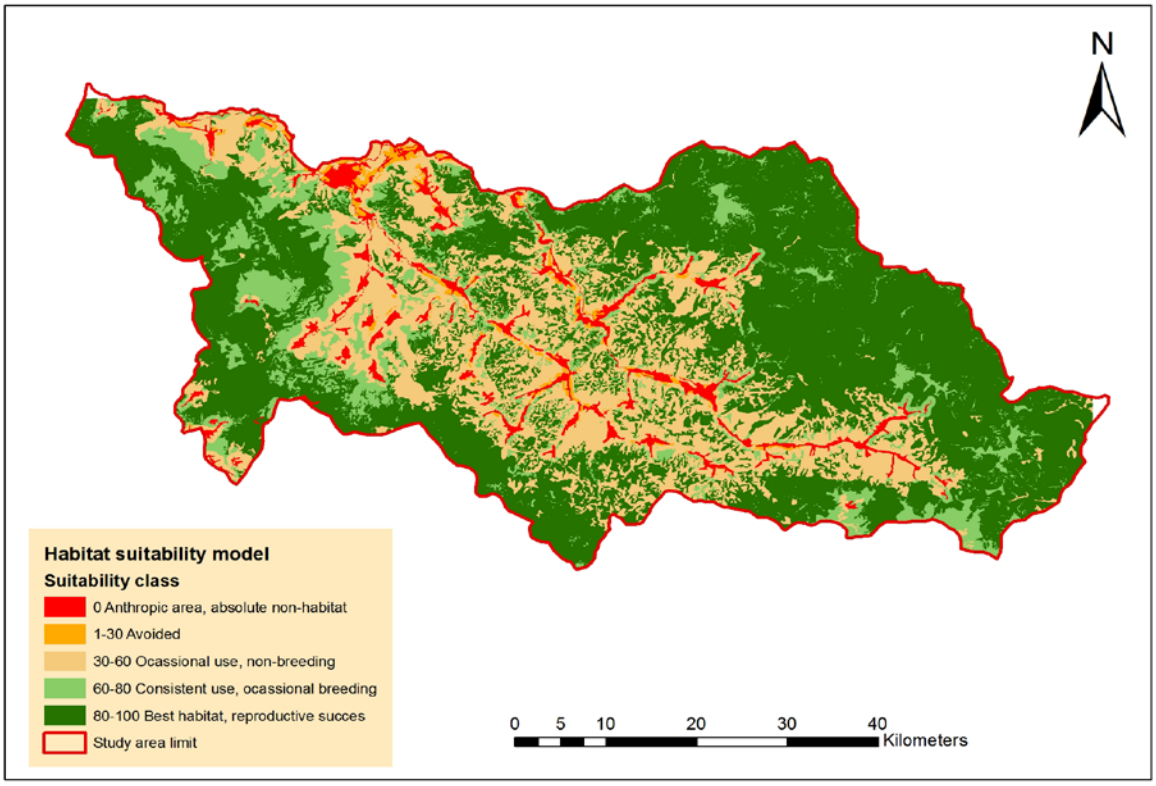

Figure 2: Habitat suitability model.

In the second step of the approach, we obtained the map with the core areas (Fig. 3) then created a map of travel cost, evaluated for the target species (Fig. 6) by indicating the possible routes for individual movement.

The third result is related to the theoretical suitability habitat classification inside the existing natural protected areas (Tab. 3). From the perspective of the brown bear theoretical habitat suitability, all the protected areas are covering a high percentage of good quality habitat.

According to the wildlife management organized at the game unit level, the habitats suitability, in relation to the brown bear population assessed by hunters, could be a good indicator for the management of the species. Using Pearson correlation we obtained a correlation coefficient r = 0.679 (n = 27, *P* = 0.000, 95% confidence interval = 0.389-0.847), showing that there is a good correlation in the study area between the mean of habitat suitability and the brown bear population. The correlation could also be observed on the brown bear distribution and the mean of the suitability coefficient for each game unit (Fig. 4).

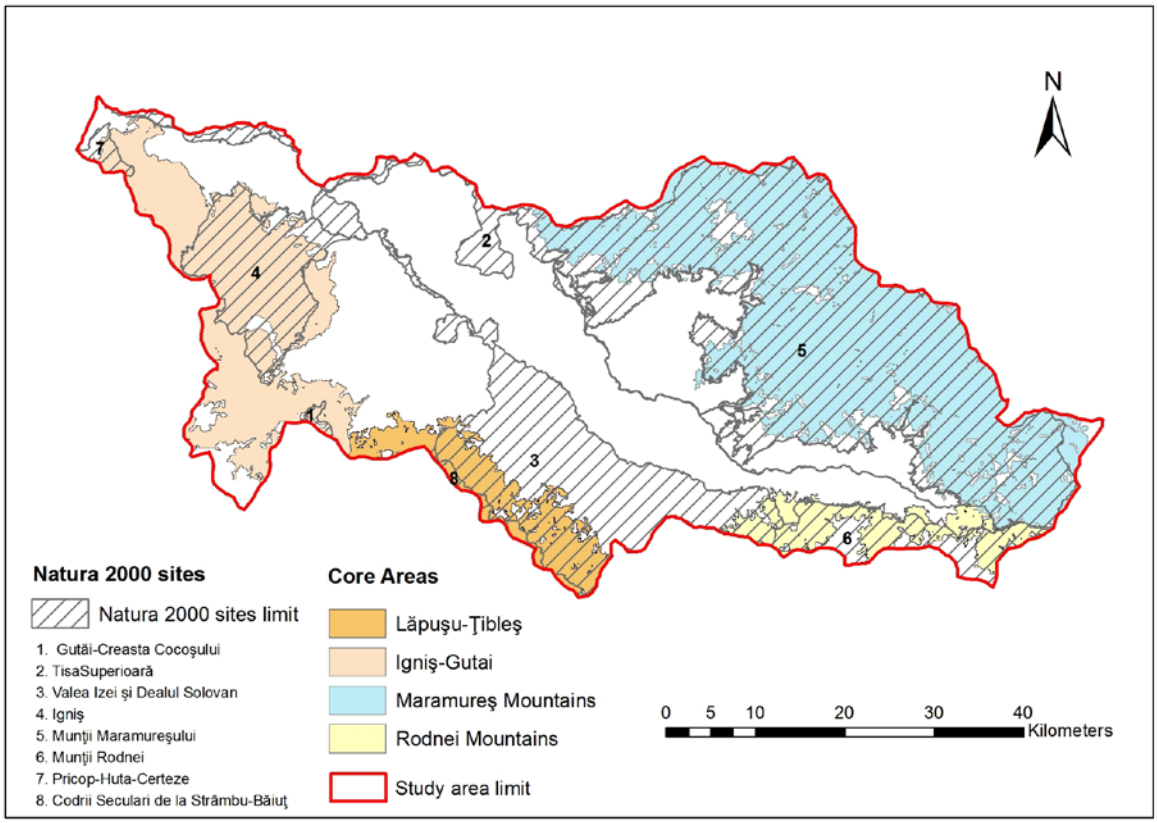

Figure 3: Core areas and Natura 2000 sites.

Table 3: Habitat suitability inside the protected areas (%).

SCI code	Habitat suitability classes					Mean habitat suitability scores
	1	2	3	4	5	
ROSCI0089	14.96	0	0	2.98	82.06	82.275
ROSCI0092	0.28	0	3.71	27.23	68.79	85.169
ROSCI0124	0.47	0.13	6.84	7.7	84.87	88.932
ROSCI0125	0.72	0	5.29	32.88	61.11	85.371
ROSCI0251	4.31	6.46	29.95	10.98	48.27	64.642
ROSCI0264	3.86	1.63	40.92	6.81	46.79	67.428
ROSCI0285	0	0	0	1.27	98.73	95.545
ROSCI0358	0	0	1.11	6.02	92.87	86.346

The graphic analysis of the data indicates a goodness-of-fit of linear regression r^2 = 0.461 (for a 95% confidence interval) between the brown bear population and the mean of the suitability coefficient, suggesting that at this existing information level, the number of bears is an indicator for high suitability habitats, but not a reliable indicator (Fig. 5).

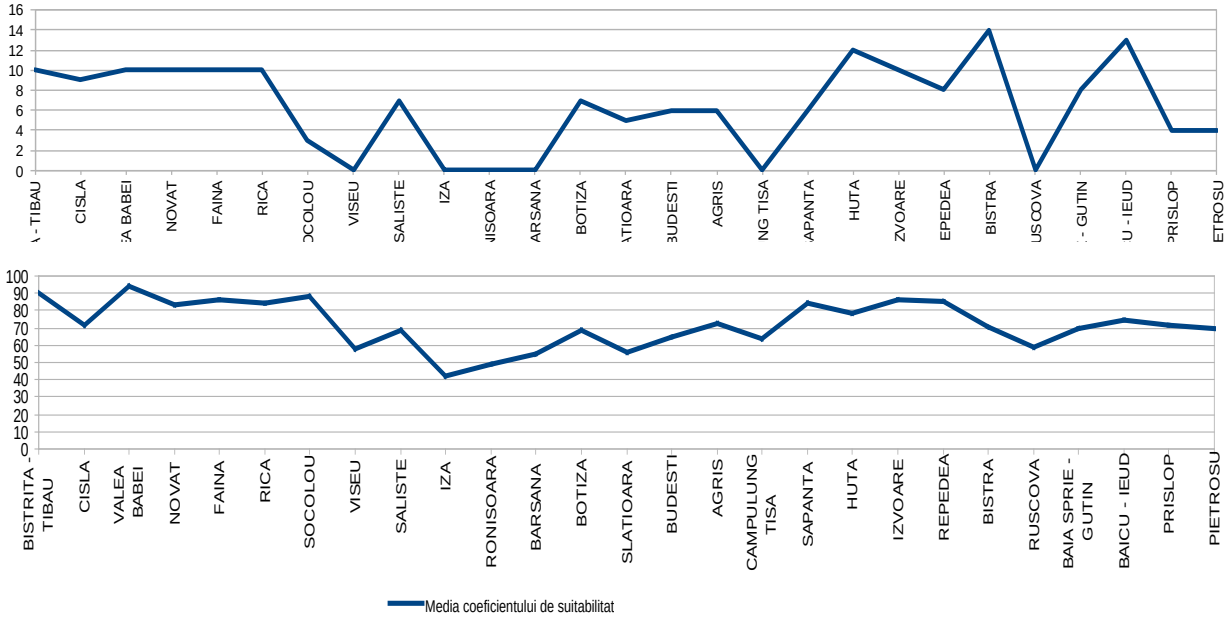

Figure 4: Brown bear population and mean of the suitability coefficient at each game unit level.

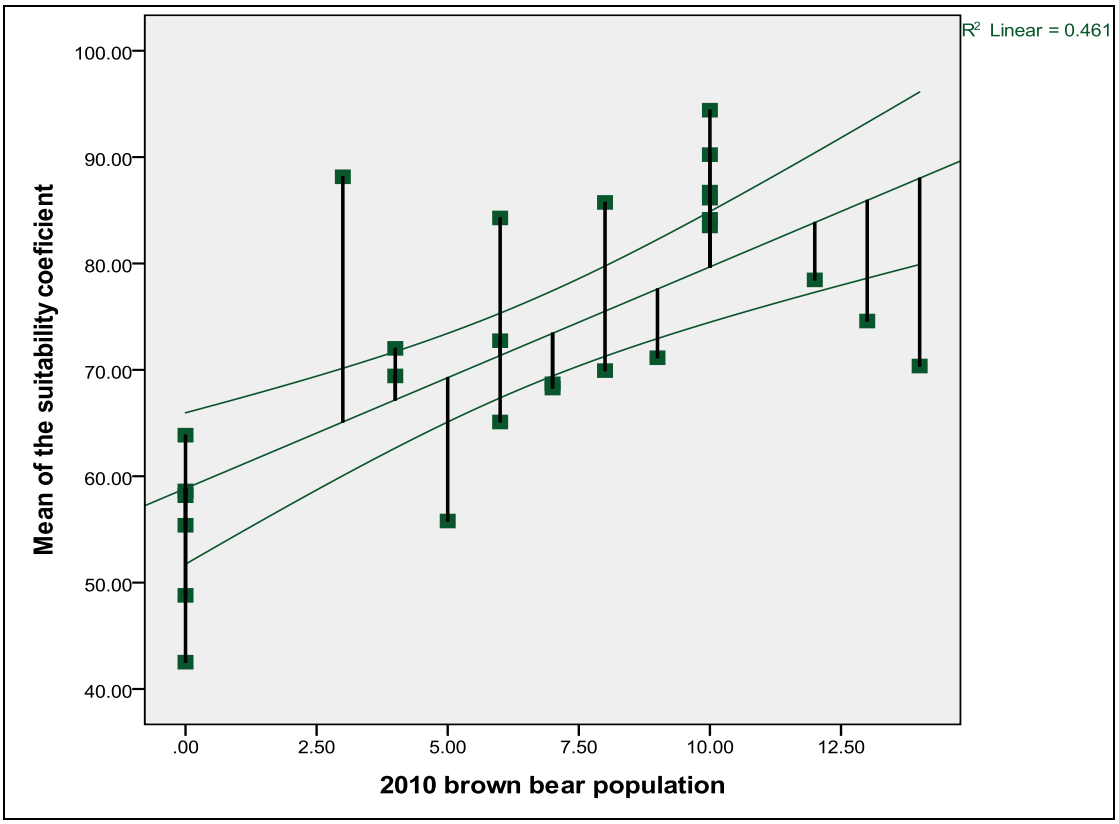

Figure 5: Goodness-of-fit of linear regression between the brown bear population and the mean of the suitability coefficient.

Using the travel cost raster and the core area distribution we have identified three possible direct routes for the bear movement from Gutâi and Ţibleş Mountains to Maramureş Mountains: (1) between the villages of Bârsana and Strâmtura continuing near Bistra; (2) between Rozavlea and Bogdan Vodă continuing between Leordina and Vişeu; (3) between Sălişte and Săcel continuing near Vişeul de Jos (Fig. 6).

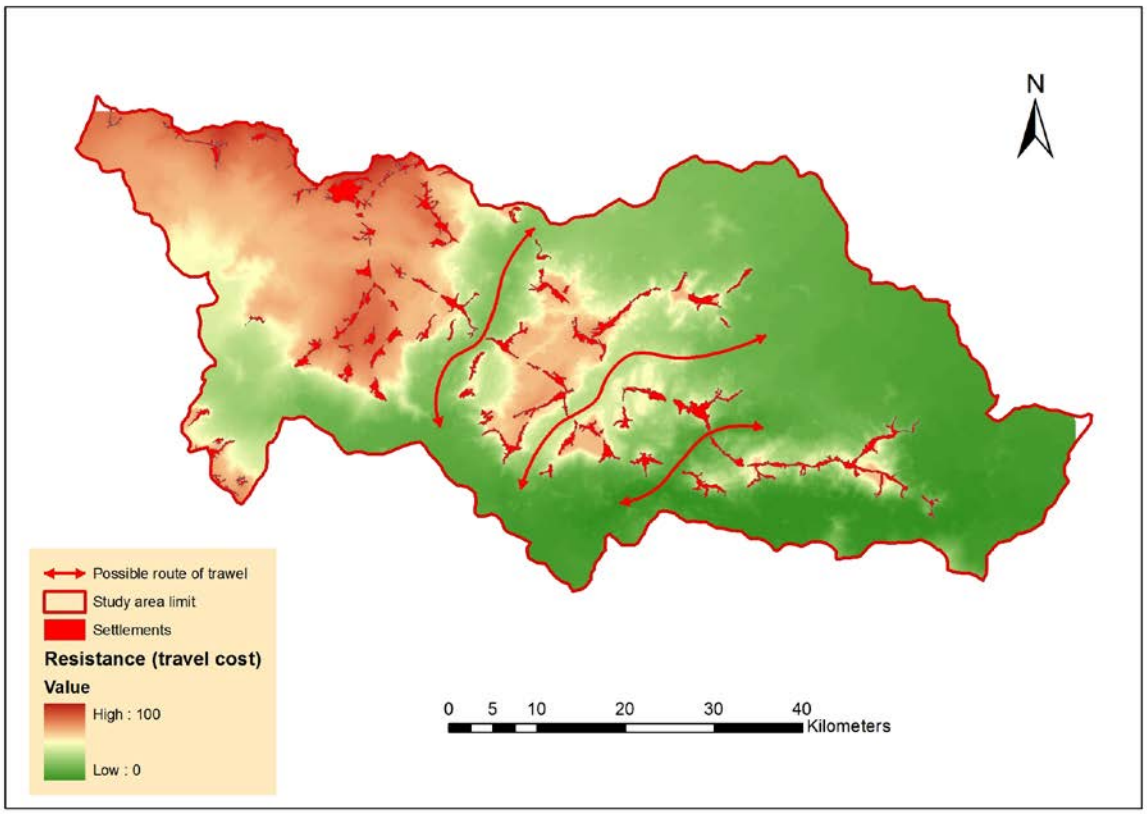

Figure 6: Travel cost and probable routes from Gutâi and Ţibleş to Maramureş mountains.

Based on the study results, approximately 55% of the habitats of the studied area are suitable for the brown bear, consisting in habitats classified in class 5 and 4, both of the classes being characterized by the possibility of breeding. The decisive factors for a bear to choose a suitable place for reproduction are availability of food, sufficient remoteness and a certain level of impermeability of the given area that minimizes potential human disturbance (Anděl et al., 2010). Analyzing the map of the habitat suitability (Fig. 2), the largest core area with best bear habitat included in class 5 and 4, is the area of the Maramureş Mountains, followed by the Gutâi and Ţibleş Mountains ranges. The first problem observed is that, even if the surface of the Maramureş Mountains is almost 40% larger than the Gutâi and Ţibleş Mountains ranges, the evaluated number of bears is almost similar (76 and 80 bears). This similarity of bear numbers between the mentioned areas could be influenced by different levels of food availability; the Maramureş Mountains area not being formed by forest patches, is too large to be considered as a sink area (Nielsen et al., 2006). The second hypothesis is that the similarity is influenced by the wildlife management or the human activities. Still without understanding the full relation within habitat processes and the management of the species, assuming that animal occurrence relates directly to habitat quality represents a risk for the adoption of the conservation measures (Nielsen et al., 2006). From the perspective that the area of Maramureş Mountains is a natural park, the conservation of the brown bear for a long period could be a problem for the administrator of the park, even if the bear population is considered to be at the optimum level. Predictive methods, based on field data, may help to define the potential bear distribution as well as preserve its habitat, (Posillico et al., 2004) but field data has to be used in order to validate the model.

Out of eight natural protected areas, six have over 80% of the surface evaluated with habitat suitability included in class 5 – "Best habitat with good reproductive success" and class 4 – "Consistent use with occasional breeding", indicating that the protected areas network is well developed from the brown bear conservation perspective (Tab. 3, Fig. 3). Still the success of the conservation cannot be evaluated by the place and size of the protected area, being directly influenced by the management and conservative measures implemented. As expected, the lowest mean scores for habitat suitability at natural protected areas level were calculated for Tisa Superioară (64.642) which has 59.25% of the surface included in class 4 and 5 of suitability and Valea Izei-Dealul Solovan (67.428) which has 53.6% of the surface included in class 4 and 5 of suitability Sites of Community Interest (SCI) due to the high level of human activity in the area (Tab. 3). In the eastern part of Tisa Superioară site and south-eastern part of Valea Izei-Dealul Solovan good habitats for bears are well represented. On the opposite side, the smaller SCI's Codrii seculari from Strâmbu Băiuţ (with 100% of the surface included in the suitability class 4 and 5) and Pricop-Huta-Certeze (with 98.89% of the surface included in class 4 and 5) have highest mean scores: 95.545 and 86.346 (Tab. 3). Due to forest composition and structure, the site from Strâmbu Băiuţ is an exceptional area for the denning sites and reproduction, but also it represents a retreat area and a good transition route between Gutâi and Ţibleş mountains. Pricop-Huta-Certeze having this mean score could be the second area of trespassing for bears and other large carnivores between Romania and Ukraine after the Maramureş Mountains, which are connected directly with the Ukraine Carpathians.

From calculations and general maps we can observe that in the study area bear movement from the Maramureş Mountains to Gutâi-Ţibleş mountain range, crossing through the high human presence area from the lowland, in the center region, has a very high travel cost. The obtained graphic representation of the travel cost suggests that the highest probability of movement route is following the south-eastern part of the region passing through the Rodnei Mountains. Identified possible direct routes for the bear movement from Gutâi and Ţibleş mountains to the Maramureş Mountains are: (1) between the villages of Bârsana and Strâmtura continuing near Bistra; (2) between Rozavlea and Bogdan Vodă continuing between Leordina and Vişeu; (3) between Sălişte and Săcel continuing near Vişeul de Jos (Fig. 6), but they need to be evaluated within a field research. Consisting of small and medium forest patches, the potential corridors could represent a "trap route" for bears. If suitable, this route could be of great importance for the brown bear population and other large carnivores, supporting the dispersal of the individuals.

In relation to the wildlife management from hunting perspective, out of the 27 game units, seven (22%) have a mean habitat suitability score under 60 points, all of them being areas with high human activity. Only one of the game units (Slătioara) with the mean of a suitability score of less than 60 points has a permanent presence of bears. In this case the permanent presence could be an influence of very good food availability (even in relation to supplementary food given to the bears). Considering the high level of human activity in this area, we believe that this area represents a high potential risk of conflicts between humans and bears.

Nevertheless, the obtained correlation coefficient ($r = 0.679$) between the distribution of the bears and the means of the habitat suitability per each game unit suggest that the existing number of bears (estimated as being similar with the optimum number) are using the available habitats being concentrated in the habitat classified as the best habitat

with high reproductive success overlapping with the core areas. The results do not confirm the hypothesis that the optimum number is well established and the population is in a good conservation status, it just confirms that the distribution of the bear at the study area level is more or less similar with the distribution of the core areas and the best habitat for brown bears. To develop a model for the optimum number of bears in the studied area, specific field research focused on assessing the habitat and the natural movement of bears (using telemetry) is strongly recommended. In fact, the status of a bear population cannot be assessed using just GIS modelling based on geo-spatial information.

CONCLUSIONS

Comparing the similarities between the obtained maps of habitat suitability and the presented data of the brown bear distribution in the area of interest, we can say that the method is applicable to the study of brown bears, to estimate the suitability of the habitats. For further information on the species conservation status and distribution, field researches are required. The remaining question is the size of the area in which the results of the method are good enough to establish conservation measures. The scores awarded to each factor could also be established based on the data collected on the field in the region in which the modeling is made. In this context, all theoretical models need to be corrected and validated by other field and statistical methods for assessing the habitat suitability.

Based on our results, it seems that the network of the protected area is well established and distributed, following the brown bear conservation objectives. Still the problem of preserving and/or improving the existing and possible ecological corridor is and will remain a problem in the following period. Studies should be run to assess the value and the importance of each corridor, not only for the brown bear but for all large carnivores.

ACKNOWLEDGEMENTS

We would like to thank the editors and reviewers for supporting us to put on paper some of our experience, with the hope that it will be useful for the large carnivore conservation in Maramureş area.

REFERENCES

Anděl P., Mináriková T. and Andreas M. (eds) 2010 – Protection of Landscape Connectivity for Large Mammals, Evernia, Liberec, 134.

Ardelean G. and Béres I., 2000 – Fauna de vertebrate a Maramureşului, Edit. Dacia, Cluj Napoca, 378. (in Romanian)

Ardeleanu A. D. and Mircea I., 2009 – Modelarea GIS a unei reţele ecologice, instrument pentru dezvoltarea durabilă, Edit. Silvică, Institutul de Cercetări şi Amenajări Silvice, 31. (in Romanian)

Bereczky L., 2010 – Practical Applications of a Bear Rehabilitation Centre in the scientific studies related with the specie's behaviour and ecology. Master thesis at University of West Sopron, Faculty of Forestry, Institute of Wildlife Management and Vertebrate Zoology. Unpublished.

Bier P., Majka D. and Jenness J., 2007a – Conceptual steps for designing wildlife corridors, 1-90, Corridordesign.org.

Bier P., Majka D. and Jenness J., 2007b – CorridorDesigner ArcGIS Toolbox Tutorial, 1-25, Corridordesign.org.

Linnell J., Salvatori V. and Boitani L., 2008 – Guidelines for population level management plans for large carnivores in Europe. A Large Carnivore Initiative for Europe report prepared for the European Commission, 85.

Maanen E., Predoiu G., Klaver R., Soule M., Popa M., Ionescu O., Jurj R., Neguş Ş., Ionescu G. and Altenburg W., 2006 – Safeguarding the Romanian Carpathian ecological network. A vision for large carnivores and biodiversity in Eastern Europe., Veenwouden, The Netherlands, ICAS Wildlife Unit, Braşov, Romania, 132.

Nielsen S. E., Stenhouse G. B. and Boyce M. S., 2006 – A habitat-based framework for grizzly bear conservation in Alberta, *Biological Conservation*, 130, 217-229.

Posillico M., Meriggi A., Pagnin E., Lovari S. and Russo L., 2004 – A habitat model for brown bear conservation and land use planning in the central Apennines, *Biological Conservation*, 118, 141-150.

Predoiu G. and Maanen E., 2003 – Building a regional ecological network in the Carpathians, based on key habitats for large carnivore (wolfes, bears and lynx), Edit. Silvică, *Anale I.C.A.S.*, 46, 1, 197-206.

Ratti J. T. and Garton E. O., 1996 – Research and Experimental Design, in Research and Management Techniques for Wildlife and Habitats, Theodore A. Bookhout (ed.), The Wildlife Society Bethesda, Maryland, 1-23.

Scott J. M., Heglund P. J., Morrison M. L., Haufler J. B., Raphael M. G., Wall W. A. and Samson F. B., 2001 – Introduction, in: Scott J. M. et al. (eds), Predicting Species Occurences: Issues of Accuracy and Scale, Island Press, Washingtin, DC, USA, 1-5.

Swenson J. E., Gerstl N., Dahle B. and Zedrosser A., 2000 – Action Plan for the Conservation of the Brown Bear in Europe, WWF International, Gland, Switzerland, 68.

Şerban-Pârâu N., 2010 – Considerations on the aggressive behavior of the brown bear (*Ursus arctos arctos*) towards humans in the Romanian Carpathians, in relation to the bear's sex, *Acta Oecologica Carpatica*, III, Curtean-Bănăduc A. (ed.), 133-144.

Tardiff S. E. and Standford J. A., 1998 – Grizzly bear digging: effects on subapline meadow plants in relation to mineral nitrogen availability, *Ecology*, 79, 2219-2228.

Yip J. Y., Corlett R. T. and Dudgeon D., 2004 – A fine scale gap analysis of the existing protected area system in Hong Kong, *Biodiversity and conservation*, 13, 943-957.

AUTHORS:

Ioan Mihai POP [1]
minelpop@yahoo.com
Association for Conserving Biological Diversity,
Vrâncioaia Street 7, Focşani, Vrancea County, Romania, RO-620095.
Szilárd SZABÓ [2]
vszabo_szilard@yahoo.com
Environmental Protection Agency of Harghita County,
Marton Aron Street 43, Miercurea Ciuc, Harghita County, Romania, RO-530211.
Silviu CHIRIAC[3]
silviu_chiriac@yahoo.com
Environmental Protection Agency of Vrancea County,
Dinicu Golescu Street 2, Focşani, Vrancea County, Romania, RO-620106.

THE ANALYSIS OF BIOLOGICALLY PRODUCTIVE AREAS AND THE ASSESSMENT OF THEIR BIOCAPACITY FROM THE MUNTENIA SOUTH DEVELOPMENT REGION AND ITS PROTECTED AREAS

Ramona CHERĂSCU[1]

KEYWORDS: biologically productive areas, ecological footprint, biocapacity, Romania, Muntenia South Development Region, protected areas, SCI, SPA.

ABSTRACT

This paper analyses five categories of productive areas from the Muntenia South Development Region, a method of calculating the ecological footprint, considered an indicator of sustainable development.

A detailed analysis was made of each category of productive area, explaining spatial differences of the biocapacity values within the region, at the county and territorial administrative unit levels, the highest values of biocapacity being cropland as a result of their large surfaces.

When calculating the ecological footprint, not only the resource needs of human society should be considered, but also the needs of other species must be taken into account. The productive areas of administrative units that overlap protected areas were also analyzed. The resulting values, predominantly in forest areas, demonstrate that protected areas were designated exactly in those areas with very high values of bio-capacity.

REZUMAT: Analiza ariilor productive și a biocapacității lor în regiunea de dezvoltare Sud Muntenia și în ariile protejate ale acesteia.

În această lucrare, se analizează biocapacitatea celor cinci categorii de arii productive din regiunea de dezvoltare Sud Muntenia, ca mijloc de calculare a amprentei ecologice, indicator de dezvoltare durabilă.

S-a făcut o analiză, pe fiecare categorie de arie productivă, explicându-se diferențierile spațiale ale valorilor biocapacității, la nivel de regiune, județ și unitate administrativ teritorială, cele mai mari valori ale biocapacității, fiind deținute de terenurile cultivate ca urmare a suprafețelor lor întinse.

În calculul amprentei ecologice nu trebuie considerată doar nevoia de resurse a societății umane, ci trebuie luate în calcul și nevoile altor specii. Astfel, s-au analizat valorile biocapacității din unitățile administrativ-teritoriale, care se suprapun peste ariile protejate. Valorile rezultate demonstrează că ariile protejate au fost desemnate exact în acele zone cu valori foarte ridicate ale biocapacității, cu predominanță în zonele de pădure.

RESUMÉ: L' analyse des zones productives et de leur capacité biologique dans la région développée du sud de la Munténie ainsi que dans les zones protégées.

Ce thèse traite cinq catégories de zones productives, dans la région sud de la Munténie, pour le calcul de l'empreinte écologique considéré comme étant l'indicateur du développement durable.

L'analyse détaillée de chaque catégorie de zone productive met en évidence les différences spatiales des valeurs de la biocapacité dans cette région, pour les localités et l'ensemble du territoire administratif. Les valeurs de la biocapacité les plus élevées sont inclues dans le périmètre des terres cultivées.

Cependant, le calcul de l'empreinte écologique doit tenir compte des besoins de la société humaine mais également des besoins des autres espèces. Les valeurs élevées de la biocapacité prouvent que les zones protégées correspondent exactement aux surfaces ayant un niveau très élevé de biocapacité, le plus souvent des zones forestières.

INTRODUCTION

According to the United Nations' Food and Agriculture Organization (FAO), the demand for food and fibres could grow by 70% by 2050.

This has considerable implications for land use and natural ecosystems, and also for the size of humanity's ecological footprint. Implications exist for ecosystem services and their mapping.

One of the sustainable development important indicators is the ecological footprint (EF), a concept launched in the early '90s by Mathis Wackernagel and William Rees.

They identified that EF is the terrestrial and aquatic surface producing resources to population needs and to neutralize the waste products.

One of the methods for calculating the ecological footprint created by Wackarnagel and Rees, is to calculate values of biocapacity.

Biocapacity is the capacity of areas to provide natural resources, ecosystems ability to provide these resources within their capacity. Global hectare (hag) is the standard unit of measurement to express biocapacity.

MATERIALS AND METHODS

For biocapacity calculation, the productive surface was divided into five categories: cropland, forest, grassland, water surfaces, built-up land. Data on land use were obtained from the Corine Land Cover from the European Environment Agency database 2006.

The values were calculated for each administrative territorial unit, following the formula: BC = A x YF x EQF, where A represents the surface available for a certain type of land use, YF is the productivity factor and is expressing the ratio between national and global yield for the same type of bioproductive area while EQF is the equivalence factor needed to convert different types of land use in one (Tab. 1).

Table 1: The values of productivity and equivalence factor.

	Cropland/ Built-up land	Forest land	Grassland	Water surface
Productivity factor	0.9	2.01	2.04	2.8
Equivalence factor	2.64	1.33	0.50	0.40

The productivity and equivalence factor for the built-up land are equal with the factors for cropland, because it is considered that the built-up lands are the results of the extension and evolvement from farmland and cropland on to the building land.

Existing studies estimated that protecting 13.4% of the planet's land surface, would prevent the extinction of 55% of species threatened with extinction at global level. Biocapacity was calculated for each bioproductive areas, by adding values resulting total biocapacity. Although, as shown in the current analysis, protected areas cover 13.2% of the total development region, I decided to substract 13.4% on the biocapacity calculation, taking into account that it is necessary to provide space for wild species whose food and habitat also depend on this very same biocapacity. Total biocapacity was calculated at regional, county, local and at protected areas level.

RESULTS AND DISCUSSION

The surface of this region is 3,446,639 ha, representing 14.45% out of the country's surface. The total biocapacity of the region is 6,940,197 hag (Fig. 1).

Per capita, the average is 2.12 hag/capita, being higher than the value for national level (hag/capita) or global level 1.78 hag/capita.

At the regional level, the highest values of biocapacity are owned by cropland which has a large area in the region, followed by grassland, surface water as shown in figure number 2.

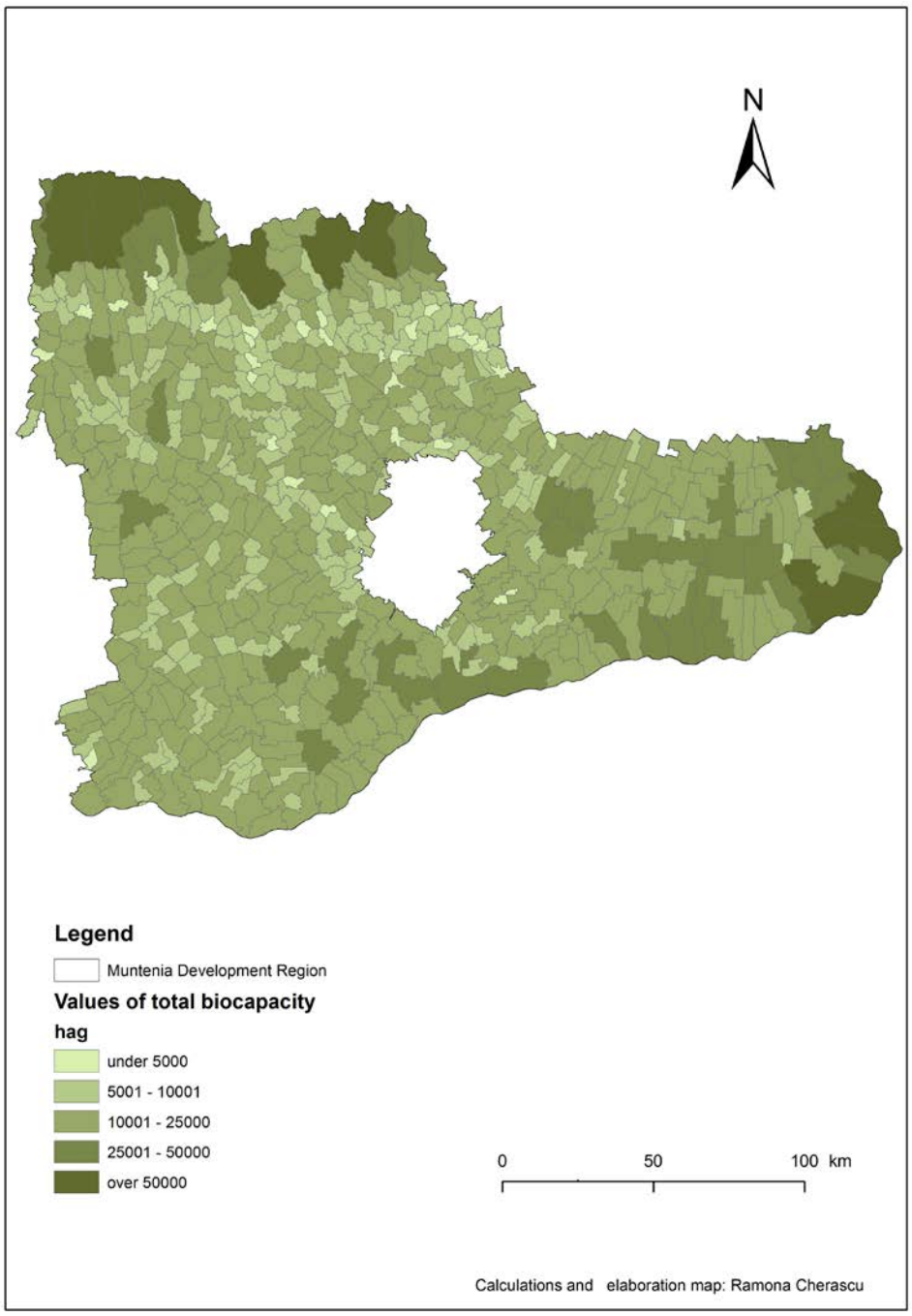

Figure 1: The values of total biocapacity in the administrative territorial unit of Muntenia South Development Region.

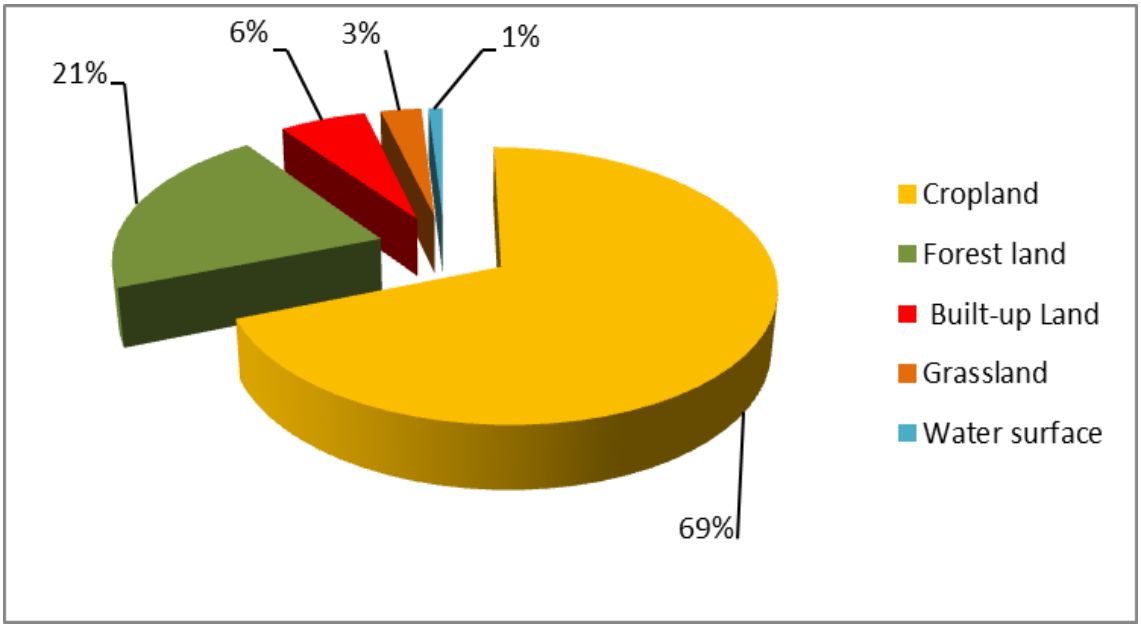

Figure 2: Percentage of total capacity values for bioproductive areas
in the territorial administrative units of Muntenia South Development Region.

The highest values of total biocapacity is owned by Argeş County. Related to the categories of productive areas, the huge values are owned by forest land, followed by cropland. The second place is occupied by Teleorman County which has huge values of biocapacity on the Romanian Plain (relief unit with the largest surface in the region – 70.7% of the total area), in meadows and Danube Valley (4,441,907 hag), followed by forest (1,346,721 hag) mainly in mountain regions and the lower values by built-up land (392,347 hag), (Fig. 3).

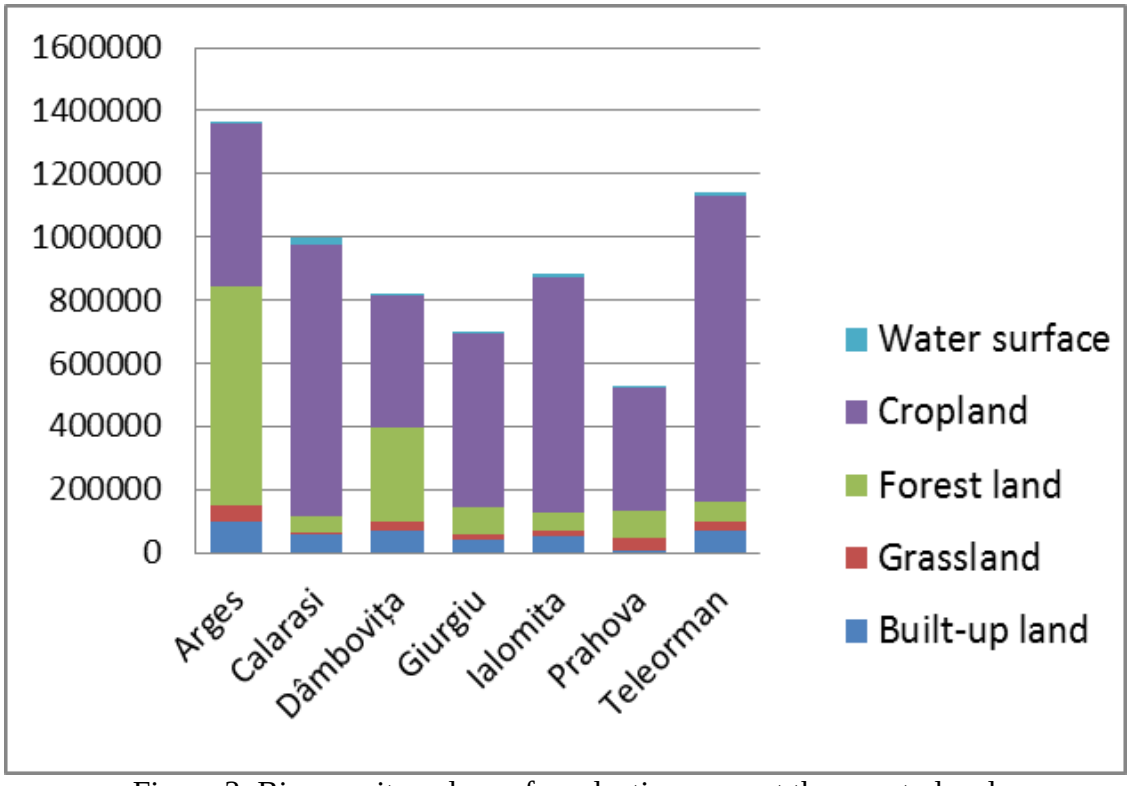

Figure 3: Biocapacity values of productive areas at the county level
in the Muntenia South Development Region.

In the case of the territorial administrative units, the lowest values are occurring in the town of Plopeni (1.881 hag) and the highest in the village Nucşoara (79.786 hag).

Related to the population size, the biocapacity's high values per capita are recorded in over 70% of administrative units: Nucşoara (52.7 hag/capita), followed by Arefu (29.6 hag/capita), Giurgeni (16.7 hag/capita), Albeştii de Muscel (15.7 hag/capita). The lowest values are recorded in county capitals: Piteşti (0.04 hag/capita), Ploieşti (0.05 ha/capita), Târgovişte (0.12 hag/capita), Giurgiu (0.14 hag/capita) etc. (Fig. 4).

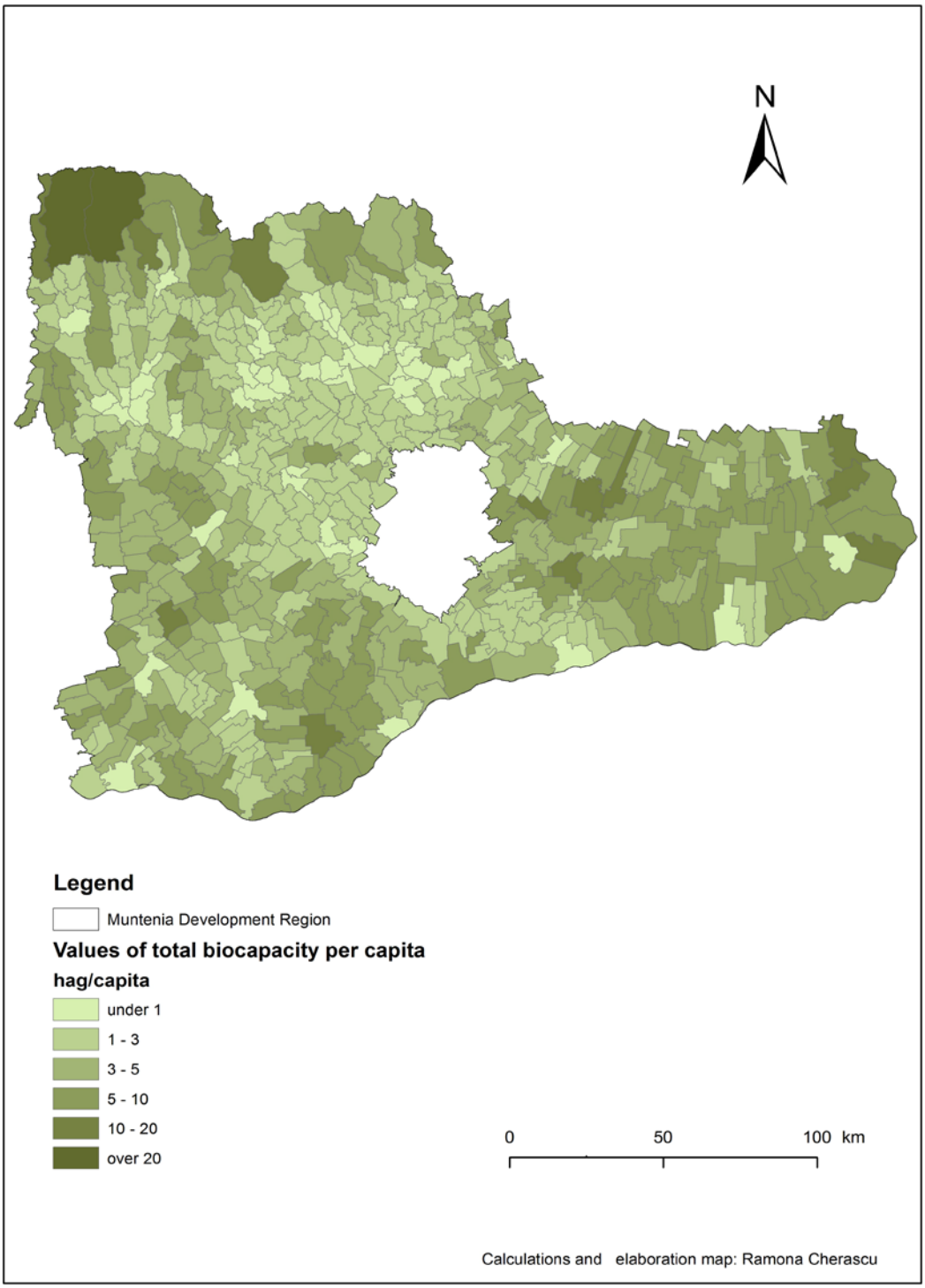

Figure 4: The values of total biocapacity per capita in the administrative territorial units of the Muntenia South Development Region.

Croplands are considered the land with the highest productivity.

The total biocapacity of cropland is 4,441,907 hag (Fig. 5). The average is 1.35 hag/capita, being higher than the national (0.58 hag/site) or the world average (0.59 hag/place). The highest values of total biocapacity are held by Teleorman County with 969.726 hag, Călărăşi County with 856.763, Ialomiţa County with 746.330 hag, and the lowest is Prahova County with 388.116 hag.

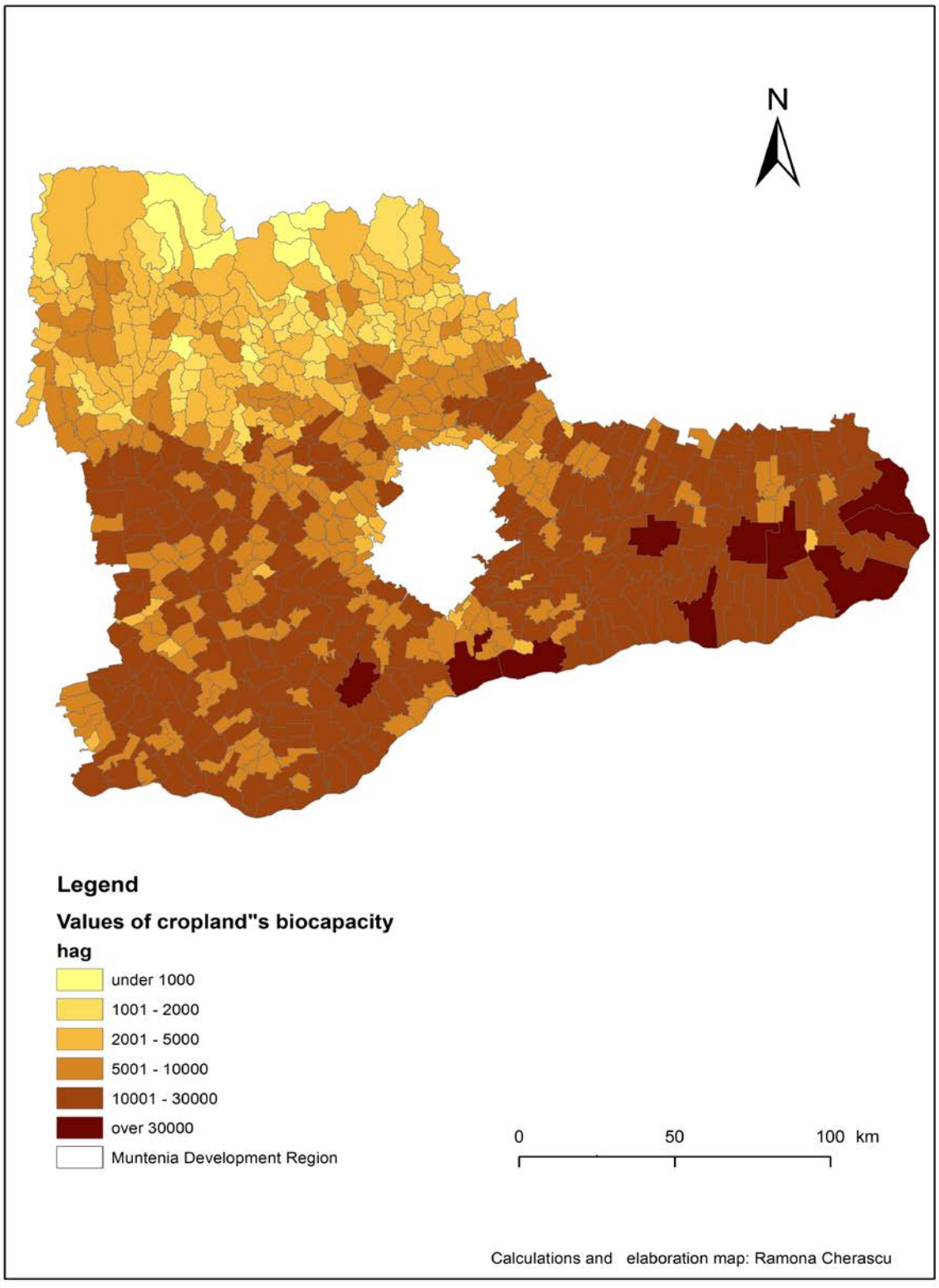

Figure 5: The values of cropland's biocapacity in the administrative territorial units of the Muntenia South Development Region.

Related to population size, the highest values of cropland's biocapacity are recorded in Călăraşi County (2.7 hag/capita), followed by Ialomiţa (2.5 hag/capita), Teleorman (2.4 hag/capita). The lowest values are recorded in Prahova (0.4 hag/capita), Dâmboviţa (0.7 hag/capita) and Argeş (0.8 hag/capita).

At the territorial administrative level, the highest values of cropland biocapacity are registered in Borcea (74.171 hag), Făcăeni (43.910 hag), Bordușani (43.040 hag), Perișoru (42.887 hag), Dragalina (40.246 hag), Chirnogi (40.050 hag), Grădiştea (39.025 hag), Prundu (35.968 hag), which are stretched throughout the Romanian Plain and the Danube Valley. The lowest values are found in the mountains: Azuga (23 hag), Bușteni (94 hag), Rucăr (227 hag) and Plopeni (51 hag). Per capita, the highest value of the cropland's biocapacity are registered in the communes from Ialomiţa and Călăraşi counties (Fig. 6): Stelnica (16.1 hag/capita), Gogoşari (13.8 hag/capita), Giurgeni (13.5 hag/capita), Vlădeni (12.3 hag/capita), Săceni, Balaciu, Drăgoești, Gurbănești.

Related to number of inhabitants, the highest values of biocapacity are registered in the municipalities of Nucşoara (3.6 hag/capita), Arefu (1.7 hag/capita), Moroeni (1.2 hag/capita), Dâmbovicioara (1.1 hag/capita), which are generally represented by mountain pastures (Fig. 6).

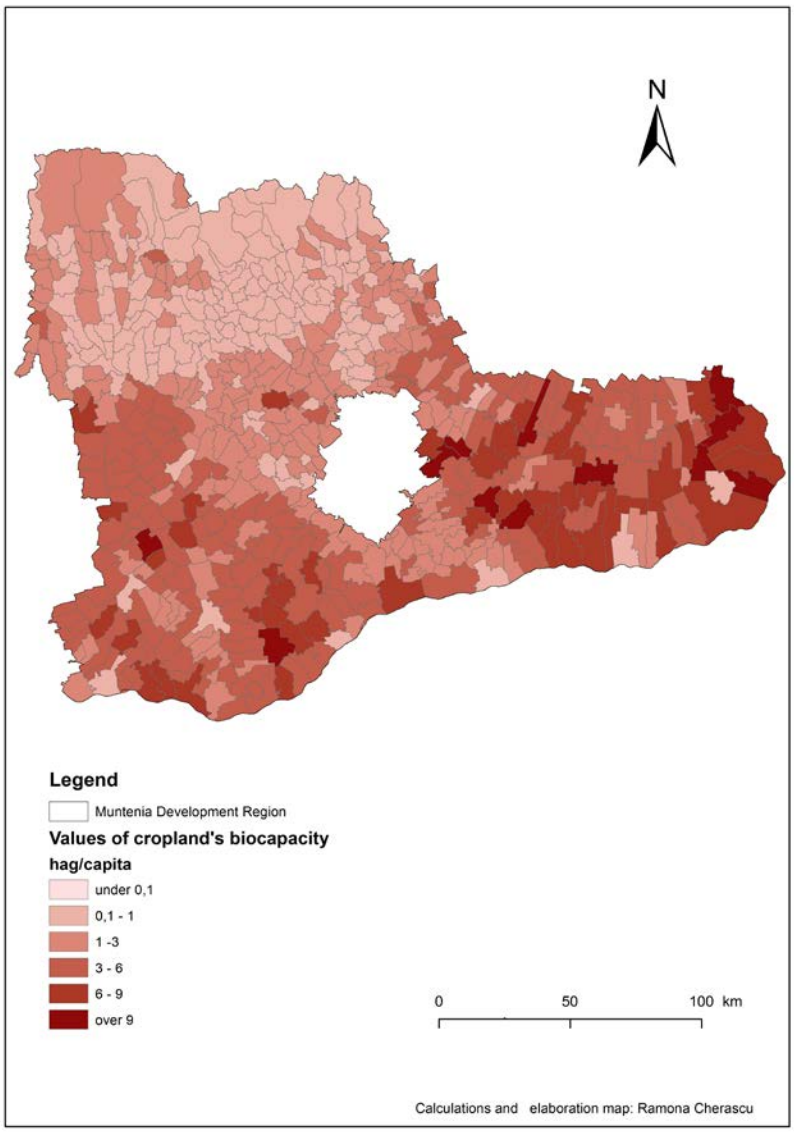

Figure 6: The values of cropland's biocapacity per capita in the administrative territorial units of the Muntenia South Development Region.

The lowest values per capita are generally recorded in the plain region (Bărăgan Plain) as it is dominated by cropland with values under 0 hag/capita: Alexandru Odobescu, Independența, Dragoș Vodă, Dragalina, Modelu, Rosetti, Vlad Țepeș, Ștefan cel Mare, Unirea. 450 of local administrative units, representing 80.9% from the units of the region are recording values of below the national average.

Grasslands are used for livestock, for milk and wool. The value of its biocapacity is 215.163 hag and the average value per capita is 0.06 hag/per capita. At the county level, the highest values are registered in Argeş (49.701 hag) and Prahova counties (41.368 hag), the values are high due to large areas of alpine grasslands.

Related to the population size, the value of biocapacity is 0.12 hag/capita in Argeş County, followed by Dâmboviţa County (0.08 hag/capita) and the lowest in Călăraşi County (0.01 hag/capita). The highest value of grassland biocapacity is registered in Moroeni (6,364 hag), followed by Nucşoara (5,553 hag), Valea Doftanei (5,335 hag), Rucăr (4,795 hag), Arefu (4,520 hag), (the here-above mentioned localities are located in the Carpathian Mountains area) and Mihail Kogălniceanu (2,723 hag) from the Romanian Plain. The lowest values are registered mainly in the territorial administrative units of Romanian Plain: Luica, Sole, Târgşoru Vechi, Dichiseni, Rosetti, Slobozia, Alexandru Odobescu, Amara, etc. (Fig. 7).

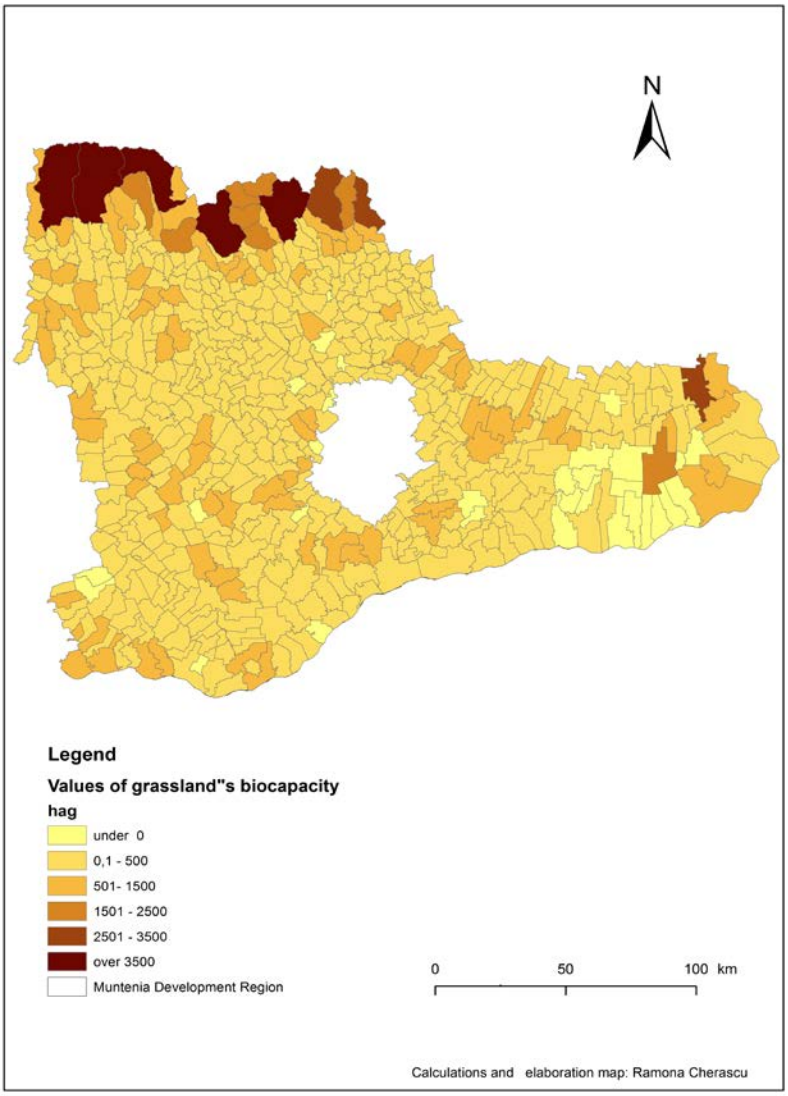

Figure 7: The values of grassland's biocapacity in the administrative territorial units of the Muntenia South Development Region.

Related to number of inhabitants, the highest values of biocapacity are registered in the municipalities Nucşoara (3.6 hag/capita), Arefu (1.7 hag/capita), Moroeni (1.2 hag/capita), Dâmbovicioara (1.1 hag/capita), which are generally represented by mountain pastures (Fig. 8).

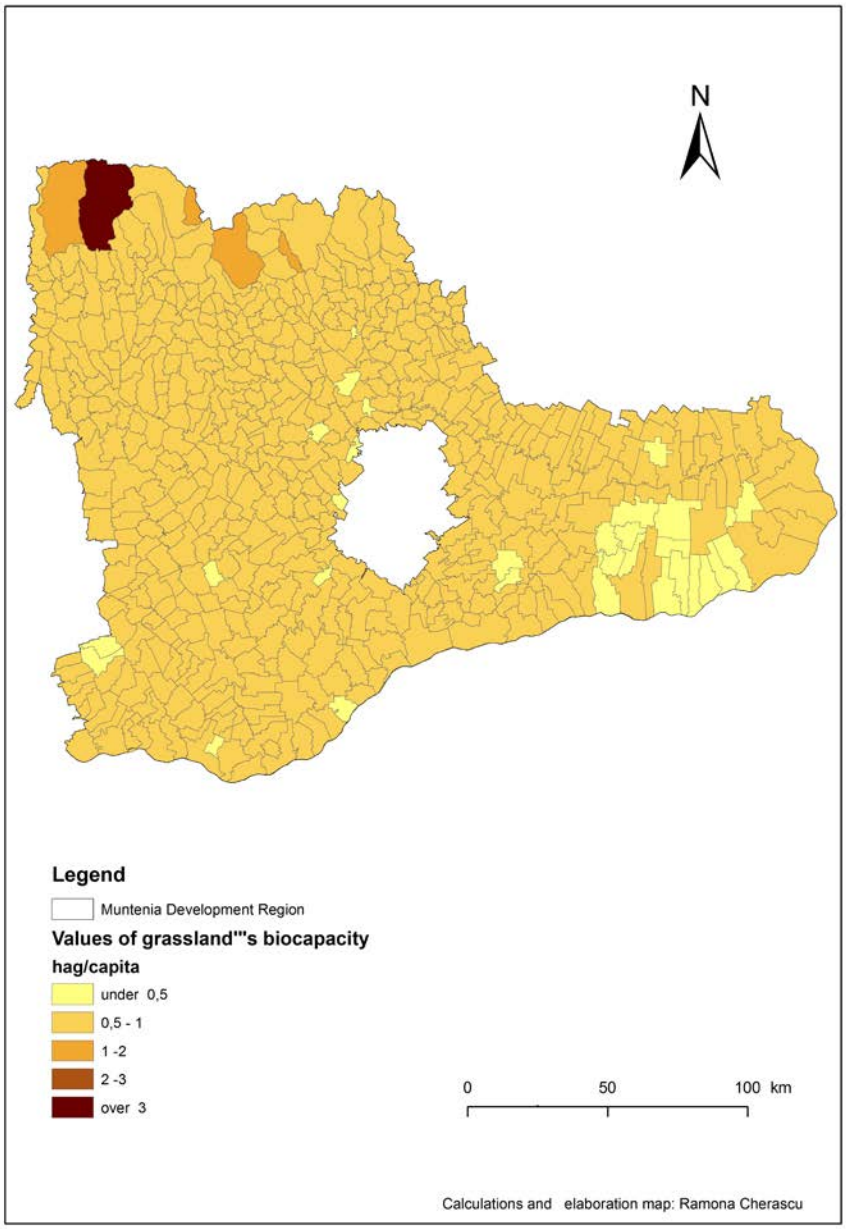

Figure 8: The values of grassland's biocapacity per capita in the administrative territorial units of the Muntenia South Development Region.

The lowest per capita values are generally recorded in the plain (Plain Bărăgan) dominated by cropland with values under 0 hag/capita: Alexandru Odobescu, Dragoş Vodă, Dragalina, Modelu, Roseti, Vlad Ţepeş, Stefan cel Mare, Unirea, etc. 450 local administrative units, representing 80.9% of the units of the region have recorded values below the national average.

The productive areas of forest land are considered to have a double role: to produce timber products and to absorb carbon dioxide. Forest areas occupy 19.3% of the regions surface and the value is 1.917.213 hag (Fig. 9). Per capita, the average is 0.58 hag/capita, lower than the national average (1.02 hag/capita) or the global average (0.74 hag/capita).

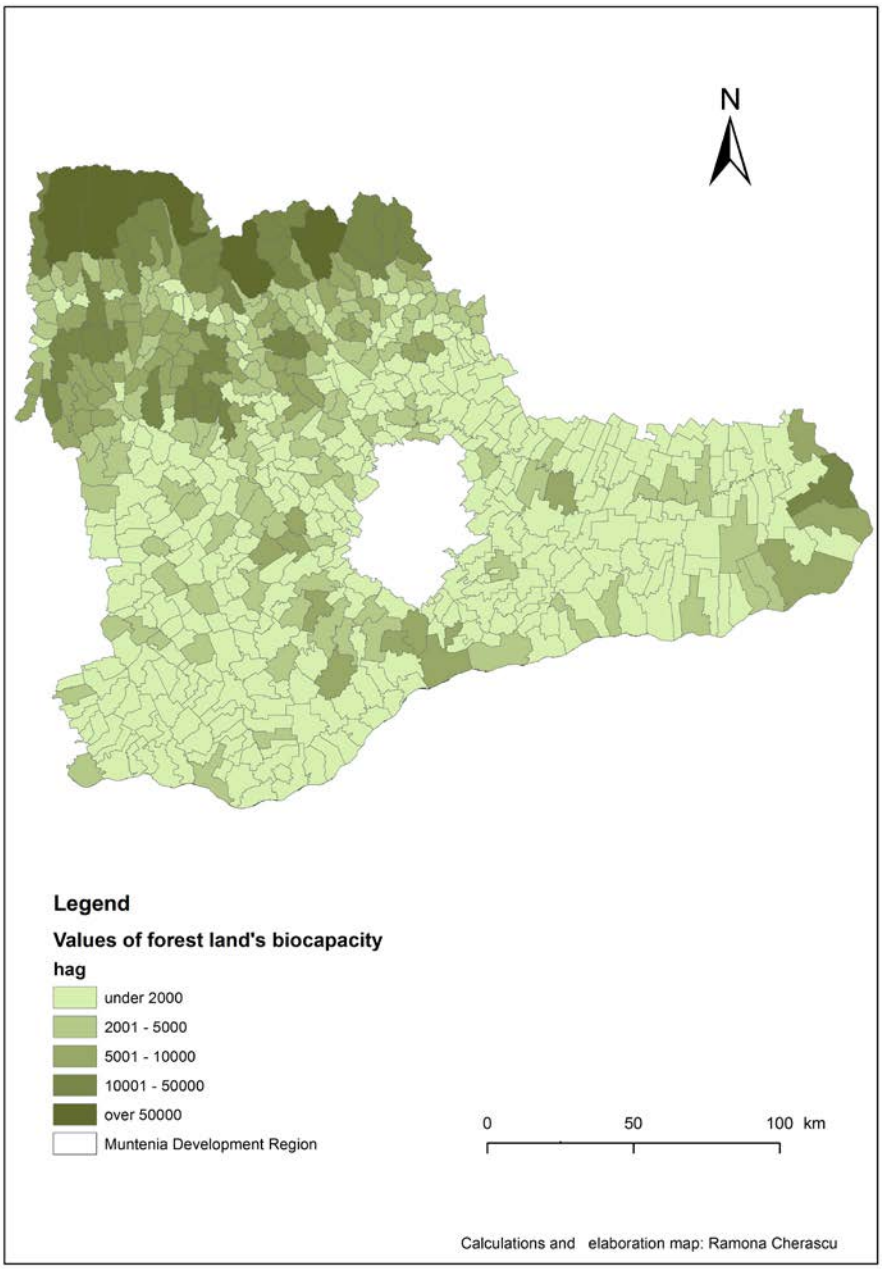

Figure 9: The values of forest land's biocapacity in the administrative territorial units of the Muntenia South Development Region.

At the county level, the highest value is registered in Argeş (695,935 hag), followed by Dâmboviţa (298,335 hag) and lowest value is registered in Călăraşi (50,825 hag). Related to population, the highest values are recorded in Argeş (1.08 hag/capita), the only county exceeding the national average, followed by Dâmboviţa and Giurgiu counties with 0.5 and 0.3 hag/capita. The lowest value is registered in Prahova County: 0.10 hag/capita, because is the most populated county in this development region, but also in Romania.

The administrative-territorial units show the highest values in the mountains, where most forest areas have been included in the Natura 2000 ecological network, some of them initially declared as national/nature parks or nature reserves: Nucşoara (83,052 hag), Arefu (77,636 hag), Valea Doftanei (56,225 hag), Rucăr (5,917 hag), Moroeni (52,663 hag). The lowest values are 0 hag and are recorded in 49 of admnistrative territorial units from Romanian Plain such as Fântânele, Independenţa, Alexandru Odobescu, Amara, etc.

Related to population, the highest values are recorded in Nucşoara (54.8 hag/capita), Arefu (29.9 hag/capita), Albeştii de Muscel (15.8 hag/capita), Sălătrucu (12.7 hag/capita), Dâmbovicioara (12 hag/capita), Moroeni (10.1 hag/capita), all the above villages being located in the mountain areas and mostly included in protected areas of national interest (Bucegi Park, Piatra Craiului National Park) or Natura 2000 sites (Făgăraş, Leaota, etc.). The lowest values are registered in municipalities from Ialomiţa, Călăraşi and Prahova counties: Mizil, Baba Ana, Tomşani, Colceag, Fulga, Sălciile etc., due to lack of forest land in this area (Fig. 10). Moreover, 74.6% of the territorial administrative units recorded values under national average.

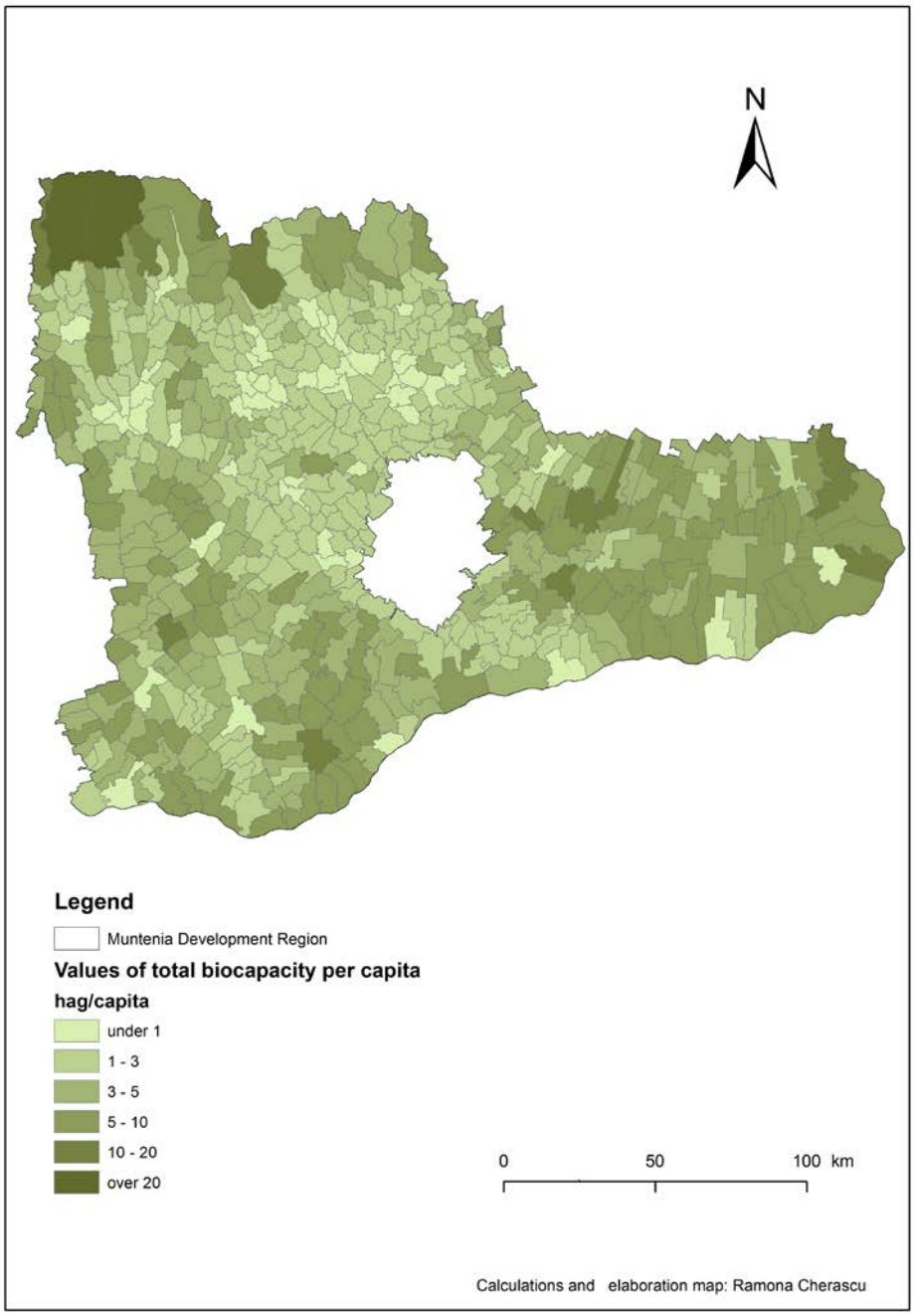

Figure 10: The values of forest land's biocapacity per capita in the administrative territorial units of the Muntenia South Development Region.

The aquatic category includes continental brackish and freshwater, reservoir lakes build on Olt, Argeș and Dâmboviţa rivers as well as wetlands from Danube floodplain (Ialomiţa Pond). The biocapacity value is 79,451 hag (Fig. 11).

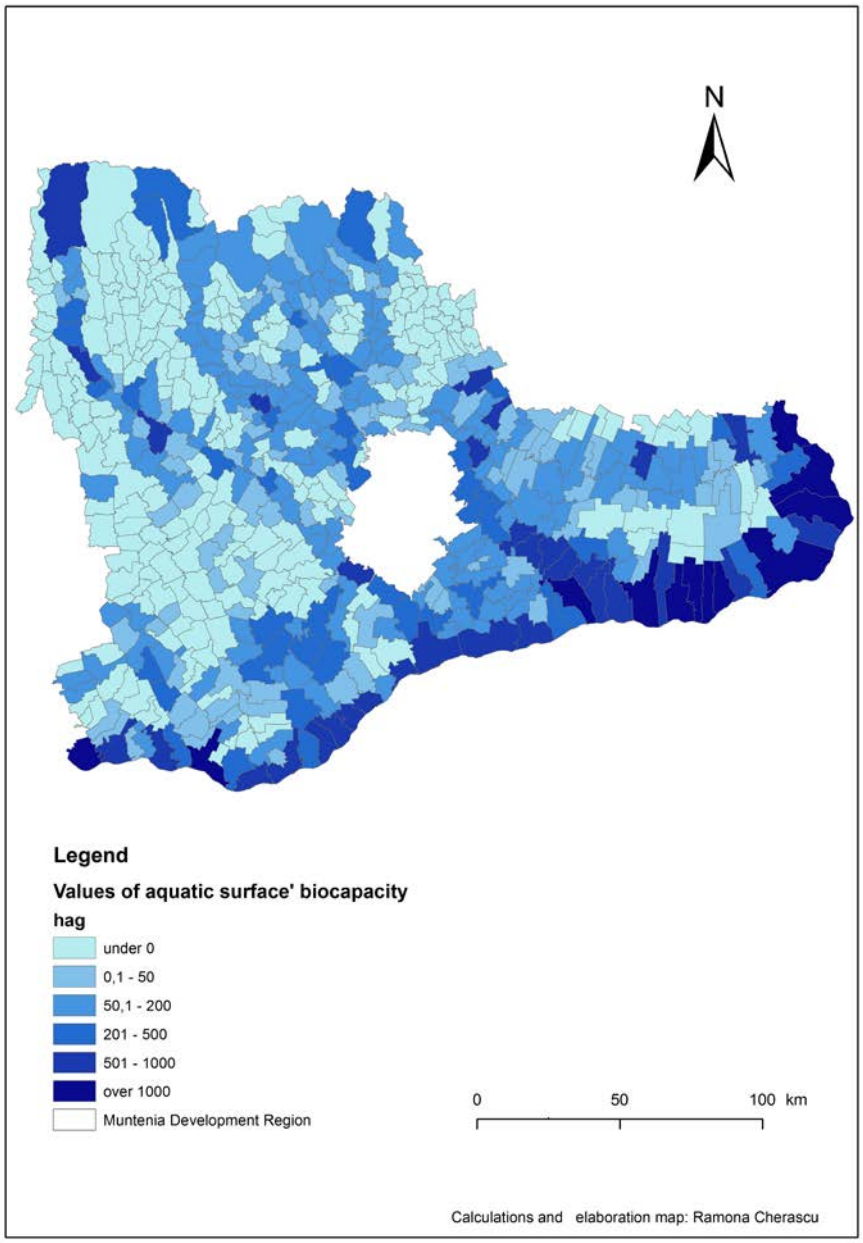

Figure 11: The values of aquatic land's biocapacity in the administrative territorial units of the Muntenia South Development Region.

Per capita, the average is 0.02 hag, being lower than the national average (0.10 hag/capita) or global average (0.18 hag/capita). The highest values, at the county level, are recorded in Călăraşi (27,150 hag), due to the Danube River and the lakes such as Mostiştea, Galaţi, Călăraşi, Iezerul, designated as special protection areas (for birds protection) as part of Natura 2000 network.

Related to the number of inhabitants, the highest values are recorded in Călăraşi (0.08 hag/capita), followed by Ialomiţa with 0.03 hag/capita and the lowest values in Prahova (0.005 hag/capita) and Argeş (0.007 hag) counties, because they are the most populated counties in the region. The highest values of aquatic surface are recorded in the following administrative territorial units: Dichiseni (4,396 hag), Rosetti (3,759 hag), Călăraşi (3,497 hag), Modelu (2,253 hag), due to the existence of the ponds of Danube River and Suhaia (1,917 hag), due to the Suhaia Lake, designated as Bird Protection Area. More than 230 administrative territorial units have a value of 0 hag.

In relation to the population size (Fig. 12), the highest values are registered in: Dichiseni (Călăraşi County) with 2.6 hag/capita, Giurgeni (Ialomiţa County), Suhaia (Giurgiu County) due to the presence of the Danube River and Suhaia Lake with 0.7 hag/capita, Ulmu (Călăraşi County) by 0.5 hag/capita due to the presence of Mostiştea Lake, Arefu Village located in the mountains, with a value of 0.38 hag/capita due to the existence of the Vidraru Lake on the Argeş River. Over 88.4% of territorial administrative units of the development region have a value under national average.

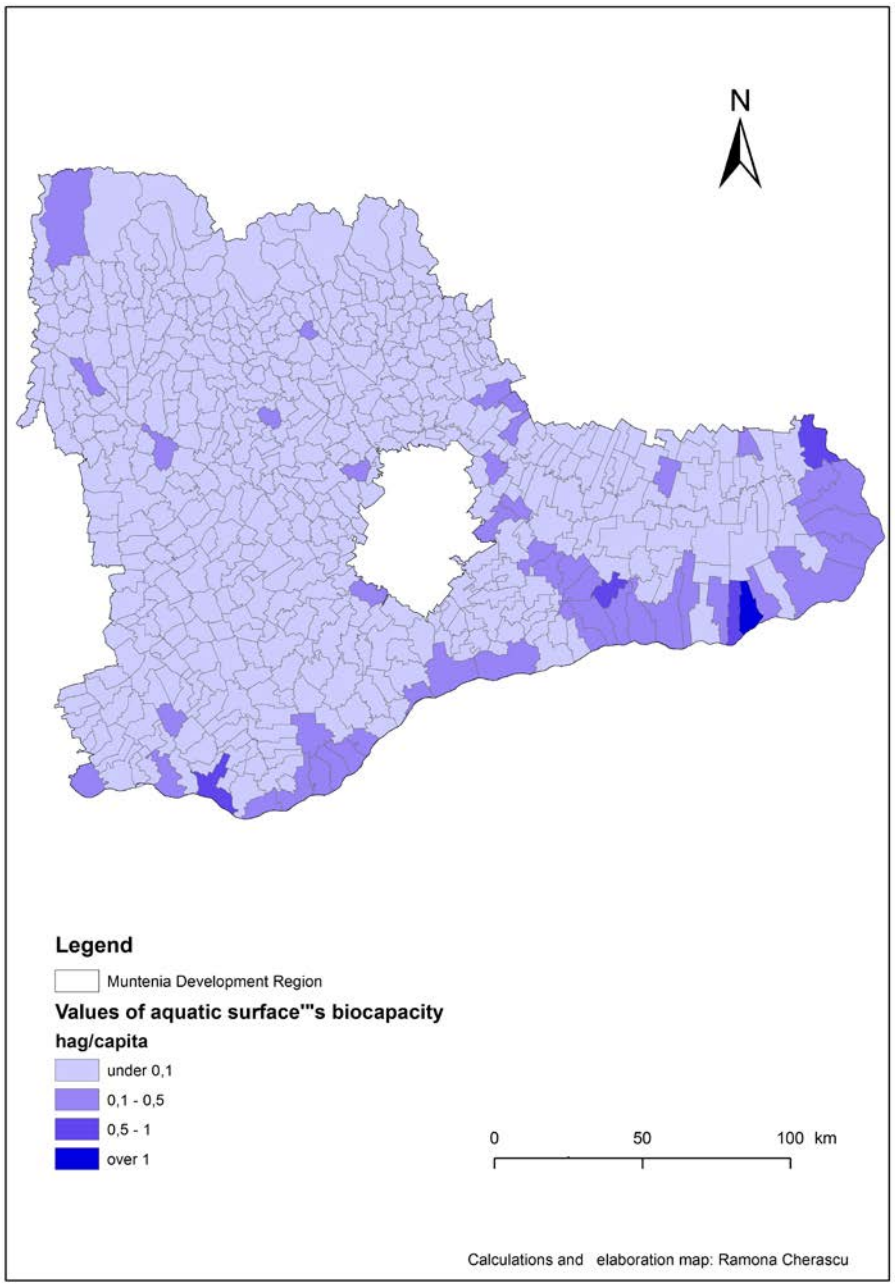

Figure 12: The values of aquatic land's biocapacity per capita in the administrative territorial units of the Muntenia South Development Region.

Built-up land represents the land occupied by infrastructure that arises from human intervention: transport network, housing, factories, etc.

The biocapacity value is 556.845 hag (Fig. 13) and related to the number of inhabitants, the average value is 0.17 hag/capita, being higher than the national average (0.14 hag/capita) as well as the global average (0.06 hag/capita).

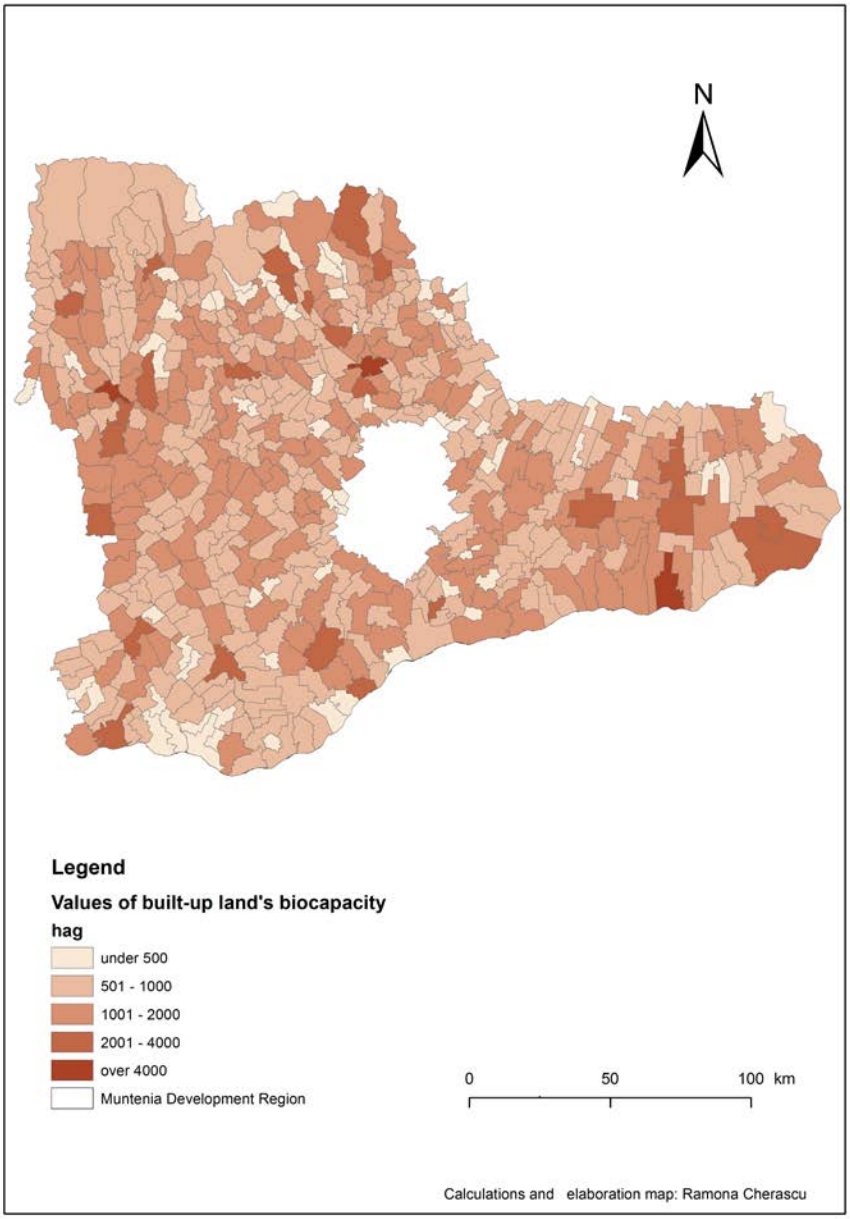

Figure 13: The values of built-up land's biocapacity in the administrative territorial units of the Muntenia Suth Development Region.

The highest values of built-up land are registered in the county municipalities: Ploieşti (8,084 hag), Călăraşi (5,551 hag), Piteşti (4,424 hag), Giurgiu (3,726 hag), Târgovişte (3,443 hag), values due to the infrastructure and housing. The lowest values are held by territorial administrative units: Provița de Jos (61 hag), Talea (210 hag), Mioarele (262 hag), Coşoba (276 hag), Ciomăgeşti, (279 hag) etc.

Related to the population size, the highest values of biocapacity per capita are recorded in Jugureni (0.98 hag/capita), Drăgoeşti (0.96 hag/capita), Ariceştii Zeletin (0.74 hag/capita), Balaci (0.69 hag/capita), Izvoarele (0.68 hag/capita) etc. It was noticed that 74% of the values are higher than the national average. The lowest values of biocapacity per capita are recorded in the communes: Provița de Sus (0.01 hag/capita), Provița de Jos (0.02 hag/capita) and in the cities Slobozia (0.01 hag/capita), Piteşti (0.02 hag/capita), Ploieşti (0.03 hag/capita), Târgovişte (0.03 hag/capita), Alexandria (0.04 hag/capita). Although biocapacity's built up land is higher in the cities, the resulting values are low due to the large number of inhabitants (Fig. 14).

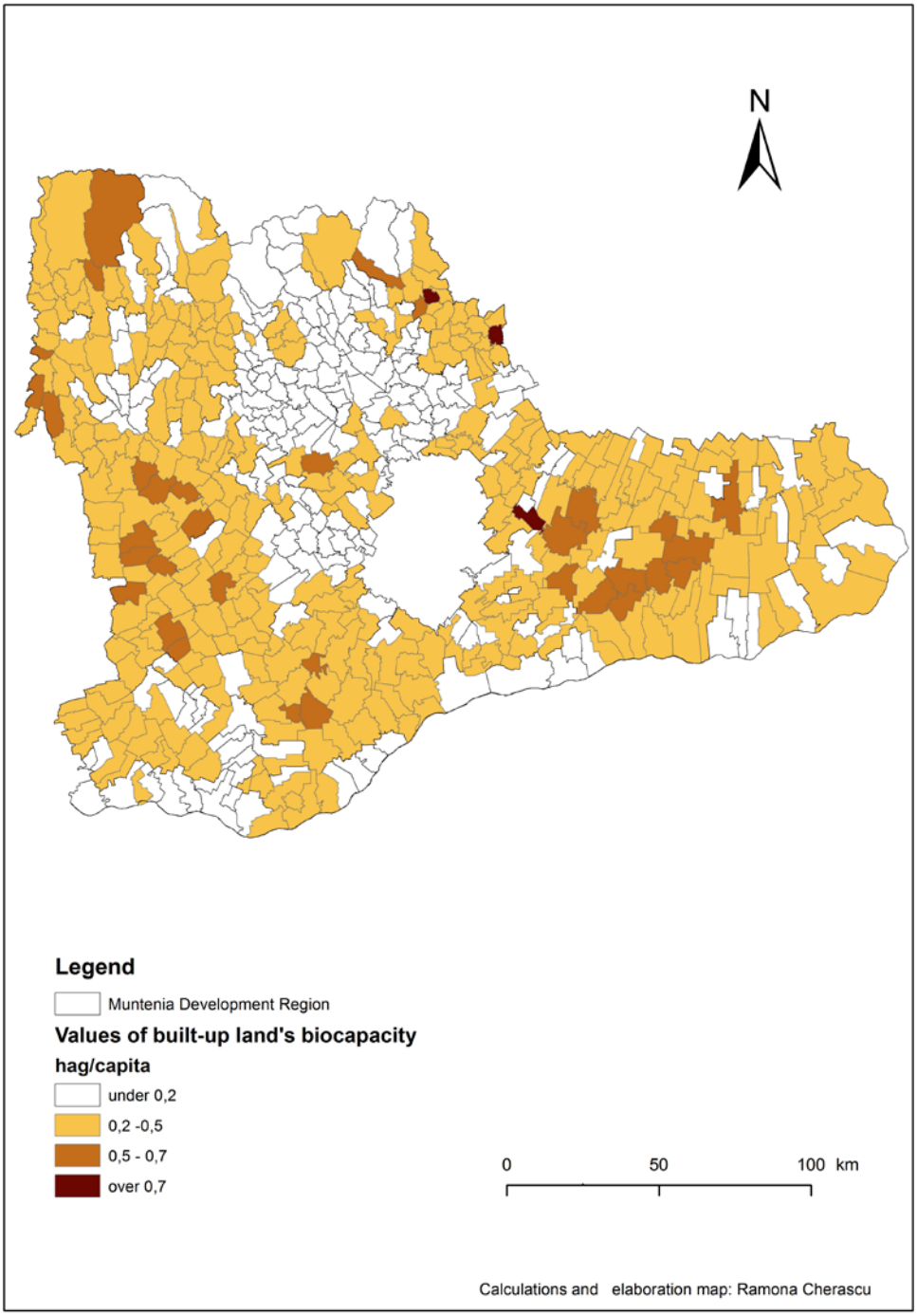

Figure 14: The values of built-up land's biocapacity per capita in the administrative territorial units of the Muntenia South Development Region.

The protected areas surface is 589,247 ha, 12.8% of the region. According to the analysis using the Corine Land Cover system, the largest surface of land is forest, covering an area of 289.732 ha (49.1%).

The protected area biocapacity is 920.194 hag (Fig. 15), representing 13.2% of the total biocapacity of the studied region.

Forest land has the highest value of biocapacity, followed by croplands with a value of 209,334 hag, grassland (51,935.9 hag), aquatic surface (42,442 hag) and built-up land (10,767.8 hag) (Fig. 16). The huge value of forest land demonstrates the importance of protected areas to maintain their biodiversity.

The protected areas are concentrated in the mountains or along the rivers. The territorial administrative units which are overlapping the surface of protected areas, generally have a value of 25,000-50,000 hag. It is noticed that territorial administrative units with a value of over 50,000 hag are not included in the protected areas.

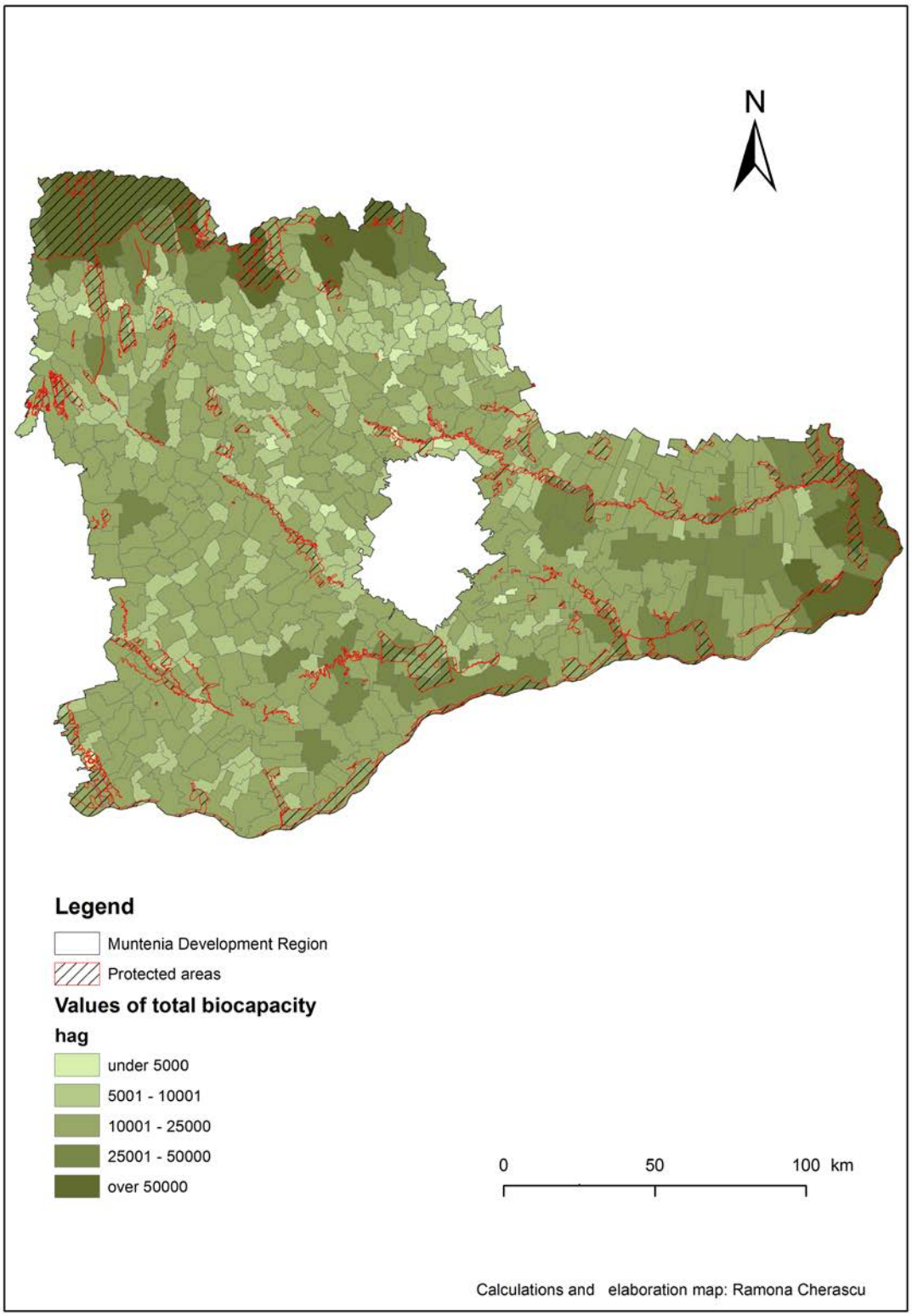

Figure 15: The values of biocapacity in the administrative territorial units related to protected areas of the Muntenia South Development Region.

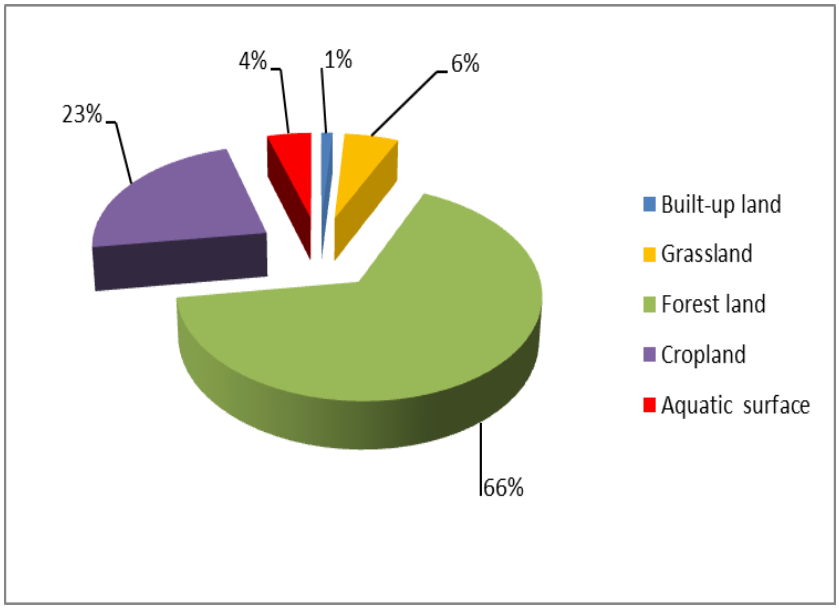

Figure 16: The percentage of biocapacity values for each productive areas in the protected areas of the Muntenia South Development Region.

The analysis shows that this value is registered in the areas that include mostly cropland with no biodiversity or with reduced biodiversity.

Analyses made on the land use between 1990-2006 shows that in the areas that were designated, Natura 2000 sites have had many changes. Between 1990-2000 the biggest changes occurred in the forest land and between 2000-2006 these changes were reduced.

Analyzing the overlapping with the territorial administrative units, it is noted that the highest concentration of biocapacity is found for the north of the region, in the mountain areas, along the Danube River and its wetlands, areas that were designated as Natura 2000 sites, including the largest: Făgăraş Mountains SCI, Borcea SPA or national and nature parks such as Bucegi Nature Park and Piatra Craiului National Park.

CONCLUSIONS

The results show that from the studied area, croplands have the highest biocapacity value, due to a large extent of Romanian Plain in the region.

The highest values of biocapacity are owned by territorial administrative units from Argeş County, but the hierarchy is changing related to the population size in the Teleorman and Călăraşi counties, because of the reduced population.

The highest values of biocapacity for the administrative units overlap with the surface of the protected areas due to the dominance of forest areas.

Compared to the population size the hierarchy changes in all productive areas, the lower value being in the mountain areas and also in the rural areas.

Calculation of biocapacity is one of the important methods to analyse the ecological footprint, one of the indicators of sustainable development. This indicator must be taken into account in the regional development plans, the National Sustainable Development Strategy as well as for the local environmental action plans.

AKNOWLEDGEMENTS

The author thanks Mrs. Pătroescu M. for her kind support in performing the above presented study.

SELECTIVE REFERENCES

Alcamo J. and Bennett E. M., 2003 – Ecosystems and human well being: a framework for assessment/ Millenium Ecosystem Assessment, World Resources Institute, Island Press, Washington, USA, 266.

Alexiu V., Stancu D. and Chiriţoiu M, 2011 – Arii protejate din judeţul Argeş, Edit. Universităţii din Piteşti, 80. (in Romanian)

Băltescu O., 2010 – Gestiunea durabilă a rezervaţiilor naturale din spaţiile montane - Studii de caz: Rezervaţia naturală Les Hauts de Chartreuse (Munţii Alpi Francezi) şi rezervaţia naturală Molidul de rezonanţă Lăpuşna (Munţii Carpaţi - grupa centrală), Universitatea din Bucureşti, 203. (in Romanian)

CCMESI, 2004 – Biodiversitatea, naturalitatea şi funcţionalitatea ecosistemelor din munţii Banatului. Protecţie, conservare şi gestiune socială, Raport CNCSIS, Universitatea Bucureşti, 29.

Davidescu D. and Florea N., 2004 – Ecological regionalization of the Romania Territory, *Proceedings of the Romanian Academy*, B, VI, 1.

Doniţă N., 1990 – Tipuri de ecosisteme forestiere din România, ICAS, II, Bucureşti, 391.

Doniţă N., 1997 – Harta forestieră a României, scara 1:500.000.

Ewing B., Reed A. and Wackernagel M., 2010 – Calculation Methodology for the National Footprint Accounts, Global Footprint Network, 19.

Gheorghe L., 2011 – Evaluarea amprentei ecologice în spaţiul Regiunii de Dezvoltare SV Oltenia, teză de doctorat, Universitatea din Bucureşti, 153. (in Romanian)

Guvernul României, Comisia Europeană, 1997 – Carta Verde a Dezvoltării Regionale, http://sites.google.com/site/dumitrusandu/CartaVerde_VarRomana.pdf?attredirects=0, 86.

Ingo M., 2007 – Protected Areas and Regional Development in Europe, Carl von Ossietzky University, Germany, 173.

Iojă C, Pătroescu M., Rozylowicz L., Popescu V. D., Vergheleț M., Zotta M. I. and Felciuc M., 2010 – The efficacy of Romania's protected areas network in conserving biodiversity, *Biological Conservation*, 143.

IUCN, 1994 – Guidelines for Protected Area Management Categories, 66.

Kapos V., 2008 – Carbon and Biodiversity: a demonstration atlas. UNEP World Conservation Monitoring Centre, Cambridge, UK, 24.

Minca E. and Petz K., 2008 – Ecosystem services and their mapping in the Tisa River basin – initial steps in Hungary and Romania, *Transylvanian Review of Systematical and Ecological Research*, 6, The Wetlands Diversity, Curtean-Bănăduc A. et al. (ed.), 87-96.

Mohan G., Ielenicz M. and Pătroescu M., 1986 – Rezervaţii şi monumente ale naturii din Muntenia, Bucureşti, Edit. Sport Turism, 208.

Phillips A., 2002 – Management Guidelines for IUCN Category V Protected Areas: Protected Landscapes/Seascapes, 9, 122.

Rodrigues R., 2003 – Global Gap Analysis: towards a representative network of protected areas, *Advances in Applied Biodiversity Science*, 5, 73-74.

Toniuc N. 1992 – List of protected areas in Romania, *Ocrotirea naturii şi mediului înconjurător*, 36, 1, 489-500.

*** 2010 – Living Planet Report 2010 Biodiversity, biocapacity and development, World Wide Fund for Nature, Zoological Society of London, Global Footprint Network.

*** Biodiversity Action Plan - halting the loss of biodiversity by 2010 http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/bio_brochure_en.pdf, 27.

*** (1983, 1984, 1987, 1992) Geografia României, vol I, II, III, IV, Edit. Academiei Române, Bucureşti.
*** Living Planet Report 2010 – Biodiversity, biocapacity and development, WWF International, 117.
*** Strategia UE pe Biodiversitate, 2010-2020, 17.
*** http://ec.europa.eu/environment/ nature/ natura2000
*** www.natura.org
*** www.defra.gov.uk

AUTHOR:

[1] *Ramona CHERĂSCU*,
ramona.natura2000@gmail.com
University of Bucharest, Faculty of Geography,
Doctoral School of Geography "Simion Mehedinţi – Nature and sustainable development",
Nicolae Bălcescu Boulevard 1,
Bucharest, Romania,
RO-010041.

MANAGEMENT OF THE ALIEN SPECIES *FALLOPIA JAPONICA* IN ROŞIA MONTANĂ AREA (TRANSYLVANIA, ROMANIA)

Oana DANCI [1]

KEYWORDS: Romania, Transylvania, alien species, impact, management measures.

ABSTRACT

The Japanese native species, *Fallopia japonica*, introduced into Europe as a decorative plant approximately 160 years ago, was frequently cultivated in parks and gardens. At the present time the species has spread throughout many European countries and is considered an invasive species. Due to the large ecological amplitude and multiplication strategy of the species, it occupies compact patches up to 500 m^2 in area, especially in riparian or disturbed places. On the basis of its ability to expand into new territories, *Fallopia japonica* was listed by IUCN as among 100 of the world's worst invasive alien species. The present study aimed to make an inventory and map the *Fallopia japonica* stands around the village of Roșia Montană, as well as to establish a management action plan to limit the distribution of the species. This is because the European environmental legislation does not contain precise provisions for the management of this species.

REZUMAT: Managementul speciei invazive *Fallopia japonica* în zona Roşia Montană (Transilvania, România).

Originară din Japonia, specia *Fallopia japonica* a fost introdusă în Europa ca specie decorativă în urmă cu aproximativ 160 de ani, fiind cultivată frecvent în parcuri și grădini. În prezent specia, din plantă cultivată, s-a răspândit sau a fost răspândită neintenționat în marea majoritate a țărilor din Europa ajungând specie invazivă. Datorită amplitudinii ecologice mari și a strategiei de înmulțire a speciei, ea ocupă în prezent suprafețe compacte chiar și de 500 m^2, în special în zone ripariene și zone perturbate de factori antropici. Datorită capacității ei de a invada teritorii noi, *Fallopia japonica* a fost listată de către IUCN printre cele mai rele 100 de specii invazive la nivel mondial. Prin intermediul acestui studiu am dorit inventarierea și cartarea suprafețelor cu *Fallopia japonica* din zona localității Roșia Montană și elaborarea unui set de măsuri de management pentru limitarea distribuției acestei specii, în condițiile în care legislația europeană de mediu nu are prevederi concrete în acest sens.

RÉSUMÉ: La gestion de l'espèce envahissante *Fallopia japonica* dans la région de Roșia Montană (Transylvanie, Roumanie).

Originaire de Japon, l'espèce *Fallopia japonica* a été introduite en Europe en tant qu'espèce décorative il y a près de 160 ans, étant fréquemment cultivée dans des parcs et des jardins. A présent, l'espèce n'est plus cultivée mais se répand par ses propres moyens dans la majorité des pays d'Europe. C'est à présent une espèce envahissante. A cause de sa grande tolérance écologique et de la manière dont l'espèce se multiplie, elle occupe à présent des surfaces compactes jusqu'à 500 mètres carrés, spécialement dans les zones ripariennes et les zones perturbées par des activités humaines. A cause de sa capacité d'expansion, *Fallopia japonica* fait partie de la liste IUCN des 100 espèces les plus envahissantes du monde. Par la présente étude, les auteurs ont souhaité inventorier et cartographier les surfaces occupées par *Fallopia japonica* aux alentours de la ville de Roșia Montană et fournir un plan de mesures de gestion dans le but de limiter la distribution de l'espèce, la législation européenne de l'environnement ne proposant rien à ce sujet.

INTRODUCTION

Fallopia japonica (Houtt.) Ronse Decraene var. *japonica*, known as Japanese knotweed is synonime with *Reynoutria japonica* Houtt., *Polygonum japonicum* Meissn., *Polygonum compactum* Hook. f., *Polygonum cuspidatum* Sieb. and Zucc., *Polygonum zuccarinii* Small, *Polygonum reynoutria* Makino, *Pleuropterus cuspidatus* (Sieb. and Zucc.) Moldenke, *Tiniaria cuspidata* (Houtt.) Hedb., *Polygonum sieboldii* Reinw. ex de Vries non Meissn., *Polygonum confertum* Hook. f., *Pleuropterus zuccarinii* (Small) Small, *Reynoutria yabeana* Honda, *Reynoutria uzenensis* (Honda) Honda, *Reynoutria japonica* var. *uzenensis* Honda, *Reynoutria hastata* Nakai, *Tiniaria japonica* (Houtt.) Hedb., (Alberternst and Böhmer, 2011).

Japanese knotweed is a perennial plant reported to have been introduced into Europe from Japan in the early to mid-1800's as an ornamental stabilisation plant or cattle fodder. Escapes were reported from the mid 19th century, with naturalisation occurring in many places by the late 19th century. Due to the subsequent spread of this invasive weed, *Fallopia japonica* is now established alongside railways, canals, rivers, streams, roadsides, and areas of human disturbance such as waste tips. It is widespread in the British Isles and many European countries. It has also become a problem in the USA, Canada, Australia, and New Zealand (Beerling et al., 1994).

Due to the species capacity to colonise new territories in short time and it's life reproduction strategy, *Fallopia japonica* is among 100 of the world's worst invasive alien species (IAS).

Japanese knotweed has vigorously invaded natural habitats and out competes native plants. Japanese knotweed forms tall thickets that exclude all other vegetation, shading the area below. Native plants can struggle to compete with this invasive species, and local plant biodiversity is reduced. Rivers, hedgerows, roadsides and railways form important wildlife corridors for native plants and animals to migrate and disperse along. Large infestations of Japanese knotweed can block these wildlife corridors.

To mitigate the invasion of *Fallopia japonica* requires adequate management at both the domestic and international level. The basic management measures needed are education about *Fallopia japonica* ecology, distribution and the affected ecosystems.

MATERIAL AND METHOD

The study area of this paper is Roșia Montană area (the villages Roșia Montană, Corna and Cărpiniș), in Alba County, Transylvania, Romania. The very rich mineral resources of this area have been exploited since the Dacians time, over 2000 years ago. This lead to extensive modifications of the environment and, in time generated anthropically disturbed sites. These sites represent perfect habitat for invasive alien species accommodation.

We conducted this survey in July and August of 2011, in the previously mentioned area. The method used requires an elaborate data collecting fact sheet and identification of the species at the site using the field guide of Ciocârlan (2009). Mapping using a GPS Garmin Dakota 10, measures the surface and notes additional information regarding the vegetation structure and other environmental problems. Data collected in the field was analysed in the office using an open source GIS programme, and a distribution map of invasive alien species *Fallopia japonica* was created. We also analysed the European legislative framework related to invasive alien species control and management.

After completing data interpretation and a impact assessment of the species. We establisehed some general and specific management measures and recommendations.

RESULTS AND DISCUSSION

Species description

Fallopia japonica is a herbaceous perennial with annual, tubular, glabrous stems that ascend from an erect base. Stems arise from strong rhizomes to form a dense thicket. The plants grow in spring (main growing period is May to June) very quickly and reach a height up to three meters. Where introduced, *F. japonica* is generally taller than in its native range in Japan where it is recorded as being 0.3-1.5 m tall (Makino 1997, in Alberternst and Böhmer, 2011). The stems are light green, often with reddish flecks, or reddish-brown, simple to minimally branched, weakly woody, hollow and swollen at the nodes. The top of the stems and the branches often arches over and twigs often zig-zag slightly from node to node. The ochrea sheathes and the stem above each node is usually fringed at the top. The leathery, broadly ovate leaves are usually 10-15 (18) cm long, sometimes wider than long and up to 13 cm wide. Leaves appear usually without trichomes on the veins of the underside of leaves. At the base of each petiole is a small gland that functions as an extra-floral nectary (Alberternst and Böhmer, 2011).

Japanese knotweed is in its native range gynodioecious (hermaphrodite flowers (male fertile) and female flowers (male sterile) are located on separate plants) and flowers from (July) August to September (October). Plants have male flowers with vestigial ovaries and 8-9 anthers, and female flowers with infertile stamens (staminodes). The panicles are axillary on upper stems, up to 15 cm long (longer in fruit), with small cup-like bracts at nodes, branched, open, lax, with numerous flowers. Tepals are 5 (6), more or less fused at the base, +/- white, 2-8 (9) mm long, outer 3-keeled. The fruits are shiny, dark brown triangular nuts (achenes), 2-4 mm long. It should be noted that only female clones have been introduced into Europe and North America (Alberternst and Böhmer, 2011).

Knotweeds are functionally dioecious. Flowers are exclusively entomophilous. Only one *Fallopia japonica* var. *japonica* female clone has been introduced and spread over Europe, earning the nickname “world’s largest female”. The number of flowers per stem exceeds 190,000; they can be fertilised by the pollen of *F. sachalinensis*, resulting in *F.* × *bohemica*, or by a congeneric climber *F. aubertii*, in which case only a low percentage are fertilized and seedling establishment is inefficient. When seed is produced, the winged achenes are dispersed by wind and water (Pyšek, 2006).

Fallopia japonica is a perennial plant (hemicryptophyte) and reproduces mainly vegetatively. Sexual reproduction occurs rarely in the alien range. The plant reproduces predominately via rhizomes that grow horizontally and have reduced leaf scales at about two to four centimeters intervals. On the lower side adventitious roots are growing into the soil. The thick and extensive rhizomes store large quantities of carbohydrates. Rhizomes are often five-six m long, but a length of up to 20 m is documented. Rhizomes grow up to one m laterally within a single vegetation period. Rhizome fragments of some centimetres can produce new plants (Alberternst, 1995). Rhizomes buried to soil depths of two meters are able to regenerate. An experiment showed that a rhizome fragment of 130 g and a diameter of two centimeters can penetrate a soil layer of 1.5 m within a single vegetation period (Alberternst, 1995). Rhizomes are even able to penetrate an asphalt layer.

The amount of seed set differs: some plants produce plenty of seeds; in some stands seeds are minuscule. Because of the lack of *F. japonica* pollen, seeds are usually of hybrid origin (Bailey, 2000). *Fallopia* seedlings occur rarely. Seedlings have been observed e.g. in Germany by Kosmale (1981), Schwabe and Krachtochwil (1991), Adler (1993), and Alberternst (1995, 1998) (Alberternst and Böhmer, 2011).

In our study area, *Fallopia japonica* was found on riverbanks, along roads and in sandy areas on Roșia and Corna valleys. It

was about two meters tall and forms compact monospecific surfaces in many cases, with medium density of 50 stems/m^2. Many plant were steel in flower in this period. We noticed that *Fallopia japonica* occupied the territory that used to be covered by alluvial forests with *Alnus incana*, affecting the regeneration capacity of alder.

In many cases, *Fallopia japonica* was situated close to another invasive alien species *Impatiens glandulifera*, especially on Roșia Valley (Fig. 1).

Figure 1: *Fallopia japonica* on Roșia Valley, Roșia Montană area (Danci, 2011).

European legislation

According to data provided by Flora Europaea, the Japanese knotweed is distributed in 22 countries as extensively naturalised species. Its impact is both an ecological and economical one, no specific measures for eradication and spread control have been taken at a global level.

The Global Strategy for Plant Conservation published by the Secretariat of Convention on Biological Diversity (CBD) recognizes that plants are endangered by a combination of factors: over-collecting, unsustainable agriculture, forestry practices, urbanisation, pollution, and land use changes. One of the targets in the strategy for 2010 was to design "Management plans in place for at least 100 major alien species that threaten plants, plant communities and associated habitats and ecosystems". This target was considered as a first step towards developing management plans for all major alien species that threaten plants, plant communities and associated habitats and ecosystems. Such species are by nature a global problem that no single country can solve on its own. Increased cooperation and effective measures adopted by all affected countries is needed.

The CBD Conference of the Parties COP 6 Decision VI/23 reaffirm the importance of national and regional invasive alien species strategies and action plans, and of international collaboration to address the threats to biodiversity of invasive alien species, and urgent need for funding to implement existing strategies.

CBD also enhances cooperation between the various sectors, including the private sector that might provide pathways or vectors for the unintended transfer of invasive alien species. In order to improve prevention, early detection, eradication and/or control of invasive alien species and in particular ensure communication between focal points of respective relevant international instruments.

Due to the large scale distribution of *Fallopia japonica* in Europe and particularly in Ireland and Northen Ireland, the Environment Agency recongnised the danger of alien species and designed Best Practices Management Guidelines for Invasive Alien Species and informative materials related to the most common aspects and common questions.

Romanian National Biodiversity Strategy and Action Plan for 2010-2020 presents a target for the control of the invasive alien species, and it recognises that at the national level there is no record as to the number and impact of invasive alien species. The objectives of the strategy for the next period regarding the control of invasive alien species would be: prevention of intended or unintended alien species introduction, rapid detection and identification of new species, quick reaction at introduction of invasive alien species, management of naturalised species and prevention of their areal enlargement.

The *Fallopia japonica* distribution map (Fig. 2), designed using open source QGIS programme, include 86 locations, situated on both valleys Roșia and Corna. The surface of the 86 patches are in between 10 and 200 m^2. Almost all the patches were situated on riverbanks, along road and close to human houses.

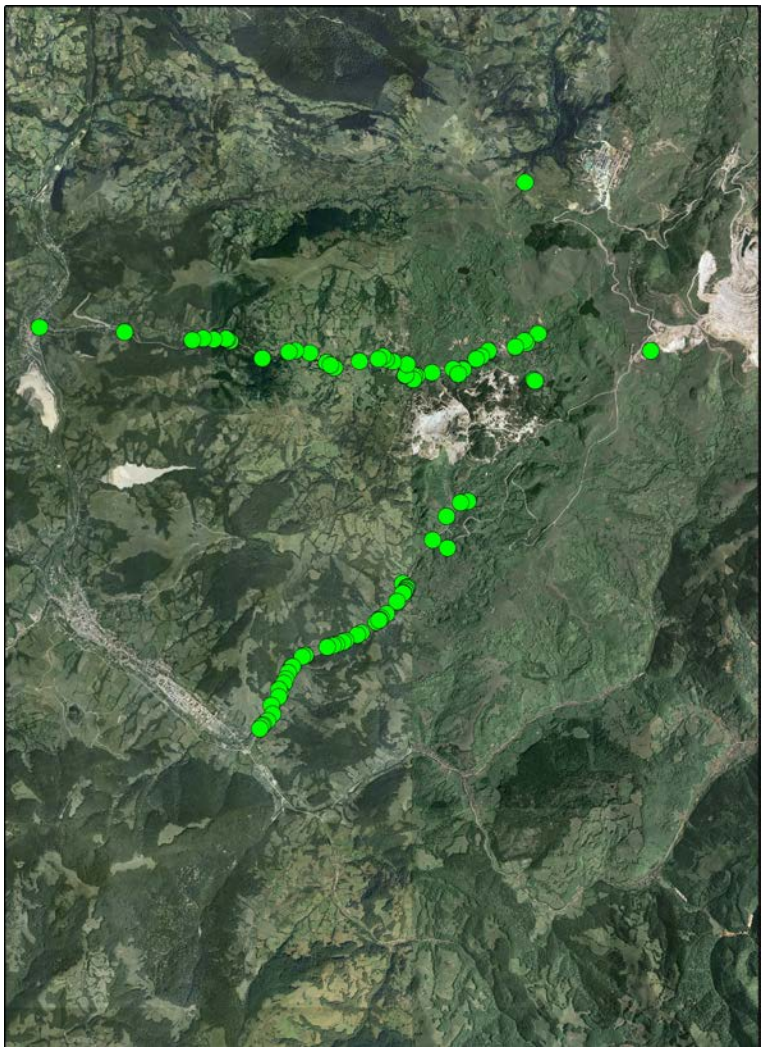

Figure 2: *Fallopia japonica* distribution map in Roșia Montană area.

Local impact

Japanese knotweed has vigorously invaded natural habitats and out competes native plants, especially the riparian ones. *Alnus incana* communities are in a capacity of regeneration as long as the *Fallopia japonica* communities are compact. It excludes all other vegetation, shading the area below. Native plants can rarely compete with this invasive species and local plant biodiversity is reduced. Rivers, hedgerows, roadsides and railways form important wildlife corridors for native plants and animals to migrate and disperse along, and large infestations of Japanese knotweed can block these routes for wildlife (Kelly et al., 2008).

Investigations conducted by Alberternst (1998) show that the number of plant species in vegetation transects with *Fallopia* are lower than in transects without the species. Japanese knotweed is capable of invading and forming dominant stands at almost any vegetation of perennial herbs and ruderal sites, especially in sunny places. In shaded sites, its competitive capacity is much weaker.

Due to the fact that the native plant composition is affected, and the shade level is increased, also *Fallopia japonica* communities installed on riverbanks can modify the aquatic biodiversity in the neighboring water streams.

Japanese knotweed can have economical impact, causing damage to buildings, hard surfaces and infrastructure. Once established underneath or around the built environment, it can be particularly hard to control, growing through concrete and tarmac and other hard standings.

When Japanese knotweed is established on riverbanks, it can damage flood defence structures and reduce the capacity of channels to carry flood water. Also it can have a negative impact on reducing ecosystems services as flood prevention service, carbon sequestration and landscape function.

Without management measures the spreading capacity of *Fallopia japonica* may influence and impact the changing local ecosystem, up to the regional and potentially global ecosystems.

Management measures

Establishment can be prevented by monitoring the introduction of *Fallopia japonica*. New plants should be removed manually. Soil containing *Fallopia* fragments should not be used as fill dirt e.g. for pathways, streets and fastenings. After mowing, Japanese knotweed plant material must be removed from the area. It should be composted by at least 70°C (Alberternst, 2011).

Adler (1993) observed that mowing for several years in succession transforms dominant stands of Japanese knotweed into diverse communities.

Horses and cattle like to feed on young leaves of *F. japonica* but this also affects the growth of native riverside woody species. In the opinion of the agencies concerned, browsing by sheep is the most effective and least expensive control method in large sized areas of vegetation along non-natural sectors of streams.

Chemicals such as Round-up (glyphosate) was applied in Europe. This herbicide effectively removes the vegetation from the area of application, but its use is prohibited in the immediate proximity of surface waters, so it is not aplicable in our case study. Moreover, stands of *F. japonica* need to be re-treated because of the high resistance of the rhizomes. An environmentally adequate alternative is to inject the herbicide (1:1 with water) into the large pith cavities of the basal internodes of the stem. This treatment also needs to be repeated in the following year, and is required to maintain a distance of five to ten meters from the watercourse (Alberternst and Böhmer, 2011).

Management efforts should be combined with information to the local inhabitants to ensure acceptance of the measures and to prevent new plantations or escapes.

CONCLUSIONS

Fallopia japonica is an invasive alien species whose management and control are difficult and expensive. Due to its rapid invasive potential, high capacity of regeneration, spreading and it's ecological amplitude. It has an increased negative ecological and economical impact. Its spread in floodplains can cause damages to indigenous habitats and plant communities (especially *Alnus* associations which have an important role in flood protection and control) (Dumitrașcu, 2012).

Main water courses in Roșia Montană area, Roșia and Corna valleys, were affected by the invasive alien species *Fallopia japonica.* 86 locations with Japanese knotweed were mapped in the area in 2011.

Measures of prevention, eradication, control, monitoring and public awareness should be taken.

A Romanian national database with invasive alien species and their distribution and a national action plan will help authorities, institutions and local communities to act appropriately in order to face the problem of this invasive alien species.

AKNOWLEDGEMENTS

The author thank to the colleagues from Wildlife Management Consulting for the field activity support and also to the *Acta Oecologica Carpatica* scientific series editors for their help.

REFERENCES

Alberternst B. and Böhmer H. J., 2006 – Invasive Alien Species Fact Sheet - Fallopia japonica, Online Database of the North European and Baltic Network on Invasive Alien Species-NOBANIS, www.nobanis.org

Alberternst B., Konold W. and Böcker R., 1995 – Genetische und morphologische Unterschiede bei der Gattung Reynoutria, in Böcker R. et al. (eds), Gebietsfremde Pflanzenarten: Auswirkungen auf einheimische Arten, Lebensgemeinschaften und Biotope. Kontrollmöglichkeiten und Management, Landsberg, 113-124. (in German)

Bailey J. P. and Conolly A. P., 2000 – Prize-winners to pariahs - A history of Japanese Knotweed s. l. (Polygonaceae) in the British Isles, *Watsonia*, 23, 93-110.

Beerling D. J., Bailey J. P. and Conolly A. P., 1994 – Fallopia japonica (Houtt.) Ronse Decraene, Biological Flora of the British Isles, *Journal of Ecology*, 82, 959-979.

Best practice management guidelines – Japanese Knotweed http://invasivespeciesireland.com/wp-content/uploads/2011/09/Japanese-knotweed-BPM

Ciocârlan V., 2000 – Flora ilustrată a României, Pteridophyta et Spermatophyta, Edit. Ceres, Bucureşti. (in Romanian)

Convention on Biological Diversity, https://www.cbd.int/doc/legal/cbd-en

DAISIE, 2005-2008 – FP6 Project - Delivering Alien Invasive Species Inventories for Europe (DAISIE), 2005-2008, European Commission www.europe-aliens.org/

Dumitrașcu M., Kucsicsa G., Grigorescu I., Dragotă C. S. and Năstase M., 2012 – Forum geografic, *Studii și cercetări de geografie și protecția mediului*, XI, 1, 45-53. (in Romanian)

Flora Europaea, http://rbg-web2.rbge.org.uk/cgi-bin/nph-readbtree.pl/feout?FAMILY_XREF=&GENUS_XREF=Reynoutria&SPECIES_XREF=&TAXON_NAME_XREF=&RANK=

Global Invasive Species Database, http://www.issg.org/database/species/distribution.asp?si=91&fr=1&sts=tss&lang=EN

Global Strategy for Plant Conservation, http://www.cbd.int/iyb/doc/prints/factsheets/iyb-cbd-factsheet-gspc-en.pdf

Invasive Alien Species in Northern Ireland http://www.habitas.org.uk/invasive/species.asp?item=3762

Ireland invasive alien species field guide, http://invasivespeciesireland.com/wp-content/uploads/2010/11/Field_guide_to_invasive_species_in_Ireland_booklet.pdf

Măruță E., 1994 – Seedling establishment of Polygonum cuspidatum and Polygonum weyrichii var. alpinum at high altitudes of Mt. Fuji, *Ecological Research*, 9, 205-213.

Pysek P., 2006 – Fallopia japonica. Delivering Alien Invasive Species Inventories for Europe (DAISIE), available from: http://www.europe-aliens.org/pdf/Fallopia_japonica.pdf

Sîrbu C. and Oprea A., 2011 – Plante adventive în flora României, Edit. „Ion Ionescu de la Brad", Iaşi, 737.

Strategia Naţională pentru Biodiversitate şi Planul de Acţiune, 2010. (in Romanian)

AUTHOR:

[1] *Oana DANCI*

oanadanci@gmail.com

Maramureș Mountains Nature Park Administration,
22 Decembrie Street 20,
Vișeu de Sus, Maramureș County,
România, RO-435700.

SIBIU ECOLOGICAL BENCHMARKS/ SIBIU REPERE ECOLOGICE

− REVIEW −

Doru BĂNĂDUC [1]

Bucșa Corneliu and Costea Marioara (eds) and the authors Curtean-Bănăduc A. (chapters VIII, IX), Benedek A. M. (chapter VII), Bucșa C. (chapters VIII, X, XVIII), Costea M. (chapters I-V, XI-VIII), Drăgulescu C. (chapter VI), Gheoca V. (chapter VII), Mărginean G. (chapter VII), Schneider-Binder E. (chapters VI, VIII), and Tăușan I. (chapter X) 2011, Sibiu Ecological Benchmarks/Sibiu Repere Ecologice, 207 pages, published in Romanian by "Lucian Blaga" University Publishing House, Sibiu, Romania, ISBN 978-606-12-0264-5.

This publication is structured in 13 main sections (Urban territorial system of the municipality of Sibiu – location and limits, Analysis and evaluation of geomorphologic conditions, Climate potential, Water resources and hydrological characteristics, Soils conditions – favorability and restrictivity, Sibiu and its surroundings vegetation, Aspects of fauna, Areas of conservative interest, Aspects regarding the aquatic ecologic systems management, Urban and nearby green areas, The landscape – synthesis of interferences between natural and anthropic, The geographical space vulnerability at natural phenomenon with risk character, SWOT analysis and the environment conditions optimization).

Beginning with the prologue of this publication, the authors emphasize that the research conducted for their work is centered on the sustainability concept. The authors started from the premise that the environment is a system that also incorporates the man. It is underlined that the environment was deeply transformed as a result of economic development and human society urbanization. In the last two decades, the ecological and sustainable development principles were more and more asserted. These are demands that should also be kept in mind in the realization of landscape and urban development strategies. Thus, in this work, the authors point out that the natural and man-made resources must be capitalized with high efficiency, but also with responsibility, in this way contributing to the local community welfare, the mitigation of dysfunctions appeared in the environment, but also to the protection and conservation of unchanged environment conditions for the benefit of future generations. This requires first an awareness of the decisional factors and the population regarding the environment sustainable capacity and the way in which intensive and irrational exploitation of resources can lead to major environment unbalances, with negative effects on human welfare and health. In this view, the use of resources and environment conditions capitalization can be made to a level known as environment support capacity – a balance between the multitude of resources and the way in which they are used.

The town of Sibiu and its surroundings represent a fairly rare case of relatively good historical knowing of their evolution in time, a context respectively provided by the variation of products and services offered by the natural and semi-natural ecologic systems from locality perimeter as well as from nearby areas. In this almost uninterrupted historical context, this work is a welcomed informational link based on which the Sibiu inhabitants can view with relative confidence the sustainable development of their city and its nearby areas.

In the General Urbanistic Plan 2009 and the development strategy for environmental problems of the Sibiu area administration for the next period, in the elaboration of which contributed the members of Ecology and Environment Protection Department, Applied Ecology Research Centre, Faculty of Sciences of "Lucian Blaga" University of Sibiu, harmonization of all environment factors represented the main imperative and the basis for the development of this technical publication whose necessity also results from the rarity of this type of publications at a national level, but not only.

The environment factors were analyzed on natural background components at regional and local level that "represents the sustaining matrix for landscape and urban development strategies and also the object of human activities and human induced changes".

In the view of a balanced and sustainable territorial development of Sibiu area geologic substratum characteristics, the relief and actual geomorphologic processes were outlined that by expansion and way of manifestation can influence in one way or another the human habitat and economic activities.

In the book there were also addressed different human intervention scenarios about geomorphologic ensemble, basic processes at rocks level and those complex at the relief form level that can change their action mechanism and determine risk situations. In this context, the areas associated with Cibin River meadow, terrace shoulders and Guşteriţa Hill sides were especially aimed.

The authors identified the possible unbalances in Sibiu area hydro-atmospheric system that can lead through a waterfall effect to geomorphologic, pedological, ecological, and economical unbalances etc. These identifications were based on data associated with air mass dynamic, temperature regime, pluviometry regime, water flow, climate and hydrologic parameter extreme analysis. The data is also analyzed in the context of the use in environment protection and landscape fields. There are several risk situations avoidance scenarios underlined, through a durable administration of the territory and also through territorial improvement measures not only in Sibiu locality administration limits, but also in the entire area of Cibin hydrographic basin upstream from Sibiu.

In addition, the soil is viewed in a significant way, which due to its structural characteristics of texture and fertility, imposes a variety of spatial and temporal conditions in exploitation. Topoclimate conditions, underground water resources and edaphic factors with a role in repartition, development and dynamic of some species and natural and semi-natural habitats and in space exploitation are outlined.

Based on the actual ecologic state analysis of the primary water flows and the stagnant waters from the administrative area of Sibiu city, management measures were identified according with sustainable development principles of aquatic systems in urban areas.

The vegetation, especially the forestry one, is identified as responsible for the creation of a favorable bioclimatic environment for Sibiu and for the landscape diversification and functional zoning of urban and nearby areas. The moderation of the meteorological and climate extremes, stopping erosion processes, the atmosphere purification, sheltering of fauna, development of forestry ecosystems, etc., are just some of the identified ecologic functions of Sibiu forests.

In this publication the biotic factors are emphasized as being some of the most important environment factors through their ecosystems control factors quality. Elements connected with competition for food, light, humidity, food chains, populations, behavior etc., were approached, all of this proving to determine direct or indirect relations between species and their habitats, including those referring to human living, pleasure, production activities etc., of Sibiu locality. These types of relations were considered in the context of a future sustainable area arrangement.

The inventory of a relatively large number of species, from some important systematic groups, especially of some valuable considered species, as well as the habitat evaluation were approached as necessary actions for biodiversity protection and conservation in the concerned area. With a view for protection and conservation of some inventory species and habitats, the work also foresights a valuable series of management measures, including the establishment of protected areas.

Along this work it is also underlined the role of man as a beneficiary of the environment factors quality, as well as an environment disturbance factor. The work specifies that especially in the last century the human fingerprint on the land was very powerful, this being of course a consequence of the economic development and space and functional evolution of the town.

The work underlines the town expansion in the detriment of green spaces and corridors, the increased pressure on the forestry areas from the town border and on the water hydrographic chain, of whose very important role in the making of a bioclimatic comfort for the population diminished significantly.

The identification and presentation of elements of direct and indirect lack of harmony in the relationship between human and nature, proposal and motivation of some optimization measures of this report in the context of ecologic principles respect were first-hand elements of the multidisciplinary studies that this complex study relied on.

We congratulate the authors of this work with a strong informative and applied character and we express our hope that an increasing number of PUGs at a national level will benefit from a scientific support of this type, in the hope of returning our localities to the living and urban development models that would permit a healthy and pleasantly life, as well as an emotional and psychological balance of its inhabitants.

The present work proves that environmental sciences far exceeded the theoretic zone and gained important practical connotations – applicable to the human society. The systematic, integrator approach, scientific motivation, but also the explicitly applied side of this study are attributes that recommend it as a useful and interesting work for students, experts from environment and landscaping fields, architects, city administrative personal, etc. The work is equally relevant to the inhabitants of Sibiu city who are directly interested in seeing their town in harmony with the welfare and also with that element that in the end represents the difference between the happiness and unhappiness of its inhabitants – nature.

REVIEWER:

[1] *Doru BĂNĂDUC*
ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu, Faculty of Sciences,
Department of Ecology and Environment Protection,
Applied Ecology Research Center,
Dr. Ioan Rațiu Street 5-7,
Sibiu, Sibiu County,
Romania, RO-550012.

WATER QUALITY ASSESSMENT OF THE CRIŞUL REPEDE RIVER USING MAYFLIES LARVAE AS BIOINDICATORS (INSECTA, EPHEMEROPTERA)

− REVIEW −

Mălina DUMBRAVĂ-DODOACĂ[1]

Petrovici Milca, 2009, Water quality assessment of the Crişul Repede River using mayflies larvae as bioindicators (Insecta, Ephemeroptera), 273 pages, published by Oradea University Press, Bihor, Romania, ISBN 978-973-759-978-0.

The present publication is structured in six major sections (Introduction, Materials and methods, Results and discussions, Conclusions, Abstract and Bibliography) and nine chapters. Overall, the book presents the water quality evaluation of Crişul Repede River using benthic invertebrates such as mayflies larvae, as well as their importance for water bodies, resulting in a complex study conducted over a period of two years.

The first section of this publication − Introduction − includes the tracked objectives, a number of aspects regarding mayflies role in lotic ecosystems, along with the progress on national and international research. This section includes three chapters. Chapter 1, which provides detailed data on population role for biocoenosis in the hierarchy of biological systems. Chapter 2 describes the secondary production and its significance for the transfer of matter and energy flow through lotic ecosystems, history studies for the secondary production worldwide and at national level, the methods used to determine the secondary production and detailed information on the relationship between production and biomass. Chapter 3 describes the main features of the investigated aquatic ecosystems: geomorphological structure, network characteristics of Crişul Repede River basin, climatic characterization of the river basin, soil, vegetation and algae communities, location and description of the sample collecting sites.

The second section − Materials and methods − includes general aspects of the sample collection program, equipment and methods, the frequency of collection, water physical-chemical parameters, the methods used for processing samples in the laboratory (extraction and identification of benthonic fauna, granulometric analyzes, analyzes of organic substances in the sediment, larval growth experiment under laboratory conditions, assessment of the secondary production, biometry, calculation of the secondary production and size classes) and also the statistical methods (density, abundance, frequency, diversity, equitability, mortality factor, spatial distribution).

The third section − Results and discussion − provides information on physical and chemical parameters of water and sediment in the investigated rivers (water velocity and hydrological variations, hydrological regime of the Crişul Repede River and its tributaries), benthic macroinvertebrates community (benthic macroinvertebrates community structure and diversity, seasonal and annual dynamics of the benthic groups). There are also included a number of aspects concerning the structure and dynamics of mayflies populations in the investigated area, together with secondary production of the studied populations and life cycle of the mayflies dominant species in the investigated river basin, with detail information on structure size classes of the identified species.

The fourth section – Conclusions − outlines the importance of mayfly larvae in the present study and explains how the diversity modifications regarding this species may produce changes in secondary production for lotic ecosystems.

Finaly, the sections Abstract and Bibliography summarize the contents and the results obtained throughout the entire study and introduce the literature sources used for this research.

This publication offers a wide variety of information on this issue considered to be of international concern. It is based on an extensive study, this topic being appreciated both nationally and worldwide. Its applicability and accuracy provide valuable information in the evaluation of water quality using benthic organisms.

This publication can be used by specialists in the field, students or decision makers, government agencies, along with local authorities and communities.

REVIEWER:

[1] *Mălina DUMBRAVĂ-DODOACĂ*
malinadumbrava@yahoo.com
West University of Timişoara,
Faculty of Chemistry, Biology and Geography,
Department of Biology and Chemistry,
Pestalozzi Street 16A,
Timişoara, Timiş County,
Romania, RO-300115.

TRANSYLVANIAN REVIEW OF SYSTEMATICAL AND ECOLOGICAL RESEARCH 13 (2012) − THE CEFA NATURE PARK

− REVIEW −

Oriana HURDUGAN-IRIMIA [1]

Curtean-Bănăduc Angela, Bănăduc Doru and Sîrbu Ioan, 2012. Transylvanian Review of Systematical and Ecological Research, 13 − The Cefa Nature Park, 212 pages, "Lucian Blaga" University Publishing House, Sibiu, Romania, ISSN 1841-7051.

The nature park is situated on the Romanian-Hungarian national border and it is part of the Tisa River catchment, in the Crișul Repede River basin, in the Pannonic Biogeographical Region.

The particular importance of this protected area results from the presence of salty soil surfaces rich in plant and animal species adapted to salt. The maintenance of this landscape within the Pannonic-Bulgarian bird migration corridor, representing one of the most important areas in western Romania for feeding, refuge and nesting for a remarkable variety of birds per unit of area, shows that interaction between man and nature has not eroded the area's initial biodiversity values.

The 15 papers in volume 13 of *Transylvanian Review of Systematical and Ecological Research* explore the aquatic vegetation richness (two papers), the park's habitats and flora (one paper), the aquatic invertebrates (four papers), the epigeal insect fauna (three articles), the reptile fauna (one paper), and the small mammal fauna (three papers). Two papers use a biotope approach, and one article gives insight into the human use of lentic biotopes and its impact on biodiversity. Due to the fact that the protected area has only been recently thoroughly investigated, it is but natural to find in this volume a majority of articles focusing on the description of various phyla and their short and mid-term dynamics.

The research carried out during eleven years of assiduous and mostly voluntary work has significantly contributed to the establishment of the Cefa Nature Park in 2010, a significant achievement for which the contributors are to be congratulated.

The first contribution belongs to Sinitean A. and Kutasi R., "A Study of the Benthic Diatom Flora of the Cefa Nature Park (Crișana, Romania)" and it looks into the benthic diatoms richness in the ponds and canals of the fish farm included in the Cefa Nature Park and identify 88 species of algae. The species richness is substantial and the habitat preferences of the species indicate eutrophic brackish water.

The next contribution, belonging to the Momeu L., Peterfi L. S. and Blaga L., is "Planktonic Algal Communities occurring in the Wetlands of the Cefa Nature Park (Crișana, Romania)". The article confirms the finding according to which the Cefa wetlands have become more eutrophic due to their use in fish farming. The recent 2007 and 2010 data are compared with other data from the same spots, collected in 1962, 1978 and 1979. The dynamic process is of particular importance in order to include the fish farming techniques adjustments in the protected area plan of actions.

"Flora and Habitats of Cefa Nature Park (Crișana, Romania)" by Benedek A.-M., Drăgulescu C., Frink J. P. and Petrovici M., presents an extensive inventory research on the cormoflora of the protected area. The authors also compare their data with the bibliography since the late 19th century onward. During six years of study, the authors have identified 504 species of plants and took notes of 38 new species in the area. One of these, an invasive species considered a menace to the wild flora in

the Western Europe, is *Helianthus tuberosus*, found by the authors in this park as well. Besides circumpolar and cosmopolitan species, Mediterranean elements were identified. Five protected species were found, as well as two species mentioned in the Red Book of Romanian plants. Five habitats protected by the Natura 2000 network were also identified.

The first contribution to the invertebrate fauna in the present volume is "The Structure of Oligochaetae and Chironomidae Communities from the Aquatic Ecosystems of the Cefa Nature Park (Crișana, Romania)" by Pavelescu C. It is the first study on these taxonomic groups in the area and it identifies 27 Oligochaetae species and 18 Chironomidae genera.

The description of the invertebrate aquatic fauna continues with "Planktonic Microcrustacean Communities from Cefa Nature Park (Crișana, Romania)" by Battes K. P. and Măluțan L. M. The authors identified 18 cladoceran and 13 copepod species in the channels and fishponds of the protected area indicating a high dissolved organic matter content in the sampled sites.

In the line follows the contribution of Copilaș-Ciocianu D. and Pârvulescu L., "Faunistic Overview upon the Aquatic Malacostracans (Crustacea, Malacostraca) of Cefa Nature Park (Crișana, Romania)". The paper presents preliminary data on the aquatic epigean malacostracans mentioning four species including *Niphargus valachicus*, a vulnerable species according to the IUCN Red List. The article adds to the data on the distribution and ecology of a poorly studied faunistic group in the Romanian territory and it is the first of its kind in this protected area.

Closing the aquatic invertebrates' series of papers in the Cefa Nature Park dedicated volume is "Caddisflies (Insecta, Trichoptera) Community Structure in Cefa Nature Park (Crișana, Romania)" by Pîrvu M., Ciubuc C. and Petrovici M. The authors present the inventory of 36 trichopteran species identified in the park as well as the analysis of the main ecological indices.

Another first-time inventory in this protected area is "Contribution to the Knowledge of the Orthoptera Fauna (Caelifera, Ensifera, Dermaptera, Mantodea and Blattaria) of the Cefa Nature Park (Crișana, Romania)" by Berei I. and Hoffmann R. The authors mention 40 species identified over a three year period study in four habitats spreading over five hectares of land, including one species subject to habitat conservation and management measures in Annex II and IV of the EU Habitats Directive: *Isophya stysi* Cejhan, 1957. The species presence and their abundance is also analyzed from the point of view of their habitat preference, humidity of the site, the way of life of the species, the associated substratum type and the hemerobiotic degree.

The terrestrial epigean insect fauna is the topic of the following contribution signed by Dehelean S. B. and Petrovici M., "Community Structure and Seasonal Dynamics of the Epigean Fauna from four main Habitats in Cefa Nature Park (Crișana, Romania)". The study was carried out during 12 months in four biotopes and identified arthropods, mollusks and annelids, besides Formicidae. Impressive is the important activity level of pseudoscorpions, gastropods, and Oligochaetae, during winter season, due to mild registered temperatures in the area. The presence of the Mediterranean floristic elements identified in a previously discussed contribution in the same volume indicates that this is not a singular event.

"Seasonal Dynamics of the Ground Beetles (Coleoptera, Carabidae) in Cefa Nature Park (Crișana, Romania)" by Dehelean S. B., Varvara M. and Petrovici M. is a study reporting detailed data on the threats of the findings concerning coleopterans in the previously mentioned article. The authors studied the carbides present in four biotopes and identified 70 species. They also analyzed the Shannon similarity index that emphasized the biotope of the dams between fishponds as having the least similarity with the other three

investigated habitats. The same dam biotope was found by the previous article as having the highest values of the frequency and abundance indices.

The invertebrate contributions are closing with a paper signed by Filimon M. N., Fulger A., Popescu R., Sinitean A., Poroșan G. and Voia S., named "Fisheries Management Influence on some Ecophysiological Groups of Bacteria in Lentic Ecosystems of the Cefa Nature Park (Crișana, Romania)". The main finding of the paper concerns the calculation of the bacterial indicator of sediment quality (BISQ) that indicates the lack of pollution sources for the fishponds, the only negative influence being provided by unsustainable management of the fisheries in the area.

The herpetofauna of the area is an important element considered in "Notes upon the Herpetofauna of Cefa Nature Park (Crișana, Romania)" by Ghira I., Covaciu-Marcov S. D., Cicort-Lucaciu A. S. and Sas I. The article lists nine amphibian species and four reptile species. Of these, three species are of community interest: *Triturus dobrogicus*, *Bombina bombina* and *Emys orbicularis*. Even though the populations of the identified species are large enough to be sustainable, the vulnerable and protected species populations are most numerous while some species are present exclusively in forest habitats, maintaining their vulnerability status at the mercy of the local human activities (especially constructions and drying out of the humid areas near the forest). The proof of this vulnerability is the disappearance from the census findings of the *Rana arvalis* species, which had been previously identified in 2000 and 2002.

The volume dedicated to Cefa Nature Park closes with a series of three articles dedicated to mammals. The first of them is "Contribution to the Knowledge of Bat Fauna (Chiroptera) from the Cefa Nature Park (Crișana, Romania)" by Hoffmann R. and Berei I. The study identifies 21 bat species, 11 more than the previous census for chiropterans that was included in the description of the Natura 2000 Cefa site ROSCI0025. Six of the identified species are included in the Annex II and IV of the EU Habitats Directive, meaning *Barbastella barbastellus* (Schreber, 1774), *Miniopterus schreibersii* (Kuhl, 1819), *Myotis bechsteinii* (Kuhl, 1817), *M. dasycneme* (Boie, 1825), *M. emarginatus* (Geoffroy, 1806) and *Rhinolophus ferrumequinum* (Schreber, 1774). These findings were facilitated by the use of new bat census techniques, such as bat detectors and specialized analysis software, in addition to the classical techniques such as roost counts, photo counting and bat traps.

The next paper is "Ectoparasites on Small Mammals (Rodents) from Cefa Nature Park (Crișana, Romania)" by Benedek A.-M. and Sîrbu I. Six species of rodents were surveyed during six years, the only bibliographical data on the site being with a single mention of the *Leptopsylla taschenbergi* species on an individual of *Microbus avails* collected in 1967. The article highlights relationships between habitats, host species' ecological preferences, community structure, abundance and frequency and parasite species' competition relationships and life cycle characteristics.

The final paper in the volume is "Presence of the Hazel Dormouse – *Muscardinus avellanarius* (Linnaeus, 1758) (Rodentia, Gliridae) in the Cefa Nature Park (Crișana, Romania)" by Sevianu E. and David A. The authors describe the 70 year old oak-tree forest habitat whose floor is nearly flooded in the early spring, making the hibernation of the researched species impossible in the area. Yet the species was found to be nesting in artificial nest boxes thus bringing hope for its survival in excess soil humidity conditions and contributing to the forest being declared a protected area, since it bears populations of a species of community interest.

Scientists still have a fertile ground to cover in exploring other floristic and faunistic groups and their dynamics under the protected area regime, as well as in deepening the knowledge for the already researched taxa.

REVIEWER:

[1] *Oriana IRIMIA HURDUGAN*
oriana.irimia@gmail.com
"Alexandru Ioan Cuza" University,
Carol I Boulevard 11, Iaşi,
Iaşi County, Romania,
RO−700506.

TRANSYLVANIAN REVIEW OF SYSTEMATICAL AN ECOLOGICAL RESEARCH 14 (2012) − THE WETLANDS DIVERSITY

− REVIEW −

Teodora TRICHKOVA [1]

Curtean-Bănăduc Angela, Bănăduc Doru and Sîrbu Ioan, 2012. Transylvanian Review of Systematical and Ecological Research, 14 − The Wetlands Diversity, 200 pages, "Lucian Blaga" University Publishing House, Sibiu, Romania, ISSN 1841-7051.

Wetlands are accepted worldwide as highly productive natural ecosystems, being characterised by rich biodiversity and habitats for many animal and plant organisms, including many endangered and threatened species. Also, they provide a broad range of ecosystem products and services that influence the human well-being. In some wetlands this can include services with climate change mitigation effects. Wetlands help with water cleaning and waste recycling, flood control and storm protection; ensure a long-term supply of groundwater, in addition to providing many recreational opportunities. Considering the important values of wetlands and the need for their conservation and proper use in the spirit of the Ramsar Convention on Wetlands (1971), the editors of the ***Transylvanian Review of Systematical and Ecological Research*** scientific series dedicated Volume 14 to the ***Wetlands Diversity***. Most of the scientific papers resulted from the *Aquatic Biodiversity International Conference, Sibiu, Transylvania, Romania, 2011* and offer data about diverse wetland areas around the world. In this context, a broad definition of the term wetland is accepted, as used in the Ramsar Convention, it includes marine/ coastal wetlands (estuaries, lagoons, tidal flats, near-shore marine areas, coral reefs, rocky marine shores, etc.); inland wetlands (lakes, rivers, springs, swamps, marshes, wet grasslands, waterfalls, peatlands, etc.); and human-made wetlands (reservoirs, fish ponds, rice fields, salt pans, etc.).

This Volume is dedicated to the memory of Nehemiah Grew (1641-1712), a distinguished English anatomist, microscopist and plant physiologist.

He made important contributions to the study of plant anatomy with his research on the microscopic structure of various parts of plants, including roots, stems, buds, leaves, flowers, fruits, and seeds, that highlight the differences and common structural aspects, revealing tissue and cell structures. He provided clear evidence of the sexual organs of flowers and the precise parts of seeds and introduced the basic concepts of parenchyma and comparative anatomy. He is considered, along with Marcello Malpighi, to be the founder of plant anatomy. His study on pollen was extensive, leading to the discovery that although all pollen grains are almost globular, their size and shape varies between different species. This discovery is a central one in palynology. Grew also undertook research on the comparative anatomy of the digestive tract of mammals, birds and fish, and he is also considered to be one of the pioneers in the field of dactyloscopy.

Among his great works is the "The Anatomy of Plants" published in 1682, which was largely based on previous smaller publications. It was constructed as four separate volumes, "Anatomy of Vegetables begun", "Anatomy of Roots", "Anatomy of Trunks" and "Anatomy of Leaves, Flowers, Fruits and Seeds", and was illustrated with more than eighty pictures (or charts). This valuable work is important mainly for its description of the structure of plants.

The 15 papers in the volume explore different aspects of the wetlands diversity, included in four thematic sections: *Biotopes, Biocenosis, Ecosystems* and *Human impact*.

The ***Biotopes*** section starts with a paper entitled "A coherent light scattering procedure to measure very small concentration of organic suspension in natural water" by *Dan Chicea*. The paper describes a method that can be used in a straightforward manner to describe light-dispersion by using optically thick suspensions, organic suspensions in natural water with a large concentration range.

The second contribution in this section is the paper entitled "Nile crocodile nesting habitat (Egypt)" by *Ashraf Hussein Ibrahim Salem*. Based on this study, the low number of nests in lake Nasser confirms the high threats posed by human disturbance of the lake Nasser Nile crocodile, mainly due to the water level, increase in hunting, skin trade and hatchling collection in the area.

There are seven contributions in the volume dealing with ***Biocoenosis***. The first is "Biodiversity of the microorganisms existing in the salt lakes at Ocna Sibiului (Romania) and Chott El Jerid (Tunisia)" by *Ecaterina Lengyel*, *Letiţia Oprean*, *Ovidiu Tiţa*, *Ramona Iancu* and *Maria Iancu*. This study provides an overview of the variety of halophilic microorganisms, comparing them to the ones in the salt lake of the Sahara Desert, Chott el Jerid, and in a temperate climate area at Ocna Sibiului in Romania.

The second paper of this section is "The Diatoms of the Marmore Waterfall (Umbria, Italy)" by *Mariacristina Torrisi* and *Antonio Dell'uomo*. The results highlighted by the analyses of the diatom communities in the three sites of the Marmore Waterfall constitute a valid reference point in consideration of the stability over time of the lotic system of this site.

The next paper is "The composition of Diatom communities in the Bega River, sections upstream Timişoara and Otelec (Romania)" by *Hanelore Elena Muntean*. Because of industrial and household water discharges, water quality on the river Bega has suffered a significant loss, the intensity of this loss being highlighted by the significant changes in the benthic diatom community structures.

The following material is "Algal diversity of the Akko Park wetlands in the Bahai Gardens (Haifa, Israel)" by *Sophia Barinova* and *Eviatar Nevo*. This multi-specific assessment of algae and cyanobacteria communities reveals that the unique Akko Park wetland ecosystem reflects a little-disturbed environment and finnaly concludes that the closed treatment method gave significant positive results.

The next paper is "First report of two species of Sea Cucumbers from Qeshm Island (Persian Gulf)" by *Maryam Ehsanpour, Majid Afkhami, Kazem Darvish Bastami, Aida Khazaali* and *Farzane Soltani*. This study was conducted in order to identify the sea cucumber species present in the northern part of the Persian Gulf in the sub-tidal zone of the northern part of Qeshm Island (Persian Gulf), namely *Holothuria scabra* and *Stichopus hermanni*.

The sixth paper is "The parthenogenetic reproduction potential in some rotifers and microscopic crustaceans" by *Elena Silitrari*, *Elena Roşcov* and *Andrei Silitrari*. This study determined the comparative reproductive capacity of the parthenogenetic females in some phylogenetically distant groups and established the ratio between the generative and somatic productivity in aquatic invertebrates (*Brachionus plicatilis, B. rubens, Daphnia magna*).

The last paper of this section is "Species-habitat relations and community structures of aquatic Heteroptera from the eastern part of the Danube Delta (Romania)" by *Horea Olosutean*, *Daniela Ilie* and *Codruţa Olosutean*. The high importance of the Danube Delta in the context of aquatic biodiversity is proved once again by this study as nine aquatic Heteroptera species were found in a very small area, including two rare species.

The authors of three papers in the volume present the results of their research on wetlands at ***Ecosystem*** level. The author of the first paper, *Joana Sender*, writes about the "Possibilities of macrophyte indicators, application for assessment of ecological status of lakes". This study reveals that the Polish macrophyte indicators used for calculating the German macrophyte index gave a slight difference, statistically insignificant.

Doru Bănăduc and *Angela Curtean-Bănăduc* present the results of a case study on the "Fish communities structural and functional aspects − Târnava River Basin (Transylvania, Romania)". This study, conducted in a Carpathian basin, reveals the ecological integrated importance of the trophic relations of two congeneric species *Barbus fluviatilis/barbus* and *Barbus meridionalis/meridionalis*.

Data on "Floral, faunal and environmental diversity of SCI. area (SICIT110097) and regional Nature Reserve Sorgenti del Pescara (Pescara Springs), as a basis for environmental programming and planning (Valle Peligna, Abruzzo Region, Italy)" are presented by *Kevin Cianfaglione* and *Piera Lisa Di Felice*. The study shows an area very rich in biodiversity and suggests that the natural features and ecosystem conservation are sometimes strongly affected in the studied area by new impacts such as river excavation, tree cutting, road works, buildings, water capture and limestone mines.

Three contributions in the Volume focus on the consequences of ***Human Impact*** on different types of wetlands. The first contribution presents data on "Saprobiological analysis of water of the Nišava River (first order tributary of the southern Morava River) in south-eastern Serbia on the basis of macrozoobenthos as a bioindicator" by *Ivana Živić*, *Jovana Matijević*, *Jelena Ćirković*, *Sanja Fužinato*, *Katarina Bjelanović* and *Zoran Marković*. At the investigated sites on the river Nišava, on the basis of macrozoobenthos, β-mesosaprobity quality of water was noted, and also significant capacity of self-purification of this river.

In the next paper, *Jacinto Elías Sedeño-Díaz, Bert Kohlmnan* and *Eugenia López-López* report on the "Benthic macroinvertebrates as indicators of water quality in the streams of Costa Rica using an adaptation of the BMWP score". The use of the BMWP-CR index proved to be an excellent tool for assessing river water quality on the Costa Rican Caribbean slope.

The paper "Effects of human activities on the biodiversity of a tropical manmade lake (Esinminrin Dam)" by *Victor Soolutayo* highlights all the main threats to the studied lake biodiversity and proposes management - restoration elements.

The high variety of themes and issues discussed in the Volume demonstrate the necessity of such a scientific forum devoted to Wetlands Diversity. Hopefully the ***Transylvanian Review of Systematical and Ecological Research*** editors will continue this significant tradition.

REVIEWER:

[1] *Teodora TRICHKOVA*
trichkova@zoology.bas.bg
Bulgarian Academy of Sciences,
Institute of Zoology,
Tsar Osvoboditel Boulevard 1,
Sofia, Bulgaria,
BG-1000.