`

TRANSYLVANIAN REVIEW OF SYSTEMATICAL AND ECOLOGICAL RESEARCH

4

The Saxon Villages Region of southeast Transylvania

Editors

Angela Curtean-Bănăduc, Doru Bănăduc & Ioan Sîrbu

Sibiu - Romania

2007

TRANSYLVANIAN REVIEW OF SYSTEMATICAL AND ECOLOGICAL RESEARCH

4

The Saxon Villages Region of southeast Transylvania

Editors

Angela Curtean-Bănăduc
„Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection

Doru Bănăduc
Brukenthal National Museum, Natural History Museum of Sibiu

Ioan Sîrbu
„Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection

Published through the „Sighişoara-Târnava Mare Potential Natura 2000 Site" Project.

A.D.E.P.T. Foundation

Darwin Initiative

"Lucian Blaga" University of Sibiu

Orange Romania

Ecotur Sibiu N.G.O.

Sibiu - Romania

2007

Editorial Office:

„Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, 31 Oituz Street, Sibiu, Sibiu County, Republic of Romania, RO - 550337, Angela Curtean - Bănăduc (banaduc@yahoo.com), Doru Bănăduc (banaduc@yahoo.com) and Ioan Sîrbu (meosirbu@hotmail.com).

ISSN 1841 - 7051

IN MEMORIAM

Charles Robert Darwin
(1809 - 1882)

Charles Darwin remains an inspiration to biologists 125 years after his death. One of history's greatest thinkers, his elucidation of evolution by natural selection has overshadowed his other outstanding contributions to scientific natural history. Darwin's many publications encompassed an impressive range of interest and expertise: the vast body of data he accumulated in support of his theory of evolution, together with major contributions on animal and human behaviour, barnacles, climbing and insectivorous plants, coral reefs, earthworms and orchid pollination. He was a geologist, and as good a botanist as he was zoologist.

Always a keen naturalist, Darwin showed little early promise as a scholar, either at school in Shrewsbury or at university. He originally studied medicine at Edinburgh but left to read theology at Cambridge University. There the botanist William Henslow befriended him, encouraging his interests and, most significantly, recommending him in 1831 to Captain Robert FitzRoy for the post of naturalist on the round-the-world voyage of the naval survey-ship HMS *Beagle*. Darwin's varied experiences on this 5-year voyage, especially in South America and the Galapagos Islands, stimulated his remarkable intellect and he followed them up with an active scientific life on his return to England. After his marriage to Emma Wedgwood, he settled at Down House in Kent and there applied himself to his studies. An invalid for much of his life, a man of substantial financial means (but who worried about money), and deeply devoted to his large family, Darwin rarely travelled far from home. Nevertheless he received many visitors and pursued extensive correspondence with colleagues in Britain and Europe.

He slowly accumulated material towards a theory of evolution, but it needed a letter in 1858 from the Far East from Alfred Russell Wallace (1823-1913) proposing a similar hypothesis, and the entreaties of Joseph Hooker and celebrated geologist Charles Lyell, to persuade Darwin to publish his work. In a famous gentlemanly compromise, a few weeks later Darwin and Wallace presented a joint communication to the Linnean Society of London. This meeting attracted little interest at the time - but publication of *On the Origin of Species by Natural Selection* the following year caused a sensation. In 1860 the British Association for the Advancement of Science met in Oxford, where Darwin's work was debated. Darwin himself, too ill or perhaps too diffident (he referred to the *Origin* as just an "Abstract" of his ideas!), did not appear to hear the Bishop of Oxford ridicule his work - only to be powerfully rebuffed by a young zoologist, Thomas Henry Huxley, an untiring champion of evolution.

Darwin, a gentle, modest and scrupulously honest man, would have been astonished at the impact of his work on biology and human thought. The ideal researcher, he had ample time to devote to his work, a surfeit of curiosity, an ability (as he put it) "for grinding general laws out of a large collection of facts", and those periodic flashes of rich intuition that are the mark of genius. He knew how much his ideas undermined the traditional teaching of the Church, and his own religious belief faltered on the death of his youngest daughter, but he refrained from general public debate - unlike his colleague Wallace, an active humanist and socialist.

Darwin rests in London's Westminster Abbey alongside Isaac Newton, another remarkable man who bequeathed a huge scientific legacy. For a time in the early 20th century Darwin was discredited by the rise of genetics, his evolutionary theory having not explained the mechanism of heredity. But today his reputation is assured by a great body of experimental work, and in the age of molecular biology he remains a pivotal figure of ecology, evolutionary biology and genetics - and all biological sciences.

The Editors

CONTENTS

Preface

For hundreds of years, anthropogenic impact on natural habitats has created valuable semi-natural habitats. Human cultural diversity has brought about a remarkable increase in diversity of flora, fauna, habitats, ecosystems and landscape globally.

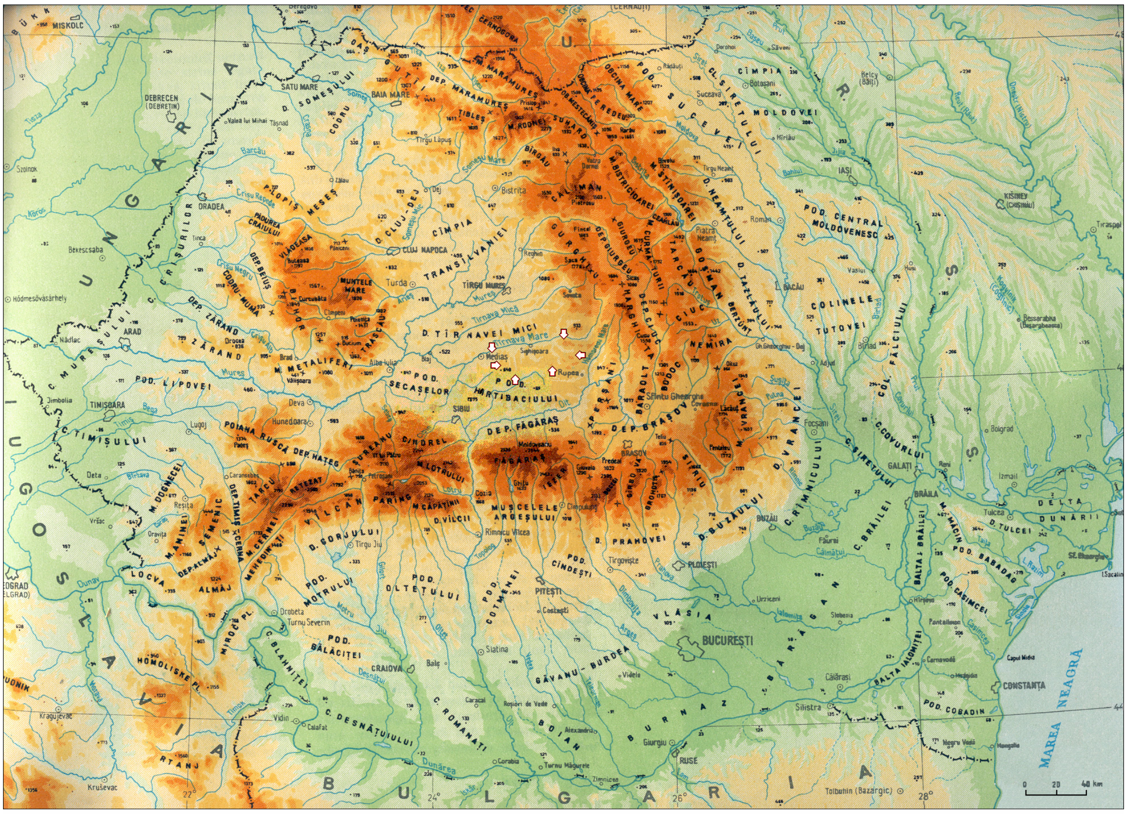
Europe is one of the main areas of such transformations. The landscapes, which they remain in a near pristine, contribute favorably to biodiversity, in contrast to the general decline of natural biodiversity all over the world, which has been so marked in the 20th Century.

One of the best examples of such preserved landscapes on a large scale is found in the Romanian inner Carpathian area, the Saxon Villages region of southeast Transylvania. Extensive forests and flower-rich hay-meadows are integral and intact elements in a landscape basically since medieval times. The large areas of species-rich grasslands are the last significant remnants of a once widespread habitat that has disappeared across much of Europe.

This historic landscape has survived due to the fact that local and regional cultural diversity and traditional management are still alive, allowing the presence of exquisite species and habitats.

The studies on natural history of the area undertaken by different researchers in recent years deserve a special volume which could offer an overview, even if incomplete, of this area that is of such importance for nature conservation.

With this in mind, the editors of Transylvanian Review of Systematical and Ecological Research, in cooperation with ADEPT Foundation, have decided to compile a special volume about this area.



The Saxon Villages Region of southeast Transylvania (Badea et al., 1983 - modified).

These new collected data will, undoubtfully, develop knowledge and understanding of the ecological status of this special area and will continue to evolve.

Acknowledgements

The editors would like to express their sincere gratitude to the authors and the scientific reviewers whose work made the appearance of this volume possible, as well as and to the *Darwin Initiative of the United Kingdom Ministry of Agriculture (DEFRA), "Lucian Blaga" University of Sibiu/Faculty of Sciences/Department of Ecology and Environment Prtection, Orange Romania, Agricultural Development and Environmental Protection in Transylvania Foundation* and *Ecotur Sibiu N.G.O.,* for the support of the field work on which a part of the necessary research was based, and for this volume printing expences.

The Editors

ASPECTS CONCERNING THE SUPERFICIAL LIQUID FLOW IN THE TÂRNAVA MARE RIVER MIDDLE HYDROGRAPHIC BASIN (TRANSYLVANIA, ROMANIA)

*Valer DOBROS **

* "Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Oituz Street 31, Sibiu, Sibiu County, Romania, RO - 550337

KEYWORDS: Romania, Transylvania, Târnava Mare River basin, geology, geomorphology, climate, hydrological regime.

ABSTRACT

The superficial liquid flow analysis (minimum and maximum) in the central Târnava Mare River hydrographical basin, was carried out through hydrological parameters analysis, the parameters adopted from the Romanian Meteorology and Hydrology National Institute archive, statistically handled, and is also based on original hydrological data obtained by the author on fieldwork.

This analysis emphasize the torrential character of the superficial flow in the basin, set off in high maximum flows in rainy periods and insignificant minimum flows, with low-flow episodes. during drought periods of the year.

RÉSUMÉ: Aspectes concernant l'écoulement liquide superficielle dans le basin hydrographique du rivier Târnava Mare (Transylvanie, Romanie).

L'analyse de l'écoulement superficielle liquide (minime et maxime) a été réalise par l'analyse des parameters hydrologiques, les donnees provenant de l'archive de l'Institute National de Météorologie et Hydrologie et aussi les données de l'autouer obtenues pendant les déplacements sur le terrain.

Cette analyse montre le character torrentiel de l'écoulement superficiale dans le basin, sougligné par des écoulement maximes dans les periodes pluviales, et des écoulements minimes, tres basses, même la séchage das les periodes sèches de l'année.

REZUMAT: Aspecte privind scurgerea lichidă superficială în bazinul hidrografic al râului Târnava Mare (Transilvania, România).

Analiza scurgerii superficiale lichide (minime şi maxime) în bazinul hidrografic Târnava Mare s-a făcut prin analiza parametrilor hidrologici preluaţi din arhiva Institutului Naţional de Meteorologie şi Hidrologie, prelucraţi statistic, şi a datelor hidrologice, obţinute de autor în campaniile de măsurători executate.

Această analiză scoate în evidenţă caracterul torenţial al scurgerii superficiale din bazin, reliefat în scurgeri maxime de amploare, în perioadele pluviale şi scurgeri minime nesemnificative, mergând până la secare, în perioadele secetoase ale anului.

INTRODUCTION

The studied area is situated in the central-south part of the Transylvanian Plateau, in the central Târnava Plateau area, drained by the Târnava Mare River.

A similar superficial liquid flow analysis was realised concerning the near Târnava Mică River (Dobros, 2005).

The superficial liquid flow analyzed (mean, minimum and maximum) in the Târnava Mare basin was carried out through hydrological parameters analysis, the parameters adopted from the Romanian Meteorology and Hydrology National Institute archive, statistically reworked, and also based on the author's own hydrological data obtained on fieldwork.

RESULTS AND DISCUSSIONS

The middle Târnava Mare River basin is situated in the central-south part of the Transylvanian Plateau, in the central Târnave Plateau, draining the main sectors of the Vânători - Sighişoara, Dumbrăveni and Mediaş sub-basins and the northern part of the Hârtibaciu Hills.

From the geological point of view, the foundation of this region, buried under a thick Neogene layer, is represented by the southern part of the Central Transylvanian mountain massif, formed of crystalline schists. Over this foundation were deposited Miocene, Pliocene and Quaternary soft formations. The interfluvial surfaces are covered by Sarmatian deposits (marls-clays, sands and tuffs) in the Saschiz and Bazna areas. The most common is the final layer of the Pliocene, that is the Pannonian, represented through the marl-clays and sands, structured on two horizons: a clay horizon at the base and a sandy one with marl-clay intercalations in the upper part, which in the Copşa Mică area is 200 m thick.

The central area of the segment (main river bed, river meadow and the first terraces) is characterised by the presence of these two Quaternary layers: Upper Pleistocene (pebbles and sands) for the middle terraces; and Holocene (sands, sandy pebbles, deluvial-coluvial, alluvial deposits) for the lower terraces, the river meadow and the main river bed of the Târnava Mare.

From the geomorphological point of view, the middle Târnava Mare sector is formed of the main river bed (with intensive meandering processes, dry river meanders, sandy stripes of the left river bank) and meanders, steep sides and cuestas for the right side, evidence which reveals its subsequent character. Partially these processes were modified through dams.

The next level is the proper river meadow suspended at approximately 5 m above the main river bed and the lower terraces (developed mainly on the left side), forming in fact hilly surfaces which are transversely fragmented by the left tributaries of the Târnava Mare River, left tributaries which are in the majority.

The right side, shorter and that is why it seems higher, with the convergence orientated to the interfluvial area with the Târnava Mică River, is affected largely by the degradation processes of the land (aerial washings, streaming, torrent activity, solifluxion processes, landslides, etc.) begun and maintained by the clearing of vegetation.

The energy relief is reduced, reaching a maximum of 100 m, and the average degree of fragmentation is 05 - 07 km/km^2.

The climatic regime, associated with the sector of the hilly area with a moderate-continental climate, is characterized by warm summers with relatively low precipitation, and cold winters with a relatively stable snow cover and rare warmer intervals.

The global solar radiation is of 115 kcal/cm^2/year.

The general circulation of the atmosphere is characterized by the high frequency of incursions of western and north-western temperate-oceanic air combination (especially in the warm season), and by the relatively low frequency of temperate continental air incursions of the north-east and east. Less frequently, south-west and south Mediterranean air masses are present, and also rarely northern Arctic air masses.

The annual average temperatures lie between +8 °C and +9 °C, with absolute values of +37 °C and -32 °C (Bratei area). The average July temperatures vary between +18 °C and +20 °C, and those of January between -3 °C and -4 °C. The atmospheric precipitation has an annual amount of 500 - 700 mm. The annual average number of days with frost is 117 (Bratei area).

The hydrographical network studied (2484 km²), is formed by the main collector Târnava Mare River (between the confluences with Feernic and Şeica streams) and its principal tributaries: Feernic - 190 km²; Scroafa - 339 km²; Saeş - 122 km²; Criş - 84 km²; Laslea - 111 km²; Valchid - 51 km²; Biertan - 56 km²; Ațel - 33 km²; Mojna - 55 km²; Visa - 555 km²). This basin sector asymmetry is determined by the more important left tributaries.

The annual (1950 - 1992) average water discharge varies between 5 m^2/s (upstream of the confluence with Feernic) and 13 m^2/s (upstream of the confluence with Şeica). Among the tributaries these values vary between 0.08 m² (Ațel) and 1.78 m² (Visa).

The minimum flows were determined with 80%, 90%, 95%, 97% assured flow for minimum values (monthly and annually), values which reveal a high variability of flow. For the Târnava Mare River the monthly minimum flows vary between 1.20 m² and 2.42 m² (80%); between 1.08 m² and 1.80 m² (90%); between 1.00 m²/s and 1.40 m²/s (95%); between 0.96 m²/s and 1.10 m²/s (97%). The minimum flows present the same variability but are much lower, in some cases appearing drought phenomena, especially on some tributaries.

The maximum flows were calculated for 1%, 5% and 10% probability levels. The values at 1% probability vary between 530 m²/s (upstream) and 940 m²/s (downstream).

The hydrological parameter values at the principal hydrometrical stations and the main confluences are presented in the table 1.

Table 1: Liquid flow parameters in some sections of the central basin of the Târnava Mare River: L km, F km^2, Hm m, Qo m^2/s.

No. crt.	River/ section	L km	F km²	Hm m	Q_0 m^3/s	L/Z Minimum flow (m^3/s)				Maximum flow (m^3/s)		
						80 %	90 %	95 %	97 %	1 %	5 %	10 %
1	Târnava Mare					1.20	1.08	1.00	0.96			
2	Upstream of the confluence with the Feernic	74	897	819	5.38	0.72	0.62	0.56	0.52	530	300	210
3	Feernic					0.062	0.042	0.030	0.022			
4	Simoneşti hydrographic station	25	145	683	0,84	0.030	0.024	0.018	0.016	185	105	70
5	Feernic					0.081	0.055	0.039	0.029			
6	Upstream of the confluence with Târnava Mare	33	190	637	1.09	0.039	0.031	0.023	0.021	200	110	75
7	Târnava Mare					1.32	1.17	1.08	1.03			

No. crt.	River/ section	L km	F km²	Hm m	Q_0 m^3/s	L/Z Minimum flow (m^3/s)				Maximum flow (m^3/s)		
						80 %	90 %	95 %	97 %	1 %	5 %	10 %
8	Upstream of the confluence with Scroafa	99	1226	730	7.10	0.81	0.67	0.60	0.55	610	340	240
9	Scroafa					0.078	0.048	0.042	0.036			
10	Upstream of the confluence with Archita	31	203	576	1.16	0.040	0.030	0.015	x	225	122	83
11	Archita					0.050	0.032	0.028	0.024			
12	Upstream of the confluence with Scroafa	19	135	597	0.77	0.025	0.020	x	x	185	100	70
13	Scroafa					0.130	0.080	0.070	0.060			
14	Upstream of the confluence with Târnava Mare	33	339	583	1.91	0.070	0.050	0.020	0.010	290	155	105
15	Târnava Mare					1.45	1.25	1.15	1.10			
16	Vânători hydrographic station	116	1634	695	9.09	0.92	0.72	0.63	0.57	690	385	273
17	Târnava Mare					1.58	1.36	1.25	1.20			
18	Sighişoara hydrographic station	123	1840	675	11.0	1.00	0.78	0.69	0.59	733	410	290
19	Târnava Mare					1.58	1.36	1.25	1.20			
20	Upstream of the confluence with Şaeş	124	1843	673	11.0	1.00	0.78	0.69	0.59	750	430	305
21	Şaeş					0.050	0.040	0.030	0.020			
22	Upstream of the confluence with Târnava Mare	32	122	531	0.33	0.020	0.010	x	x	190	100	70
23	Târnava Mare					1.63	1.40	1.28	1.22			
24	Upstream of the confluence with Criş	139	1999	660	11.2	1.02	0.79	0.70	0.59	816	456	323
25	Criş					0.040	0.030	0.020	0.010			
26	Upstream of the confluence with Târnava Mare	16	84	507	0.23	0.020	0.010	x	x	155	85	57
27	Târnava Mare					1.65	1.42	1.31	1.25			
28	Upstream of the confluence with Laslea Stream	142	2121	650	11.3	1.05	0.81	0.72	0.060	840	475	335
29	Laslea River					0.062	0.052	0.047	0.043			
30	Laslea hydrographic station	20	109	503	0.34	0.031	0.016	x	x	165	95	60
31	Laslea					0.062	0.052	0.047	0.043			

No. crt.	River/ section	L km	F km²	Hm m	Q_0 m^3/s	L/Z Minimum flow (m^3/s)				Maximum flow (m^3/s)		
						80 %	90 %	95 %	97 %	1 %	5 %	10 %
32	Upstream of the confluence with Târnava Mare	21	111	498	0.34	0.031	0.016	x	x	180	100	65
33	Târnava Mare					1.75	1.50	1.39	1.32			
34	Upstream of the confluence with Valchid	151	2267	638	11.8	1.06	0.82	0.73	0.60	860	486	343
35	Valchid					0.040	0.030	0.020	x			
36	Upstream of the confluence with Târnava Mare	19	51	478	0.13	x	x	x	x	120	66	44
37	Târnava Mare					1.80	1.54	1.43	1.36			
38	Upstream of the confluence with Biertan	156	2341	631	12,0	1.07	0.83	0.74	0.60	874	500	350
39	Biertan					0.030	0.020	0.010	x			
40	Upstream of the confluence with Târnava Mare	16	56	424	0.14	x	x	x	x	130	170	48
41	Târnava Mare					1.88	1.58	1.46	1.39			
42	Upstream of the confluence with Aţel	165	2440	621	12.2	1.09	0.85	0.75	0.60	900	515	360
43	Aţel					0.015	0.010	x	x			
44	Upstream of the confluence with Târnava Mare	9	33	418	0.08	x	x	x	x	95	52	35
45	Târnava Mare					1.96	1.60	1.46	1.39			
46	Upstream of the confluence with Mojna	182	2591	608	12.4	1.12	0.87	0.78	0.68	920	524	376
47	Mojna					0.030	0.020	x	x			
48	Upstream of the confluence with Târnava Mare	13	55	420	0.13	x	x	x	x	125	68	47
49	Târnava Mare					2.00	1.64	1.46	1.39			
50	Mediaş hydrographical station	183	2649	603	12.5	1.13	0.88	0.80	0.75	930	530	380
51	Târnava Mare					2.00	1.64	1.46	1.39			
52	Upstream of the confluence with Visa	198	2771	595	12.8	1.13	0.88	0.80	0.75	930	530	380
53	Visa					0.105	0.088	0.070	0.059			
54	Upstream of the confluence with Calva	29	268	458	0.90	0.029	0.025	0.024	0.022	280	150	100
55	Calva					0.070	0.060	0.048	0.040			

No. crt.	River/ section	L km	F km²	Hm m	Q_0 m^3/s	L/Z Minimum flow (m^3/s)				Maximum flow (m^3/s)		
						80 %	90 %	95 %	97 %	1 %	5 %	10 %
56	Upstream of the confluence with Visa	29	179	487	0.60	0.020	0.015	0.012	0.010	235	125	85
57	Visa					0.180	0.0150	0.120	0.100			
58	Şeica Mare hydrographical station	30	447	485	1.50	0.050	0.044	0.042	0.038	332	188	135
59	Visa					0.200	0.160	0.130	0.110			
60	Upstream of the confluence with Târnava Mare	42	555	462	1.78	0.053	0.048	0.046	0.041	370	210	150
61	Târnava Mare					2.42	1.80	1.50	1.40			
62	Upstream of the confluence with Şeica	210	3381	572	13.2	1.45	0.97	0.82	0.75			

CONCLUSIONS

The determined hydrological parameters analyzed allow the hydrological regime characterization as not an uniform one (with high variations), fed exclusively from precipitation and subterranean water, with high and short floods - in the spring (see 1920 - 1975 period). The minimum flow was produced in the autumn season (September - October) with values which reach 0 level on some tributaries.

Finally it is mentioned the fact that the presented hydrological parameters refer to the linear flow in a natural regime, this being in reality mainly influenced by the Zetea Dam reservoir and other seasonal consumers. For a qualitative analysis of the hydrologic phenomena on the Târnava Mare River it is highly necessary to make a reconstruction of the actual flow regime based on the actual hydrological state at the Zetea Dam reservoir.

ACKNOWLEDGEMENTS

The author is grateful to the Darwin Initiative of the United Kingdom Ministry of Agriculture (DEFRA), the Orange Romania, and the NGOs Ecotur Sibiu and Fundaţia-ADEPT for supporting both the author's fieldwork and publication of this paper.

REFERENCES

1. Dobros V., 2005 – Aspects concerning the liquid flow in Târnava Mică River Hydrographic Basin, *Transylv. Rev. Syst. Ecol. Res.* 2, Edit. Universităţii "Lucian Blaga" din Sibiu, Sibiu, 1 - 4.

CHARACTERISTICS OF THE RELIEF FROM THE CENTRAL-EASTERN PART OF THE TÂRNAVELOR PLATEAU, WITH REFERENCE TO PRESENT MODELLING AND THE ASSOCIATE GEOMORPHOLOGIC RISK (TRANSYLVANIA, ROMANIA)

Marioara COSTEA *

* "Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Oituz Street 31, Sibiu, Sibiu County, Romania, RO - 550337, marioara_costea@yahoo.com

KEYWORDS: Romania, Transylvania, Târnavelor Plateau, present modelling, geomorphologic processes of slope and riverbed, geomorphologic processes of risk, potential factors, factors of release, geomorphologic risk.

ABSTRACT

The present modelling of the Târnavelor Plateau is subordinated to certain geomorphologic processes with permanent and seasonal rhythm of manifestation, but with a special intensity. These are favoured by the petrographic composition of plastic rocks with a high morpho-dynamic potential, of monoclinal folding structure, of domes, by the taking over in modelling of certain slopes with different dips or of riverbeds.

The contemporary processes of modelling and the forms resulted are in a dynamic equilibrium arose from the interaction of certain active “stress” factors (force of gravity, the climate by the temperature oscillation, rich rainfall, drought etc,), the man by the activities carried on, with passive factors, of resistance (nature of the rocks, structure, preexistent relief by its morpho-metric and morpho-graphic characteristics). The modification of the normal parameters of any of the above-mentioned factor entails a qualitative leap and implicitly a modification of the equilibrium, hence a progressive dynamic of the forms of relief. The intensity and the rhythmicity of manifestation of the actual modelling processes, as well as their diversity, lead to the apparition of a varied range of degradation.

The risk character derive from the aggressiveness, the intensity, the extension and the length of manifestation of these processes and from the negative consequences they have on man and the human society, being identified four categories: weak and very weak risk, moderate risk, high risk and severe risk. The geomorphologic phenomena of risk have a certain impact on the environment conditions, on the population and the human activities and lead to the modification of the geo-components, especially of the preexistent forms of relief, visibly modifying the human habitat. There are aimed especially the geomorphologic phenomena of risk that derive from the rocks bearing to the action of the external agents, from their physical and chemical properties and from the manifestation of the present geomorphologic processes, with direct consequences upon the land degradation, upon the development of the human settlements and the social condition of the population, by the aspects they generate: loss of soil fertility, destruction of homesteads, economic losses, human lives losses, social dimension associated.

RÉSUMÉ: Caracteristiques du relief du est - central part du Târnavelor Plateau, a l'egard du modelage actuel et du risque geomorphologique associe (Romanie).

Le modelage actuel du relief de Târnavelor Plateau est subordoné aux certains processus géomorphologiques avec rythme permanent et saisonnier de manifestation, mais avec une intensité de manifestation spéciale. Ceux-ci sont favorisés par la composition pétrographique des roches plastiques avec un potentiel morpho dynamique élevé, de structure monoclinale, plié, de dômes, par inclinaisons différents ou des lits des rivières. Les processus de modelage contemporains et les formes résultés se trouvent dans un équilibre dynamique résulté de l'interaction des facteurs actifs "de stress" (la force de gravitation, le climat par l'oscillation l'homme par les activités déployés, la structure, le relief préexistant par les caractéristiques morpho métriques et morpho graphiques). La modification des paramètres normaux de tout facteur susmentionné a pour conséquence un bond qualitatif et implicitement une modification de l'équilibre, alors une dynamique progressive des formes de relief. L'intensité de la rythmicité de manifestation des processus de modelage actuel, ainsi que leur diversité, conduisent à l'apparition d'une gamme variée de dégradation. Le caractère de risque dérive de l'agressivité, l'intensité, l'extension et la durée de manifestation de ces processus et par les conséquences négatives qu'ils ont sur l'homme et la société humaine, étant identifié quatre catégories: risque faible et très faible, risque modéré, risque majeur et risque sévère. Les phénomènes géomorphologiques du risque ont un certain impact sur les conditions d'environnement, sur la population et sur les activités humaines et concourent à la modification des géocomposants, spécialement des formes de relief préexistants, modifiant visible l'habitat humain. Se sont visé avant tout les phénomènes géomorphologiques du risque qui dérivent du comportement des roches à l'action des agents externes, de leurs propriétés physiques et chimiques et de la manifestation des processus géomorphologiques actuels, avec directs implications sur la dégradation des terrains, sur le développement des habitats et de l'état sociale de la population, par les aspects qu'ils génèrent: la perte des vies humaines, la dimension sociale associée.

REZUMAT: Caracteristicile reliefului din partea central - estică a Podişului Târnavelor, cu privire asupra modelării actuale şi riscului geomorfologic asociat (Romanie).

Modelarea actuală a reliefului Podişului Târnavelor este subordonată unor procese geomorfologice permanente şi sezoniere, cu o intensitate de manifestare deosebită. Acestea sunt favorizate de alcătuirea petrografică din roci plastice cu potenţial morfodinamic ridicat, de structura monoclinală, cutată, de domuri, prin preluarea în modelare a unor versanţi cu înclinări diferite sau a albiilor râurilor. Procesele de modelare actuale şi formele rezultate sunt într-un echilibru dinamic rezultat din interacţiunea unor factori activi „de stres" (gravitaţia, oscilaţiile temperaturii, secetă, precipitaţii bogate etc.), activităţile umane, cu factorii pasivi, de rezistenţă (natura rocilor, relieful preexistent prin caracteristici morfometrice şi morfografice). Modificarea parametrilor oricărui factor amintit atrage un salt calitativ şi implicit o modificare a echilibrului, deci o dinamică progresivă a formelor de relief. Intensitatea şi ritmicitatea de manifestare a proceselor de modelare actuală şi diversitatea acestora, duc la apariţia unei game variate de degradări. Riscul derivă din intensitatea, extensiunea şi durata acestor procese şi din consecinţele negative asupra societăţii, fiind identificate patru categorii de risc: slab şi foarte slab, moderat, mare şi sever. Fenomenele geomorfologice de risc au impact asupra condiţiilor de mediu, populaţiei umane şi a activităţilor ei şi concură la modificarea geocomponentelor, în special a reliefului preexistent, modificând habitatul uman. Sunt vizate îndeosebi fenomenele geomorfologice de risc care derivă din comportamentul rocilor la acţiunea agenţilor externi, din proprietăţile lor fizice şi chimice şi din manifestarea proceselor geomorfologice, cu implicaţii asupra degradării terenurilor, asupra dezvoltării aşezărilor umane şi a stării sociale a populaţiei, prin aspectele legate de pierderea fertilităţii solurilor, distrugerea gospodăriilor, pierderi economice, pierderi de vieţi omeneşti, dimensiunea socială asociată.

REGIONAL FEATURES OF THE RELIEF

The general traits of the Târnavelor Plateau relief are the consequence of the unrolling in time and space of certain morphogenetic endogenous and/or exogenous processes and phenomena. The internal factors action through tectonics, rock and structure imposed a distinct evolution of the relief, circumscribed to the paleo-geographic evolution of the Transylvanian Plateau.

The geologic substratum consist mainly from Pannonian sedimentary deposits (clays, sands, grits weak cemented), Sarmatian, insular Badenian and Quaternary deposits on the valleys (sands, gravels of different sizes, mud). The Quaternary deposits appear under the form of alluvial deposits on the bottom of minor riverbed or in river meadows, under the form of prolluvial and/or the terraces along Hârtibaciu, Târnava Mare or local even in major riverbeds of their affluents.

Morpho-structure completes the morpho-lithologic picture. Thus in Târnavelor Plateau the monoclinal structure is dominant, and central there is presented the structure in domes. The relief presents in this way a visible asymmetry induced by the structure and an adaptation to lithology and structure, with forms of direct concordance - fronts of cuesta, structural surfaces, subsequent and obsequent valleys, or inverse - dome buttonholes, on which slope and riverbed processes develop.

Interfluves present paleogeographic evolution traces; the erosion exerted by the external agents and repeated moves have made possible the polycyclic modelling of the erosion surfaces. The superior surface[1] situated at 550 - 600 - 700 m altitude in east, with different local names as Proştea Mare (David, 1945), Amnaşului, (Posea, 1969) is representative on the main interfluve Târnava Mare - Hârtibaciului, being synchronous with the Transylvanian surface (Mac, 1972; Josan, 1979; Posea, 1969, 2002). The inferior surface is situated at 500 - 550 - 600 m altitude, being called the surface of Hârtibaciului[2] after the good representation in this plateau or the inferior level (Grecu, 1992; Posea, 2002), being followed by a valley level at 400 - 450 m altitude, identified in every valleys in the plateau: in Hârtibaciului (Grecu, 1992), Secaşul Mare (Costea, 2005) and Târnave (Josan, 1979).

The configuration of the valleys and interfluves highlights evolutive and genetic aspects subordinated to the structure and allows the hierarchical placing of the forms of relief from the central eastern part of the Târnavelor Plateau. The total fragmentation of the plateau on east-west direction or partial fragmentation on north-south direction, led to the individualization of certain territorial subunits (Fig. 1) which will be analyzed in our study:

1. **Târnavelor Hills**[3] - represented in the limits of the studied area through Dumbrăveni Plateau[4] (Posea, 1980, 2002; Posea and Badea, 1982) and the Târnava Mare River corridor,

---

[1] Modeled during the time after the post-Pontian exundation, as a result of Rodanic movements, up to the Vlach movements in the superior Pliocene (Romanian) (*Romania's Geography*, III, p.580).

[2] Is equivalent to Levantine - Pleistocene sediment from Transylvanian Subcarpathians (Mac, 1972). The process of sedimentation and the climate in which it has developed is demonstrated by the presence of the lateric deposits from Beia Hills.

[3] Known in specialized literature under different names from author to author: Târnava Mare Hills, Târnava Mica Hills (Posea, 2002), the hills between Târnave as a subunit of Târnava Mica Hills (Josan, 1979).

[4] Dumbrăveni Plateau passes as extension the limits of the studied area, being comprised between Eliseni Valleys in the east and Păucea in the west, Târnava Mare in the south and Târnava Mică in the north.

respectively through the cuesta front which corresponds to the south slope of this hills and through the meadows and terraces of Târnava Mare. The north limit of the area follows in this subunit the watershed between Târnava Mare and Târnava Mică between Săcel and Hoghilag on the alignment: Răchiţii Hill (641 m) - Bârlibăşoaia - Jacu (625 m) - Coasta Mare (647 m) - Dealul Mare (the Big Hill) (599 m) - Radler Hill (539 m) - Hoghilag. From here the limit insinuates in Târnava Mare Valley, following its minor riverbed between Dumbrăveni and Mediaş. For the corridor of Târnava Mare we mention the clear asymmetry of the valley, with a disposing and a monolateral development of the terraces on the left side, except the sector from Sighişoara[5], where the terraces have a bilateral development.

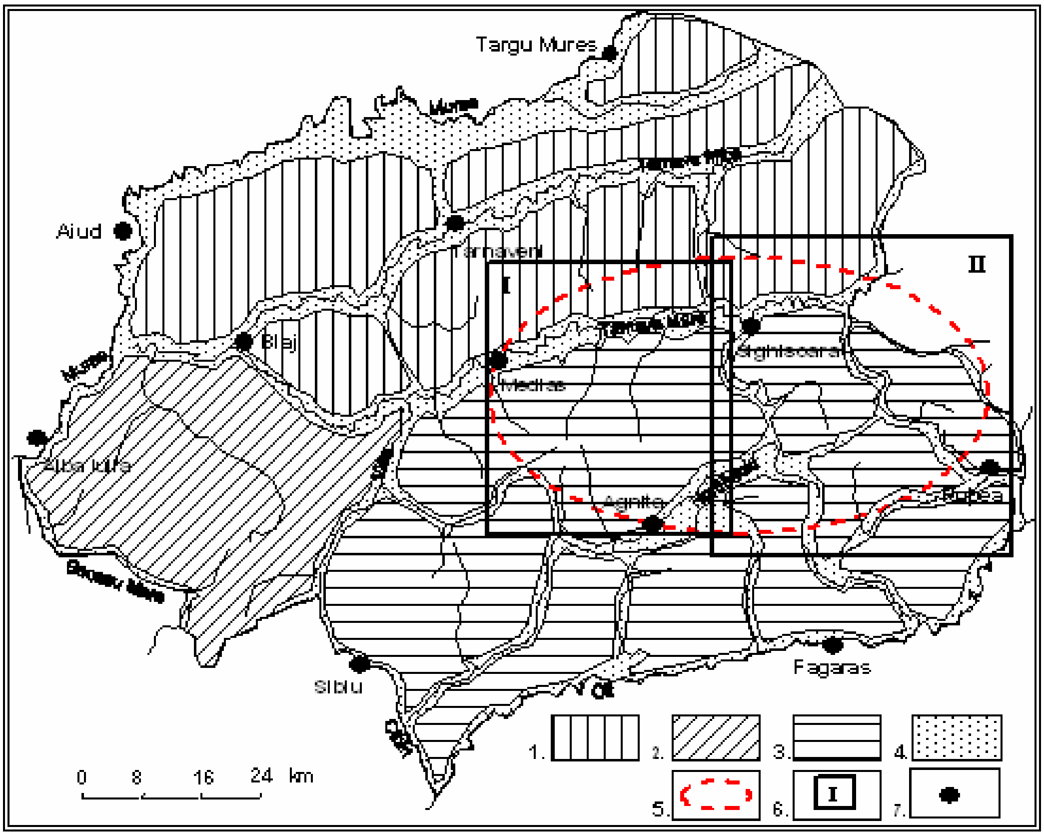


Figure 1: The Târnavelor Plateau territorial subunits: Târnavelor Hills; 2. Secaşelor Plateau; 3. Hârtibaciului Plateau; 4. valleys corridors; 5. studied area - the plateau central-easternern part; 6. the sectors of geomorphological risk map (Figs. 2I, 2II); 7. towns.

[5] In Sighişoara Târnava Mare goes through a lithologic bar composed of harder Pontian grits, passing through that emerged a narrow and sinuous epigenetic sector. The terrace of 30 m relative altitude is well kept, at its level being established the biggest part of the town - the medieval core (*Romania's Geography*, III, p.580).

Thus, towards Hârtibaciului Plateau we encounter the meadow well developed and the whole series of the eight terraces, beginning with the first, of 8 - 12 m relative altitude, 18 - 25 m, 30 - 40 m, 50 - 60 m, 80 - 90 m, 110 - 120 m and up to the last one of 150 - 160 m relative altitude (Josan, 1979). This last terrace can be encountered in the whole Târnava Mare Valley downstream Sighişoara, having a great extension at Dumbrăveni, where it reaches the absolute altitude of 470 m.

Following closely the connection between the geological structure and the hydrographic network in the Târnavelor Hills area, Josan (1979) says that Târnava Mare Valley isn't adapted very well to the structure, crossing both the domes (Sighişoara, Copșa Mică), and large synclinals, in the same time, going through a monocline in which the strata incline towards north. The quoted author explains the asymmetry of the valley by a weak movement of dipping which the whole Transylvanian Depression suffered towards the central area, causing in this way an unequal dipping of the big rivers, a permanent displacement towards north, a greater development of the affluents on the left side and stimulated the regressive erosion, which pushed the watershed to the south[6]. As an echo of these negative movements from the area of middle Mureş, the main rivers - and thus Târnava Mare - displaced towards north, undermining ceaselessly the right slope. Locally the geologic structure accentuated the asymmetry of the main valleys-implicitly of the Târnava Mare (Josan, 1979).

2. Hârtibaciului Plateau is represented in the limits of the studied area through the Northern Hârtibaciului Plateau, the Southern Hârtibaciului Plateau and Beia Summit.

The Northern Hârtibaciului Plateau[7] (Grecu, 1992) is superposing partially to the studied sector, being represented by the Mediaşului Hills comprised between Moşna and Șaeş (with the two divisions - Roandolei and Agnitei hills) and by Vânători Plateau entirely, including the monticles (glimee) from Şaeş and Apold. The Roandolei Hills have a relief subordinated to the domes structure from Nou Săsesc and Copşa Mare, which have a very important role in the development of a relief with an obvious asymmetry, related to the axis of the followed anticlinal between Nou Săsesc and Laslea localities (*Romania's Geography,* III, 1987, p. 580). In Agnitei Hills, the structural relief is influenced by the succession of anticlines and synclinals whose flanks are slightly inclined: Ghijasa - Beneşti, Alțâna.

The regressive erosion, manifested with intensity on the affluents of Târnava Mare River in their source areas partially destroyed the old watershed between Târnava Mare and Hârtibaciu and pushed it to the south, beyond the line of the great heights. This is the reason why the interfluves between the affluents have been less fragmented, resulting, from east to west, a succession of long trapezoidal interfluves on the south-north direction, separated from parallel deep valleys with "canyon" profile (Romania's Geography, III, 1987). The cemented sands from the substratum lead to a less accelerated modelling, to the accentuation of the dips and to the maintenance of a straight or slightly convex profile of the slopes, delaying by their hardness the advanced evolution and conferring a youth relief character.

[6] This thing can also be explained by the activation of the active subsidence area from Alba Iulia where the basic level, which Mureş offers, is closer and lower then the level of the Olt at Turnu Roşu.

[7] The Northern Hârtibaciului Plateau is situated between the valleys of Târnavei Mari in the north, Hârtibaciului - Valea Mare in the south, Visa in the west and the Transylvanian Subcarpathians (Mac, 1972, *Romania's Geography*, III, 1987).

The Southern Hârtibaciului Plateau is represented in the analyzed sector by the Grânari Plateau, expanded to south up the alignment of the localities Dacia - Jibert - Lovnic - Văleni - Şoarş - Seliştat and partially by Rodbavului Hills between Hârtibaciu and Valea Roşii, to south up to the alignment Felmer - Şoarş - Rodbav - Merghindeal, which is superposing to the Rodbav dome. In the Sarmatian deposits from this side of the Hârtibaciului Plateau (marls, clays, sands, grits and weak cemented conglomerates) the external agents have modeled a hilly relief with weaker dips and with a more reduced horizontal fragmentation. The marl-clay and the sandy deposits favored a more intense denudation generating a different aspect from the northern part, with more advanced slopes whose contact with the meadow is marked of thick dilluvial deposits.

Beia Summit represents the eastern part of the Hârtibaciului Plateau and it superpose partially to the studied sector, being comprised between Archita Valley in north and north-east - lengthened to south-east with Paloşului Valley and Homorodul Mic, Saschiz Valley[8] and Fişer to west and closed to the south by Mare Valley. The affiliation of this summit to Hârtibaciului Plateau was disputed a lot in the specialized literature and is attributed to the common features of the anthropic and natural landscape. Thus the geographic limit of this summit passes beyond the geomorphologic one[9] (Mac, 1972) and therefore the limit of the Hârtibaciului Plateau was implicitly pushed to the inferior course of Homorodului Mare, continued to north with Paloşului Valley and Archita Valley (*Romania's Geography*, III, 1987). The tectonics and the petrographic composition of this sector comprised between Rupea and Cristuru Secuiesc, which to west passes beyond the limit of Beia Summit, evidence in the geomorphologic landscape by the diversity and the massiveness of the forms: structural relief with interfluves bridges and plateaus, cuesta steep slopes, bigger energy of relief (300 - 400 m) given by higher heights then the rest of the Hârtibaciului Plateau (700 - 800 m).

Within the limits of the studied area, the altitude lowers prevalently from south to north and from east to west, which determined the general direction east-west of the representative valleys network[10], orientated to the local subsidence areas from Turda - Luduş and from Alba Iulia. The energy of relief vary from 10 - 20 - 50 m on the valley corridors to 100 - 140 m, 180 - 200 m, 200 - 240 m north of Târnava Mare, in the sector comprised between Sighişoara and Mediaş.

---

[8] Including the monticles (glimee) from the Saschiz.

[9] The morphometric characteristics of the relief in this sector, the configuration of the relief sculptured in Miopliocene but also the geomorphologic particularities imprinted by the direct concordance (the superposition of the summits with the anticlines, and of the intrahilly depression basins with synclinals) or the one of inverse concordance (by the formation of certain depressions of anticlinal button type), have determined Mac (1972) to consider Beia Summit as integral part of Homoroadelor Subcarpathiens, pushing their limit towards west up to the depression corridor Saschiz - Daia - Buneşti, continued to south around Hârtibaciului springs by the saddle from Fişer - Cohalm - Jibert. The quoted author asserts for this limit its geologic evidencing in north by the Sarmatian formations (conglomerate facies) with the Pannonian (sandy-marl) within the limits of the major synclinal from Sighişoara, and in south, by the orientation change of the major fold bundle and their turning away to north and also the change of orientation of the main summits from the north- west - south- east direction (Gherghelău - Beia Summit) to north-east - south-west direction in Southern Hârtibaciului Plateau (quoted book).

[10] The obvious deepening of the valleys network with 200 - 300 m in comparison with the initial interfluves level lead to a fragmentation of the Târnavelor Plateau and to the outlining of its major subdivisions.

The lithologic variety, with the pelites and the detitral rocks predominance is grouping in asymmetrical rhythmical sequences from the point of view of the composition, subordinated to the marine transgressions and regressions[11]. The thickness of the layers and their alternating sediment, the presence of certain clay and marl galls inserted in the sand banks, the physical and chemical properties of the pelites particularly are just a few lithological factors that lead to the ample development of the geomorphologic processes, particularly of the gravitational ones and of those subordinated to pluvial denudation.

The torrential fragmentation register on this background a series of degraded areas at the level of interfluves and of the steeps terrace from Târnavei Mari Corridor, Hârtibaciului Basin and from the hydrographic basins of inferior order afferent to the two hydrographic artery. The relief fragmentation has a divergent character from the center of the studied sector to periphery, or, in another order of ideas, a convergent character towards the two big hydrographical axes - Târnava Mare in north and Hârtibaciul in south, to which Valea Mare is added towards Homorodul Mare. These have conditioned the modelling accordingly to the closeness of the two basic levels: Mureş at Alba Iulia and Olt at Turnu Roşu.

The present modelling and the geomorphologic risk character

In the morpholithologic and morphostructural conditions mentioned above, the processes which operates at this moment in the central-eastern part of the Târnavelor Plateau acted in the geologic past, but by their manifestation tendency, uniform and gradual in a long time, are capable of essential changes in the present geomorphologic landscape.

The researches made allow us to group the causes that lead to the amplification of the present modelling processes in Târnavelor Plateau in two groups: natural causes and anthropic causes. Beside gravity, the **natural causes** refer to: the geologic substratum through the alternation of permeable horizons with impermeable ones, the predominant monocline structure, with dip to east and north, the insertion of the anticlinal and synclinal folds, domes, which complicates the situation and generates cuesta alignments with predominantly south and west exposure; the morphometric and morphographic characteristics of the relief by the undulating configuration of interfluves, accentuated dips of the cuesta slopes and their considerable length, that condition a proportional growth of the rock volume dislocated by the gravitational processes; the meteo-climatic conditions by the predomination of the oceanic circulation, with a longer regime of precipitations in transition seasons, the alternating of these periods with intense droughts periods of the summer, manifestations with torrential character of the rainfalls at the end of spring and the first part of the summer, with a development of the torrential nucleus in the middle or in the second part of the rainfall, by the intense insolation of the slopes with southern and south-western exposure, which determines the forming of certain deep cracks in the slope, these being ulterior taken by the water in the precipitations or the melt of the masses of snow; the hydrologic conditions with a relative low flow of the rivers (except Târnava Mare), but with an accentuated torrential process of the flow down in transition seasons, with great oscillations of the flows and levels, to which it adds the existence of the springs at the end of the layers or even on the layer planes detached of erosion, which generates bog surfaces at the base of the slopes, between the land slide waves or in the longitudinal depressions between the monticles alignments (Noiştat - Movile, Apold, Saschiz, Şaeş, Valea Ciorii, Retiş etc.).

[11] The marine transgressions were accompanied by sedimentation cycle and by the deposit of certain thin horizons of clays and mud.

The **anthropic causes** are multiple, being connected mainly to land use (inadequate agricultural practices - ploughed along the dip line, grazing in excess), the change of the usage category by massive clearings in the past to obtain agricultural land or grasslands, the lack of interest for slope arrangement, the abandoning of certain arrangement works or even their inadequate execution, the fulfilling of certain regularization works which did not have the anticipated effect[12].

In the geologic, bio-pedo-climatics and anthropic conditions of the central-eastern part of the Târnavelor Plateau take place a series of processes that can be grouped in two categories, as follows. The first category includes the permanent processes that have a slow and equilibrate developing, being connected with the hydrographic network which is in a dynamic equilibrium related to the basic level (Mureş or Olt rivers). The second category of processes is the one with a seasonal rapid evolution, which periodicity and spasmodic regime of manifestation impose in the geomorphologic landscape by its effects of lack of equilibrium and the degradation of the lands, which constitutes in geomorphologic risks. These are dependent of the climatic regime and of the human intervention and take over the structural and lithologic fond modeled in advance by the rhythmical deepening of the valley network.

The mechanic impact of the raindrops (splash erosion) and the erosion in the surface (sheet erosion) are presented everywhere, being extremely active in spring and autumn on the slopes of convex form and on the surfaces with reduced degree of vegetation coating (grasslands, surfaces destined to agriculture). The rill erosion and the gulling are processes with the biggest frequency in the source areas of the affluents Târnavei Mari and Hârtibaciului, developed on cuesta slopes, on structural surfaces or even on the steep and weak inclined terraces that surpass 7 - 10^{o} dip and generate more and more evolved forms, with linear display (drains, gully) or branched (ravine). We mention the gulling source area of Vorumlacului, Moşnei and Nemşei, of Biertanului, Mălâncravului and Stejereni valleys, Şapartocul, all affluent hydrographic networks of left of Târnava Mare, as well as the ones form Grânari Plateau (Meşendorf, Fundătura - Valea Mare) tributary directly or indirectly to Olt River. Also the right affluents of Hârtibaciului (Înfundătura, Stejeriş, Iacobeni, Valea Mălaiului) have their source areas and even the ravine courses, because of an anthropic measure of deepening the course of Hârtibaciului, measure that accentuated the erosion on the affluents.

The torrential process is extended throughout the studied surface, because the majority of the affluents of the two main hydrographic arteries, as well as the brooks directed to Homorod (Valea Mare) or Olt (Şoarş), have torrential basins. This process has taken great amplitude in the past few decades (40 - 50 years), the main cause of its amplification and extension in surface being of anthropic nature, by the massive clearings of the plateau for the extension of the agriculture surfaces, practiced at the beginning of the twentieth century. This process that engraft on a clay-sandy substratum favored the deepening of the autochtonous network. The torrential aggressiveness is different especially on the cuesta and on the dip slopes with grassland utilization.

[12] Herbay (1963) mentions the inefficiency and even the risk of the regularization works effectuated on Hârtibaciu by the artificial deepening of the river bed, which accelerated the erosion on its affluents from Agnita Hills through deepening and regressive erosion and lead to slope degradation through gulling and torrential process.

Throughout Târnavelor Plateau, and mostly in its central-eastern part, the gravitational processes that model the slopes are associated in complexes, their differentiation being difficult. From these, the landslides developed both on cuesta and on structural surfaces, on the domes flanks or on the dome buttonhole slopes, impose as frequency in surface and intensity of manifestation.

In Hârtibaciului Plateau the presence of the thick sand strata with marl insertions favored the releasing of certain massive slop landslides[13], known as monticle (glimee), of great proportions (surface, the hillock dimension). These are representative in certain localities: Şaeş (1550 ha), Saschiz, Movile (800 ha), where they engraft on whole surface of the slopes and have a complex morphology. The landslide waves have great dimensions (20 - 50 m average medium height and great length, ones of a few tens and thousands of meters, having a base of 10 - 15 - 20 ha).

The monticles (glimee) display on parallel alignments (in number 3 - 6 - 8 rows, at Movile are 8 alignments), with detachment precipices with lengths of kilometers order (at Şaeş the detachment precipice has over 5 km length), being possible on their basis the reconstitution of the landslide fases. The hillock alignments[14] comprise among them big longitudinal depressions in which dominant are the processes of subsidence and suffusion associated to the cessation of the meteoric waters at the surface under the form of bogs and marshes. The hillocks decrease in height the closer they are to the base of the slope. The terminal part of these landslides is formatting of the landslide glacis, with relative reduced dips, which makes the connection with the meadow. There are also singular hillocks, spread either on the slopes (Valea Halmerului, Valea Ciorii), or on the interfluve watershed (Apold), but without being clearly marked the detachment precipice. Although apparently stabilized, these landslides constitute the domain of other geomorphologic processes with complex character of manifestation, existing a permanent risk of reactivation.

The landslides of small depth also appear under other forms - pseudoterraces, waves, and tongue. Also, the muddy flows and the solifluxion are very frequent in the studied area. These processes affect large surfaces of the slopes, manifesting mostly in their superior and medium part. The majority of the present forms are superficial and of small depth and give a wavy and uneven aspect of the slopes. The most frequent are at the base of certain structural steeps, along the contact between the Pannonian and Sarmatian formations, either against the background of an old landslide, or in the sectors where the depth of the ravines determined the breaking of slope equilibrium.

---

[13] These landslides affect generally the Sarmatian deposits, but they are to be found mostly at the limit between Sarmatian and Pliocene (Pontian - Grecu, 1992). As for the age of these land slides, we quote the results obtained by Morariu et al., (1964) after the spore-pollen analysis performed on peat samples picked from the bog areas behind the land slides waves from Şaeş (Draşcăviz and La Lac) and from Movile. These indicates a glacial-postglacial age, beginning with Pleistocene (Würm), then another phase in postglacial and a third phase at the beginning of Holocene, in the periods with important rainfalls when there were conditions of maximum lubrification of the impermeable deposits from depth, capable to release and to perpetuate the phenomenon, even in the conditions of the existence of a protector carpet of forests (Herbay, 1963).

[14] The name is given considering their shape: monticle - sharp shape, coffin - parallelepiped shape or precipice - round shape.

Considering the morphologic particularities and the regionalization made in precedence, in the central-eastern part of the Târnavelor Plateau appear important differentiations of the modelling processes and of the distribution mode in territory, in regional subunits. In this way the accumulating processes, the lateral erosion and the transportation of the fine materials (sands, clays) are specific to Târnavei Mari and Hârtibaciului Corridor. The instability of the banks and the dynamics of the meanders, by their lateral and towards downstream movement (especially in the case of Târnava Mare in the sector Daneş - Hoghilag - Dumbrăveni - Mediaş), constitute the elements which are suppose to be monitor. In the case of Târnava Mare the lateral erosion determines a permanent retirement of the right slope by the acceleration of the collapses and the land slides on the whole length of the slope.

The supply of fine alluviums (clays, mud) from the slopes contributes obvious to the filling with alluviums of the Hârtibaciului and Târnavei Mari riverbeds, to the formation of certain bog areas even to the clogging of certain lacustrine basins arranged for pisciculture or water supplying (Ighiş, Brădeni). Also, the instability of the banks and their dynamics are controlled by the torrential character of the draining, especially on the affluents of the two hydrographic collector arteries. In the conditions of a seasonal transport of slope, composed of mud draining, the valleys that drain the studied plateau region are drowned in their own alluviums. Both in north of Târnava Mare, but especially in south of Hârtibaciului Plateau, are presented the processes of regressive erosion, which determines the retirement of the sources areas and the extension of a basin to the detriment of the neighboring one (the case of Târnava Mica and Târnava Mare, or the case of Târnava Mare and Hârtibaciu) as well as a great sinuosity in surface of the watersheds.

On the linear cuesta it is registered a greater amplitude of the deep landslides[15] and semi-deep of slope, while on the structural surfaces the splash erosion is predominantly installing, the gulling and the torrential process, generating advanced forms of degradation.

The correspondence in the practical field of these processes aims the geomorphologic risk by the unpredictable character, the destructive potential of these phenomena related to the human community and to the activities carried on the territorial level. The geomorphologic risk is induced by the association of the present processes on small hydrographic basins, of I, II and III order, assignable directly and indirectly to Târnava Mare, Hârtibaciu and Olt, and the engrafting of these processes on the forms of relief with accentuated instability, generated in historical time or longer by the manifestation of certain amplitude processes (the massive land slides which have generated the monticles (glimee). A few basins remark: Şaeş, Scroafa, Stejereni, Mălâncravul, Halmerul, Valea Morii and others, in which the gravitational amplitude processes prevail (land slides, collapses) associated with pluvial denudation, which confers to the relief a special morpho-dynamic process. The speed of manifestation of these processes is great, being proved by the amplitude and the dimensions of the dislocated masses. Archive documents and the locals from Ţeline (at the spring of Hârtibaciu) described such a phenomenon, that took place violently, in 1850 near the precincts of the village, by the instant collapse of the slope and its land slide accompanied by a scary noise (Herbay, 1963).

[15] These are best represented in south by Târnava Mare at Şaeş, Saschiz, Apold, Noiştat, Ţeline, Grânari, etc.

The series of the present geomorphologic processes gain risk character when these are completed and amplified by the anthropic processes, which have as cause the clearrings, intense exploitations of the grasslands, embanking and damming of the water courses, the exploitation of the construction materials from slopes or riverbeds (Târnava Mare), as well as by the exploitation of the methane gas resources from the subsoil (Nou Săsesc, Copşa Mare, Mediaş, Sighişoara, Rodbav etc). These actions lead to the modification of the slope and riverbed morphology and to the intensification of certain present geomorphologic processes, to their association and the releasing of the geomorphologic risks. The present processes with risk character can release chain reactions at the level of the other geographic components, generating associated risks: hydrological, ecological, social, economic etc.

The regionalization and the typology of the geomorphologic risk

In the geomorphologic context presented prior to this and of the geologic and climatic conditions from central-eastern part of the Târnavelor Plateau, the geomorphologic risk phenomena are the result of the association between the rock, structure and the exogenous processes of contemporary modelling. These appear dispersed with an accelerated rhythm of action, permanently manifested or in leaps with a great frequency and amplitude. The geomorphologic risk phenomena in this area are unpredictable and have a raised destructive potential, considering the density of the human settlements and the land use. The action of these processes with risk character generates economic losses, which derive from the loss of the soil fertility and from the diminution of their productivity. In the situation of the extreme manifestations these would have as effect the impossibility to continue the gas exploitation and eventually human lives losses or critical social conditions.

Considering the high series of geomorphologic risk phenomena and their frequency, as well as their effects, next we propose a regionalization of the geomorphologic risk in the central-eastern part of the Târnavelor Plateau and a classification on degrees and different genetic criteria, from weak risk to sever risk (Fig. 2). The classification and the regionalization take into account the chronology of the forms, the dynamic of the phenomena evolution, the duration and the intensity of the present processes and their amplitude.

The weak and very weak to inexistent risk appears on the interfluvial wooded summits and on the weak inclined terraces with low dips (0 - 3 - 5^{o}). The areas with weak risk have low extension in north of Târnava Mare, presented under the form of patches in Prodului, Seleuş (542 m) and Pădurea Bisericii hills. In south, in Hârtibaciului Plateau, the areas with weak and very weak risk are more expanded at the level of the main sinuous interfluve between Târnava Mare and Hârtibaciu, in Pelişor Hill (640 m), Făgetului Hill - Chiafardoala - Poieni - Apold, or to the east at the Hârtibaciu springs in Lempeş, Cloaşterf, Rosieş, Meşendorf hills.

From these summits unloose to north and south secondary interflluvial surfaces with weak risk comprised between the parallel valleys affluent to Târnava Mare: Lupoaia Hill (501 m), Valchidului Hill - Lat Hill, Roandolei Summit, Felții Hill, the interfluve between the Stejereni and Şaeş Valley. In south, to Hârtibaciu, these surfaces are more and more restrained in Strumşelului Hill to Stejeriş, in Stribrich and Tichiu hills to Iacobeni.

The summits are narrow and present a weak limited risk, especially in the deforest sectors, because of the regressive erosion manifested through gulling in torrential basins of I and II order. The weak risk also occurs on the slopes with dips of 5 - 7^{o}, expanded under the form of colluvio - prolluvial glacises of one side and the other of the riverbeds in their medium and inferior course, as well as on the glacises that fossilize the steep terraces and make an easy passing among the weak inclined terraces of Târnava Mare.

These areas are not under the influence of degradation or very little amendable to pluvial denudations or superficial landslides, they being used in agriculture.

The **moderate risk** occurs at the level of the slopes with dips bigger than 5 - 7^o up to 15^o and is conditioned by the periodical reactivations of low depth landslides and surface landslides, by the gulling source area and by the gulling associated with low amplitude collapses. The slopes affected by the moderate risk are dispersed, being especially deforested, with grassland use, in medium and upper basin of Moşna, Nemşa, Biertan, Laslea, Crişului and Stejereni valleys, with an extension to north up to the Târnava Mare Valley at Sighişoara. At east of Şaeş, in Vânători Plateau, the moderate risk is present at the level of the wooded slopes of the autochtonous: Vâlcandorf, Şapartoc, Naghiroc, Scroafa, powerful gullied.

In the eastern part of the Hârtibaciului Plateau, the moderate risk occurs on the slopes with different dips from average to powerful of Beia, Valea Mare valleys on the left and on the right up to Rupea. In Grânari - Beia sector the moderate risk is caused by the annual reactivations of certain depth land slides on the interfluvial slopes and areas under the form of grassland use, affected in association of ravines, gullies, rill and splash erosion. The representative areas with moderate risk occur in north of Hârtibaciu in Apold - Netuş - Iacobeni - Stejerişu - Ruja sector, on the deforest slopes of the right affluent valleys of Hârtibaciu, but also in south in Agnita (west) - Movile - Valea Nouă (east) sector, on the deforest slopes of the interfluve between Albac and Hârtibaciu.

The Târnava Mare and Hârtibaciu riverbeds and their affluents moderate risk is subordinated to the liquid and solid flows transit, which condition the alluvionation, linear erosion and undermine of the banks. The supply of fine and very fine alluviums contributes to agglomeration of the riverbeds and getting stuck of the courses in the sectors.

The **high risk** occurs on the slope areas with big and very big dips (over 15 - 20^o), with sunny and semi sunny exposure and the slopes near the lacustrine cuvettes on the Hârtibaciului Valley (Brădeni). These are predominant as extension in north of Târnava Mare, the cuesta front being the place of display of certain powerful evaporation because of the insolation, with the activation of certain slope processes (dry land slides) which are based on the disintegration - drying fundamental processes. In the periods with precipitations, the moistening of the deposits lead to low depth land slides under the form of tongue and pseudo-terraces and to mud flows on the slopes. Frequently these processes are associated with collapses (rock falls).

The slopes with high risk to depth landslides frequently associated with gulling and torrential process occupy important areas in south of Şaeşului Valley in Daia - Apold sector, in Halmerului basin and on the eastern slope of Hârtibaciului at Brădeni. Also, areas with high risk occur on the left slope of Hârtibaciu in source area between Brădeni - Retiş - Bărcuţ, where the torrential process associated with splash erosion and with landslides have weathered the whole slope.

The Buneşti - Beia - Rupea sector of Beia Hills has a high risk because of the depth landslides associated with powerful ravines and torrential process. There are also superficial landslides of low depth, which reactivates the deep ones. The lands are weak productive, used as grassland and meadow, the acceleration of the processes are also due to man negligence by the abandonment of the anthropic terrace works.

The high risk is also common to riverbeds autochtonous to the plateau, their thalweg being depth in their own alluviums; the banks are steep and amendable to erosion and collapse. A special situation is Târnava Mare where the major riverbed presents a high risk to floods and overflowing subordinated to meandering processes of the minor riverbeds in

Sighişoara - Hoghilag sector, with frequent mutations of riverbed in historical time, caused by the flow oscillations in the periods with rich precipitations (1998, 1996, 1975, 1970 etc.). This risk is amplified by the rigidifying through the damming up of the course in certain sectors, by the construction of certain sub-dimensioned bridges (Daneş, Hoghilag, Aţel) in the situations of certain extreme levels and flows (1970, 1975), or by the exploitation of the building materials from the riverbed (sands). The excavations in the minor riverbed determines the lateral migration of the thalweg and the accentuation of the depth erosion through whirlpool streams, modifies the report accumulation erosion between the riversides and activates new meander or untwining sectors.

Associated, the major riverbed of the studied area presents risk at swampy sector by the directly supplying from the minor riverbed through overflowing, or indirectly supplying by infiltrations and supplying through ground-water layers. The high risk in the swampy area occurs also in Hârtibaciu riverbed in the upper and the middle course within the intrahilly depression from Brădeni area. The harness of the course and the retention lakes from downstream up to Netuş area haven't solved the existing "problem" of the swampy meadow presence, even more it changed the basic level of the water, accentuated the local erosion manifested on Halmer and on Hârtibaciu in upstream. Also the depth of the Hârtibaciu River course on the anthropic way obliged the affluent rivers to reach the new basic level and in this way to deep the riverbeds, gaining ravine courses and degradation the slopes through regressive erosion.

The sever risk is presented on an important surface in the Hârtibaciului Plateau (on a total surface of over 2500 ha) and is subordinated to massive slope landslides of monticles (glimee) type. The slopes have accentuated dips; have no forest vegetation, with erosioned erodisoils and argilluvial soils, the erosion being special both in depth and in surface, the local affected lands being pulled out from the agriculture circuit. Although apparently stabilized the local moticules (glimee) constitutes the object of the reactivations by depth landslides, collapses, by the reopening of the old detachment precipices or the creation of new ones in monticules alignments or by the intensification of the torrential erosion with regressive character. In the longitudinal depressions between the monticules alignments the swampy areas and the pools that stagnate between the soil-waves constitutes potential nucleuses of reactivation by the influencing and the generating of certain subsidence processes and also suffusion processes.

All these kind of processes is verifying on the right slope of the Scroafa Valley at Saschiz, on the right slope of Şaeş Valley in south of Sighişoara (where it occupies in the present a very large area of a total of over 1200 ha, being the most representative such surface with this kind of landslide from the whole Transylvania area), on the right slope of Morii Valley at Movile area, in the basin of Halmerului and of Cioara Valley (on the right side), in the south part of the Agnita locality, near Telina precincts in Ocolului Hill area, at Retiş locality of one side and the other of Hârtibaciu, in Grânari - Trei Movile sector at Văii Mari source area.

The problem of the risk of reactivation of these massive slope landslides is very important because of the presence of the accentuated dips of the local monticle slopes, because of the local swampy areas and the stagnations between the monticules and last but not least because of the location of certain constructions (sheepfolds and stables) and pastoral or even agriculture utilization of the slide glacis from the contact with the rivers meadow in the quoted areas.

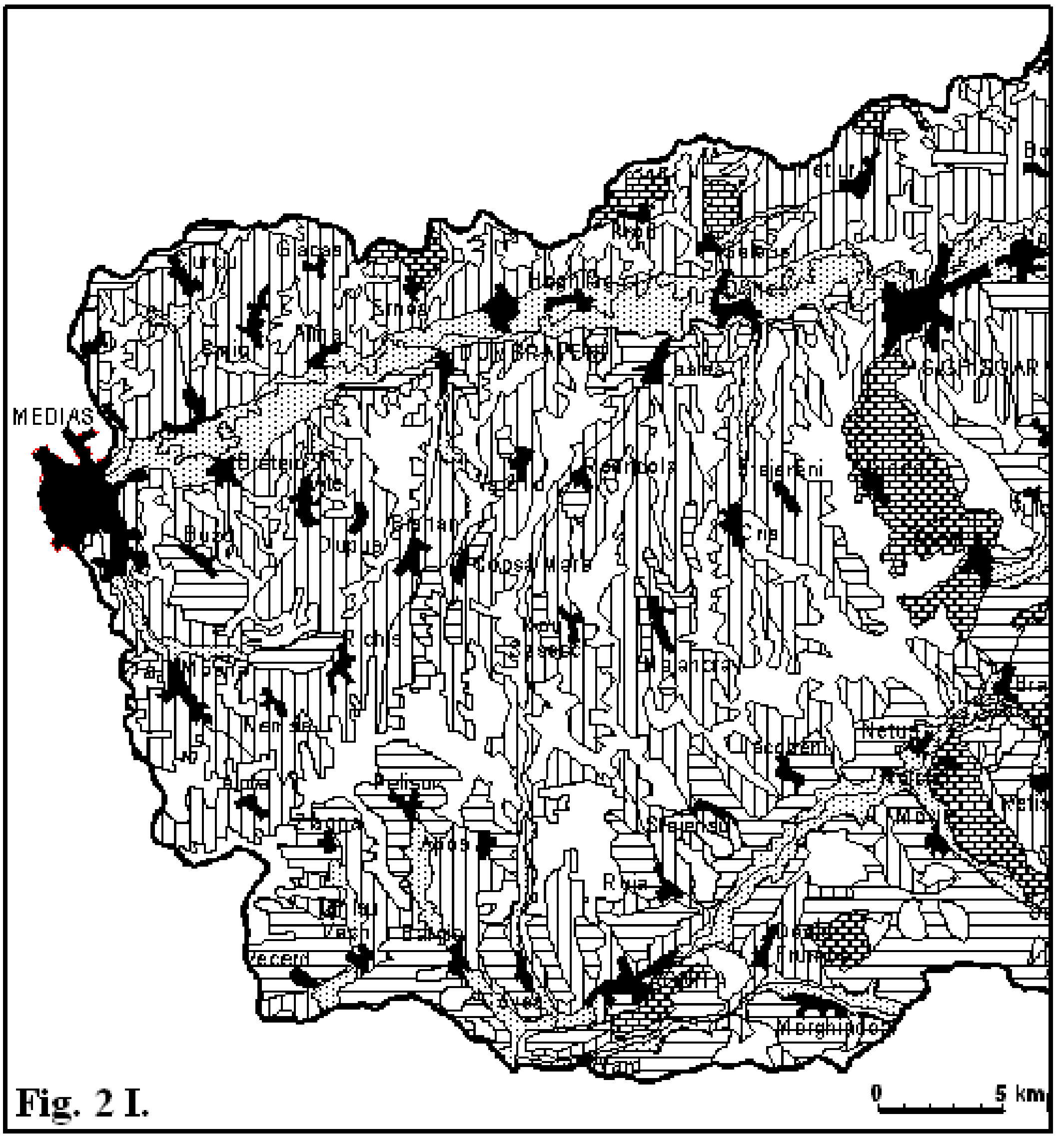


Fig. 2 I.

Figures 2 I - II: Geomorphologic risk map in the central-eastern part of the Târnavelor Plateau (I the western and II the estern sector of the studied area 1. Slopes at sever risk subordinated to massive slope landslides of monticles (glimee) type and to reactivation of them by the intensification of the torrential erosion with regressive character; 2. Slopes at high risk to depth landslides frequently associated with gulling and torrential process; 3. Slopes at moderate risk conditioned by the periodical reactivations of certain low depth landslides and surface landslides, by the gulling source area and by the gulling associated with low amplitude collapses; 4. Weak and very weak risk on the interfluvial wooded summits and on the weak inclined terraces, narrowed by the regressive erosion manifested through gulling in torrential basins of I and II order; 5. Alluvial plains at high risk to floods and overflowing subordinated to processes of the minor riverbeds, caused by the flow oscillations in the periods with rich precipitations, by meandering processes with frequent mutations of riverbed in historical time; 6. Riverbeds at moderate risk subordinated to the transit of liquid and solid flows, which condition the processes of alluvionation, linear erosion, the undermine of the banks; 7. Lacustrine basins arranged for pisciculture or water supplying as nucleuses of reactivation by the influencing and the generating landslides and falls; 8. Swampy areas and the pools that stagnate between the soil-waves constitutes nucleuses of reactivation by the influencing and the generating of certain subsidence and suffusion processes; 9. Settlements.

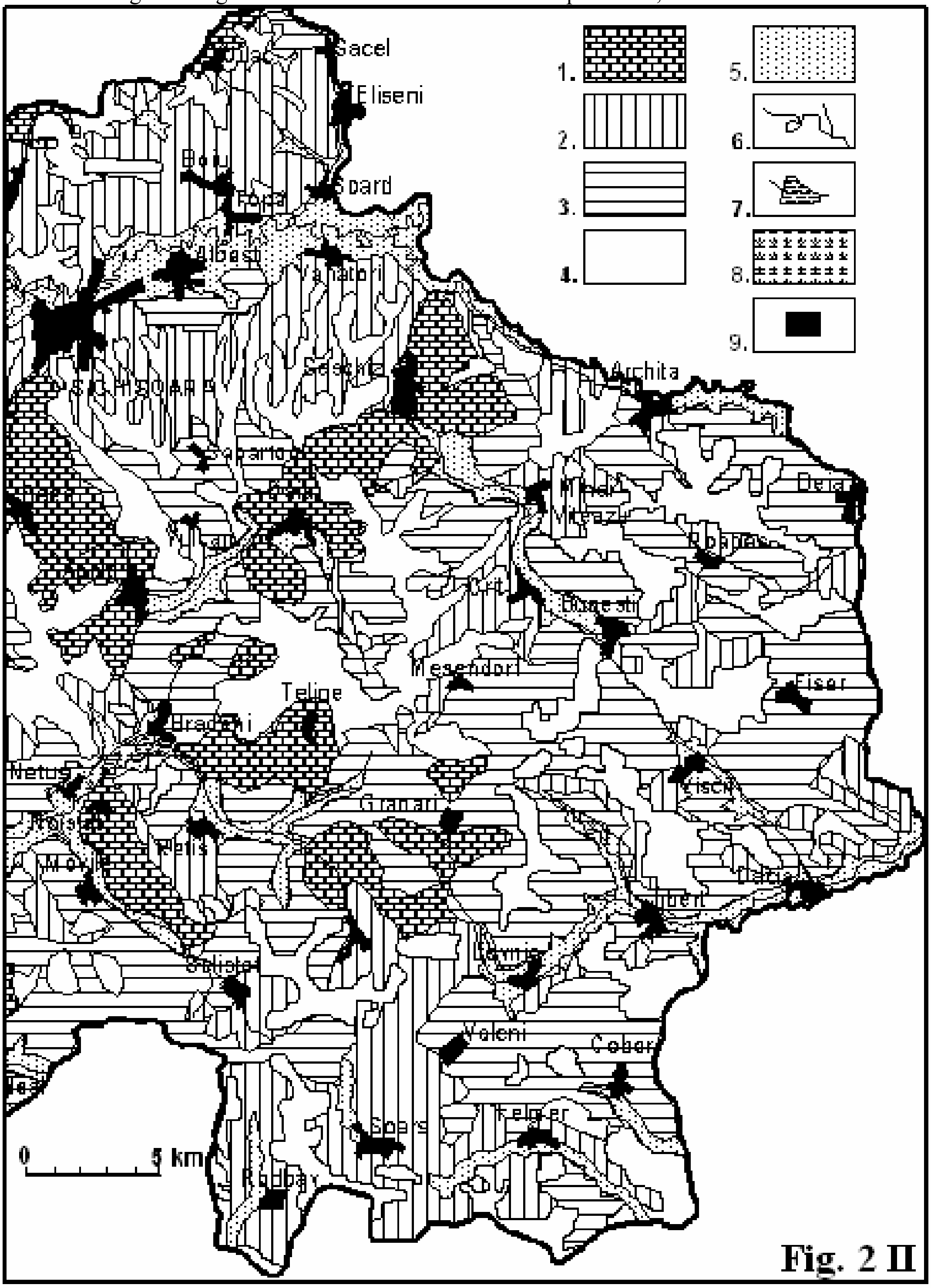


Fig. 2 II

CONCLUSIONS

The present geomorphologic processes in the central-eastern part of Târnavelor Plateau, mostly the ones developed at the level of the slopes are of great amplitude, have a great frequency and an intensity of manifestation that confers them a risk character. These determine state modifications of the geomorphosystem; qualitative leaps induced by the exceeding of the state parameters. In these cases the geomorphologic system can't come back to the state of equilibrium previous to the manifestation of the process or of the complex of disturbing processes, being in a chaos and lack of balance state - a transition phase to a new equilibrium. In this context, the appearance and the development of the present geomorphologic processes with strict rhythms and intensities that determine their risk character impose an intensification of the observations, an estimate and a qualitative and quantitative reference of them in time and space.

In this direction, the geomorphologic phenomena prognosis is based on specialized studies which relates to the delimitation of the potential factors, the evaluation of the present and relict forms, the evolution in time and space of the phenomena, the capacity of supporting the substratum, to which it adds the restriction categories and the land adaptability. The equilibrium adjustment and maintenance can be solved on anthropic way by a series of measures for the prevention and attenuation of the effects of these processes, but the witness of their manifestation remains for a log time, being necessary a reconversion of the lands and a rational management of the soil and subsoil resources in the resistance limits of the environment.

REFERENCES

1. Grecu, F., 1992 – Bazinul Hârtibaciului. Elemente de morfohidrografie. Edit. Academiei Române, Bucureşti, 167 pp.
2. Herbay, A., 1963 – Porniturі de teren în Bazinul Hârtibaciu. In: *Probl. de Geogr.*, X, pp. 121 - 133.
3. Josan, N., 1979 – Dealurile Târnavei Mici. Studiu geomorfologic. Edit. Acad., Bucureşti, 142 pp.
4. Mac, I., 1972 – Subcarpaţii Transilvăneni dintre Mureş şi Olt. Edit. Acad., Bucureşti, 156 pp.
5. Morariu, T., Diaconeasa, B., Gârbacea, V., 1964 – Age of land-slidings i the Transylvanian Tableland. In: *Rev. Roum. Géol. Géophys. Géogr., Série deGéographie,* tme 8 pp. 149 - 157.
6. Posea, G., 2002 – Geomorfologia României. Edit. Fund. “România de Mâine”, Bucureşti, 444 pp.
7. * * * , 1987 – Geografia României, III, Carpaţii şi Depresiunea Transilvaniei. Edit. Acad. Rom., Bucureşti, 647 pp.

STRATIGRAPHIC CONSIDERATIONS ON THE SOUTHERN SECTOR OF THE TÂRNAVA MARE PLATEAU (TRANSYLVANIA, ROMANIA)

*Rodica CIOBANU **

* Brukenhal National Museum, Natural History Museum of Sibiu, Cetății Street 1, Sibiu, Sibiu County, Romania, RO - 550160, rodi_ciobanu2005@yahoo.com, rodica.ciobanu@brukenthalmuseum.ro

KEYWORDS: Romanian Transylvanian Basin, Târnava Mare River Plateau, stratigraphie.

ABSTRACT

The paleo-geographical evolution of the south-eastern Transylvanian sector, thus also of the area which is the subject of the current study, encompasses two stages: the former includes the sedimentation cycles of the Miocene, Pliocene and up to that of the Pleistocene, the latter the stabilization of the relief, which started at the end of the Pontian. The geology of the area has involved marine transgression stages with complex sedimentation cycles (marine, continental and aeolian deposits), as well as regression stages, tectonic deformation and major erosion.

The area is characterised by the variety of the facies. Gritstones, conglomerates, tuffs - alternating with marls or loams. The thick layers of sand intercalations between the permeable and impermeable strata are allowing active geomorphological processes in the area. The deep tectonic condition, due to salt domes, is also contributing to these processes.

RÉSUMÉ: Stratigraphique contributions en ce qui concerne le secteur sud du Plateau Târnava Mare (Transylvanie, Romanie).

Dans l'evolution paléogéographique du secteur Sud-Est de Transylvanie et de l'espace qui fait l'objet de cette étude, on peut mettre en èvidence deux ètapes: celle qui renferme les cycles de sédimentation, les phases de la troisième période de l'ère tertiaire entre l'Oligocène, le Pliocène jusqu'au début du Pleistocène; celle de la stabilisation du relief débutant à la fin du Pontian. La géologie de la zone a connu des étapes de transgressions marines aux cycles de sédimentation (dépôts marins, continentaux, éoliens) et de regression, déformations tectoniques, fortes érosions.

L'aire se caractérise du point de vue tectonique par la variété des faciès pétrographiques. On y trouve, alternativement, des dépôts de grès, des conglomérats, des tufs, marnes et argiles. Les intercalations des couches épaisses de sable et des sédiments de roches perméables et imperméables favorisent au Nord du Plateau de Hârtibaci des processus géomorphologiques actif (tel glissement de terrain-glimes). À cea procès contribuent aussi la tectonique de profondeur dûe aux dômes salins et aux plis ondulés.

REZUMAT: Considerații stratigrafice privind sectorul sudic al Podişului Târnavelor (Transilvania, România).

În evoluția paleogeografică a sectorului sud-estic transilvănean şi deci şi al arealului ce face obiectul prezentului studiu, s-au conturat două etape: cea care include ciclurile de sedimentare, fazele tectonice miocene, pliocene până la începutul Pleistocenului şi cea de a doua a perfectării reliefului, începută la sfârşitul Ponțianului. Geologia zonei a cunoscut etape de transgresiuni marine cu cicluri de sedimentare complexe (depozite marine, continentale, eoliene) şi de regresiune, deformări tectonice, eroziuni puternice.

Arealul este caracterizat din punct de vedere tectonic de varietatea faciesurilor petrografice. Sunt prezente în alternanță depozite de gresii, conglomerate, tufuri respectiv marne sau argile. Intercalațiile de strate groase de nisipuri între strate permeabile şi impermeabile favorizează în zona ce corespunde nordului Podişului Hârtibaciului, procese geomorfologice active (alunecări de teren de tip glimee). La aceste procese, contribuie şi tectonica de adâncime, datorată domurilor salifere şi cutelor diapire.

INTRODUCTION

The specific area that we have investigated represents a part of the central eastern sector of the Transylvanian Basin, situated between the Târnava Mare and Hârtibaciu rivers. From a geological perspective, the entire region of the inner area of the Romanian Carpathians is regarded as the Transylvanyan Basin. Geographically, this sector is included in the area of the Târnava Plateau, more specifically in its southern region, which corresponds to the eastern part of the Mediaş Hills and the Hârtibaciu Plateau (central-eastern part).

The area has caught the attention of geologists, especially with regard to its salt domes, mostly those that are productive. The exploitation of natural gas has led to an intensification of research on the salt domes, particularly in Noul Săsesc, Noiştat, Dealul Frumos, etc. In the 1960s drilling was undertaken, later to be further analysed and assessed from a scientific perspective. In the gas domes to the north and south of the Târnava Mare River, drilling was undertaken from which the analysis of the mechanical recording has led to a better understanding of the deep geology. The researches conducted by Vancea (1960), Ciupangea et al., (1970) still represent important reference points for the geology of the depression basin and of Transylvania, especially of the gas domes. Several geological studies, addressing this studied area, have unfortunately remained at the manuscript stage, in methane gas central offices.

The diverse lithology and fragility of the geological structure against environmental elements enabled the area to develop a special slope process relief, due to large-scale landslides - which are actually cited in the geographical literature, such as the glimees (landslips) from Movile, Saeş etc. The area studied (Fig. 1) has attracted the interest of both geologists and geographers (researches from other fields too have looked at this area, but these are not the focus of the current study). The geologists focused not only on issues related to stratigraphy (lithological descriptions, fossil fauna identifications) but also on particular economic issues. It was indeed the latter that supported the former.

MATERIALS AND METHODS

The current study, which relates to the stratigraphic description of the deposits in the area under study (Fig. 1), was undertaken in order to complete the picture by revealing also the geological substrates. The considerations regarding the stratigraphy of the area are the result of an analysis of the literature, together with the mapping of the zone.

RESULTS AND DISCUSIONS

Stratigraphy

Since the habitat is part of the Transylvanian Basin, the south-eastern sector, the geological evolution is connected to that of the basin. Thus, the entire basin has experienced in its geological history two major phases - that of a basin, in which the sedimentary molasse deposits of the Badenian-Pontian cycle have accumulated, and another of Quaternary modification, which led to the current morphological aspect of the system. The zone placed within the depression basin of Transylvania began its evolution at the same time as the Alpine orogenesis, when the crystalline mountain heights were covered with thick layers of sediments. The uplifting of the north-western part of the depression, followed by Neogene volcanic eruptions on the eastern side of the system, facilitated the sedimentation of salt beds of rich lacustrine systems (sands and clays). The main part of the sediments which fill the Transylvanian Basin is represented by these Neogene deposits, which play an important role in the composition of the methane gas accumulation. The foundation is the result of the dismemberment of the Transylvanian-Pannonian Plate, with crystalline Mesozoic schists - the pre-Alpine crystalline schists, the Mesozoic sedimentary rocks and the Neogene volcanic rocks.

The Transylvanian system started to evolve as an accumulation basin placed in between the mountains towards the end of the Cretaceous. Up until the Middle Miocene, the sea had not yet covered the Transylvanian system entirely, but rather only in the form of incursions, such as in the southern and south-western sector. The evidence lies in the limited spread of the Palaeogene deposits.

From the final stage of the Badenian, the emergence of the Carpathian orogenesis and the submergence at the edge of the basin have led to the accumulation of significant deposits of conglomerates, of piedmont nature. The sediments laid down in the second stage of the Transylvanian basin evolution, the Neogene molasses, can also be tracked in the study area, starting with the middle Miocene. It is here that the Miocene sediments show the greatest development - especially the Sarmatian, Maeotian, lower Pontian and the Quaternary. The Neogene sediments which are included in the composition of the Transylvanian Basin are characterized by petrographic uniformity and monotony. These sediments belong to the Miocene and to the Quaternary. The Sarmatian is made up of bluish-grey marls, with intercalations of sand, slightly cemented at times, which extend beyond 10 m in thickness. The Sarmatian is covered by young formations towards its surface (Fig. 1).

The Neogene is characterised by the development of various lacustrine continental deposits, which become salty laterally, marked by frequent marine recurrences. Towards the end of the Miocene, the waters sweetened significantly, a process accompanied by an intensification of aeolian deposition, so that Dacian deposits are recorded only on the south-eastern border of the Transylvanian Basin.

The Sarmatian deposits, regardless of any distinction whatsoever, have formed over the Badenian deposits (salt formations plus marl formation with *Spiriatella*) and when they come across in bore holes they do so in the form of molasses, monotonous from the lithofacies perspective. The Sarmatian is made up of marl, clay, sands and, depending on conditions, one may encounter limestone and dolomite. Stratigraphic bench-marks appear at different levels in the sequence, such as the Ghiris Tuff which can also be found in bore holes and outcrops due to erosion. Therefore the Sarmatian is characterized by thick beds of brownish-grey marls (up to 120 m), alternating thick layers of sand (up to 60 m), with thin intercalations of limestone-dolomite and tuffs, of various aspect and thickness. The pelitic-psammitic facies become coarser (conglomerates, gravel, etc.) in the marginal areas (Tab.1).

The Sarmatian in the study area is highly fossiliferous; thus a great number of fossils have been described, especially around the localities of Saschiz, Retiş, Grânari, Apold, Daia - especially collected from a stratum of conglomerates and gravels. Note that the village of Daia, near to Sighişoara, is referred to in older papers as Daia Săsească, in order to distinguish it from the locality of Daia near Sibiu, also called Daia Românească.

Figure 1: The southern sector of the Târnava Mare Plateau - geological map
(after map Sighişoara, Sibiu, Braşov, Covasna 1:50.000).

Table 1: The Sarmatian fauna from the study area (Vancea, 1960; Ciupangea et. al., 1970; augmented by the author).

Areas of collection		Lithology	Fauna
Noiştat - Daia Noiştat - Retiş	Saschiz-Rodbav Sector	conglomerate-gravel	*Ervilia podolica,* *Tapes gregaria,* *Cardium obsoletum,* *Potamides mitrale*
south of Retiş		sand-marl deposits	
north of Daia		marl deposits with coal remains located on clay conglomerates	*Ervilia podolica,* *Tapes gregaria,* *Cardium obsoletum,* *Potamides mitrale* *Cerithium rubiginosum* *Mohrensternia inflata*
south of Apold		marls with thin intercalations of hard limestone	*Cerithium pictum* *Cerithium disjunctum* *Mactra podolica* *Cardium* sp.
Retiş - south of Grânari		coarse sand	*Ervilia podolica* *Tapes gregaria,* *Cardium obsoletum* *Potamides* sp. *Cardium* sp. *Modiola* sp. *Buccinum* sp.
Dealul Frumos Dealul Blosiului			*Ervilia podolica* *Ervilia trigonula* *Mohrensternia inflata* *Bulla* sp. *Cardium* sp.
Retiş - Ţeline Grânari		tuffs similar to the Ghiriş Tuff (0.20 - 6 m)	
North-west of Bărcuţ	Criţ-Văleni Sector	sandy conglomerate	*Potamides mitrale* *Hydrobia* sp. *Mactra podolica* *Cardium* sp.
Lovnic - Grânari		alternating violet-blue marls with sandstones and grit stnes	
East of Jibert		a sandy complex (~ 200 m thick) with an intercalated coarser conglomerate emerges over the marls-sandstones-gritstones alternation	
Lovnic		sand complex and conglomerate beds accompanied by violet-blue marls, which include beds of coarser tuffs (1.5 - 6 m)	

Within the Sarmatian succession, based on the fossils identified here, are the Buglovian, the Volhinian and the lower Bassarabian. The analysis of the data from the prospecting bore holes indicate within the Sarmatian a passing from a peltic to a psammitic facies, in the central part of the Sighişoara - Agnita alignment within the study area (Ciupangea et al., 1970)

The lithological variations in the Sarmatian succession point towards the tectonic evolution of the depression during the settlement of the formations. Thus, it is believed that the high frequency of molluscs in this region is due to their transport from the edge of the depression, the same place of origin of the gravel.

The studies undertaken on the volcanic tuffs, that is mineralogical-petrographic and chemical analyses, have led to the conclusion that the tuffs of the upper Sarmatian are different from those of the lower Sarmatian (Buglovian) through their basic character. Among the Sarmatian tuffs, the most intense development can be seen in those from the border of the Buglovian-Volhinian, the Ghiriş Tuff, which is distinct from the other Sarmatian tuffs that are encountered in the bore holes, as revealed by their mineralogical composition, similar to an andesite with augite.

When the Buglovian - which marks the beginning of the Sarmatian - can be distinguished, it displays no special characteristics and is believed to include the marl-sand deposits between the marls with *Spiriatella* (Badenian) and the Ghiriş tuff. Within the complex of Buglovian strata, approximately 240 m under the Ghiriş tuffs another tuff level was identified, the Hădărăni Tuff (at the Noul Săsesc bore hole the Hădărani Tuff was found at a depth of 1.322 m) (Ciupangea et al., 1970).

The Volhinian and Bassarabian include formations with a similar lithology to the Buglovian, and a rich fauna which includes: *Ervilia podolica, Mohrensternia inflata, Ceritium rubiginosum, Mactra podolica, Elphidium aculeatum* and *Elphidium macellum* (Mutihac, 1990). The Volhinian-Bassarabian succession is enclosed by marl-clay horizons with tuffs.

In a nutshell, we estimate that the Sarmatian in the study area reaches the surface especially in its eastern sector and, from a lithological point of view, is marly-sandy towards the west of the area, whereas towards the east the sandy deposits are developed as thick beds (the Sarmatian finishes with sand strata 350 - 400 m thick) with sandy or marl conglomerate intercalations, and every now and then with intercalations of tough limestone and tuffs, among which the Ghiriş Tuff is distinctive.

The superior Miocene deposits cover the sector studied from south-west to south. The relation between the Sarmatian and the Meotian with respect to the lower Pontian was clarified by Ciupangea and Vancea: there is a gap of sediments between them (Mutihac, 1990).

Towards the end of the Sarmatian, there must have been a period of erosion in the south-eastern area of the Transylvanian Basin as well, in a period which corresponds to a withdrawal phase of the sea, one which witnessed the sedimentation of the strata which make up the Meotian. At the beginning of the Upper Miocene a discordance which appears related to the expansion of the area held by the waters of the Transylvanian Basin, the younger strata were laid down over the older formations. The Meotian deposits are transgressive over the Sarmatian. At Apold, Daia and Saschiz they display a change of facies, represented by massive conglomerates. In the eastern sector they are turning into sandy facies. The alternation of the marine field with the continental one was frequent on the banks of the basin, and we usually come across psefit-psammitic coastline facies.

In the area of the gas domes from the Transylvanyan Basin drillings were undertaken and the mechanical logging was searched into throughly by many geologists, among whom Vancea (1960), Ciupangea et al., (1970), have published the results of their research. Of these gas domes, Noul Săsesc represents the most easterly. The Noul Săsesc dome was researched thoroughly and Vancea (1960) has described the lithology of the deposits around and on the top of the dome. He discovered that these deposits are mostly thick banks of sand. Besides the sands and the marl packages, one notices that entirely subordinated to this fact discontinuous volcanic tuffs come up, especially when sands arise (the Meotian deposits from Noul Săsesc are made up of marl (- 98 m) and sand (- 81 m)).

In the eastern part, a second horizon of the Meotian is made up of weakly consolidated conglomerates, sometimes tough and with much more cement. In the domes from Nadeş and Noul Săsesc, the complex of strata on the top of the Sarmatian contains fresh water (Vancea, 1960).

Within the Pontian deposits of the Transylvanian Basin, and therefore for the study area as well, the following horizons were distinguished: the lower sands horizon, middle marl horizon and upper sands horizon (Tab. 2).

In the neighbourhood of Sighişoara, the Pontian deposits display intercalations of eruptive material, represented by andesite tuff, distributed fairly frequently. To the east of Sighişoara one can observe the Pontian conglomerates, which arose as a result of the gravel torrents as well as from marl and clay balls of various sizes, spread all over the sand beach.

Table 2: Stratigraphy of the Pontian deposits (Vancea, 1960; Ciupangea et al.; Mutihac, 1990; augmented by the author).

Pontian deposits	Areas where the fossil fauna was collected	Lithology	Fossil fauna and flora	Areas of characteristic development
Lower Sands Horizon	Sighişoara, Şaeş, Apold, Vulcan, Daia	thick sandstone beds with coarser concretions and marl intercalations	*Congeria partsch* *Melanopsis fossilis* *Melanopsis impressa* *Cardium* sp. *Pinus kotschyana* *Pinus* sp.	Apold-Vulcan-Daia-Saschiz Sighişoara (200m thick) Noul Săsesc (160m)
Middle Marl Horizon		grey marls, of limestone with sandy intercalations, tuff levels towards the upper side	*congerii* *limnocardiide*	outcrops north of Albeşti, Boiu, Şoard, north of Şapartoc, east of Sighişoara-Vulcan
Upper Sand-stone Horizon		thick beds of sandstone which contain gravel lenses	*Congeria subglobosa* *Melanopsis impressa* *Unio* sp.	

Throughout the Quaternary the area was subject to intense erosion, the continuation of erosion which had started in the Upper Pliocene. The erosion is due to the small degree of cementation of the Neozoic deposits, and the strong uplift of the depression sediments as a result of the general uplift of the Carpathian blocks.

The uneven uplift of the latter broad blocks undergone by the Neozoic deposits resulted in the uneven distancing of the Pliocene and Sarmatian deposits from the Transylvanian Depression. Although the predominant phenomenon was one of erosion, the Quaternary deposits display a very wide distribution. Thus, glacial piedmont at the contact with the depression, torrent piedmont, proluvial deposits in the cone of debris ejection, terraces, alluvial and aeolian deposits, etc., indicate deposition.

Tectonics

Over the divided letter board of the Transylvanian Basin, Miocene, Pliocene and Quaternary formations are laid, which are involved in diapir folds (anticlinal fold where salt pierces overlying rocks) and dome tectonics (Fig. 2). Salt migration from the centre of the basin towards marginal areas, where it generated diapir folds, and the thickening of the salt bed through tectonic pressure, have led to the emergence of domes, among which the Cristur - Țeline alignment is also included in the study area.

Geophysical prospecting has pointed out several deep fractures of various degrees in the Transylvanian Basin, which divide the letter board of the depression into blocks which are further affected by a network of faults. The post-Badenian tectonic movements have determined the hydrological entities which used to flow through the Pliocene deposits, to change their course after the moving off the pre-Pliocene deposits.

The area displays a complicated tectonic structure due to the salt plate which covers the entire Basin of Transylvania. This salt plate (50 - 500 m thick) has played also the role of lubricant, and has slipped slightly westward as a result of the great uplift of the Eastern Carpathians from the Western, so that folds and domes were created. It is likely that the sliding took place to west and east, thus creating diapir folds and domes all over the basin. Here and there, the salt in the domes has reached through the post-Badenian formations in the north, east and west (Posea, 2002).

The Sarmatian deposits and especially those from the end of the Miocene display a monocline disposition since between them there are major differences of tectonic style. The Badenian and Sarmatian deposits represent the main supporting structure, the „bone structure" of the anticline**,** whereas the Meotian and Pontian deposits represent the filling of the syncline**,** which have themselves suffered second-degree foldings.

From the tectonic point of view, the Neogene is folded, the strata displaying significant dislocations, which led to anticline and syncline formation, the former being domed and widened, as in the Sighişoara-Nadeş anticline case, while the Lacul-Albeşti syncline is narrow.

The Neogene foldings gave rise to gas domes, among which the Filitelnic and Nadeş domes can be indicated. The great 5000 m thickness of the Neogene deposits, among which the Sarmatian represents a significant proportion, alongside their facies aspect, imply a slight but continuous subsidence movement for the entire infill period of the Basin.

The Neogene formations which emerge belong to the Upper Miocene (Meotian and lower Pontian); it seems that during the Dacian the sedimentation process of the old lake was finished. At the beginning of the Quaternary, the entire Basin of Transylvania was uplifted along with the Carpathian Space, and the hydrographical network sank at the same time with the general uplift and the fragmentation of the platform, which was transformed into a hilly region. The study area is part of the Târnave Plateau, which can be characterized by a hillock-hilly landscape, with valleys alongside terraces and river-beds.

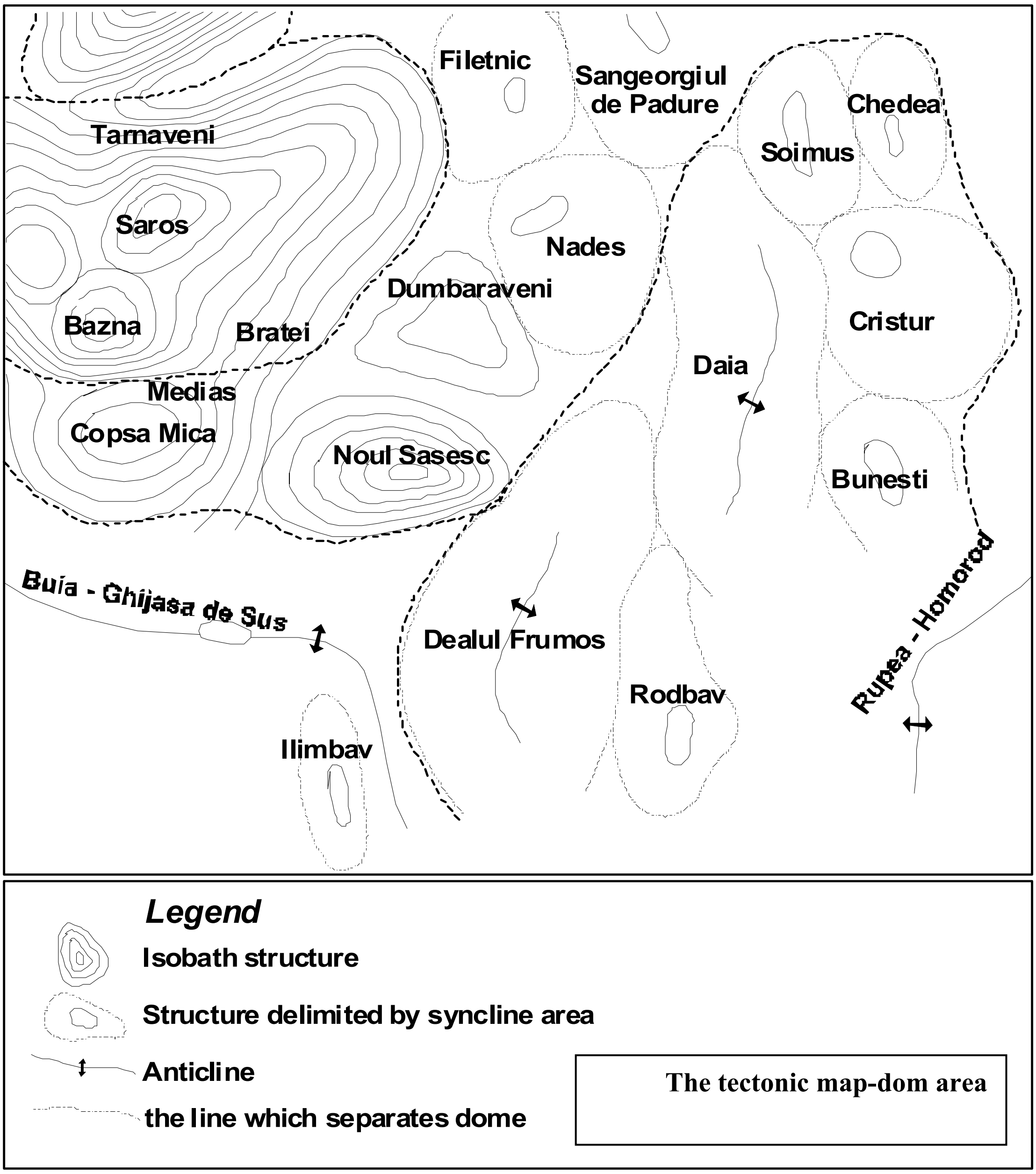


Figure 2: The tectonic map-dom area (Vancea, 1960).

CONCLUSIONS

One can identify two stages in the paleo-geographical evolution of the south-eastern Transylvanian sector, and therefore as well of the area which represents the subject of our study: the one which includes the sedimentation cycles and the Miocene, Pliocene up to the beginning of the Pleistocene tectonic phases, and a second stage, of geomorphological completion, which began at the end of the Pontian. The geology of the area has known marine transgression phases with complex sedimentation cycles (marine, continental and aeolian deposits) as well as phases of regression, tectonic deformation and strong erosion.

The variety of petrographic facies, the presence of permeable rocks, but especially the alternation of impermeable with permeable rocks, the significant thickness of some sand, grit stones, conglomerate, tuff strata - with intercalations of marl and clay strata – allow the emergence of currently active geomorphologic processes. The great displacements inside the study area are also due to the mineralogical composition of the pelites, and especially to the presence in high quantities of illites and montmorillonites, which predominate in the the lower Pontian deposits (Matei, 1983). Together with iron oxides, these clay minerals modify the degree of water saturation inside the rocks. Thus, given the conditions of water saturation of the sand, local disequilibria on the slopes come across and the movements of the masses comes across when the sliding bed is not continuous but rather made up of clay and marl lenses.

The most extensive areas with glimee (landslides) are to be found especially at the border of Meotian/Pontian occurences (generally sandy and therefore maintaining moisture, and to which the marl intercalations are added) with the Sarmatian made up of marl and sands, with intercalations of grit stone (coarse greywackes) and volcanic tuff (e.g. Movile, Agnita, Dealul Frumos, Merghindeal). Significant areas with glimee overlap the Sarmatian deposits in the upper basin of the Hîrtibaciu River (at Țeline, Bărcuț, etc.). The evolution of the slumping hills at Movile is connected to the presence and evolution of the Meotian and sandy Pontian which enable the water infiltration into Sarmatian deposits, made up of marl and sand with intercalations of gritstones and volcanic tuffs, with high porosity and plasticity indices. The latter make up an impermeable surface, along which water infiltrates, flowing across the sand beds, to create a water scour which softens the rocks and generates sliding along the sands.

The geographical distribution of glimee in the Hârtibaciu Basin points out the conformity between the areas affected by such sliding and the dome and anticline structures. This explains the role of the inclines within the anticline and dome limbs, as well as the role of the neo-tectonic and currently occuring movements in creating the disequilibrium of the slopes and the triggering of sometimes massive landslides.

ACKNOWLEDGEMENTS

The author is grateful to the NGOs Ecotur Sibiu and Fundația-ADEPT for supporting the publication of this paper.

REFERENCES

1 Ciupangea, D., Paucă, M. and Ichim, T., 1970 – „Geologia Depresiunii Transilvaniei”, Editura Academiei Române, București, 256 p., 50 figs.
2. Matei, I. 1983 – „Argilele panoniene din Transilvania”, Editura Academiei, București.
3. Mutihac V., 1990 – „Structura geologică a României”, Editura Tehnică, Bucureşti, 418 p.
4. Mutihac V., Startulat M. Iuliana, Fechet R. Magdalena, 2004 – „Geologia României”, Editura Didactică şi Pedagogică, Bucureşti, 225 p.
5. Posea, G. 2002 – „Geomorfologia României”, Editura Fundației România de Mâine, Bucureşti, 445p.
6. Vancea, A. 1960 – Neogenul din Bazinul Transilvaniei, Editura Academiei R.S.R, Bucureşti, 249p.

MACROMYCETES OF THE BREITE NATURE RESERVE OF ANCIENT OAKS (TRANSYLVANIA, ROMANIA)

*Livia BUCŞA **

* "Lucian Blaga" University of Sibiu, Faculty of History and Patrimony "Nicolae Lupu", Department of Conservation - Restauration, Victoriei Bd. 5 - 7, Sibiu, Sibiu County, Romania, RO - 550024, livia.bucsa@ulbsibiu.ro, lbucsa@yahoo.com

KEYWORDS: Romania, Transylvania, Nature Reserve, edible and toxic fungi, oaks.

ABSTRACT

This work presents the results of preliminary mycological research carried out in 2006 at the Breite Nature Reserve of ancient oaks. From the mycological material collected, 121 species of macromycetes (three species of Myxomycota and 118 species of Eumycota) have been identified. The families represented by the largest number of species are: Tricholomataceae (16 species), Russulaceae (14 species), Polyporaceae (14 species), Amanitaceae (eight species) and Agaricaceae (seven species). The distribution of species was analysed according to the substrate, mode of nutrition, occurrence, edibility and toxicity.

At the end of the report we make proposals for continuation of the research.

ZUSAMMENFASSUNG: Makromyzeten im Naturschutzgebiet der jahrhundertealten Eichen der Breite (Transylvanien, Rumänien).

Die Arbeit stellt die Ergebnisse im Jahr 2006 durchgeführter mykologischer Forschungen im „Naturschutzgebiet der jahrhundertealten Eichen der Breite" bei Sighişoara / Schäßburg vor Aus dem gesammelten Material wurden 121 Arten von Makromyzeten (drei Myxomycota und 118 Eumycota) bestimmt. Die artenreichsten Familien sind: Tricholomataceae mit 16 Arten, Russulaceae mit 14 Arten, Polyporaceae mit 14 Arten, Amanitaceae mit acht Arten und Agaricaceae mit sieben Arten. Die Arten wurden auch in Bezug auf ihre Unterlage Ernährungsweise, Vorkommen, Genießbarkeit und Toxizität analysiert.

Schließlich werden Empfehlungen für die Fortführung der Untersuchungen.

REZUMAT: Macromicete din Rezervaţia Naturală de stejari seculari Breite (Transilvania, România).

Lucrarea prezintă rezultatele cercetărilor micologice, preliminare, efectuate în Rezervaţia naturală de stejari seculari Breite în anul 2006. Din materialul micologic colectat au fost identificate 121 specii de macromicete (trei specii din Myxomycota şi 118 specii din Eumycota). Familiile cu cel mai mare număr de specii prezente sunt: Tricholomataae 16 sepcii, Russulaceae 14 specii, Polyporaceae 14 specii, Amanitaceae opt specii, Agaricaceae şapte specii. S-a analizat repartiţia speciilor după suport, modul de nutriţie, ocurenţă, comestibilitate şi toxicitate.

În finalul lucrării, se fac propuneri pentru continuarea cercetărilor.

INTRODUCTION

The fungi popularly named „mushrooms” are an important constitutive element of temperate forest ecosystems. The majority are saprophytic and develop both on the soil and on dead wood. They are one of the main decomposers of organic matter.

The mycorrhizal fungi live in symbiosis with trees and facilitate the absorption of water and mineral salts necessary for their existence. Their populations are important signs of the ecological health of woods. The decrease of mycorrhizal fungal populations, as a result of pollution, has constituted the main cause of woods dying in Central Europe. Parasitic fungi that develop on trees could contribute to their death, but only on very old or damaged ones.

At the same time, fungi constitute a source of food for numerous organisms such as insects, gastropods and vertebrates, and some of them are collected and consumed by many people. The study of fungi can provide data about specific biodiversity of a particular area and also about potential edible and poisonous fungi.

We studied the Breite ancient oaks nature reserve, situated near Sighişoara locality on the northern edge of the Saxon Villages area. We selected this habitat, with a land surface of 120 ha, which is representative of the whole area, including both groves of oaks between 200 and 800 years old, younger wood sections and also extensive clearings. For the inhabitants of the Sighişoara town, this nature reserve constitutes an attractive, frequently visited place, and a large number of mushroom collectors are present.

MATERIALS AND METHODS

The field trips for collecting mycological material were made during the period 20 July - 20 September 2006. The material collected during the five field trips contained 121 species. Species identification was made on the fresh material, by means of microscopic and macroscopic examination. As reference material, the papers of the following authors were of great help: Bernnichia (1990), Breitenbach and Kranzlin (1986), Bucşa (1995), Courtecuisse (1994), Pârvu (1999), Phillips (1981), Sălăgeanu (1985) and Tănase and Mititiuc (2001).

RESULTS AND DISCUSSIONS

Taxonomic evaluation

1. The diversity of mycoflora

The 121 species of fungi identified are presented in systematic order in the table number 1. They belong to two Phyla: Myxomycota,with three species, and Eumycota, with 118 species.

The Macromyceta belong to phylum Eumycota and are divided into two subphyla: Ascomycotina, with 14 species, and Basidiomycotina, with 104 species.

Subphylum Ascomycotina includes species in two classes: Pyrenomycetae, with an order and a family, a total of six species, and Discomycetae, with two orders and four families, a total of eight species.

Subphylum Basidiomycotina includes species in two classes: Hymenomycetae, with four orders and 24 families, a total of 98 species, and Gasteromycetae,with two orders and two families, a total of 5 species.

Table 1: List of macromycete species collected from the Breite Nature Reserve of Ancient oaks; W - wood, S - soil, LW - living wood, M - leafmould, s - saprophytic, p - parasitic, C - common, O - occasional, Nc - uncommon, R - rare, Vc - very common, F - frequent, n.c. - not edible, t. - toxic, c. - edible, c.v.b. - edible, very good, m.t. - deadly toxic.

Crt. no.	Taxon	Substrate	Nutrition	Occurence	Edibility
	Phylum MYXOMYCOTA Class Myxomycetes Order Stemonitales Fam. Reticulariaceae				
1.	Tubifera ferruginosa (Batsch) J.F.Gmel	W	s	C	n.c.
	Fam. Arcyriaceae				
2.	Arcyria cinerea (Bull.) Pers.	W	s	O	n.c.
	Order Physarales Fam. Physaraceae				
3.	Fuligo septica (L.) F.H.Wigg.	W	s	C	n.c.
	Phylum EUMYCOTA Subphylum Ascomycotina Class Pyrenomycetae Order Spheriales Fam. Xylariaceae				
4.	Xylaria hypoxilon (L. ex Hook) Greville	W	s	F	n.c.
5.	Xylaria longipes Nitschke	W	s	F	n.c.
6.	Xylaria filiformis (A.,S. ex Fr.) Fr.	W	s	R	n.c.
7.	Xylaria polymorpha (Scop.) Grev.	W	s	C	n.c.
8.	Hypoxylon fragiforme (Pers. ex Fr.) Kicks	W	s	C	n.c
9.	Humaria hemisphaerica (F.H.Wigg.) Fuckel	S, W	s	O	n.c.
	Class Discomycetes Order Helotiales Fam. Helotiaceae				
10.	Chlorociboria aeruginascens (Nyl.)Kanouse	W	s	O	n.c
11.	Bulgaria inquinans (Pers.) Fr.	W	s	C	n.c.
12.	Bisporella citrina (Batsch) Korf,S.E.Carp.	W	S	C	n.c.
	Order Pezizales Fam. Pezizaceae				
13.	Aleuria aurantia Peck	W	s	C	c.
	Fam. Helvellaceae				
14.	Leptopodia atra (Konig ex Fr.) Boud.	S	s	F	n.c.
15.	Helvella elastica Bull.	S	s		t.
16.	Helvella lacunosa Afzel	S	s	F	t.
	Fam. Diatrypaceae				
17.	Diatrype disciformis (Hoffm.) Fr	W	s	C	n.c.

Crt. no.	Taxon	Substrate	Nutrition	Occurence	Edibility
	Subphylum Basidiomycotina Class Hymenomycetae Order Tremellales Fam. Tremellaceae				
18.	Exidia glandulosa (Bull.) Fr.	W	s	F	n.c.
	Order Dacrymycetales Fam. Dacrymycetaceae				
19.	Dacrymyces stillatus Nees: Fr.	W	s		n.c.
20.	Calocera cornea (Batsch ex Fr.) Fr.	W	s		n.c.
	Order Aphyllophorales Fam. Stereaceae				
21.	Stereum hirsutum (Willd. ex Fr.) Fr.	W	s	C	n.c.
22.	Stereum rugossum (Pers. ex Fr.) Fr.	W	s	F	n.c.
	Fam. Cantharellaceae				
23.	Craterellus cornucopioides (L.) Pers.	S	s	O	c.
	Fam. Clavariaceae				
24.	Ramaria flava (Tourn. ex Battarra) Quel.	S	s	R	c.
	Fam. Corticiaceae				
25.	Xylobolus frustulatus (Pers.) Boidin	W	s		n.c.
	Fam. Peniophoraceae				
26.	Peniophora quercina (Pers.) Cooke	W	s	C	n.c.
	Fam. Hyphodermataceae				
27.	Hyphoderma praetermissum(P.Karst.) J.Erikss.,A.Strid	W	s	O	n.c.
	Fam. Hymenochaetaceae				
28.	Hymenochaete rubiginosa (Dicks. ex Fr.) Lev.	W	s	C	n.c.
	Fam. Meruliaceae				
29.	Merulius tremellosus Schrad..	W	s	O	n.c.
30.	Byssomerulius corium (Pers.) Parmasto	W	s	O	n.c.
	Fam. Polyporaceae				
31.	Polyporus varius (Pers.) Fr.	W	s	O	n.c.
32.	Laetiporus sulphureus (Bull ex Fr.) Murr.	W	s	C	c.
33.	Inonotus hispidus (Bolton) P.Karst.	W	s	F	n.c.
34.	Fomes fomentarius (L: Fr.) Fr.	W	s	Nc	n.c.
35.	Phellinus robustus (Karst.) Bourd.and Galtz	LW	p	R	n.c.
36.	Trametes hirsuta (Wulfen) Pilat	W	s	C	n.c.
37.	Trametes gibbosa (Pers. ex Fr.) Fr.,	W	s	F	n.c.
38.	Trametes versicolor (L.ex Fr.) Pilat	W	s	C	n.c.
39.	Trychaptum abietinum (Dicks.) Ryvarden,	W	s	C	n.c.
40.	Daedalopsis confragosa (Bolt. ex Fr.) Schroet,	W	s	F	n.c.
41.	Daedalea quercina L. ex Fr.,	W	s	C	n.c.
42.	Ganoderma applanatum (Pers. ex Wallr.)Pat., n.c.	W	s	Nc	n.c.
43.	Ganoderma lucidum (Curt. ex Fr.) Karst. n.c.	W	s	Nc	n.c.
44.	Bjerkandera adusta (Wild. ex Fr.) Karst., n.c.	W	s	O	n.c.
	Fam. Fistulinaceae				
45.	Fistulina hepatica Schaeff.: Fr. c.	W	s.p	R	c.

Crt. no.	Taxon	Substrate	Nutrition	Occurence	Edibility
	Order Agaricales Fam. Agaricaceae				
46.	Agaricus arvensis Schaeff., c.v.b.	S	s	F	c.v.b.
47.	Agaricus xanthodermus Genev., t.	S	s	O	t.
48.	Macrolepiota procera (Scop.) Singer, c.v.b.	S	s	F	c.v.b.
49.	Macrolepiota rhacodes var.rhac.(Vittad.) Singer, c.v.b.	S	s	F	c.v.b.
50.	Macropepiota mastoidea (Fr.) Singer, c.	S	s	Nc	c.
51.	Lepiota aspera (Pers.) Quel., n.c.	S	s	Nc	n.c.
52.	Lepiota cristata (Bolton) P.Kumm., n.c.	S	s	F	n.c.
	Fam. Pluteaceae				
53.	Pluteus cervinus var. cervinus (Schulzer) P.Kumm., c.	W	s	F	c.
54.	Pluteus salicinus (Pers.) P.Kumm., c.	W	s	F	c.
	Fam. Amanitaceae				
55.	Amanita alba Thiers, n.c.	S	s	Nc	n.c.
56.	Amanita ceciliae (Berk,Broome) Bas, n.c.	S	s	Nc	n.c.
57.	Amanita citrina var. citrina (Schaeff.) Pers., t.	S	s	F	t
58.	Amanita fulva (Schaeff.) Fr., n.c.	S	s	C	n.c.
59.	Amanita pantherina (DC.) Krombh., t	S	s	Nc	t.
60.	Amanita phalloides Secr., m.	S	s	O	m
61.	Amanita rubescens var. rubescens (Pers.) Gray, c.	S	s	Vc	c.
62.	Amanita vaginata var.vaginata (Bull.) Fr., t.	S	s	F	t.
	Fam. Tricholomataceae				
63.	Tricholoma pseudonictitans Bon, n.c.	S	s	O	n.c.
64.	Tricholoma sulphureum var.sulphureum(Bull.) Fr., n.c.	S	s	O	n.c.
65.	Mycena inclinata	W	s	C	n.c.
66.	Mycena polygramma (Bull.)Gray, n.c.	W	s	O	n.c.
67.	Mycena pura (Pers.ex Fr.) Kumm., n.c	S	s	C	n.c.
68.	Mycena rosea (Bull.)Gramberg, n.c.	S	s	O	n.c.
69.	Laccaria amethystina Cooke, c.	S	s	Vc	c.
70.	Laccaria laccata (Scop.) Fr., c.	S	s	Nc	c.
71.	Megacollybia platyphylla (Pers.) Kotl,Pouzar, c.	S	s	Nc	c.
72.	Xerula radicata (Relhan) Dorfelt, c.	S	s	O	c.
73.	Hygrophorus eburneus var. eburneus (Bull.) Fr., c.	S	s	R	c.
74.	Hygrophorus penarius Fr., c.v.b.	S	s	O	c. f.b
75.	Hygrophorus chrysodon (Batsch) Fr., c.	S	s	Nc	c.
76.	Clitocybe odora (Bull.) P.Kumm., c.	S	s	C	c.
77.	Gymnopus fusipes (Bull.) Gray, n.c.	W	s	O	n.c.
78.	Rozites caperatus (Pers.) P.Karst., c.	S	s	R	c.
	Fam. Cortinariaceae				
79.	Cortinarius olearioides Rob. Henry, c	S	s	C	c.
80.	Inocybe rimosa (Bull.) P.Kumm., t.	S	s	C	t.
81.	Inocybe geophylla var. geoph. (Sowerby) P.Kumm., t.	S	s	C	t.
82.	Crepidotus variabilis (Pers.ex Fr.) Kumme, n.c.	W	s	C	n.c.

Crt. no.	Taxon	Substrate	Nutrition	Occurence	Esculentivity
	Fam. Marasmiaceae				
83.	Armillaria tabescens (Scop.) Emel, n.c.	W	s	R	n.c.
84.	Marasmius alliaceus (Jacq.) Fr., n.c.	S	s	Nc	n.c.
85.	Marasmius rotula (Scop.) Fr., n.c	W	s	C	n.c.
86.	Oudemansiella mucida (Schrad.) Hohn., n.c.	W	s	C	n.c.
	Fam. Russulaceae				
87.	Russula xerampelina var.xerampelina (Schaeff.) Fr., c.	S	s	C	c.
88.	Russula ochroleuca (Pers.) Fr., c.	S	s	Vc	c.
89.	Russula atropurpurea (Krombh.) Maire, c.	S	s	Vc	c.
90.	Russula nigricans (Bull.) Fr., n.c.	S	s	Vc	n.c.
91.	Russula delica Fr., c.	S	s	C	c.
92.	Russula cyanoxantha (Schaeff.) Fr., c.	S	s	Vc	c.
93.	Russula luteotacta Rea, t.	S	s	O	t.
94.	Russula virescens (Schaeff.) Fr., c.v.b.	S	s	Nc	c.v.b.
95.	Russula heterophylla (Fr.) Fr., c.	S	s	O	c
96.	Russula foetens (Pers.) Fr., n.c.	S	s	C	n.c.
97.	Lactarius circellatus (Battarra) Fr., n.c.	S	s	Vc	n.c.
98.	Lactarius blennius (Fr.) Fr., n.c.	S	s	Vc	n.c.
99.	Lactarius vellereus var.vellereus (Fr.) Fr., n.c.	S	s	C	n.c.
100.	Lactarius violascens (J. Otto) Fr., n.c	S	s	Nc	n.c.
	Fam. Paxilaceae				
101.	Paxillus involutus (Batsch) Fr., m.t.	S	s	Vc	m.t.
	Fam.Strophariacea				
102.	Stropharia aeruginosa (Curtis) Quel, S.Lundell, Nannf.	S	s	C	n.c.
103.	Hypholoma fasciculare (Huds.) Quel, t.	W	s	Vc	t.
104.	Pholiota aurivella (Batsch) Fr., c.	W	s	O	c.
	Fam.Psatyrellaceae				
105.	Psathyrella piluliformis(Bull.) P.D.Orton, c.	S	s	O	c.
106.	Lacrymaria lacrymabunda (Bull.) Pat., c.	S	s	O	c.
	Fam. Bolbitiaceae				
107.	Hebeloma sinapizans (Fr.) Sacc., n.c.	S	s	Nc	n.c.
108.	Panaeolus semiovatus var.semiovatus (Sowerby)	M	s	O	n.c.
	Fam. Coprinaceae				
109	Coprinus micaceus (Bull. ex. Fr.) Fr. c.	W	s	C	c.
110.	Coprinus picaceus (Bull.) Gray n.c.		s	Nc	n.c.
	Fam. Boletaceae				
111.	Boletus subtomentosus L., c.	S	s	Nc	c.
112.	Boletus griseus (Quel) Sacc.,D.Sacc., c.	S	s	O	c.
113.	Boletus rubellus Krombh., c.	S	s	O	c.
114.	Boletus edulis Bull., c.v.b.	S	s	C	c.v.b.
115.	Boletus chrysenteron Bull., c.	S	s	Vc	c.
116.	Gyroporus castaneus (Bull.) Quel, c.v.b.	S	s	R	c.v.b.

Crt. no.	Taxon	Substrate	Nutrition	Occurence	Edibility
	Class Gasteromycetes Order Lycoperdales Fam. Lycoperdaceae				
117.	Lycoperdon echinatum Pers., n.c.	S	s	Nc	n.c.
118.	Lycoperdon perlatum Pers., c.	S, W	s	C	c.
119.	Lycoperdon pyriphorme Schaeff.:Pers. n.c	W	s	C	n.c.
120.	Calvatia excipuliformis (Scop.) Perdeck, n.c.	S	s	C	n.c.
	Order Sclerodermatales Fam. Sclerodermataceae				
121.	Scleroderma verrucosum (Bull.) Pers., t.	S	s	O	t.

Analysis of species by their frequency of occurrence

The situation concerning the occurrence of the identified species is presented in table 3.

Table 2: The number of species by families.

Crt. no.	Family	Number of species	%
1.	Reticulariaceae	1	0.82
2.	Arcyriaceae	1	0.82
3.	Physaraceae	1	0.82
4.	Xylariaceae	6	4.96
5.	Helotiaceae	3	2.48
6.	Pezizaceae	1	0.82
7.	Helvellaceae	3	2.48
8.	Diatrypaceae	1	0.82
9.	Tremellaceae	1	0.82
10.	Dacrymycetaceae	2	1.65
11.	Stereaceae	2	1.65
12.	Cantharellaceae	1	0.82
13.	Clavariaceae	1	0.82
14.	Corticiaceae	1	0.82
15.	Peniophoraceae	1	0.82
16.	Hyphodermataceae	1	0.82
17.	Hymenochaetaceae	1	0.82
18.	Meruliaceae	2	1.65
19.	Polyporaceae	14	11.57
20.	Fistulinaceae	1	0.82
21.	Agaricaceae	7	5.78
22.	Pluteaceae	2	1.65
23.	Amanitaceae	8	6.61
24.	Tricholomataceae	16	13.30
25.	Cortinariaceae	4	3.30
26.	Marasmiaceae	4	3.30
27.	Rusulaceae	14	11.57
28.	Paxilaceae	1	0.82

Crt. no.	Family	Number of species	%
29.	Strophariacea	3	2,48
30.	Psatyrellaceae	2	1,65
31.	Bolbitiaceae	2	1,65
32.	Coprinaceae	2	1,65
33.	Boletaceae	6	4,96
34.	Lycoperdaceae	4	3,30
35.	Sclerodermataceae	1	0,82

Table 3: The frequency of occurrence of the species identified.

Crt. no.	Occurence	Number of species	%
1.	Rare	8	6.61
2.	Occasional	32	26.44
3.	Uncommon	18	14.87
4	Frequent	16	13.30
5.	Common	36	29.75
6.	Very common	11	9.09

Species considered in the literature as being rare represent 6.61% of the total of the species identified in the studied area. They are the following: *Xylaria filiformis, Ramaria flava, Phellinus robustus, Fistulina hepatica, Hygrophorus eburneus* var. *eburneus, Armillaria tabescens, Rozites caperatus* and *Gyroporus castaneus*.

Among them, *Fistulina hepatica* species is frequently present in the Breite area, on ancient oak trees and on recently fallen trunks, because they are the favourable habitat for this species.

The occasional species represent 27.33% of the total of the species identified, the uncommon species, 14.87%. Taking into consideration these three categories of species mentioned above, we establish that they represent 47.98% of the species identified.

This result justifies us to affirm that the Breite area deserves protection of its mycoflora, as well as its ancient oaks and wood pasture, because it is a refuge for a considerable number of fungal species that are of scientific importance.

Analysis of species by their their edibility and toxicity

The edible species (Tab. 4) regarded as being very good to eat represented 5.78% of the species, and they are: *Macrolepiota procera*, *Macrolepiota rhacodes, Hygrophorus penarius, Russula virescens, Agaricus arvensis, Gyroporus castaneus* and *Boletus edulis*. The remaining edible species comprise 28.09%. The result is that 34.47% of the species are edible.

Table 4: The edibility and toxicity of the species identified.

Crt. no.	Edibility	Number of species	%
1.	edible	34	28.09
2.	edible, very good	7	5.78
3.	Non-edible	66	54.54
4.	Toxic: poisonous	11	9.09
5.	Toxic: deadly poisonous	2	1.65

On the basis of questioning the collectors, of the total of 41 edible species, only 16 species are harvested and consumed, which represents 39%. Among them, only 10 species are consumed by the highest number of collectors. These are: *Ramaria flava, Agaricus arvensis, Macrolepiota procera, Macrolepiota rhacodes, Amanita rubescens, Russula cyanoxantha, Russula virescens, Russula atropurpurea, Russula xerampelina* and *Boletus edulis*.

The species harvested by a small number of collectors are: *Craterellus cornucopioides, Fistulina hepatica, Clitocybe odora, Russula ochroleuca, Russula delica, Russula heterophyla* and *Boletus subtomentosus*.

From the data presented we understand that, although there is a high potential of edible species, the local human population knows only a low percentage of them. The reasons are: the small number of specialists in the field of Macromycetes (ten in Romania); the absence of knowledge of mushrooms, as a result of the lack of education in this field; the absence of specialized literature in the Romanian language, especially popular literature; the absence of amateur mycological associations or organizations; the ban on the commercialization and marketing of mushrooms from the wild.

The toxic (poisonous) species represent 9.09% of the species identified. They are as follows: *Helvella elastica, H. lacunosa, Russula luteotacta, Agaricus xanthodermus, Inocybe geophilla, Hypholoma fasciculare, Inocybe rimosa, Scleroderma verrucosum, Amanita vaginata, A. pantherina* and *A. citrina*.

The toxic (deadly poisonous) species are: *Amanita phaloides* and *Paxillus involutus*. *Amanita phaloides* was found in large numbers during our official trips in September, fruiting at the same time as *Agaricus arvensis* and *Russula xerampelina*, for which it can easily be mistaken.

On questioning, the amateur collectors point out that they are unaware of any of these poisonous species. However, except for those that they consider to be edible, they think that all other mushrooms are 'mad'.

CONCLUSIONS

We consider the research up to the present concerning the mycoflora of the Breite area as preliminary, but our results justify the following proposals: continuation of the research through repeated samplings, from springtime till autumn; extension of the collecting zones into other habitats such as downy oak woods (*Quercus pubescens*), associations of sycamore (*Acer pseudoplatanus)* and hornbeam (*Carpinus betulus*), beech (*Fagus sylvaticus*) and hornbeam, also in meadow grasslands of different aspects; carrying out surveys among the rural population concerning the known mushroom species, the edible ones, their means of preparation and utilization for other purposes; presentation of lectures on mycological subjects in schools and to NGOs; contacts with amateur mushroom-hunters from the area and initiation of mycological trips with them; production of posters showing the main edible and toxic species and their display in easily accesible places such as the Breite plateau.

ACKNOWLEDGEMENTS

The author is grateful to the Darwin Initiative of the UK Ministry of Agriculture (DEFRA), Orange Romania, and the NGOs Fundația ADEPT and Ecotur Sibiu for supporting the fieldwork and the publication of this paper.

REFERENCES

1. Breitenbach, J., Kranzlin, F., 1986 – Fungi of Switzerland, Vol. 2, Non gilled fungi, Verlag Mykologia, Lucerne.
2. Bernnichia, A., 1990 – Polyporaceae s.l. in Italia, Univ. degli Studi di Bologna.
3. Bucşa. L.,1995 – Ciuperci comestibile de pe piața liberă din Sibiu şi frecvența intoxicațiilor, Acta oecologica nr. 1-2, Sibiu.
4. Courtecuisse, R., Duhem, B., 1994 – Guide des champignons de France et D Europe, Delachaux et Niestle S.A., Lausanne (Switzerland)-Paris.
5. Pârvu, M., 1999 – Atlas micologic, Editura Presa Universitară Clujeană, Cluj-Napoca.
6. Phillips, R., 1981, Mushrooms and other fungi of Great Britain and Europe, Pan Books, London.
7. Sălăgeanu, G., 1985 – Determinator pentru recunoaşterea ciupercilor comestibile, necomestibile şi otrăvitoare din România, Ed. Ceres, Bucureşti.
8. Tănase, C., Mititiuc, M., 2001 – Micologie, Ed. Univ. "A. I. Cuza", Iaşi.

THE RIVERSIDE THICKETS OF THE SAXON VILLAGES AREA OF SOUTH-EAST TRANSYLVANIA (ROMANIA)

Constantin DRĂGULESCU *

* "Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Oituz Street 31, Sibiu, Sibiu County, Romania, RO - 550337, ctindrg@yahoo.com

KEYWORDS: Romania, Transylvania, wet habitats, riverside thickets.

ABSTRACT

The author identified three types of wet habitats extant in the investigated area that are included in Annex 1 of the EU Habitats Directive, as follows: 3130; 6430 - subtype 37.7; and 91E0 - subtype 44.13. Habitat 3130 is represented by temporary pools, as well as small ditches inhabited by ephemeral species of the Isoëto-Nanojuncetea class. Habitat 6430, subtype 37.7, includes, in the investigated area, tall hygrophilous ruderals of the classes Glecometalia hederaceae and Convolvuletalia sepium, particularly in alliances such as Convolvulion sepium/ Senecion fluviatilis, Aegopodion podagrariae, Petasition, Filipendulion. Habitat *91E0, subtype 44.13, is of principal concern; it includes the arborescent willow (especially *Salix alba* and *S. fragilis*) and poplar communities on the rivers, that is riverside thickets of the Salicion albae alliance. These are stratified phytocoenoses and cover a total area of *c.* 500 ha. Considering, on the one hand, that the largest habitats are *91E0 - subtype 44.13, and 6430 - subtype 37.7, and that the two habitats are juxtaposed in the wet meadows of several rivers and streams, I believe that some sectors of such meadows which include both habitats could be declared protected areas, where the two habitats exhibit the highest degree of naturalness: i.e. the river sectors between Daneş and Criş; Viscri and Dacia; Apold and Daia; and Pelişor and Richiş.

ZUSAMMENFASSUNG: Die Weiden-Weichholzauen im Umkreis der sächsischen Dörfer Südost-Transylvanien (Rumänien).

Im untersuchten Gebiet hat der Verfasser drei Typen von Feuchtgebietshabitaten festgestellt, die im Anhang 1 der Habitatdirektive aufgelistet sind. Es handelt sich um die Habitattypen 3130, 6430 Subtyp 37.7 und * 91E0 Subtyp 44.13. Der Habitattyp 3130 ist im Gebiet durch temporäre Tümpel und kleine Gräben vertreten, die mit kurzlebigen Arten der Zwergbinsengesellschaften Isoeto -Nanojuncetea besiedelt sind. Der Lebensraumtyp 6430 Subtyp 37.7 umfasst im Untersuchungsgebiet feuchte Unkraut-Hochstaudenfluren der Glecometalia hederaceae und der Convolvuletalia sepium, vertreten vor allen durch die Verbände Convolvulion sepium/ Senecion fluvialtilis, Aegopodion podagrariae, Petasition und Filipendulion. Der prioritäre Lebensraumtyp *91E0 Subtypus 44.13 umfasst die vor allen aus Weiden (Silber- und Bruchweide) und Pappeln aufgebauten Galeriewälder entlang der Wasserläufe, d.h. die Weichholzauen des Salicion albae. Die stufig aufgebauten Phytozönosen nehmen im Gebiet etwa 500 ha ein. Zieht man in Betracht, dass die beiden Habitattypen *91E0 Subtyp 44.13 und 6430 Subtyp 37.7 in den Bachauen des Gebietes auf größerer Fläche nebeneinander und eng miteinander verzahnt vorkommen, sollte man einige der Auenzüge, in denen die beiden Lebensraumtypen einen hohen Grad an Natürlichkeit aufweisen, zu Schutzgebieten erklären. Dabei handelt es sich um den Cris/Kreisch-Bach zwischen Daneş/Dunnesdorf und Criş/Kreisch, um die Bachauen zwischen Viscri/ Deutsch Weißkirch und Dacia/Stein, um die Auen zwischen Apold/Trappold und Daia/Denndorf sowie jene zwischen Pelişor/Magerei und Richiş/Reichesdorf.

REZUMAT: Zăvoaiele cu sălcii din perimetrul satelor saseşti din sud-estul Transilvaniei (România).

În teritoriul investigat autorul a identificat trei tipuri de habitate umede din Anexa I a Directivei habitate: 3130, 6430 subtipul 37.7 şi *91E0 subtipul 44.13. Habitatul 3130 este reprezentat în teritoriu de bălți temporare şi mici şanțuri populate cu specii efemere din clasa Isoëto-Nanojuncetea. Habitatul 6430 subtipul 37.7 cuprinde buruienişuri înalte higrofile din clasa Glecometalia hederaceae şi Convolvuletalia sepium, în teritoriul studiat, mai ales din alianțele Convolvulion sepium/Senecion fluviatilis, Aegopodion podagrariae, Petasition, Filipendulion. Habitatul prioritar *91E0 subtipul 44.13 include galeriile arborescente de sălcii (îndeosebi *Salix alba* şi *Salix fragilis*) şi plopi de pe cursurile râurilor adică zăvoaiele din alianța Salicion albae. Sunt fitocenoze stratificate care însumează în teritoriu cca. 500 ha. Ținând seama de faptul că cele mai întinse habitate sunt *91E0 subtipul 44.13 şi 6430 subtipul 37.7 şi că acestea două sunt situate unul lângă celălalt în luncile râurilor şi pârâurilor, se pot declara situri ocrotite câteva tronsoane/sectoare de luncă în care se găsesc amândouă şi în care aceste habitate au cel mai mare grad de naturalețe. Acestea sunt pe pârâul Crişului între Daneş şi Criş, între Viscri şi Dacia, între Apold şi Daia, între Pelişor şi Richiş.

INTRODUCTION

The earliest botanical information in the covered area (Sighişoara, Şaeş, Dealu Frumos, Merghindeal, Biertan, Saschiz, etc) was provided by Baumgarten in 1816. His input would be supplemented by Fronius (1858), Fuss (1866), and Schur (1866). Thanks to these authors, the flora of the Sighişoara area came to be well known, whereas the flora of the area situated between Sighişoara and the upper basin of the Hârtibaci River, though published briefly, would capture the attention of 20th-century botanists, thanks to such floristic rarities as: *Thelypteris palustris, Silene conica, Myosurus minimus, Ranunculus lingua, Crambe tataria, Comarum palustre, Prunus tenella, Waldsteinia geoides, Genista pilosa, Lathyrus pannonicus* subsp. *collinus, Lathyrus transsilvanicus, Euphorbia brittingeri, Daphne cneorum, Drosera rotundifolia, Viola pumila, Silaum silaus, Menyanthes trifoliata, Cynoglossum germanicum, Salvia nutans, Cymbalaria muralis, Adenophora lilifolia, Asyneuma canescens, Achillea nobilis* ssp. *neilreichii, Carduus hamulosus, Sagittaria sagittifolia, Allium albidum* var. *ammophilum, Veratrum nigrum, Narcissus poeticus* subsp. *radiiflorus, Gladiolus imbricatus, Iris aphylla, Spirodela polyrhiza, Orchis militaris*, etc.

Early in the 20th century, Fekete and Blattny (1913) mention several tree species in the same sector. Pop (1960) provides an analysis of the swamps located near Şaeş, and on the upper Hârtibaci respectively, calling attention to the local flora. Csűrös and Kovács (1962) and Turcu (1962), produce vegetation data along with the first phyto-coenological information from an area situated between the villages of Movile, Brădeni, Noiştat, Netuş, Şaeş, Dealu Frumos, Iacobeni, Merghindeal, and Saschiz. Sanda et al. (1976) undertake a study of the area along the middle course of Târnava Mare River, whereas that of Drăgulescu (1978, 1987, 2005) looks at the phytocoenoses of *Narcissus radiiflorus* at Movile, Noiştat, Dealu Frumos and Merghindeal, and also enumerates the general flora and the hydro- and hygrophilous vegetation on the Târnava Mare River. The most valuable phyto-coenological piece of research is that of Erika Schneider-Binder (1984, 1994, 1996), a study of the landslip (or unstable mound) vegetation of Movile, Noiştat, Apold and Saschiz.

RESULTS

The outcome of the research I undertook upon the hydro- and hygrophilous vegetation in 2003 - 2006 consists of the following:

In the investigated area, three different types of wet habitats occur that are on Annex 1 of the European Union Habitats Directive, as follows: 3130; 6430 - subtype 37.7; and 91E0 - subtype 44.13.

Habitat 3130 is represented by temporary pools, as well as small ditches inhabited by ephemeral species of the Isoëto-Nanojuncetea class. Patches of vegetation of this type were found in areas neighbouring the villages of Bărcuț, Biertan, Bârghiş, Dacia, Dumbrăveni, Laslea, Netuş, Retiş, Saschiz, Şaeş, Şaroş and Viscri. They occur in areas that range from several to several dozen square metres, and more often than not they disappear before the next year. The total area covers about 0.5 hectares (1.25 acres). These are 'pioneer' phytocoenoses of low species representation (about 20 species of cormophytes, of which most are small).

Habitat 6430, subtype 37.7 includes, in the investigated area, tall hygrophilous ruderals of the classes Glecometalia hederaceae and Convolvuletalia sepium, particularly in alliances such as Convolvulion sepium/Senecion fluviatilis, Aegopodion podagrariae, Petasition and Filipendulion. They dwell in patches of 20 m^2 to 1 ha, along such minor water-courses as Biertan, Laslea, Mălâncrav, Saschiz, Scroafa, Şaeşului, Valchid, Valea Mare, etc., as well as on the upper course of the Hârtibaciu and Târnava Mare (the segment between Dumbrăveni and Sighişoara). They occupy a total area in excess of 100 ha and enjoy a medium-to-good state of preservation, whereby they are sometimes affected by hay-making, as well as by floods. Unfortunately, most of them are pervaded by adventive species (e.g. *Erigeron annuus*, *Helianthus decapetalus*, *Solidago canadensis*), which prevents them for qualifying for the status of protected areas. Worthy of protection for their highly naturalistic character are the habitats situated between Pelişor and Richiş, upstream of Laslea, downstream of Mălâncrav, upstream of Daneş, between Apold and Daia, and downstream of Bărcuț.

Habitat *91E0, subtype 44.13 is of main concern. It includes arborescent willows (especially *Salix alba* and *S. fragilis*) and poplar communities on the rivers, that is riverside thickets of the Salicion albae alliance. These are stratified phytocoenoses where three strata are encountered - trees, shrubs and grasses. They form a linear (waved) arrangement and occupy a total area of about 500 ha. Yet, less than one quarter are relatively wild and could be placed under protection (e.g. upstream of Daneş, downstream of Dacia, upstream of Richiş, upstream of Mălâncrav, upstream of Criş, between Apold and Daia). In the villages proper, as well as in their close vicinity, the willow pastures are either deforested or turned into ruderal areas, because of the huge amounts of debris and litter that the villagers discard. Sectors measuring dozens of kilometres are pervaded by adventive species (e.g. *Echinocystis lobata, Erigeron annuus, Helianthus decapetalus, Impatiens glandulifera, Polygonum cuspidatum, Robinia pseudacacia, Rudbeckia laciniata, Solidago canadensis* and *Xanthium italicum*), or are ruined by the spoiled grazing fields and cultivation that are pushed right to the edge of rivers (e.g. Sighişoara, downstream of Biertan, downstream of Laslea, downstream of Mălâncrav, downstream of Nou Săsesc, downstream of Valchid, between Jibert and Lovnic, Ruja, etc.). In the riverside thickets under consideration, a total number of 209 species of hygrophilous, mezophilous, and hydrophilous cormophytes have been identified (tables 1 and 2).

Table: 1 Habitat *91E0 subtype 44.13 - Salicetum albae-fragilis.

Species / Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Salix alba	3	2	3	3	2	2	2	3	4	3	3	4	3	4	4	1	2	3
Salix fragilis	3	3	2	3	3	4	3	3	2	2	3	1	3	1	1	4	4	3
Salix triandra								1				1						
Salix caprea																		
Salix cinerea	+						+									1		
Salix purpurea																		
Salix viminalis						+												
Acer negundo											1							
Alnus glutinosa				1							1							
Alnus incana					1													
Fraxinus excelsior																		
Malus sylvestris													1					
Populus alba																		
Populus nigra																		
Populus tremula																		
Prunus avium																		+
Pyrus pyraster									+							+		+
Robinia pseudacacia					+				+	1	+			1				
Cornus sanguinea					+				+		+	+				1		+
Corylus avellana			1	1					+									
Euonymus europaeus						+	+	+	+				+		+		+	+
Frangula alnus		1																
Sambucus nigra			1	1	+		1	+	1	1			1	+	+	1	+	1
Clematis vitalba			+	1	+				+	1				+				
Viburnum opulus					+													+
Humulus lupulus	+		+	+	+	+	1		1	+	+			1	+			
Rubus caesius	2	1		1	1	2	2	1	1		2	+	1	2		1	1	2
Abutilon theophrasti						+												
Achillea millefolium	+			+				+	+				+				+	+
Aegopodium podagraria			1	1	+			1			1	+			+		1	
Agrostis stolonifera	1	1	1					+	+	1	1	1	1	+		1		1
Alisma plantago-aquatica	+	+																
Alliaria officinalis																		
Althaea officinalis																		
Angelica sylvestris	+	+	+	+	+	1	+		+	+	+	+	1	+	+	+	+	+
Arctium lappa				+	+	+			+				+	+		+		
Arctium tomentosum					+					+			+	+	+			+
Armoracia rusticana									+	+				+	+			
Artemisia vulgaris		1	1	+	+		1		+	1	1		+	1			1	+
Asclepias syriaca									+									
Aster lanceolatus?	1											+						
Astragalus cicer																		+
Ballota nigra	1	+	+					+	+				+					+
Bidens tripartita																+		
Calystegia sepium	+	+		+	+	+	+		+	+	+	+	1	+	+		+	
Centaurea phrygia				+					+									

Sample number / Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Chaerophyllum aromaticum	1				1	+			+		1	+	1	1	+			
Chelidonium majus											+							
Cichorium intybus		+	1	+	+	+	+	+	+	+		+		+				
Cirsium canum	+														+		+	1
Cirsium oleraceum	1	1	1	+	+	1	+	1	1		1	+	1	+	1		+	1
Conium maculatum	1	+	+		+	1	1	+	+	+		1		+		+	1	+
Convolvulus arvensis	+		+					+	+				+	+		+	+	
Coronilla varia			+	+					+			+	+					
Cucubalus baccifer			+															
Cuscuta europaea + epithymum	+		+						+					+				
Dactylis glomerata		1						+	+	+			+		+	1	+	
Daucus carota		+	+	+	+		+		+			+	+				+	
Deschampsia caespitosa		1						+					1			+		
Dipsacus fullonum												+	+			+		
Dipsacus laciniatus				+	+			1							+			1
Echinocystis lobata		+	+		1	+	+	+	+			2						+
Epilobium hirsutum	+	+															+	
Epilobium obscurum	+																	
Epilobium roseum								+										
Equisetum arvense					+	+	+		+			1		+			+	
Equisetum palustre		+																
Equisetum telmateia		+		+			+	+					1			1		
Erigeron annuus		1		1	+			1	+	1	+	+	1		+		+	1
Erigeron canadensis	+		+		+								+					
Eupatorium cannabinum	1	+		+	1	1	+	1		+				+			+	
Euphorbia serrulata/platyphyllos	+																	
Fallopia dumetorum	+			+														
Festuca arundinacea													+					
Festuca gigantea				+				+							+			+
Filipendula ulmaria		1									+							
Galega officinalis		+									1							
Galeopsis speciosa			1	+	+	+	+	1	+		+	+	+	+	+			
Galium aparine									+			+		+	+			
Geranium palustre											+							
Geranium phaeum															+			
Geranium pratense	+	+					+				1				+		+	+
Geum urbanum								+		+								
Glecoma hederacea												+						
Helianthus decapetalus	+													1	2	+		
Heracleum sphondylium														+				
Holcus lanatus	+			+				+			+							+
Impatiens glandulifera								+	+									
Inula helenium		+										+	1		+	+		
Juncus articulatus		+																
Juncus effusus	+														+		+	+
Juncus inflexus								+										

Sample number Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Knautia arvensis				+														
Lactica serriola	+											+					+	
Lamium album			+							+	+			+				
Lapsana communis															+			
Lathyrus hirsutus													+					
Lavathera thuringiaca			+		+	+											+	
Lotus corniculatus	+	+		+	+			+	+	+		+	+					
Lycopus europaeus	+					+							+					
Lysimachia nummularia	1	+						+				1	+	+			+	
Lysimachia vulgaris					+						+							+
Lythrum salicaria		+		1	+				+			1						
Medicago falcata		+				+												1
Medicago lupulina	+	+	+	+				+		+			+					+
Melilotus officinalis			+		+	+	+		+	+							+	
Mentha aquatica																		
Mentha arvensis	+		+												+			
Mentha longifolia		1	1	+		+	+	1	1		+	1	+			1	1	
Myosotis scorpioides	+	+	+															+
Oenothera biennis	+				+										+	1		
Oxalis stricta									+									
Pastinaca sativa		+	+	+	+	+	1		+		1	+	+		+	1	+	
Petasites hybridus		+		1		1	+		+			1	+		1			+
Phragmites australis	+	1		+	1	+	1	+	+			1	+			1		
Polygonum cuspidatum							+											1
Polygonum hydropiper																		
Polygonum persicaria	+				+				+									
Potentilla anserina		+	+							+	+							
Potentilla reptans								+										
Prunella vulgaris		+		+		+	+					+						
Pulicaria dysenterica	+			+	+		+	+								+		
Ranunculus repens			1	+		+		+		1	+	+	+	+	+	+		+
Rorippa sylvestris						+												
Rudbeckia laciniata		1				+	+					+				+		
Rumex crispus															+			
Rumex obtusifolius																+		
Salvia glutinosa								+										
Saponaria officinalis				+														
Scirpus sylvaticus		+									+					1	1	
Senecio erucifolius													+	+		+		
Silene alba							+		+	+	+			+			+	+
Sisymbrium strictissimum						+			+		+	+	+	+	+			
Solanum dulcamara																	+	
Solidago canadensis		1	1	1	1	+	1		+	1		+			+			
Sonchus palustris					+	+						+	+					
Stachys officinalis	+																	
Stachys palustris				+	+		+						+				+	
Stachys sylvatica							+									+		+

Species / Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Stellaria media		+	1					+	+	+	+			+	+	+		
Stellaria nemorum			+				+	+		+							+	+
Symphytum officinale	+	+	1			+		1	+	1	1	+	1		+	1	+	
Tanacetum vulgare					+	+											+	+
Telekia speciosa						+	+				+	+						
Thalictrum flavum						+												
Torilis arvensis						+			+									
Trifolium pratense	+	+	+	+		+	+				+		+	+		+		
Trifolium repens		+	+	+	+	+	+	+		+	+	+	1			1		
Tussilago farfara								+	+									
Urtica dioica	1	+	+	1	2	+	+	1		1	1	2	+	1	2	+	1	
Valeriana officinalis		+					+									+		1
Verbena officinalis								+										
Veronica beccabunga	+	+																
Vicia cracca	+			+	+	+				+	+	+					+	
Vicia dumetorum					+													+
Vicia sepium																		
Viscum album													+					
Xanthium italicum						+			+			+						

Table 2: Habitat *91E0 subtype 44.13 -Salicetum albae-fragilis.

Species / Sample number	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Salix alba	4	3	3	1	1	4	2	4	3	3	3	2	4	2	2	3	2	3
Salix fragilis	1	3	3	4	4	1	3	1	3	3	2	3	2	4	4	2	3	1
Salix triandra												1						1
Salix caprea	+								+				+					
Salix cinerea		1			1													
Salix purpurea				+									+					
Salix viminalis	+				1	1			+			+	+			+		
Acer negundo													+			+		
Alnus glutinosa																		
Alnus incana												1	1					1
Fraxinus excelsior			1					1	1					1	1			2
Malus sylvestris								+										
Populus alba																1		
Populus nigra								1								1		
Populus tremula	+																	+
Prunus avium																		
Pyrus pyraster				+														
Robinia pseudacacia		1	+					+		1	1		+	1		1	1	
Cornus sanguinea	+	+	+					+	+	+			1	+	1	+	+	
Corylus avellana									+		1							
Euonymus europaeus	+		+	+	+				+	+			+					

Sample number / Species	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Frangula alnus																		
Sambucus nigra																	1	
Clematis vitalba		+	1	1		+	+	+	+	1			+	+			+	
Viburnum opulus				+	+			+	+					+				
Humulus lupulus											+			+			+	+
Rubus caesius	+	+		+	+	+	+	+	+	+	1			+	+	+	2	1
Abutilon theophrasti	1	2	1		2	1			2	1			1	2	1	1		
Achillea millefolium																	+	
Aegopodium podagraria		+		+				+		+		+				+		
Agrostis stolonifera	1							+	1		+			+	1	1	+	
Alisma plantago-aquatica	+	2	1	+	+	1	+	+	1	+		1	1		1	+		
Alliaria officinalis					+													
Althaea officinalis															+			
Angelica sylvestris					+													+
Arctium lappa	+	+	+	+	+	+	+	+			+		+	+		+	+	
Arctium tomentosum			+			+	+	+		+	+	+				+	+	
Armoracia rusticana				+	+			+		+						+		
Artemisia vulgaris						+		+		+	2			+			1	1
Asclepias syriaca	+	2		1	1	1	1	1	1	1		1	+	+	1	+		
Aster lanceolatus ?													+					
Astragalus cicer														+	+			
Ballota nigra																		
Bidens tripartita		+	+				+	+				+		+		+	+	
Calystegia sepium			+					+									+	
Centaurea phrygia	+	+	+	+	+	+	+	+		+	+	+		+	+	+		
Chaerophyllum aromaticum				+	+			+					+			+	+	
Chelidonium majus	+		+	1			+					1	+		+			
Cichorium intybus								+			+						+	
Cirsium canum				+			+	+	+	+	+					+	+	+
Cirsium oleraceum		+	+	1		+					1		+					1
Conium maculatum	+	+	2	+	+	+	+	+	+	+	1	+	1	+	+		1	+
Convolvulus arvensis	+	1	+	1	1	+	+	+	1	+				+		+	+	
Coronilla varia	+	+		+	+		+	+		+	+		+			+		
Cucubalus baccifer	+	+											+		+	+		
Cuscuta europaea+epithymum					1	1		+								+		
Dactylis glomerata											+						+	
Daucus carota						+						+	+			+	+	+
Deschampsia caespitosa				+	+	1	+	+		+		+				+		
Dipsacus fullonum				+				+					1			+		
Dipsacus laciniatus				+													+	
Echinocystis lobata					+			+		+					+		+	1
Epilobium hirsutum	2			+				+		1	+	2				+		
Epilobium obscurum	+	+	+	+	+			+	+	+						+		
Epilobium roseum																		
Equisetum arvense																	+	+
Equisetum palustre	+		+			+	+	+					+	+		+		

Sample number Species	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Equisetum telmateia																	+	
Erigeron annuus											1						1	+
Erigeron canadensis		+						+					1					
Eupatorium cannabinum	1	+	1	1		1	+	1		1			+			1		+
Euphorbia serrulata	+									+		+				+		
/platyphyllos	1			+	+			+	+			+	+	+	+			
Fallopia dumetorum								+					+	+				
Festuca arundinacea									+									+
Festuca gigantea																		
Filipendula ulmaria		+											+	+	+	+		+
Galega officinalis																	1	
Galeopsis speciosa										+								
Galium aparine	1	+	+	+	+	+	+	+				+	+	+	+	+		
Geranium palustre					+			+										
Geranium phaeum					+						+							+
Geranium pratense										+								
Geum urbanum	1	+	+	+	+	+	+	+					+	+	+			
Glecoma hederacea														+				
Helianthus decapetalus										2					+			
Heracleum sphondylium					+							1	+	+	+	1		
Holcus lanatus													+				+	
Impatiens glandulifera																	+	
Inula helenium									+				+	+		+		
Juncus articulatus		1		1	+	+								+	+	+		
Juncus effusus																		
Juncus inflexus						+			+									
Knautia arvensis					1		+											
Lactica serriola	+														+			
Lamium album		+	+	+		+	+	+						+				
Lapsana communis								+										
Lathyrus hirsutus				+					+				+	+				
Lythyrus sylvestris		+									+							
Lavathera thuringiaca					+												+	
Lotus corniculatus				+	+			+								+		+
Lycopus europaeus						+	+	+								+		
Lysimachia nummularia			+					+			+	+		+		+		
Lysimachia vulgaris					+					+	+							+
Lythrum salicaria		+		+						+	+					+		
Medicago falcata		+	+	+	+	1				+		+				+		+
Medicago lupulina				+	+		+										+	
Melilotus officinalis			+	+	+					+								
Mentha aquatica	+			+	+	+		+										
Mentha arvensis		+															+	
Mentha longifolia		+					+							+		+		
Myosotis scorpioides	1	+	1	+	+	+		1				1	1	+	1	+		
Oenothera biennis																		+

Sample number Species	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Oxalis stricta										+	1						1	
Pastinaca sativa																+		+
Petasites hybridus	1	+	+	1	+					1								
Phragmites australis																		+
Polygonum cuspidatum	+						1	+			+		2	1	1	1	+	
Polygonum hydropiper	1	1	1	1	2	1	1	1	1					1	+			
Polygonum persicaria			+						+			1		+		1		
Potentilla anserina					1				+									
Potentilla reptans												+		+		+	+	
Prunella vulgaris					+		+					+					+	
Pulicaria dysenterica																	+	
Ranunculus repens								+	+				+					
Rorippa sylvestris		+	+	+				+	+			+	+	+				
Rudbeckia laciniata	+	1	+		+		+	+				1						
Rumex crispus												+						
Rumex obtusifolius						+										1		
Salvia glutinosa																		
Saponaria officinalis	+			+														
Scirpus sylvaticus									+				+					
Senecio erucifolius														+		+	+	
Silene alba												+		1	1		+	
Sisymbrium strictissimum		+															+	
Solanum dulcamara	+	+	+		+	+	+	+		1			+	+	+	+		+
Solidago canadensis			+				+				1			+		+		
Sonchus palustris																		
Stachys officinalis				+		2		1	+			+	+			1		
Stachys palustris				+													+	
Stachys sylvatica								+										
Stellaria media	+	+			+								1	+		+		
Stellaria nemorum									+	+								+
Symphytum officinale						+		+		+								
Tanacetum vulgare		+						+					+			+		+
Telekia speciosa	+	+	+	+	1	+	1	+					+	+		+		
Thalictrum lucidum/flavum	+	+	+	+	+	+		+							+	+		
Torilis arvensis									+	+			+				+	
Trifolium pratense		+		+						+	+			+			+	+
Trifolium repens + hybridum			+								+						+	
Tussilago farfara	+			+				+		1		+				+	1	
Urtica dioica	+		1	1	+	+	+	1			1					+		+
Valeriana officinalis												+						
Verbena officinalis	1	+	2	1	1		1	1	+			1	+	1	1	1		
Veronica beccabunga		+		+								+	+					
Vicia cracca								+			+						+	
Vicia dumetorum																		
Vicia sepium				+	+			+				+	+		+	+		
Viscum album																		
Xanthium italicum		+		+	+						+							

The sample plots are situated: 1. between Bârghiş and Pelişor, 460 m altitude, 46°00'33" N and 24°31'09" E, 08.08.2006; 2. between Pelişor and Richiş, 480 m, 46°03'58" N and 24°28'55" E, 08.08.2006; 3. downstream Biertan in Biertan Valley, 345 m, 46°07'28" N and 24°30'12" E, 08.08.2006; 4. between Copşa Mare and Valchid in Valchid Valley, 400 m, 46°06'59" N and 24°32'27" E, 08.08.2006; 5. downstream Valchid, 340 m, 46°12'53" N and 24°36'06" E, 08.08.2006; 6. Laslea in Laslea Valley, 360 m, 46°11'05" N and 24°38'02" E, 08.08.2006; 7. upstream Roandola, 400 m, 46°09'21" N and 24°35'58" E, 08.08.2006; 8. downstream Noul Săsesc, 450 m, 46°07'51" N and 24°35'51" E, 08.08.2006; 9. between Laslea and Mălâncrav, 390 m, 46°10'54" N and 24°38'36" E, 09.08.2006; 10. downstream Mălâncrav, 415 m, 46°07'49" N and 24°38'29" E, 09.08.2006; 11. upstream Daneş, 360 m, 46°12'18" N and 24°42'29" E, 09.08.2006; 12. aval Stejăreni, 410 m, 46°09'40" N and 24°43'03" E, 09.08.2006; 13. between Apold and Daia, 460 m, 46°09'40" N and 24°43'03" E, 09.08.2006; 14. Saschiz, 415 m, 46°11'00" N and 24°58'15" E, 10.08.2006; 15. Criț, 480 m, 46°07'03" N and 25°01'38" E, 10.08.2006; 16. between Buneşti and Viscri, 540 m, 46°05'10" N and 25°03'24" E, 10.08.2006; 17. Viscri, 500 m, 46°02'37" N and 25°07'16" E, 10.08.2006; 18. upstream Dacia 490 m, 46°01'42" N and 25°08'34" E, 10.08.2006; 19. between Jibert and Lovnic, 490 m, 46°00'06" N and 25°02'26" E, 10.08.2006; 20. between Văleni and Şoarş, 490 m, 45°56'00" N and 24°56'55" E, 10.08.2006; 21. downstream Bărcut, 505 m, 46°00'43" N and 24°55'08" E, 10.08.2006; 22. between Retiş and Brădeni, 500 m, 46°03'37" N and 24°50'59" E, 10.08.2006; 23. Brădeni, 480 m, 46°03'51" N and 24°47'51" E, 03.08.2005, 10.08.2006; 24. Netuş, 475 m, 46°03'23" N and 24°47'29" E, 03.08.2005, 10.08.2006; 25. upstream Movile, 490 m, 10.08.2006; 26. Roandola, 08.09.2003, 03.08.2005; 27. Noul Săsesc, 08.09.2003; 28. Ruja, 08.09.2003, 03.08.2005; 29. downstream Mălâncrav, 03.08.2005; 30 Sighişoara in Şaeş Valley at confluenced with Târnava Mare, 360 m, 01.08.2005; 31. Şaeş Valley, 5 km upstream Sighişoara, 400 m, 46°10'38" N cu 24°45'26" E, 01.08.2005; 32 Şaeş Valley at 31 km to Agnita, near bridge, 01.08.2005; 33. between Apold and Daia, 1 km downstream the sample, 13, 01.08.2005; 34. Târnava Mare at confluence with Laslea, 02.08.2005; 35. upstream Laslea in Laslea Valley on its tributary, 03.08.2005; 36. Laslea Valley upstream Laslea cca. 360 m, 03.08.2005.

Other species: *Acer campestre* (1, 15, 27, 35), *Agrimonia eupatoria* (4, 8, 18, 22, 23, 26, 31, 34), *Anchusa officinalis* (3, 4, 26, 34), *Anthemis arvensis* (7), *Anthriscus sylvestris* (33, 34), *Arrhenatherum elatius* (24, 29, 30, 31, 34), *Brassica nigra* (34), *Bryonia alba* (29, 34), *Carduus acanthoides* (2, 22, 26, 28, 29, 31, 33, 35), *Cerinthe minor* (4), *Chenopodium album* (5, 17, 25, 26, 27, 29, 30, 34), *Circaea lutetiana* (34), *Cirsium arvense* (1, 5, 9, 18, 19, 22, 23, 24, 26, 29, 30), *C. furiens* (1), *Crataegus monogyna* (1), *Crepis biennis* (1, 12, 17), *Cruciata glabra* (31), *Echinochloa crusgali* (5, 10, 12, 24, 25, 29, 34, 35, 36), *Festuca pratensis* (31), *Galeopsis ladanum* (18, 20), *Galinsoga ciliata* (29, 30), *G. parviflora* (3, 5), *Hypericum perforatum* (2, 4, 26, 31, 34, 35), *Impatiens noli-tangere* (33), *Lamium maculatum* (34), *Lathyrus latifolius* (31), *L. pratensis* (35), *L. tuberosus* (33, 34), *Lolium perenne* (26, 30, 34, 35), *Melilotus albus* (4, 9, 34, 35), *Ononis arvensis* (4, 8), *Pimpinella major* (26, 31), *Plantago lanceolata* (3, 5, 28, 34, 35), *P. major* (1, 3, 7, 9, 10, 34), *Polygonum aviculare* (3, 7, 9, 25, 26, 30, 34, 35), *Rosa canina* (3), *Salvia nemorosa* (34), *S. verticillata* (4, 29, 33), *Setaria pumila* (3, 9, 26, 28, 29, 34, 35), *Sonchus oleraceus* (14, 32, 35), *Succisa pratensis* (31), *Taraxacum officinale* (26, 28), *Tilia cordata* (21, 31), *Tragopogon orientalis* (6), *Typha latifolia* (28), *Verbascum blattaria* (7), *Verbascum phlomoides* (4, 7, 34), *Veronica chamaedrys* (3).

CONCLUSIONS

Considering, on the one hand, that the largest of the riverside habitats studied are *91E0 - subtype 44.13, and 6430 - subtype 37.7, and that the two habitats are juxtaposed in the wet meadows of several rivers and streams, I believe that some sectors of such meadows including both habitats should be declared protected areas, where the two habitats exhibit the highest degree of naturalness. These are the river sectors between Daneş and Criş; Viscri and Dacia; Apold and Daia; and Pelişor and Richiş.

REFERENCES

1. Baumgarten, J.C.G., 1816 − Enumeratio stirpum Magno Transsilvaniae principatui praeprimis indigenarum in usum nostrarum botaniphilorum conscripta 1-4, Vindobonae.
2. Csűrös, Şt., Kovács, A., 1962 − Cercetări asupra vegetației din raioanele Sighişoara şi Agnita, Contr. bot. Cluj, 205-232.
3. Drăgulescu, C., 1978 − Originea şi corologia speciei Narcissus poeticus L. s.l., St. şi com. Muzeul Brukenthal Sibiu, t. nat., 22, 105-128.
4. Drăgulescu, C., 1987 −Die Coenologie der Narzisse (Narcissus poeticus L. ssp. stellaris (Haw.) Dost.) in den Karpaten im Vergleich zu ihrer Vergesellschaftung in anderen Teilen Europas, Tuexenia, NS, 7, Gottingen, 233-243.
5. Drăgulescu, C., 2005 − The hydrophylous and hygrophilous flora and vegetation of Târnave rivers, Transylvanian review of systematical and ecological research, 2. The Târnava river basin, Sibiu, 13-30.
6. Fekete, L., Blattny, T., 1913 − Az erdeszeti jelentosegu fak es cserjek elterjedese a Magyar allam teruleten, I-II, Selmecsbanya.
7. Fronius, F., 1858 − Flora von Schässsburg, Programm d. evang. Gymn. v. Schässsburg 1857-1858, Sighişoara.
8. Fuss, M., 1866 − Flora Transsilvaniae excursoria, Cibinii.
9. Pop, E., 1960 − Mlaştinile de turbă din Republica Populară Română, Edit. Acad. Bucureşti.
10. Sanda, V., Popescu, A., Doltu, M.I., 1976 − Contribuții la cunoaşterea vegetației din bazinul mijlociu al Târnavei Mari, St. şi com. Muzeul Brukenthal Sibiu, Şt. nat., 20, 65-94.
11. Schneider-Binder, Erika, 1984 − Die Waldreben-Laserkraut-Staunderflur (Clematido recti-Laserpitietum latifolii ass. nova) im südsiebenbürgischen Hügelland, St. Com. Muz. Brukenthal, Şt. nat., 26, 143-159.
12 Schneider Erika, 1994 − Die Blaugras-Gesellschaften im Hügelland Siebenbürgens, Naturwiss. Forsch. ü. Siebenbürgen, Siebenb. Archiv, V, Bohlau, 107-132.
13. Schneider-Binder, Erika, 1996 − Reliefbedingte Abfolge von Pflanzengesellschaften an Rutschungshügeln in Siebenbürgen (Harbachhochland), Staphia, Linz, 45, 83-93.
14. Schur, F., 1866 − Enumeratio plantarum Transsilvaniae, Vindobonae.
15. Turcu, L. G., 1962 − Cercetări geobotanice în sectorul sud-estic al Pod. tîrnavelor, Dări de seamă ale şed. Comit. geol. Bucureşti, 43, 1955-1956, 635-658.

XEROPHILOUS AND XERO-MESOPHILOUS GRASSLANDS ON SLUMPING HILLS AROUND THE SAXON VILLAGES APOLD AND SASCHIZ (TRANSYLVANIA, ROMANIA)

*Erika SCHNEIDER-BINDER **

* Karlsruhe University, Institute for Waters and River Basin Management, Division WWF- Institute for Floodplain Ecology, Josefstr. 1, 76437 Rastatt, Germany, erika.schneider@iwg.uka.de

KEYWORDS: Romania, Transylvania, microlandscape units, slumping hills or mounds, ecological gradients, relation between insolation, slope gradient and vegetation, xerophilous and xero-mesophilous grasslands.

ABSTRACT

This paper presents the slumping hills near Apold and Saschiz, with their complex mosaic of different plant communities situated along ecological gradients. Slope gradient, aspect, as well as insolation, play an important role in this respect. In the focus of the study are grasslands characterized by the sedge *Carex humilis*, which occurs, depending on site factors, with varying combinations of species. On south-facing slopes *Carex humilis* occurs together with xerophilous species of the Stipion lessingianae alliance, whereas on south-west-, south-east-, west- and east-facing slopes, as well as to some extent on those that are north-facing, the association that occurs is Cariceto humilis-Brachypodietum pinnati, belonging to the xero-mesophilous grassland alliance Cirsio-Brachypodion. To obtain a general view of the vegetation of the slumping hills in the area investigated, this study includes as well stands characterized by *Sesleria heufleriana*, classified as Orchido-Seslerietum heuflerianae and also attributed to the Cirsio-Brachypodion alliance.

RÉSUMÉ: Les associations herbeuses xérophiles et xéro-mésophiles des collines de glissement près des communes saxonnes d'Apold et de Saschiz (Transylvanie, Romanie).

Ce communication présente les collines de glissement près des communes saxonnes d'Apold et de Saschiz avec leur mosaïque complexe des communautés végétales, lesquelles sont assemblées le long de gradients écologiques. Inclinaison et exposition de la pente ainsi que l'insolation allant de pair jouent un rôle important. L'étude est concentrée en tout premier lieu sur les associations herbeuses constituées de *Carex humilis*, lequel peut être trouvé, selon les facteurs du site, avec des compositions d'espèces très variées. Sur les versants sud *Carex humilis* co-existe avec les espèces xérophiles de l'alliance Stipion lessingianae, alors que sur les pentes sud-ouest, sud-est, ouest et est de même qu'en partie sur les pentes nord on trouve la communauté Cariceto humilis- Brachypodietum pinnati faisant partie de l'alliance des associations herbeuses xéro-mésophiles Cirsio-Brachypodion. Afin d'obtenir une vue générale de la végétation des collines de glissement de la région étudiée, ce rapport comprend également les peuplements de Sesleria heufleriana, regroupés sous Orchido-Seslerietum heuflerianae qui peuvent également être attribués à l'alliance Crsio-Brachypodion.

REZUMAT: Pajiştile xerofile şi xero-mezofile de pe colinele de alunecare din zona satelor săseşti Apold şi Saschiz (Transilvania, România).

Colinele din zona alunecărilor de teren de lângă Apold şi Sachiz sunt prezentate cu mozaicul lor complex de comunități de plante, repartizate de-a lungul unor gradienți ecologici. Rolul decisiv îl are expoziția şi înclinarea pantelor, precum şi insolația legată de aceşti factori. In centrul atenției stau comunitățile edificate de rogozul pitic (*Carex humilis*) în diferite combinații de specii caracteristice. Pe pantele sudice *Carex humilis* intră în combinație cu specii xerofile caracteristice ordinului Stipion lessingianae, pe când în expoziție sud-estică, estică, sud-vestică, vestică şi parțial spre nord, sunt caracteristice fitocenoze ale asociației Cariceto-humilis-Brachypodietum pinnati din alianța Cirsio-Brachypodion. Pentru a avea o imagine cuprinzătoare asupra vegetației movilelor din zona alunecărilor de teren studiată, sunt incluse şi cenozele edificate de *Sesleria heufleriana*, cuprinse în asociația Orchido-Seslerietum heuflerianae, aparținând de asemenea alianței Cirsio-Brachypodion.

INTRODUCTION

The highly structured hills of Transsylvania are composed of small-scale units with mosaic-like, interwoven plant communities, the occurrence of which is closely related to edaphic and microclimatic factors. Relief and vegetation and most of all varying landscape components, i. e. small landscape units, or micro-landscape units, that are spread all over the hilly country - and more specifically in the study area in the Saxon Villages - determine this landscape's character. In the western part of the area investigated, around the Mediaş highlands, the micro-landscape units show a greater diversity as compared to the highlands situated to the east of Sighişoara (Schässburg), called 'Podişul Burgului' by Mihăilescu (1966). Even the hilly areas alter from west to east. Whereas the western areas are characterized by altitudes of 400 - 600 m, the eastern areas show, besides elevations of 400 - 600 m, also those up to 700 (750) m.

INVESTIGATION AREA/BACKROUND, MATERIALS AND METHODS

While considering the different landscape components, i.e. micro-landscape units, some of them are specifically characteristic of the area. A unique natural scenery may be found, e.g. on the steep slopes of the sheltered lateral valleys of the Mediaş highlands that are marked by extreme insolation. They are much narrower compared with the Târnava Mare valley and are of southern, south-eastern or south-western aspect. These slopes with a gradient of at least 45° offer a perfect habitat for the vine. One may also find numerous thermophilic species of fauna and flora that provide the Transylvanian landscape with its very specific character. The open, steep slopes that are sparsely covered with vegetation are frequently subject to erosion and slumping, which occur as a result of the slipping of water-permeable layers (sandstone, sandy marl) from underlying water-impervious clay layers on steeper slopes.

In contrast to the insolated steep slopes, the steep slopes of northern or north-eastern aspect are cool and usually characterized by shade-loving species. They mainly offer adequate sites for beech forest. On the gentler lower slopes one may find mesic grassland sites that are managed as meadows or pastures. However, in the case of larger areas, mainly east of Sighişoara, rolling hills are also characteristic of this landscape and the micro-climatic differences among gentle slopes of varying aspect are less distinctive.

The high ground between the valleys forms shallow, level or slightly convex ridges, in particular plateaux 1 km or more wide. These are frequently called 'Breite' (as in the famous example near Sighişoara) and offer favourable sites for oaks. In many places they are managed as pastures or wood-pastures.

The small, very narrow and deep valleys of the upper river courses and small gullies also show quite specific characteristics. Insolation is very low in these places. As a result, the small valleys are cool, and humidity is higher on both slopes. They offer optimal sites for beech. The larger lateral valleys that are situated between the individual groups of hills, of varying gradients and aspects, comprise the characteristic floodplains of the rolling country with slowly flowing streamlets. However, in the whole hilly country summer torrential rains mainly account for very intense and short episodes of flooding (Schneider, 1998). High groundwater levels allow the formation of swamps and in some places even bogs.

In the whole mosaic of various small landscape units, the vegetation is arranged along ecological gradients depending on slope gradient, aspect and soils, which in their turn determine the conditions of temperature and moisture. The most distinctive differences in the vegetation distribution become apparent on the southern and northern slopes of the hills. Site down-slope differences may even be denoted between upper and lower slope of a hill. Even very small differences in gradient and aspect of a slope are reflected in the plant community composition.

The small-scale mosaic of varying plant communities occurring along the slopes of the hilly country have repeatedly been of particular concern in scientific considerations. Particular attention has always been paid to the south-facing steep slopes with their xerothermic plant communities. The steep slope, strong insolation and substrate composed of sandstone and marl layers, which is heating up correspondingly, favours the existence of xerothermic plant communities along the slopes. Their occurrence is comparable for all hills studied (Csürös et al. 1961, Schneider, 1977, 1983, 1996, Wendelberger, 1994). In contrast to the south-facing slopes with extreme temperatures, the highest insolation, low humidity, highest evaporation rates and most distinct continentality, the shaded slopes of northern aspect show the highest humidity ratios, and lowest light and temperature values, as well as the lowest evaporation rates and less distinct continentality. This is where montane plant communities occur, i.e. beech forests and montane meadows. The wide differences between the site conditions on southern and northern slopes are expressed both in the seasonal fluctuations and in the daily curves of the individual factors (Schneider, 1976).

The small-scale differences occuring on the hill slopes exist exactly the same on even smaller sites on slumping hills or mounds. In the area of the Saxon Villages investigated, these may be found near Apold (Trappold), near Saschiz (Keisd) and, not far from the main area of investigation, between Noiştat (Neustadt) and Movile (Hundertbücheln). The vegetation in the site gradients of these slopes has been the subject of previous studies (Csürös and Kovács, 1962, Niedermaier, 1977, Schneider, 1984, 1994, 1996).

This work is based on studies conducted over various periods of time. The first samples were taken in 1981 - 1984 in the areas of slumping mounds at Apold (between Apold and Brădeni) and Saschiz ("the ten hills" area (Zehnbüchel) and Dealul Furcii (Galgenberg)). Moreover, samples from the Movile area (just south of to the Saxon Villages study area), as well as from the Malâncrav (Malmkrog) and Biertan (Birthälm) areas, have been considered as well. Later on, in 1999, these areas were inspected again to determine alterations in the composition of the phytocoenoses. It became clear that the plant communities along the steep slopes had barely changed and were in a relatively stable condition.

The samples were taken along slope sections according to the Braun-Blanquet method for the evaluation of abundance and dominance on a 7-point scale. By doing so, the samples taken along differing sections following ecological gradients were subsequently arranged to make sure that the transition areas were recorded as well, and to determine the changes in the composition of the phytocoenoses depending on slope gradient and aspect.

The samples have been summarized in a phyto-sociological table where the various phyto-sociological units are grouped according to indicator species. Moreover, ecological aspects have been considered as well and the species grouped according to ecological indicator values with respect to their requirements for moisture and temperature, and in each case their behaviour within a stand has been analysed (Sanda et al., 1983).

RESULTS AND DISCUSSIONS

Small-scale, xerothermic, continental xerophilous grasslands occur along south-facing slopes and are characterized by *Carex humilis* and *Stipa pulcherrima*, *Salvia nutans*, *Brassica elongata*, *Cephalaria radiata* and *Astragalus asper*, and, in some places along erosion sites (on the top of the hills), also by *Artemisia pontica*. However, on north-, north-east- and north-west-facing slopes, xero-mesophilous grasslands mainly composed of *Brachypodium pinnatum*, *Carex montana*, *Dorycnium herbaceum*, *Onobrychis viciaefolia* and other meadow species may be found, as well as sporadic colline *Sesleria heufleriana* associations. Tall-herb vegetation with *Clematis recta* and *Laserpitium latifolium* occurs along the north-facing slopes and has been subject to extensive studies, and various variants of xerophilous meadows (Schneider, 1994).

A summary is given below of the xerophilous and xero-mesophilous grasslands, mainly of the arc of slumping hills around Apold and Saschiz, considering as well a number of phyto-sociological samples from other parts of the project area (Mălâncrav, Biertan) and the neighbouring area of Moşna (Meschen).

Both in Apold and Saschiz the xerophilous grasslands are limited to the extremely arid front areas of the south-facing slopes of the small slumping hills. The more we expand into the hilly country south of the Târnava Mare from west to east, the more temperature and altitudes are changing, the smaller in extent are the xerophilous grasslands that, for edaphic reasons, merely represent fragments of associations even though they can easily be recognized.

The micro-landscape units on the slumping hills around Apold and Saschiz also imply a close interaction of the individual plant communities. This is why only a precise analysis of the tables allows the determination of the various phytocoenoses. Some samples, however, have to be considered as transitional stages.

These cases mainly concern grassland communities composed of *Carex humilis* with various combinations of species. On the one hand, *C. humilis* occurs in extremely dry variants. In this area, however, it mainly forms xero-mesophilous grasslands together with *Brachypodium pinnatum*, which is associated with the Cirsio-Btrachypodion alliance (Tab. 1, columns 1 - 3).

In the more arid areas, *Carex humilis* forms grassland stands with the xerophilous species *Stipa pulcherrima*, together with other xerophilous species such as *Salvia nutans*, *Jurinea mollis* (moisture value U 1 = xerophilous species) and *Brassica elongata* (U = 1.5) (Tab. 1, columns 4, 5). These species are characteristic of the Stipion lessingianae alliance. In the area studied, however, such stands merely occur in micro-landscape units on the front areas of the south-facing slopes of the hills. Along erosion edges they are closely intermixed with stands of *Artemisia pontica* communities, found at both Apold and Saschiz (Tab. 1, columns 6, 7).

Table 1: Xerophilous and xero-mesophilous grassland communities edified by *Carex humilis* in dfferent species combination.

		1	2	3	4	5	6	7	8	9	10	I	II
	Locality	M	Sa	Sa	A	A	Sa	A	Mo	Mo	Bi	Mov	A, Sa
	Exposition	SW	SW	E	S	SW	S	SW	S	SE	SW		
	Inclination	40	35	30	45	50	45	40	40	40	30		
	Coverage degree %	85	70	90	70	75	65	55	90	85	90		
	Sampling surface m^2	25	25	25	25	25	15	10	25	25	25		
	Number of samples											8	8
	Frequency %											F%	F%
Me	*Sesleria heufleriana*	.	.	.	.	.	.	.	.	.	.	-	100
Me	*Orchis militaris*	+	.	1	.	.	.	.	.	.	.	-	100
CB	*Brachypodium pinnatum*	3	1	4	.	.	.	.	+	+	1	87.5	25
CB	*Inula ensifolia*	1	.	.	.	.	.	.	1	.	+	62.5	25
CB	*Dorycnium herbaceum*	.	.	1	.	.	.	.	1	+	1	62.5	87.5
CB	*Plantago media*	.	.	+	.	.	.	.	1	+	.	50	62.5
CB	*Cirsium pannonicum*	.	.	+	+	+	.	.	.	.	.	-	50
CB	*Onobrychis viciaefolia*	.	+	+	.	+	.	.	.	.	+	87.5	62.5
CB	*Polygala major*	.	.	+	.	+	.	.	.	.	+	87.5	37.5
CB	*Thesium linophyllum*	.	.	+	+	.	.	.	+	+	.	50	37.5
CB	*Ranunculus polyanthemos*	+	+	+	.	.	.	.	+	.	+	37.5	37.5
CB	*Stipa stenophylla*	+	.	.	.	.	.	.	.	.	.	-	-
CB	*Linum catharticum*	.	.	.	.	.	.	.	.	+	+	87.5	-
Me	*Carex montana*	2	+	1	.	.	.	.	.	.	.	25	12.5
Me, F	*Hieracium cymosum*	.	.	.	.	.	.	.	.	+	.	62.5	37.5
Me	*Chrysopogon gryllus*	.	.	.	.	.	.	.	3	2	3	-	-
Stl	*Salvia transsilvanica*	.	+	.	.	.	+	.	.	.	.	-	-
Stl	*Stipa pulcherrima*	.	.	.	2	2	.	.	.	.	.	12.5	-
Stl	*Iris pumila*	.	.	.	+	.	.	.	.	.	.	12.5	-
Fion	*Astragalus asper*	.	.	.	+	+	.	.	.	.	.	75	12.5
Ag K	*Brassica elongata*	.	.	.	.	+	.	+	.	.	.	12.5	-
Fion	*Pulsatilla montana*	+	.	+	.	.	.	.	+	+	+	25	12.5
Fion	*Vinca herbacea*	+	.	.	.	.	.	.	.	.	.	-	-
Fion	*Inula germanica*	.	.	.	.	.	.	.	+	+	+	-	-
Fion	*Salvia autriaca*	.	.	.	.	.	.	.	1	1	.	-	-
F	*Salvia nutans*	.	.	.	1	2	.	+	.	.	.	62.5	12.5
F	*Artemisia pontica*	.	.	.	1	+	4	3	.	.	.	-	12.5
F	*Carex humilis*	3	3	2	3	+	+	+	3	3	3	100	37.5
F	*Campanula sibirica*	.	.	.	+	+	.	.	.	+	.	87.5	12.5
F	*Jurinea mollis*	.	+	.	+	1	.	.	.	.	+	62.5	62.5
F	*Artemisia campestris*	.	.	.	.	+	+	+	.	.	.	62.5	12.5
F	*Cephalaria radiata*	.	+	.	+	+	+	+	.	.	.	-	12.5
F	*Stachys recta*	.	.	.	.	+	.	.	.	.	+	75	50
F	*Elymus hispidus*	1	.	.	.	2	.	2	.	.	+	50	50
F	*Chamaecytisus austriacus*	.	+	.	+	.	.	.	.	.	+	75	75
F	*Centaurea micranthos*	.	.	.	+	+	+	+	+	+	+	37.5	-
F	*Falcaria sioides*	.	.	.	+	.	.	.	.	.	.	87.5	25
F	*Astragalus monspessulanus*	+	+	.	+	2	+	.	+	+	.	50	12.5

		1	2	3	4	5	6	7	8	9	10	I	II
F	*Asyneuma canescens*	.	.	.	.	.	.	.	+	.	.	-	25
F	*Leontodon asper*	.	+	.	.	.	.	.	.	.	.	-	12.5
F	*Anthyllis vulneraria*	.	.	+	.	.	.	.	.	.	.	-	12.5
F	*Thymus marschallianus*	.	.	.	+	.	+	.	+	1	1	-	25
F	*Potentilla arenaria*	+	.	.	+	.	+	.	+	1	1	62.5	12.5
F	*Aster amellus*	.	+	.	+	.	.	.	.	.	.	12.5	-
F	*Festuca valesiaca*	.	+	.	+	.	.	.	.	.	.	62.5	25
F	*Teucrium montanum*	1	.	.	.	.	.	.	1	1	.	-	-
F	*Adonis vernalis*	+	+	.	+	.	+	.	+	+	.	-	12.5
F	*Scabiosa ochroleuca*	.	.	+	.	+	.	.	+	+	+	50	25
F	*Veronica praecox*	.	.	.	.	.	.	.	.	.	.	-	37.5
F	*Astragalus austriacus*	.	.	.	.	.	.	.	+	+	+	75	-
F	*Verbascum phoeniceum*	.	.	.	.	.	.	.	.	.	.	50	-
F	*Hypericum elegans*	.	.	.	.	.	.	.	.	.	.	37.5	-
F	*Oxytropis pilosa*	.	.	.	.	.	.	.	.	.	.	62.5	-
F	*Veronica spicata*	.	.	.	.	.	.	.	+	+	+	-	-
FB	*Teucrium chamaedrys*	.	.	.	+	1	.	.	1	2	1	87.5	25
FB	*Koeleria gracilis*	.	.	.	+	.	.	+	+	.	+	100	-
FB	*Medicago falcata*	+	.	.	.	+	.	.	+	.	+	25	37.5
FB	*Potentilla recta*	.	.	.	.	.	.	.	.	.	.	-	12.5
FB	*Tragopogon dubius*	.	+	+	+	.	.	.	.	.	.	50	12.5
FB	*Pimpinella saxifraga*	.	.	.	.	.	.	.	.	+	.	-	62.5
FB	*Filipendula vulgaris*	.	.	+	.	.	.	.	+	.	+	37.5	25
FB	*Botriochloa ischaemum*	.	.	.	+	.	.	+	1	1	1	25	12.5
FB	*Asperula cynanchica*	.	.	.	.	+	.	.	+	+	+	50	25
FB	*Eryngium campestre*	.	.	.	1	.	.	.	+	+	.	75	-
FB	*Muscari comosum*	.	+	.	+	+	.	.	.	+	+	-	-
FB	*Euphorbia cyparissias*	.	+	.	+	+	.	+	+	+	.	-	25
FB	*Salvia pratensis*	+	+	+	.	.	.	.	+	+	+	62.5	50
FB	*Hypericum perforatum*	.	.	.	.	.	.	.	+	+	.	-	-
FB	*Achillea collina*	.	.	.	.	.	.	.	+	+	.	-	-
FB	*Gentiana cruciata*	.	+	+	.	.	.	.	.	.	.	-	-
FB	*Abietinella abietina*	.	.	.	.	.	.	.	.	.	.	-	25
Mo	*Stachys officinalis*	.	.	+	.	.	.	.	.	.	.	-	12.5
Mo	*Serratula tinctoria*	.	.	.	.	.	.	.	.	.	.	-	25
MA	*Heracleum sphondylium*	.	.	.	.	.	.	.	.	.	.	-	25
MA	*Carex tomentosa*	.	.	.	.	.	.	.	.	.	.	-	50
MA	*Veronica chamaedrys*	.	.	+	.	.	.	.	.	.	.	-	12.5
MA	*Hypochoeris radicata*	.	.	.	.	.	.	.	.	.	.	-	25
Mo	*Calamagrostis epigeois*	+	.	.	.	.	.	.	.	.	.	-	12.5
MA	*Centaurea jacea*	.	.	+	.	.	.	.	.	.	.	-	12.5
MA	*Lotus corniculatus*	.	.	+	.	.	.	.	+	.	.	-	25
MA	*Plantago lanceolata*	.	.	.	.	.	.	.	+	+	.	-	37.5
MA	*Rhinanthus rumelicus*	.	.	+	.	.	.	.	.	.	.	62.5	37.5
MA	*Achillea millefolium*	.	+	+	.	.	.	.	.	.	.	-	12.5
A	*Briza media*	.	2	2	.	.	.	.	.	.	.	25	25
MA	*Taraxacum officiale*	.	.	.	.	.	.	.	+	.	.	-	100
MA	*Galium mollugo*	.	.	.	+	.	.	.	.	.	.	-	75
MA	*Dactylis glomerata*	+	.	.	.	.	.	.	.	.	.	-	50
MA	*Poa pratensis*	+	.	+	.	.	+	.	.	.	.	37.5	62.5
MA	*Valeriana officinalis*	.	.	.	.	.	.	.	.	.	.	-	50
MA	*Leucathemum vulgare*	.	.	+	.	.	.	.	.	.	.	37.5	75

		1	2	3	4	5	6	7	8	9	10	I	II
Qu	*Campanula bononiensis*	.	.	.	.	.	.	.	.	.	.	-	62.5
Qu	*Primula officinalis*	.	.	.	.	.	.	.	.	.	.	-	100
Qu	*Thalictrum aquilegifolium*	+	.	+	+	.	.	.	.	.	.	-	62.5
Qu	*Euphorbia angulata*	.	+	.	.	.	.	.	.	.	.	-	37.5
Qu	*Chrysanthemum corymbosum*	.	.	.	.	.	.	.	.	.	.	-	25
Qu	*Genista tinctoria*	.	.	.	.	.	.	.	+	+	.	-	-
TG	*Centaurea scabiosa*	+	.	.	.	.	.	.	.	.	.	62.5	87.5
TG	*Viola hirta*	.	+	.	+	.	.	.	+	+	+	50	50
TG	*Bupleurum falcatum*	.	.	.	+	.	.	.	.	+	.	25	50
TG	*Crepis praemorsa*	.	.	.	.	+	.	.	.	.	.	-	75
TG	*Laserpitium latifolium*	.	+	.	+	.	.	.	.	.	.	-	37.5
TG	*Trifolium alpestre*	.	.	+	.	.	.	.	.	.	.	25	37.5
TG	*Anemone sylvestris*	.	.	.	.	.	.	.	.	.	.	-	12.5
TG	*Ferulago sylvatica*	.	.	.	.	.	.	.	.	.	.	-	37.5
TG	*Coronilla varia*	.	.	+	.	.	.	.	.	.	.	25	25
TG	*Peucdanum oreoselinum*	+	.	+	.	.	.	.	.	.	.	25	37.5
TG	*Agrimonia epatoria*	.	.	.	.	.	.	.	+	+	+	-	-
TG	*Origanum vulgare*	.	.	.	.	.	.	.	.	.	1	-	-
	Other species												
AP	*Listera ovata*	.	.	+	.	.	.	.	.	.	.	-	12.5
QF	*Viola mirabilis*	.	.	.	.	.	.	.	.	.	.	-	25
QF	*Crataegus monogyna*	.	+	.	.	.	.	.	.	+	+	25	12.5
ON	*Salvia verticillata*	.	.	.	.	.	.	+	.	.	.	-	25
PTr	*Traunsteinera globosa*	1	.	.	.	.	.	.	.	.	.	-	-

Note: Species with "+" represented in one sample: *Anthericum ramosum*, *Peucedanum officinale*, *Quercus pubescens*, *Veronica prostrata*, *Verbascum phoeniceum* (1), *Meicago minima*, *Orchis incarnate* (2), *Senecio inegrifolius* (3), *Allium flavum*, *Convolvulus arvensis*, (4), *Nonea pulla* (5), *Diplachne serotina* (8).

CB - Cirsio-Brachypodion, Me - Mesobromion, Stl - Stipion lessingianae, Fion - Festucion valesiacae, AgK - Agropyro-Kochion, F - Festucela valesiacae, FB - Festuco-Brometea, Qu - Quercetea pubescenti-petraea, TG - Trifolio-Geranietea, AP - Alno-Padion, QF - Querco-Fagetea, ON - Onpordion, PTr - Polygono-Trisetion.

Place of sampling and sampling date: 1 M/Mălâncrav/Malmkrog, 18.05.1980; 2 Sa/Saschiz/Keisd, Dealul Furcii/Galgenberg, May, 1999; 3 Sa/Saschiz /Keisd, "ten hills" area/Zehnbüchel. May 1999; 4, 5, 7 A - Apold near Sighişoara/Trappold, 21.05.1981 (with verification in 1999); 6 Saschiz/Keisd, "ten hills area"/Zehnbüchel, 30.05.1982 (with verification in 1999); 8, 9 Mo/Moşna/Meschen, Moşna Valley/Dealul Morii/Morii Hill, 09.1984; 10 Bi/Biertan/Birthälm, hill to Copşa Mare/Groß-Kopisch, July 2003.

I - 8 samples from Movile/Hundertbücheln (synthetic view with frequency in % 06.1980); II - 8 samples from Saschiz/Keisd and Apold/Trappold (syntetic view with frequency in %).

Besides the xero-mesophilic species *Artemisia pontica* (moisture value U 2), this species-poor community is characterized on the one hand by xerophilous species of the Stipion lessingianae-alliance, such as *Salvia nutans*, *S. transsilvanica* and *Brassica elongata*, and on the other hand by xero-mesophilous species such as *Carex humilis* and various species of the Festucetalia valesiacae order (Tab. 1, columns 6, 7). *Elymus hispidus (Agropyron intermedium)* also occurs increasingly in some places and is characteristic too of eroding slopes.

For a better recognition and characterization of the site-specific species combinations in these micro-landscape units of slumping mounds, samples from the Movile area situated just south of the investigated area, with broad slumping hills, have been analysed for comparison. These are listed in a table showing their total frequency values. On these hills one may observe a distinct interaction of the xero-mesophilous *Carex humilis* with xerothermic xerophilous grasslands. However, besides the xerophilous and thermophilous species *Stipa pulcherrima*, *Salvia nutans* and *Brassica elongata* mentioned for Apold and Saschiz and which occur here as well, further xerophilous species (moisture value 1) have also been found: *Stipa capillata, Cleistogenes serotina, Botriochloa ischaemum*, *Festuca valesiaca, Oxytropis pilosa, Vinca herbacea* and *Onobrychis arenaria*. Provisionally this variant could be called Carici humilis-Stipetum; however, much more comprehensive samples would be required to describe a unit determined according to phyto-sociological and ecological criteria.

With regard to the xero-mesophilous grasslands, *Carex humilis* and *Brachypodium pinnatum* associations are prevalent in this investigation area. In the literature these are described as Cariceto humilis-Brachypodietum pinnati (Schneider, 1971). Both these plant species have similar moisture requirements, *Brachypodium pinnatum* (U = 2.5) being somewhat more mesophilous compared with *Carex humilis* (U = 2). In addition to these two stand-forming species, a number of xero-mesophilous species occur of the Cirsion-Brachypodion alliance, among them *Dorycnium herbaceum*, *Onobrychis viciifolia*, *Polygala major*, *Thesium linophyllon*, *Linum catharticum* and *Carex montana* (Tab. 1, columns 1 - 3). Regarding the sampling in the Mălâncrav area, the occurrence of the species *Stipa stenophylla* should be mentioned as well (Tab. 1, column 1).

Characteristic of Carici-Brachypodietum, as different species compared to more xerophilous associations, are also species of Arrhenatheretalia and Molinio-Arrhenatheretea, among them, for example, *Briza media*. The association is very rich in species, and characterized by a number of xerophilous grassland species of Festucetalia valesiacae, tall herbaceous vegetation of Trifolio-Geranietea (Tab. 1), as well as species of thermophilous oak forests (Quercetea pubescenti-petraeae). In the Mălâncrav samples, downy oak (*Quercus pubescens*) has also been recorded.

The comparative samples from Movile gathered outside the actual investigation area (Tab. 1, column I), point out even more distinctly the species abundance of the xero-mesophilous grassland association: *Carex humilis* and *Brachypodium pinnatum* and simultaneously their transitional stage between xerophilous grassland communities and mesophilous meadows occurring in the area all together.

A further association based on the species *Carex humilis* and *Chrysopogon gryllus* is notable for the investigation area and has been found near Biertan in the direction of Copşa Mare (Groß-Kopisch) (Tab. 1, columns 8 - 10). The association occurs on wide areas of the southern Transsylvanian hills and has also been discovered just next to the investigation area in the Moşna Valley (Schneider, unpublished), as well as further west (Drăgulescu, unpublished 2007). This association spreads from the Mieresch Valley in the west into Transylvania, its main distribution area being however the Balkan-Moesic area. Regarding the moisture requirements of *Chrysopogon gryllus*, they are comparable to those of *Carex humilis*, even though it prefers a more xerophilous area (U = 1.5). Its temperature requirements are somewhat higher compared with *Carex humilis*, which generally has a slightly broader ecological amplitude for the heat factor. The species composition of the xero-mesophilous grasslands with *Carex humilis* and *Chrysopogon gryllus* is altogether very similar to those of *Brachypodium pinnatum* and *Carex humilis* and justifies their uniting within an alliance. However, in southern Transsylvania Chrysopogon-characterized grasslands may only be regarded as an edge effect of the Chrysopogon associations of their main distribution area.

Besides the associations characterized by *Carex humilis*, a further association may be found in the area of the slumping hills near Apold and Saschiz, which is counted among the xero-mesophilous grasslands. These are stands of the Transsylvanian blue moor-grass (*Sesleria heufleriana*) association, which has been described in a comparative study on slumping hills (Schneider, 1994). They are briefly outlined below to provide a comprehensive picture of the xero-mesophilous grasslands of these slumping hills. The *Sesleria heufleriana* association, described as Orchido-Selerietum heuflerianae (Schneider 1994), is well delimited, even though in its boundary areas one may observe transitional stages towards *Brachypodium* associations. Such transitions have been recorded at Apold on a north-facing hill slope. The stands are also closely intermixed with stands of *Artemisia pontica*, as well as variants of xero-mesophilous grasslands in which *Elymus hispidus* forms stands on extremely steep slopes.

The stands of *Sesleria heufleriana* take a medium position regarding moisture in the investigated area of Apold and Saschiz and have a relatively good soil water supply, which is not the case for comparable stands in Câmpia Transilvaniei (Schneider, 1994).

The colline *Sesleria* associations of the Hârtibaciu (Harbach) uplands in the south-eastern border area of the Transsylvanian Uplands are part of a continental xero-mesophilous group of associations, just as in Câmpia Transilvaniei, that corresponds to the xero-mesophilous grasslands of the Cirsio-Brachypodion-alliance. This classification has already been elaborated by Krausch and was later upheld by further sampling (Schneider, 1994). In the case of the stands found in the area investigated in the Saxon villages the characteristics of the xero-mesophilous grasslands are reflected by a broad share of indicator species of moderately dry sites, respectively species of the Cirsio-Brachypodion and Mesobromion alliances (Tab. 1, column II, synthesis with frequency values). A number of species in Molinio-Arrhenatheretea characteristic of xerophilous grasslands differentiate the association as compared to more arid variants with *Sesleria heufleriana*, occurring on rocky ground along the borders of the Apuseni Mountains, as well as in southern Transsylvania on the conglomerate hills of Podu Olt (Măgura Boiței).

The colline associations of *Sesleria heufleriana* occurring on especially steep slopes are extremely stable. The stands studied in the early 1980s were subject to further investigations in 1999, which showed that they had barely changed. Even the occasional burning of the slopes near Apold did not alter the association. Now and then these stands are also subject to cutting.

Regarding the grasslands with *Brachypodium pinnatum* and *Carex humilis*, especially those not occurring on the steepest slopes and terraces (Mălâncrav), these are partly managed by cutting. In those places, however, which are completely without management measures, scrub grows up and in the long run will lead to changes in the associations. Eventually these sites will predominantly show species of the Trifolio-Geranietea and, last but not least, the proportion of forest species will increase as well.

Carex humilis associations occurring on steeper slopes show a higher stability in their species composition, and their share of characteristic xerophilous grassland species increases. The xerophilous grassland fragments on the front areas are caused by the extreme conditions, steep slopes, extreme insolation and also special edaphic sites that are relatively stable.

The somewhat orchid-abundant sites in the xerophilous and xero-mesophilous grasslands deserve a higher attention especially due to the abundance of orchids, given that, as such, they belong to the grassland types (habitat type 6210) that comprise the Natura 2000 network. This status takes effect even if there is no diversity of various orchids but where there is a considerable population of one rare species within a specific area (Schneider and Drăgulescu, 2005).

CONCLUSIONS

To conclude, it may be said that in the study area of slumping hills the xerophilous grasslands occur on microlandscape units in the front areas of the south-facing slopes. The present xero-mesophilous grasslands do, however, occur, according to their moisture requirements, partly on south-west- and south-eastward-facing respectively eastward- and west-facing slopes as well as on the upper, steep sections of north-facing slopes. Xero-mesophilous grasslands may be found on middle and lower slopes, as well as on ancient terraces all over the hilly country. The broader perspective of these xero-mesophilous grasslands will still require further attention with regard to their management and, from the point of view of nature conservation, long-term sustainable continuity.

ACKNOWLEDGEMENTS

The author is grateful to the Darwin Initiative of the UK Ministry of Agriculture (DEFRA), Orange Romania, and the NGOs Fundaţia ADEPT and Ecotur Sibiu for supporting this publication.

REFERENCES

1. Csürös, St. and Kovács, A, 1962 – Cercetări fitocenologice în raioanele Sighişoara şi Agnita (in Romanian), Contrib. Bo. Cluj, 205-232.
2. Csürös, St., Resmeriţă, I., Csürös-Kaptalan, M. and Gergely, I., 1961, Contribuţii la cunoaşterea pajiştilor dine Cîmpia Transilvaniei şi unele consideraţiuni cu privire la organizarea terenului (in Romanian), Studia Univ. Babes-Bolyai, Ser. II, 2, Biologie, 15-61.
3. Mihăilescu, V., 1966 – Dealurile şi Cîmpiile României. Studiu de geografie a reliefului (in Romanian), Editura Ştiinţifică, Bucureşti.
4. Niedermaier, 1977 – Geheimnisvolle siebenbürgische Landschaft. Naturwissenschaftliche Wanderungen zwischen Alt und Großer Kokel, 23 Jg, Jb. 78, 1-20, München.
5. Sanda, V., Popescu, A., Doltu, M. I. and Donata, N., 1983 – Caracterizarea ecologică şi fitocenologică a speciilor spontane din flora României (in Romanian), Studii si Comunic. St. Nat., Muz. Brukenthal Sibiu, 25, supliment, 1-126.
6. Schneder-B., E., 1971 - Die Halbtrockenrasen der Zibinssenke und ihrer Randgebiete, Studii si Comunic. St. Nat., Muz. Brukenthal Sibiu, 16, 135-172.
7. Schneider-B., E., 1977 - Über die Pflanzengesellschaften des Stipion lessingianae Soó 47 in Rumänien.- Studii si Comunic. St. Nat., Muz. Brukenthal Sibiu, 21, 91-113.
8. Schneider-B., E., 1983 - Die Flora des Steppenreservates am Zakelsberg (Slimnic, Südsiebenbürgen), Studii si Comunic. St. Nat., Muz. Brukenthal Sibiu, 25: 153-176.
9. Schneider-B., E., 1984 - Die Waldreben-Laserkraut Staudenflur (Clematido-Laserpitietum latifolii ass. nova) im südsiebenbürgischen Hügelland, Studii si Comunic. St. Nat., Muz. Brukenthal Sibiu, 26: 143-159.
10. Schneider, E., 1994 - Die Blaugras-Gesellschaften im Hügelland Siebenbürgens.- Naturwiss. Forschungen über Siebenbürgen V. Beiträge zur Flora, Vegetation und Fauna von Siebenbürgen, 107-131, Böhlau Köln, Weimar, Wien.
11. Schneider, E., 1996 - Reliefbedingte Abfolge von Pflanzengesellschaften an Rutschungshügeln in Südsiebenbürgen (Harbachhochland).- Stapfia 45: 83-93, Linz.
12. Schneider, E., 1998 - Die Auen im Hügelland Siebenbürgens aus ökologisch-vegetationskundlicher Sicht.- Mauritiana (Altenburg), 16: 481-497.
13. Schneider, E. and Drăgulescu, C,, 2005 – Habitate şi situri de interes comunitar (in Romanian), Editura Universităţii Lucian Blaga, Sibiu, 1-168.
14. Schneider, E. A., 1976 – Untersuchungen über die Arthropodenfauna xerothermer Standorte im südsiebenbürgischen Hügelland. III. Die Carabidenfauna eines Südhanges und angrenzender Habitate im Hügelland Südsiebenbürgens, Stud. Si Com. St. Nat., Muz. Sibiu, 20, 209-253.
15. Wendelberger, G., 1994 – Die siebenbürgischen Mergelsteppen, Naturwiss. Forschungen über Siebenbürgen V. Beiträge zur Flora, Vegetation und Fauna von Siebenbürgen, 107-131, Böhlau Köln, Weimar, Wien.

RUDERAL FLORA OF THE SAXON VILLAGES (TRANSYLVANIA, ROMANIA): A NEGLECTED CONSERVATION CONSTITUENCY

John AKEROYD *

* Agricultural Development and Environmental Protection in Transylvania Foundation, Lawn Cottage, West Tisbury, Salisbury, Wiltshire SP3 6SG, United Kingdom, jrakeroyd@dsl.pipex.com

KEYWORDS: Romania, Trasylvania, medicinal plants, ruderal species and habitats, weeds.

ABSTRACT

The Saxon Villages possess a rich assemblage of wayside plants, none of them individually rare, which conservationists have largely ignored. The flora of these modified and disturbed habitats includes a group of ancient food, medicinal and other cultural plants, which comprise a significant biological and cultural resource. This sort of plant community will become more precarious as rural development alters the character of the villages.

If ruderal plants are to survive they will require the application of special conservation measures, perhaps within the context of the conservation of churches and other village buildings.

ZUSAMMENFASSUNG: Die Ruderalflora der sächsischen Dörfer (Transylvanien, Rumänien): eine vernachlässigte Pflanzengruppe.

In den sächsischen Dörfern findet sich eine reiche und vielfältige Flora an wegbegleitenden Pflanzen, die von den Ökologen meist vernachlässigt wurde, da es sich nicht um seltene Arten handelt. Die Flora dieser vom Menschen beeinflussten und gestörten Standorte umfasst eine Gruppe alter Nahrungs-, Heil- und anderer Kulturpflanzen, die eine bemerkenswerte biologische und kulturelle Ressource darstellen. Diese Pflanzenbestände werden immer weniger vertreten sein, in dem Maße wie die Dorfentwicklung den Charakter der Ortschaften verändern wird.

Um das Überleben dieser Ruderalarten zu sichern, ist die Anwendung spezieller gesetzlicher Vorschriften für den Schutz der Umwelt erforderlich, die auch in Zusammenhang mit der Erhaltung der Kirchen und anderer dörflicher Gebäude gesehen werden können.

REZUMAT: Flora ruderală a satelor săseşti (Transilvania, România): o categorie de plante neglijată.

Satele săseşti prezntă o mare diversitate de plante marginale care au fost în mare măsură ignorate de către ecologi, nici una nefiind în mod individual plante rare. Flora acestor habitate modificate şi perturbate antropic include un grup de plante stravechi pentru hrană, medicinale şi alte plante de cultură; acestea repezintă o resursa biologică şi culturală semnificativă. Acest tip de comunitate de plante va deveni din ce în ce mai rară pe masură ce dezvoltarea rurală modifică caracterul satelor.

Pentru păstrarea speciilor ruderale va fi necesară aplicarea unor legi specifice de protecție a mediului, ținând seama de protejarea bisericilor şi a altor clădiri din sate.

INTRODUCTION

In recent years botanists have become increasingly aware of the rich native flora and biodiversity of the Saxon Villages area of southern Transylvania. It is now clear that the countryside that surrounds these historic villages constitutes a remarkable biological resource of international significance, which needs to be conserved at landscape level, as an ecological and cultural entity (Akeroyd, 2002, 2006; Akeroyd and Page 2006; Mountford and Akeroyd 2005).

Traditional and non-intensive farming has allowed the persistence of important biodiversity-rich habitats, plants and animals in intimate association with agriculture and food production. The villages themselves, famous for their fortified churches and handsome farmhouses, also possess a rich assemblage of wayside flowers and woody plants, but conservationists (both those concerned with assessing biodiversity and those who restore and protect village buildings) have largely failed to draw attention to the characteristic flora of church enclosures, yards, streets and road-verges. This human-influenced flora of these modified and disturbed habitats is itself an important biological and cultural resource, and one that requires special conservation measures if it is to survive. This type of plant community will become more precarious as modern farming procedures, rebuilding and increasing prosperity tidies up the villages.

The nature of weeds

The plants that grow in such disturbed communities are those we call weeds or, specifically on waste ground or waysides, ruderals. Weeds are opportunist taxa or variants, adapted to or associated with the colonization of the disturbed habitats created by human activities. They and their habitats, numerous and familiar, can loosely be grouped into arable ('segetals' - weeds of field crops and gardens plots) or ruderal ('rubbish plants' of waste ground and waysides) weed communities. Weeds have evolved or been recruited from disturbed open habitats, such as the steep, slumping clay slopes and the exposed silt and river-gravels of southern Transylvania, although most have migrated from other geographical regions in Europe or other continents. The habitats in which weeds occur are ephemeral and liable to periodic episodes of disturbance, destruction or gradual loss through natural succession to grass and scrub, which imposes selection pressures to evolve survival strategies such as seed dormancy, fast root and shoot growth or short life histories.

Since they are, to a greater or lesser extent, a nuisance, weeds have gathered a huge scientific literature on their control, biology and evolution. At the same time, in recent years, conservationists have been concerned that some arable weeds are disappearing in Europe, many of them former immigrants with Neolithic farmers and agricultural practices from south-east Europe, Anatolia and the Middle East. The flora of waste ground has received much less attention, despite village weeds or ruderals of disturbed and nutrient-enriched ground comprising a rich assemblage of ancient medicinal and cultural plants. This characteristic flora represents a living museum of useful plants.

In the Saxon Villages area, untended corners of yards, cobbled sidewalks and the village greens that run alongside the streets provide such ruderals with ecological niches in which to survive. The livestock and poultry that graze the greens, and the passage of animals at morning and evening, disturb the habitat, enrich the soil and spread seed. However these specialized relict plant communities face an uncertain future from inevitable changes in agriculture and the rural economy, and the gradual rise in living standards of country people.

MATERIAL AND METHODS

The observations presented here form part of a continuing investigation since 2000 of the flora and vegetation of the Saxon villages (e.g. Akeroyd et al., 2003). Field studies were concentrated in the communes of Buneşti (Braşov County) and Saschiz (Mureş County). In addition to recording plants in the field, conversations with village people yielded information on the wild plants that are still being collected and utilized. Species nomenclature follows Flora Europaea (Tutin et al., 1964 - 80; 1993).

RESULTS AND DISCUSSIONS

Some of the ruderal weeds species of the Saxon Vllages area are native to this region, others are ancient naturalized introductions or archaeophytes. Since the distribution of weed species is so dependent upon human activity, travel and trade, the 'native' habitats of most weed taxa are obscure (Baker, 1972). In fact many may not have surviving 'native' variants or populations, having evolved from cultivated crops, and may instead represent 'wild and cultivated' gene pools from which characters have been incorporated into crop plants through natural episodes of hybridization and back-crossing (Harlan, 1965). More or less disturbed habitats around human habitation are therefore almost a natural habitat for many weeds, especially ruderals.

Many of the village weeds and ruderals have at some time been used as foods, medicines, dyes and other useful products. Not only are these plants as much a part of the culture of the Saxon Villages as the fortified churches (vide Blacker 1997) and wildflower meadows (Akeroyd, 2006), but also they represent a genetic resource of great evolutionary interest. It is likely that populations of these species have been modified over millennia by at least some conscious degree of selection by man. For example, *Potentilla anserina*, a ubiquitous species of damp, trampled grassland, road-verges and village greens in the Saxon Villages was formerly a food-plant in Europe, and its roots are known to have been widely eaten (perhaps even grown as a crop) until the 19th century in parts of Scotland and Ireland (Grigson, 1955). Like acorns, they were probably a significant foodstuff in times of famine. *Trifolium fragiferum*, which grows with *P. anserina*, is another useful species, a forage crop in some regions of the world, especially Australia, and presumably is a useful source of nutrition to the many farm animals that graze the village greens.

Among these ruderals are several *Chenopodium* species, notably two ancient spinach-like leaf vegetables, the abundant annual goosefoot *Chenopodium album*, formerly an important leaf and grain crop throughout Europe, and the much rarer perennial *C. bonus-henricus*, native to the Carpathians and other south and cntral European mountains, once widely grown for its leafy shoots and, on the basis of its vernacular names (Guter Heinrich or Good King Henry) clearly popular. Both have been replaced in gardens by spinach and spinach-beet. Another goosefoot, *C. vulvaria*, a foetid former medicinal plant, is a classic ancient 'village weed' that would have been common in 18th-century Britain but is now almost extinct there. Even the nettles (*Urtica dioica*) that dominate ruderal communities along walls and in untended corners were probably once a useful source of fibre and dye, ingredient of soups in spring, and a medicinal herb for the treatment of urinary problems. Rich in iron, mineral nutrients and vitamins, the young leaves are still fed, chopped with maize, to poultry chicks.

Other village plants

Not all the plants associated directly with villages are true ruderals. Ferns are a specialized group of plants that profit from human activity in a landscape dominated by grassland and farmland, where rock outcrops are few. For example, the stone steps and walls around the porch of Viscri church and the free-standing tower and churchyard retaining wall of Saschiz church have a small but interesting fern flora: both *Asplenium ruta-muraria* and *Cystopteris fragilis* grow in vigorous clumps from lime-rich mortar. Recent restoration of the steps beside the porch at Viscri severely damaged the ferns, but they have nonetheless persisted, if much reduced in numbers. This apparently trivial incident demonstrates how important it is for conservationists to co-ordinate activities and to inform each other of restoration projects and initiatives.

There is also a woody village flora associated with people. Almost all the trees in and around the villages are planted for some sort of human use, with native or semi-natural woodland largely restricted to higher slopes and valleys. Streams and larger ditches often have a fringe of willow scrub (association Salicetum albo-triandrae) of *Salix alba*, *S. cinerea* and *S. triandra*, a traditional source of twigs or withies for weaving baskets. Willow hurdles are a traditional material for reinforcing the banks of streams and water-courses in the villages. Perhaps the most typical woody plant of human settlements, and indeed a true ruderal, is Elder (*Sambucus nigra*), common in and around village yards, about churches, in hedges and along roads. The presence of this small tree, tolerant of eutrophic conditions and with a multitude of practical and medicinal uses, in village gardens and hedges, is part of ancient rural tradition. Elder was noted as a medicine by 14th-century English poet Geoffrey Chaucer in the Nun's Priest's Tale from his celebrated work The Canterbury Tales (c.1387), when talking of a poor widow's village small-holding: "A yard she had, enclosed all about with sticks … elder berry that grows there…" In the Saxon Villages an infusion of the flowers has been used to reduce fevers and chest infections, and remains a popular cordial (suc de soc) to drink in hot weather.

The ruderal flora is a historic adjunct to the ongoing collection of medicinal plants for local use and trade. Villagers continue to gather several medicinal plants from the wild, especially flowering shoots of *Hypericum perforatum* (Johanneskraut), used to treat stomach upsets and diarrhoea. Much of the material (especially that gathered by gypsies) is sold to the herbal plant trade, but *H. perforatum* is also used locally, mixed with mint (*Mentha* spp.) and lime-fruits (*Tilia cordata*) in a refreshing herbal tea that also soothes coughs and colds. The flowers and fruits of *Crataegus monogyna* are gathered extensively and used to alleviate high blood pressure and circulatory problems. *Achillea millefolium* too is gathered, and used in an infusion to treat ailments of "the heart" and blood circulation. It has general antiseptic properties and helps staunch wounds. These last two species are among the most important wild-harvested herbs in Romania (*C. monogyna*, 58 tonnes per annum, mostly from Transylvania; *A. millefolium*, 12.8 tonnes per annum) (Kathe et al. 2003). Another widely collected herb, *Centaurium erythraea* (Gentianaceae), once a popular medicine in England and mentioned, like Elder, by Geoffrey Chaucer in his Nun's Priest's Tale, is used as a general tonic and stimulant to digestion. Perhaps over-collected, it is surprisingly scarce in some districts, as is another medicinal gentian, *Gentiana cruciata*.

Other medicinal plants are grown in gardens, many of them bright with traditional 'cottage garden' plants alongside vegetables and fruit. The most important is *Calendula officinalis* (Latin, *officinalis*: 'from the druggist's shop'), prized by local people as a medicinal plant that is, when drunk as a tea, apparently an effective remedy for biliary complaints, and also aids digestion. It has excellent healing and anti-inflammatory properties, especially for skin disorders, and has long been used in Europe and Turkey as a saffron substitute and orange dye.

Notes on some individual ruderal species

Arctium lappa (Compositae). This common plant of yards and waysides, unlike other village ruderals, is still harvested in large quantities in Romania - nationally 10.5 tonnes were gathered in the 2001 period (Kathe, 2003). The roots of this species and those of *Arctium tomentosum* remain in medicinal use for their antibiotic properties (Bartram, 1997), including treatment of a range of skin complaints (Oroian, 2004). It is still used for this purpose in Viscri, and is widely employed too in the villages of Făgăraş (Drăgulescu, 1995). *A. lappa* also has an unusual traditional village use: the hooked-spiny fruit-heads or burs, which adhere to one another like 'Velcro' (the inventor of which was inspired by burs), are placed around the strings of suspended hams to deter mice. This was especially useful in the former communal larders of the fortified Saxon churches.

Althaea officinalis (Malvaceae). Locally common, as on the southern edge of Buneşti, this attractive plant yields a mucilage that is a remedy for coughs and to treat skin and digestive complaints (Oroian, 2004). Native in damp, often saline places over much of Europe, it was long grown as a garden plant and widely used for medicinal purposes. It was present, for example, in Britain since at least Anglo-Saxon times, certainly from the end of the 10^{th} century (Harvey, 1981). Rarely in gardens today, replaced by Hollyhock (*Alcea* spp.), this plant can persist as a ruderal around old buildings and ruins, for example on islands off south-west Ireland (Akeroyd, 1996).

Ballota nigra (Lamiaceae). Known since at least Roman times, and formerly prized for healing wounds and alleviating coughs, nausea and sleeplessness, this plant is rarely employed medicinally today. A commoner plant in the villages, of the same family, *Lamium album* is still used by local people to alleviate urinary disorders. The flowers and floral shoots have antibiotic properties, with many applications in the herbal treatment of respiratory and digestive disorders, inflammation of the skin, and other complaints (Oroian, 2004; Van Wyk and Wink, 2004).

Chelidonium majus (Papaveraceae). A common inhabitant still of walls, yards and church surrounds, this plant yields an acrid yellow sap used in the villages to treat warts. Rarely, as elsewhere in Europe, does it occur away from houses but it may be native in rocky woods.

Inula helenium (Asteraceae). This robust, deep-rooted plant with prominent rosettes of broadly spear-shaped leaves, originally from the Central Asia region and apparently common in Russia, has spread throughout the Europe as a medicinal plant. Familiar to Pliny the Elder and Dioscorides in Roman times, it has been known in Britain since at least the late 10^{th} century and in Spain it was mentioned by Ibn Bassal, garden curator for the Sultan of Toledo, in his 1080 Book of Agriculture (Harvey, 1981). Scarce in Viscri and some other villages, it is still common near Buneşti, Criț and Daia. Like *Althaea officinalis*, the roots were a remedy for coughs and chest complaints. It too persists as a historic ruderal around old buildings and ruins on islands off south-west. Ireland (Akeroyd, 1996), but has become rarer there during the last decade, as road-verges and waste ground have been tidied. Still employed as an expectorant, elecampane has antibiotic and diuretic properties (Van Wyk and Wink, 2004), and is used to treat horses as well as people.

Leonurus cardiaca subsp. *villosus* (Lamiaceae). This often overlooked nettle- or hemp-like plant, widespread but rarely common around yards, sometimes occurs in large numbers where animals gather and disturb the ground, as near Buneşti. A tea made with the flowering shoots makes a herbal remedy, which is particularly good for the heart. This cure-all tonic, emetic and sedative, which is said to lower blood pressure and aid child-birth, was formerly much prized across the Europe, as in the Isle of Man between north-west England

and Ireland: "Valued as a febrifuge and emetic, this rated supreme in warding off ills, to the extent that mothers sewed it into their babies' clothes and fishermen tied a sprig of it to their nets to bring them luck" (A. W. Moore in Allen, 1984). It is now a scarce, decreasing plant in Britain.

Plantago major subsp. *major* (Plantaginaceae). In Viscri, both *Plantago major* and *P. lanceolata* are used to soothe wounds, burns and (the mucilaginous seeds) coughs, and *P. major* especially is extensively employed for a range of complaints in the villages of Făgăraş (Drăgulescu, 1995), as it is in Britain and North America (Bartram, 1997). Many of the plants along the sidewalks of the main street in Viscri have purple leaves and stems. This attractive variant is sometimes grown in western European gardens under the names *P. major* cultivar 'Rubrifolia' and 'Purpurea'.

Saponaria officinalis (Caryophyllaceae). Clumps and patches of this showy plant ('Soapwort') in and near villages, as around Viscri church, are often a relict of its long use as a soap substitute. The crushed shoots produce a soapy froth when crushed and agitated in water, still used in the textile industry (Oroian 2004), and over much of Europe it remains a popular cottage garden plant - a feature of villages from Turkey to Ireland.

Conservation

Ruderal plant communities are not easily conserved. Not only do they tend to be ephemeral, but also they infrequently contain rare or threatened species. Like many of the massed wild flowers of the hay-meadows in the Saxon Villages study area (Akeroyd and Page, 2006), none of the ruderal species discussed above are as yet rare in Romania, although they have sometimes disappeared over large parts of northern and western Europe. Often species present are of indeterminate native status, adventive or associated with cultivation. Nevertheless they constitute a special community that has historic and living links to the Saxon culture and village communities in which they persist. Most villages in N and W Europe have lost their ruderal flora, as prosperity has led to a tidying of waysides and waste places.

Ruderal species are difficult to classify accurately in terms of phyto-sociology, as they form an irregular mosaic of vegetation that varies seasonally and is constantly subject to destruction or modification. Saxon Village ruderal communities all fall within the widespread alliance *Arction lappae* of central and west Europe (Szafer, 1966). A notable assemblage of tall ruderals around yards and barns belongs to the association Leonureto-Arctietum tomentosi. Characteristic species are two burdocks (*Arctium tomentosum* and *A. lappa*), *Ballota nigra* and *Leonurus cardiacus*. In the longer term, this distinctive floral facies, which many ignore, despise or take for granted, needs to be conserved alongside the 'native' plants of grassland and woodland.

This ruderal assemblage is similar to another distinctive (but for the most part not threatened) circum-boscal tall herb community of humid deciduous woodland margins, for example on roadsides just west of Dacia and hillsides above Saschiz. It includes *Arctium lappa*, *A. tomentosum*, *Cirsium oleraceum*, *C. dissectum*, *Geranium pratense*, *Sonchus arvensis* subsp. *uliginosus* and *Telekia speciosa*, species which occur in and around villages. This community is in some ways closer to village ruderal communities than those of drier open ground, disturbed roadsides and areas where animals congregate, the alliance Onopordion acanthii (association Onopordetum acanthi), dominated by tall thistles such as *Onopordon acanthium*, *Carduus acanthoides* and *C. nutans*, widespread in central Europe, replaces *Arction lappae*. Other plants in this community include *Echium vulgare* and mulleins such as *Verbascum phlomoides*.

The Saxon Villages, one of the last traditional European landscapes, continue to support many remarkable agricultural, ecological and cultural features that represent an older Europe, not least the survival of a living tradition of plant use. Although use of most of the botanically interesting ruderals is obsolete, medicinal plants continue to be employed in everyday life, and provide a means by which some local people earn a living. Some species such as gentians are certainly over-collected, while others such as *Achillea millefolium* are common enough to allow unregulated harvest to continue. Others are not apparently collected at all. For instance, *Colchicum autumnale*, locally frequent in mesic hay-meadows, might be a useful species for future sustainable collection. Known as a medicinal plant (*Semen colchici*) since ancient Greece, it remains a remedy for gout and one fully approved by the medical establishment.

Obviously the larger and more aggressive weeds, which usually have few cultural attributes, require measure of control. The invasive, perennial weed *Reynoutria japonica* (*Fallopia japonica*) forms dense thickets by streams, as at Buneşti and Saschiz; on roadsides, as on the road to Meşchendorf; and on waste ground, as near Mălâncrav church. It is likely to become a pestilential weed problem unless a rigorous control programme is initiated sooner rather than later. Another invasive weed, *Asclepias syriaca*, from North America, locally forms patches.

Precisely how to conserve the more interesting and diverse ruderal plant communities is a problem. They will survive as long as traditional village life continues, but the accession of Romania to the European Union from January 2007 means that the rural economy will inevitably face considerable change. Even if the villages evolve through sensitive sustainable development, it may not be possible to accommodate a group of plants that thrives on conservative agricultural practice, neglect and human poverty. Biologists and farming communities have greater priorities, so perhaps the way forward may be to conserve these plants in the context of the churches and other village buildings, which themselves pose considerable long-term problems of survival. Fortunately these are being addressed, but the task is a considerable challenge and one that requires a holistic vision (Wilkie, 2001). Ruderals frequently persist around churches, but are mostly unappreciated by all but a very few botanists. Yet it would be a pity to lose - and Transylvania would be much the poorer for it - such an unloved but culturally and biologically fascinating constituency.

Postscript: added in press

At least two plants closely associated with human settlement in the Saxon Villages are already rare. On 1 July 2007 Dr Andrew Jones and I noted *Aristolochia lutea* (listed as Rare in Oltean, 1994; NT in Oprea, 2005), on basalt rocks at the foot of the southern curtain wall of the medieval Saxon citadel at Rupea. Perhaps a persistent relic of former medicinal use, it was reported (as *A. pallida* Willd.) from Rupea by Săvulescu (1955: 27) and, mostly 19th century records, several places in Sibiu county (Drăgulescu, 2003). Just two days before our visit to Rupea, our colleague Dr Silvia Oroian had shown us a thriving population of *A. lutea* beside a dirt road near the Saxon church at Saeş, 10 km south of Sighişoara. A native of south Europe from Italy to Turkey, *A. lutea* extends up into the north of Romania (Jalas and Suominen 1976: 118, as *A. pallida*; J. R. Akeroyd and E. Nardi in Tutin et al., 1993), but it is interesting that at in its two Mureş county stations in the Saxon Villages it grows near ancient human settlements.

Dr. Oroian also showed us a several plants of *Hyoscyamus niger* growing in disturbed ground beside the road that runs south through Buneşti towards Viscri. This highly poisonous, annual or biennial medicinal plant is often irregular in occurrence but can persist for decades at a particular locality. Over the last century, its distribution in Britain and Ireland has contracted considerably and this pattern of decline will probably be repeated in eastern Europe.

ACKNOWLEDGMENTS

The author thanks the Mihai Eminescu Trust for supporting the initial study of the ruderal flora of the Saxon Villages, and the ADEPT Foundation, sponsored by Orange Romania and the Darwin Initiative of the UK Ministry of Agriculture (DEFRA) for subsequent funding. Nat Page kindly read an earlier draft and Diana-Elena Antonescu provided the Romanian abstract.

REFERENCES

1. Akeroyd J. R. 1996 − *The wild plants of Sherkin, Cape Clear and adjacent islands of West Cork.* Sherkin Island Marine Station, County Cork.
2. Akeroyd, J. R. 2002 − Protecting Romania's Lost World. *Plant Talk*, 30: 19-24.
3. Akeroyd, J. R. 2006 − *The historic countryside of the Saxon Villages of southern Transylvania/Peisajul Istoric al Satelor Sasesti din Sudul Transilvaniei.* Fundația ADEPT, Saschiz.
4. Akeroyd, J. R. and Page, N. 2006 − The Saxon Villages of southern Transylvania: conserving biodiversity in a historic landscape. In Gafta, D. and Akeroyd, J.R., eds (2006) *Nature Conservation: Concepts and Practice*, pp. 199-210. Springer Verlag, Heidelburg.
5. Akeroyd, J. R., Sârbu, A., Oroian, S. and Hirişiu, M. 2003 − *Botanical assessment of the Saxon Villages region (Târnava plateau) of southern Transylvania, Romania*. Unpublished report to IFC, Washington DC.
6. Allen, D.E. 1984 − *The Flora of the Isle of Man*. Manx Museum, Douglas.
7. Baker, H.G. (1972) The migrations of weeds. In Valentine, D.H. (ed.) *Taxonomy, phytogeography and evolution*, pp. 327-347. Academic Press, London.
8. Bartram, T. (1997) *Bartram's Encyclopedia of Herbal Medicine*. Robinson Publishing, London.
9. Blacker, W. 1997 − *The plight of the Saxons of Transylvania and their fortified churches*. Mihai Eminescu Trust, London.
10. Drăgulescu, C. 1995 − *Botanica populara in Tara Fagaraşului*. Editura Constant, Sibiu.
11. Drăgulescu, C. 2003 − *Cormoflora Județului Sibiu*. Editura Pelicanos, Braşov.
12. Grigson, G. 1955 − *The Englishman's Flora*. Phoenix House, London.
13. Harlan, J. R. 1965 − The possible role of weed races in the evolution of cultivated plants. *Euphytica*, 14: 173-176.
14. Jalas, J. and Suominen, J. 1976 − *Atlas Florae Europaeae*. Vol. 3. Salicaceae to Balanophoraceae. Committee for Mapping the Flora of Europe. Helsinki.
15. Harvey, J. 1981 − *Mediaeval gardens*. B.T. Batsford, London.
16. Kathe, W., Honnef, S. and Heym, A. 2003 − *Medicinal and aromatic plants in Albania, Bosnia-Herzegovina, Bulgaria, Croatia and Romania.* (BfN-Skripten 91) Bundesamt für Naturschutz, Bonn.
17. Mountford, J. O. and Akeroyd, J.R. 2005 − A biodiversity assessment of the Saxon villages region of Transylvania*. Transylvanian Review of Systematical and Ecological Research*, 2: 31-42.
18. Oltean, M., Negrean, G., Popescu, O., Roman, N., Dihoru, G., Sanda, V. and Mihăilescu, S. 1994 − *Lista Roşie a Plantelor Superioare din România.* Academia Română, Institutul de Biologie, Bucharești.
19. Oprea, A. et al. 2005 − *Lista critica a plantelor vasculare din România.* Editura Universitații 'Al.I.Cuza', Iaşi.
20. Oroian, S. 2004 − *Botanica Farmaceutica: plante medicinale şi aromatice*. Volume 2. Târgu-Mureş University Press.
21. Săvulescu, T. 1955 − *Flora Republicii Populare Romane*. Vol. 3. Bucharești.
22. Szafer, W. 1966 − *The vegetation of Poland*. Pergamon Press, London.
23. Tutin, T.G. et al. 1964-80; 1993 − *Flora Europaea*, 1-5; 1, ed.2. Cambridge University Press.
24. Van Wyk, B.-E. and Wink, M. 2004 − *Medicinal plants of the world*. Timber Press, Oregon.
25. Wilkie, K. 2001 − *The Saxon villages of Transylvania, Romania.* Kim Wilkie Associates, Richmond-upon-Thames, UK.

THE CHALLENGE OF HIGH NATURE VALUE GRASSLANDS CONSERVATION IN TRANSYLVANIA (ROMANIA)

Andrew JONES *

* Jacobs, 8th Floor, Churchill House, Churchill Way, Cardiff CF10 2HH, United Kingdom, llanllawddog@gmail.com, ajones@ieep.eu

KEYWORDS: Romania, Transylvania, high nature value grassland, farming, conservation, biodiversity, wildflower indicators.

ABSTRACT

Transylvania has some of the richest wildflower grasslands still remaining in Europe. These are notable for high species diversity and variability in species composition and have unique botanical hotspots on remnant post-glacial hillocks, containing unusual combinations of rare steppic and montane species. Entry into the European Union (EU) will change the economic climate for grassland farming, with implications for wildlife conservation and these new pressures and opportunities under EU accession are discussed in terms of agri-environment schemes that will become available and criteria in selection of grassland for inclusion.

ZUSAMMENFASSUNG: Die Herausforderung der Erhaltung von hochwertigem naturnahem Grünland in Transylvanien / Siebenbürgen (Rumänien).

Die Grünlandgesellschaften in Transylvanien/Siebenbürgen gehören zu den artenreichsten, die in Europa erhalten geblieben sind. Sie zeichnen sich durch eine bemerkenswerte Artenvielfalt und Variabilität ihrer Artenzusammensetzung aus. Als einzigartige botanische Kleinodien finden sich kleine postglaziale Hügel mit einer ungewöhnlichen Kombinationen seltener Steppen- und Berglandarten. Der Eintritt in die Europäische Union (EU) wird eine Veränderung der wirtschaftlichen Bedingungen für die Grünlandbewirtschaftung mit sich bringen, die Auswirkungen auf den Artenschutz (Flora und Fauna) haben wird. Diese neuen Zwänge und Gegebenheiten werden vor dem Hintergrund verfügbarer Agrar-Umweltprogramme diskutiert sowie in Zusammenhang mit Auswahl- und Einbeziehungskriterien von Grünland.

REZUMAT: Provocarea conservării pajiştilor cu valoare naturală mare în Transilvania (România).

Transilvania are unele dintre cele mai bogate pajişti cu floră încă rămase în Europa. Acestea sunt remarcabile pentru diversitatea şi variabilitatea ridicată în specii şi au ca zone botanice unice deluşoare posglaciare remanente, care conțin combinații neobişnuite de specii stepice şi montane. Intrarea în Uniunea Europeană (EU) va schimba mediul economic spre gospodărirea prin ferme a pajiştilor, cu implicații în conservarea faunei. Aceste noi presiuni şi oportunități datorate aderării la UE sunt discutate în termenii schemelor de agro-mediu, care vor deveni disponibile şi a criteriilor pentru selectarea şi includerea pajiştilor.

INTRODUCTION

The grasslands of Romania, and of Transylvania in particular, represent some of the most intact traditional farming systems that remain in Europe in equilibrium with the valuable legacy of high biodiversity that they contain. Within the Saxon villages area these traditional systems have developed over centuries as part of a sustainable system of land utilisation that was developed (Akeroyd, 2006; Akeroyd and Page, 2006). However changes following entry into the European Union, and modernisation of Romania along with the agriculture sector, mean inevitable changes that will affect the pattern and methods of farming and threaten the associated dependant biodiversity.

Although, during farm collectivisation, up to the early 1990s Romania had a period of farm intensification comparable to that of Western Europe (the increase in fertiliser use over the period 1960 - 90 matched that of western Europe: FAO, 2002; Sârbu et al., 2004), it can be argued that this was not sustained for long enough to cause significant loss of grassland diversity, and in fact farmers returned to traditional low input or extensive farming systems. The extensive nature of this traditional farming is reflected in existing stocking levels of both cattle and sheep that are some of the lowest in Europe (Romanian Agricultural Census, 2005).

Romania can be considered to have one of the most valuable and extensive grassland resources surviving in Europe, when considered under the title of High Nature Value (HNV) farmland (definition in EEA, 2004) or in terms of the survival of critical groups of plants and animals. Studies of the grassland systems that are found in Transylvania (A. Jones, J. R. Akeroyd, unpublished) have shown that they have high botanical diversity (for review of grassland biodiversity see Partel et al., 2005) and are general more so than other remaining grasslands in central and eatern Europe. This diversity is often associated with some unusual geo-morphological features and a suite of rare plant species of contrasting ecology (see below). It is believed that this HNV grassland resource extends to 2.6 million ha, about 11% of the national territory, though 50% of this has been affected by economic activities (Sârbu et al., 2004), such as being periodically ploughed for arable crops.

The threat to this rich legacy of biodiversity, which is dependent on continued traditional farming, is mounting despite entry of Romania into the European Union. Rural areas have low economic growth with the threat of rural depopulation (Romanian National Strategic Reference Framework, 2006), relocation of potential young farmers to adjacent cities under pressures for employment, and collapse of the existing pattern of small farms that includes subsistence and semi-subsistence systems, with depressed agricultural commodity prices, e.g. for meat or milk and possible negative effects of milk quota introduction. This may affect the continued management of these habitats, with the likelihood of abandonment increasing. An equally and opposite threat exists of increased intensification of land-use and possible conversion of grassland to arable or intensive grassland farming. Such goals of productive, efficient and competitive farming are linked to increased funding for farm investment and development through European Fund for Agriculture and Rural Development Axis 1 that also may attract farmers from other countries to seek opportunities within Romania.

This paper describes some of the wildlife grassland resources in the Saxon Villages area and the challenges for designing a system of conservation measures. It also faces the difficulty of developing methods so that the best areas of grassland can be identified and designated under systems of protection that are available. Opportunities exist following EU accession within the sectors of agriculture and rural development (European Commission Council regulation 1257/1999 articles 22 - 24) to aid the conservation of grassland under so-called agri-environment schemes. Here selection of high quality, High Nature Value grassland resource is an important objective in targeting resources efficiently at the most valuable sites.

RESEARCH PROGRAMME

The research on grassland is part of the programme of Fundația ADEPT (Agricultural Development and Environmental Protection in Transylvania), which integrates sustainable rural development and biodiversity conservation. The study has focused on a botanical analysis of sites covering a range of grassland management systems, from more intensively farmed areas in the valley bottoms to the most diverse wildflower-rich slopes. This was initially part of a study facilitating the design of a grassland agri-environment scheme under SAPARD, the European Community support programme for pre-accession measures for agriculture and rural development (European Commission Council regulation 1268/1999). This programme has been carried out in the Saxon Villages area, south of Sighişoara in Braşov county (Buneşti commune – Viscri and Buneşti), Mureş county (Saschiz commune - Saschiz, Mihai Viteazu and Archita) and Sibiu county (Laslea commune - Mălâncrav). Detailed survey and analysis of the composition of the vegetation has been carried out by 0.25 m^2 relevées, and the nutrient status of soils analysed by a contracted soil chemistry laboratory. In addition information on the farming systems has been gathered from interviews with village farmers and agronomists, and state agronomists in the regional agricultural extension offices.

RESULTS AND DISCUSSIONS

Grassland characteristics

Characteristically, the grasslands exhibit extreme patchiness in terms of composition of wildflower species and habitat or sub-habitat type at a range of scales across landscapes. This feature is sometimes called 'gamma diversity', as opposed to alpha and beta diversity which measure numbers of species packed into small unit areas, typically 1 m^2, and diversity changes over small scale, e.g. 5 m (Lande, 1996; Martin et al., 2005), that are not necessarily always explained by gradients in ecological conditions. Gamma diversity is an undervalued aspect of biodiversity that has been under threat from moves towards agricultural intensification, narrowing of farming methods and a polarisation of farming systems into arable or grassland that has resulted in uniform species composition and habitat-poor environments. Gamma diversity can be considered an attribute or indicator of High Nature Value traditionally farmed landscapes and its reduction associated with loss of ecological function such as the processes of species colonisation and gene flow.

The grasslands in the study area have a large potential plant species pool (i.e. the species area curve does not plateau rapidly) being at the crossroads of several bio-geographical zones, including Pannonic, Continental, Pontic, Mediterranean, Alpine (Carpathian) and their associated floras (Sârbu et al., 2004). This contributes to botanical diversity at all spatial levels and the presence of species 'hot-spots'.

Typically grasslands occur in a mosaic with some or all of the year's grass crop of hay cut once or twice and grazed. Much of the grassland is on old arable fields, often on narrow man-made terraces cut into the hillsides and there is even evidence of some 'ridge and furrow' (evidence of ancient arable fields) in wetter areas. The grasslands occur within an undulating landscape of deep valleys and plateaux with isolated hillocks, banks, small marshes and occasional ponds, and wet slip-zones with seepages. The different age of seral stages of grassland recolonization from arable is associated with a range of grassland types, with some stands extremely diverse, containing many species rare at a European level. Possibly because of the large proportion of extensively managed land, the high wildflower species seed rain allows even young grassland fields to accumulate a high number of species that would be of conservation importance if recorded in another European country.

At a larger scale, above this rich detail of grassland diversity, the existing patchy spatial pattern of the Transylvanian landscapes and land-use shared by forestry, wood-pasture (such as the Breite landscape near Sighişoara: Akeroyd, 2003), extensive grasslands and arable farming contrast sharply with the uniform and monotonous landscapes produced by intensive land management for farming in much of Western Europe.

Preliminary findings show that the grasslands follow the same models in terms of the relationship between species diversity and soil nutrient status as those in other parts of Europe, with a negative correlation, i.e. increasing nutrient status is correlated with lower species diversity. Multivariate analysis of data using BIPLOT (Braak, 1990) also demonstrated an association between higher soil nitrogen status and low nature value grassland habitats containing species typical of disturbed ground, including weedy species and widespread perennial wildflowers (Fig. 1). Definition of valuable grassland on the basis of nutrient status was complicated by the fact that some north-facing, sloping wet grassland with montane species such as *Trollius europeaus* had high nutrient status, possibly as a result of flushing of nutrients and their concentration in areas of soil down the slope. However, it must be emphasized that the soils sampled indicated low nutrient status for the majority of the dry grasslands of the study area.

The implication of this is that the Transylvanian grasslands are sensitive to the effects of nutrient enrichment equivalent to those HNV grasslands in wider studies on grassland vulnerability to agricultural intensification across the whole Europe (e.g. Gough and Marrs, 1990). All these studies suggested that nitrogen application of as little as 50 - 80 kg per hectare per year would endanger the ecology of the more sensitive and threatened plant species.

As well as the generally diverse grassland habitats that occur on level ground, a striking feature of the ecology of the grasslands is the role of aspect in exhibiting highly contrasting floras on north and south slopes. Within the same altitudinal ranges, small pockets of steppic (xerothermic) species survive on south-facing, steep, dry banks that exist within the matrix of more mesic (meadow condition) grassland habitats, and conversely on some north-eastern slopes, montane and boreal species are found.

The most extreme example of this relationship occurs on small discrete hillocks or ‘tumps’, possibly left by the erosion of a surface of clay and marl and usually less than 100 m in diameter and 30 m high (see also the paper, and cited references, of Schneider-Binder in the present volume). They can have different shapes, being very steep or flatter with convex or concave faces and comprising different surface substrates, e.g. marl, sand or even gravel. They have two extreme conditions, a south and south - west facing side where temperatures rise to extremes and drought is the norm. A north- and north-east-facing side is cool and shady and often damp, the clay probably providing moisture through capillary action. The rest of the hillock surface provides all conditions between these two extremes. Because of this wide range of conditions, plant species of every possible kind of ecological grouping can be found, from steppic and drought-tolerant plants on the south side through meadow species to woodland, wetland plants or montane/boreal on the north side. Rather than clearly defined species associations determined by mapping of recognised habitats (e.g. under EUNIS habitat classification system), these ‘tumps’ can support apparently random assemblages of plants that may represent relicts of a range of climatic conditions through past millennia, stranded on these ecological islands in a matrix of unsuitable more mesic level agricultural land which has been ploughed or grazed more intensely.

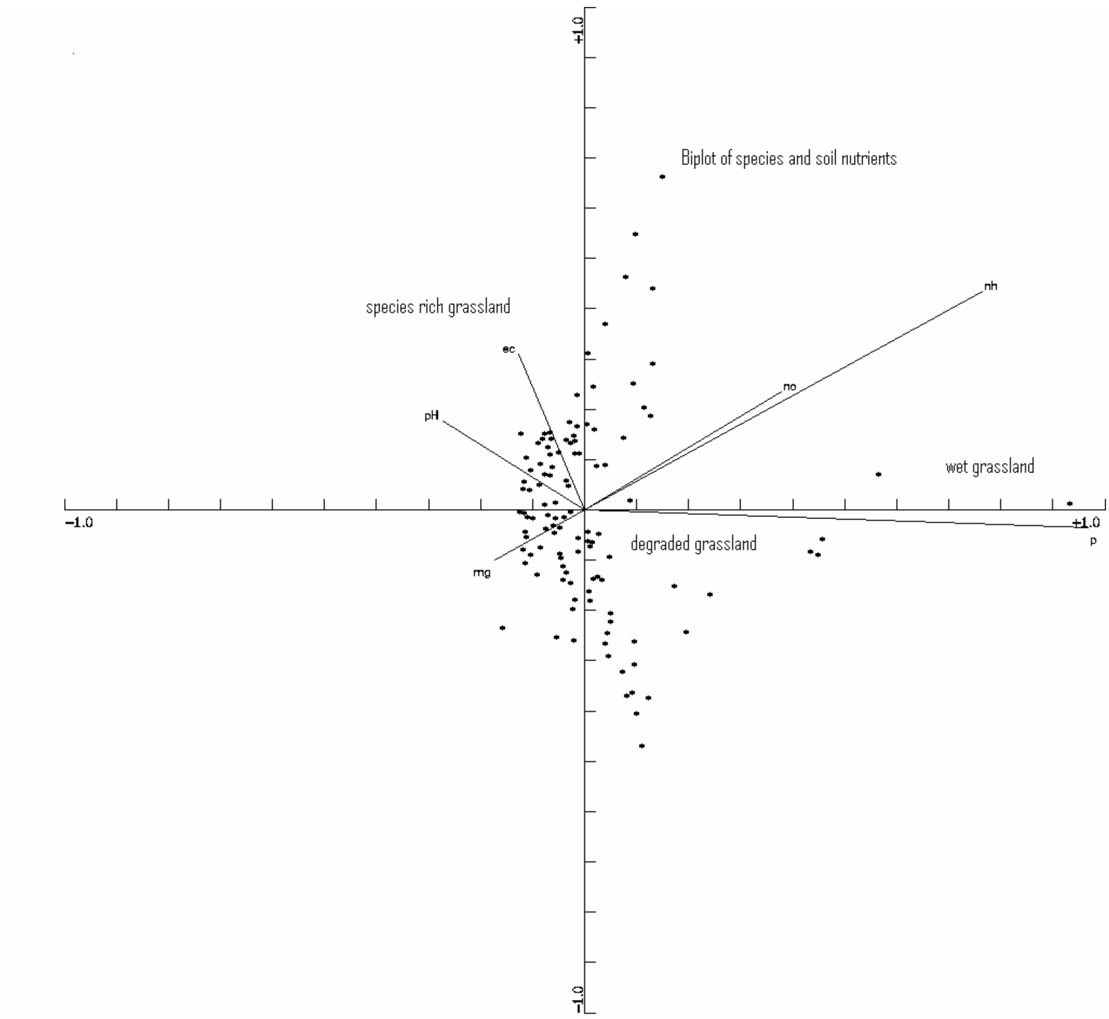


Figure 1: Biplot of survey samples and soils with lines from origin of graph denoting increasing soil concentration and showing relationship between soil nutrient status and broad grassland type; Increasing NO-nitrates, NH-nitrogen as ammonium ion and P-phosphates to the right of plot associated with grassland degraded through agricultural intensification and also with wet species-rich grassland; EC-Electrical conductivity and pH associated with species rich grassland; Potassium not plotted, as soils show uniform concentrations.

One hillock in the Calea Dracului (Dragon's Avenue) complex of hillocks, 2 km south of Saschiz (we have also studied similar hillock complexes near Apold, Buneşti and Vănâtori) has *Prunus frutescens* and the endemic *Cephalaria radiata* - steppic plants - on the south side, with *Daphne cneorum* and *Anemone sylvestris* - montane plants of the Carpathians and high woodland respectively - on the north side, all within 30 m. Plant species with contrasting ecological requirements can occur in an ecological 'Alice in Wonderland' sward composition. On this particular hillock, *Sanguisorba officinalis* of wet grassland, the presence of which is used to define high priority wet meadow communities, and *Geranium sanguineum*, a xerophyte of dry sunny grassland and woodland margins, were growing together.

There is also a randomness about the plant species that occur within each hillock complex. In particular, hillocks in close proximity (even within 30 m) may not share species that would be otherwise have been expected to colonise such short distances. Random or stochastic processes in terms of colonisation, catastrophe and associated extinction or population decline, defined by models of island biogeography (MacArthur and Wilson, 1967), may have resulted in the present distribution of these species, which steepness, size and height of slope and substrate composition are possibly not sufficient alone to explain distributions.

The ecological events that have allowed these plant species distributions to evolve must be related to landscape history. This would include both periods of warmer, drier climate and of colder drier and wetter climate in the past, with reduced tree cover during the post-glacial period, which has allowed some of these species to spread and colonise, making the inter-hillock areas alternately steppic or more boreal. With increasingly discontinuous dispersal, over time the remaining species distribution represent relict populations stranded on ever- smaller islands of suitable habitat. Some of these relict populations may be thousands of years old.

Some of these topographic features show evidence of modification by man, probably over millennia, as defensive or other structures, but then bare soil surfaces and susceptibility to erosion would imply that they are doomed in the long term unless erosion of a new horizon takes place, possibly along a slump/slip-zone representing contrasting layers of clay or marl.

It is clear that these hillock complexes represent a botanical wonder of Europe, comparable in some respects with the strange relict plant species assemblages of the Burren in western Ireland or on cliffs on the Canary Islands and some Mediterranean islands. They represent a rich heritage of biodiversity that holds potential for investigation in terms of historical ecology, island biogeography and population genetics and need both to be conserved on scientific grounds and recognized in term of their value and contribution to grassland biodiversity.

Opportunities for Conservation

The challenge is to conserve this biodiversity-rich grassland resource using both appropriate national and European systems of government policy and protection, while and also providing potential for landowners and farmers to benefit from the ownership and management of these areas. Because of the varying nature of grassland in terms of area, different aspects of protection and incentive will be needed.

A primary objective for grassland conservation in this and other regions is to maintain traditional grassland management. Various options are available for this but the new European Rural Development Programme agri-environment measures to be launched holds potential to reward farmers and landowners for maintaining these areas using traditional farming methods. Essentially this scheme will compensate for income forgone in not turning grassland to more intensive use and will pay for special wildlife management requirements. Details of general requirements for management includes a ban on the use of fertiliser or the use of only low levels and organic manures and low stocking rates for livestock, typically below one livestock unit per hectare. Cutting dates by mechanical means are often later than usual to conserve bird populations nesting in the grassland or alternatively further compensation would be to encourage the manual cutting which has a low impact on wildlife.

Key features of conservation plans necessary to maintain Romania's grassland heritage include the management of large contiguous areas. Many management processes operate at the landscape scale, such as shepherding of large flocks of sheep and village herds of cows and horses. This may be difficult to maintain in the future, with the breakdown of shared, community farming and movement towards farming by entrepreneurial individuals. This would need concerted local action under special funding instruments within the EU-funded rural development programme operating beyond agri-environment scheme options and linked to the labelling of local agricultural products such as cheese or high quality meat, and consolidated with opportunities under EU structural funding (for economic development) which are available throughout Romania.

Whereas some aspects of traditional management can be incorporated into local agri-environment measures such as stocking rate and utilisation requirements, other aspects can be more difficult to design within a system of statutory prescriptions, such as the use of fire in burning of encroaching scrub. However this management, for instance, has a highly significant role in maintaining biodiversity allowing steep banks with some of the highest diversity and rarest species to remain as grassland. Other features of management such as the retention of mature trees, folding of livestock and some traditional practices we may yet discover are similar in their importance. Elsewhere in Europe it is the disappearance of such routine manual targeted management which is of equal importance, as intensification in causing habitat and species loss through habitat degradation. Great efforts are made to simulate this management with machinery and other 'fixes' in the absence of traditional skills (e.g. see series of English Nature ENACT publications).

Targeting of schemes

Regarding the potential of rural development programme funding to facilitate grassland conservation, it is important that it is targeted to the most valuable areas of grassland and, if so, to perhaps create large contiguous areas under agri-environment schemes, the most important objective in conserving species and countering the effect of habitat fragmentation (Tscharntke et al., 2002; Honnay et al., 2006). Nationally within Romania this targeting can be at the county level, based on counties with a minimum proportion of land with High Nature Value grassland. At a secondary level or filter this targeting can operate at the level of individual applications. Applications can be potentially scored on the presence of wildflower species indicators, species and habitat diversity, or conversely the absence of significant cover by agricultural species.

The former method using wildflower indicators is gaining more acceptance and support, being used in Germany and Switzerland as part of agri-environment criteria selection (Oppermann and Gujer, 2003; Oppermann, et al., 2006). Indicator species are chosen that are easily identified, conspicuous and associated with high quality grassland, supported by pictorial aids allowing farmers to self- assess their grasslands as part of the application process. This method may have potential for use in Romania in the identification of High Nature Value grassland, once awareness of the potential benefits of agri-environment schemes has been achieved and support and training provided by agency field officers or NGOs.

As part of the multivariate analysis of species data conducted as part of our survey study, species have been scored along axes associated with High Nature Value quality and influences of agriculture and these multivariate scores or eigenvalues could be used as an objective method in choosing robust indicators. Rare or more ecologically sensitive species with high negative scores would not be suitable, neither would species associated with agricultural intensification with high positive scores. Species should be easily identified and have reasonably long flowering periods.

Table 1: Potential wildflower indicator species in relation to multivariate analysis scores.

Species and attribute	Axis 1	Axis 2
1. Rare and sensitive species		
Linum flavum	-0.38	-1.00
Adonis vernalis	-0.40	-1.10
Teucrium montanum	-0.38	-1.44
Scabiosa ochroleucon	-0.33	-0.92
2. Suitable indicators		
Leontodon hispidus	-0.24	-0.14
Thymus serpyllum	-0.28	-0.29
Veronica austriaca	-0.23	-0.02
Trifolium montanum	-0.27	-0.14
3. Species associated with agricultural intensification		
Daucus carota	-0.08	0.80
Taraxacum agg.	-0.04	0.76
Medicago lupulina	-0.03	0.78
Centaurea pannonica	0.02	0.81

It must be emphasized that currently much of the grassland in the Saxon Villages would meet general application requirements and the need for such a secondary filter in terms of the scoring of individual applications will arise in the future when agricultural intensification has begun to have an impact, reducing quality and extent of semi-natural grassland.

Habitat protection

Conservation of grasslands is ultimately dependant on economic imperatives which allow management to be profitable. If such measures are not always possible then another option is to use habitat protection legislation, but it is a priority to use this if possible in concert with available funding from a range of sources including the rural development programme. The European Habitats Directive (Directive 92/43/EEC; 1992) is aimed at conserving the best European examples of habitat and associated species found within the different bio-geographical zones. The ADEPT project area is due for inclusion as a large (90.000 ha) protected area within Târnava Mare Site of Community Interest (SCI) under Natura 2000. The focus of the Habitats Directive is to maintain favourable status for the features identified as part of designation and duly incorporated in management plans. Some features such as steppic slopes, and especially the unique heritage of hillocks or 'tumps', will need special investigation to identify existing management and for it to be incorporated into plans designed to maintain favourable conservation status in case farming practices show the shifts under market forces that are expected.

Other national systems of protection are available such as designation as national monuments or national parks, e.g. Law no. 462/2001 regarding the protected natural areas regime, conservation of the natural habitats, the wild flora and fauna. This might solve the problem that large-scale management systems such as shepherded grazing and burning may be difficult to administer if special features such as the 'tumps' are protected under local designations. Lessons should be learnt from conservation in other parts of Europe where piecemeal conservation for many species and habitats is failing where areas are insufficiently large enough and management fails due to critical mass of livestock or resources. The end of this process is overly prescriptive micro-management for species, a sign that the ecological system has failed and is in collapse. Opportunities still exist in Romania to prevent this.

CONCLUSIONS

The challenge is to conserve this rich grassland resource in the face of inevitable changes resulting from European Union accession, but also despite EU accession in terms of technological and societal changes that are occurring everywhere.

Agri-environmental schemes need to be more highly developed than the ‘broad and shallow’ definitions that would mean only limited restrictions on fertiliser application rates. In order to maintain these grasslands and to conserve the patterns of diversity that have been surveyed there would need to be relatively heavy restrictions on the use of fertiliser input, limiting stocking density and hence a lowering of potential production levels and profitability of the farm enterprises. It would essentially be about retaining existing traditional farming management in the face of pressure to change. Furthermore, to conserve bird species such as corncrake and to maintain insect and plant species diversity, mechanical cutting dates would have to be restricted to the latter half of June or July. The challenge is to impose such restriction with the agreement of farmers under a voluntary agri-environmental scheme that pays sufficient compensation to provide a financial incentive.

The pattern in other countries has been for farming on the poorer, less productive land to be co-financed by agri-environmental schemes or to be included in least favoured area designation or under Natura 2000 with the better land succumbing to pressure to intensify or conversion to arable. Much of the lower land of the Saxon Villages area may be sufficiently high grade to be profitable if converted to arable farming and this will remain an issue that conservation programmes will have to address.

ACKNOWLEDGEMENTS

The author is grateful to Orange Romania and the Darwin Initiative of the UK Ministry of Agriculture (DEFRA) for supporting the work of Fundația ADEPT, including grassland research. Dr. John Akeroyd collaborated on the fieldwork, and he and Nathaniel Page commented on drafts of this paper.

REFERENCES

1. Akeroyd, J. 2003 − A Transylvanian wood-pasture. *Plant Talk*, 34: 34-37.
2. Akeroyd, J. 2006 − *The historic countryside of the Saxon Villages of southern Transylvania/Peisajul Istoric al Satelor Sasesti din Sudul Transilvaniei*. Fundația ADEPT, Saschiz.
3. Akeroyd, J. R. and Page, N. 2006 − The Saxon Villages of southern Transylvania: conserving biodiversity in a historic landscape. In Gafta, D. and Akeroyd, J.[R.], eds (2006) *Nature Conservation: Concepts and Practice*, pp. 199–210. Springer Verlag, Heidelburg, Germany.
4. FAO, 2002 − Database of the UN Food and Agriculture Organization. FAO, Rome.
5. Gough, M. W. and Marrs, R. H. 1990 − A comparison of soil fertility between semi-natural and agricultural plant communities: implications for the creation of species-rich grassland on abandoned agricultural land. *Biological Conservation*, 51: 83-96.
6. Honnay, O, Roldán-Ruiz, I. and Baguette, M. 2006 − Conservation and restoration of fragmented biodiversity hot spots: calcareous grasslands of south Belgium (BIOCORE report) contract: EV/01/26A, Belgian Science Policy.
7. Lande L. 1996 − Statistics and partitioning of species diversity and similarity among multiple communities. *Oikos*, 76: 5-13.
8. MacArthur, R.H. and Wilson, E.O. 1967 − *The theory of island biogeography.* Princeton Univ. Press, Princeton, New Jersey, USA.
9. Martin, L. M., Moloney, Kirk, A. and Wilsey, B.J 2005 − An assessment of grassland restoration success using species diversity components. *Journal of Applied Ecology,* 42: 327-336.
10. Ministry of Agriculture, Forests and Rural Development, Government of Romania, 2007-2013 − *National strategic plan of rural development*.
11. Oppermann, R. and Gujer, H.U. 2003 − *Artenreiches Grunland bewerten und forden MEKA und OQV in der Praxis*, Stuttgart.
12. Oppermann, R., Meyerhoff, E. and van Elsen, T. 2006 − *Naturschutzberatung für die Landwirtschaft. Einführende Beratermaterialien.* (BfN-Script 162). Bundesamt für Naturschutz (BfN), Bonn.
13. Partel, M., Bruun, H.H. and Sammul, M., 2005 − *Biodiversity in temperate European grassland: origin and conservation. Integrating efficient grassland farming and biodiversity.* Proceedings of the 13th International Occasional Symposium of the European Grassland Federation Tartu, Estonia (published by organising committee).
14. Sarbu, A., Coldea G., Negrean G., Cristea, V., Hanganu J. and Veen, P. 2004 − *Grasslands of Romania*. Final report on National Grassland Inventory 2000-2003. University of Bucharest and Royal Dutch Society for Nature Conservation.
15. Ter Braak, C. J .F. 1990 − Interpreting canonical correlation analysis through biplots of structural correlations and weights. *Psychometrika*, 55: 519-531.
16. Tscharntke, T., Steffan-Dewenter, I., Kruess, A. and Thies, C. 2002 − Contribution of small habitat fragments to conservation of insect communities of grassland-cropland landscapes. *Ecological Applications*, 12 (2): 354-363.

THE XERO-MEZOPHYLIC AND XEROPHYLIC GRASSLANDS OF FESTUCO – BROMETEA CLASS IN THE SIGHIŞOARA - TÂRNAVA MARE POTENTIAL NATURA 2000 SITE (TRANSYLVANIA, ROMANIA)

Silvia OROIAN *, *Mariana HIRIŢIU* ** and *Manuela CURTICĂPEAN* *

* University of Medicine and Pharmacy of Târgu-Mureş, Faculty of Pharmacy, Pharmaceutical Botany and Cell Biology Department, 38 Gheorghe Marinescu Street, Târgu-Mureş, Mureş County, RO - 540139, Romania, osilvia@umftgm.ro, manuela_claudia@yahoo.com
** University of Medicine and Pharmacy of Târgu-Mureş, Botanical Garden, 38 Gheorghe Marinescu Street, Târgu-Mureş, Mureş County, RO-540139, Romania, mariana_hiritiu@yahoo.com

KEYWORDS: Romania, Transylvania, flora, vegetation, red list, habitats.

ABSTRACT

The objective of this study was the identification of the principal habitat types, types of semi-natural grasslands and the associations of which they are composed, and also the identification of vascular plants on the critical list. Observations and field research for the identification of habitat types and semi-natural communities in the Târnava Plateau were carried out in the period 2003 - 2007, during the growing season, in the following localities within the Sighişoara-Târnava Mare pSCI: Angofa, Apold, Archita, Beia, Brădeni, Cloaşterf, Criş, Daia, Daneş, Fişer, Floreşti, Grânari, Iacobeni, Laslea, Mihai Viteazu, Movile, Mureni, Noiştat, Nou Săsesc, Ruja, Saschiz, Stejărenii, Stejărişu, Şaeş, Şarpatoc, Ţeline and Vulcan. The grasslands studied form parts of the counties of Mureş, Sibiu, Braşov and Harghita. The phytocenozes identified were ascribed to the Festuco-Brometea class under the system of Mucina, Grabherr and Ellmauer (1993). Ten vegetal associations were identified from 174 relevées. In the flora of these grasslands we identified many taxa in various categories of threat, endangered at European level, or included in national Red Lists: *Adenophora liliifolia, Crambe tataria, Echium russicum, Cephalaria radiata*, *Salvia transsilvanica, Orchis coriophora, O. morio, O. tridentata, O. ustulata, Alcea pallida, Euphorbia virgata, Inula bifrons, Limodorum abortivum, Dictamnus albus, Salvia nutans*, etc.

ZUSAMMENFASSUNG: Die xero-mesophilen und xerophilen Grünlandgesellschaften der Festuco-Brometea in dem potentiellen NATURA 2000 Gebiet (p SCI) Sighişoara/Schässburg - Târnava Mare/Große Kokel (Transylvanien, Rumänien).

Das Ziel der vorliegenden Studie war die Erfassung der wichtigsten Habitattypen halbnatürlichen Grünlands und der dazugehörigen Assoziationen sowie der auf der kritischen Liste angegebenen Gefäßpflanzen. Dafür wurden im Kokel - Hochland während der Vegetationsperioden der Jahre 2003 - 2007 Beobachtungen und Feldforschungen in den folgenden Ortschaften (alle im Bereich des geplanten Schutzgebietes von gemeinschaftlicher Bedeutung SCI Sighişoara - Târnava Mare) durchgeführt: Angofa/Ungefug (neben Sighişoara/Schässburg), Apold/Trappold, Archita/Arkeden, Beia/Meeburg, Brădeni/Henndorf, Cloaşterf/Kloßdorf, Criş/Kreisch, Daia/Denndorf, Daneş/Dunnesdorf, Fişer/Schweischer, Floreşti, Grânari, Iacobeni/Jakobsdorf, Laslea/Groß-Lasseln, Mihai Viteazu, Mureni, Movile/Hundertbücheln, Noiştat/Neustadt, Nou Săsesc/Neudorf, Ruja/Roseln, Saschiz/Keisd, Stejărenii/Peschendorf, Şaes/Schaas, Şarpotoc, Ţeline und Vulcan/Wolkendorf. Die Grünlandgesellschaften liegen teiulweise im Verwaltungsgebiet der Kreise Mureş, Sibiu, Braşov und Harghita. Die untersuchten Phytozönosen wurden zur Klasse Festuco-Brometea in das von Mucina, Grabherr und Ellmauer (1993) ausgearbeitete System eingegliedert. Es wurden zehn Pflanzengesellschaften festgestellt, die mit insgesamt 174 Bestandaufnahmen belegt sind. Die Flora dieser Grünlandgesellschaften umfasst Arten, die zu unterschiedlichen Gefährdungskategorien gehören. Einige sind auf europäischer Ebene bedroht, andere sind in den nationalen Roten Listen erfasst. Dabei geht es um die folgenden Arten: *Adenophora liliifolia, Crambe tataria, Echium russicum, Cephalaria radiata*, *Salvia transsilvanica, Orchis coriophora, O. morio, O. tridentata, O. ustulata, Alcea pallida, Euphorbia virgata, Inula bifrons, Limodorum abortivum, Dictamnus albus, Salvia nutans* etc.

REZUMAT: Pajişti xero-mezofile şi xerofile din clasa Festuco-Brometea din potenţialul sit Natura 2000 Sighişoara-Târnava Mare (Transilvania, România).

Obiectivele acestui studiu au constat în identificarea principalelor tipuri de habitate, tipuri de pajişti seminaturale şi a asociaţiilor care le alcătuiesc, precum şi identificarea plantelor vasculare din lista critică. Observaţiile şi cercetările de teren pentru identificarea unor tipuri de habitate, a unor comunităţi seminaturale instalate în Podişul Târnavelor, din localităţile: Angofa, Apold, Archita, Beia, Brădeni, Cloaşterf, Criş, Daia, Daneş, Fişer, Floreşti, Grânari, Iacobeni, Laslea, Mihai Viteazu, Movile, Mureni, Noiştat, Nou Săsesc, Ruja, Saschiz, Stejărenii, Stejărişu, Şaeş, Şarpatoc, Ţeline, şi Vulcan (incluse în potenţialul sit Natura 2000 Sighişoara-Târnava Mare) s-au realizat în perioada 2003 - 2007, în perioadele de vegetaţie. Pajiştile cercetate sunt în judeţele Mureş, Sibiu, Braşov, Harghita. Fitocenozele identificate au fost raportate la clasa Festuco-Brometea după sistemul autorilor: Mucina, Grabherr and Ellmauer (1993). Au fost identificate 10 asociaţii vegetale, efectuându-se 174 de relevee. În flora acestor pajişti au fost identificaţi o serie de taxoni aflaţi în diverse stadii de periclitare, taxoni europeni ameninţaţi sau incluşi în listele roşii naţionale: *Adenophora liliifolia, Crambe tataria, Echium russicum, Cephalaria radiata*, *Salvia transsilvanica, Orchis coriophora, O. morio, O. tridentata, O. ustulata, Alcea pallida, Euphorbia virgata, Inula bifrons, Limodorum abortivum, Dictamnus albus, Salvia nutans* etc.

INTRODUCTION

The biodiversity conservation is a complex process which is carried out within a well-defined legislative framework. The Natura 2000 programme proposes the collection of data on certain plant species and habitats, the classification of data on species and habitats (identification, mapping and assuring they are included in protected areas). The objectives of this study were the identification of the principal types of habitats, types of semi-natural grasslands and associations that accompany them, and the identification of vascular plants on the critical list.

Abbreviations:	Circumbor	-	Circumboreal	U	-	Humidity
	Paleotemp	-	Paleotemperate	T	-	Temperature
	Eua	-	Eurasian	R	-	Soil reaction
	Eurosib	-	Eurosiberian	H	-	Hemicryptophyte
	Eur-Cauc	-	European-Caucasian	Th	-	Therophyte
	Eur	-	European	G	-	Geophyte
	Oroph-Eur	-	Orophyte European	Ph	-	Phanerophyte
	Pont-Pann	-	Pontic-Pannonian	Ch	-	Chamaephyte
	Pont-Balc	-	Pontic-Balcanian	D	-	Diploid
	Pont-Med	-	Pontic - Mediterranean	P	-	Polyploid
	Med	-	Mediterranean	D-P	-	Diplo-Polyploid
	End	-	Endemic	N	-	Unknown

MATERIAL AND METHODS

The study area included the communes: Angofa, Apold, Archita, Beia, Brădeni, Criş, Cloaşterf, Daia, Daneş, Fişer, Floreşti, Grânari, Iacobeni, Laslea, Mihai Viteazu, Movile, Mureni, Noiştat, Nou Săsesc, Ruja, Saschiz, Stejărenii, Stejărişu, Şaeş, Şarpatoc, Ţeline, and Vulcan. Field research for the identification of certain habitat types, some semi-natural communities in the Târnava rivers (Târnava Mare and Târnava Mica) plateau, in these communes, were carried out in 2003 - 2007, during the growing season. Grassland types were identified, and in the process many phytosociological relevées were carried out based on the method of Braun-Blanquet (Braun-Blanquet 1964; Braun-Blanquet and Pavillard 1928). The test areas were selected in order that the altitude variations found in the project area were included. For a correct characterisation and classification in associations, subjective criteria were also used to assure the homogeneity of habitats and climatic conditions.

The determination of species was carried out in the field or, in the case of taxa that were more difficult to identify, in the laboratory based on collected material, using Flora României (Săvulescu, 1952 - 1976). The nomenclature of species follows Flora Europaea (Tutin 1991; Tuti et al. 1964 - 1980). Syntaxonomic identification was carried out on the basis of the most recent works on vegetation classification at a European level (Mucina et al., 1993a, b) and also synthetic summary works on Romanian vegetation (Burlescu, 2003; Cristea et al., 2004; Csürös and Kovács, 1962; Doniţă et al., 2005 - 2006; Drăgulescu, 2005, 2006; Mountford and Akeroyd, 2005; Oroian, 1998; Pop et al., 2002; Sanda, 2002; Sărmăghiţan, 2003).

RESULTS AND DISCUSSIONS

The habitats described are characterised by a remarkable floristic richness, important for the conservation of plant and animal diversity in Romania. Some of them are being recognised as key habitats for maintaining biodiversity at a European level. Particular attention was paid to species that are endemic, sub-endemic, rare, vulnerable and threatened in the National Red List (Boşcaiu et al., 1994; Oltean et al., 194). Some habitats marked with an asterisk (*) are not found in the Habitats Directive or Berne Convention, and are coded according to EUNIS - the European system for classification of habitat types, used in the implementation of the Natura 2000 programme. Other habitat types are those identified as threatened at a European level, some of them marked as Priority in Annex I of the Habitats Directive - and which are found also in the Habitats Annex (Appendix I) of the Berne Convention. Others are non-priority habitats found in Annex I of the Habitats Directive which are listed also in the Habitats Annex (Appendix I) of the Berne Convention or in national legislation (***).

1. 1. Xero-mezofilic phytocenozes, moderately thermophylic, are widespread across all hilly parts of the Târnava Plateau and contain numerous examples of Brometalia. These develop on basic soils and include the following characteristic species: *Asperula cynanchica, Stachys recta, Galium verum, Pimpinella saxifraga, Dianthus carthusianorum*, etc.

The correspondence between the system of classification for habitat type used at European level and within Romania is:

NATURA 2000: 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometea) - (Priority for important orchid sites)

HdR R3408, R3413

These grasslands are classified thus:

FESTUCO-BROMETEA Br.-Bl.et R.Tx.ex Klika et Hadač, 1944

BROMETALIA ERECTI Br.-Bl.1936

Bromion erecti Br.-Bl.1936
1. Rhinantho rumelici-Brometum erecti Sanda et Popescu, 1999
Cirsio-Brachypodion pinnati Hadač et Klika in Klika et Hadač, 1944
2. Brachypodio pinnati-Festucetum rupicolae Ghişa, 1962
Danthonio-Brachypodion pinnati Boşcaiu, 970
3. Danthonio-Brachypodietum pinnati Soó, 1946
4. Polygalo majoris-Brachypodietum pinnati Wagner, 1941

Rhinantho rumelici-Brometum erecti Sanda et Popescu, 1999

The phytosociological associations of erect brome (little studied up until the present) occupy the sunny sides of the hills of the Târnava Plateau. În the period 2004 - 2007 phytocenozes were analysed on the hills of: Apold, Archita, Daia, Mureni, Saschiz, Şaeş, Şarpatoc, Vulcani, Beia and Brădeni, at altitudes of 440 - 680 m, south-, southeast- or northwest- facing slopes, with slopes of 3 - 30°.

The floristic composition includes 196 species in the 18 done releve (Tab. 1 include 16 relevée). With the dominant species *Bromus erectus,* many species present are characteristic of the Festuco-Brometea class, along with many transgressive species of the Molinio-Arrhenatheretea class (Tab. 1).

Ecological analysis of the associations reveals the predominance of xero-mezophylic species (54.08%), mezophylic (27.56%), micro-mezothermic (57.14%) and moderate-thermophylic (20.92%), weakly acid-neutrophylic (42.35%,) euriionic (30.61%), followed by acido-neutrophylic species (19.89%).

Life-form spectrum: Ch-5.10%, H-65.30%, G-5.62%, T-20.92% (Th-12.25%, TH-8.67%), Ph-3.06% (mPh-2.04, nPh-1.02%).

Spectrum of geo-elements: Circumbor-6.12%, Dac-Balc-1.53%, Eur-Cauc-6.12%, Eurosib-12.25%, Eur-16.84%, Eua-24.49%, Orop-1.53%, Paleotemp-12.25%, Pont-Pann-5.10%, Siber-1.02%, Adv-0.51%, Cosm4.08%. In the phytocenozes we recorded, along with plants specific to a temperate continental climate, a significant percentage of Mediteranean species (8.16%).

Caryological spectrum: D-46.43%, P-43.37%, D-P-6.63%, ?-3.57%.

At a young stage, the forage value of erect brome grassland is favourable, but it is weak in the period after grass seed-heads are formed.

Table 1: *Rhinantho rumelici-Brometum erecti* Sanda *et* Popescu, 1999.

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Altitude (m s.m.)	482	557	603	616	568	565	584	440	463	677	679	554	632	636	587	544	
Aspect	-	-	S	-	-	-	-	-	-	-	-	-	-	-	SE	NV	
Slope (°)	-	-	25	-	-	-	-	-	-	-	-	-	-	-	3	30	
Area (m^2)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Vegetation cover (%)	100	83	90	83	100	100	92.5	98	98.5	81.5	80.5	100	94.5	95.0	90.0	85.5	K
Char. assn																	
Bromus erectus	3	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	V
Rhinanthus rumelicus	-	-	-	-	+	+	+	+	+	-	-	+	+	+	-	-	III

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Brometalia erecti																	
Astragalus cicer	+	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	II
Centaurea scabiosa	+	-	-	-	+	+	+	-	-	+	+	+	+	+	-	-	III
Danthonia alpina	-	-	-	-	-	-	-	-	1	-	-	+	-	-	+	-	I
Dianthus carthusianorum	+	-	+	-	-	-	+	-	-	+	-	-	+	-	+	-	II
Helianthemum nummularium	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Onobrychis viciifolia	+	-	+	-	+	+	1	-	-	+	+	-	+	-	+	+	IV
Phleum phleoides	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	+	I
Teucrium chamaedrys	+	-	+	+	-	-	-	+	-	-	-	-	+	-	+	+	III
Festucion rupicolae																	
Falcaria vulgaris	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Geranium columbinum	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	I
Medicago minima	-	-	-	-	1	+	-	-	-	+	-	+	+	-	-	-	II
Festucetalia valesiacae																	
Astragalus onobrychis	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I
Bupleurum falcatum	+	-	+	-	+	+	+	-	-	+	+	-	-	+	-	-	III
Campanula sibirica	+		+	-	+	+	-	-	+	+	+	+	+	-	-	-	III
Carlina biebersteinii brevibracteata	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	I
Centaurea rhenana	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	+	II
Chamaecytisus albus	+	-	-	-	-	-	+	-	-	-	-	-	-	-	1	-	I
Dorycnium pentaphyllum herbaceum	2	+	+	-	+	+	+	+	-	+	-	-	-	2	-	+	IV
Elymus hispidus	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	+	I
Eryngium campestre	+	-	+	+	+	+	+	+	-	-	-	-	-	-	+	+	III
Euphorbia salicifolia	-	-	-	-	-	-	+	-	-	-	-	+	+	-	-	-	I
Festuca valesiaca	+	+	+	-	-	-	-	+	-	-	-	-	+	-	-	+	II
Fragaria viridis	+	-	-	+	-	-	-	+	-	-	-	-	+	-	+	-	II
Inula hirta	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	I
Linum flavum	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	I
Linum perenne	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	I
Muscari tenuiflorum	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	II
Nonea pulla	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Polygala major	-	-	-	-	+	+	+	-	-	+	+	-	-	+	+	-	III
Stachys recta	-	-	+	-	+	+	+	-	+	-	+	-	+	-	+	+	III
Thesium lynophyllon	-	-	-	-		-	-	-	1	-	+	-	-	-	-	-	I
Veronica spicata orchidea	+	-	+	-	-	-	-	-	-	-	-	-	+	-	-	+	II
Festuco-Brometea																	
Agrimonia eupatoria	+	+	+	+	+	+	+	+	+	-	-	+	+	-	+	+	V
Allium oleraceum	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Anthericum ramosum	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	I
Artemisia campestris	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	+	I
Asparagus officinalis	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	I
Asperula cynanchica	+	-	+	+	+	+	-	-	-	+	-	-	-	+	+	+	III
Astragalus austriacus	-	-	-	-	+	+	-	-	-	-	-	+	-	-	-	-	I
Astragalus monspessulanus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	I

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Brachypodium pinnatum	+	+	+	+	+	+	+	+	-	+	+	-	-	-	+	-	IV
Campanula glomerata	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Carlina vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Brachypodium pinnatum	+	+	+	+	+	+	+	+	-	+	+	-	-	-	+	-	IV
Campanula glomerata	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Carlina vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Centaurea apiculata spinulosa	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	I
Cerinthe minor	+	-	-	+	+	+	+	-	-	+	-	-	-	-	-	-	II
Clinopodium vulgare	-	+	-	+	+	+	-	-	-	-	-	-	+	-	+	-	II
Coronilla varia	+	+	+	-	+	+	+	+	-	+	+	+	+	-	-	-	IV
Dichanthium ischaemum	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	+	I
Echium vulgare	+	-	+	+	+	+	-	+	-	+	+	-	+	-	-	+	IV
Erigeron acris	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	I
Euphorbia cyparissias	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	II
Filipendula vulgaris	-	-	+	-	-	-	+	-	+	-	+	-	-	+	+	-	II
Galium album	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I
Galium mollugo	+	-	-	-	+	+	-	-	1	+	-	-	-	-	-	-	II
Galium verum	+	-	+	+	+	+	+	+	-	+	+	+	-	+	+	-	IV
Hypericum perforatum	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	III
Koeleria cristata	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	I
Lavatera thuringiaca	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I
Lotus corniculatus	+	+	+	-	+	+	-	+	+	-	+	+	+	+	+	-	IV
Medicago falcata	+	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	I
Pimpinella saxifraga	+	-	-	-	+	+	-	-	1	-	-	+	-	+	+	-	III
Plantago lanceolata	+	-	+	+	-	+	-	+	-	+	+	+	+	+		+	IV
Plantago media	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	III
Poa pratensis angustifolia	-	-	+	-	-	-	-	-	-	-	-	+	+	-	-	+	II
Potentilla cinerea	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	I
Potentilla recta	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I
Prunella laciniata	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	I
Salvia pratensis	+	-	+	-	+	+	+	-	-	+	-	-	-	-	-	-	II
Salvia verticillata	1	+	-	+	+	+	+	-	-	-	-	-	-	-	-	+	III
Scabiosa ochroleuca	+	-	+	+	+	+	+	+	-	+	+	-	+	-	+	+	IV
Senecio jacobaea	+	-	-	-	-	-	+	+	-	-	-	+	+	-	+	-	II
Sesel annuum	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Stachys germanica	-	+	-	-	+	+	+	-	-	-	-	-	+	-	+	-	II
Thalictrum minus	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	I
Thymus glabrescens	-	-	+	+	+	+	+	-	-	-	-	-	-	-	-	+	II
Thymus pulegioides	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	I
Trifolium campestre	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	I
Trifolium pannonicum	+	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	II
Achillea millefolium	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	V
Agrostis capillaris	-	+	-	+	-	-	-	+	+	-	+	-	+	+	-	-	III
Anthoxanthum odoratum	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	I
Briza media	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	V

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Molinio-Arrhenatheretea																	
Campanula patula	-	-	+	-	-	-	-	-	-	-	+	-	+	-	-	-	I
Carum carvi	-	-	+	+	-	-	-	-	-	-	-	-	-	+	+	+	II
Centaurea nigrescens	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Centaurium erythraea	-	-	+	-	-	-	-	-	-	-	-	+	+	-	-	-	I
Centaurium pulchellum	-	-	+	-	-	-	-	-	-	-	-	+	+	-	-	-	I
Cerastium holosteoides	-	-	+	-	-	-	-	+	+	-	+	-	-	-	-	-	II
Cichorium intybus	+	+	+	+	+	+	+	+	+	-	-	-	+	+	+	+	V
Crepis biennis	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	-	I
Cynosurus cristatus	-	-	-	-	-	-	-	+	+	-	+	-	+	-	-	-	II
Dactylis glomerata	+	-	+	+	+	+	+	+	+	+	+	-	+	-	+	-	IV
Danthonia decumbens	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	I
Daucus carota	-	+	+	-	+	+	+	+	+	+	+	-	+	+	-	+	IV
Erigeron annuus	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	I
Eryngium planum	+	+	+	-	+	+	+	-	-	-	-	+	-	-	-	-	III
Euphrasia rostkoviana	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	I
Genista tinctoria	+		-	-	-	-	+	-	-	-	-	-	-	+	-	-	I
Inula britannica	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	I
Knautia arvensis	+	+	+	-	+	+	+	-	-	+	+	+	-	-	+	+	IV
Lathyrus pratensis	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	I
Leontodon hispidus danubialis	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	I
Linum catharticum	-	-	-	+	+	+	-	-	-	-	-	-	+	-	-	-	II
Medicago lupulina	+	+	+	-	-	-	+	2	-	-	-	-	-	-	+	-	II
Myosotis arvensis	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	I
Ononis arvensis	+	+	+	-	+	+	+	+	-	-	-	-	+	+	+	-	IV
Primula veris	-	-	-	+	+	+	-	-	-	-	-	-	-	+	-	-	II
Prunella vulgaris	-	-	+	+	-	+	-	+	-	-	-	+	+	-	+	-	III
Leontodon hispidus danubialis	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	I
Leontodon hispidus danubialis	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	I
Leucanthemum vulgare	+	-	-	-	-	-	-	+	+	+	+	+	-	-	-	+	III
Linum catharticum	-	-	-	+	+	+	-	-	-	-	-	-	+	-	-	-	II
Medicago lupulina	+	+	+	-	-	-	+	2	-	-	-	-	-	-	+	-	II
Myosotis arvensis	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	I
Ononis arvensis	+	+	+	-	+	+	+	+	-	-	-	-	+	+	+	-	IV
Primula veris	-	-	-	+	+	+	-	-	-	-	-	-	-	+	-	-	II
Prunella vulgaris	-	-	+	+	-	+	-	+	-	-	-	+	+	-	+	-	III
Rhinanthus rumelicus	-	-	-	-	+	+	+	+	+	-	-	+	+	+	-	-	III
Leontodon hispidus danubialis	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	I
Rhinanthus rumelicus	-	-	-	-	+	+	+	+	+	-	-	+	+	+	-	-	III
Molinietalia																	
Alopecurus pratensis	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	+	I
Deschampsia caespitosa	-	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Lythrum salicaria	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Menthia longifolia	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	I
Trifolium hybridum	-	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-	I
Querco-Fagetea																	
Allium scorodoprasum	-	+	+	+	+	+	-	-	-	-	-	-	+	-	-	-	II
Astragalus glycyphyllos	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Campanula bonobiensis	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	II
Crataegus monogyna	+	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	I
Prunus spinosa	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Pyrus pyraster	+	+	-	+	-	-	-	-	-	-	-	-	-	+	-	-	II
Rosa canina	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	I
Quercetea pubescenti-petraeae																	
Echinops sphaerocepalus	+	+	-	-	-	+	-	-	-	-	-	-	-	-	+	-	II
Helleborus purpurascens	+	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-	II
Lembotropis nigricans	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	II
Melampyrum bihariense	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	I
Variae syntaxa																	
Bromus arvensis	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Consolida regalis	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Convolvulus arvensis	-	-	+	-	+	+	+	-	-	+	-	-	+	-	-	-	II
Cuscuta europaea	+	-	-	-	-	-	+	+	-	-	-	-	-	+	-	-	II
Dipsacus laciniatus	-	+	+	+	+	+	-	+	-	-	-	-	-	-	-	-	II
Equisetum arvense	-	-	-	-	+	+	+	-	-	-	-	-	-	+	-	-	II
Euphorbia helioscopia	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	I
Galium album	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	I
Lapsana communis	-	-	-	-	+	+	-		-	-	-	-	-	-	-	-	I
Lolium perenne	-	+	-	-	+	+	-	-	-	-	-	-	+	-	-	-	II
Melilotus officinalis	-	-	-	-	+	+	+	-	-	-	-	-	-	-	+	-	II
Onopordum acanthium	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Plantago major	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	II
Ranunculus polyanthemos	-	-	-	-	-	-	-	-	-	+	+	-	-	+	-	-	I
Trifolium medium	+	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-	II
Vicia grandiflora	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I

Species present in a single relevée: *Arrhenatherum elatius* (1), *Cornus sanguinea* (1), *Equisetum hyemale* (1), *Rubus caesius* (1), *Anchusa officinalis* (2), *Asyneuma canascens* (2), *Galium rubioides* (2), *Gentiana cruciata* (2), *Lysimachia vulgaris* (2), *Nepeta nuda* (2), *Origanum vulgare* (2), *Reseda lutea* (2), *Verbascum lychnitis* (2), *Althaea officinalis* (3), *Mentha arvensis* (3), *Ornithogalum pyramidale* (3), *Carduus acanthoides* (4), *Holcus lanatus* (5), *Veronica chamaedrys* (5), *Inula ensifolia* (7), *Lathyrus aphaca* (7), *Lathyrus tuberosus* (7), *Orobanche lutea* (8), *Campanula persicifolia* (8), *Carex distans* (9), *Festuca rubra* (10), *Symphytum officinale* (10), *Taraxacum officinale* (10), *Carex caryophyllea* (11), *Potentilla argentea* (15), *Rorippa pyrenaica* (15), *Viola tricolor* (15), *Dianthus cruciata* (15), *Festuca rupicola* (15), *Calystegia sepium* (16), *Hieracium pilosella* (16), *Polygala comosa* (16), *Trifolium alpestre* (16), *Astragalus cicer* (17), *Laser trilobium* (17), *Prunella grandiflora* (17), *Linum hirsutum* (18), *Cephalaria radiata* (18).

Places and dates of relevées: R1 - Mureni, N 46°13', E 25°00'; 2004.07.16; R2 - Mureni, N 46°13', E 25°00'; 2004.07.16; R3 - Daia, N 46° 09' E 24°53'; 2004.07.23; R4 - Vulcan, N 46° 09' E 24°50'; 2004.07.23; R5 - Vulcan, N 46° 09' E 24°50'; 2004.07.23; R6 - Apold, N 46°06', E 24°50'; 2004.07.27; R7 - Apold, N 46°06', E 24°50'; 2004.08.27; R8 - Apold, N 46°06' E 24°50'; 2004.08.27; R9 - Şaeş, N 46°08' E 24°49'; 2004.07.27; R10 - Daia N 46°10', E 24°56'; 18.06.2005.06.18; R11-13 Saschiz, Volcos, N 46°10', E 25°01'; 2005.06.30; R14 - Archita, Coastele Saschizului, N 46°10', E 25°04', 2006.07.11; R15 - Şarpatoc, N 46°09', E 24°50', 2006.07.25; R16 - Beia, N 46°08', E 25°09', 2007.07.18; R17 - Brădeni; N 46°06', E 24°50', 2007.07.31; R18 - Brădeni; N 46°06', E 24°50', 2007.07.31.

Brachypodio pinnati-Festucetum rupicolae Ghişa, 1962

The Phytocenosic associations occupy the sunny slopes of many areas included in the Sighişoara-Târnava Mare pSCI: Daneş (2004), Daia and Vulcan (2006) and Movile, Noiştat and Brădeni (2007), on hills generally of eastern aspect, but also of southern or northern aspect, with a slope of 5 - 30°.

Floristically, this phytocenoze is characterised by a homogeneous composition which includes 195 species of cormophyte (Tab. 2). Species which are members of the units within the association are well represented (54.87%). Along with these, the presence of a few trangressive species was recorded from class Festuco-Brometea.

Ecological characteristics are explained by the predominance in these communities of xero-mezophylic plants (52.82%), micro-mezothermic (54.87%), moderate-thermophylic (22.05%) and weak acid-neutrophylic (46.67%), followed by euriionic species (28.72%).

Life-form spectrum: Ch-4.62%, H-65.64%, G-10.26%, T-16.41% (Th-10.26%, TH-6.15%), Ph-3.07% (mPh-1.02%, nPh-2.05%).

Spectrum of geo-elements: Atl-0.52%, Balc-1,02%, Circumbor-4.61%, Dac-Balc-0.52%, Eur-Cauc-5.13%, Med-9.74%, Eurosib-13.33%, Eur-18.46%, Eua-21.02%, Oroph-2.06%, Paleotemp-10.77%, Pont-Pann-8.72%, Siber-1.02%, Adv-0.52%, Cosm-2.56%

Caryological spectrum: D-44.62%, P-38.46%, D-P-11.79%, ?-5.13%

The grasslands are used as hay-meadows, having a high productivity of green-mass / ha.

Table 2: *Brachypodio pinnati-Festucetum rupicolae* Ghişa, 1962.

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Altitude (m s.m.)	389	389	389	438	438	438	410	567	611	524	575	566	576	575	594	512	
Aspect	E	E	E	E	E	E	E	V	S	E	-	V	V	-	N	N	
Slope (°)	30	20	20	10	10	10	20	3	15	5	-	5	15	-	3	7	
Area (m²)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Vegetation cover (%)	99.5	100	100	100	100	100	94.5	99.5	91	93.5	100	99.0	95.1	100	95.0	100	K
Char. assn																	
Festuca rupicola	4	3	4	3	4	4	4	2	+	1	3	+	1	+	2	+	V
Brachypodium pinnatum	+	3	2	3	1	1	1	4	3	4	3	4	4	4	3	5	V
Cirsio-Brachypodion pinnati																	
Dianthus carthusianorum	-	-	-	+	+	+	+	-	-	-	-	-	-	-	+	-	II
Linum austriacum	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	I
Peucedanum oreoselinum	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	-	I
Teucrium chamaedrys	1	+	+	+	+	+	+	-	+	+	+	+	+	+	-	-	IV

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Festucetalia valesiacae																	
Asperula cynanchica	-	-	-	+	+	+	+	+	+	+	-	-	+	+	-	-	III
Astragalus austriacus	-	-	+	-	-	-	-	-	-	+	+	-	-	-	+	-	II
Bupleurum falcatum	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	III
Campanula sibirica	-	-	+	+	-	-	+	-	+	+	+	-	-	-	-	+	III
Centaurea apiculata scabiosa	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	IV
Centaurea biebersteinii	-	-	-	-	-	-	-	-	+	+	+	-	+	+	+		II
Centaurea rhenana	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	II
Chamaecytisus albus	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	-	II
Dorycnium pentaphyllum herbaceum	+	+	+	+	+	+	+	+	1	+	+	+	+	+	+	+	V
Elymus hispidus	-	-	-	-	-	-	-	-	-	-	+	+	-	1	1	-	II
Eryngium campestre	-	-	-	-	-	-	-	-	+	-	+	+	1	+	+	-	II
Euphorbia salicifolia	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	II
Euphorbia virgata	-	-	-	-	-	-	-	-	-	+	-	+	+	+	+	+	II
Festuca valesiaca	-	+	+	-	-	-	-	+	+	+	-	-	-	-	-	-	II
Fragaria viridis	+	+	+	+	-	+	+	-	+	-	-	-	-	-	-	-	III
Helianthemum nummularium	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	I
Inula ensifolia	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	I
Iris aphylla	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Jurinea mollis	+	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	I
Linum flavum	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	II
Medicago minima	-	-	-	+	-	+	+	-	+	+	-	+	-	-	-	-	II
Muscari tenuiflorum	+	-	-	+	+	+	-	-	-	+	-	-	-	-	-	-	II
Nonea pulla	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	I
Plantago media	-	+	+	+	+	+	+	-	+	+	+	+	-	-	+	-	IV
Polygala major	+	+	+	+	1	+	-	-	-	-	-	-	-	+	+	-	III
Potentilla cinerea	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	I
Salvia nemorosa	+	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	II
Stachys recta	+	+	+	-	-	-	-	-	-	+	-	-	-	-	-	-	II
Thesium lynophyllon	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Thymus pannonicus	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Veronica spicata orchidea	+	+	-	+	-	+	-	-	+	-	-	-	-	-	-	-	II
Vincetoxicum hirundinaria	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Festuco Brometea																	
Achillea collina	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	I
Agrimonia eupatoria	+	+	-	-	-	-	+	-	-	-	+		+	+	+	+	III
Anthericum ramosum	-	-	-	-	-	-	-	-	+	-	+	2	+	+	+	+	III

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Astragalus asper	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	I
Astragalus monspessulanus	-	-	-	-	-	-	-	-	+	+	+	-	+	+	-	-	II
Astragalus onobrychis	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	I
Calamintha acinos	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	I
Campanula glomerata	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	I
Carex caryophyllea	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	I
Carlina vulgaris	+	+	-	-	-	-	+	-	+	+	+	+	-	+	+	+	IV
Cerinthe minor	-	-	-	-	-	-	-	-	-	+	+	+	-	-	+	-	II
Coronilla varia	+	+	+	+	+	+	+	+	-	-	+	-	+	+	-	-	IV
Dichantium ischaemum	-	-	-	-	-	-	-	-	-	+	+	+	-	1	-	-	II
Echium vulgare	-	+	-	-	-	+	-	-	-	+	+	-	-	+	-	-	II
Erigeron acris	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	+	I
Euphorbia cyparisias	+	+	+	-	-	-	-	-	+	-	-	-	-	-	-	+	II
Falcaria vulgaris	-	-	-	-	-	-	-	+	-	+	+	-	-	-	+	-	II
Filipendula vulgaris	-	-	+	-	+	+	+	+	+	-	-	-	-	+	+	-	III
Galium glaucum	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	I
Galium molugo	+	+	-	-	-	+	+	-	-	+	-	-	-	-	+	-	II
Galium verum	+	+	+	+	+	+	-	+	-	-	-	-	-	-	+	-	III
Gentiana cruciata	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	I
Hypericum perforatum	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	II
Inula germanica	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Koeleria cristata	-	+	-	-	+	+	-	+	-	-	-	-	-	-	-	-	II
Lavathera thuringiaca	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Linum Perenne	-	-	-	+	-	-	-	-	-	+	+	-	+	+	-	-	II
Lotus corniculatus	+	+	+	+	+	+	+	+	-	+	+	-	-	-	+	+	IV
Medicago falcata	+	+	+	-	-	-	-	+	-	-	-	-	+	+	-	-	II
Muscari comosum	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	I
Onobrychis viciifolia	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	-	V
Orchis ustulata	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Orobanche alba	+	+	-	-	-	+	-	-	+	+	-	-	-	-	-	-	II

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Phleum phleoides	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	I
Pimpinella saxifraga	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	+	V
Plantago lanceolata	+	+	+	-	-	+	+	+	+	+	+	+	-	-	+	+	IV
Poa pratensis angustifolia	-	+	-	+	-	-	-	+	-	-	-	-	-	-	-	-	I
Potentilla recta	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	I
Prunella grandiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Prunella laciniata	+	+	-	+	+	+	-	-	+	-	-	-	-	-	-	-	II
Salvia pratensis	+	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	II
Scabiosa ochroleuca	+	+	-	-	-	+	-	+	+	+	+	+	-	-	+	+	IV
Stachys germanica	-	-	+	-	-	+	-	-	+	-	-	-	+	+	-	-	II
Stachys recta	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	+	II
Thalictrum minus	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	-	II
Tragopogon dubius	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	I
Trifolium pannonicum	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Molinio-Arrhenatheretea																	
Achillea millefolium	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	V
Agrostis stolonifera	-	-	-	+	+	+	+	-	-	-	+	-	-	-	+	-	II
Alopecurus pratensis	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	I
Anthoxanthum odoratum	-	-	-	+	+	+	+	-	-	-	+	-	-	-	-	-	II
Briza media	+	+	+	+	+	+	+	+	+	+	-	+	-	+	+	+	V
Carum carvi	+	-	+	+	+	+	+	-	+	+	-	-	-	-	+	-	III
Centaurium erythraea	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	I
Cerastium holosteoides	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	I
Colchicum autumnale	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	I
Cynosurus cristatus	-	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	II
Dactylis glomerata	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	V
Epipactis palustris	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Erigeron annuus	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	I
Eryngium planum	+	+	+	+	-	-	+	-	+	-	+	-	-	-	-	-	III
Knautia arvensis	-	-	+	+	-	+	+	+	-	+	+	-	+	+	+	+	IV
Leucanthemum vulgare	+	+	+	+	+	+	+	+	+	-	-	-	-	-	+	-	IV
Linum catharticum	-	-	-	-	+	+	+	+	+	-	-	+	-	+	+	-	III
Ononis arvensis	-	-	-	+	+	+	-	+	-	+	-	+	-	-	+	-	III
Orchis coriophora	-	-	-	+	-	+	+	-	-	-	-	-	-	-	+	-	II
Orchis morio	-	+	-	+	-	-	-	-	-	-	-	-	-	-	+	-	I
Polygala comosa	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	I
Polygala comosa	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	I
Primula veris	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	I
Rhinanthus angustifolius	-	-	-	+	-	+	1	+	+	+	+	-	+	+	+	+	IV
Senecio jacobaea	-	-	-	-	+	-	+	-	+	+	+	-	+	+	+	-	III
Stachys officinalis	-	-	-	-	+	+	-	+	+	+	-	+	-	-	+	-	III
Stellaria graminea	-	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	II
Thymus pulegioides	1	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	II

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Tragopogon pratensis orientalis	-	-	-	+	-	+	-	+	-	+	+	-	-	-	+	-	II
Trifolium alpestre	-	+	+	-	+	+	-	-	+	-	-	-	-	-	-	-	II
Trifolium pratense	-	+	-	+	-	+	-	-	+	-	-	-	-	-	-	-	II
Trifolium repens	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	I
Trisetum flavescens	+	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	I
Nardo-Callunetea																	
Chamaspartium sagittale	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	I
Genista tinctoria elata	+	+	-	+	+	-	+	-	-	-	-	-	-	-	-	-	II
Querco-Fagetea																	
Campanula rapunculoides	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	I
Campanula trachelium	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	I
Clematis vitalba	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Crataegus monogyna	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	-	II
Helleborus purpurascens	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	I
Rosa canina	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	I
Vicia sepium	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Quercetea pubescenti-petraeae																	
Cruciata laevipes	-	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-	I
Echinops sphaerocepalus	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	I
Inula bifroms	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	I
Lembotropis nigricans varsericeus	-	-	+	+	1	+	-	-	+		+	+	+	+	+	-	IV
Origanum vulgare	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Rosa gallica	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	I
Variae syntaxa																	
Allium scrodoprasum	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	I
Bromus hordeaceus	+	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	II
Bromus riparius	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	I
Carex distans	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	I
Centaurium pulchellum	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	I
Cichorium intybus	+	+	-	-	-	+	+	-	-	+	+	-	-	-	+	-	III
Convolvulus arvensis	+	-	-	-	+	+	-	-	-	+	-	-	-	-	+	-	II
Cuscuta europaea	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	II
Daucus carota	-	+	-	+	-	+	-	-	+	-	+	+	+	+	+	-	III
Equisetum arvense	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	I
Eryngium campestre	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Galium rubioides	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	I
Prunella vulgaris	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	I
Ranunculus polyanthemos	-	-	+	-	-	+	-	-	-	-	-	-	-	-	+	-	I
Salvia verticillata	+	+	-	-	-	-	-	1	-	+	+	+	+	-	+	-	III
Vicia grandiflora	+	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	I

Species present in a single relevée: *Equisetum hyemale* (1), *Mentha longifolia* (1), *Silene vulgaris* (1), *Trifolium micranthum* (1), *Tetragonolobus maritimus* (1), *Sanguisorba minor* (2), *Nepeta nuda* (3), *Achillea setacea* (4), *Campanula bononiensis* (6), *Holcus lanatus* (7), *Leontodon autumnalis* (7), *Deschampsia caespitosa* (7), *Polygala comosa* (8), *Euphorbia epithymoides* (9), *Inula britannica* (9), *Pyrus pyraster* (9), *Dianthus armeria* (9), *Sedum maximum* (9), *Carduus hamulosus* (9), *Acinos arvensis* (9), *Euphrasia stricta* (9), *Erysimum odoratum* (10), *Inula hirta* (10), *Melilotus officinalis* (10), *Allium oleraceum* (10), *Melampyrum arvense* (10), *Agrostis capillaris* (11), *Vicia cracca* (11), *Anthyllis vulneraria* (11), *Arrhenatherum elatior* (12), *Linum hirsutum* (12), *Festuca pratensis* (12), *Centaurea micranthos* (12), *Cephalaria radiata* (14), *Orchis militaris* (15), *Tanacetum corymbosum* (15), *Polygonatum odoratum* (15), *Adenophora liliifolia* (15), *Campanula persicifolia* (15), *Clematis recta* (15), *Laser trilobium* (15), *Peucedanum carvifolia* (15), *Vicia tetrasperma* (15). *Allium flavum* (15), *Ferulago silvatica* (15), *Hyperium elegans* (15), *Festuca rubra* (16).

Places and dates of relevees: R1-3 - Daneş; N 46°12', E23°42'; 2004.06.23; R4,5,6 - Daneş; N 46°12', E 24°42'; 2004.06.23; R 7 - Daneş ; N 46°12', E 24°42'; 2004.06.23; R8 - Daia; N 46°07', E 24°54'; 2006.07.18; R9 - Vulcan; N 46°09', E 24°51'; 2006.07.19; R10 - Movile; N 46°01', E 24°47'; 2007.07.26; R11 - Movile; N 46°01', E 24°47'; 2007.07.26; R12 - Movile; N 46°01', E 24°43'; 2007.07.26; R13 - Noiştat; N 46°02', E 24°48'; 2007.07.27; R14 - Noiştat; N 46°02', E 24°48'; 2007.07.27; R15 - Brădeni; N 46°06', E24°50'; 2007.07.31.

Danthonio-Brachypodietum pinnati Soó, 1946

This is a widespread association around the communes of Saschiz and Mihai Viteazu, occupying less steeply-inclined slopes of hills, at altitudes of 450 - 650 m, and also in communes Fişer and Țeline, where they favour gentle slopes of south or southwest aspect, and altitudes of 550 - 580 m. The phytocenozic flora includes 151 cormophyte species, which for the most part (55.62%) belong to characteristic cenotaxa (Tab. 3).

The grasslands are found exclusively in the form of hill hay-meadows, on the sites of former grubbed-out forests of the oak stage. In the vegetational succession of this territory, the phytocenozes of these associations replace other associations of *Pruno spinosae-Crataegetum* after these shrubs have been cleared. In intensely grazed grasslands, the outstanding species *Danthonia alpina* is replaced by *Festuca rupicola*. Along with *Danthonia alpina,* one constantly finds the species *Festuca rupicola, Brachypodium pinnatum, Briza media, Dorycnium pentaphyllum* ssp. *herbaceum, Polygala major, Knautia arvensis, Stachys germanica* and *Rhinanthus rumelicus*.

In line with the factor of humidity, xero-mezophylic species (54.96%) occupy the highest percentage in these phytocenozes. As regards temperature, the predominant species are the micro-mezotherms (50.99%) and moderate-thermophylic (22.51%). As regards soil reaction, the most numerous species are weakly acid-neutrophylic (45.69%) and euriionic (28.47%).

Life-form spectrum: H-66.88%, T-15.23% (Th-9.27%, TH-5.96%), G-8.60%, Ch-5.29%, Ph-3.,96 (mPh-1.98, nPh-1.98%). Spectrum of phytogeographical elements: Eua-24.50%, Eur-15.23%, Eurosib-13.24%, Paleotem-10.59%, Circumbor-5.96% etc. The pedo-climatic conditions in which the association develops favour also a significant number of Mediterranean species (11.25%).

Caryological spectrum: diploid (47.68%), polyploid (41.05%), diplo-polyploid (8.60%, ?-2.64%). The grasslands are used as hay-meadows, and have moderate productivity.

Table 3: Danthonio-Brachypodietum pinnati Soó, 1946.

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	
Altitude (m s.m.)	389	389	389	438	438	438	410	567	611	524	575	566	576	
Aspect	E	E	E	E	E	E	E	V	S	E	-	V	V	
Slope (°)	30	20	20	10	10	10	20	3	15	5	-	5	15	
Area (m^2)	100	100	100	100	100	100	100	100	100	100	100	100	100	
Vegetation cover (%)	99.5	100	100	100	100	100	94.5	99.5	91	93.5	100	99.0	95.1	
Char. assn														
Brachypodium pinnatum	+	+	+	+	2	+	+	+	1	+	4	4	3	V
Danthonia alpina	4	4	5	5	4	4	4	4	4	4	2	+	+	V
Cirsio-Brachypodion pinnati														
Briza media	+	+	1	-	+	+	-	-	+	+	+	+	-	III
Centaurea scabiosa	-	-	-	-	-	-	-	+	-	-	-	+	+	II
Helianthemum nummularium	-	-	-	+	-	+	-	-	-	-	-	-	-	I
Knautia arvensis	+	-	-	-	+	+	-	-	+	+	-	+	+	III
Lotus corniculatus	+	+	-	-	+	+	-	-	-	+	+	+	-	III
Onobrychis viciifolia	+	+	-	-	-	-	+	-	-	-	+	+	+	II
Ononis arvensis	+	+	-	-	-	+	-	-	+	+	-	+	+	III
Orchis tridentata	-	+	-	+	-	-	-	-	-	-	-	-	-	I
Phleum phleoides	-	-	-	-	-	+	-	-	+	-	-	-	-	I
Plantago lanceolata	-	+	-	-	-	+	-	-	-	-	+	-	-	II
Plantago media	+	+	-	-	+	-	-	-	-	-	+	-	+	II
Polygala major	+	+	-	+	+	+	-	+	+	-	-	-	-	III
Prunella laciniata	-	-	-	-	-	-	-	-	+	+	+	-	-	II
Scabiosa ochroleuca	+	+	-	-	-	+	+	+	+	+	-	-	+	III
Teucrium chamaedrys	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Danthonio-Brachypodion														
Centaurea apiculata ssp. *spinulosa*	+	+	-	-	-	+	-	-	+	-	-	-	+	II
Festucetalia valesiacae														
Bupleurum falcatum	-	+	-	-	-	+	-	-	+	-	-	+	+	II
Campanula sibirica	+	+	-	-	+	-	-	+	-	-	-	+	+	II
Centaurea rhenana	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Chamaecytisus albus	-	-	-	+	-	-	-	-	-	-	-	+	+	II
Dorycnium pentaphyllum herbacea	+	1	-	1	+	-	+	+	+	+	+	1	1	V
Festuca rupicola	+		+	+	-	-	-	-	-	-	-	-	-	II
Fragaria viridis	-	-	-	-	+	+	-	-	-	-	-	-	-	I
Inula ensifolia	-	+	-	-	+	-	-	-	-	-	-	-	-	I
Inula hirta	-	-	-	-	-	-	+	-	+	-	-	+	-	II
Melampyrum cristatum	-	-	-	-	-	+	-	-	+	1	-	+	-	II
Nonea pulla	-	+	-	+	-	-	-	-	-	-	-	-	-	I
Stachys recta	-	+	-	-	+	-	-	-	-	-	-	+	+	II
Trifolium pannonicum	-	-	-	-	-	+	+	+	+	+	-	-	-	II
Festuco-Brometea														
Acinos arvensis	-	-	-	-	-	+	-	-	+	-	-	+	+	II
Agrimonia eupatoria	+	-	-	-	+	+	+	+	+	+	+	+	+	IV
Ajuga genevensis	-	-	-	-	-	-	+	+	-	-	-	-	-	I
Asparagus officinalis	-	-	-	-	-	-	-	-	-	+	-	+	+	II
Asperula cynanchica	+	+	-	-	+	+	-	-	-	+	+	+	+	III

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	
Campanula glomerata	-	-	-	-	-	+	+	-	-	-	-	-	-	I
Carlina vulgaris	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Coronilla varia	+	+	-	-	-	+	-	-	-	-	-	+	-	II
Dianthus carthusianorum	+	-	-	-	-	+	-	-	+	+	+	-	-	II
Erigeron acris	-	-	-	-	-	-	+	-	-	-	-	+	+	II
Eryngium campestre	-	+	-	-	-	-	-	-	-	-	+	-	-	I
Euphorbia cyparissias	-	+	-	-	-	+	-	-	-	-	-	-	-	I
Filipendula vulgaris	+	+	-	-	+	+	-	-	+	+	+	-	-	III
Galium mollugo	+	-	-	-		+	-	-	-	-	-	+	-	II
Galium verum	+	+	-	-	+	+	-	-	+	-	+	-	+	III
Medicago falcata	-	-	+	+	+	+	-	-	-	-	-	-	+	II
Medicago lupulina	-	+	-	-	-	-	-	-	-	+	-	+	-	II
Medicago minima	-	-	+	-	+	-	-	-	+	+	-	-	-	II
Peucedanum cervaria	-	-	-	-	-	+	+	+	+	-	-	-	-	II
Pimpinella saxifraga	+	+	-	-	+	-	-	-	-	-	-	-	-	II
Polygala comosa	-	-	-	-	+	+	+	-	-	+	-	-	-	II
Potentilla recta	-	-	+	-	-	+	-	-	+	+	-	-	-	II
Salvia pratensis	+	+	-	-	+	-	+	-	-	-	-	-	-	II
Salvia verticillata	+	+	-	-	-	-	-	-	-	-	-	+	+	II
Stachys germanica	+	+	-	-	+	+	+	+	+	-	-	+	-	III
Thalictrum minus	-	-	-	-	-	-	-	+	-	-	-	+	+	II
Thymus glabrescens	-	+	-	-	+	-	-	-	-	-	-	-	-	I
Trifolium montanum	+	+	-	-	-	+	+	+	+	+	-	-	-	III
Veronica spicata orchidea	+	+	-	-	-	+	-	+	+	+	+	-	-	III
Viola hirta	-	-	-	-	-	-	-	-	+	+	-	-	-	I
Molinio-Arrhenatheretea														
Achillea millefolium	+	-	-	-	+	-	-	+	+	+	+	+	+	III
Agrostis capillaris	-	-	-	-	+	+	1	+	+	+	-	+	-	III
Alopecurus pratensis	+	+	-	-	-	-	-	-	-	-	-	-	-	I
Anthoxanthum odoratum	+	+	-	-	-	+	-	+	+	-	-	-	-	II
Arrhenatherum elatius	-	-	-	-	-	+	-	-	+	+	-	-	-	II
Campanula patula	-	-	-	-	+	+	-	+	-	-	-	+	-	II
Carex pallenscens	-	-	-	-	+	+	-	-	+	-	-	-	-	II
Carum carvi	-	-	-	-	-	+	-	-	+	+	-	-	-	II
Cerastium holosteoides	+	-	-	-	+	+	-	+	+	-	-	-	-	II
Cichorium intybus	+	+	-	-	-	+	-	-	-	-	-	-	-	II
Colchicum autumnale	+	-	-	-	-	+	-	-	+	+	-	-	-	II
Crepis biennis	-	-	-	-	-	+	-	-	-	-	-	+	+	II
Cynosurus cristatus	+	+	-	-	-	+	-	-	+	-	-	-	-	II
Dactylis glomerata	+	+	-	-	-	+	-	-	-	-	-	+	-	II
Daucus carota	-	-	-	-	+	+	-	-	-	+	+	+	-	II
Euphrasia rostkoviana	-	-	-	-	-	-	+	+	-	+	-	-	-	II
Festuca rubra	-	+	-	-	-	+	-	-	-	-	-	-	-	I
Gymnadenia conopsea	+	-	-	-	+	+	-	-	-	-	-	-	-	II
Holcus lanatus	+	+	-	-	-	+	+	+	-	-	-	-	-	II
Leucanthemum vulgare	+	+	-	-	+	+	-	--	+	+	-	-	-	II
Linum catharticum	+	+	-	+	+	+	-	-	-	-	-	+	-	II
Luzula campestris	+	-	+	-	-	-	-	-	-	-	-	-	-	I
Lythrum salicaria	-	-	-	-	-	-	+	-	-	+	-	-	-	I
Orchis coriophora	-	+	-	-	-	-	-	-	-	+	-	-	-	I
Pedicularis comosa campestris	-	-	-	-	-	-	+	1	-	+	-	-	-	II
Primula veris	+	-	-	-	-	+	-	-	-	-	-	-	-	I
Prunella vulgaris	+	-	-	-	+	+	-	-	-	+	-	-	-	II
Ranunculus polyanthemos	+	+	-	-	+	+	-	-	-	+	-	-	-	II
Rhinanthus rumelicus	+	-	-	-	+	+	-	-	-	-	-	+	+	II
Rorippa pyrenaica	-	-	+	+	-	-	-	-	-	-	-	-	-	I
Sanguisorba officinalis	-	-	-	-	-	+	+	+	-	-	-	-	-	II
Senecio jacobaea	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Stellaria graminea	+	-	-	-	+	+	-	-	+	+	-	-	-	II

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	
Thalictrum flavum	-	-	-	-	-	+	-	-	+	-	-	-	-	I
Tragopogon pratensis orientalis	+	+	-	-	-	-	+	+	-	-	-	+	-	II
Trifolium alpestre	+	-	-	+	-	+	+	-	+	-	-	+	-	II
Trifolium pratense	+	-	-	-	-	-	-	+	-	-	-	-	-	I
Querco-Fagetea														
Allium scorodoprasum	-	1	-	-	-	+	+	+	-	-	-	-	-	II
Campanula persicifolia	-	-	-	+	-	+	-	-	-	-	-	-	-	I
Crataegus monogyna	-	+	-	-	+	-	+	-	+	+	+	+	+	III
Prunus spinosa	-	+	-	-	+	-	-	-	-	-	-	-	-	I
Pyrus pyraster	-	+	-	-	+	-	-	-	-	+	+	-	-	II
Rosa canina	-	+	-	-	-	-	+	+	+	+	-	-	-	II
Quercetea pubescenti-petraea														
Rosa gallica	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Variae syntaxa														
Echinops sphaerocephalus	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Echium vulgare	+	+	-	-	-	-	-	+	+	-	-	+	-	II
Genista tinctoria	-	+	-	-	-	+	-	-	-	+	+	-	-	II
Myosotis arvensis	-	-	-	-	-	-	-	-	+	+	-	-	-	I
Ornithogalum pyramidale	-	-	-	-	-	+	-	-	+	-	-	-	-	I
Plantago major	+	-	-	-	-	-	-	-	+	-	-	-	-	I

Species present in a single relevee: *Festuca pratensis* (1), *Orobanche alba* (1), *Potentilla arenaria* (1), *Eryngium planum* (2), *Cuscuta europaea* (2), *Festuca valesiaca* (2), *Lembotropis nigricans* (2), *Linum flavum* (2), *Muscari tenuiflorum* (2), *Teucrium montanum* (2), *Tetragonolobus maritimus* (4), *Koeleria cristata* (5), *Lathyrus nissolia* (5), *Ranunculus acris* (5), *Cirsium rivulare* (6), *Equisetum arvense* (6), *Festuca peudonina* (6), *Lychnis flos-cuculi* (6), *Lathyrus pratensis* (6), *Stachys officinalis* (6), *Rumex acetosa* (6), *Trifolium hibridum* (6), *Vincetoxicum hirundinaria* (7), *Vicia craca* (7), *Deschampsia caespitosa* (9), *Trifolium campestre* (10), *Centaurium erythraea* (10), *Hypericum perforatum* (11), *Aster amellus* (12), *Linum hirsutum* (12), *Lithospermum arvense* (12), *Anthericum ramosum* (12), *Cephalaria radiata* (12), *Melampyrum arvense* (12), *Astragalus cicer* (12), *Convolvulus arvensis* (12), *Adonis vernalis* (13), *Allium oleraceum* (13), *Elymus hispidus* (13), *Lavatera thuringiaca* (13).

Places and dates of relevees: R1 - Mihai Viteazu, La Fânațe, N 46° 09’, E 25° 02’; 2005.06.18; R2, 3,4,5 - Mihai Viteazu, N 46° 09’, E 25° 03’; 2005.06.22; R6 -10 - Saschiz, Fața Soarelui, N 46°11’, E 25°00’; 2005.07.07; R11 - Fişer, N 46°03’, E 25°08’; 2007.07.17; R12 - Țeline; N 46°03’, E 24°54’; 2007.07.30; R13 - Țeline; N 46°03’, E 24°54’; 2007.07.30.

Polygalo majoris-Brachypodietum pinnati Wagner, 1941

Extending from the border of the Eastern Alps, this association is widespread in the study area, and was identified at all localities studied. In 2007 it was identified in many localities along the southern boundary of the Sighişoara-Târnava Mare pSCI: Fişer, Ruja, Stejărişu, Iacobeni, Movile, Netuş, Noiştat, Grânari and Angofa. Among the diagnostic species in the grasslands we analysed: *Polygala major, Brachypodium pinnatum, Melampyrum cristatum*, along with their constant companions such as *Anthyllis vulneraria, Bromus erectus, Festuca rupicola, Inula ensifolia, Bupleurum falcatum, Asperula cynanchica, Medicago falcata, Plantago media*, etc. (Tab. 4). The sub-continental character of this association is confirmed by the remarkable number of familiar species of the order Festucetalia valesiacae, and also of the class Festuco-Brometea.

The climatic conditions in which this association develops favour a large number of xero-mezophylic species (50.36%), along with which are found some mesophylic species (27,46%) and xerophylic species (11.99%).

The temperature regime favours the development of micro-mesothermic species (54,93%) and moderate-thermophylic species (22.88%). The largest number of species of this association are weakly acid-neutrophylic (46.48%) and euriionic (24.65%) followed by acido-neutrophylic species (21.48%).

Life-form spectrum: Ch-3.87%, H-65.49%, G-7.39%, T-1867% (Th-12.68%, TH-5.99%), Ph-4.58% (MPh-1.41%, mPh-1.76%, nPh-1.41%).

Spectrum of geo-elements: Alp-Carp-0.35%, Asiat-0.35%, Atl-0.35%, Balc-0.35%, Circumbor-5.28%, Dac-Balc-1.41%, Eur-Cauc-1.05%, Med-8.45%, Eurosib-10.22%, Eur-19.38%, Eua-30.28%, Oroph-1.41%, Paleotemp-9.51%, Pont-Pann-6.34%, Siber-0.70%, Adv-0.70%, Cosm-3.87%

Caryological spectrum: D-49.82%, P-33.21%, D-P-10.60%, ?-6.36.

Table 4: *Polygalo majoris-Brachypodietum pinnati* Wagner, 1941.

County	1	2	3	4	5	6	7	8	9	10	11	12
Relevée	5	6	5	10	5	7	5	5	8	6	5	7
Char. Assn												
Brachypodium pinnatum	V	V	V	V	V	V	V	V	V	V	V	V
Polygala major	IV	IV	IV	V	IV	III	III	I	III	II	V	V
Astragalus cicer	I	-	-	-	I	-	-	-	-	-	-	-
Briza media	IV	V	V	IV	V	III	IV	III	III	IV	III	V
Bromus erectus	-	-	-	-	-	II	-	I	I	I	I	-
Centaurea apiculata spinulosa	-	-	-	I	-	II	I	-	-	-	IV	IV
Gentiana cruciata	-	-	IV	III	I	-	I	I	I	I	I	III
Knautia arvensis	I	III	V	V	V	V	III	IV	IV	III	IV	III
Leontodon hispidus hispidus	-	-	I	-	-	III	-	-	II	I	-	-
Lotus corniculatus	II	V	II	III	IV	III	IV	IV	II	IV	I	III
Onobrychis viciifolia	IV	-	IV	V	IV	V	III	V	V	IV	IV	V
Ononis arvensis	I	III	III	III	III	I	IV	IV	IV	II	III	IV
Plantago lanceolata	-	II	-	IV	-	III	I	II	-	II	I	III
Plantago media	I	IV	IV	I	I	II	I	II	-	IV	III	III
Prunella laciniata	I	-	I	II	-	II	II	II	-	-	-	II
Scabiosa ochroleuca	I	III	III	IV	IV	V	III	IV	V	III	III	V
Festucion rupicolae												
Astragalus monspessulanum	III	-	-	II	I	III	-	I	I	-	II	I
Bromus tectorum	I	-	-	-	I	II	-	-	-	II	I	I
Carduus hamulosus	-	-	-	-	-	II	-	I	-	-	-	-
Crambe tatarica	-	-	-	-	II	-	-	-	-	-	-	-
Dianthus armeria	-	-	-	I	I	-	I	-	I	-	-	-
Dorycnium pentaphyllum herbaceum	V	V	V	V	IV	V	V	V	IV	I	V	V
Euphorbia virgata	-	-	-	-	-	I	-	I	-	-	II	II
Falcaria vulgaris	-	-	-	II	I	III	-	-	I	-	-	I
Ferulago sylvatica	-	-	-	-	-	-	-	-	-	-	I	I
Festuca rupicola	-	-	-	I	-	III	-	I	I	II	-	II

County	1	2	3	4	5	6	7	8	9	10	11	12
Relevée	5	6	5	10	5	7	5	5	8	6	5	7
Linum hirsutum	II	I	I	I	I	I	II	II	-	-	-	II
Nepeta nuda	-	-	-	-	II	III	-	I	-	-	-	I
Nonea pulla	III	-	-	III	II	IV	-	I	-	I	-	III
Orchis tridentata	-	-	-	-	-	II	-	I	-	-	-	I
Stipa joannis	II	-	-	-	-	-	-	-	-	-	-	-
Festucetalia valesiacae												
Adonis vernalis	-	-	-	III	I	-	-	-	-	-	-	I
Anthemis tinctoria	-	-	III	-	-	II	-	-	-	-	-	-
Artemisia campestris	-	-	-	I	-	-	-	-	-	I	-	I
Astragalus onobrychis	III	-	-	-	I	I	I	I	-	-	-	-
Asyneuma canescens	-	-	-	I	-	-	-	-	-	I	-	-
Brassica elongata	-	-	-	-	-	I	-	I	I	-	-	I
Bupleurum falcatum	II	-	V	IV	III	V	II	V	III	II	V	III
Campanula sibirica	I	-	III	III	III	IV	I	IV	IV	III	III	V
Centaurea rhenana	II	-	III	III	III	V	I	IV	II	-	III	IV
Cerinthe minor	-	-	-	I	II	II	-	I	I	I	V	II
Chamaecytisus albus	I	-	III	IV	III	V	III	II	IV	I	I	IV
Chamaecytisus hirsutus	II	-	I	II	III	-	-	-	-	-	-	I
Chrysopogon gryllus	-	-	-	-	-	-	-	-	-	-	II	-
Cruciata laevipes	-	-	-	I	III	II	-	-	I	II	-	I
Elymus hispidus	-	-	-	I	I	II	-	I	-	I	-	III
Euphorbia salicifolia	II	-	-	-	I	I	I	II	II	-	-	-
Festuca valesiaca	-	-	II	II	I	II	II	IV	I	-	I	I
Fragaria viridis	III	-	I	I	I	V	-	III	I	I	II	III
Galium glaucum	-	-	-	I	-	II	-	I	-	-	-	-
Helianthemum nummularium	II	-	I	I	I	III	-	-	I	I	-	-
Inula ensifolia	I	-	-	I	I	I	-	II	-	II	-	II
Inula hirta	-	-	-	-	-	II	I	-	-	-	-	I
Jurinea mollis	II	-	-	I	III	-	-	-	I	I	-	II
Linum flavum	-	-	III	III	III	IV	II	III	II	-	II	-
Linum perenne	-	-	I	I	-	III	-	-	II	-	-	I
Linum tenuifolium	I	-	-	-	-	I	-	-	-	I	-	-
Melampyrum cristatum	-	-	-	-	II	II	-	II	I	-	-	I
Muscari tenuiflorum	II	-	-	I	I	II	-	-	-	II	-	I
Potentilla cinerea	-	-	-	I	I	IV	-	I	II	-	-	I
Salvia transsilvanica	II	-	-	-	-	I	-	-	-	-	-	-
Sanguisorba minor	-	-	-	I	-	-	-	-	-	-	-	I
Scorzonera purpurea	V	II	-	I	I	-	-	-	I	II	-	-
Silene italica	I	-	-	I	-	I	-	-	-	I	-	III
Stachys recta	IV	-	-	II	V	V	-	II	I	II	I	IV
Thymus pannonicus	-	-	-	I	-	III	-	I	-	-	-	-
Verbascum phoeniceum	II	-	-	-	I	II	-	-	-	-	II	-
Viola arvensis	-	-	-	I	-	-	-	-	-	-	-	I

County	1	2	3	4	5	6	7	8	9	10	11	12
Relevée	5	6	5	10	5	7	5	5	8	6	5	7
Festuco-Brometea												
Achillea collina	-	-	-	-	-	-	-	-	-	-	I	I
Agrimonia eupatoria	V	V	II	V	IV	V	V	V	III	I	V	IV
Allium flavum	-	-	-	-	I	-	-	-	I	-	-	II
Allium oleraceum	-	-	-	-	-	-	-	-	-	-	-	II
Alysum alyssoides	I	I	-	-	-	-	-	-	-	-	-	-
Anthericum ramosum	II	-	III	IV	III	V	III	-	III	II	I	IV
Anthyllis vulneraria	III	III	I	IV	I	-	I	-	-	I	-	II
Asparagus officinalis	I	-	-	I	II	I	-	-	-	-	-	-
Asperula cynanchica	II	V	V	V	II	V	IV	V	IV	IV	V	IV
Aster amellus	-	-	-	-	-	-	-	I	-	-	I	-
Astragalus austriacus	III	-	-	-	I	II	-	II	-	-	-	I
Campanula glomerata	-	I	-	I	-	I	-	I	IV	I	II	II
Carex caryophyllea	-	-	-	I	-	I	-	I	-	-	I	-
Carlina vulgaris	I	-	-	-	-	III	-	1	I	-	III	IV
Centaurea scabiosa	-	-	-	-	I	I	II	IV	-	II	IV	-
Cephalaria radiata	-	-	-	-	-	-	-	-	-	-	III	III
Clinopodium vulgare	I	-	III	III	III	II	II	IV	IV	II	II	I
Coronilla varia	IV	V	V	V	V	V	III	IV	IV	III	I	IV
Danthonia alpina	-	-	-	I	-	-	-	-	-	I	-	-
Dianthus carthusianorum	II	III	III	II	V	II	IV	IV	III	IV	III	III
Dichanthium ischaemum	-	-	-	-	-	-	I	-	-	-	I	III
Echium vulgare	II	I	III	II	I	III	III	III	-	I	I	III
Erigeron acris	II	-	-	III	I	I	II	I	-	I	I	III
Eryngium campestre	I	II	II	II	III	IV	-	III	III	II	III	III
Euphorbia cyparissias	III	-	II	II	II	IV	-	I	II	III	-	III
Euphrasia stricta	-	-	-	I	I	-	IV	-	-	-	-	-
Filipendula vulgaris	IV	II	I	III	III	III	II	IV	II	IV	I	II
Galium mollugo	II	I	I	I	-	-	II	I	I	II	I	II
Galium verum	II	IV	IV	IV	IV	IV	IV	III	IV	IV	I	II
Hieracium pilosella	I	-	-	II	I	I	-	I	-	I	I	II
Hypericum perforatum	II	III	II	I	III	III	IV	IV	II	III	I	III
Koeleria cristata	-	-	-	I	-	II	II	I	I	I	-	III
Lavathera thuringiaca	-	-	I	-	-	I	-	II	I	-	-	I
Linaria vulgaris	-	-	-	I	-	-	-	-	-	-	-	-
Medicago falcata	I	II	II	II	I	I	I	I	-	II	-	I
Medicago lupulina	-	-	-	-	II	V	I	II	I	-	-	III
Medicago minima	-	I	-	I	I	-	IV	II	IV	-	-	II
Muscari comosum	-	-	-	II	IV	III	-	-	II	III	-	-
Odontites verna	I	-	-	-	-	-	I	-	-	-	-	-
Orchis morio	I	-	-	-	-	I	-	I	-	I	-	-
Orobanche alba	I	-	-	I	-	I	-	I	-	I	-	-
Peucedanum carvifolia	-	-	-	-	-	I	-	I	I	III	I	-
Peucedanum cervaria	III	-	II	I	III	I	I	-	-	-	IV	II
Phleum phleoides	II	-	-	-	-	II	-	-	-	I	I	I
Pimpinella saxifraga	V	-	II	III	III	III	I	IV	II	III	II	III
Poa pratensis ssp.*angustifolia*	-	-	-	-	-	III	-	I	-	-	-	I

County	1	2	3	4	5	6	7	8	9	10	11	12
Relevée	5	6	5	10	5	7	5	5	8	6	5	7
Polygala comosa	-	II	-	-	-	-	-	-	-	-	-	-
Polygonatum odoratum	-	-	-	-	-	-	-	I	-	-	-	I
Potentilla recta	-	I	I	I	IV	III	I	I	-	I	1	I
Prunella grandiflora	I	-	III	-	-	-	II	-	II	I	IV	II
Salvia nemorosa	-	II	I	I	II	-	-	-	-	-	-	-
Salvia pratensis	V	II	II	I	IV	III	-	I	-	II	1	I
Salvia verticillata	I	I	IV	V	III	V	III	IV	IV	II	III	V
Seseli annuum	-	-	-	-	-	II	-	-	II	-	-	-
Stachys germanica	-	-	-	IV	IV	I	II	III	II	II	I	II
Teucrium chamaedrys	IV	V	III	IV	IV	V	III	II	I	-	IV	III
Thalictrum minus	-	-	-	I	III	III	I	-	I	III	I	III
Thymus glabrescens	II	-	-	I	I	II	-	-	I	I	-	I
Trifolium campestre	-	-	-	I	-	-	-	-	I	-	-	I
Trifolium medium	-	-	I	II	III	-	V	I	II	-	-	I
Trifolium montanum	IV	-	II	III	II	III	III	II	IV	IV	-	II
Trifolium pannonicum	I	V	II	III	III	I	-	-	-	-	-	-
Veronica spicata ssp.*orchidea*	-	IV	IV	III	IV	IV	II	V	I	II	II	-
Molinio-Arrhenatheretea												
Achillea millefolium	IV	V	IV	V	V	V	IV	V	II	IV	III	III
Agrostis capillaris	-	II	I	II	I	I	-	-	II	II	I	-
Alopecurus pratensis	III	-	III	-	II	-	I	-	-	I	-	-
Anthoxanthum odoratum	II	-	II	-	II	-	I	-	-	IV	-	-
Arrhenatherum elatius	-	I	-	I	I	-	II	I	I	II	I	-
Campanula patula ssp.*patula*	-	I	I	I	I	II	III	III	-	II	I	II
Carlina acaulis	-	-	-	I	-	I	-	-	-	I	-	-
Carum carvi	-	I	-	I	I	I	I	I	-	I	I	II
Centaurea nigrescens	-	-	III	II	-	-	I	-	II	-	-	I
Centaurea phrygia ssp.*phrygia*	I	-	-	-	I	-	-	-	-	I	-	-
Centaurium erythraea	-	III	-	-	-	-	I	-	-	-	-	II
Cerastium holosteoides	-	-	-	II	I	-	-	-	-	II	-	-
Cichorium intybus	-	IV	III	III	IV	III	II	III	II	III	II	IV
Colchicum autumnale	-	-	-	I	I	-	-	-	-	II	-	-
Crepis biennis	-	-	II	-	I	I	I	II	-	II	I	II
Cynosurus cristatus	-	IV	-	I	III	I	I	-	-	II	-	I
Dactylis glomerata	III	III	IV	III	IV	-	III	IV	II	III	III	V
Daucus carota	I	II	I	I	III	II	II	IV	-	III	II	III
Deschampsia caespitosa	-	-	-	-	-	-	I	-	II	-	-	-
Elymus repens	-	-	I	-	-	-	-	I	-	I	-	I
Epipactis palustris	I	-	-	I	-	-	-	-	-	-	-	-
Erigeron annuus	I	I	IV	-	III	-	II	II	-	-	-	-
Eryngium planum	IV	II	III	III	IV	III	II	II	-	-	-	-
Euphrasia rostkoviana	-	-	-	-	-	-	-	-	II	I	-	-
Festuca pratensis	II	-	-	I	-	-	-	-	-	-	I	I
Festuca rubra	-	-	-	-	II	-	-	-	-	-	-	-
Genista tinctoria	I	-	III	IV	II	I	II	-	V	I	-	I

County	1	2	3	4	5	6	7	8	9	10	11	12
Relevée	5	6	5	10	5	7	5	5	8	6	5	7
Heracleum sphondyllium	-	-	-	I	I	-	-	-	-	III	-	-
Holcus lanatus	-	-	III	I	III	-	-	-	-	II	I	I
Juncus effusus	-	I	-	I	-	-	-	-	-	-	-	-
Lathyrus pratensis	-	-	-	-	-	-	-	I	-	-	-	I
Leontodon autumnalis	-	I	-	-	-	-	-	-	-	-	-	-
Leucanthemum vulgare	II	V	IV	III	IV	III	III	II	III	IV	I	I
Linum catharticum	-	IV	II	III	I	-	II	II	II	III	I	I
Lythrum salicaria	-	I	-	I	-	-	-	-	-	-	-	-
Mentha arvensis	-	-	I	I	-	-	-	-	-	-	-	-
Mentha longifolia	-	I	-	-	-	-	-	-	-	-	-	-
Orchis coriophora	II	-	I	-	-	I	II	-	I	-	-	-
Pastinaca sativa	-	-	-	-	-	-	-	-	-	-	-	I
Peucedanum oreoselinum	IV	-	-	-	I	II	II	-	-	-	-	II
Phleum pratense	-	-	-	I	I	-	-	-	-	I	I	-
Poa pratensis	-	-	I	I	-	-	-	-	-	-	-	-
Primula veris	-	-	-	I	II	-	-	I	II	III	I	-
Prunella vulgaris	II	II	I	III	II	II	II	IV	IV	II	-	-
Ranunculus polyanthemos	II	-	-	-	I	II	-	-	-	III	II	I
Rhinanthus angustifolius	III	-	III	I	II	II	-	-	-	-	-	I
Rhinanthus rumelicus	-	IV	-	III	I	III	III	III	II	II	II	IV
Rumex acetosa	-	-	-	-	I	-	-	-	-	II	-	-
Sanguisorba officinalis	-	IV	-	-	-	-	-	-	-	-	-	-
Senecio jacobaea	I	-	II	II	I	-	II	II	II	-	II	III
Silene vulgaris	-	-	-	-	-	-	-	-	-	I	-	I
Stachys officinalis	-	III	IV	IV	III	I	III	III	IV	I	-	-
Stellaria graminea	-	-	II	II	III	-	-	I	II	III	-	-
Tetragonolobus maritimus	II	-	-	-	-	-	-	-	-	-	-	-
Thymus pulegioides	V	V	IV	IV	III	II	III	-	II	-	-	-
Tragopogon pratensis orientalis	-	-	I	IV	III	III	I	IV	III	III	II	III
Trifolium hybridum	I	-	-	-	-	-	-	I	II	-	-	-
Trifolium pratense	I	IV	-	II	I	-	-	II	-	I	I	I
Vicia craca	I	-	-	-	-	-	-	-	-	-	-	-
Vicia sepium	-	-	II	-	-	-	-	I	II	-	-	I
Quercetea-Pubescenti petraea												
Clematis recta	-	-	-	I	-	-	-	I	-	-	-	I
Cornus sanguinea	-	-	-	-	-	-	-	I	I	-	-	-
Dictamnus albus	I	-	-	I	-	-	-	-	-	-	-	-
Echinops sphaerocephalus	-	-	-	-	II	V	-	I	II	-	-	I
Inula bifrons	-	-	-	-	-	-	-	II	-	-	-	-
Lembotropis nigricans	III	-	III	III	I	IV	III	III	III	I	I	III
Melampyrum bihariense	-	I	I	-	-	-	I	-	-	-	-	-
Origanum vulgare	-	II	II	I	-	III	IV	II	I	I	III	III
Quercus pubescens	IV	-	-	I	-	-	-	-	-	-	-	-
Rosa gallica	-	-	-	II	I	-	-	-	-	-	I	II
Vincetoxicum hirundinaria	IV	-	-	I	-	I	-	I	-	I	-	II

County	1	2	3	4	5	6	7	8	9	10	11	12
Relevée	5	6	5	10	5	7	5	5	8	6	5	7
Querco-Fagetea												
Allium scorodoprasum	-	-	I	II	II	I	I	II	II	-	-	I
Astragalus glycyphyllos	-	-	I	I	-	I	I	II	-	I	-	I
Campanula bononiensis	-	-	II	-	-	I	-	-	II	-	-	-
Campanula persicifolia	-	-	I	II	I	-	I	-	II	II	II	-
Campanula trachelium	-	-	-	-	-	I	II	-	II	-	I	I
Crataegus monogyna	III	-	-	II	1	III	I	V	III	-	-	II
Helleborus purpurascens	I	-	-	I	-	-	-	I	-	-	-	-
Prunus spinosa	-	-	-	I	-	I	-	-	-	-	-	-
Pyrus pyraster	II	I	-	I	1	III	-	I	-	-	-	I
Variae syntaxa												
Althaea officinalis	-	-	-	I	-	-	-	-	-	-	-	-
Carex distans	-	III	II	II	-	-	-	-	-	-	-	-
Clematis vitalba	II	-	I	I	-	-	I	I	-	-	-	I
Convolvulus arvensis	-	I	I	-	III	I	II	I	I	II	-	I
Cuscuta europaea	I	-	I	II	II	-	-	I	-	-	I	II
Eupatorium cannabinum	-	II	-	I	-	-	-	-	-	-	-	-
Euphorbia helioscopia	-	-	I	-	-	-	I	I	-	-	-	-
Galium album	-	III	-	-	II	I	I	II	-	III	-	-
Galium aparine	I	-	-	-	I	-	-	-	-	-	-	-
Galium rubioides	-	-	-	I	-	-	-	I	-	-	-	-
Gymnadenia conopsea	-	-	-	I	-	-	-	-	-	-	-	I
Inula britannica	I	-	-	I	II	-	-	I	I	-	-	-
Inula helenium	-	-	-	-	-	-	-	II	-	-	-	-
Laser trilobum	-	-	-	-	-	-	-	-	III	-	-	-
Lathyrus tuberosus	-	-	-	I	II	-	-	I	I	-	-	-
Ligustrum vulgare	II	-	-	-	-	-	-	-	-	-	-	-
Lolium perenne	II	-	-	I	I	II	I	-	II	-	-	-
Melilotus officinalis	-	I	-	II	I	-	I	II	I	-	-	I
Myosotis arvensis	I	-	-	I	-	-	-	-	-	-	-	-
Ornithogalum pyramidale	I	-	-	IV	III	-	-	I	-	-	-	-
Plantago major	-	-	II	III	I	I	-	I	-	II	-	-
Populus tremula	I	-	-	-	-	-	-	-	-	-	-	-
Rosa canina	I	-	-	I	II	I	II	I	-	-	-	I
Seseli libanotis	-	-	-	I	-	-	-	I	-	-	-	-
Silene latifolia ssp.alba	-	I	-	-	-	-	-	-	-	I	-	-
Thalictrum aquilegifolium	II	-	-	-	I	I	-	-	-	-	-	-
Veronica chamaedrys	-	-	-	-	-	-	-	-	II	-	-	-

Species present in a single relevée: *Adonis aestivalis* (1), *Diplotaxis muralis* (1), *Potentilla argentea* (1), *Lithospermum purpurocaeruleum* (2), *Lathyrus hirsutus* (3), *Viola tricolor* (3), *Limodorum abortivum* (4), *Solidago gigantea* ssp. *serotina* (4), *Polygala vulgaris* (10), *Bromus arvensis* (12), *Geum urbanum* (15), *Chamaespartium sagittale* (22), *Dianthus compactus ssp. barbatus* (25), *Alcea pallida* (26), *Viola hirta* (26), *Verbena officinalis* (31), *Carlina biebersteinii ssp. braevibracteata* (32), *Artemisia pontica* (37), *Teucrium montanum*

(37), *Trifolium micranthum* (39), *Cnidium dubium* (41), *Tanacetum vulgare* (41), *Artemisia vulgaris* (44), *Rubus caesius* (44), *Salvia nutans* (49), *Stipa capillata* (48), *Phlomis tuberosa* (49), *Hieracium cymosum* (57), *Ulmus minor* var. *gemina* f. *suberosa* (58), *Melica ciliata* (60), *Centaurium pulchellum* (61), *Melampyrum arvense* (63), *Galega officinalis* (65), *Hypericum elegans*(67), *Sedum maximum* (67), *Verbascum chaixii* ssp. *austriacum* (67), *Trifolium alpestre* (71), *Campanula rapunculoides* (72), *Lithospermum arvense* (73), *Gentiana ciliata* (74).

Places and dates of relevées: R1,2 - Criş, on the woodland edge of the Gotca forest, N 46°07', E 24°41'; 2004.06.02; R3 - Criş, la marginea pădurii, N 46°07', E 24°41'; 2004.06.23; R4 - Criş, edge of forest of *Quercus petraea*; N 46°07', E 24°41'; 2004.06.23; R5 - Criş, N 46°07', E 24°41'; 2004.06.23; R 6,7 - Stejărenii, N 46°09', E 24°42'; 2004.07.07; R 8,9 - Stejărenii, N 46°09', E 24°42'; 2004.07.07; R 10,11 - Stejărenii, N 46°10',E 24°43'; 2004.07.07; R12,13 – Laslea, N 46°11', E 24°38'; 2004.07.07; R14 - Mihai Viteazu, N 46°08', E 25°01'; 2004.07.15; R15 - Mihai Viteazu, near *Epipactis*, N 46°08', E 25°01'; 2004.07.15; R16 - Mihai Viteazu, N 46°08', E 25°01'; 2004.07.15; R17 - Mihai Viteazu, N 46°08', E 25°01'; 2004.07.15; R18 - Mihai Viteazu, N 46°08', E 25°01'; 2004.07.15; R19-21 - Mihai Viteazu, N 46°09', E 25°01'; 2004.07.15; R22 - Mihai Viteazu, N 46°09', E 25°02'; 2004.07.15; R23-25 - Cloaşterf, Fundătura, N 46°08', E 24°57'; 2004.07.15; R26 - Mureni, N 46°13', E 25°00'; 2004.07.16; R27 - Mureni, N 46°13', E 25°00'; 2004.07.16; R28 - Floreşti, N 46°09', E 24°39'; 2004.07.16;R29 - Floreşti, N 46°09', E 24°39'; 2004.07.16;R30 - Floreşti, N 46°09', E 24°39'; 2004.07.16; R31 - Nou Săsesc, N 46°05', E 24°36'; 2004.07.16; R32 - Nou Săsesc, N 46°05', E 24°36'; 2004.07.16; R33 - Nou Săsesc, N 46°05', E 24°36'; 2004.07.16; R34 - Nou Săsesc, N 46°05', E 24°36'; 2004.07.16; R35 - Nou Săsesc, N 46°05', E 24°36'; 2004.07.16; R36 - Daia, N 46° 08', E 24° 53'; 2004.07.23; R37 - Daia, N 46° 08', E 24° 52'; 2004.07.23; R38 - Vulcan, N 46° 09', E 24° 50'; 2004.07.23; R39 - Apold, N 46°06', E 24°50'; 2004.08.26; R40 - Apold, N 46°06', E 24°50'; 2004.08.26; R41 - Apold, N 46°06', E 24°50'; 2004.08.26; R42 - Apold, N 46°06', E 24°50'; 2004.08.26; R43 - Apold, N 46°06', E 24°50'; 2004.08.26; R44 - Apold, N 46°06', E 24°49'; 2004.08.26; R45 - Apold, N 46°08', E 24°48'; 2004.08.26; R46 - Apold, N 46°08', E 24°50'; 2004.08.26; R47 - Apold, N 46°08', E 24°46'; 2004.08.26; R48 - Cloaşterf, Arsăl, N 46°08', E 24° 57'; 2004.07.15; R 49 - Mihai Viteazu, N 46°09'; E 25°02'; 2005.06.21; R50-52 - Saschiz, N 46°11', 24°57'; 2005.06.22; R53-55 - Saschiz, Groapa lui Schusler, N 46°12', E 24° 58'; 2005.07.21; R56 - Archita, Calea Groapelor, N 46°11´, E 25°06´; 2006.07.08 ; R57 - Archita, Calea Groapelor, N 46°12´, E 25°02´; 2006.07.08; R58 - between Mureni and Archita, N 46°13´, E 25°02´; 2006.07.14 ; R59 - între Mureni and Archita, N 46°13´, E 25°02´; 2006.07.14 ; R60 - between Mureni and Archita, N 46°13´, E 25°02´; 2006.07.14 ; R 61 - Vulcan, N 46°08´, E 24°51´; 2006.07.19 ; R 62 - Şaeş, N 46°09´, E 24°46´; 2006.07.22 ; R 63 - Fişer, N 46°04´, E 25°10´; 2007.07.16; R64 - Beia, N46 09, 25 10, 2007.07.18; R65 - Ruja, N 46°01´, E 24°33´; 2007.07.23; R66 - Ruja, N 46°01´, E 24°38´; 2007.07.23; R67 - Stejărişu, N 46°03´, E 24°39´; 2007.07.24; R68 - Iacobeni; N 46°03´, E 24°42´; 2007.07.24; R69 - Movile; N 46°01´, E 24°49´; 2007.07.26; R70 - Noiştat; N 46°02´, E 24°48´; 2007.07.27; R71 - Grânari; N 46°01´, E 24°58´; 2007.08.06; R72 - Angofa; N 46°10´, E 24°47´; 2007.08.07; R73 - Angofa; N 46°10´, E 24°47´; 2007.08.07; R74 - Angofa; N 46°10´, E 24°46´; 2007.09.27.

1. 2. Xerophylic and xero-mezophylic phytocenozes are used as grazing pasture which develop on arid soils. They have a xerophylic character, with a large number of xerophylic species.

The correspondence between the system of classification for habitat type used at a European level and within Romania is:

NATURA 2000: 6240 Sub-pannonic steppic grasslands (Priority)

HdR R3411, R3414, R3415

This habitat type is of Community Interest and is a Priority Habitat.

These grasslands, from a phytosociological point of view, have been classified thus:

FESTUCO-BROMETEA Br.-Bl.et R.Tx.ex Klika et Hadač, 1944

FESTUCETALIA VALESIACAE Br.-Bl. et R.Tx.ex Br.-Bl. 1949

Festucion valesiacae Klika, 1931

5. Botriochloetum ischaemi (Krist., 1937) Pop, 1977
6. Festuco rupicolae-Caricetum humilis Soó, (1930), 1947
7. Medicagini minimae-Festucetum valesiacae Wagner, 1941
8. Thymio pannonici-Chrysopogonetum grylli Doniță et al., 1992
9. Elytrigetum hispidi (Dihoru, 1970) Popescu et Sanda, 1988

Stipion lessingianae Soó, 1947

10. Stipetum capillatae (Hueck, 1931) Krausch, 1961

Botriochloetum ischaemi (Krist., 1937) Pop, 1977

The beard-grass grasslands (Tab. 5) present in the hilly areas occupy sunny and eroded slopes. The grasslands have resulted from degradation, excessive grazing and erosion of the phyotocenozes exemplified by *Festuca valesiaca* and *F. rupicola*, processes which are demonstrated by the presence in these communities of noda of the characteristic species which have been substituted. The vegetative components include 107 cormophyte species.

Analysis of the associations according to ecological indicators reveals that the majority of species are xero-mesophylic (54.20%) and xerophylic (18.7%). According to temperature, the predominant species are micro-mezothermic (51.40%), followed by moderate-thermophylic (25.23%). According to their behaviour in reaction to soil reaction, we found the predominant species to be weakly acid-neutrophylic (44, 86) and euriionic (28.98%).

Life-form spectrum: Ch-8.42%, H-64.48%, G-3.74%, T-20.56% (Th-13.08%, TH-7.48%), Ph-2.8% (mPh-1.87%, nPh-093%).

Spectrum of phyto-geographical elements: Eua-22.43%, Eur-15.88%, Paleotemp-14.02%, Eurosib-13.08%, Pont-Pann-8.42%, Circumbor-3.74%, Eur-Cauc-3.74%, Oroph-1.86%, Balc-0.93%, Cosm-3.74%. The pedo-climatic conditions under which the association develops also favour a significant number of Mediterranean species (12, 16%).

Caryological spectrum: D-50.47%, P- 36.45%, D-P-9.34%, ?-3.74%.

The productivity of beard-grass grasslands is poor, both qualitatively and quantitatively, and only a small number of the component plants have an economic value.

Table 5: Botriochloetum ischaemi (Krist., 1937) Pop, 1977.

Relevée	1	2	3	4	5	6	
Altitude (m s.m.)	472	480	520	562	598	541	
Slope (°)	20	15	10	20	5	30	
Aspect	V	V	V	S	S	S	
Area (m^2)	100	100	100	100	100	100	
Vegetation cover (%)	100	92,5	89,0	99,0	90,5	99,0	K
Characteristic association							
Dichanthium ischaemum	4	4	4	4	4	5	V

Relevée	1	2	3	4	5	6	
Festucetalia valesiacae							
Achillea setacea	-	+	-	-	-	+	II
Anchusa officinalis	-	+	+	-	-	-	II
Bupleurum falcatum	-	-	+	-	+	-	II
Campanula sibirica	-	+	+	-	+	-	III
Carduus hamulosus	+	+	-	-	-	-	II
Centaurea apiculata spinulosa	+	-	+	-	+	-	III
Centaurea rhenana	-	-	+	-	+	+	III
Dorycnium pentaphyllumherbaceum	-	+	+	2	+	-	IV
Festuca rupicola	-	+	-	-	+	-	II
Festuca valesiaca	2	1	+	-	+	+	V
Fragaria viridis	+	+	+	-	+	-	IV
Inula ensifolia	+	-	+	+	-	-	III
Linum hirsutum	-	+	+	-	-	-	II
Medicago minima	+	+	+	-	-	+	IV
Senecio jacobaea	+	-	+	+	-	-	III
Stachys recta	-	-	+	+	-	+	III
Thymus pannonicus	-	-	-	-	+	+	II
Veronica spicata orchidea	+	+	+	-	+	-	IV
Cirsio-Brachypodion							
Brachypodium pinnatum	-	+	+	-	1	+	IV
Onobrychis viciifolia	-	+	+	-	+	-	III
Teucrium chamaedrys	+	-	+	+	+	+	V
Festuco-Brometea							
Achillea millefolium	+	+	+	+	+	-	V
Acinos arvensis	-	+	-	-	-	+	II
Agrimonia eupatoria	+	+	+	-	+	-	IV
Alopecurus pratensis	-	-	-	+	-	+	II
Alyssum alyssoides	-	+	+	-	-	-	II
Asperula cynanchica	+	+	+	+	+	+	V
Briza media	+	+	+	+	+	-	V
Centaurea biebersteinii biebersteinii	-	+	+	-	-	-	II
Cerastium holosteoides	+	+	+	-	-	-	III
Clinopodium vulgare	+	-	-	-	+	-	II
Coronilla varia	-	+	+	-	+	-	III
Cynosurus cristatus	-	-	-	+	+	-	II
Dactylis glomerata	+	+	+	-	+	-	IV
Daucus carota	+	+	+	+	-	-	IV
Dianthus carthusianorum	+	+	+	+	-	-	IV
Echium vulgare	-	-	+	-	+	-	II
Eryngium campestre	+	+	+	-	+	+	V
Euphorbia cyparissias	+	+	-	+	-	+	IV
Euphrasia rostkoviana	+	+	+	-	-	-	III
Filipendula vulgaris	+	+	+	+	+	-	V
Galium mollugo	-	+	+	-	-	-	II
Galium verum	+	+	+	+	+	-	V
Hypericum perforatum	+	-	+	-	-	-	II
Leontodon hispidus hispidus	+	+	+	-	-	-	III

Relevée	1	2	3	4	5	6	
Leuchanthemum vulgare	+	+	+	-	-	-	III
Lotus corniculatus	+	+	+	+	+	-	V
Medicago falcata	-	+	+	+	+	-	IV
Molinio-Arrhenatheretea							
Pimpinella saxifraga	+	+	+	+	-	+	V
Planago lanceolata	+	-	+	-	+	-	III
Plantago media	-	+	-	+	+	-	III
Potentilla cinerea	-	+	-	-	+	+	III
Potentilla recta	-	+	+	-	-	-	II
Prunella laciniata	+	+	-	-	+	-	III
Salvia nemorosa	+	+	-	-	-	-	II
Salvia pratensis	-	+	+	-	-	-	II
Salvia verticillata	+	+	+	+	-	+	V
Scabiosa ochroleuca	-	+	+	+	+	-	IV
Stachys germanica	+	+	+	-	-	-	III
Stachys officinalis	-	-	-	+	+	-	II
Thymus glabrescens	-	+	+	-	-	-	II
Tragopogon dubius	-	+	+	-	-	-	II
Trifolium campestre	-	+	-	-	-	+	II
Querco-Fagetea							
Crataegus monogyna	-	-	-	+	+	-	II
Helleborus purpurascens	+	-	-	+	-	-	II
Prunus spinosa	+	-	-	+	-	-	II
Variae syntaxa							
Cichorium intybus	-	+	+	-	+	-	III
Convolvulus arvensis	+	-	+	-	-	-	II
Cuscuta europaea	+	-	-	+	-	-	II
Prunella vulgaris	+	-	+	-	-	-	II

Species present in a single relevée: *Rosa gallica* (1), *Trifolium medium* (1), *Thymus puleginoides* (1), *Inula hirta* (2), *Linum catharticum* (2), *Silene otites* (3), *Astragalus onobrychis* (3), *Polygala major* (4), *Astragalus cicer* (4), *Chamaecytisus albus* (4), *Ononis arvensis* (4), *Knautia arvensis* (4), *Leontodon autumnalis* (4), *Muscari comosum* (4), *Phlomis tuberosa* (4), *Trifolium pannonicum* (4), *Astragalus glycyphyllos* (4), *Allium scorodoprasum* (4), *Echinops ruthenicus* (5), *Elymus hispidus* (5), *Agrostis capillaris* (5), *Anthoxanthum odoratum* (5), *Carlina vulgaris* (5), *Carum carvi* (5), *Centaurium erythraea* (5), *Crepis biennis* (5), *Danthonia alpina* (5), *Euphrasia stricta* (5), *Hieracium pilosella* (5), *Linum catharticum* (5), *Ononis arvensis* (5), *Echinops sphaerocephalus* (6), *Artemisia campestris* (6), *Falcaria vulgaris* (6), *Asparagus officinalis* (6), *Astragalus monspessulanus* (6).

Places and dates of relevees: R1-3 Şaeş, N 46°08', E 24°48', 2004.07.27; R4 - Saschiz, towards Daia, N 46°10', E 24°55'; 2005.08.16; R5 - Brădeni; N 46°06', E 24°51'; 2007.07.31; R6 - Brădeni; N 46°06', E 24°51'; 2007.07.31.

Festuco rupicolae-Caricetum humilis Soó, 1930, 1947

These phytocenozes are distributed along the sunny and eroded slopes of hills of southern or south-western aspect, with slopes of 5°, 20°,40°, and altitudes of 550 - 640 m, on a clayey substrate. We presume that these grasslands represent steppic relics, which had a wider distribution in the Boreal period. As a result of its distribution, on less accessible slopes, the flora of the association is less altered by human activity. It includes 105 cormophyte species, the majority being characteristic of the cenotaxons which are subordinate to the vegetal community analysed (Tab. 6). Owing to the degradation of the grassland, following the advanced erosion of the soil as a result of intensive grazing, the species *Thymus pannonicus* and *Salvia nutans* are found.

With regard to the humidity preferences of species we observe the predominance of xero-mezophylic species (60%), followed by xerophylic (18.09%). According to temperature, micro-mezothermic species are predominant (44.76%) followed by moderate-thermophylic (29.52%), and according to preferences of soil reaction weak acid-neutrophylic species predominate (56.19%), followed by euriionic species (18.09%).

Life-form spectrum: Ch-4.76%, H-63.81%, G-6.66%, T-15.23% (Th-8.57%, TH-6.66%), Ph-9.54% (MPh-1.90%, mPh-3,82%, nPh-3.82%).

Spectrum of phyto-geographical elements: Eua-25.72%, Eur-22.86%, Eurosib-11.43%, Paleotemp-10.47%, Pont-Pann-9.52%, Med-8.57%, Eur-Cauc-3.81%, Circumbor-2.86%, Oroph-2.86%, Balc-0.95%, Cosm-0.95%.

Caryological spectrum: diploid (46.66%), poliploid (34.29%), diplo-poliploid (12.39%), ?-666%.

The productivity of this grassland is poor, both quantatitively and qualitatively.

Table 6: *Festuco rupicolae-Caricetum humilis* Soó, (1930), 1947.

Relevée	1	2	3	4
Altitude (m s.m.)	578	588	640	545
Aspect	S	SV	S	S
Slope (°)	40	20	40	5
Area (m^2)	100	100	100	100
Vegetation cover (%)	84,5	88	92	69
Characteristic association				
Festuca rupicola	2	2	3	3
Carex humilis	1	1	1	+
Brometalia				
Knautia arvensis	-	+	+	-
Onobrychys viciifolia	-	+	+	-
Cirsio-Brachypodion pinnati				
Brachypodium pinnatum	+	1	+	-
Briza media	+	+	+	+
Lotus corniculatus	-	+	+	+
Festucetalia valesiacae				
Brassica elongata	-	+	+	-
Bupleurum falcatum	-	+	+	-
Campanula sibirica	+	+	+	-
Cerinthe minor	-	+	+	-
Chamaecytisus albus	+	+	+	-

Relevée	1	2	3	4
Cruciata laevipes	-	+	+	-
Dorycnium pentaphyllu .herbacea	+	+	+	2
Festuca valesiaca	-	+	+	-
Fragaria viridis	+	+	+	+
Inula ensifolia	+	1	-	-
Jurinea mollis	-	+	+	-
Linum flavum	-	+	+	-
Linum perenne	-	+	+	-
Muscari tenuiflorum	+	+	+	-
Nonea pulla	+	+	+	-
Potentilla cinerea	-	+	+	-
Salvia nutans	3	2	2	-
Stachys recta	-	+	+	-
Thymus pannonicus	1	1	+	-
Festuco-Brometea				
Agrimonia eupatoria	+	+	+	+
Asparagus officinalis	-	+	+	-
Asperula cynanchica	+	+	+	-
Astragalus monspessulanus	-	+	+	-
Centaurea scabiosa	-	+	+	-
Coronilla varia	1	1	+	-
Dianthus carthusianorum	-	+	+	+
Echium vulgare	-	+	+	-
Erigeron acris	-	+	-	+
Eryngium campestre	-	+	+	-
Euphorbia cyparissias	+	+	+	-
Falcaria vulgaris	+	+	+	-
Galium glaucum	+	+	-	-
Galium verum	-	+	+	+
Hypericum perforatum	-	+	+	+
Orobanche alba	-	+	+	-
Pimpinella saxifraga	-	+	+	-
Plantago lanceolata	-	+	+	+
Plantago media	-	+	+	+
Polygala major	-	+	-	+
Phlomis tuberosa	+	+	-	-
Potentilla recta	-	+	+	+
Prunella grandiflora	-	+	+	-
Salvia pratensis	-	+	+	-
Scabiosa ochroleuca	-	+	+	-
Stachys germanica	-	+	+	-
Teucrium chamaedrys	-	+	+	-
Veronica spicata ssp.orchidea	-	+	+	+
Molinio-Arrhenatheretea				
Achillea millefolium	+	+	+	+
Holcus lanatus	-	+	+	-

Relevée	1	2	3	4
Leucanthemum vulgare	-	+	+	-
Linum catharcticum	-	+	+	-
Orchis coriophora	-	+	+	-
Ranunculus polyantemos	-	+	+	-
Stachys officinalis	-	+	-	+
Quercetea pubescenti-petraea				
Dictamnus albus	+	+	1	-
Lembotropis nigricans	-	+	+	-
Rosa gallica	+	+	+	+
Vincetoxicum hirundinaria	-	+	+	-
Querco-Fagetea				
Crataegus monogyna	-	+	-	+
Prunus spinosa	-	+	+	-
Variae syntaxa				
Centaurea biebersteinii	-	+	+	-
Clematis vitalba	-	+	+	-
Galium album	-	+	+	-
Lapsana communis	-	+	+	-

Species present in a single relevee: *Anthyillis vulneraria* (1), *Artemisia pontica* (1), *Astragalus glycyphyllos* (1), *Cephalanthera damasonium* (1), *Gymnadenia conopsea* (1), *Quercus pubescens* (1), *Elymus hispidus* (1), *Medicago falcata* (1), *Seseli libanotis* (1), *Trifolium alpestre* (1), *Adonis vernalis* (1), *Echium russicum* (2), *Lithospermium arvense* (2), *Primula veris* (2), *Clematis recta* (2), *Cornus sanguinea* (2), *Prunus tenella* (2), *Rosa canina* (2), *Ulmus minor* f. *suberosa* (2), *Helleborus purpurascens* (2), *Euphorbia epythymoides* (2), *Ajuga laxmanni* (2), *Salvia verticillata* (2), *Anchusa officinalis* (2), *Filipendula vulgaris* (4), *Bromus erectus* (4), *Centaurea scabiosa* (4), *Ononis arvensis* (4), *Inula hirta* (4), *Senecio jacobea* (4), *Agrostis capillaris* (4), *Centaurium erythraea* (4), *Daucus carota* (4), *Linaria vulgaris* (4).

Places and dates of relevees: R1 - Mihai Viteazu; 2005.06.21; R 2,3 - Mihai Viteazu, route leading to „La Fânațe" , N 46°09', E 25° 03'; 2005.06.22; R4 - Fiser, N 46°03', E 25° 08'; 2007.07.17.

Medicagini minimae-Festucetum valesiacae Wagner, 1941

Steppic hair-grass grasslands with *Medicago minima* in the study area are found not only on flat terrain but also on sunny slopes and hills of varied slope, 5 - 45°, and southerly or easterly exposure. They are developed on chernozem soils, leached and semi-carbonated, weakly acid or neutral in reaction.

The 199 species that make up the association (Tab. 7) mostly belong to cenotaxa of the class Festuco-Brometea.

The subcontinental climate favours the development of xero-mezophylic species (51.76%), followed by mesophylic (29.14%) and xerophylic (8.55%), micro-mezothermic (56.78%) and moderate-thermophylic (18.09%), and the edaphic conditions result in the development of a remarkable number of weakly acid-neutrophylic (39.70%) and euriionic species (31.66%).

Life-form spectrum: Ch-5.53%, H-67.35%, G-5.03%, T-19.59 (Th-12.56%, TH-7.03%), Ph-2.5 (MPh-0.5%, mPh-1%, nPh-1%).

Spectrum of phyto-geographical elements: Eua-21.62%, Eur-16.09%, Eurosib. and Paleotemp. 13.06% each, Med-8.55%, Circumbor-7.03%, Eur-Cauc-6.03%, Pont-Pann-4.52%, Oroph-1.51%, Dac-Balc-1%, Siber-0.5%, Cosm-6.03%, Adv-1%.

Caryological spectrum: D-48.24%, P-38.69%, D-P-7.54%, ?-5.53%.

The quality of this grassland is poor to moderate. Some species have economic value for honey production, food or medicinal use, or ornament.

Table 7: *Medicagini minimae-Festucetum valesiacae* Wagner, 1941.

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Altitude (m s.m.)	465	522	470	623	431	651	622	469	531	522	472	518	589	597	624	565	
Aspect	-	-	-	S	E	-	-	-	-	-	-	-	-	E	-	-	
Slope (°)	-	-	-	4	5	-	-	-	-	-	-	-	-	5	-	-	
Area (m^2)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Vegetation cover (%)	94.5	100	100	100	100	82.5	100	81.5	90.5	100	90	94.5	92.5	91.5	100	100	K
Char. assn																	
Festuca valesiaca	4	4	5	4	4	2	4	4	4	4	4	4	4	4	4	4	V
Medicago minima	-	-	-	-	-	-	-	+	+	-	-	+	+	+	+	2	III
Festucetalia valesiacae																	
Artemisia absinthium	-	-	-	-	-	-	-	-	-	-	-	1	-	+	-	-	I
Bupleurum falcatum	-	-	-	-	-	-	-	-	-	-	+	+	+	-	+	+	II
Campanula patula patula	-	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	V
Campanula sibirica	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	I
Centaurea rhenana	+	-	-	1	+	+	+	-	-	-	+	-	-	+	+	+	III
Chamaecytisus albus	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	I
Dianthus armeria	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	I
Dorycnium pentaphyllum herbaceum	-	+	-	+	+	+	-	-	-	+	+	+	+	-	+	+	
Elymus hispidus	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	I
Falcaria vulgaris	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	I
Fragaria viridis	-	-	-	+	+	+	-	-	+	-	+	+	-	+	+	-	III
Inula ensifolia	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	+	II
Linum flavum	-	+	-	-	-	-	-	-	-	+	+	+	+	-	-	+	II
Linum perenne	-	-	-	-	+	-	-	-	-	-	+	+	-	-	-	-	I
Nonea pulla	-	-	-	+	-	-	-	-	-	-	+	+	-	-	-	-	I
Polygala major	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	I
Stachys recta	-	-	-	-	+	-	-	-	-	-	+	+	+	-	+	+	II
Veronica spicata orchidea	-	-	-	+	+	-	-	-	-	-	+	-	+	+	+	-	II
Cirsio-Brachypodion																	
Brachypodium pinnatum	-	2	-	-	+	3	+	-	-	2	+	+	-	-	+	+	III
Carlina vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	I
Centaurea scabiosa	-	-	-	-	+	-	-	-	+	-	-	+	+	+	-	-	II

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Onobrychis viciifolia	-	-	-	+	+	+	-	-	-	-	+	+	+	+	+	+	III
Prunella laciniata	-	+	-	+	+	-	-	+	+	+	-	+	-	+	+	-	III
Teucrium chamaedrys	+	+	-	+	-	-	-	-	+	-	+	+	+	-	-	-	III
Festuco-Brometea																	
Agrimonia eupatoria	+	+	+	+	+	+	+	-	-	+	-	+	-	+	+	+	IV
Anthericum ramosum	-	-	-	-	-	-	-	-	-	-	+	+	1	-	-	-	I
Asperula cynanchica	-	+	-	+	+	+	-	-	+	+	+	+	+	+	+	+	IV
Astragalus monspessulanus	-	-	-	+	-	-	-	-	-	-	+	-	-	-	+	-	I
Bromus erectus	-	-	-	-	+	-	-	+	-	-	-	-	-	-	+	+	II
Carex caryophyllea	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	I
Carlina biebersteinii brevibracteata	+	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	I
Cerinth minor	-	-	-	+	-	-	-	-	-	-	+	-	-	-	+	-	I
Clinopodium vulgare	-	+	-	-	+	+	+	-	-	+	-	+	-	-	+	-	III
Coronilla varia	+	+	-	+	+	-	-	-	+	+	+	+	+	+	+	-	IV
Dianthus carthusianorum	-	-	+	-	-	-	-	+	-	-	+	+	+	+	+	-	III
Dichanthium ischaemum	-	-	+	-	+	+	-	-	-	-	-	-	-	-	+	-	II
Echium vulgare	+	-	-	+	+	+	-	-	+	-	-	-	+	-	+	-	III
Erigeron acris	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	I
Eryngium campestre	-	-	+	-	+	-	-	-	+	-	-	+	-	+	+	+	III
Euphorbia cyparissias	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	II
Euphrasia stricta	-	+	-	-	+	-	-	-	-	+	-	+	-	+	+	-	II
Filipendula vulgaris	-	+	-	-	+	+	-	+	+	+	-	+	-	+	-	-	III
Galium album	+	-	+	-	+	-	-	+	-	-	-	-	-	-	-	-	II
Galium mollugo	-	-	-	-	+	-	-	+	-	-	+	+	-	-	-	-	II
Galium verum	+	+	-	-	+	+	+	+	+	+	-	-	+	+	-	-	IV
Hieracium pilosella	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	I
Hypericum perforatum	+	+	+	+	+	-	+	-	-	+	-	-	-	-	-	+	III
Koeleria cristata	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	I
Lavatera thuringiaca	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	I
Lotus corniculatus	+	+	+	+	+	+	+	+	+	+	-	-	+	-	+	+	V
Medicago falcata	+	+	-	+	+	+	-	-	+	+	-	-	-	+	-	-	III
Peucedanum oreoselinum	-	-	-	-	-	-	-	+	-	-	+	-	+	-	-	+	II
Pimpinella saxifraga	-	+	+	-	+	+	-	-	+	+	-	+	+	+	+	+	IV
Plantago lanceolata	-	+	-	+	+	+	+	-	+	+	-	+	+	+	+	-	IV
Plantago media	-	+	-	+	+	-	-	-	+	+	-	+	-	+	+	+	III
Poa pratensis angustifolia	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	II
Polygala comosa	-	-	-	-	+	-	-	-	-	-	-	-	-	+	+	-	I
Potentilla cinerea	-	+	-	+	+	-	+	-	-	-	-	+	-	-	1	-	II
Potentilla argentea	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	I
Potentilla recta	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	I
Prunella grandiflora	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	I
Salvia pratensis	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	-	I
Salvia verticillata	-	+	-	+	-	+	-	-	-	+	+	+	+	-	-	+	III
Scabiosa ochroleuca	-	+	-	+	-	+	-	-	-	+	+	+	+	-	-	+	III
Stachys germanica	-	-	+	+	+	+	+	-	-	-	-	+	-	+	+	-	III
Thalictrum minus	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	I
Thesium lynophyllon	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	I
Thymus glabrescens	-	-	-	1	1	-	-	-	-	-	-	+	-	1	1	-	II

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Thymus pulegioides	-	+	+	-	-	1	+	-	-	+	+	-	-	+	-	-	III
Trifolium pannonicum	-	+	-	-	-	-	-	-	-	+	+	+	-	-	-	-	II
Arrhenatherethalia (incl.Molinio-Arrhenatheretea)																	
Achillea millefolium	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	V
Agrostis capillaris	2	+	+	-	+	+	2	-	-	+	-	-	-	+	-	-	III
Alopecurus pratensis	-	-	-	-	-	+	-	-	-	-	+	+	-	-	-	-	I
Arrhenatherum elatius	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	I
Briza media	-	+	+	+	+	+	-	+	-	+	-	+	+	+	+	+	IV
Carum carvi	+	+	-	-	+	-	-	+	-	+	-	-	+	+	-	-	III
Centaurea nigrescens	-	+	+	-	-	-	-	-	-	+	-	-	-	-	-	-	I
Centaurium erythraea	-	-	-	-	+	-	+	-	-	-	-	-	+	-	+	+	II
Centaurium pulchellum	-	-	-	-	+	-	-	-	-	-	-	-	-	+	+	-	I
Cerastium holosteoides	+	+	-	-	+	+	+	+	+	+	-	-	-	+	+	-	IV
Colchicum autumnale	-	-	-	-	+	-	-	+	-	-	-	-	+	-	-	-	I
Cynosurus cristatus	+	-	-	-	-	+	+	+	1	-	-	-	-	+	+	-	III
Dactylis glomerata	+	-	-	-	-	+	-	-	-	-	-	+	+	-	+	+	II
Eryngium planum	-	+	+	+	-	-	-	+	-	+	-	-	-	-	-	-	II
Heracleum sphondylium	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	I
Holcus lanatus	+	-	-	+	+	-	-	-	-	-	-	-	-	-	+		II
Dactylis glomerata	+	-	-	-	-	+	-	-	-	-	-	+	+	-	+	+	II
Eryngium planum	-	+	+	+	-	-	-	+	-	+	-	-	-	-	-	-	II
Heracleum sphondylium	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	I
Holcus lanatus	+	-	-	+	+	-	-	-	-	-	-	-	-	-	+		II
Juncus effusus	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	I
Knautia arvensis	-	+	-	-	+	-	-	+	+	+	-	+	+	+	-	+	III
Leucanhemum vulgare	-	+	+	+	+	-	-	+	+	+	-	+	-	+	+	-	IV
Linum catharticum	-	+	+	-	-	-	-	-	+	-	-	-	+	+	+	+	III
Medicago lupulina	-	-	+	-	-	+	+	-	-	-	+	-	-	-	-	-	II
Ononis arvensis	-	+	+	+	+	+	-	+	+	+	-	-	+	-	+	-	IV
Primula veris	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	I
Rhinanthus rumelicus	-	+	-	-	-	-	-	+	-	+	-	+	+	+	-	-	II
Senecio jacobaea	-	-	-	+	-	-	-	-	-	-	+	-	-	+	-	+	II
Stachys officinalis	-	+	-	-	+	+	-	+	-	-	-	-	-	-	-	-	II
Stellaria graminea	-	-	-	-	+	+	+	+	+	-	-	-	-	+	+	-	III
Tragopogon pratensis ssp. *orientalis*	-	-	-	-	-	-	-	+	-	-	-	-	+	-	+	-	I
Trifolium montanum	-	+	-	-	+	-	+	-	-	+	-	-	-	-	-	-	II
Trifolium pratense	+	-	-	+	+	+	+	+	-	-	-	-	+	+	+	-	III
Trifolium repens	-	-	-	+	+	+	-	-	+	-	-	-	-	+	+	-	II
Querco-Fagetea																	
Allium scorodoprasum	-	-	-	-	+	+	-	-	-	-	-	-	+	-	-	-	I
Campanula bononiensis	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	I
Crataegus monogyna	-	-	-	+	+	+	+	-	+	-	-	-	-	+	-	-	II
Pyrus pyraster	-	-	+	-	+	-	+	-	+	-	-	-	-	+	+	-	II
Trifolium alpestre	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I
Quercion pubescenti-petraea																	
Lembotropis nigricans	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	I
Variae syntaxa																	
Carduus acanthoides	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	I
Cichorium intybus	+	+	+	+	+	+	+	+	+	+	-	-	+	+	-	-	IV
Cirsium arvense	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	I

Relevée	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Cirsium arvense	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	I
Convolvulus arvensis	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	I
Convolvulus arvensis	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	I
Daucus carota	+	-	+	+	+	+	+	-	-	-	-	+	+	+	-	-	III
Equisetum arvense	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	I
Euphorbia helioscopia	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	I
Genista tinctoria	-	+	-	-	-	-	-	-	-	+	+	-	-	-	-	-	I
Lolium perenne	-	-	-	+	-	-	+	-	+	-	-	-	+	+	-	-	II
Mentha arvensis	-	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	I
Myosotis arvensis	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	I
Origanum vulgare	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	I
Plantago major	-	-	-	-	+	+	+	-	+	+	-	-	-	-	-	-	II
Prunella vulgaris	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-	II
Ranunculus polyanthemos	-	-	-	-	-	-	+	+	+	-	-	-	+	+	-	-	II
Rosa canina	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	I
Rumex acetosa	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	I
Rumex crispus	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	I
Trifolium hybridum	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	I
Trifolium medium	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	I
Verbena officinalis	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	I

Species present in a single relevée: *Veronica chamaedrys* (1), *Astragalus cicer* (5), *Chrysopogon gryllus* (5), *Carex ovalis* (5), *Inula britannica* (6), *Alcea pallida* (6), *Centaurea stenolepys* (6), *Vicia sepium* (6), *Melilotus officinalis* (6), *Cruciata laevipes* (6), *Echinops sphaerocephalus* (7), *Muscari comosum* (7), *Linum hirsutum* (7), *Prunus spinosa* (7), *Gentiana cruciata* (8), *Rumex acetosella* (8), *Dipsacus fullorum* (8), *Elymus repens* (9), *Inula hirta* (9), *Viola tricolor* (10), *Brachypodium sylvaticum* (11), *Dianthus armeria* (11), *Rhinanthus angustifolius* (12), *Campanula persicifolia* (12), *Leontodon hispidus* ssp. h*ispidus* (12), *Potentilla anserina* (14), *Pulicaria vulgaris* (14), *Luzula campestris* (14), *Poa compresa* (14), *Anagalis arvensis* (15), *Festuca rupicola* (15), *Rubus caesius* (16), *Artemisia campestris* (16), *Euphorbia salicifolia* (16), *Lathyrus pratensis* (16), *Picris hieracioides* (17), *Scorzonera purpurea* (18), *Silene italica* (18), *Teucrium montanum* (18), *Orobanche alba* (18), *Lapsana communis* (18), *Peucedanum cavifolia* (18), *Astragalus onobrychis* (19), *Phleum phleoides* (19), *Erigeron annus* (19), *Helianthemum nummularium* (19), *Melampyrum cristatus* (19), *Nepeta nuda* (19), *Tanacetum corymbosum* (20), *Laserpitium latifolium* (20), *Vincetoxicum hirundinaria* (20), *Euphorbia virgata* (23), *Campanula glomerata* (23), *Cephalaria radiata* (23), *Jurinea mollis* (23).

Places and dates of relevees: R1-3: Stejărenii, N 46° 09’, E 24° 43’, 2004.07.07; R4 - Mihai Viteazu, N 46° 08’, E 25° 01’, 2004.07.15; R5 - Noul Săsesc, N 46° 05’, E 24° 36’, 2004.07.16; R6 - Daia, N 46° 08’E 24° 53’; 2004.07.23; R7 - Daia, N 46° 09’, E 24° 53’; 2004.07.23; R8 - Vulcan, N 46° 09’,E 24° 50’;2004.07; R9 - Şarpatoc, N 46°09’, E 24° 50’; 2004.07; R10 - Şarpatoc, N 46°09’, E 24° 51’; 2004.07; R11 - Şarpatoc, N 46° 09’, E 24° 50’; 2004.07; R12 - Şaeş, N 46°08’ E 24°49’; 2004.07.27; R13 - Saschiz, towards Daia, N 46° 10’, E 24° 56’, 2005.06.18; R14,15 - Mihai Viteazu, N 46° 09’, E 25° 02’, 2005.06.22; R16 - Mihai Viteazu, N 46° 09’, E 25° 03’, 2005.06.22; R17 - Mihai Viteazu, N 46° 08’, E 25° 01’, 2005.07.15; R18 - Saschiz Groapa lui Schusler, N 46°12’, E 24° 58’, 2005.07.21; R19 - Archita, Calea Groapelor, N 46° 11’, E 25° 06’; 2006.07.08; R20 - Archita, Coastele Saschizului,N 46°10’, E 25°04’; 2006.07.11; R21 - Daia, La Ochiuri, N 46°07’, E 24°54’; 2006.07.18; R22 - Vulcan, N 46°09’, E 24°52’, 2006.07.19. R23-Ruja; N46°01’, E24°39’; 0007.07.23.

Thymio pannonici-Chrysopogonetum grylli Doniță et al., 1992

The phytocenozes of this association are widespread in less dry areas, with a higher air humidity, which reflects also a richer floristic composition. The association is characterised by the presence, in most of the area, of xero-thermophylic species, which develop on dry to very dry land.

The composition is dominated by the indicator species *Anthericum ramosum*, which in some places is very abundant. The cenotic assemblage of 97 component species (Tab. 8) presents as xero-mezophylic species (54.64%) and xerophylic species (16.49%), micro-mezothermic species (46.39%) and moderate-thermophylic species (22.68%) as well as weakly acid-neutrophylic species (54.64%).

Life-form spectrum: Ch-6.18%, H-69.07%, G-9.27%, T-13.40%, (Th-10.31%, TH-3.09%), nPh-2.06%.

Spectrum of phyto-geographical elements: Eua-25.77%, Eur-12.37%, Eurosib (21.64%), Paleotemp (10.30%, Med-5.15%, Circumbor-6.18%, Eur-Cauc-8.24%, Oroph-2.06%, Balc-3.09%, Cosm-4.12%, Adv-1.03%.

Caryological spectrum: diploid (46.39%), poliploid (48.45%), diplo-poliploid (5.15%).

Table 8: Thymio pannonici-Chrysopogonetum grylli Doniță et al., 1992.

Relevée	1	2	3	4	5	6	7	8	
Altitude (m s.m.)	400	400	472	518	528	543	495	543	
Aspect	E	E	-	SV	V	S	-	S	
Slope (°)	45	30	-	45	40	30	-	30	
Area (m^2)	100	100	100	100	100	100	100	100	
Vegetation cover (%)	100	100	100	100	100	100	100	100	K
Characteristic association									
Chrysopogon gryllus	4	4	4	5	5	5	5	4	V
Thymus pannonicus	2	1	1	+	+	+	+	+	V
Festucion rupicolae									
Astragalus monspessulanus	+	+	-	-	-	+	-	-	II
Dorycnium pentaphyllum herbaceum	-	-	+	+	+	-	+	+	IV
Knautia arvensis	-	+	-	+	+	-	+	-	III
Polygala major	+	+	+	+	+	+	+	+	V
Festucetalia valesiacae									
Anthemis tinctoria	+	+	-	-	-	-	-	-	II
Anthericum ramosum	1	2	1	+	+	-	+	-	IV
Asperula cynanchica	-	+	+	+	+	-	+	+	IV
Astragalus onobrychis	-	-	-	+	-	+	-	-	II
Brachypodium pinnatum	-	-	+	+	+	+	+	-	IV
Bupleurum falcatum	-	-	+	+	+	+	+	-	IV
Campanula sibirica	+	+	+	+	+	-	+	-	IV
Centaurea rhenana	-	-	+	-	-	-	-	+	II
Centaurea scabiosa	+	+	-	-	+	-	+	+	IV
Chamaecytisus albus	+	+	+	+	+	-	+	+	V

Relevée	1	2	3	4	5	6	7	8	
Coronilla varia	+	+	+	+	+	-	-	-	IV
Dianthus carthusianorum	+	+	+	+	+	-	+	-	IV
Dichanthium ischaemum	-	-	-	-	-	+	+	+	II
Erigeron acris	+	-	-	-	+	-	-	+	II
Eryngium campestre	-	-	+	-	-	-	+	+	II
Euphorbia cyparissias	+	-	-	-	-	-	-	+	II
Festuca valesiaca	+	+	-	+	-	-	-	+	III
Festuco-Brometea									
Agrostis capillaris	-	+	-	-	-	+	-	-	II
Galium verum	-	+	+	-	+	-	-	-	II
Helianthemum nummularium	+	-	-	+	-	+	-	-	II
Hypericum perforatum	-	-	+	-	+	-	-	-	II
Koeleria macrantha	-	-	-	-	-	+	+	-	II
Linum flavum	-	-	-	-	-	+	+	+	III
Lotus corniculatus	-	+	-	-	+	-	-	+	III
Medicago minima	+	-	-	-	+	-	+	+	III
Muscari tenuiflorum	-	-	-	-	+	-	+	-	II
Onobrychis viciifolia	+	+	1	+	+	-	-	+	IV
Peucedanum cervaria	-	-	+	+	+	1	+	-	IV
Plantago media	-	+	+	+	-	-	-	-	II
Prunella grandiflora	-	-	+	+	+	+	+	-	IV
Salvia pratensis	+	-	-	+	-	-	-	-	II
Salvia verticillata	-	-	-	+	-	-	-	+	II
Scabiosa ochroleuca	+	+	+	-	+	-	+	+	IV
Senecio jacobaea	+	-	-	+	-	-	-	-	II
Teucrium chamaedrys	+	+	+	+	-	-	-	+	IV
Trifolium medium	-	-	+	+	-	-	-	-	II
Trifolium montanum	-	-	+	+	-	-	-	-	II
Veronica spicata ssp.orchidea	+	+	+	-	-	-	+	+	IV
Arrhenatheretalia (incl. Molinio- Arrhenatheretea)									
Briza media	+	+	+	-	-	-	-	+	III
Dactylis glomerata	+	+	-	-	-	-	-	+	III
Leucanthemum vulgare	-	+	+	-	-	-	-	-	II
Ononis arvensis	-	-	+	-	-	-	-	+	II
Rhinanthus angustifolius	-	-	+	-	-	-	-	+	II
Stachys officinalis	+	+	+	-	-	-	-	-	III
Origanetalia vulgaris									
Campanula rapunculoides	-	-	+	-	-	-	-	+	II
Origanum vulgare	+	-	-	-	-	-	-	+	II
Querco-Fagetea									
Allium scorodoprasum	+	-	+	-	-	-	-	-	II
Lembotropis nigricans	+	+	+	-	-	-	-	-	II
Variae syntaxa									
Cuscuta europaea	+	-	+	-	-	-	-	-	II

Species present in a single relevée: *Linum perenne* (1), *Jurinea mollis* (1), *Silene otites* (1), *Verbascum phoeniceum* (1), *Anthyllis vulneraria* (2), *Plantago lanceolata* (2), *Salvia nemorosa* (2), *Carum carvi* (2), *Prunella vulgaris* (2), *Alopecurus pratensis* (3), *Anthoxanthum odoratum* (3), *Arrhenatherum elatius* (3), *Cichorium intybus* (3), *Erigeron annuus* (3), *Filipendula vulgaris* (3), *Linum catharticum* (3), *Melilotus officinalis* (3), *Pimpinella saxifraga* (3), *Vicia craca* (3), *Ceratium holosteoides* (5), *Trifolium pannonicum* (5), *Epipactis palustris* (6), *Linum hirsutum* (6), *Orchis coriophora* (6), *Asparagus officinalis* (7), *Astragalus austriacus* (7), *Falcaria vulgaris* (7), *Nepeta nuda* (8), *Orchis tridentata* (8), *Elymus hispidus* (8), *Agrimonia eupatoria* (8), *Allium oleraceum* (8), *Bromus erectus* (8), *Carlina vulgaris* (8), *Galium album* (8), *Medicago falcata* (8), *Medicago lupulina* (8), *Peucedanum oreoselinum* (8), *Achillea millefolium* (8), *Tragopogon pratensis* ssp. *orientalis* (8), *Festuca rupicola* (8), *Rosa gallica* (8).

Places and dates of relevées: R1,2-Laslea, N 46°11',E 24°38', 2004.07.07; R3- Floreşti, N 46°09', E 24°39', 16.07.2004; R4-7: Nou Săsesc,N 46°05', E 24°36', 16.07.2004; R8 – Stejărişu; N 46°03', E 24°39', 2007.07.24.

NATURA 2000: 62C0 Ponto-Sarmatic steppes (Priority)

Elytrigietum hispidi (Dihoru, 1970) Popescu *et* Sanda 1988

The phytocenozes of *Elymus hispidus* comprised two principal categories of species: steppe species, characterised by the class Festuco-Brometea, and elements occuring along the margins of forests and in grasslands (Tab. 9). In the study area the phytocenozes of these associations were found on steeply-inclined slopes of southerly and south-westerly aspect, in localities Apold, Daia, Ruja, Ţeline and Grânari.

The 119 species of cormophytes which comprise this association belong mainly to the cenotaxa of the class Festuco-Brometea.

The large number of xero-mezophyte species (60.5%) and xerophyte (16.80%) micro-mezotherms (48.74%) followed by moderate-thermophylic species (28.57%) and weakly acid-neutrophylic species (48.74%) reflects the edapho-climatic conditions of the area.

Life-form spectrum: Ch-5.04%, H-69.76%, G-5.88%, T-14.28 % (Th-7.56%, TH-6.72%), Ph-5.04 (mPh-2.52%, nPh-2.52%).

Spectrum of phyto-geographical elements: Eua-24.38%, Eur-16.80%, Med-12.61%, Eurosib-11.77%, Pont-Pann-10.08%, Paleotemp-9.24%, Eur-Cauc and Circumbor-3.36% each, Oroph and Siber-1.68% each, Balc and Dac-Balc-0.84% each, Adv-0.84%, Cosm-2.52%.

Caryological spectrum: diploid (46.22%), poliploid (38.66%), diplo-poliploid (8.40%), ?- 6.72%.

Table 9: Elytrigietum hispidi (Dihoru, 1970) Popescu et Sanda, 1988.

Relevée	1	2	3	4	5	6	
Altitude (m s.m.)	594	550	518	508	595	580	
Aspect	S	S	S	-	SV	V	
Slope (°)	40	40	15	-	10	3	
Area (m^2)	100	100	100	100	100	100	
Vegetation cover (%)	89,5	66,5	96,5	75,5	84	97	K
Characteristic association							
Elymus hispidus	4	3	4	4	3	4	V

Relevée	1	2	3	4	5	6	
Festucetalia valesiacae							
Allium oleraceum	-	2	+	-	-	-	II
Anthericum ramosum	-	-	-	-	+	+	II
Bupleurum falcatum	+	-	-	-	-	+	II
Centaurea rhenana	+	-	+	-	+	-	III
Cerinthe minor	+	-	-	+	-	-	II
Chamaecytisus albus pallidus	-	+	+	-	+	1	IV
Euphorbia salicifolia	+	-	+	-	-	-	II
Euphorbia virgata	-	-	-	-	+	+	II
Fragaria viridis	+	+	+	-	-	-	III
Inula ensifolia	+	+	2	-	-	-	III
Linum hirsutum	+	-	+	-	-	-	II
Senecio jacobaea	+	-	+	-	-	+	III
Stachys recta	+	-	+	+	+	-	IV
Thymus pannonicus	+	-	-	-	+	-	II
Cirsio-Brachypodion							
Brachypodium pinnatum	+	-	+	-	2	-	III
Onobrychis viciifolia	+	-	+	-	-	+	III
Festuco-Brometea							
Agrimonia eupatoria	+	-	+	+	-	-	III
Asperula cynanchica	+	+	+	+	+	+	V
Astragalus monspessulanus	-	+	-	-	+	-	II
Centaurea apiculata spinulosa	-	-	-	+	-	+	II
Clinopodium vulgare	+	-	+	-	-	-	II
Coronilla varia	+	-	+	-	-	+	III
Dianthus carthusianorum	-	-	+	+	-	+	III
Dichantium ischaemum	-	-	-	+	+	1	III
Dorycnium pentaphyllum herbaceum	+	+	+	-	-	+	IV
Echium vulgare	+	-	-	-	+	-	II
Erigeron acris	-	-	-	+	-	+	II
Eryngium campestre	+	+	+	-	-	+	IV
Euphorbia cyparissias	+	+	+	-	-	-	III
Falcaria vulgaris	-	+	-	-	+	+	III
Filipendula vulgaris	-	-	-	-	+	+	II
Galium mollugo	-	+	+	-	+	-	III
Hypericum perforatum	+	-	+	-	-	-	II
Lavatera thuringiaca	+	+	-	+	+	-	IV
Lotus corniculatus	+	-	+	+	-	-	III
Medicago falcata	+	-	+	+	-	+	IV
Muscari comosum	+	+	-	-	+	-	III
Plantago media	-	-	-	+	-	+	II
Potentilla recta	+	+	-	-	+	-	III
Salvia verticillata	+	-	+	-	+	+	IV
Scabiosa ochroleuca	+	-	+	+	+	-	IV
Teucrium chamaedrys	+	+	+	+	+	-	V
Thalictrum minus	-	-	+	+	+	-	III
Veronica spicata ssp. *orchidea*	+	+	+	-	+	-	IV

Relevée	1	2	3	4	5	6	
Molinio-Arrhenatheretea							
Achillea millefolium	+	+	-	+	+	+	V
Agrostis capillaris	-	-	-	+	-	1	II
Briza media	-	-	-	+	-	+	II
Crepis biennis	+	-	-	-	-	+	II
Dactylis glomerata	+	-	-	+	-	+	III
Knautia arvensis	+	-	-	-	+	-	II
Ranunculus polyanthemos	-	-	-	+	-	+	II
Stachys officinalis	-	-	-	+	-	+	II
Tragopogon pratensis orientalis	+	-	-	-	+	+	III
Variae syntaxa							
Convolvulus arvensis	+	-	+	-	-	+	III

Species present in a single relevée: *Asparagus officinalis* (1), *Asperula tinctoria* (1), *Allium scorodoprasum* (1), *Astragalus glycyphyllos* (1), *Crataegus monogyna* (1), *Cuscuta europaea* (1), *Erysimum odoratum* (1), *Erigeron annuus* (1), *Echinops sphaerocephalus* (1), *Centaurea nigrescens* (1), *Prunus spinosa* (1), *Nonea pulla* (1), *Rosa canina* (1), *Cichorium intybus* (1), *Clematis recta* (1), *Ononis arvensis* (1), *Melilotus officinalis* (1), *Potentilla reptans* (1), *Senecio vulgaris* (1), *Clematis vitalba* (2), *Cornus sanguinea* (2), *Artemisia pontica* (2), *Brassica elongata* (2), *Koeleria macrantha* (2), *Iris pumila* (2), *Jurinea mollis* (2), *Linum flavum* (3), *Salvia pratensis* (3), *Festuca valesiaca* (3), *Alopecurus pratensis* (3), *Lembotropis nigricans* (3), *Anthoxanthum odoratum* (4), *Nepeta nuda* (4), *Salvia nutans* (4), *Leucanthemum vulgare* (4), *Linum catharticum* (4), *Pimpinella saxifraga* (4), *Astragalus austriacus* (5), *Inula bifrons* (5), *Adonis vernalis* (5), *Vincetoxicum hirundinaria* (5), *Melica ciliata* ssp. *transsilvanica* (5), *Artemisia campestris* (5), *Potentilla arenaria* (5), *Stachys germanica* (5), *Galium glaucum* (5), *Marubium vulgare* (5), *Hypericum elegans* (5), *Inula hirta* (5), *Chamaecytisus hirsutus* (5), *Echinops ruthenicus* (5), *Galium verum* (6), *Polygala major* (6), *Anthyllis vulneraria* (6), *Festuca rupicola* (6), *Peucedanim cervaria* (6), *Poa pratensis* ssp. *angustifolia* (6), *Trifolium alpestre* (6), *Carlina acaulis* (6), *Daucus carota* (6), *Primula veris* (6), *Rhinanthus rumelicus* (6), *Euphorbia esula* (6), *Campanula sibirica* (6).

Places and dates of relevees: R1 - Daia, N 46° 09’, E 24° 53’, 2004.07.23; R2 - Apold, N 46°06’, E 24°49’, 2004.07.23; R3 - Archita, Calea Groapelor, N 46°11’, E 25°06’, 2006.07.08; R4 - Ruja, N46°03’, E24°38’; 2007.0723; R5 - Ţeline; N46°03’, E24°54’; 2007.07.30; R6 - Grânari; N46°01’, E24°58’; 2007.08.06.

Stipetum capillatae (Hueck, 1931) Krausch, 1961

The phytocenozes of this association we analysed are widespread on the southern or intermediate slopes of hills of moderately to steep slope, with high aridity and high exposure to sun. In the floristic composition (126 cormophyte species, Tab. 10) we observe species of order Festucetalia valesiacae.

The association is dominated by xero-mezophylic species (65,08%), followed by xerophylic (19.05%), micro-mezothermic species (49.22%), followed by moderate-thermophylic (34.12%), weakly acid-neutrophylic species (54.76%) and acid-neutrophylic species (21.44%).

Life-form spectrum: Ch-5.55%, H-65.88%, G-10.32%, T-13.5% (Th-5.55%, TH-7.95%), Ph-4.75% (MPh-0.79%, mPh-1.58%, nPh-2,38%).

Spectrum of phyto-geographical elements: Eua-26.98%, Eur-15.88%, Med-11.11% and Pont-Pann-11.11%, Eurosib-10.33%, Paleotemp-6.36%, Eur-Cauc-4.76%, Circumbor-3.98%, Balc-1.58%, Dac-Balc-1.58%, Oroph-1.58%, Siber-1.58%, Trans(end)-0.79%, Cosm-2.38%.

Caryological spectrum: D-39.68%, P-35.71%, D-P-13.49%, ?-11.12%.

Table 10: *Stipetum capillatae* (Hueck, 1931) Krausch, 1961.

Relevée	1	2	3	4	5	6	
Altitudea (m s.m.)	497	547	547	569	576	594	
Aspect	E	SE	S	S	SE	S	
Slope (°)	45	40	40	5	15	10	
Area (m^2)	100	100	100	100	100	100	
Vegetation cover (%)	83,5	89,5	91	78,5	74	78,5	K
Characteristic association							
Stipa capillata	3	4	4	3	3	3	V
Festucetalia valesiacae							
Adonis vernalis	-	-	-	-	+	+	II
Astragalus onobrychis	-	-	-	-	+	+	II
Asyneuma canescens	-	-	+	-	+	+	III
Brassica elongata	+	+	+	-	-	-	III
Bupleurum falcatum	+	+	+	-	-	-	III
Campanula sibirica	+	-	+	+	+	+	V
Carlina biebersteinii biebersteinii	+	+	+	-	-	+	IV
Centaurea apiculata spinulosa	+	+	-	-	+	-	III
Cerinthe minor	-	+	+	-	-	+	III
Chamaecytisus albus	-	+	+	+	+	-	IV
Dorycnium pentaphyllum herbaceum	+	+	+	+	-	+	V
Elymus hispidus	+	-	-	-	-	+	II
Elymus hispidus ssp. *barbulatus*	-	+	+	+	+	-	IV
Eryngium campestre	-	+	+	+	+	+	V
Euphorbia virgata	-	+	-	+	-	-	II
Falcaria vulgaris	-	+	+	+	+	-	IV
Festuca rupicola	2	+	+	-	-	+	IV
Festuca valesiaca	-	+	+	-	-	+	III
Inula ensifolia	-	1	1	+	+	-	IV
Jurinea mollis	-	-	+	+	+	-	III
Linum flavum	-	+	-	-	-	+	II
Linum perenne	-	-	-	+	+	-	II
Potentilla arenaria	+	+	+	-	-	+	IV
Salvia nutans	-	-	-	-	2	+	II
Salvia transsilvanica	+	-	-	+	+	-	III
Stachys recta	+	+	+		+	+	V
Thalictrum minus	-	+	+	+	+	+	V
Thymus pannonicus	1	-	+	+	+	+	V
Veronica spicata orchidea	+	+	+	-	-	+	IV
Brometalia erecti							
Brachypodium pinnatum	+	+	+	+	-	-	IV
Teucrium chamaedrys	+	+	-	2	+	2	V

Relevée	1	2	3	4	5	6	
Festuco-Brometea							
Allium oleraceum	-	+	+	-	-	+	III
Anthericum ramosum	-	-	-	-	+	+	II
Artemisia campestris	-	+	+	1	+	+	V
Asparagus officinalis	-	-	+	-	+	+	III
Asperula cynanchica	-	+	+	+	+	-	IV
Astragalus austriacus	-	+	-	+	-	-	II
Astragalus monspessulanus	+	+	+	+	+	+	V
Campanula glomerata	+	+	+	-	-	-	III
Carex caryophyllea	+	+	+	-	-	-	III
Cephalaria radiata	+	+	+	-	+	-	IV
Clinopodium vulgare	+	-	-	+	-	-	II
Coronilla varia	+	-	+	-	-	-	II
Dichanthium ischaemum	-	-	-	+	+	+	III
Erysimum odoratum	-	-	-	+	-	+	II
Euphorbia cyparissias	+	-	+	-	-	-	II
Filipendula vulgaris	-	+	+	-	-	-	II
Inula salicina	-	+	+	-	-	-	II
Medicago falcata	-	+	+	-	-	-	II
Onobrychis viciifolia	-	-	-	+	+	+	III
Orobanche alba	+	+	-	-	-	-	II
Plantago lanceolata	+	-	-	+	-	-	II
Salvia verticillata	+	+	+	+	+	+	V
Scabiosa ochroleuca	+	-	-	+	+	+	IV
Molinio-Arrhenatheretea							
Briza media	-	+	+	-	-	-	II
Campanula patula patula	+	-	+	-	-	+	III
Dactylis glomerata	-	+	+	-	-	-	II
Rhinanthus rumelicus	-	+	+	-	-	-	II
Tragopogon pratensis orientalis	-	+	+	-	-	+	III
Querco-Fagetea							
Clematis vitalba	-	+	+	-	-	-	II
Crataegus monogyna	+	+	+	-	-	-	III
Prunus spinosa	+	+	+	-	-	-	III
Pyrus pyraster	+	+	+	-	-	-	III
Rosa canina	+	+	+	+	-	-	IV
Variae syntaxa							
Convolvulus arvensis	+	+	+	-	-	-	III
Laserpitium latifolium	-	+	+	-	-	-	II

Species present in a single relevée: *Agrimonia eupatoria* (1), *Calamagrostis epigeios* (1), *Clematis recta* (1), *Cichorium intybus* (1), *Knautia arvensis* (1), *Galium glaucum* (1), *Helianthemum nummularium* (1), *Hypericum perforatum* (1), *Hypericum elegans* (1), *Inula germanica* (1), *Linum catharticum* (1), *Myosotis arvensis* (1), *Ornithogalum pyramidale* (1), *Prunella vulgaris* (1), *Carduus hamulosus* (1), *Pimpinella saxifraga* (1), *Plantago media* (1), *Sanguisorba minor* (1), *Polygala major* (3), *Silene italica* (4), *Astragalus asper* (4), *Echium vulgare* (4), *Centaurea micranthos* (4), *Koelaria cristata* (4), *Linum austriacum* (4), *Phleum* *phleoides* (4), *Salvia nemorosa* (4), *Salvia pratensis* (4), *Elymus repens* (4), *Lembotropis nigricans* (4), *Medicago minima* (4), *Campanula rotundifolia* (5), *Nonea pulla* (5), *Orchis tridentata* (5), *Dianthus carthusianorum* (5), *Peucedanum oreoselinum* (5), *Gentiana cruciata* (5), *Euphorbia plathyphyllos* (5), *Eryngium planum* (5), *Gymnadenia conopsea* (5), *Allium fuscum* (5), *Senecio jacobea* (5), *Chamaecytisus hirsutus* (6), *Echinops ruthenicus* (6), *Fragaria viridis* (6), *Inula hirta* (6), *Melica transsilvanica* (6), *Muscari tenuiflorum* (6), *Verbascum phoenicetum* (6), *Veronica austriaca* (6), *Bromus inermis* (6), *Lavathera thuringiaca* (6), *Teucrium chamaedrys* (6), *Daucus carota* (6), *Ranunculus polyanthemos* (6), *Helleborus purpurascens* (6), *Vincetoxicum hirundinaria* (6), *Carlina acaulis* (6), *Inula bifrons* (6).

Places and dates of relevées: R1 - between Mureni and Archita, N 46°13’, E 25° 00’, 2006.07.14; R2 - Apold, by Movile, N 46°06’, E 24° 49’, 2006.08.12; R3 - Apold, by Movile, N 46°06’, E 24° 49’, 2006.08.12; R4 - Movile; N 46°01’, E 24° 49’, 2007.07.26; R5 - Movile; N 46°01’, E 24° 49’, 2007.07.26; R6 - Țeline; N 46°03’, E 24° 54’, 2007.07.30.

CONCLUSIONS

The phytocenozes identified were ascribed to the class Festuco-Brometea according to the system proposed by Mucina, Grabherr and Ellmauer (1993). Ten vegetation associations were identified.

In the flora of these grasslands a series of plant taxa were identified which are under various degrees of threat, including threatened at a European level (Tab. 11), or included in national Red Lists (Tab. 12): *Adenophora liliifolia*, *Cephalaria radiata*, *Salvia transsilvanica, Orchis coriophora, O. morio, O. tridentata, Euphorbia virgata* and *Inula bifrons*.

Table 11: List of species threatened at European level. Species included in Habitats Directive Annexes II b and IV b, Berne Convention - Appendix I and national Red List (Critical, Threatened, Vulnerable - not included in the first category).

Taxon	Family	Locality
Adenophora liliifolia (L.) Ledeb. ex A.DC.	Campanulaceae	Brădeni
Crambe tataria		Cloaşterf, Viscri
Cephalaria radiata Griseb. and Schenk (endemic to Romania)	Dipsacaceae	Brădeni, Criş, Mureni, Noiştat, Ruja, Țeline
Echium russicum		Mihai Viteazu
Salvia transsylvanica (Schur ex Griseb.) Schur (endemic to Romania)	Lamiaceae	Apold, Archita, Criş, Movile, Mureni

Table 12: List of threatened, vulnerable and rare species on national Red Lists. Abreviations: R - Rare; E - Threatened; V- Vulnerable; nt - near threatened.

IUCN Category	Taxon	Family	Locality
V	*Adonis vernalis* L.	Ranunculaceae	Cloaşterf, Mihai Viteazu, Movile, Țeline
nt	*Alcea pallida* (Willd.) Waldst. and Kit.	Malvaceae	Daia, Mureni
nt	*Bromus hordeaceus* L.	Poaceae	Daneş
R	*Cephalanthera rubra* (L.) Rich.	Orchidaceae	Beia, Movile

IUCN Category	Taxon	Family	Locality
V	*Dictamnus albus* L.	Rutaceae	Criş, Mihai Viteazu
R	*Epipactis palustris* (L.) Crantz	Orchidaceae	Criş, Daneş, Mihai Viteazu, Nou Săsesc
nt	*Euphorbia virgata* Waldst. and Kit.	Euphorbiaceae	Angofa, Apold, Beia, Grânari, Fişer, Iacobeni, Ruja, Movile, Noiştat, Ţeline, Vulcan
V	*Gentiana pneumonanthe* L.	Gentianaceae	Angofa, Brădeni
R	*Gymnadenia conopsea* (L.) R.Br.	Orchidaceae	Mihai Viteazu, Movile, Brădeni, Saschiz
V	*Inula bifrons* (L.) L.	Asteraceae	Angofa, Apold, Brădeni, Daia, Grânari, Noiştat, Ţeline
E	*Iris aphylla* L.	Iridaceae	Noiştat
R	*Limodorum abortivum* Swartz	Orchidaceae	Criş
R	*Orchis coriophora* L.	Orchidaceae	Apold, Brădeni, Daia, Daneş, Laslea, Mihai Viteazu, Mureni, Nou Săsesc, Saschiz, Şaeş, Vulcan
R	*Orchis militaris L.*	Orchidaceae	Brădeni
R	*Orchis morio* L.	Orchidaceae	Angofa, Daia, Daneş, Brădeni, Mureni to Archita, Şaeş, Vulcan
R	*Orchis tridentata* Scop.	Orchidaceae	Apold, Mihai Viteazu, Movile, Mureni to Archita, Stejărişu, Vulcan
R	*Orchis ustulata* L.	Orchidaceae	Daneş
V	*Prunus tenella* Batsch	Rosaceae	Mihai Viteazu
V	*Salvia nutans* L.	Lamiaceae	Mihai Viteazu, Movile, Ruja, Ţeline

ACKNOWLEDGEMENTS

We would like to thank Fundaţia ADEPT, through the good offices of Nathaniel Page and Jim Turnbull, and collaboration with UK botanists Dr. John Akeroyd and Dr. Andrew Jones, for making it possible for us to study in this area.

REFERENCES

1. Boşcaiu, et.al., 1994 – *Lista roşie a plantelor vasculare dispărute, periclitate, vulnerabile şi rare din flora României*, (in Romanian), Ocrot.Nat. Med.Înconj., Tom 38, 1, 45 - 56.
2. Braun-Blanquet, J., 1964 – *Pflanzensoziologie*, ed.III, Springer-Verlag ed., Wien, New-York.
3. Braun-Blanquet, J., Pavillard, J., 1928 – *Vocabulaire de Sociologie Végétale*, ed.3, Impr. Lemaire-Andres.
4. Burlescu, P., 2003 – *Flora şi vegetația zonelor umede din nord-vestul României*, (in Romanian), Ed. Acad. Române, Bucureşti.
5. Cristea, V., Gafta, D., Pedrotti F., 2004 - *Fitosociologie*, Ed. Presa Universitară Clujeană, Cluj-Napoca.
6. Csűrös, Şt., Kovács, A., 1962 – *Cercetări asupra vegetației din raioanele Sighişoara şi Agnita*, (in Romanian), Contribuții Botanice, Cluj, 205-232.
7. Doniță N., et al.2005,2006 – *Habitatele din România*, Ed. Tehnică Silvică, Bucureşti.
8. Drăgulescu, C., 2005 - *The Hydrophilous and Hygrophilous Flora and Vegetation of Târnave rivers*, Transylvanian Review of Syxtematical and Ecological Reserch, 2, Sibiu-Romania, 13-30.
9. Drăgulescu, C., 2006 – *Wiesen mit Chrysopogon gryllus in Süd-Siebenbürgen*, Contribuții botanice, Cluj, XLI (2), 53-59.
10. Grabherr, G., Mucina, L., 1993 - *Die Pflanzengesellschaften Österreich,* Teil II, VEB Gustav Fischer Verlag Jena, Stuttgart, New York.
11. Mountford , O., Akeroyd, J., 2005 – *A Biodiversity assessment of the Saxon Villages Rregion of Transylvania,* Transylvanian review of systematical and ecological research, 2, Sibiu-Romania.
12. Mucina, et. al., 1993a - *Die Pflanzengesellschaften Österreich,* Teil I, VEB Gustav Fischer Verlag Jena, Stuttgart, New York.
13. Mucina, et. al., 1993b - *Die Pflanzengesellschaften Österreich,* Teil III, VEB Gustav Fischer Verlag Jena, Stuttgart, New York.
14. Oltean, et. al., 1994 - *Listă roşie a plantelor superioare din România,* (in Romanian), in Studii, sinteze, documentații de ecologie, 1, Acad. Română, Instit. de Biologie, Bucureşti.
15. Oroian, S., 1998 – *Flora şi Vegetația Defileului Mureşului între Toplița şi Deda*, (in Romanian), Casa de Editură Mureş.
16. Pop, et. al., 2002 – *Vegetația județului Cluj (Studiu fitocenologic, ecologic, bioeconomic şi eco-protectiv)*, (in Romanian), Contribuții botanice, Cluj, 5-254.
17. Sanda, V., 2002 – *Vademecum ceno-structural privind covorul vegetal din România*, (in Romanian), Ed. Vergiliu, Bucureşti.
18. Sămărghițan, M., 2003 – *Pajişti xerofile din clasa Festuco-Brometea de pe Valea Gurghiului*, (in Romanian), Marisia XXVII, Fasc. 5, Tg-Mureş, 99-118.
19. Săvulescu, Tr. (red.), 1952 - 1976 – *Flora Republicii Populare Române şi Flora Republicii Socialiste România,* (in Romanian), I – XIII, Ed. Acad. Române, Bucureşti.
20. Tutin, T.G., 1991 - *Flora Europaea*, I, Ed.II, Cambridge University Press.
21. Tutin, et. al., (eds) 1964-1980 - *Flora Europaea*, 1-5, Cambridge University Press.
22. ***1991 - *CORINE biotopes manual. Check-list of threatened plants.* Part 1, Luxembourg.
23. ***1991 - *CORINE biotopes manual. Habitats of the European Community. Data specifications*. Part 2, Luxembourg.
24. *** 1991 - *CORINE biotopes manual. Metodology,* Luxembourg.
25. ***1996 – *CORINE biotopes. The design, compilation and use of sites of major importance for nature conservation in the European Community*, Brussels-Luxembourg.
26. *** 1999 – *Manuel d'interprétation des habitats de l'Union Européenne*, Strasbourg.
27. *** 2000 – *Convention on the Conservation of European wildlife and natural habitats. The Emerald Network – a network of Areas of Special Conservation Interest of Europe*, Strasbourg.
28. ***2000 – *Convention on the Conservation of European wildlife and natural habitats. Building up the Emerald Network: a guide for Emerald Network country team leaders*, Strasbourg.

ASPECTS REGARDING THE TERRESTRIAL MALACOFAUNA OF THE SAXON VILLAGES AREA OF SOUTHERN TRANSYLVANIA (ROMANIA)

Voichița GHEOCA *

* "Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Oituz Street 31, Sibiu, Sibiu County, Romania, RO - 550337, vgheoca@yahoo.com

KEYWORDS: Romania, Transylvania, Târnava River basin, biodiversity, malacofauna, terrestrial gastropods.

ABSTRACT

This paper presents qualitative results on the terrestrial malacofauna of the Saxon Villages area of Southern Transylvania. Sampling was carried out in August 2006 and included 29 sampling points, mostly in riverside thickets (20), but also in woodlands (5), on sunny slopes (3), and on ex-arable land (1). Fifty taxa were identified, included in 22 families. The highest species diversity was recorded in the Biertan Valley (26 species), in a riverside thicket, followed by Criț and Valchid (with 19 species each). The high number of taxa is due to the well-conserved riverside thickets in which live a large number of hygrophilous and meso-hygrophilous species. The most common terrestrial gastropods of the area are *Helix pomatia, Fruticicola fruticum, Zonitoides nitidus* and *Cochlicopa lubrica.* Local conditions allow the development of large populations of the genus *Helix*, which may represent, for the local population, an important source of income by collecting and raising these snails.

RĖSUMĖ: Aspects concernant les gastropodes terrèstres des villes saxonnes du sud de la Transylvanie (Roumanie).

Ce travail présent des résultates préliminaires qualitatives sur la malacofaune terrèstre du villes saxonnes du sud de la Transylvanie, apres une campagne au moi d'aut 2006. Le material provien de 29 stations de prélèvement, localisées dans des habitats riveraines des cours d'eau (20), mais aussi dans des habitats forestières (5), sur des pantes ensoleillés (3), et des anciennes terrains agricoles (1). Ils ont été identifiées 50 espèces appartenant a 22 families. La diversité specifique la plus elevée a été trouve sur la vallée de Biertan (26 espèces), suivie par Criț et Valchid (19 espèces). Le nombre elevé des gastropodes terrèstres est déterminée par la bonne conservation de la végétation riveraine des cours d'eau qui abrite un grand nombre d'espèces hygrophiles et mesohygrophiles. Les plus communes espèces dans la region sont *Helix pomatia, Fruticicola fruticum, Zonitoides nitidus* et *Cochlicopa lubrica*. Les conditions locales pèrmetent le développement des population importantes appartenent au gen Helix, qui peut représenté une importante source d'argent pour les gents de la région.

REZUMAT: Aspecte privind malacofauna terestra a zonei satelor săseşti din sudul Transilvaniei (România).

Lucrarea prezintă date calitative, privind malacofauna terestră din rezultatele unei campanii desfăşurate în august 2006 şi care a cuprins 29 de stații localizate în zona investigată, majoritatea în zăvoaie (20), dar şi în habitate forestiere (5), pe pante însorite (3) şi pe terenuri arabile necultivate (1). Au fost identificate 50 de specii de gastropode terestre, aparținând la 22 de familii. Cea mai mare diversitate specifică a fost înregistrată pe valea Biertanului, în zăvoi, unde au fost identificate 26 de specii, de asemenea la Criț şi Valchid, (19 specii). Numărul relativ mare de specii se datorează zăvoaielor bine conservate care adăpostesc un numar mare de specii higrofile şi mezohigrofile. Cele mai comune specii de gastropode terestre sunt *Helix pomatia, Fruticicola fruticum, Zonitoides nitidus* şi *Cochlicopa lubrica*. Condițiile locale permit, în zăvoaie în special, dezvoltarea unor populații importante, aparținând genului Helix, care pot reprezenta o sursă substanțială de venit pentru populația locală, atât prin colectare, dar mai ales, prin creştere intensivă.

INTRODUCTION

In the past, the importance of land snails and their relationship to a variety of higher organisms was largely ignored. Live snails and their shells provide a food source and calcium supplement for a variety of animals. Many small mammals such as shrews and mice include land snails in their diet. Their shells are an important source of calcium for many birds and some snail species are also of interest for the human diet. The situation of land snail declines during the past century have been attributed to a variety of threats, including the loss of indigenous habitats as a result of urban sprawl and other changes in land use, acid rain, and the introduction of new species.

The conservation of a habitat must consider all the aspects leading to a good function and needs to start with the knowledge of its actual condition. This is also the context for the present work, a piece in the puzzle intended to describe the region of the Saxon Villages in southern Transylvania, and find the instruments and resources for its conservation.

MATERIAL AND METHODS

Qualitative samples were collected in 2006, including soil samples, and the gastropods identified. Twenty-nine sites were selected in the study area; the location of the sampling sites and the type of vegetation is presented as follows:

S1 Bârghiş - Salicetum albae-fragilis (46°00’33’’ N, 24°31’09’’ E, 462 m alt.)
S2 Pelişor - Richiş - Carpinetum (46°03’58’’ N, 24°28’55’’ E, 478 m alt.)
S3 1 km fom Richiş - Fagetum (46°04’47’’ N, 24°28’41’’ E, 480 m alt.)
S4 Biertan Valley near village - Salicetum albae-fragilis (46°07’28’’ N, 24°30’12’’ E, 405 m alt.)
S5 Valchid Valley upstream Copşa Mare - Salicetum albae-fragilis (46°06’59’’ N, 24°32’27’’ E, 423 m)
S6 Copşa Mare - Festucetum rupicole
S7 Valchid - Salicetum albae-fragilis
S8 Hoghileag - Salicetum albae (46° 12’ 53’’ N 24° 36’ 06’’ E alt 302 m)
S9 Laslea - Salicetum albae-fragilis (46° 11’ 05’’ N 24° 31’ 09’’ E alt 462 m)
S10 Roandola - Salicetum albae-fragilis (46° 09’ 21’’ N 24° 35’ 58’’ E alt 326 m)
S11 Nou Săsesc - Fagetum (46° 05’ 38’’ N 24° 36’ 21’’ E alt 430 m)
S12 Nou Săsesc 2 - Salicetum albae-fragilis (46° 05’ 31’’ N 24° 36’ 29’’ E alt 423 m)
S13 Laslea - Mălâncrav - Salicetum albae-fragilis (46° 10’ 50’’ N 24° 38’ 36’’ E alt 386 m)
S14 Mălâncrav - Chrysopogonetum grilli (46° 07’ 12’’ N 24° 38’ 55’’ E alt 432 m)
S15 Mălâncrav - Salicetum albae-fragilis (46° 07’ 40’’ N 24° 38’ 29’’ E alt 415 m)

S16 1 km upstream Daneş - Salicetum albae-fragilis (46° 12' 18'' N 24° 42' 29'' E alt 358 m)
S17 Criş - Salicetum albae-fragilis (46° 12' 22'' N 24° 42' 26'' E alt 354 m)
S18 Stejăriş - Festucetum rupicole (46° 09' 40'' N 24° 43' 03'' E alt 417 m)
S19 Apold - Querco-carpinetum (46° 10' 38'' N 24° 45' 24'' E alt 410 m)
S20 Between Apold and Daia - Salicetum albae-fragilis (46° 09' 40'' N 24° 43' 03'' E alt 417 m)
S21 Saschiz - Tanaceto-Artemisietum vulgaris (46° 11' 00'' N 24° 58' 15'' E alt 415 m)
S22 Criț - Salicetum albae-fragilis (46° 07' 03'' N 25° 01' 38'' E alt 485 m)
S23 Viscri la 2 km de Dacia - Salicetum albae-fragilis (46° 02' 37'' N 25° 07' 16'' E alt 504 m)
S24 1 km amonte de Dacia - Salicetum albae-fragilis (46° 01' 42'' N 25° 08' 34'' E, alt 489 m)
S25 Lovnic - Salicetum albae-fragilis (46° 00' 06'' N 25° 02' 26'' E alt 491 m)
S26 Văleni - Şoarş - Salicetum albae-fragilis (45° 56' 00'' N 24° 56' 55'' E alt 493 m)
S 27 Bărcuț - Querco petreae carpinetum (45° 59' 17'' N 24° 55' 29'' E alt 491 m)
S28 Bărcuț - Salicetum albae-fragilis (46° 00' 43'' N 24° 55' 08'' E alt 505 m)
S29 Retiş - Brădeni - Salicetum albae-fragilis (46° 03' 38'' N 24° 50' 59'' E, alt 505 m)

RESULTS AND DISCUSSIONS

References concerning the terrestrial malacofauna of the area studied are poor, and only sporadic (Bielz, 1843; Bielz, 1867; Kimakowicz, 1883 - 1884; Grossu, 1955, 1956, 1981, 1983, 1987, 1993). Gheoca (2004) is used as base for comparison.

Among the investigated sites, 20 sampling points were in riverside thickets, five in woodland, three on sunny slopes and one on former arable land. Fifty species of terrestrial gastropods were identified from 22 families, the most important, in number of species, being the families Helicidae, Clausilidae and Hygromiidae (Fig. 1).

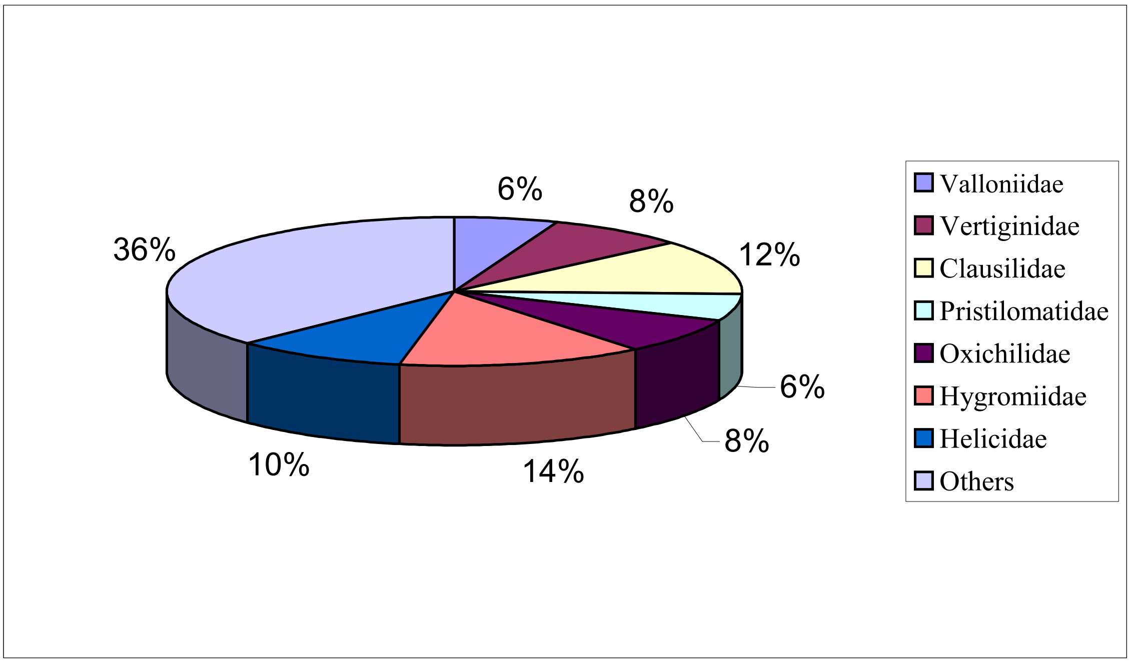


Figure 1: The distribution of species in terrestrial gastropod families.

The species of Helicidae family were found in 28 stations, Clausilidae in 22, Bradibenidae and Hygromiidae in 20, and Coclicopidae in 19 (Fig. 2).

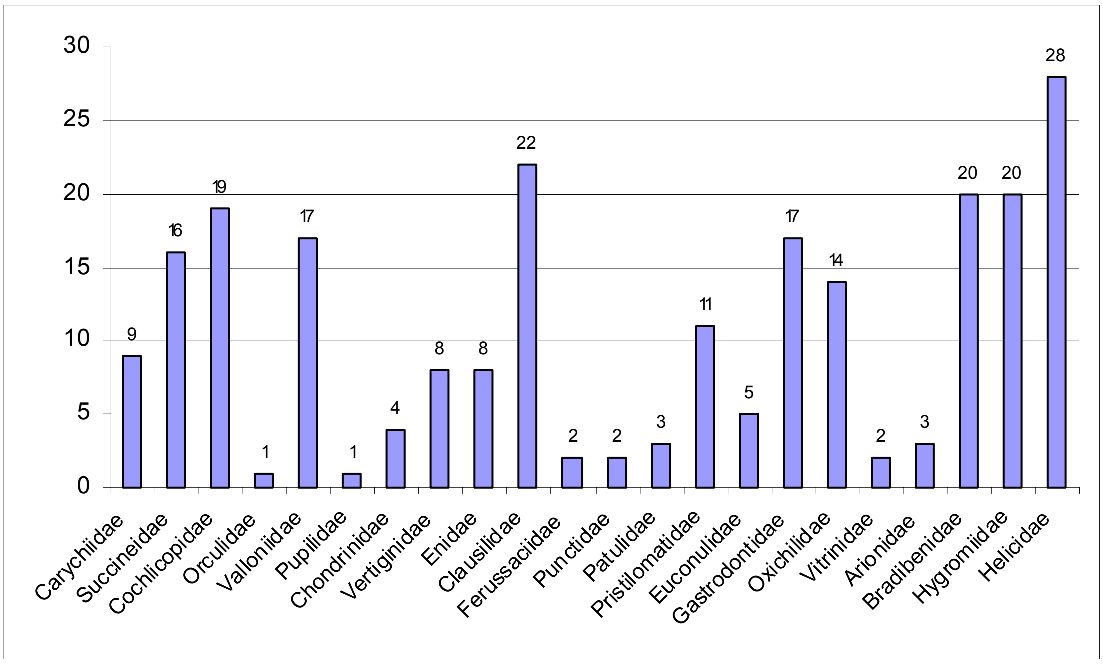


Figure 2: Number of sampling stations at which each terrestrial gastropod family was found.

The highest number of species was found in riverside thickets: we can mention Biertan with 26 species, and Criț and Valchid with 19. This number is due to the fact that this habitat is generally rich in snails, because of the vegetation and humidity, and this type of habitat was the most extensively investigated (20 of the 29 sampling points). The remainder of the stations had between 4 and 16 species. A study made on the Târnava River basin (Gheoca, 2004) found a very reduced number of species at each sampling point, mostly between 3 and 6, except the sampling points from woodlands. This difference can be explained by the absence of riverside thickets in the main course of the Târnava Mare, Târnava Mica and Târnava rivers, which in the area of the Saxon villages are present and well conserved.

The most widespread gastropod species is *Helix pomatia*, found in 24 of 29 sampling points, followed by *Fruticicola fruticum* found at 20 stations, *Zonitoides nitidus* and *Cochlicopa lubrica* at 15 stations (Fig. 3).

This situation is probably due to the fact that it is a heterogeneous area, not fully studied before and there are only few sporadic references concerning terrestrial gastropods. As we mentioned before, the majority of sampling points were riverside thickets, and the other habitats are poorly or not represented.

The comparative analysis of this list of taxa and the references on the malacofauna of this area show that 23 of the 50 species found in 2006 are not signalled for the region, but also 13 of the 39 noted before (Bielz, Kimakowicz, Grossu, Gheoca) were not found, mostly hygromiid (*Zenobiella rubiginosa, Z. umbrosa, Hygromia transylvanica, Trichia bielzi, Perforatella dibothryon*) and clausilid (*Cochlodina orthostoma, Macrogastra latestriata, Clausilia pumila, Vestia turgida, Bulgarica cana*) species. Undoubtedly, further investigations are necessary for the completion of this list of taxa.

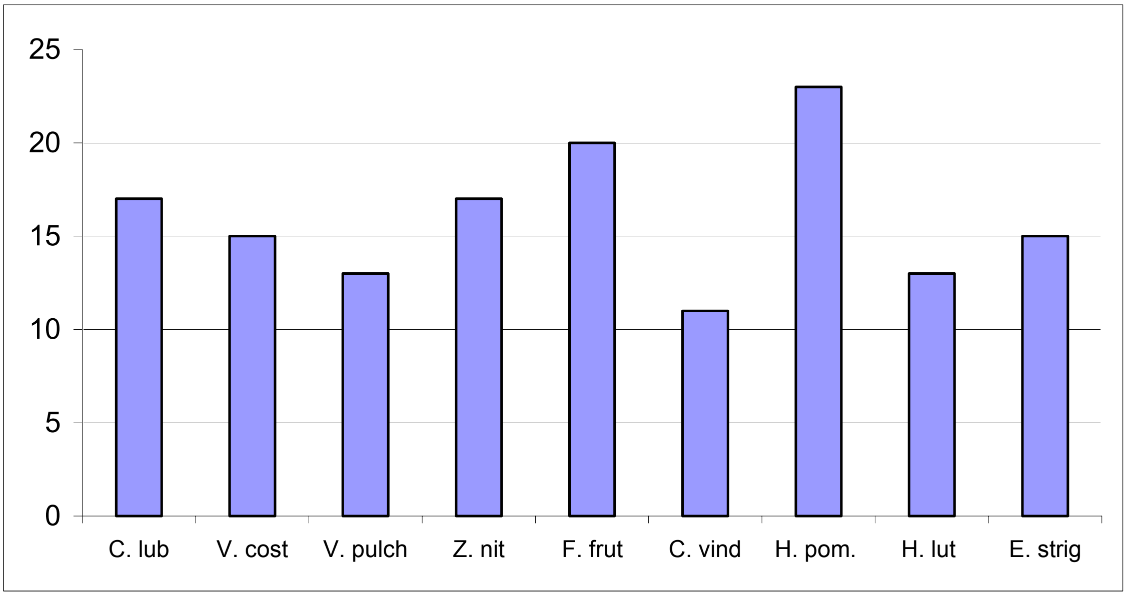


Figure 3: Number of sampling stations for the commonest species:
Cochlicopa lubrica, Vallonia costata, V. pulchella, Zonitoides nitidus, Fruticicola fruticum, Cepaea vindobonensis, Helix pomatia, H. lutescens, Euomphalia strigella).

It should be mentioned that we have found important populations of *Helix pomatia* and *H. lutescens*, the first present in 24 of 29 sampling points and the second in 13 of them. We emphasize that *Helix pomatia* is a species from Annex 3 of the Bern Convention, concerning protected plants and animals, and also in Annex 5B of the law 462/2001 concerning species of community interest for which exploitation requires management.

Both species are valuable economically, and good conservation of habitats and their judicious exploitation may represent a source of income for the local population. Also, the existence of favorable conditions for the development of these species, and especially for *Helix pomatia*, the most valuable species of the genus *Helix* strictly and protected in western Europe, give the opportunity to develop snail farms.

Systematic list

The systematic list of the terrestrial gastropods found in the study area is presented below. A species previously recorded (Bielz, 1843, 1867; Grossu 1951, 1956, 1981, 1983, 1987, 1993; Kimakovicz, 1883, 1884) is marked with 'ref.'.

Carychiidae Jeffreys, 1830

Carychium minimum Müller 1774 (S1, 4, 12, 13, 15, 20, 21, 22, 23, 25, 29, ref)

Succineidae Beck, 1826

Succinea putris Linnaeus, 1758 (S4, 7, 18, 20, 24, ref)

Succinea oblonga Draparnaud, 1801 (S1, 4, 5, 7, 9, 12, 13, 15, 17, 21, 22, 23, 25, 29, ref)

Cochlicopidae Pilsbry, 1900

Cochlicopa lubrica Müller, 1774 (S1, 4, 5, 7, 9, 10, 12, 13, 17, 20, 21, 22, 24, 25, 26, 28, 29, ref)

Cochlicopa lubricella Rossmässler, 1835 (S6, S11)

Orculidae, Pilsbry, 1900
Sphyradium doliolum Bruguière, 1792 (S11)
Valloniidae Morse, 1864
Vallonia pulchella Müller, 1774 (S1, 4, 5, 7, 9, 13, 15, 21, 22, 23, 25, 26, 29, ref)
Vallonia costata Müller, 1774 (S4, 7, 9, 11, 12, 13, 15, 17, 20, 21, 22, 23, 25, 26, 29, ref)
Vallonia excentrica Sterki, 1893 (S6)
Pupillidae, Turton, 1831
Pupilla muscorum Linnaeus, 1758 (S4)
Chondrinidae, Steenberg, 1925
Granaria frumentum Draparnaud, 1801 (S5, 14, 16, 18, ref.)
Vertiginidae Fitzinger, 1833
Vertigo pygmaea Draparnaud, 1801*(ref.)*
Columella edentula Draparnaud, 1805 (S4, 17, 22, 16, 28, 29, ref.)
Vertigo angustior Jeffreys, 1830 (S 29, ref.)
Vertigo antivertigo Draparnaud, 1801 (ref.)
Truncatellina cylindrica Férrusac, 1807 (S15, 23, ref.)
Enidae Woodward, 1903
Chondrula tridens Müller, 1774 (S4, 6, 11, 14, 16, 18, 22, ref.)
Merdigera obscura Müller, 1774 (S26)
Clausiliidae Gray, 1855
Cochlodina laminata Montagu, 1803 (S5, 13, 17, 19, 28, ref.)
Cochlodina orthostoma Menke, 1828 (ref.)
Ruthenica filograna Rossmässler, 1836 (S1, 7, 13, 17, 20, 22, 25, 26, 29, ref.)
Macrogastra plicatula Draparnaud, 1801 (S1, 2, 7, 13, 15, 19, 23)
Macrogastra latestriata Schmidt, 1858 (ref.)
Clausilia dubia Draparnaud, 1805 (S4, 9, 12, 13, 15, 21, 22, 23, 24, 25, 27)
Clausilia pumila Pfeiffer, 1828 (ref.)
Laciniaria plicata Draparnaud, 1801 (S4, 8, 13, 15, 17, 24, 25, 28, 29, ref.)
Vestia elata Rossmässler, 1836 (S9, ref.)
Vestia turgida Rossmässler, 1836 (ref.)
Bulgarica cana Held, 1836 (ref.)
Ferrusaciidae Bourguignat, 1883
Cecilioides acicula Müller, 1774 (S15, S29, ref.)
Punctidae, Morse, 1864
Punctum pygmaeum Draparnaud, 1801 (S11, S12)
Patulidae Tryon, 1866
Discus rotundatus Müller, 1774 (S22)
Discus ruderatus Hartmann, 1821 (S2, 4)
Pristilomatidae Cockerell, 1891
Vitrea transsylvanica Clessin, 1877 (S2, 4, 11, 17, 20, 21, 22)
Vitrea cristallina Müller, 1774, (S4, 7, 9, 10)
Vitrea diaphana Studer, 1820 (S4, 10 13, 21)

Euconulidae Baker, 1928
Euconulus fulvus Müller, 1774 (S4, 19, 22, 23, 28)
Gastrodontidae Tryon, 1866
Zonitoides nitidus Müller, 1774 (S1, 2, 4, 5, 7, 9, 10, 12, 13, 15, 17, 18, 19, 21, 22, 25, 29, ref.)
Oxychilidae Hesse, 1927
Oxychillus draparnaudi Beck, 1837 (S4, 27)
Aegopinella epidentosoma Fagot, 1869 (S2, 4, 5, 7, 9, 12, 13, 15, 18, 19, 21, 28)
Perpolita hammonis Strom, 1765 (S20, 28)
Nesovitrea petronella Pfeiffer, 1853 (S7, 19, 20)
Vitrinidae Fitzinger, 1833
Vitrina pellucida Müller, 1774 (S1, 15)
Arionidae Gray, 1840
Arion hortensis Férussac, 1819 (S4, 18, 20)
Bradybaenidae Pilsbry, 1934
Fruticicola fruticum Müller, 1774 (S1, 2, 3, 4, 5, 7, 8, 9, 12, 13, 15, 17, 18, 20, 21, 22, 25, 26, 28, 29, ref.)
Hygromiidae Tryon, 1866
Euomphalia strigella Draparnaud, 1801 (S1, 2, 3, 4, 5, 7, 8, 9, 11, 15, 21, 22, 23, 24, 27, ref.)
Xerolenta obvia Menke,1828 (S18, ref.)
Zenobiella rubiginosa Schmidt, 1858 (ref.)
Zenobiella umbrosa Pfeiffer, 1828 (ref.)
Hygromia transsylvanica Westerlund, 1876 (ref.)
Trichia bielzi Schmidt, 1860 (ref.)
Trichia hispida Linnaeus, 1758 (S7, 9)
Monacha cartusiana Müller, 1774 (S5, 18, ref.)
Monachoides incarnatus Müller, 1774 (S11, 12)
Monachoides vicinus Rossmässler, 1842 (S5, 7, 9, 18, 19, 20, 21, 22, 27, 28, ref.)
Perforatella bidentata Gmelin, 1791 (S4, 5, 7, 9, 12, 20, ref.)
Perforatella dibothryon Kimakowicz, 1890 (ref.)
Helicidae, Rafinesque, 1851
Faustina faustina Rossmässler, 1835 (S4, 5, 7, 10, 19, 20, ref.)
Isognomostoma isognomostomos Schroter, 1784 (S13, 19, 20, ref.)
Cepaea vindobonensis Pheiffer, 1828 (S1, 2, 6, 7, 14, 15, 18, 21, 22, 23, 29, ref.)
Helix pomatia Linnaeus, 1758 (S1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 29, ref.)
Helix lutescens Rossmässler, 1837 (S1, 3, 4, 6, 8, 9, 23, 24, 25, 26

CONCLUSIONS

The area investigated is very rich with regard to terrestrial malacofauna, due to the diversity of the habitats, and their relatively good conservation status. The existence of many water courses and riverside thickets made the hygrophilous and mezohygrophilous species numerically dominant. The sunny slopes with xerophylous and mezoxerophylous vegetation develop large populations of several species characteric of this habitat. The malacofauna is completed by the woodland species, of which the reduced number is caused by the climatic conditions at the time of sampling, and also the small number of samples taken in this type of habitat. Certainly, their number is more important. Further investigations are needed, especially in woodlands.

A quantitative analysis will be able to bring more information on the situation and perspectives of molluscan communities of the Saxon Villages.

ACKNOWLEDGEMENTS

The author is grateful to the Darwin Initiative of the UK Ministry of Agriculture (DEFRA), Orange Romania, and the NGOs Fundatia ADEPT and Ecotur Sibiu for supporting both the fieldwork and the publication of this paper.

REFERENCES

1. Bielz, A.E., 1867 − Fauna der Land- und Süsswasser-Mollusken Siebenbürgens. Zweite aufl., *Comissions-Verlag v.Filtsch*, Hermannstadt.
2. Bielz, M., 1843 − Aufzählungen der Siebenbürgischen Land- und Süsswasser-Mollusken. *Kronstädter Zeitung*.
3 Gheoca, V. 2004 − Preliminary note concerning the terrestrial malacofauna of the Târnava hydrographic basin, *Transylv. Rev. Syst. Ecol Res. 2: 5-9.*
4. Grossu, Al.V., 1955 − Gastropoda, Pulmonata, Mollusca, *Fauna R.P.R.,* 3, 1: 1-520 Edit.Litera, Bucuresti : 1-524.
5. Grossu, Al.V., 1956 − *Gastropoda, Prosobranchia si Opistobranchia din R.P.R*. 3: 1-220.
6. Grossu, Al.V., 1981 − *Gastropoda Romaniae*. Vol. 3: Subclasa Pulmonata, Ord. Stylommatophora: Suprafam. Clausiliacea ; Achatinacea. Edit.Litera, Bucuresti : 1-269.
7. Grossu, Al.V., 1983 − *Gastropoda Romaniae*. Vol. 4: Subclasa Pulmonata, Ord. Stylommatophora: Suprafam. Arionacea, Zonitacea, Ariophantacea; I Helicacea. Edit. Litera, Bucuresti : 1-534.
8. Grossu, Al.V., 1987 − *Gastropoda Romaniae*. Vol. 2: Subclasa Pulmonata, Ord. Basommatophora ; ord. Stylommatophora: Suprafamilia Succinacea, Cochlicopacea, Pupillacea. Edit.Litera, Bucuresti: 1- 442.
9. Grossu, Al. V., 1993 − The catalogue of the moluscs from Romania. *Trav. Mus. Hist. nat."Grigore Antipa",* 33, Bucuresti, 291 - 366.
10. Kimakowicz, M.v., 1883 - 1884 – Beitrag zur Molluskenfauna Siebenbürgens. *Verh. Mitt. Siebenb. Ver. Naturw., Hermannstadt*, 33, 13 - 83, 34, 57 - 116.

BENTHIC MACRO-INVERTEBRATE AND FISH COMMUNITIES OF SOME SOUTHERN TÂRNAVA MARE RIVER TRIBUTARIES (TRANSYLVANIA, ROMANIA)

Angela CURTEAN-BĂNĂDUC * and *Doru BĂNĂDUC* **

* "Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Oituz Street 31, Sibiu, Sibiu County, Romania, RO - 550337, banaduc@yahoo.com
** Brukenthal National Museum, Natural History Museum, Cetății Street 1, Sibiu, Sbiu County, Romania, RO - 550160, banaduc@yahoo.com, doru.banaduc@brukenthalmuseum.ro

KEYWORDS: Romania, Transylvania, benthic macro-invertebrates, fish, communities, human impact, habitats quality, zonation.

ABSTRACT

This paper presents an analysis of the structure of aquatic communities (macro-invertebrates and fish) of the rivers Şaeş, Stejăreni, Criş, Mlâncrav, Laslea and Valchid, southern tributaries of the Târnava Mare River.

The rivers studied shelter communities of characteristic structure for small water-courses, which meander, with a low gradient and substrates formed mainly by sediments and water that are rich in nutrients, and banks rich in hygrophilous vegetation. In the study area fish species are present which are protected at national and international level: *Barbus petenyi*, *Barbus barbus*, *Alburnoides bipunctatus*, *Chondrostoma nasus*, *Sabanejewia balcanica*, *Squalius cephalus* and *Alburnus alburnus*. Analysing the structure of the macro-invertebrate and fish communities in correlation with the characteristics of the biotope, it can be concluded that the Stejăreni and Criş valleys present an almost natural ecological condition. In these cases anthropogenic impact is insignificant; moderate anthropogenic impact is present in the Mălâncrav and Valchid valleys; while the Şaeş downstream from Apold is the most affected by human impact.

ZUSAMMENFASSUNG: Makrozoobenthos- und Fischartengemeinschaften einiger südlicher Zuflüsse zum Fluss Târnava Mare (Transylvanien, Rumänien)

In der vorliegenden Arbeit wird eine Analyse der Gesellschaftsstrukturen aquatischer Lebensgemeinschaften (Makrozoobenthos und Fische) in den Flüsse Şaeş, Stejăreni, Criş, Mlâncrav, Laslea und Valchid, allesamt südliche Zuflüsse zum Fluss Târnava Mare, präsentiert.

Die untersuchten Gewässer beherbergen Artengemeinschaften, die typisch für kleine, mäandrierende Flüsse und Bäche mit niedrigem Gefälle, feinsedimentdominierter Sohle, nährstoffreichem Wasser und natürlicher Ufervegetation sind. Im Untersuchungsgebiet konnten Fischarten nachgewiesen werden, die nationalen und internationalen Schutzstatus genießen: Barbus petenyi, Barbus barbus, Alburnoides bipunctatus, Chondrostoma nasus, Sabanejewia balcanica, Squalius cephalus und Alburnus alburnus. Die Analyse der Gesellschaftsstrukturen unter Einbeziehung der Lebensraumcharakteristika führte zu dem Ergebnis, daß die Flüsse Stejăreni und Criş einen beinahe natürlichen ökologischen Zustand aufweisen. In diesen beiden Einzugsgebieten sind menschliche Beeinträchtigungen nicht oder nur kaum nachweisbar. Geringfügige anthropogene Störungen wurden in den Flussgebieten des Mălâncrav und des Valchid festgestellt. Im Şaeş flussab von Apold wurde von allen untersuchten Gewässern die stärkste menschliche Beeinträchtigung nachgewiesen.

REZUMAT: Comunități de macronevertebrate bentonice şi peşti din unii afluenți sudici ai râului Târnava Mare (Transilvania, România).

Lucrarea prezintă o analiză a structurii comunităților acvatice (macronevertebrate, peşti) din râurile Şaeş, Stejăreni, Criş, Mlâncrav, Laslea şi Valchid, afluenți de sud ai Târnavei Mari.

Râurile studiate adăpostesc comunități cu structură caracteristică cursurilor de apă de dimensiuni mici, meandrate, cu panta scăzută cu substrat predominant de natură sedimentară şi apă bogată în nutrienți, cu maluri bogate în vegetație higrofilă. În zona de referință sunt prezente specii de peşti protejate la nivel național şi internațional: Barbus petenyi, Barbus barbus, Alburnoides bipunctatus, Chondrostoma nasus, Sabanejewia balcanica, Squalius cephalus şi Alburnus alburnus. Analizând structura comunităților de macronevertebrate şi peşti, în corelație cu caracteristicile de biotop se poate concluziona că văile Stejăreni şi Criş prezintă o stare ecologică apropiată de cea naturală, în aceste cazuri impactul antropic fiind nesemnificativ; impact antropic moderat se manifestă în cazul văilor Mălâncrav şi Valchid; Şaeşul aval de localitatea Apold este cel mai afectat de impactul antropic.

INTRODUCTION

The diversity of nature is one of the main themes of practical concern to academic, administrative and civil society.

Cultural diversity was conceded not very long time ago as a main component of the general issue of biodiversity. In the last century, anthropogenic impact on natural habitats created new valuable semi-natural habitats (called also secondary habitats), which bring as a consequence of the human cultural diversity presence an increase of flora, fauna, habitats, ecosystems and landscape diversity at a local, national and regional level (Akeroyd and Page, 2006; Curtean-Bănăduc, 2005b; Mountford and Akeroyd, 2005; Curtean-Bănăduc et al., 2006; Bavaru et al., 2007).

Europe is one of the main area of such human-induced transformations. These specific areas with secondary habitats can have a very good influence, improving biodiversity through qualitative aspects in contrast with the general decline of the biodiversity all over the world (*1992; **2006), which was recorded most acutely in the last half of the 20th Century.

As a consequence, the conservation of these types of area is a major and complex practical challenge for European conservationists.

The study area (Fig. 1) is situated in the southern part of the Târnava Mare River basin, in South-East Transylvania, in Sibiu, Mureş and Braşov counties (județe).

The existing habitats vary greatly: extensively used agricultural land, pasture, wetlands, meadows (xerophilic, mosophilic or hygrophilic), forest patches (beech, hornbeam, spruce, oak, pine, etc.), gallery forests along the main water courses, lakes, marshes, ponds, temporarily pools, rivers, rocky areas, etc.

The microhabitat, habitat and landscape diversity of the Saxon Villages area of the south-east of Transylvania, its micro-climates and traditional agriculture, comprise an exquisite fragment of a few centuries older Europe and continue to represent a suitable area for a healthy composition of numerous valuable species associations.

This study was focused on the description of the structure of the aquatic communities (macro-invertebrates and fish) of the lotic systems of this study area.

The land surfaces to north, in relatively similar/comparable valleys/relief in the Sighişoara-Târnava Mare proposed Natura 2000 site.

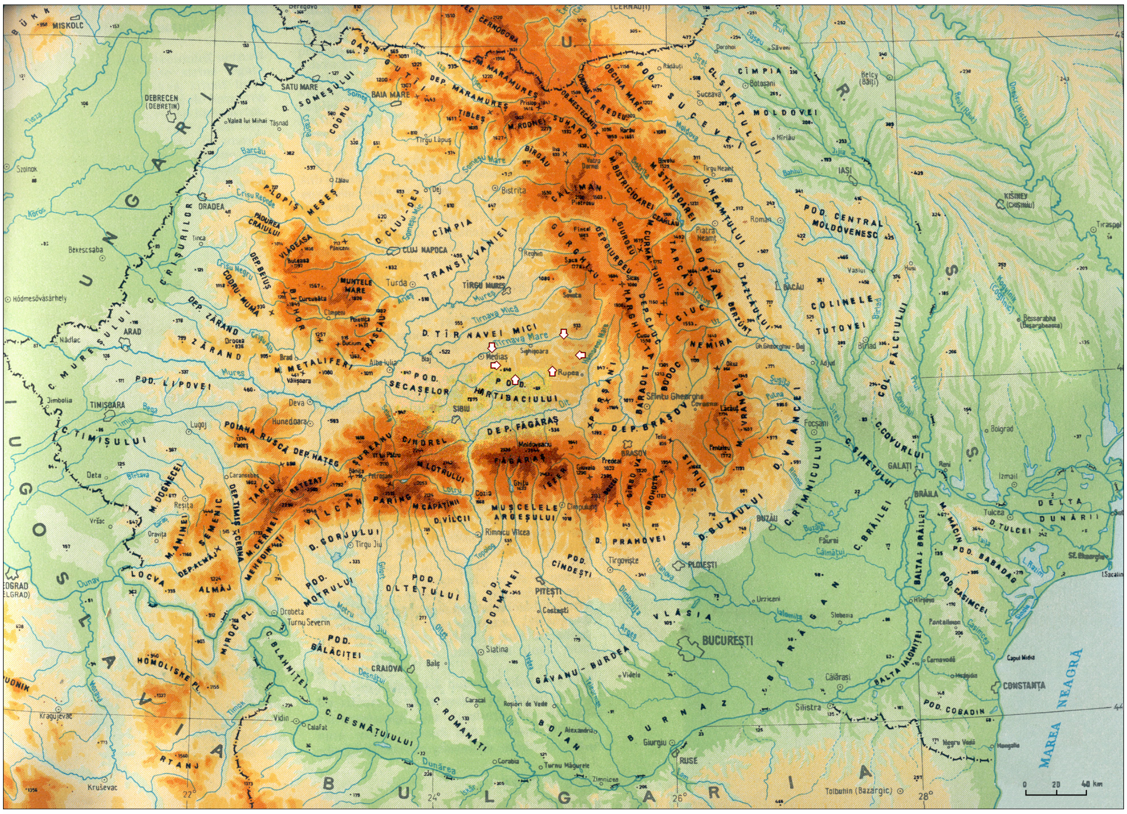


Figure 1: The study unit (⇨) location
(Badea et al., 1983 - modified).

Biological and ecological studies related to the targeted area rivers and the local taxonomic groups are very few and unrepresentative in time and space, with the most data concerning the Târnava Mare River.

Existing data concerning the interest of the macro-invertebrates of the area can be grouped into two main categories.

The oldest scientific data regarding the aquatic invertebrate fauna of the middle Târnava Mare River basin relate to the molluscan and heteropteran fauna, data from 1840s, collected by the Transylvanian Natural Sciences Society members, preserved in the Sibiu Natural History Museum and published in "*Verhandlungen und mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt*".

The aquatic molluscan fauna was studied in the 19th Century by Bielz (1843, 1851), Bielz (1853, 1867) and Kimakowicz (1884). In the publication "Die Land und susswasser Mollusken Siebenburgens", Bielz (1863) put together data published in 1849–63 in the publication of the Transylvanian Natural Sciences Society, including species of the middle Târnava River basin.

The naturalist Mayr (1853) published the first publication concerning Transylvanian heteroptera, this work including also a few species of heteroptera from the middle Târnava River basin. Müller (1933) and Worell (1943) sampled aquatic heteroptera in the area of Sighişoara, and biological material was published by Schneider (1973).

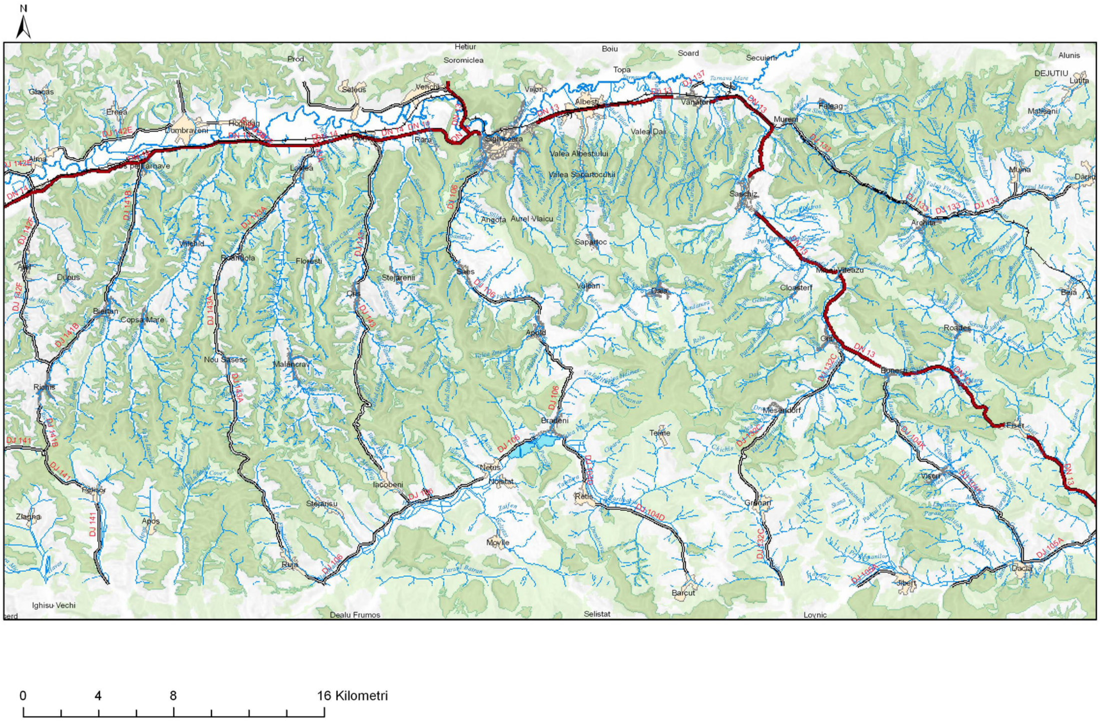


Figure 2: The rivers studied : localisation and the access roads (mapping support by Bogdan Florescu).

Complex data concerning the structure of the macro-invertebrate and other taxonomic groups of the Târnava Mare River were obtained recently (2000–2003) in a programme conducted by the hydrobiology research team of the Ecology and Environment Protection Department, "Lucian Blaga" University of Sibiu. On this occasion faunistic data concerning molluscs, oligochaeta, heteroptera, trichoptera, plecoptera, ephemeroptera, odonata and chironomids were obtained (Curtean-Bănăduc et al., 2005a).

In general, in Romania, the macro-invertebrate fauna of small hilly rivers (which have their sources in hilly areas) have not been well studied and also studies of fish are less well represented than those of other types of rivers/areas. These rivers should shelter characteristic communities of fauna, a reason for the need for special studies in such areas.

Fish data concerning the study area can be grouped into three main categories.

Data since 1900, concerning only the Târnava Mare River, in the area of Sighişoara, about the presence here of two common species (*Leuciscus cephalus cephalus* and *Sabanejewia aurata balcanica*), data based on collectons in the Natural History Museum of Sibiu.

Data included in volume XIII of the Romanian Fauna (Pisces-Osteichthyes) 1964, like a synthesis of the ichthyological knowledges before 1964, from which unfortunately complete information cannot be extracted due to the lack of some special studies for the interest area, with references only to seven species from that period of time (*Leuciscus cephalus cephalus*, *Alburnus alburnus alburnus*, *Gobio gobio obtusirostris*, *Gobio kessleri kessleri*, *Barbus barbus barbus*, *Sabanejewia aurata balcanica* and *Lota lota lota*), only from the Târnava Mare River.

Actual interdisciplinary studies, including ichthyological, on the Târnava Mare River in the same mentioned programe of the hydrobiology research team of the "Lucian Blaga" University of Sibiu, where faunistic and ecological data were obtained in relation to human impact (Curtean-Bănăduc et al., 2005a).

It must be mentioned that, with the exception of the Târnava Mare River, studied in the upper approach described, its tributaries (within the actual study area), also the other wetland categories, were not studied from a hydrobiological point of view.

This study of the Târnava Mare River tributaries, the Şaeş, Stejăreni, Criş, Mălâncrav, Laslea and Valchid rivers, has as a principal aim to determine the main permanent ichthyological communities and their ecological status.

The Şaeş River has a length of 32 km and a basin surface of 122 km^2; Laslea River has a length of 21 km and a basin surface of 111 km^2; Valchid and Biertan rivers have a length of 16 km and a basin surface of 56 km^2. The Şaeş River has an average multiannual flow of 0.384 m^3/s, Criş River 0.260 m^3/s, Stejăreni River 0.109 m^3/s, Laslea River 0.345 m^3/s, Mălîncrav River 0.100 m^3/s, and Valchid River 0.120 m^3/s (data of Environment Protection Agency, Mureş).

MATERIALS AND METHODS

The present paper is based on quantitative macro-invertebrate and fish samples, from the 2003 - 2007 period, in summer sampling campaigns, at 15 sampling stations (Fig. 3, Tab. 1).

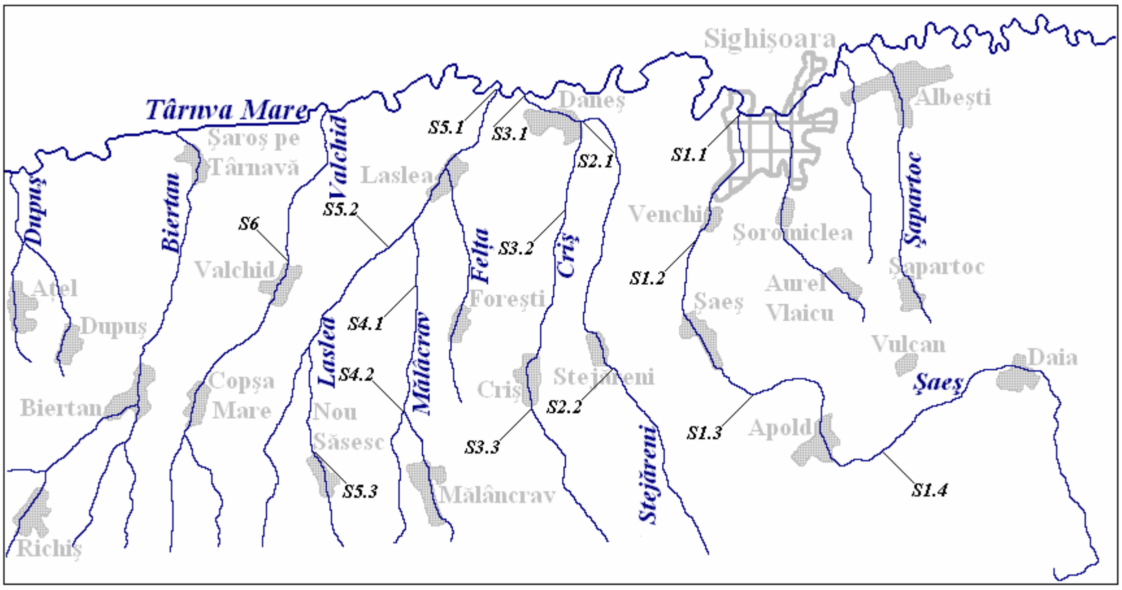


Figure 3: The quantitative sampling stations (S1.1 - S6) on the Şaeş, Stejăreni, Criş, Mălâncrav, Laslea and Valchid rivers.

The sampling stations were chosen according to valley morphology, the type of the river substrate, the confluence with the main tributaries and the type and degree of human impact on the river sectors, in order to highlight the diversity of aquatic organisms, and also the variation of these communities of organisms.

Table 1: Location of sampling stations in the study area.

River	Sampling stations codes and position	
Şaeş	S1.1	10 m upstream the confluence with Târnava Mare River
	S1.2	5 km upstream the confluence with Târnava Mare River
	S1.3	3 km downstream the Apold locality
	S1.4	17 km upstream the confluence with Târnava Mare River
Stejăreni	S2.1	10 m upstream the confluence with Criş River
	S2.2	0.5 km upstream the Stejăreni locality
Criş	S3.1	10 m upstream the confluence with Târnava Mare River
	S3.2	5 km upstream the confluence with Târnava Mare River
	S3.3	10.5 km upstream the confluence with Târnava Mare River
Mălâncrav	S4.1	8 km upstream the confluence with Târnava Mare River
	S4.2	13 km upstream the confluence with Târnava Mare River
Laslea	S5.1	10 m upstream the confluence with Târnava Mare River
	S5.2	5 km upstream the confluence with Târnava Mare River
	S5.3	10 km upstream the confluence with Târnava Mare River
Valchid	S6	8 km upstream the confluence with Târnava Mare River

At each sampling station many samples were taken, in order to highlight the specific habitat diversity. During the study period, 225 quantitative benthic macro-invertebrate samples were collected and analyzed. Benthic macro-invertebrate quantitative samples were carried out using an 887 cm^2 surface Surber Sampler, with a 250 μ mesh net. This sampled biological material was fixed in 4% formaldehyde solution, to which $NaHCO_3$ was added.

The invertebrate biological material was sorted and analyzed in the laboratory, preserved in 70% alcohol and included in the collection of the "Lucian Blaga" University of Sibiu, Department of Ecology and Environment Protection, Hydrobiology Laboratory.

The fish assemblages survey presented, through time (one hour) on effort unit quantitative samplings were made with a hand-net, also at a total of 15 sites in 2003–2007, in summer sampling campaigns.

The fish were identified, counted, some were released back into the stream and others fixed in a 4% formaldehyde solution, then preserved in 70% alcohol and included in the collections of the Natural History Museum of Sibiu.

For the quantitative structure description of benthic macro-invertebrates statistic density was used - the average number of individuals (average value among the samples of the same sampling stations) on the sampling unit and the relative abundance (A%) (Gomoiu and Skolka, 2001), and for the fish communities quantitative structure description was used the individuals number in the unit of time and effort unit - average value for the samples of the same sampling station and the relative abundance (A**%**).

RESULTS AND DISCUSSIONS

The discussions are based on the sampled macroinvertiebrates and fish (Tab. 2).

Table 2: The structure of the benthic macro-invertebrate and fish communities in the 15 river sectors studied (Sn) (Ds: statistic density in number of individuals/887 cm^2; I: number of fish individuals in the unit of effort/time; A%: relative abundance).

Sampling station	The structure of the benthic macro-invertebrate communities			The specific structure of fish communities		
	Sistematic groups	Ds	A%	Species	I	A%
S1.1.	Oligochaeta	3	4.35	*Barbus petenyi*	2	7.41
	Gastropoda	1	1.45	*Gobio obtusirostris*	4	14.81
	Araneida	4	5.80	*Alburnoides bipunctatus*	9	33.33
	Amphipoda	5	7.24	*Alburnus alburnus*	7	25.93
	Ephemeroptera	5	7.24	*Chondrostoma nasus*	3	11.11
	Trichoptera	4	5.80	*Sabanejewia romanica*	1	3.70
	Coleoptera	1	1.45	*Sabanejewia balcanica*	1	3.70
	Chironomidae	46	66.67			
S1.2.	Oligochaeta	3	4.48	*Barbus petenyi*	1	8.33
	Amphipoda	42	62.69	*Gobio obtusirostris*	4	33.34
	Ephemeroptera	13	19.40	*Sabanejewia romanica*	7	58.33
	Trichoptera	3	4.48			
	Chironomidae	6	8.95			
S1.3.	Oligochaeta	8	9.09	*Carassius gibelio*	1	6.66
	Gastropoda	1	1.14	*Barbus barbus*	1	6.67
	Araneida	3	3.41	*Gobio obtusirostris*	9	60.0
	Amphipoda	12	13.64	*Sqalius cephalus*	1	6.67
	Ephemeroptera	6	6.82	*Orthrias barbatulus*	3	20.0
	Trichoptera	15	17.04			
	Heteroptera	2	2.27			
	Chironomidae	41	46.59			
S1.4.	Oligochaeta	3	4.11	*Orthrias barbatulus*	2	100
	Amphipoda	5	6.85			
	Ephemeroptera	18	24.66			
	Trichoptera	3	4.11			
	Coleoptera	1	1.37			
	Chironomidae	43	58.90			
S2.1.	Oligochaeta	41	39.42	*Barbus petenyi*	2	16.67
	Amphipoda	16	15.38	*Gobio obtusirostris*	4	33.33
	Trichoptera	7	6.73	*Sabanejewia romanica*	6	50.00
	Coleoptera	5	4.81			
	Chironomidae	23	22.12			
	Tabanidae	9	8.65			
	Heleidae	3	2.88			

Sampling station	The structure of the benthic macro-invertebrate communities			The specific structure of fish communities		
	Sistematic groups	Ds	A%	Species	I	A%
S2.2.	Oligochaeta	38	69.10	*Gobio obtusirostris*	7	53.85
	Gastropoda	3	5.45	*Squalius cephalus*	2	15.38
	Bivalvia	1	1.82	*Orthrias barbatulus*	4	30.77
	Amphipoda	3	5.45			
	Coleoptera	1	1.82			
	Chironomidae	5	9.09			
	Tabanidae	3	5.45			
	Heleidae	1	1.82			
S3.1.	Oligochaeta	21	18.75	*Barbus petenyi*	7	36.84
	Araneida	6	5.36	*Gobio obtusirostris*	5	26.32
	Amphipoda	11	9.82	*Chondrostoma nasus*	4	21.05
	Ephemeroptera	19	16.96	*Sabanejewia balcanica*	2	10.53
	Trichoptera	14	12.5	*Sabanejewia romanica*	1	5.26
	Coleoptera	2	1.79			
	Chironomidae	39	34.82			
S3.2.	Oligochaeta	7	10.0	*Barbus petenyi*	3	25.0
	Gastropoda	1	1.43	*Gobio obtusirostris*	6	50.0
	Amphipoda	35	50.0	*Squalius cephalus*	1	8.33
	Ephemeroptera	12	17.14	*Sabanejewia romanica*	2	16.67
	Trichoptera	5	7.14			
	Chironomidae	10	14.29			
S3.3.	Oligochaeta	25	40.98	*Gobio obtusirostris*	2	33.33
	Gastropoda	1	1.64	*Squalius cephalus*	1	16.67
	Amphipoda	10	16.39	*Orthrias barbatulus*	3	50.00
	Ephemeroptera	6	9.84			
	Trichoptera	12	19.67			
	Chironomidae	7	11.48			
S4.1.	Oligochaeta	3	5.00	*Barbus petenyi*	3	30.0
	Amphipoda	47	78.33	*Gobio obtusirostris*	5	50.0
	Trichoptera	1	1.67	*Orthrias barbatulus*	2	20.0
	Chironomidae	8	13.33			
	Heleidae	1	1.67			
S4.2.	Oligochaeta	12	10.91	*Gobio obtusirostris*	2	22.22
	Amphipoda	47	42.73	*Squalius cephalus*	1	11.11
	Ephemeroptera	9	8.18	*Orthrias barbatulus*	6	66.67
	Trichoptera	7	6.36			
	Chironomidae	35	31.82			

Sampling station	The structure of the benthic macro-invertebrate communities			The specific structure of fish communities		
	Sistematic groups	Ds	A%	Species	I	A%
S5.1.	Oligochaeta	16	17.20	*Barbus petenyi*	2	16.67
	Araneida	4	4.30	*Gobio obtusirostris*	4	33.33
	Amphipoda	1	1.08	*Chondrostoma nasus*	2	16.67
	Colembola	8	8.60	*Orthrias barbatulus*	1	8.33
	Ephemeroptera	13	13.98	*Sabanejewia romanica*	1	8.33
	Trichoptera	2	2.15	*Sabanejewia balcanica*	2	16.67
	Coleoptera	2	2.15			
	Chironomidae	47	50.54			
S5.2.	Oligochaeta	7	9.46	*Barbus petenyi*	2	12.50
	Gastropoda	1	1.35	*Gobio obtusirostris*	1	6.25
	Araneida	1	1.35	*Alburnus alburnus*	6	37.5
	Amphipoda	10	13.52	*Chondrostoma nasus*	3	18.75
	Ephemeroptera	2	2.70	*Sabanejewia balcanica*	4	25.0
	Trichoptera	5	6.76			
	Chironomidae	40	54.05			
	Psychodidae	1	1.35			
	Tabanidae	7	9.46			
S5.3.	Oligocheta	10	16.95	*Orthrias barbatulus*	3	100
	Amphipoda	13	22.03			
	Ephemeroptera	2	3.39			
	Trichoptera	4	6.78			
	Chironomidae	28	47.46			
	Tabanidae	2	3.39			
S6	Oligochaeta	3	2.02	*Barbus petenyi*	3	42.86
	Gastropoda	1	0.68	*Gobio obtusirostris*	3	42.86
	Bivalvia (Pisidium)	8	5.41	*Squalius cephalus*	1	14.28
	Amphipoda	132	89.18			
	Trichoptera	1	0.68			
	Chironomidae	2	1.35			
	Psychodidae	1	0.68			

The general characteristics of the valleys studied are: relative small gradient, short length, meandering course, dominance of sedimentary substrate (mud, clay, sand), maximum 1m depth, minor river bed of small width (0.5 - 3m), the presence on the river banks of a corridor with hygrophilous vegetation of willows and alders. From the trophic point of view, these rivers can be considered to be mesotrophic.

On the valley slopes, the forested areas (deciduous forests, deciduous/pine forests and pine forests) alternate with hay-meadsows and extensive agricultural land.

In these valleys major river-beds, due to the raised underground water table, eutrophic and mezotrophic marshes are also present.

Analysing the similarity of the **benthic macro-invertebrate communities** in the 15 sampled lotic sectors, on the basis of the relative abundance of the systematic groups present (Tab. 2), allows these communities to be grouped in four classes (Fig. 3), the benthic macro-invertebrate communities present in the water courses studied corresponding to the types described below (characteristic for the present habitats).

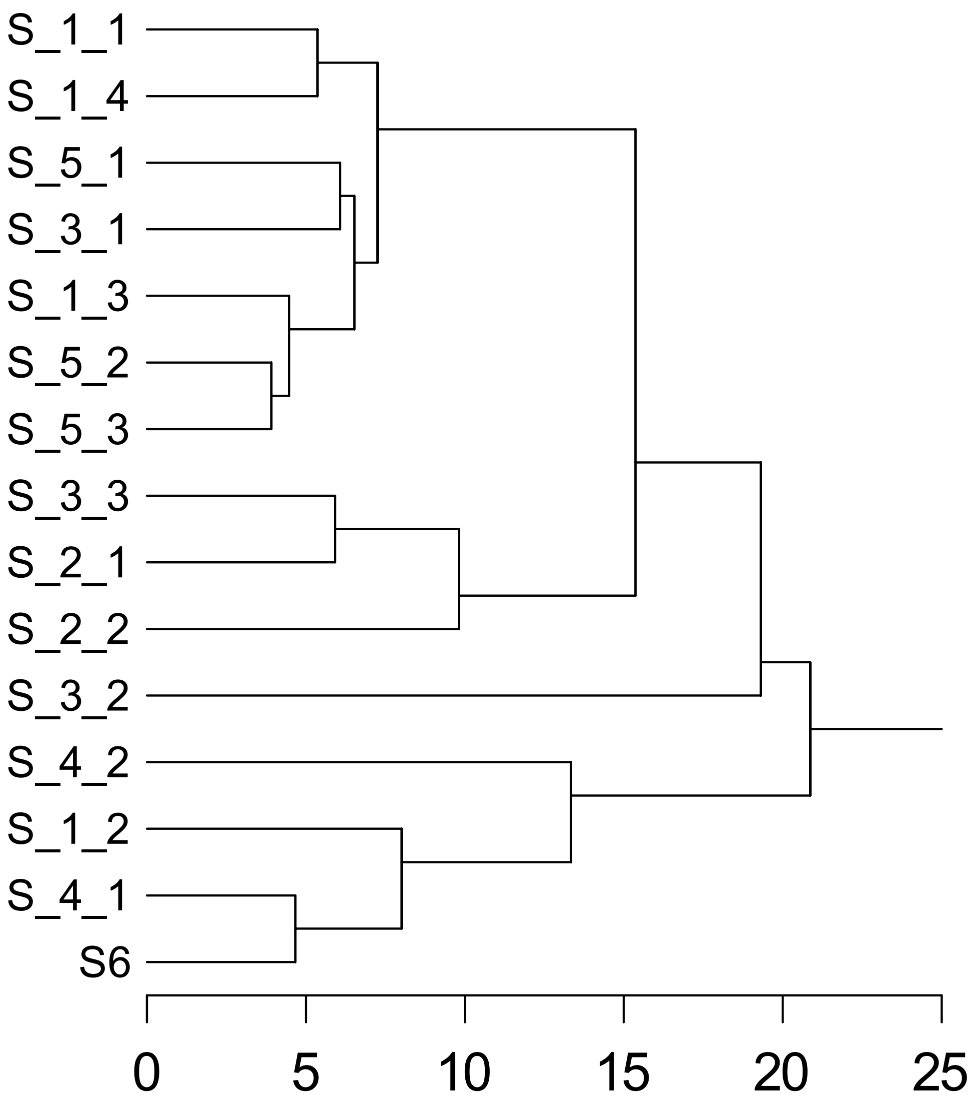


Figure 3: The benthic macro-invertebrate communities similarity in the 15 studied river sectors (S1.1 - S6) - Tree diagram based on the relative abundance values of the taxonomic groups, euclidian averages distances).

a. Communities for the river sectors with substrates formed of pebbles and rocks covered with mud, with a slow water flow, in which chironomids are dominant, with ephemeropterans and the amphipods subdominant, in the upper and lower Şaeş River course (S1.4, S1.1), or ephemeropterans and the oligochetes in the lower Laslea and Criş courses (S5.1, S3.1), or trichopterans and amphipods in the course of the middle Şaeş (S1.3), or the amphipods and the oligochetes in the course of the upper and middle Laslea (S5.3, S5.2).

b. Communities for the sectors with muddy substrate and slow-flowing (water pools) where oligochetes are dominanat, and chironomids subdominant, are present in the upper Criş (S3.3), the lower course of the Stejăreni (S2.1) and the upper course of the Laslea (S5.3).

c. Communities for the river sectors with a substrate formed of medium-sized rocks covered with a thin layer of mud, where small rapids alternate with 0.5–1 m pools deep and slow-flowing, where numerical dominants are amphipods, co-dominants the ephemeropterans and the chironomids, present in the middle course of the Criş (S3.2).

d. Communities in which amphipods and chironomids are numerical co-dominants, present in the river sectors with a muddy substrate and sandy intercalations, where the water has a slow speed of flow (course of the upper and middle Mălâncrav course – S4.2).

e. Communities in which amphipods are numerically dominant, ephemeropterans are subdominant; also present with relative abundances under 9% are chironomids, trichopterans and oligochetes. These communities are present in the river sectors with a substrate formed of rocks sitting on a clay layer and covered with mud, with slow water speed, present in the course of the lower Şaeş (S1.2).

f. Communities of the sectors with a substrate of pebbles and sand, with slow water speed, in which amphipods are eudominant, near which appear, with relative abundance under 15% oligochetes, dipteran larvae, trichopterans and gastropods (Mălâncrav middle course – S4.1 and Valchid lower course – S6; here are also present *Pisidium* genus individuals).

The **fish** material studied, belonging to two families and nine genera, consists of the following eleven species: *Squalius cephalus* (Linnaeus, 1758); *Alburnus alburnus* (Linnaeus, 1758); *Alburnoides bipunctatus* (Bloch, 1782); *Chondrostoma nasus* (Linnaeus, 1758); *Gobio obtusirostris* Valenciennes, 1844; *Barbus barbus* (Linnaeus, 1758); *Barbus petenyi* Heckel, 1852; *Carassius gibelio* (Bloch, 1783); *Orthrias barbatulus* (Linnaeus, 1758); *Sabanejewia romanica* (Băcescu, 1943); *Sabanejewia balcanica* (Karaman, 1922).

As a longitudinal zonation of these rivers we can reveal few zones based on the present local fish species. In the first upper zone are present two cases, one with *Orthrias barbatulus* alone and the second with *O. barbatulus* and *Gobio obtusirostris*. *Orthrias barbatulus* is a normal presence in the upper sectors of some small/medium rivers which rise in hilly areas of Romania, a species which did not need special biotope conditions and more than that is well adapted to the relatively high organic polluted waters (Bănărescu, 1964). *Gobio obtusirostris* is a species with a large representation in the Romanian rivers, also being one of the species very well adapted to high organic polluted waters (Bănăduc 1999, 2005; Curtean-Bănăduc 2005). The presence of individuals of one or both of these organic pollution-resistant species everywhere in these rivers, can reveal sewage water input.

The middle zones are influenced through the fish diversity both by the upper and lower zones. Characteristic speies here are: *Gobio obtusirostris*, *Barbus petenyi*, *Barbus barbus*, *Sabanejewia romanica*, *Sabanejewia balcanica* and *Leuciscus cephalus*. The presence of the *Sabanejewia romanica* and *Sabanejewia balcanica*, and also the appearance of the *Carassius gibelio* reveal the existence here of siltation.

The few fish farm ponds of the area (in Stejăren, Mălâncrav and Şaeş valleys) can have influences regarding the accidental releases of some species (*Carassius gibelio*).

Due to the presence of the upper zones characteristic species *Orthrias barbatulus* individuals in the lower zones, it can be stated the fact that these zones still keep important upstream and middle biotope characteristics. The influence as a fish diversity reservoir of the much biggest river Târnava Mare through the river confluences is present due to the species *Chondrostoma nasus*, *Alburnoides bipunctatus* and *Alburnus alburnus*. These tributaries can act as a refuge and breeding area for some fish species of the Târnava Mare.

Bearing in mind relatively small dimensions of biotope of the studied rivers and the anthropogenic impact (organic pollution and siltation problems), the number of species present here are considered to be good.

Among the fish present in the water courses studied are some under different protection status: Law 13 of 11 March 1993 through which Romania became a part of the Convention on the Conservation of European Wildlife and Natural Habitats Bern 19.09.1979; Annex 2 (*Barbus petenyi*), Annex 3 (*Alburnoides bipunctatus, Chondrostoma nasus* and *Sabanejewia balcanica*); IUCN Red List of Threatened Species, 02 May 2006, Geneva, Switzerland, (*Squalius cephalus*; *Alburnus alburnus*; *Alburnoides bipunctatus*; *Chondrostoma nasus*; *Barbus barbus*; *Barbus petenyi*; *Sabanejewia balcanica*; Annex II and V of the European Habitats Directive (*Barbus peteny* and *Sabanejewia balcanica*). We should also mention the presence of crayfish (*Astacus astaus*) a species protected by the Bern Convention, in the rivers Şaeş upstream of Apold, Criş upstream of Criş, and Valchid.

CONCLUSIONS

Analysis of the structure of the aquatic communities in correlation with the biotope characteristics revealed that Stejăreni Valley and Criş Valley are the closest to a natural status, human impact being insignificant along their courses. With a moderate human impact (waste water and farm animal water inputs) are the Mălâncrav and Valchi valleys. Şaeş (downstream from Apold) is the most affected by human impact – waste water and farm animal water pollution, water catchings for agriculture.

It must be underlined the fact that none of the villages in the area of interest has channelized waste waters (or other management system), and with few exceptions the waters are discharged directly into the rivers; in general in the vicinity of these localities, garbage is deposited on the river banks. In drought conditions, with not enough dilution flow, the rivers are transformed into sewage canals.

Relatively small as the volumes and dimensions of the local wetlands are, they may be undoubtedly be very near their ecological tolerance if the anthropogenic impact should increase even slightly.

The potential ecological sensitivity of these wetlands, the presence here of good populations of protected species and the refuge and breeding area role for the high human impact Târnava Mare River aquatic organisms, reveal the fact that the future local Natura 2000 site should include in its management plan all these areas too, and a proper monitoring system should be enforced. These management plan should include at least the following elements: reduction of pollution, water flow management, the protection of the river bed profile and its mineral exploitation.

ACKNOWLEDGEMENTS

The authors are grateful to the Darwin Initiative of the UK Ministry of Agriculture (DEFRA), Orange Romania, ADEPT Foundation and Ecotur Sibiu N.G.O. for supporting the work required in the field and the publication of this paper, and to Mr Nathaniel Page and Dr John Robert Akeroyd, whose love and care for this special area can be a lesson for many of us.

REFERENCES

1. Akeroyd, J. R. and Page, N. 2006 − The Saxon Villages of southern Transylvania: conserving biodiversity in a historic landscape. In Gafta, D. and Akeroyd, J.R., eds (2006) *Nature Conservation: Concepts and Practice*, pp. 199-210. Springer Verlag, Heidelburg, Germany.
2. Badea, et al., 1983 – Geografia României I, Geogr. Fiz., Editura Academiei Române, 1983, 1 - 662.
3. A. Bavaru, G. Butnaru, S. Godeanu and A Bogdan. 2007 − Biodiversitatea şi Ocrotirea Naturii, Editura Academiei Române, 1-580.
4. D. Bănăduc 1999 − Data concerning the human impact on the ichthyofauna of the upper and middle sectors of the Olt River, Transylvanian Review of Systematical and Ecological Research 1. The Upper and Middle Olr River Basin 157 - 164 pp. Ed. I. Sîrbu, A. Curtean and D. Bănăduc.
5. Bănărescu, P. M., 1964 – Pisces - Osteichthyes Fauna R.P.R., 13, Ed. Acad. Române, Buc., 659.
6. E. A. Bielz, in 1863 − Fauna der Land und Süswasser-Mollusken Siebenbürgens, Comissions-Verlag v. Filtsch, Hermannstadt.
7. M. v. Kimakowicz 1883 - 884 − Beitrag zur Molluskefauna Sibenbürgens. Verh. Mitt. Siebenb. Ver. Naturw., Hermannstadt, 33, 13 - 83,34, 57 - 116.
8. Curtean - Bănăduc A., Bănăduc D., and Sîru I., eds 2005 − Transylvanian Reiew of Systematical and Ecological Research 2 The Târnava River Basin, pp. 1-182. Editura Universității Lucian Blaga din Sibiu România.
9. A. Curtean-Bănăduc, D. Bănăduc and C. Bucşa 2006 − Waterheds management (Transylvania, Romania): implications, risks, solutions, 225-238, Strategies to Enhance Environmental Security in Transition ountries, NATO Security through Sciences Series - C: Environmental Security, 1-429.
10. A. Curtean-Bănăduc 2005 − Râul Cibin Caraterizare Ecologică, Editura Universității Lucian Blaga Sibiu, 1-240.
11. M., Bielz 1843 − Aufzählungen der Siebenbürgischen Land - und Süsswasser - Mollusken. Kronstädter Zetung.
12. M., Bielz 1851 − Verzeichniss der Land - und Süsswasser - Mollusken Siebenbürgens, Verh. Mitt. Siebenb. Nat. Hermannstadt, 2: 1 - 19.
13. E. A. Bielz 1853 − Übersicht der lebenden Fische Sibenbürgens, Verh. U. Mitt. Siebenb. Ver. Naturw. Hermannstadt, 4: 172 - 185.
14. E. A. Bielz 1867 − Fauna der Land - und Süsswasser - Mollusken Siebenbürgens. Zweite Aufl., Comissions - Verlag v. Filtsch, Hermannstadt.
15. G. Mayr 1853 − Beiträge zur Insectenfauna von Siebenbürgen, Verh. U. Mitt. Siebenb. Ver. F. Naturw. Hermanstadt, 8: 141 - 143.
16. E. Schneider., 1973 −, Catalogul heteopterelor din colecțiile Muzeului de Istorie Naturală Sibiu. Stud. Com. Şt. Nat. Muz. Bruckethal, Sibiu, 18: 139 - 182.
17. M. T. Gomoiu and M. Skolka., 2001 − Ecologie. Metodolgii pentru studii ecologice, "vidius" University Press, Constanța, 175 pp.
18. Mountford, O. J. and Akeroyd, J. R. 2005 − A biodiversity assessment of the Saxon villages region of Transylvania. In Curtean - Bănăduc A., et al., eds (2005) Transylvanian Reiew of Systematical and Ecological Research 2 The Târnava River Basin, pp. 31-42. Editura Universității Lucian Blaga din Sibiu România.
19. * Global Biodiversity 1992 − Status of the Earth's Living Resources. (London, Chapman and Hall), pp. 1-450.
20. ** Halting biodiversity loss by 2010 - an EU action plan, 2006 − www.euractiv.com/en/environment/halting-biodiversty-loss-2010-eu-action-plan/article-157424.

REGIONAL DISTRIBUTION, DYNAMIC AND DETERMINANTS OF BREEDING POND USE IN *PELOBATES FUSCUS* (AMPHIBIA) IN THE MIDDLE SECTION OF THE TÂRNAVA MARE BASIN (TRANSYLVANIA, ROMANIA)

*Tibor HARTEL *, Kinga ÖLLERER ***
and *Cosmin Ioan MOGA ****

* "Mircea Eliade" Highschool, 1 Decembrie 1918 Street 31, Sighişoara, Mureş County, Romania, RO - 545400, asobeka@yahoo.com
** Bucharest Institute of Biology - Romanian Academy of Sciences, 296 Splaiul Independenței, Bucharest, Romania, RO - 060031, evetke17@yahoo.com
*** "Ecotransilvania" Association, 13A Tăbăcarilor Street, Sighişoara, Mureş County, Romania, RO - 545400, cimmoga@yahoo.com

KEYWORDS: Romania, Transylvania, Târnava Mare Basin, *Pelobates fuscus*, habitat use, distribution, conservation.

ABSTRACT

In this paper we present the distribution and habitat use of the Common Spadefoot Toad (*Pelobates fuscus*) in the middle section of the Târnava Mare Basin. Pond occupancy was 39% for permanent ponds and 11.53% for temporary ponds. Variables describing the ponds were found to be more important for *P. fuscus* than the landscape variables. Significant positive relationship was found between the calling index and pond age, pond area, emergent macrophyte vegetation cover, water conductivity and the amount of pasture within a distance of 800 m around each pond. Negative relationship was found between the calling index and predatory fish. We suggest that former and actual flooded areas along the Târnava Mare River and its tributaries are important migration corridors for the species.

RÉSUMÉ: La distribution régionale, la dynamique et les facteurs déterminants de l'utilisation des mares par Pelobates fuscus dans la secteur moyen du basin de Târnava Mare (Transilvanie, Roumanie).

On présente la distribution et utilisation des habitats par *Pelobates fuscus* dans le secteur moyen du basin de Târnava Mare. L'espèce a été identifie dans 39% des mares permanents et 11.5% des mares temporaires. Les variables qui décrivent les habitats aquatiques sont plus importantes que les variables qui caractérisent le paysage (les habitats terrestres voisines). Une association signifiante positive existe entre l'indice de vocalisation (calling index) et l'age et la superficie des mares permanents, le pourcentage de couverture par la végétation, la conductivité de l'eau et la surface couverte par des pâturages situe jusque a 800 m distance. Une association négative existe entre l'indice de vocalisation et les poissons prédateurs. Notre étude indique que la zone ripariene au long de la rivière Târnava Mare et ses tributaires est un important couloir de migration pour cette espèce.

REZUMAT: Distribuția regională, dinamica şi factorii determinanți ai folosirii habitatelor acvatice la *Pelobates fuscus* în porțiunea mijlocie a bazinului Târnava Mare (Transilvania, România).

În acest articol, prezentăm distribuția şi folosirea habitatelor de către *Pelobates fuscus* în porțiunea mijlocie a bazinului Târnava Mare. Specia a fost identificată în 39% dintre bălțile permanente şi 11.53% dintre bălțile temporare investigate. Variabilele care descriu habitatele acvatice sunt mai importante decât variabilele care descriu peisajul (habitatele terestre din împrejurimile bălților). Asociere semnificativ pozitivă a fost găsită între indicele de vocalizare („calling index") şi vârsta şi dimensiunea bălților permanente, acoperirea cu vegetație emergentă a acestora, conductivitatea apei, precum şi suprafața acoperită de pajişte la 800 m distanță în jurul bălților. Asociere negativă a fost găsită între indicele de vocalizare şi peştii răpitori. Studiul nostru sugerează că zonele inundabile, de-a lungul râului Târnava Mare şi a afluenților săi, reprezintă culoare de migrare importante pentru această specie.

INTRODUCTION

Amphibian populations are declining in many parts of the world (Houlahan et al., 2000; Stuart et al., 2004). Several field and experimental studies conducted in the past few years demonstrate that the causes of amphibian declines are multiple, including habitat loss and fragmentation (Cushman, 2005), introduced species (especially fish) (Kats and Ferrer, 2003), chemical pollutants (Hartel and Hoffmann, 1989) emerging infectious diseases, perhaps tied to climate change (Arajuo et al. 2006), and UV-β radiation (reviewed by Beebee and Griffiths, 2005). The factors involved in amphibian declines are "context dependent" (Alexander and Eischeid, 2001; Kieseker et al., 2001; Beebee and Griffiths, 2005), and in many cases there is no single underlying factor.

Field studies need to be conducted in order to assess the importance of environmental factors in determining habitat use and population fluctuations of amphibians. The importance of these studies is enhanced in eastern and central Europe, because many ecosystems have been less impacted there than in the more developed west (Palang et al., 2006), a situation that is likely to change in the near future. Such data can be gathered on a regional scale through amphibian habitat surveys and on a local scale through long-term monitoring and inventory programmes on specific amphibian populations or communities (Hecnar and M`Closkey, 1996; Dodd and Barichivich, 2007).

We present the distribution, habitat characteristics and habitat use of the Common Spadefoot Toad (*Pelobates fuscus*) in the middle section of the Târnava Mare Basin. Regional and local scale studies have been carried out in the middle region of the Tarnava Mare Basin, Romania (Hartel et al., 2006; 2007 a, b). As with the great majority of temperate amphibians, this species of toad is dependent on two habitats: the aquatic habitats where it breeds and the terrestrial ones where feeding, overwintering and dispersion occur. Although recent studies and reviews suggest that *Pelobates fuscus* is actually common in Transylvania (Ghira et al., 2002; Dzukic et al., 2007 and the references cited therein), studies that try to identify which habitat parameters are the most important determinants of the breeding pond use of this toad, to our knowledge, are absent in Romania. Habitat features data are important for this declining species in many parts of Europe for management plans, the causes being the destruction of the habitats (complete destruction or habitat fragmentation) (Gasc et al., 1997; Hels and Buchwald, 2001; Nyström et al., 2002; 2007, and references). *Pelobates fuscus* is protected under the Bern Convention (Annex II), EU Habitats Directive (92/43/EEC Annex IV) and the Romanian Law 462/2001.

MATERIALS AND METHODS

Surveys

An area approximately 101 x 26 km was studied in the middle section of the Târnava Mare Basin between 2000 and 2007. The area is dominated by hills with maximum altitudes of 750 - 800 m in the east to 600 - 800 m in the west. Mean annual temperatures increase from 6.5 °C in the east to 9 °C in the west. Ponds were located using 1:25 000 scale topographic maps, on information provided by landowners and through active searches (Hartel et al., 2006; 2007a, 2007b). The altitude and the exact location of the ponds were established using handheld GPS.

In 2000 - 2007 a total of 89 permanent and 130 temporary ponds were localized by GPS (Fig. 1). These data are used to present the regional distribution of Common Spadefoot Toads and the habitats surveyed (Fig. 1). When temporary ponds appeared in clusters (i.e. separated by tens to 100s of metres) they were considered a breeding area and represented as one point on the distribution map, although every pond was located with GPS. Such clusters may have from 35 to up to 120 temporary ponds.

The call index data were analysed for 38 ponds. The call index is usually used as an index of “population size” with the assumption that all or the majority of males in that population are vocalizing at the moment of survey (observations of many authors). The scores used in the call index estimation varied between 0 (no call) and 3 (overlapping calls, no estimation of the number of calling males is possible) (Gagne and Fahrig, 2007). Since the calling activity of *P. fuscus* occurs underwater there was a possibility to underestimate the call intensity. To account for this bias, the statistical analyses were made at two levels: using the call index and the presence/absence data (see details below).

A total of 21 ponds were regularly monitored in the perod 2003 - 2007. These ponds were both easily accessible (from Sighişoara locality) and representative in terms of landscape composition and configuration. In this subset we were able to estimate the gain and loss events, following the method of Hecnar and M`Closkey (2006) (see below).

A long-term study was carried out in an easily accessible pond near the town of Sighişoara between 1997 and 2007. Here the number of calling males was used as population size estimator. Since the number of calling males never exceeds 20, the bias in estimating their number due to overlapping was minimal. The number of nights when toads were counted in this pond varied between five and 15 in April to the second half of May. Egg strings were found in each year when vocalizing males were identified.

Toads were identified by dip netting, torch counts at night, and call surveys (Nyström et al., 2002, 2007). Each permanent pond was surveyed 3 - 4 times, and the temporary ponds 1 - 2 times by at least two persons for each pond. Night observations were made for each permanent pond and the majority of temporary ponds. Because the larvae and egg strings are relatively easily observable in daylight (eggs are laid close to the surface of the pond and the large larvae can be detected visually) during the night surveys we identified the vocalizing males. We believe that with the sampling effort used we were always able to detect if a pond was occupied/used by Common Spadefoot Toads.

Following Hecnar and M`Closkey (1996) we considered the Common Spadefoot Toad as present when any life-stage (egg, larvae, adult) was identified, otherwise we considered the species absent. Data regarding the yearly variation of the presence or absence (hereafter: gains and losses, following Hecnar and M`Closkey, 1996) were available for the above-mentioned sample of 21 ponds. Immigration into a new habitat patch is one of the processes of colonization (Ebenhard, 1991). Using the change in gains and losses (see above) in the 21 intensively studied ponds we were able to estimate the immigration potential of ponds by this species (Hecnar and M`Closkey, 1996) in five years.

Eight pond and 17 landscape variables were used to characterize the ponds and the surrounding landscape. These variables, together with the descriptive statistics are presented in the table 1. The land cover within a 400 m, 600 m and 800 m radius around each pond was calculated using GIS software Manifold 7x, based on CORINE Land Cover 2000 of Romania (European Environment Agency, 2005), completed and adjusted with visual estimations. The measurement method and definition of pond- and landscape variables is presented in detail in Hartel et al. (2006; 2007 a, b). The presence of fish was determined using visual counts, dip netting and information gathered from fishermen and pond owners. The fish species were grouped into two categories: non-predatory fish (*Carassius auratus*, *Cyprinus carpio*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Leucaspius delineatus*, *Scardinius erythrophthalmus*) and predatory fish (*Esox lucius*, *Squalius cephalus*, *Lepomis gibbosus*, *Perca fluviatilis*, *Pseudorasbora parva*, *Silurus glanis*, *Stizosteidon lucioperca*, *Salmo fario*). A detailed presentation of the different methods used to detect the presence of fish, and also the criteria on the base of which the different fish species were categorized as predators or non-predators are presented in detail in Hartel et al. (2007b).

Data analysis

The rate of change of population size was estimated using the Δ*N* method (Houlahan et al., 2000; Green, 2003) for the population that was studied for 11 years.

According to this formula, changes in population sizes between years are related to each other by $\Delta N = \log(N+1)_t - \log(N+1)_{t-1}$, where *N* is the population size at time *t*.

Descriptive statistics were used for the pond and landscape variables. The largest calling score recorded at each pond during the years was used in the statistical analysis. To analize the relationship between the *P. fuscus* calling index and the environmental variables, multinomial logistic regression was used. This type of logistic regression is used when the dependents have more than two classes (in our case: 0, 1, 2, 3, according to the call scores). The minimal adequate models were selected using Akaike`s Information Criterion (AIC). The *AIC* is remarkably superior in model selection than the regression analysis (its use in amphibian ecology research is reviewed by Mazerolle, 2006). The AIC is useful when multiple explanatory variables are used to test their relationship with a dependent variable. The model with lowest AIC value was considered the best one.

The association between the presence/absence of toads and the environmental variables was tested by binary logistic regression, with the presence/absence data as dependent binary (0 - 1) variable. We opted for these two approaches (multinomial and binomial logistic regression) because of the possible bias in estimating „population size” using call intensity. The association between the call index and environmental variables was also separately tested with Spearman correlation. The collinearity between environmental variables was tested with Pearson correlation. One of the variables of which were strongly correlated with an other ($r > 0.6$) was removed from the analysis. High collinearity ($r > 0.6$) was found only between the landscape variables. Thus, the following landscape variables were included in two regression analyses: forest distance (m), amount of pasture (%) at 600 m, settlements (%) (800 m), agricultural lands (%) (800 m), pasture (%) (800 m) and forest cover (%), (800 m). The significance level at which we considered relationships significant was 0.1 (Mazerolle, 2004; Dragomirescu and Wanzer - Drane, 2006).

RESULTS

Regional distribution

The distribution of the ponds according to their use by *P. fuscus* is presented in the figure 1. The pond occupancy was 39% for the permanent ponds and 11.53% for the temporary ponds. Many permanent and temporary ponds occupied by this toad are along the Târnava Mare River (Fig. 1). Large *P. fuscus* populations were recorded in the following ponds: Apold, Şaeş marsh system, Brădeni, in one pond at Boiu, and the ponds at Dumbrăveni and Uilac. We never found Common Spadefoot Toads in the ponds situated in the forests.

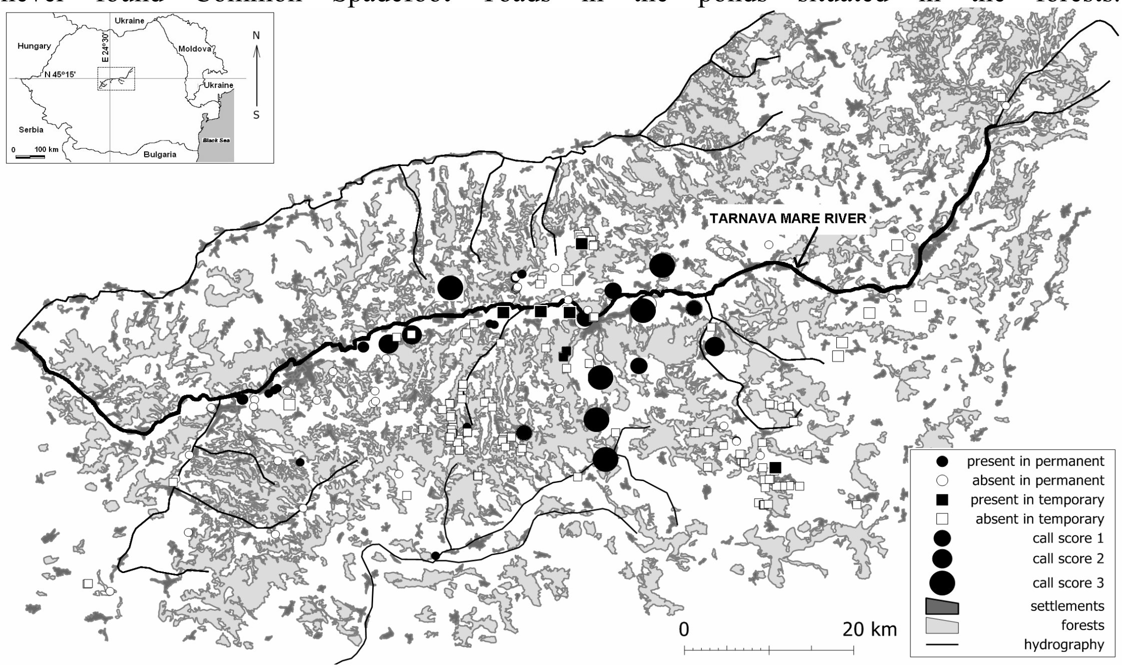


Figure 1: The distribution of the aquatic habitats and their use by the Common Spadefoot Toad in the study area. The call scores are also showed.

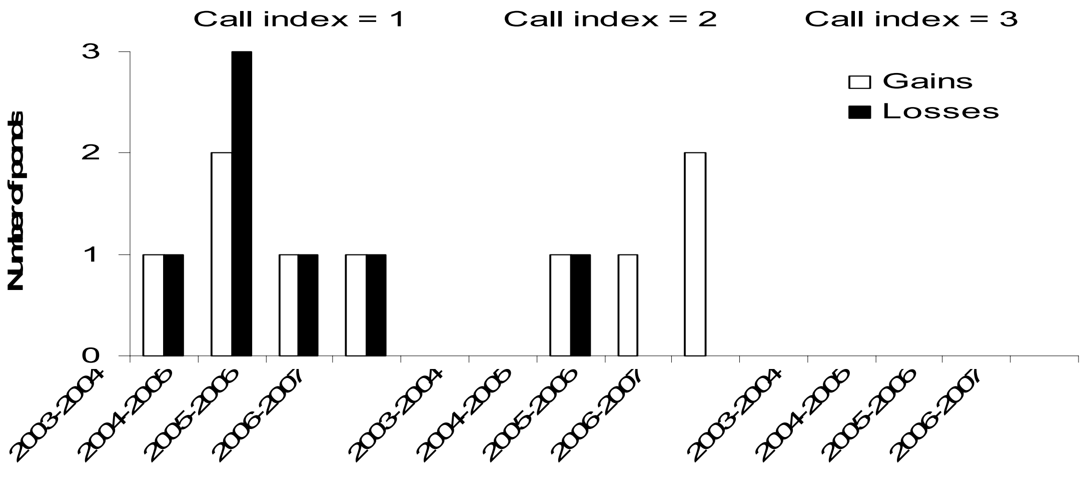


Figure 2: Change in the gains and losses according to the call intensity in the 39 ponds in five years.

The dynamic of gains and losses at individual ponds

There is a large variability in the gains and losses of individual habitat patches (ponds). As suggested in the figure 2, the small populations (call index "1") have frequent losses, whereas the larger populations (call index "3") seem to be more stable (no losses). The highest difference in gain and loss events was recorded in the years 2004 - 2005 when the number of ponds in which losses were recorded was largest relative to gains. Significant decrease in call index was recorded in the ponds from Boiu (three ponds) and Vânatori (one pond), Apold (two ponds) and "DCA" pond near Sighişoara (data not showed here). The causes are most probable multiple. We suspect predatory fish introductions (see below) and pond destruction. No large populations (call index "3") were formed during the five years (Fig. 2), suggesting that five years is not enough for the establishment of large *Pelobates fuscus* populations.

The long-term fluctuation of one population

There is no trend in the *P. fuscus* population studied near Sighişoara in 11 years (Spearman r = -0.0005, P > 0.6) although at least one loss occurred: in 2005 (Fig. 3). The values of ΔN are negative in three years and positive in seven (Fig. 4). At least one extinction has occurred (in 2005).

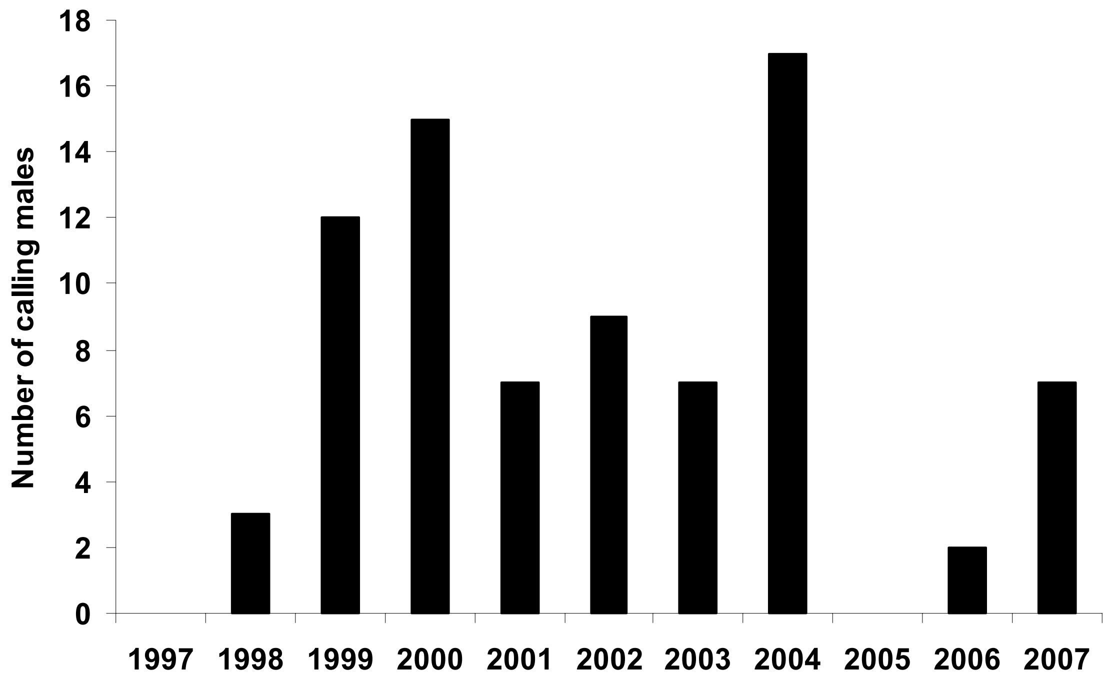


Figure 3: The fluctuation of the number of calling males of *Pelobates fuscus* in the Şercheş pond, near the town of Sighişoara.

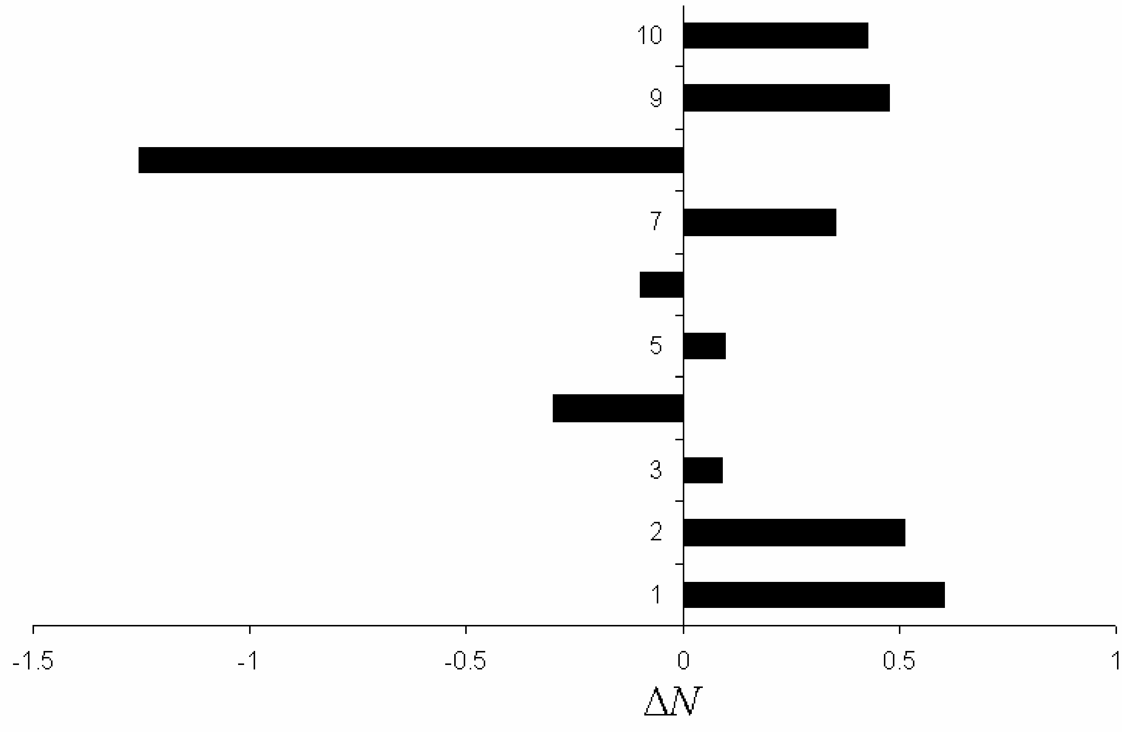


Figure 4: The values of Δ*N* for the population fluctuation.

Habitat variables affecting the pond use

21.05% of the ponds presented in this paper are without fish, 31.57% contain non-predatory fish and 47.36% contain predatory fish. Predatory fish introductions tend to be frequent in the ponds in this area. The descriptive statistics of the 39 landscapes are presented in the table 1.

The multinomial logistic regression analysis shows that pond-related variables were more important (66% of variables have a significant effect) for the Common Spadefoot Toad call index than the landscape variables (16.6%). Significant positive relationship was found between the calling index and pond age (B = 0.11, P = 0.03), pond area (B = 0.05, P = 0.01), water conductivity (B = 0.01, P = 0.02) and the amount of pasture within a distance of 800 m around the ponds (B = 0.03, P = 0.09). Negative relationship was found between the calling index and predatory fish (B = - 1.64, P = 0.07) (Nagelkerke r^2 = 0.59). The pond age had the lowest AIC value (AIC = 106.36).

The binary logistic regression model evidenced two important variables determining the pond occupancy of Common Spadefood Toads; both being pond-related variables: the age of the ponds (B = 0.14, P = 0.005) and the presence of predatory fish (B = - 0.96, P = 0.09) (Nagelkerke r^2 = 0.39). These results show that the call index provide more ecologically meaningful data about habitat use than simply the presence/absence data.

Table 1: The descriptive statistics of the pond and landscape variables. LCI = Lower Confidence Interval, UCI = Upper Confidence Interval, SD = Standard Deviation, CV = Coeficient of Variation.

	Average	LCI	UCI	SD	CV	Skewness
Pond area (ha)	11.38	0.28	22.48	33.78	2.96	3.41
Altitude above sea (m)	397.66	376.03	419.29	65.81	0.16	1.21
pH (Median value)	8.15	7.54	8.06	0.78	0.09	- 0.62
Water conductivity	612.90	553.55	672.25	180.57	0.29	- 0.73
Pond age (years)	18.63	15.29	21.97	10.17	0.54	0.05
Percentage shallow water	28.55	20.37	36.74	24.90	0.87	1.56
Percentage reeds cover	32.61	23.74	41.47	26.96	0.82	0.99
Forest distance (m)	325.00	210.35	439.65	348.80	1.07	1.01
Settlement 400 m (%)	19.41	10.12	28.71	28.27	1.45	1.30
Agriculture 400 m (%)	18.11	10.64	25.57	22.70	1.25	1.05
Pasture 400 m (%)	39.28	29.58	48.99	29.54	0.75	0.49
Forest cover 400 m (%)	17.20	10.75	23.64	19.62	1.14	0.78
Settlement 600 m (%)	18.02	9.15	26.90	27.00	1.49	1.56
Agriculture 600 m (%)	18.43	12.17	24.70	19.06	1.03	0.68
Pasture 600 m (%)	39.36	30.60	48.12	26.65	0.67	0.43
Forest 600 m (%)	19.81	13.49	26.13	19.22	0.97	0.58
Settlement 800 m (%)	16.36	8.35	24.36	24.36	1.48	1.70
Agriculture 800 m (%)	18.32	12.39	24.25	18.05	0.98	0.60
Pasture 800 m (%)	40.75	32.43	49.07	25.31	0.62	0.36
Forest 800 m (%)	20.68	14.65	26.71	18.35	0.88	0.48

Spearman correlation shows significant relationships between the call index and the pond age (r = 0.44, P = 0.002), water conductivity (r = 0.26, P = 0.05), reed cover (r = 0.2, P = 0.1), and predatory fish (r = - 0.21, P = 0.08). The call index (median) was significantly smaller in the ponds with predatory fish than in the other ponds (Kruskal-Wallis test: H (2, N = 38) = 7.81, P = 0.02).

DISCUSSION

Our results show a large variation in gain and loss events at individual patches (ponds). It is also possible that we are detecting the immigration of a propagule and/or the maturation of an early local juvenile cohort. The breeding and terrestrial habitat quality are important determinants of the local population size. The importance of the amount of pasture round the pond (the largest scale, 800 m) suggests that open lands may have a role in the dispersion and (re)colonization of habitats. The soil type along the river and its tributaries is alluvial sandy, the preferred terrestrial habitat for *P. fuscus* (Fuhn, 1960; Nyström et al., 2007). The former flooded areas are the most threatened by human activities, since are increasingly being converted to intensive agriculture; moreover, anthropogenic impact is strengthened in these areas.

The Common Spadefoot Toad populations in this area are more influenced by pond variables than by landscape ones. This study shows that a good pond for the Common Spadefoot Toads is large, permanent, old, vegetated, with no predatory fish and situated in an open area. These results are in agreement with other studies on this species (Nyström et al., 2002; 2007). The importance of pond age in determining the pond's use by *P. fuscus* (positive relationship between the call index and pond age) suggests the importance of time after colonization for the formation of larger populations. Older ponds probably are more vegetated and more productive, both features being important for the Common Spadefoot Toad. The positive relationship between the emergent aquatic vegetation cover and the Common Spadefoot Toad call index (evidenced by the Spearman correlation coefficient) can be explained by the variety of micro-habitats available in habitats covered by reeds (Hartel et al., 2007b).

We found a negative relationship between the call index and predatory fish. A negative impact of introduced predatory fish on *P. fuscus* has also been documented in northern Europe (Nyström et al., 2002). The larvae of *P. fuscus* are sensitive to predatory fish probably due to their nektonic life, which exposes them, and lack of noxious skin compounds. Since the tadpoles of *P. fuscus* are very large, the impact of fish may be considerable even in the early life stages.

The *Bufo bufo* counted here were not related significantly to pond variables, but to landscape variables, although the ponds used by toads for reproduction tend to contain both predatory and non-predatory fish. The green corridors (linking the ponds with forests) and the amount of forested areas were significant predictors for *B. bufo* population size (Hartel et al., 2007a). This comparison shows that the habitat requirement of amphibians is species specific. The management of amphibians should take into account such differences between species, otherwise an intervention that favours one species may have a bad consequence for others.

The evidence suggests that restricting fish introductions to non-predatory fish, and maintaining a high level of vegetation cover in older ponds, are crucial for the formation of large, self-sustainable populations. We suggest that former and actual flooded areas along the Târnava Mare and its tributaries are important migration corrridors for *B. bufo*. Considering that "habitat association" studies are absent in Romania, we encourage studies that investigate the breeding habitat use by amphibians. Our study highlights important further research questions in the local population ecology of amphibians: Do individual ponds support individual populations? What is the dispersion distance of juvenile Common Spadefoot Toad, and how is this related to the matrix quality? How large should be an immigrating propagule to assure a self-sustainable population? Are the populations of *Pelobates fuscus* in this area organized in metapopulations?

ACKNOWLEDGMENTS

The study was supported by Declining Amphibian Populations Task Force, British Ornithological Union and the Swedish Biodiversity Centre. Special thanks to the Mihai Eminescu Trust for their support during 2005 - 2007. The manuscript was improved due to discussions with D. Cogălniceanu, D. Ruşti and L. Demeter.

REFERENCES

1. Alexander, M. A. and Eischeid, J. K., 2001 − Climate variability in regions of amphibian declines. *Conservation Biology* 15: 930-942.
2. Arajuo, M.B., Thuiller, W., and Pearson. R.G., 2006 − Climate warming and the decline of amphibians and reptiles in Europe. *Journal of Biogeography* 33:1712-1728.
3. Beebee, T.J.C., and Griffiths, R.A., 2005 − The amphibian decline crisis: A watershed for conservation biology? *Biological Conservation* 125: 271-285.
4. Cushman, S. A., 2005 − Effects of habitat loss and fragmentation on amphibians: A review and prospectus. *Biological Conservation* 128: 231-240.
5. Dodd, C.K., Jr. and Barichivich, W. J., 2007 − Establishing a baseline and faunal history in amphibian monitoring: the amphibians of Harris Neck, GA. *Southeastern Naturalist* 6: 125-134.
6. Dragomirescu, L. and Wanzer Drane. J., 2006 − Biostatistică. Editura CREDIS Bucureşti.
7. zukic, G., Beskov, V., Sidorovska, V., Cogălniceanu, D., Kalezik, M., 2007 − Contemporary chorology of the spadefoot toads in the Balkan Peninsula. *Zeitschrift Feldherpetologie,* 1-18 (*in press*).
8. Ebenhard, T., 1991 – Colonization in metapopulations: a review of theory and observations. *Biological Journal of Linnean Society* 42: 105-121.
9. Fuhn, I. E., 1960 − Fauna R.P.R. Amphibia. Ed. Acad. Rep. Soc. Rom.
10. Gagne, S. A. and Fahrig. L., 2007 − Effect of landscape context on anuran communities in breeding ponds in the National Capital Region, Canada. *Landscape Ecology* 22: 205-215.
11. Ghira I., Venczel, M., Covaciu - Marcov, S.V., Mara, G., Ghile, P., Hartel, T., Török, Z., Farkas, L., Rácz, T., Farkas, Z., Brad. T., 2002 − Mapping Transilvanian Herpetofauna. *Nymphaea* 29: 145-201.
12. Green, D. M., 2003 − The ecology of extinction: population fluctuation and decline in amphibians. *Biological Conservation* 111: 331-343.
13. Hartel, J. and Hoffmann, E., 1989 − Possible effects of acidic deposition on a Rocky Mountain population of the tiger salamander *Ambystoma tigrinum*. *Conservation Biology* 2: 149-158.
14. Hartel, T., Demeter, L., Cogălniceanu D., and Tulbure, M., 2006 − The influence of habitat characteristics on amphibian species richness in two river basins of Romania. In: M. Vences, J. Köhler, T. Ziegler, W. Böhme (eds): *Herpetologia Bonnensis* II. Proceedings of the 13th Congress of the Societas Europaea Herpetologica. pp. 47-50.
15. Hartel, T., Nemes, Sz., Cogălniceanu, D., Öllerer, K., Schweiger, O., Moga, C.I., Demeter L., 2007a − The effects of fish and habitat complexity on amphibians. *Hydrobiologia* 583: 173-182.
16. Hartel, T., Nemes, S., Demeter, L., Öllerer, K., 2007b − Pond and landscape characteristics: which are more important for the common toad? A case study from Romania. *Applied Herpetology* in press.
17. Hecnar, S. J. and M`Closkey. R. T., 1996 − Regional dynamics and status of amphibians. *Ecology* 77: 2091-2097.
18. Hels, T., and Buchwald, E.. 2001 − The effect of road kills on amphibian populations. *Biological Conservation* 99: 331-340.
19. Houlahan, J.E., Findlay, C. S., Schmidt, B.R, Meyer, A.H., and Kuzmin, S.L., 2000 − Quantitative evidence for global amphibian population declines. *Nature* 44: 752-755
20. Kats, L.B. and Ferrer, R. P., 2003 − Alien predators and amphibian declines: review of two decades of science and the transition to conservation. *Diversity and Distributions* 9: 99-110.
21. Kieseker, J.M., Blaustain, A. R., and Belden, L., 2001 − Complex causes of amphibian population declines. *Nature* 410: 681-684.
22. Mazerolle, M. J., 2004 – Amphibian road mortality in response to nightly variations in traffic intensity. *Herpetologica* 60: 45-53.
23. Mazerolle, M., 2006 – Improving data analysis in herpetology: using Akaike`s Information Criterion (AIC) to assess the strength of biological hypotheses. *Amphibia – Reptilia* 27: 169-180.
24. Nyström, P., Birkedal, L., Dahlberg, C., and Brönmark, K. C., 2002 − The declining spadefoot toad *Pelobates fuscus*: calling site choice and conservation. *Ecography* 25: 488-498.
25. Nyström, P., Hansson, J., Mansson, J., Sundstedt, M., Reslow, C., Broström. A., 2007 − A documented amphibian decline in 40 years. *Biological Conservation* doi:10.1016/j.biocon.2007.05.007
26. Palang, H., Printsmann, A., Gyuró, É. K., Urbanc, M., Skowronek, E., and Woloszyn, W., 2006 − The forgotten landscapes of Central and Eastern Europe. *Landscape Ecology* 21: 347-357.
27. Stuart, S.N., I.S. Chanson, N.A. Cox, B.E. Young, A.S.L. Rodrigues, D.L.Fishman, R.W. Waller, 2004 - Status and trends of amphibian declines and extinctions worldwide. *Science* 3: 1783-1785.

THE HERPETOFAUNA OF THE SIGHIŞOARA AREA (TRANSYLVANIA, ROMANIA)

*Ioan GHIRA **

* Babeş-Bolyai University, Biology and Geology Faculty, Department of Taxonomy and Ecology, 1 Kogălniceanu Street, Cluj-Napoca, Cluj County, Romania, RO - 400084 ighira@hasdeu.ubbcluj.ro

KEYWORDS: Romania, Transylvania, herpetofauna, amphibians, reptiles.

ABSTRACT

Of the 42 species of herpetofauna which live in Romania, 21 species were observed in the area south of Sighişoara: 13 amphibians (*Salamandra salamandra, Triturus cristatus, Lissototriton vulgaris, Bombina variegata, Pelobates fuscus, Bufo bufo, Elapidea viridis, Hyla arborea, Rana arvalis, R. dalmatina, R. temporaria, Pelophylax esculentus. P. ridibundus*) and eight reptiles (*Emys orbicularis, Lacerta agilis, L. viridis, Anguis fragilis, Natrix natrix, N. tessellata, Coronella austriaca, Zamenis longissimus*). The biodiversity is more marked for the amphibian species, representing 76.4% of the species of Transylvania, while the percentage of reptile species is 57.1%. From a quantitative point of view, neither of these vertebrate groups is in a very strong position; the populations are numerically low as a result of human impact. Four species are regarded as threatened in the area studied: *Pelobates fuscus, Elapidea viridis, Rana arvalis* and *Emys orbicularis*. Another three species are vulnerable: *Triturus cristatus, Lissototriton vulgaris, Hyla arborea.* Another seven species are rare: *Salamandra salamandra, Rana dalmatina, Lacerta viridis, Anguis fragilis, Coronella austriaca* and *Zamenis longissimus.* The other seven species are common.

ZUSAMMENFASSUNG: Die Herpetofauna des Gebietes von Sighişoara/ Schässburg (Transylvanien, Rumänien).

Von den 42 Arten der Herpetofauna Rumäniens, wurden 21 Arten im Gebiet südlich von Sighisoara / Schässburg beobachtet: 13 Amphibien (*Salamandra salamandra, Triturus cristatus, Lissototriton vulgaris, Bombina variegata, Pelobates fuscus, Bufo bufo, Elapidea viridis, Hyla arborea, Rana arvalis, R. dalmatina, R. temporaria, Pelophylax esculentus. P. ridibundus*) und acht Reptilien (*Emys orbicularis, Lacerta agilis, L. viridis, Anguis fragilis, Natrix natrix, N. tessellata, Coronella austriaca, Zamenis longissimus*). Die Biodiversität ist ausgeprägter im Bereich der Amphibien, die 76.4% der in Transylvanien vorkommenden Arten repräsentieren, während der Anteil der Reptilienarten bei 57.1% liegt. Quantitativ betrachtet, ist keine dieser Wirbeltiergruppen sehr stark vertreten. Bedingt durch menschlichen Einfluss, sind die Populationen klein. Von den untersuchten Arten werden vier im Untersuchungsgebiet als stark gefährdet eingestuft: *Pelobates fuscus*, *Elapidea viridis*, *Rana arvalis* and *Emys orbicularis*. Weitere drei Arten sind gefährdet: *Triturus cristatus*, *Lissototriton vulgaris*, *Hyla arborea*. Darüber hinaus sind sieben Arten als selten einzustufen: *Salamandra salamandra*, *Rana dalmatina*, *Lacerta viridis*, *Anguis fragilis*, *Coronella austriaca* und *Zamenis longissimus*. Die übrigen sieben Arten gehören in die Kategorie der verbreiteten Arten.

REZUMAT: Herpetofauna zonei Sighişoara (Transilvania, România).

Din cele 42 de specii ale herpetofaunei care trăiesc în România, în zona de la sud de Sighişoara, au fost observate 21 de specii: 13 de amfibieni (*Salamandra salamandra, Triturus cristatus, Lissototriton vulgaris, Bombina variegata, Pelobates fuscus, Bufo bufo, Elapidea viridis, Hyla arborea, Rana arvalis, R. dalmatina, R. temporaria, Pelophylax esculentus. P. ridibundus*) şi opt de reptile (*Emys orbicularis, Lacerta agilis, L. viridis, Anguis fragilis, Natrix natrix, N. tessellata, Coronella austriaca, Zamenis longissimus*). Pentru speciile de amfibieni, biodiversitatea este mai ridicată, ele reprezentând 76,4% din speciile din Transilvania, pe când reptilele reprezintă doar 57,1% dintre acestea. Din punct de vedere cantitativ, nici una dintre cele două grupe de vertebrate nu prezintă o situație strălucită, datorită impactului antropic, populațiile fiind reduse numeric. Patru specii sunt considerate a fi amenințate în zona studiată: *Pelobates fuscus, Elapidea viridis, Rana arvalis* and *Emys orbicularis*. Alte trei specii sunt vulnerabile: *Triturus cristatus, Lissototriton vulgaris, Hyla arborea.* Rare sunt alte sapte specii: *Salamandra salamandra, Rana dalmatina, Lacerta viridis, Anguis fragilis, Coronella austriaca* and *Zamenis longissimus.* Celelalte şapte specii sunt comune.

INTRODUCTION

Transylvania in its broad sense includes many levels of vegetation, from lowland to alpine levels. Of the 42 species of herpetofauna which live in Romania, 21 species were observed in the area south of Sighişoara.

The area that we have studied lies in the Târnava River Plateau, and a small part in the Hârtibaciu Plateau, which is not dissimilar geomorphologically. The lowest altitudes, found in the northern part along the course of the Târnava Mare River, are c. 350 m, and the highest do not exceed 700 m, in the hilly parts. Herpetofauna study in this area have been sporadic: Fuhn (1960), Fuhn and Vancea 1961, Graef, 1972, Ghira et al., 2002, Hartel et al., 2006.

MATERIALS AND METHODS

The studies of the herpetofauna were carried out during years 2005 - 2007, and have included several field excursions each year, between May and August, covering most of the area proposed as a Natura 2000 site. Field excursions were made in daytime and at night-time. Some areas were covered several times. Animals were collected in order to be studied and photographed, and then released.

RESULTS AND DISCUSSION

Amphibians

Fire Salamander (*Salamandra salamandra*). The Fire Salamander is a terrestrial and nocturnal species which inhabits humid and grassy forests between altitudes of 400 - 500m and 1400 m, and sometimes outside those limits. It is considered a rare species at national level. In order to deposit larvae, salamanders need shallow brooks (Fuhn, 1960; Arnold and Burton, 1978). The lack or rarity of these in forests can be a limiting factor on population density. A rare species in the study area (Cogălniceanu, 1991; Cogălniceanu et al., 2000; Ghira et al., 2002); we saw indications at Albeşti, Apold, Brădeni, Şaeş, Saschiz and Sighişoara.

Threats. The main threat is the reduction of forest in the study area. The drying of the climate that has been observed in recent years has led to the drying-up of certain springs and ponds in the forests which has caused a reduction in reproductive capacity of the populations.

Great Crested Newt or Warty Newt (*Triturus cristatus*). The Great Crested Newt is a predominantly aquatic species found at 0 - 1000 m altitude in shallow stagnant water (ponds, canals, ditches with water, puddles, etc.) which have a swampy vegetation, but also at the edges of larger lakes, ponds or other water bodies (Fuhn, 1960). Similarly you can find it in stagnant water in forests if these are available. A vulnerable species in the studied area (Cogălniceanu, 1991; Cogălniceanu et al., 2000; Ghira et al., 2002, Mara et al., 1999); we observed this in the following localities: Apold, Daneş, Jibert, Şaeş and Sighişoara. At a national level, the species is in decline and is considered rare, because of the destruction of aquatic habitats, which are required for reproduction, and the pollution of small water bodies. Locally the species is vulnerable.

Threats. The destruction or pollution of aquatic habitats required for reproduction is the principal threat for this species (Botnariuc and Tatole, 2005). The adult can still survive in humid habitats (leaves in forests or humid parts of reed-beds) but the larval stage is strictly aquatic. The stocking of lakes with different fish species has brought about the dramatic reduction of the Great Crested Newt population in the study area. All of these threats have brought about the fragmentation of suitable habitats and the isolation of populations of reduced size which are threatened.

Smooth Newt or Common Newt (*Lissototriton vulgaris)*. This species is met generally in the same aquatic habitats as the previous species, *Triturus cristatus*. Its population area is broader because it is not so demanding as regards depth and quality of water. Thus, the Smooth Newt can be found in ditches, lakes, canals and permanent waters which are very shallow (15 - 30 cm). The waters can be polluted with organic residues (for example from cattle or pig farms) because the species is very tolerant of water of poor quality. If there are enough trophic resources, the newt can remain in the summer in lakes.

In habitats where both species are present (*Lissototriton vulgaris* and *Triturus cristatus*), one can observe a zonation which is suitable to them: always the Smooth Newt is found in areas immediately next to the bank, while the Great Crested Newt is found at greater depths. The Great Crested Newt is a predator and eats the Smooth Newt at its young juvenile and even adult stages. The characteristics of its reproduction are the same as in the previous species. At a national level, it is considered common, since at the moment there is no danger of population fall, because of the adaptability of the species (Cogălniceanu et al., 2000). In the study area, the Smooth Newt is vulnerable, having approximately the same habitation area as the previous species and was observed in: Apold, Daia, Daneş, Iacobeni, Jibert, Şaeş and Sighişoara. We note that in the study area is also found the sub-species *T. vulgaris ampelensis* which is mentioned on Annexe 3 of Ordinance number 57/2007. At the local level, the Smooth Newt is still rare because the reduction of reproductive habitats has led to a drastic reduction in the population of this species.

Threats. Threats are the same as for the previous species.

Yellow-Bellied Toad (*Bombina variegata*). This is a diurnal aquatic species, found at altitudes of 300 - 1900 m (Fuhn, 1960). In contrast to related species, *Bombina variegata* is very tolerant at water quality and prefers aquatic habitats which are small, and so it can be found in temporary water bodies, in boggy areas with small open water areas, on the banks of streams, in ditches, canals etc. It is very widespread throughout the localities studied, and can be found in practically every aquatic habitat of small dimensions. It is more rarely found in large water bodies, lakes, etc. (Arnold and Burton, 1978; Fuhn, 1960; Cogălniceanu et al., 2000, Botnariuc and Tatole, 2005).

In the study area the Yellow-bellied Toad is a common species. We found it in many localities, especially those on the slopes of hills, in puddles or ponds found in pasture, hay-meadows, arable land and even woodland (Albeşti, Apold, Archita, Biertan, Buneşti, Chiafardola, Copşa Mare, Criş, Daia, Daneş, Iacobeni, Jibert, Laslea, Mureni-Feleag, Nou Săsesc, Richiş, Roandola, Şaeş, Saschiz, Sighişoara, Valchid - Floreşti and Vânători).

Threats. In the study area *Bombina variegata* does not seem to be threatened at present. Similarly, at a national level, it is not threatened. In Transylvania, Yellow-bellied Toad hybridises with Fire-bellied Toad (*Bombina bombina).* According to studies carried out in this area, at altitudes lower than 250 m can be found *bombina*-like hybrids, and at over 500m can be found only *variagata*-like hybrids. At altitudes between 250 and 500 m one can find all three hybrid categories, the populations being distributed in a mosaic (Ghira et al., 2003). The situation is similar to a hybrid area in Slovakia where the parental species and the hybrids have been described. The explanation is found in the spotty nature of the habitat which creates the possibility of segregation between these two taxa which are genetically different. The mosaic distribution of hybrids is in relation to the habitat and the limited number of places to occupy in time and space (Szymura, 1988; 1993). At altitudes of 250 - 500m the altitude does not influence the distribution of hybrids. Here the important factors which control the distribution of hybrids are the proportion of shallow waters and the surroundings. The localities in which *Bombina variegata* x *B. bombina* hybrids were observed are: Criş, Iacobeni and Mureni - Feleag.

Common Spadefoot Toad (*Pelobates fuscus*). A terrestrial nocturnal species, it is present only in areas of sandy or clay soil, in meadowland, in which it can burrow easily, and usually situated close to humid areas. It reaches an altitude of 700 - 800m. For reproduction it requires permanent water bodies, towards which it migrates in spring after leaving hibernation. In the daytime (except in periods of reproduction when it can be found in water bodies) it stays burrowed in the sand at a depth of up to 30 - 50 cm. (Fuhn, 1960; Arnold and Burton, 1978). At a European level, this burrowing toad is in continuous decline. In Romania the species is vulnerable (Cogălniceanu, 2000; Botnariuc and Tatole, 2005), and in the study area it is threatened**.** In the Sighişoara - Târnava Mare area the Spadefoot Toad has been indicated up until current times (Ghira et al., 2000) only in a few localities: Apold, Daneş, Jibert, Şaeş and Sighişoara. Being a threatened species and extremely difficult to study, the Spadefoot Toad requires special attention.

Threats. Two threats face the Spadefoot Toad: first, destruction of terrestrial habitats where it carries out its summer activities, generally the edges of rivers in cultivated areas. Ploughing in spring or autumn can kill hundreds every year, causing a continuous reduction in population. Second, pollution of reproductive water bodies can bring about the death of tadpoles, which require a prolonged period of development in water (April - August) and clean, unpolluted water.

Common Toad (*Bufo bufo*). A terrestrial species, generally nocturnal, which prefers wooded habitats in hilly and mountain areas up to 1800 m altitude (Fuhn, 1960; Cogălniceanu et al., 2000). The largest populations are found in the humid valleys of deciduous forests, particularly beech. It is not restricted to forests, and can be found also in grassland, orchards, cultivated areas, gardens, cemetaries and rock piles. It is not a heat-loving species and therefore requires a certain amount of humidity. In the spring, during the reproductive period, *Bufo bufo* congregates in water bodies within or close to its territory in order to deposit its eggs. Occasionally, in some water bodies, groups of thousands can be found. In Romania the species is common.

Threats. In this area, *Bufo bufo* is common. We presume that it is spread throughout most localities; it was observed in Albeşti, Apold, Archita, Brădeni, Daia, Daneş, Laslea, Malâncrav, Mureni-Feleag, Nou Săsesc, Roandola, Şaeş, Şapartoc, Saschiz, Sighişoara, and Stejereni.

Green Toad (*Elapidea viridis*). A heat-loving species, terrestrial and nocturnal except for the period of reproduction when it is diurnal and aquatic. It is tolerant of water serenity, of the pollution of water and is extremely resistant to drying. It is widespread in a variety of habitat types, preferring areas which are lower and dryer. In altitude it reaches from lowland up to 800 - 1000 m, identification above this being rare (Fuhn, 1960; Cogălniceanu et al., 2000). It is the most tolerant of human activity of all our amphibian species. It is found widely in villages, where it stays hidden in the daytime in order to come out to hunt at nightfall. It collects around street-light posts where it waits for insects to fall from where they circle the lights. In the Sighişoara - Târnava Mare Basin the Green Toad is a rare species and is found at five localities: Apold, Bradeni, Daia, Daneş and Sighişoara.

Threats. In the area studied, *Elapidea viridis* is threatened by destruction of its habitat.

Common Tree Frog (*Hyla arborea*). Our only arboreal species, *Hyla arborea* is diurnal and heat-loving and is found at altitudes up to 700 - 800 m. The most numerous populations are found in steppic zones near wet areas (Fuhn, 1960; Cogălniceanu et al., 2000). Apart from reproductive periods, when it is aquatic, *Hyla arborea* can be found in tall vegetation (tall scrub, reeds and rushes, willows, in the clearings of deciduous forests, orchards, etc.) In the study area this is a vulnerable species found in many localities and around humid areas: Albeşti, Apold, Archita, Brădeni, Daia, Daneş, Mălâncrav, Şaeş, Şapartoc, Saschiz and Sighişoara.

Threats. The species is threatened due of deterioration of habitats; the significant drying of the climate has caused a significant reduction in the lakes it requires for reproduction.

Green Frog complex (*Pelophylax esculentus* complex). In this complex of species are three forms: *Pelophylax ridibundus* (Marsh Frog)*, P. lessonae* (Pool Frog) and the intermediate *P. esculentus* (Edible Frog). In Romania studies on the distribution of these three forms have been few, such that we do not know the extent of their populations. Approximately, we can say that *P. ridibundus* and P. *esculentus* are widespread, while *P. lessonae* is much more restricted, known from only a few localities (Tesio and Marinescu, 1982), being a rare species (mentioned on Annex 3b of Order no. 1198 of 25 November 2005).,

Pelophylax ridibundus is an aquatic species found in a wide variety of aquatic habitats - canals, ditches, small permanent lakes and large lakes. It is very tolerant of water quality and can often be found in polluted waters. It is a heat-loving species, reaching an altitude of 700 - 800 m; it prefers warmer waters and thick grassy vegetation on the banks. It is the largest amphibian species in Europe, carnivorous and cannibalistic, eating not only its own offspring but also other frog species. Alongside the Green Toad, it forms part of a group of the most human-tolerant species of amphibian and can be found within villages where environmental conditions permit (Arnold and Burton, 1978; Fuhn, 1960; Cogălniceanu et al., 2000).

P. esculentus lives in almost all habitats where *P. ridibundus* can be found; statistically it is observed to avoid large lakes, preferring ponds of various sizes, bogs, ditches and canals. Otherwise, its habitats are very similar to the first species. Currently *P. esculentus* is considered to be a hybrid species derived by natural cross breeding of the other two species.

P. lessonae is the least linked to aquatic habitats, being found in very small water bodies with much aquatic vegetation which can dry out in the summer. It is the only one of the three species strictly protected by law (Annex 3b of Order 1198 of 25 November 2005).

In the study area, both *Pelophylax ridibundus* and *P. esculentus* are common species found in all ponds, streams and bogs. *P. lessonae* was not found in the study area.

Threats. Up until now these two species are not threatened.

Moor Frog (*Rana arvalis*). Largely nocturnal, it occupies humid habitats in fields and hills. It prefers marshy land with ponds, regularly flooded lowland woodland, and bogs and ponds near river banks. It lives in groups, not being uniformly distributed in humid habitats. In Romania it is quite rare, found only in few Transylvanian localities (Fuhn, 1960; Stugren, 1966; Arnold and Burton, 1978; Cogălniceanu et al., 2000). At a national level it is a vulnerable species (Cogălniceanu et al., 2000; Botnariuc and Tatole, 2005) and at local level it is threatened, being found only at one locality, Brădeni.

Threats. Being fairly sensitive to water and habitat quality, this species is in steep decline: many wet habitats have been drained and the majority of water courses are of low quality.

Agile Frog (*Rana dalmatina*). This terrestrial and diurnal species is very well adapted to the terrestrial habitats in which it moves, with long jumps of up to 2 m in length and 0.75 m in height (the best jumper of all our frog species). It is not so well adapted to swimming, having reduced webs between its toes. It enters water in autumn for hibernation and for the next reproductive season. Its preferred habitats are weedy forest scrub, the scrub at ground level under trees and even under dead leaves from which it has borrowed its colour; it can also be found in grassland, orchards, and clearings in deciduous forests (hornbeam and oak). It prefers a warmer climate and habitat, reaching an altitude of up to a maximum of 800 m (Fuhn, 1960; Cogălniceanu et al., 2000). At national level it is vulnerable (Cogălniceanu et al., 2000).

In the study area, *Rana dalmatina* has been indicated in many localities (Albeşti, Apold, Archita, Buneşti, Chiafardola, Criş, Daia, Daneş, Laslea, Malâncrav, Mureni-Feleag, Nou Săsesc, Richiş, Roandola, Şaeş, Şapartoc, Saschiz, Sighişoara, Valchid - Floreşti), and is a rare species considering the suitable habitats that are available.

Threats. At a general level a serious decline is observed due of the destruction, of habitats, particularly reproductive ponds because of the development of industry, tourism, urbanisation, and pollution (particularly from agriculture as a result of pesticides and fertilisers, and manure spreading in reproductive areas). It is affected by clearance and drying. In the past it was very widespread but now it is rare, particularly in the southern part of the country. A further threat may be its capture for eating (Botnariuc and Tatole, 2005). Locally, the clearing of forests and pollution of reproductive ponds have caused the drastic diminution of Agile Frog populations. The large number of wild duck species which have invaded many ponds and marshes populated by the tadpoles represent a serious threat. Bird species of the orders Ciconiide, Ardeide, Falconide and Laniide eat the tadpoles and adults of *R. dalmatina*.

Common Frog (*Rana temporaria*). A terrestrial species with nocturnal tendencies, it is linked to a certain level of habitat humidity. It can be found at 300 - 2300 m (among our frogs, it is the species that reaches the highest altitudes). Mainly it inhabits deciduous and more rarely coniferous woodland, particularly the clearings. It prefers humid grassland in hilly, mountain and more rarely sub-alpine areas. It is aquatic only during the period of reproduction, being the first to enter the water, some even in the middle of March if the air temperature has allowed it to become active. It reproduces in larger lakes, temporary or permanent. This species was very widespread in the past and currently, although it is not on the list of protected species, it is rare at a national level (Cogălniceanu et al., 2000). Locally the Common Frog is common, being indicated at: Albeşti, Apold, Archita, Chiafardola, Criş, Daneş, Laslea, Mălâncrav, Nou Săsesc, Şaeş, Saschiz, Sighişoara and Stejereni.

Threats. These include the decline of air quality through the degradation of habitat quality resulting from the negative effects of pathogens, pollutants or parasites, modifications to human occupation to habitats and exploitation of habitats. The Common Frog is a prey for many animal species. The most frequent bird predators are ciconiiforms (*Ciconia ciconia, C. nigra* and *Ardea cinerea*), anseriforms (*Anas* spp., *Anser* spp.), certain species of falcon (*Falco* spp.), corvids (*Corvus cornix*) and laniids (*Lanius* spp.) among passerines; owls, kingfishers and terns also may prey on the Common Frog. Exceptionally *Saxicola torquata* feeds on the young of *R. temporaria* when unfavourable weather conditions prevent the appearance of large insects on which it normally feeds. Similarly, certain mammals prey on this species: hedgehogs, otters, badger, weasels, and rats. It is the basic diet of grass snakes. Many species of aquatic insect (Dytiscidae, Notonectidae, Gerridae) are predators on the eggs and tadpoles of *R. temporaria*; similarly some aquatic larvae of trichoptera or diptera (Stratiomyidae, Tipulidae). But the most important predators of the tadpoles are fish (Ciprinidae) and newts (*Triturus alpestris* and *T. cristatus*). Currently, *Rana temporaria* is not protected, although a species of European Community interest for which capture and exploitation are subject to management measures (Ordinance no. 57/2007, Annexe 5a). Thus, in Romania a significant reduction in the population of *R. temporaria* has been seen in the last 20 - 30 years. Predictable consequences: at national level we can predict a major decline in the populations of *R. temporaria* due of the destruction, degradation of habitats, in particular reproductive lakes, through industrial, tourist and urban development, pollution, scrub clearance, road building, intensive grazing and through the illegal collection. In some areas it is still quite frequent but in general it is very rare, especially in areas where it is collected (Botnariuc and Tatole, 2005).

Reptiles

European Pond Terrapin (*Emys orbicularis*). A semi-aquatic species, heat-loving, which lives in still waters of a large scale (lakes, fish ponds) or in flowing waters in fields and hilly regions. It captures and eats its prey (normally larvae if invertebrates, tadpoles, fish) in the water. It also hibernates in water. This is timid species, difficult to observe. At national level it is a threatened species (Arnold and Burton, 1978; Fuhn and Vancea, 1961). In the Sighişoara - Târnava Mare Basin the European Pond Terrapin is indicated only in Brădeni. It is a threatened species and the study area could protect important populations of this turtle.

Threats. Although this species has no obvious predators due to its exoskeleton, still its numbers have drastically fallen in the last 50 years at national and local level. The pollution of aquatic habitats, scrub clearance along river banks, killing by local people (among whom there is a widespread belief that this turtle causes large losses among young fish) are some of the factors that have brought about this situation. The newborn young of *Emys orbicularis* have natural enemies because their carapace is still soft (lake birds and various mammal species).

Sand Lizard *(Lacerta agilis).* This is probably our most common lizard species, being widespread from lowland areas up to 1500 m altitude. For micro-habitats it prefers humid or shady grassland (near fences and scrub, in vineyards, along the arable fields edges, in the grassy banks of hills, in grassland, cleared forests, the grassy banks of ponds etc.). It does not necessarily require the presence of bushy or tree vegetation. It is widespread everywhere. It was observed in most localities in the Sighişoara - Târnava Mare Basin (Apold, Archita, Biertan, Brădeni, Buneşti, Chiafardola, Copşa Mare, Criş, Daia, Jibert, Laslea, Mălâncrav, Mureni - Feleag, Nou Săsesc, Richiş, Roadeş, Roandola, Şaeş, Şapartoc, Saschiz, Sighişoara, Valchid, Floreşti, Valea Stejereni and Viscri). It is a common species at local and national level and does not currently require protection measures.

Threats. As well as natural enemies (carnivorous bird and mammal species) over-grazing and over-mowing of grassland can disturb populations and reduce their numbers.

Green Lizard *(Lacerta viridis).* A heat-loving species, up to 45 cm, very timid and quick. In altitude it does not reach above 700 - 800 m. It prefers dry habitats of southern aspect with scree and stones, and high grass and scrub. It can also be seen in clearings in oak and hornbeam woodland and also in scrub on the edges of cultivated fields, vineyards, orchards, etc. (Vancea and Fuhn, 1959; Fuhn and Vancea, 1961). It has an island distribution, at least in Tranyilvania, the most important populations being linked to limestone areas. Nationally it is considered common. In the study area it was observed in many localities (Albeşti, Apold, Archita, Biertan, Copşa Mare, Criş, Daia, Daneş, Nou Săsesc, Richiş, Roandola, Saeş, Şapartoc, Saschiz and Sighişoara) and in populations of very low numbers. It is a rare species.

Threats. Threats are the same as for the previous species.

Slow Worm (*Anguis fragilis*). A terrestrial species more crepuscular than diurnal, it is widespread in damp grassland at 400 - 1500 metres, but it can also be found in orchards, gardens, parks, cemeteries. It prefers shady micro-habitats with a certain degree of humidity. It is not very sensitive to low temperatures. The largest populations are found in hilly and low mountain areas. Because its main diet is land slugs and earthworms, it can be active after rain (Fuhn and Vancea, 1961). At national level it is a common species. In the Sighişoara - Târnava Mare Basin it is rare and was observed in Albeşti, Apold, Archita, Biertan, Chiafardola, Copşa Mare, Criş, Daia, Daneş, Laslea, Malâncrav, Nou Săsesc, Şaeş, Saschiz and Sighişoara**.**

Threats. The main danger, which annually kills thousands of Slow Worm individuals, is the mowing of hay. Then, local people kill the animal, mistaking it as a viper (in some areas of the country the Adder *(Vipera berus)* is called by the same common name, năpârcă). Because of its hidden habit of lifestyle, apart from man and a few species of birds of prey, it has few enemies. On the other hand the reproductive capacity of *A. fragilis* is high: annually, each female can give birth to about 16 young, so that this species is not threatened.

Grass Snake *(Natrix natrix).* A species which is facultatively semi-aquatic, it feeds almost exclusively on frogs (it prefers brown frogs to green frogs) and is widespread throughout the country, from lowland up to 800 m, being encountered in almost all habitats where these frog species live (Fuhn and Vancea, 1961). Numerous populations are found around humid areas. In the study area it is widespread, indicated at: Apold, Bradeni, Chiafardola, Criş, Daia, Daneş, Iacobeni, Jibert, Nou Sasesc, Saeş, Sapartoc, Saschiz, Sighişoara and Valchid - Floreşti.

Threats. Its moves very quickly and is difficult for predators to catch. If it has the misfortune to be captured by local people, it is generally killed in the belief that it is a venomous species.

Dice Snake *(Natrix tessellata).* A semi-aquatic species, strictly linked to aquatic habitats, it feeds almost exclusively on fish which it hunts skilfully in water. It prefers micro-habitats on the banks of lakes or in scrub on river-banks (Fuhn and Vancea, 1961). At a sign of danger it hides in water. At national level it is rare, being in steep decline because of the destruction of vegetation along river-banks and the reduction in populations of freshwater fish in rivers because of pollution. In the Sighişoara - Târnava Mare area the species is rare, found at a single locality (Sighişoara).

Threats. The strong human interference in lakes (especially building villages close to them) and the clearance of scrub along river-banks have caused the reduction of Dice Snake populations.

Smooth Snake (*Coronella austriaca*). This very shy species, hard to observe because of its camouflage, is heat-loving and linked to large populations of lizards (*Lacerta agilis, L. viridis, Podarcis muralis*), the numbers if which it controls. It also preys on rodents. It prefers dry habitats on scree, edges of oak and hornbeam forests, the margins of vineyards, orchards, grasslands, etc. (Fuhn and Vancea, 1961). At a national level it is rare. In the study area the Smooth Snake was indicated in several localities (Albeşti, Apold, Criş, Şaeş, Saschiz and Sighişoara) but is considered to be a rare species.

Threats. Its natural predators (bird and mammal species) and man represent the threats to this species. It is easily confused with a viper, because it has a similar design pattern on its head and dark stripes on the side of the head. Because of its method of hunting (by ambush) the Smooth Snake is not a very fast-moving species. If seen by local people it is generally killed.

Aesculapian Snake (*Zamenis longissimus*). This is the only tree-dwelling snake species in our fauna, and can reach 1.5 metres long. Its diet is mainly rodents, but also the eggs and chicks of birds. Its preferred habitats are linked to woodland but it can occasionally be seen near woodlands especially where there is scrubby vegetation (clearings, steep scrubby slopes, among ruins invaded by vegetation, etc.). It is found from lowland up to c. 900 m (Fuhn and Vancea, 1961). It is distributed in island populations, not uniformly. The species is considered to be rare at a national level. In the study area, the wood snake was indicated at four localities - Criş, Daia, Saschiz and Sighişoara - and is considered rare.

Threats. These are man and its natural predators (predatory bird and mammal species). When the Aesculapian Snake is cornered or immobilised, it becomes aggressive, for which reason local people often kill it without mercy, considering it to be dangerous.

CONCLUSIONS

The Herpetofauna of the area to the south of Sighisoara include 21 species: 13 amphibian species (*Salamandra salamandra, Triturus cristatus, Lissototriton vulgaris, Bombina variegata, Pelobates fuscus, Bufo bufo, Elapidea viridis, Hyla arborea, Rana arvalis, R. dalmatina, R. temporaria, Pelophylax esculentus and Pelophylax ridibundus*) and eight reptile species (*Emys orbicularis, Lacerta agilis, L. viridis, Anguis fragilis, Natrix natrix, N. tessellata, Coronella austriaca, Zamenis longissimus*).

Although the biodiversity of the area is quite high (76.4% of the species of Transylvania), from a quantitative point of view it is not so good. Amphibian populations are not numerous, even though the potential food represented by a vast array of invertebrate species is very abundant; the microhabitats necessary for reproduction, that is lakes, ponds, channels, and water-filled ditches are rare and even entirely lacking in some areas.

Three threatened amphibian species are: *Pelobates fuscus, Elapidea viridis, Rana arvalis;* another three are vulnerable*: Triturus cristatus, Lissototriton vulgaris, Hyla arborea;* two are rare *(Salamandra salamandra* and *Rana dalmatina*), and the other five are common.

The reptile fauna is poorer from a qualitative point of view (57.1% of the species of Transylvania) because of the lack of microhabitats favourable to some species (rock and scree areas). Quantitatively, we can say that the situation for reptiles is similar to that for amphibians, but in this case because of pronounced human impact (overgrazing, agricultural cultivation, machine mowing of grass). Only one species is threatened: *Emys orbicularis*; another four species are rare: *Lacerta viridis, Anguis fragilis, Coronella austriaca, Zamenis longissimus, Natrix tessellata* and the other three species (*Lacerta agilis* and *Natrix natrix*) are common.

ACKNOWLEDGMENTS

I should like to thank to the Darwin Initiative of the United Kingdom Ministry of Agriculture (DEFRA), the Orange Romania, and the NGOs Ecotur Sibiu and Fundaţia-ADEPT for supporting both the author's fieldwork and publication of this paper, especially Nathaniel Page, who kindly translated this article into English, and also the students who assisted with the field investigations: Maria Baciu, Carmen Cărbune, Tudor Ghira, Alin Marinău and Adrian Martin.

REFERENCES

1. Arnold, E. N., Burton, J. A. 1978 – A Field Guide to the Reptiles and Amphibians of Britain and Europe. William Collins and Co. Ltd, London, 272 p.
2. Botnariuc, N. and Tatole, V., (ed.) 2005 – Cartea Rosie a Vertebratelor, Ed. Muzeul de Istorie Naturala Grigore Antipa, Bucuresti, 260 p.
3. Cogălniceanu, D., 1991 – A preliminary report on the geographical distribution of Amphibians in Romania, *Rev. Roum. Biol.- Biol. Anim.*, 36, 1, :39 - 50.
4. Cogălniceanu D., Aioanei F. and Bogdan M. 2000 – Amfibienii din Romania - Determinator, Ed. Ars Docendi, Bucuresti, 100 p.
5. Fuhn, I. E., 1960 – Fauna Republicii Populare Române. Amphibia; Editura Academiei R.P.R., Bucureşti, 288 pag.
6. Fuhn, I. E. and Vancea, Şt. 1961 – Fauna Republicii Populare Române. Reptilia; Editura Academiei R.P.R., Bucureşti, 352 pag.
7. Ghira I, Marinescu I. and Domşa C., 2003 – Habitat preferences of different hybrid categories between *Bombina bombina* (L.) and *B. variegata* (L.) in Transylvanian Plain. Studii si Cercetari Stiintifice, Biologie, Serie noua, 2003, 8, pp: 211 -215.
8. Ghira, I., Venczel, M., Covaciu-Marcov, S., Mara, G., Ghile, P., Hartel, T., Torok, Z., Farkas, L., Racz, T., Farkas, Z., Brad, T., 2002 – Mapping of Transylvanian Herpetofauna. Nymphaea - Folia Naturae Bihariae, Oradea, XXIX, pp: 145 - 201.
9. Graef, P-R. 1972, Fauna herpetologica a judetului Sibiu. Lucrare de Diploma, Univ. Babes-Bolyai Cluj-Napoca, Fac. de Biologie, pp:1-121.
10. Hartel T., Demeter L., Cogălniceanu D., Mirela Tulbure. 2006 - The influence of habitat characteristics on amphibian species richness in two river basins of Romania. M. Vences, J. Köhler, T. Ziegler, W. Böhme (eds): Herpetologia Bonnensis II; Proceedings of the 13th Congress of the Societas Europaea Herpetologica. pp. 47-50.
11. Mara G., Ghira I. and Farkas L., 1999 – Preliminary report on herpetofauna of upper and middle Olt river basin. Transylv. Rev. Syst. Ecol.Res. 1: 169 - 180.
12. Stugren, B., 1966 – Geographic variation and distribution of the moor frog, *Rana arvalis* Nilss. Ann. Zool. Fennici, 3,pp: 29 - 39.
13. Szymura, J. M., 1988 – Regional differenciation and hybrid zones between fire-bellied toads *Bombina bombina* (L.) and *B. variegata* (L.) in Europe [in Polish] Jagellonian University, Cracow.
14. Szymura, J. M., 1993 – Analysis of hybrid zones with Bombina. In R. G. Harrison (ed.) Hybrid zones and the evolutionary process: 261 - 289; Oxford University Press.
15. Tesio, C. and Marinescu, A., 1982 – Sur la presence de la petite grenouille verte, *Rana lessonae* Camerano (1882) en Roumanie. Anal. Univ. Buc. Biol., 31, pp: 73 - 80.
16. Vancea, Şt. and Fuhn, I. E., 1959 – Contributions à la systématique et à l'écologie des Lacertides de la R.P.R. II. Le lézard vert des bois - *Lacerta viridis viridis* Laurentus. Ann. Sci. Univ. "Al. I. Cuza" Iassy (nouv. Série), 5 pp: 61 - 80.
17. ORDONANŢĂ DE URGENŢĂ Nr. 57 din 20 iunie 2007 privind regimul ariilor naturale protejate, conservarea habitatelor naturale, a florei şi faunei sălbatice.

DISTRIBUTION, POPULATION SIZE AND DYNAMICS OF THE WHITE STORK (*CICONIA CICONIA* L.) IN THE HÂRTIBACIU RIVER BASIN (TRANSYLVANIA, ROMANIA)

Ferenc KÓSA * and *Tamás PAPP* **

* Babeş-Bolyai" University, Faculty of Biology and Geology, 5 - 7 Cliniciilor Street, Cluj, Cluj County, Romania, RO-400006, kosa@hasdeu.ubbcluj.ro, kosaferenc@gmail.com
** Milvus Group, 22 Crinului Street, Târgu-Mureş, Romania, RO-540620, tamas.papp@milvus.ro

KEYWORDS: Romania, Transylvania, White Stork, Hârtibaciu River Basin, distribution, population size, breeding success, nest site, habitat selection, population trends.

ABSTRACT

Based on the results of the censuses carried out in 2004, the total White Stork population of the Hârtibaciu River Basin is 44 HPa, distributed in 34 localities. The mean population density (StD) for the whole area was only 2.81 HPa/100 km^2. Most common nest sites are electric pylons (48.93%), chimneys (42.55%) and barns (6.38%). The mean JZa and JZm values for the region were 2.95 and 3.61, values which are higher than the estimated JZa and JZm values needed to keep the population stable. In comparison to the last complet survey in 1974, the 2004 surveys shows a - 30.16% HPa decrease in the Târnave River Basin.

ZUSAMMENFASSUNG: Die Verbretung Populationsgröße und Dynamik des Weißstorchs (*Ciconia ciconia* L.) im Einzugsgebiet des Hârtibaciu/Harbachs (Transylvanien, Rumänien).

Im Jahre 2004 wurden in 34 Ortschaften insgesamt 44 HPa gezählt. Die durchschnittliche Populationsdichte (StD) betrug nur 2.81 HPa/100 km^2. Heute baut ein großer Prozentsatz der Vögel (48.93%) seine Nester auf Elektromasten, 42.55% und 6.38% brüten weiter auf Schornsteinen und Scheunen. Die Werte für den Gesamtbruterfolg (JZa=2.95) und Teilbruterfolg (JZm = 3.61) lagen über 2.0 und 2.5 und sind zum Bestanderhalt ausreichend. Für die letzten 30 Jahre (1974 - 2004) ergibt sich ein Rückgang im Zählungsgebiet von - 30.16% HPa.

REZUMAT: Distribuţia, mărimea populaţiei şi dinamica berzei albe (*Ciconia ciconia* L.) în bazinul râului Hârtibaciu (Transilvania, România).

În urma recensămintelor din 2004, am identificat 44 perechi de berze albe în 34 de localităţi ale bazinului Hârtibaciului. Densitatea medie a perechilor (StD) a fost de numai 2,81 HPa/100 km^2. Valorile medii ale parametrilor JZa şi JZm au fost mai mari decât 2,0 şi 2,5. Între 1974 - 2004, în bazinul Hârtibaciului, numărul perechilor clocitoare a scăzut cu - 30,16%.

INTRODUCTION

During the VIth International White Stork Census (2004 - 2005) data of 4585 nests were obtained from 2083 localities distributed in 40 counties. The total White Stork population in Romania can be estimated to 5000 - 6000 HPa (Kósa, 2007). With the exception of high mountainous regions and forested areas, the White Stork is distributed all over Romania.

The first regional White Stork census in the Hârtibaciu River Basin was conducted in 1974 by G. Folberth (Klemm, 1975a, b). Some scattered data on the numbers of the White Stork in the Târnave River Basin were published by the following authors: Klemm (1983), Klemm and Salmen (1988), Philippi (2001), Philippi and Popa (1990), Salmen (1980).

In 2004, the White Stork population from the Hârtibaciu River Basin was censused again. The main goal of this study was to evaluate the population size, breeding parameters and population dynamics of the White Stork in the Hârtibaciu River Basin. The second aim was to characterize the nest sites and the habitat selection of White Storks in this region.

Definition of the study area

The Hârtibaciu River Basin occupies the middle part of Romania and is situated mainly within Sibiu County along about 88 river kilometers. The total size of the Hârtibaciu River Basin is 1563.15 km^2. The geographical range of the area is from 24˚12'E to 24˚58'E and from 45˚43'N to 46˚06'N.

METHODS

Between 11 June and 10 July 2004, 38 villages from the Hârtibaciu River basin were surveyed for White Stork nests by the "Milvus Group" members. The population size and breeding success were established by standard methods used during the International Census of White Stork (Schulz, 1999a, b). The following parameters were registered and calculated: HPa - number of pairs occupying a nest, nesting pairs (Hpa = HPm + Hpo + HPx); HPm - number of pairs with fledglings; HPo - number of pairs occupying a nest but without fledgling; HPx - number of pairs with unknown breeding success; JZG - total number of fledglings in a defined area per year; JZa - breeding success, avearage number of fledged young per pair related to all HPa of a defined area (JZG/HPa); JZm - breeding success, average number of fledged young per pair related to all HPm of a defined area (JZG/HPm); Std - "Stork density": number of pairs (HPa) per 100 km^2 of a defined area.

Brood sizes were estimated from the ground and the number of successful nests used in the analyses was strictly the number of nests with young about to fledge. It was not always clear whether young from these nests did actually fledge. Nest were photographied with a Canon PowerShot A60 and the geographical location of the stork nests were determined with a Garmin 12CX. Data analysis was made with the FileMaker Pro software and the maps were produced with the ArcGIS 3.2 software.

RESULTS AND DISCUSSION

Distribution, population size and density

The distribution of the 47 White Stork nests identified in the study area is presented in the figure 1. The species was identified in 34 localities (Tab. 1). The mean number of nests/localities is 1.2 and the maximal number of nest/localities is 6 nests/locality. No White Stork nests were identified at the following localities (Fig. 1): Ghijeasa de Sus, Hosman, Ilimbav and Zlagna. Only one locality was not visited by us (Ghijeasa de Sus). One nest was destroyed in Marpod - in spring 2004 - by the electricity company.

Based on the results of the censuses carried out in 2004, the total population of the Hârtibaciu River Basin is 44 HPa (Tab. 1).

Using the definition for the Romanian White Stork colonies - villages with minimum five breeding pairs, among which the maximal distance does not exceed one km (Kósa et al., 2002) - we could identify only two White Stork colonies in the Hârtibaciu River Basin: one in Dealu Frumos (5 H) and the second in Nocrich (6 H). About 1.09% of the Romanian White Stork population breeds in the study area.

The mean population density (StD) for the whole area was 2.81 HPa/100 km^2. It is much lower than the average value for Romania (4.33 HPa/100 km^2 in 2004 - Kósa, 2007), but is very similar to the low density calculated (1.68 HPa/100 km^2) for the neighbouring Târnava Rivers Basin (Kósa et al., 2005).

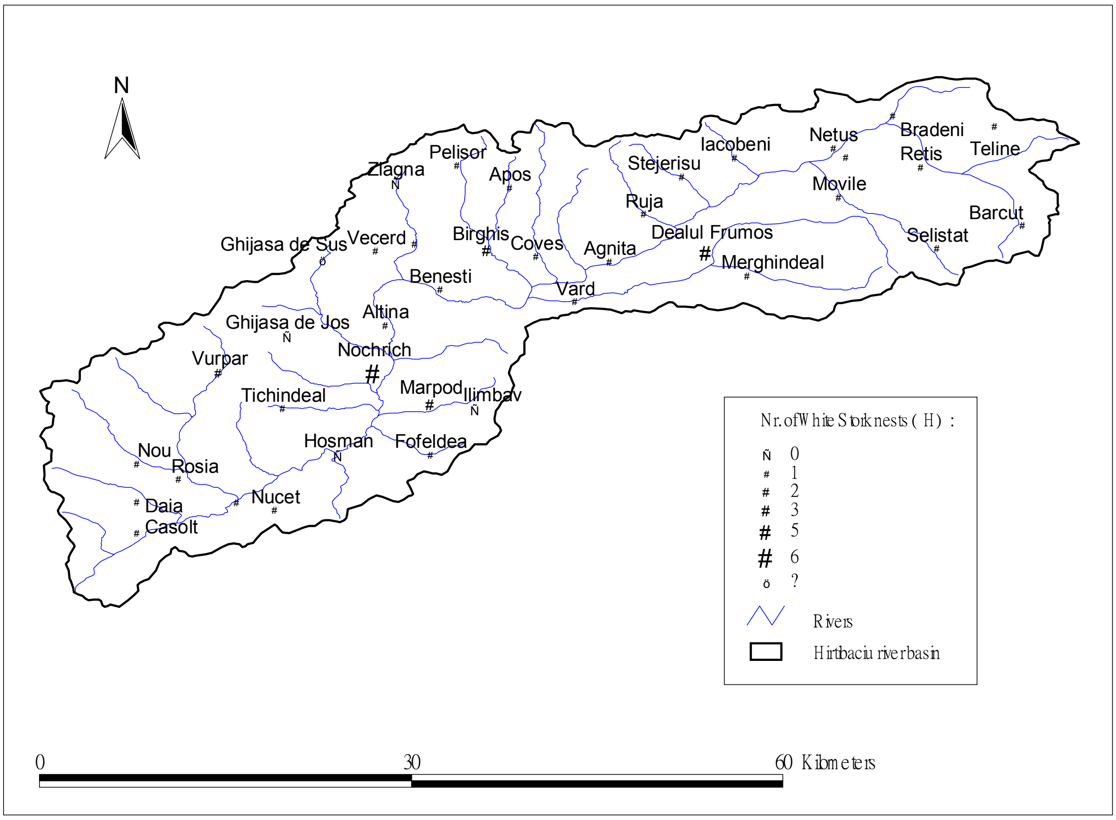


Figure 1: Distribution and number of White Stork nests (H) in the Hârtibaciu River Basin (+ - surveyed localities without White Stork nests, ? - locality not surveyed).

Table 1: List of White Stork nests in the Hârtibaciu River Basin in 2004; Nest support: E - electric pylon, C - chimney, B - barn, CR - church or ruin; Latitude and longitude are expressed in decimal degrees; * - the coordinates represent only the coordinates of the given locality).

Locality	Latitude	Longitude	Altitude (m)	Nest support	HP m	HP o	HP x	uH	JZ G
Agnita	45.97108	24.61637	489	E	1				5
Alțina	45.92975	24.45967	456	CR		1			0
Apoş	46.02717	24.55049	503	E	1				4
Bărcut	45.99733	24.91953	557	C	1				4
Beneşti	45.95741	24.49776	433	E	1				2
Bârghiş 1	45.98035	24.53977	464	E				1	0
Bârghiş 2	45.98018	24.53997	457	B	1				4
Bârghiş 3	45.98743	24.53703	474	B	1				4
Brădeni	46.07968	24.82854	474	E	1				5
Caşolt	45.778	24.28232	409	C	1				5
Cornățel	45.80212	24.3571	420	E	1				5
Coveş	45.98911	24.56957	465	E			1		0

Locality	Latitude	Longitude	Altitude (m)	Nest support	HP m	HP o	HP x	uH	JZ G
Daia	45.80205	24.27899	451	C	1				3
Dealul Frumos 1	45.97849	24.6983	470	E			1		0
Dealul Frumos 2	45.98407	24.69555	474	C	1				4
Dealul Frumos 3	45.98445	24.6958	474	C	1				4
Dealul Frumos 4	45.98385	24.69544	474	C				1	0
Dealul Frumos 5	45.98461	24.69604	474	C	1				3
Fofeldea	45.83535	24.49789	469	E		1			0
Iacobeni	46.05018	24.71865	489	E	1				2
Ighişu Vechi	45.98893	24.48377	452	E		1			0
Marpod 1	45.86716	24.46927	430	E		1			0
Marpod 2	45.86966	24.49973	447	E	1				4
Merghindeal	45.96592	24.7246	479	C	1				4
Movile	46.02323	24.79101	503	C	1				4
Netuş	46.05869	24.78733	528	C	1				2
Nocrich 1	45.89638	24.45474	431	C	1				4
Nocrich 2	45.89606	24.45446	432	C	1				4
Nocrich 3	45.89488	24.45451	435	C	1				3
Nocrich 4	45.89362	24.45398	431	C	1				4
Nocrich 5	45.8944	24.45749	430	C	1				2
Nocrich 6	45.89378	24.45321	430	C	1				4
Noiştat	46.05057	24.79987	523	E	1				5
Noul	45.82611	24.28112	479	C	1				2
Nucet*	45.79503	24.3821	492	E	1				4
Pelişor	46.04674	24.51608	496	E	1				3
Retiş	46.04336	24.85103	519	C	1				3
Roşia	45.81396	24.31675	478	C	1				1
Ruja	46.00171	24.67054	490	E		1			0
Seliştat	45.98742	24.85837	556	E	1				4
Stejerişu	46.03815	24.67541	493	E	1				1
Ţeline*	46.07447	24.90444	583	B	1				3
Ţichindeal	45.86958	24.39004	459	E				1	0
Vărd	45.94688	24.59986	456	C	1				5
Vecerd	45.9837	24.45542	451	E	1				5
Vurpăr 1	45.86479	24.319	454	E		1			0
Vurpăr 2	45.89066	24.33825	464	E	1				5
Total					36	6	2	3	130

Breeding success

To characterize the breeding success we calculated the JZa and JZm values. In 2004, 44 HPa (36 HPm + 2 HPx + 6 HPo) and 130 JZG were recorded. The mean JZa and JZm values for the Hârtibaciu River Basin were 2.95 and 3.61. Thus the mean JZa and JZm values for the region were above 2.0 and 2.5, values which are higher than the estimated JZa and JZm values needed to keep the population stable (Burnhauser, 1983; Lakeberg, 1995). However, these values have been taken with caution: the last 10 pairs of the White Storks breeding in Switzerland had a breeding success of 2.3 young per pair and this did not halt the decline to extinction by 1950 (Moritzi et al., 2001). The frequency distribution of brood size for the study area in 2004 was as follows (Fig. 2): the percentage of nests with one young (HPm1) was 5.55%, HPm2 - 13.88%, HPm3 - 16.66%, HPm4 - 44.66%, HPm5 - 22.22% (n = 36 HPm).

In 2004 the percentage of breeding failure (%HPo) was low, only 13.63%.

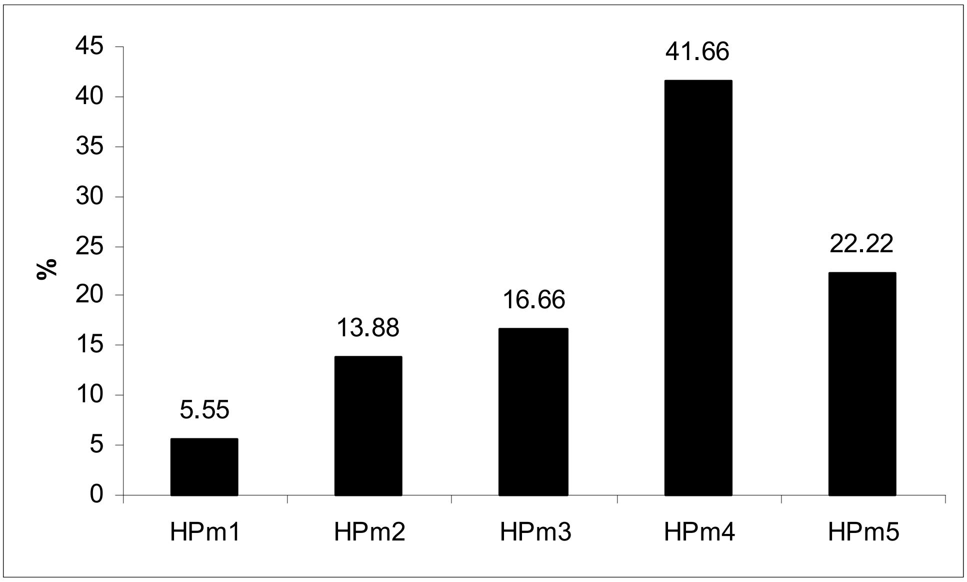


Figure 2: The frequency distribution of brood size in the Hârtibaciu River Basin in 2004 (n = 36 HPm).

Nest site selection

The most common nest sites in the Hârtibaciu River Basin are electric pylons (48.93%), chimneys (42.55%) and barns (6.38%) (Tab. 1 and Fig. 3.). This frequency distribution is similar with that observed in the Târnava Rivers Basin (Kósa et al., 2005). The frequency distribution of nest sites for Romania (2004 - 2005) is the following: 83.9% of nests are constructed on electric pylons and only 12.62% on buildings (chimneys + barns + roofs) (Kósa, 2007). Thus these two river basins remains behind other regions in Romania as far as the proportion of nests constructed on electric pylons is concerned.

During the last decades massive changes have been observed in Romania in nest site preferences, birds moving from buildings to electricity pylons (Kósa, 2001; Kósa et al., 2002). This process has differed significantly in various parts of the country (Kósa et al., 2002).The first White Stork nests placed on electric poles were recorded in Romania in the late 1960s in the Târgu Secuiesc locality rea (Lemnia) and in Sibiu County in 1988 (Kósa et al., 2002). In this county their number increased from 5 nests in 1988 to 96 nests in 2004 (Philippi and Popa, 1990; Philippi, 2001). Unfortunately, due to the lack of data we do not know when and where this process started in the Hârtibaciu River Basin.

In 1990s, through the national electricity company, the installation of artificial nest platforms on electricity poles was begun in Romania and until 2006 about 1100 poles from 18 counties were equipped with such platforms. Unfortunately no platforms were installed in the Hârtibaciu Basin and here 23 nests are in direct contact with electric wires.

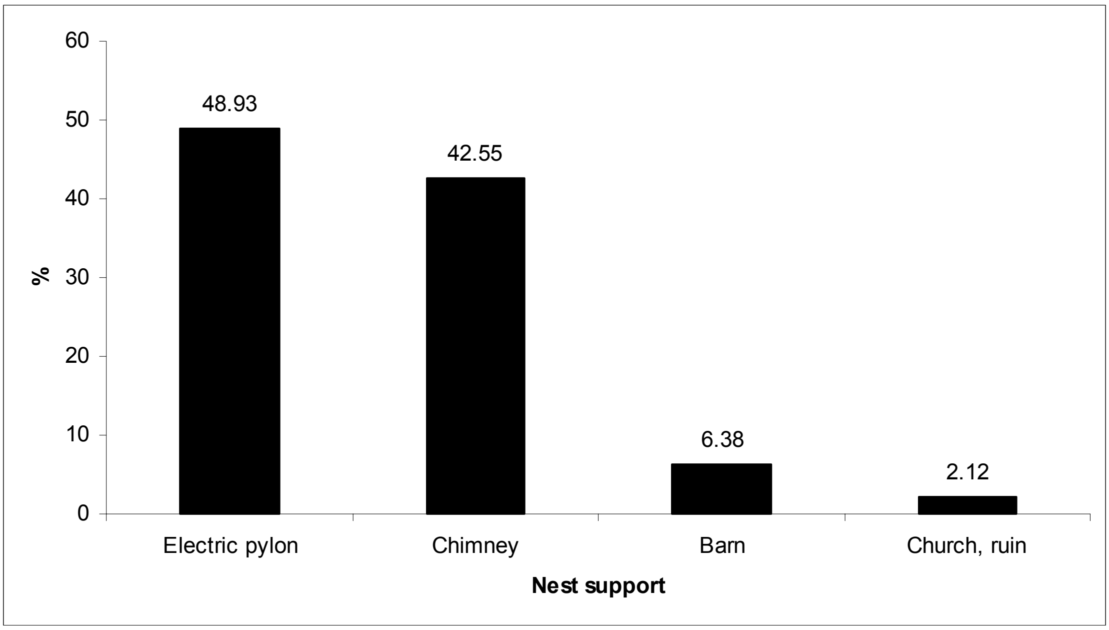


Figure 3: The frequency distribution of White Stork in different nest sites in the Hârtibaciu River Basin (n = 47).

Habitat selection

The availability of high-quality foraging sites close to the nest is one of the factors determining the breeding success of the White Storks. For estimating the general suitability of the environment for the White Stork, a radius of 2.5 km representing the estimated home range of Transylvanian White Storks was drawn around the nests, and these areas were analysed (Fig. 4). Level 2 of Corine Land Cover classes occurring in the buffers were then compared with their occurrence in the Hârtibaciu River Basin.

The table 2 shows observed and expected extension for each category, under the hypothesis of a non-selective use of land types. The distribution of observed values differ significantly from the expected, with a probability of < 0.001 (chi-square test). „Pastures", and „Arable land" are selected, occuring in the 31% and 25.41% of the area around the nests, against the expected frequencies (29% and 23.13%). Forests are mainly avoided.

Table 2: The observed and expected Corine Land Cover classes occurrring within the home range (r = 2.5 km) of White Stork nests (for CLC code abbrevations see Fig. 4).

Habitat type	CLC codes	Observed		Expected	
		ha	%	ha	%
Settlement	112, 121	2524.04	2.186	2102.150842	1.821
Arable land	211, 221-222, 242-243	29339.12	25.415	26711.51466	23.139
Pastures	231	35693.59	30.922	33644.803	29.145
Forests	311-313	43031.28	37.277	47627.97326	41.258
Scrub	321,324	3944.57	3.417	4682.220648	4.056
Inland wetlands	411	772.08	0.668	569.11607	0.493
Inland waters	512	125.45	0.108	92.3514921	0.08
Total		115430.13	99.993	115430.13	99.992

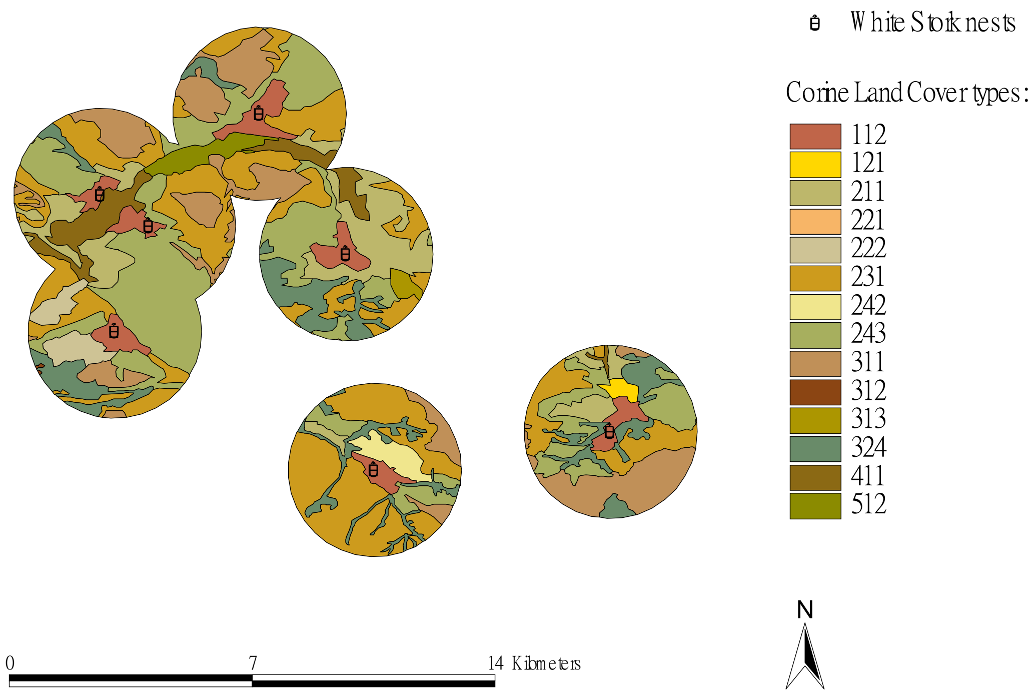


Figure 4: Distibution of Corine Land Cover (Level 2) classes within the home range (r = 2.5 km) of seven White Stork nests; 112 - Urban fabric, 121 - Industrial, commercial and transport units, 211 - Arable land, 221 - 222 - permanent crops, 231 - pastures, 242 - 243 - Heterogeneous agricultural areas, 311 - 313 - forest , 324 - scrub, 411 - wetlands, 512 - inland waters).

Population trends

Considering the available amount of White Stork data, the Hârtibaciu Basin is a relative well-studied area in Romania, but the only census covering the whole area was organised in 1974 (Klemm, 1975). Difficulties arise also from the fact that in different years different localities were included in the census. To compare the population trends in a period only those localities were included in the analyses where census data are avaible in two consecutive censuses.

As we can see in the tables 3 and 4, in comparison to the last survey in 1974, the 2004 census shows a - 30.16% HPa decrease in the Hârtibaciu River Basin. The decrease is smaller than that observed in the Târnava Rivers Basin (Kósa et al., 2005). In 1974 - 2004 the White Stork disappeared from Ghijeasa de Jos, Hosman and Zlagna, but appeared as nesting bird in the following localities: Nucet, Seliştat and Stejerişu.

The Romanian breeding White Stork population underwent a large decline between 1958 and 1978 (Klemm, 1983). Among the causes of the decline, Klemm (1983) listed the disappearance of wetlands due to drainage and river regulation following a systematic government plan and structural changes of the human settlements and attitudes with transition to urban building and behaviour. In the period 1974 - 1989 this decline continued in all the regions of the Olt River Basin from where census data are available (Kósa et al., 2002). For the Hârtibaciu River Basin the HPa decrease was - 34.15% (Tab. 3. and 4.).

Table 3: Population changes (HPa) of the White Stork in the localities of the Hârtibaciu Basin from 1974 to 2004, Klemm (1975 a, b), Philippi, Popa (1990), Philippi (2001).

Locality	1974	1989	1999	2004
Agnita	1		1	1
Alțina	4	1	1	1
Apoş	1	1	1	1
Bărcut	1			1
Beneşti	2			1
Bârghiş	4	2	2	2
Brădeni	2	1	1	1
Caşolț	1	1	1	1
Cornățel	1	1	0	1
Coveş	2			1
Daia	1	1	1	1
Dealu Frumos	7	4	6	4
Fofeldea	1			1
Ghijeasa de Jos	1			0
Ghijeasa de Sus	1			?
Hosman	1		0	0
Iacobeni	1		1	1
Ighişu Vechi	1			1
Ilimbav	0			0
Marpod	1	1	2	2
Merghindeal	1		1	1
Movile	1	1		1
Netuş	1	1		1
Nocrich	9	4	5	6
Noiştat	2		0	1
Nou	2	1	1	1
Nucet	0	1		1
Pelişor	1			1
Retiş	3		1	1
Roşia	2	2	1	1
Ruja	1			1
Selişțat	0			1
Stejerişu	0	1		1
Țeline			0	1
Țichindeal	1			0
Vărd	2	1	1	1
Vecerd	1	1		1
Vurpăr	1	1	1	2
Zlagna	1	?	0	0
Total	63	27	28	44

Although in 1989 - 1999 and 1999 - 2004 the species experienced moderate increases (9.09 and 10.71%), the population has not recovered to the 1974 level (Tab. 3 and 4). A similar positive trend for this time interval was seen in many regions in Eastern Europe and is generally attributed to the crisis in agriculture during the economic transition period, which resulted in a rapid recovery of biological diversity on agricultural landscapes (Schulz, 1999b).

Table 4: Population dynamics (HPa) of the White Stork in the Hârtibaciu Basin from 1974 to 2004 (n – number of compared localities (Klemm, 1975a, b; Philippi and Popa ,1990; Philippi, 2001).

Year	n	I (HPa)	II (HPa)	%
1974-1989	19	41	27	- 34.15
1989-1999	14	22	24	9.09
1999-2004	21	28	31	10.71
1974-2004	39	63	44	- 30.16

CONCLUSIONS

Based on the results of the census carried out in 2004, the total population of the Hârtibaciu River Basin is 44 HPa distributed in 34 localities. The mean population density (StD) for the whole area was only 2.81 HPa/100 km^2. The most common nest sites are electric pylons (48.93%), chimneys (42.55%) and barns (6.38%). The mean JZa and JZm values for the region were 2.95 and 3.61, values which are higher than the estimated JZa and JZm values needed to keep the population stable. In comparison to the last survey in 1974, the 2004 census shows a -30.16% HPa decrease in the Hârtibaciu River Basin.

From a conservation point of view it is necessary to continue to monitor the White Stork populations in this region and to begin the installation of artificial nest platforms on electricity poles.

ACKNOWLEDGEMENTS

Our work was supported by the Sapienia Foundation and the Agricultural Bureau of the Royal Netherlands Embassy.

REFERENCES

1. Burnhauser, A., 1983 – Zur ökologischen Situation des Weiβstorchs in Bayern: Brutbestand, Biotopansprüche, Schutz und Möglichkeiten der Bestandserhaltung und -verbesserung. Abschlussbericht, Inst. f. Vogelk., Garm.-Partenk., 1-488.
2. Klemm, W., 1975a – Rezultatele recensămintelor de barză alba (*Ciconia ciconia* L.) în Ţara Bîrsei, Valea Hîrtibaciului şi Ţinutul Tîrnavelor. *Stud. şi Com. Şt. Nat., Muz. Brukenthal* 19:305-309.
3. Klemm, W., 1975b – Recenesămîntul berzei albe (*Ciconia ciconia* L.) în ămprejurimile Sibiului. *Stud. şi Com. Şt. Nat., Muz. Brukenthal* 19:311-318.
4. Klemm, W., 1983 – Zur Lage des Weiβstorchs (*Ciconia ciconia)* in der S. R. Rumänien. *Ökol. Vögel* 5: 283-293.
5. Klemm, W., Salmen, H., 1988 – Die Ornis Siebenbürgens. Beitrage zu einer Monographie der Vogelwelt dieses Landes. Böhlau Verlag, Köln-Wien, Vol. III.:17-28.
6. Kósa, F., 2001 – Bestanderfassung des Weiβstorchs *(Ciconia ciconia)* in Rumänien im Jahr 1999. In: Kaatz, C. und Kaatz, M. (Eds.) (2001): 2. Jubiläumsband Weiβstorch – 2. Jubilee Edition White Stork, 8. u. 9. Storchentag 1999/2000. Tagungsbandreihe des Storchenhofes Loburg (Statliche Vogelschutzwarte im Landesamt für Umweltschutz Sachsen-Anhalt), 30-34.
7. Kósa, F., 2007 - Distribution, population size and dynamics of the white stork *(Ciconia Ciconia L.)* in Romania in 2004-2005 - *in press.*
8. Kósa, F., Demeter, L., Papp, T., Philippi, F., Lutsch, H.-J., György, K., 2002 – Distribution, population size and dynamics of the White Stork *(Ciconia ciconia L.)* in the Upper and Middle Olt River Basin (Romania*), Tiscia Monograph Series*, 6: 205-234.
9. Kósa, F., Papp, T., Pap, P., 2005 – Distribution, population size and dynamics of the White Stork *(Ciconia ciconia Linnaeus, 1758)* in the Târnava Rivers Basin (Romania*), Transylv. Rev. Syst. Ecol. Res*, 2: 155-165.
10. Lakeberg, H., 1995 – Zur Nahrungsökologie des Weiβstorchs *Ciconia ciconia* in Oberschwaben (S-Deutschland): Raum-Zeit-Nutzungsmuster, Nestlingsentwicklung und Territorialverhalten. *Ökologie der Vögel*, 17:1-87.
11. Moritzi, M., Maumary, L., Schmid, D., Steiner, I., Vallotton, L., Spaar, R., Biber, O., 2001 – Time budget, habitat use and breeding success of White Storks *Ciconia ciconia* under variable foraging conditions during the breeding season in Switzerland. *Arde*a, 89(3): 457-470.
12. Philippi, F., 2001 – Bestanderfassung des Weiβstorchs 1988-2000 im Kreis Hermannstadt (Sibiu - Rumänien). In: Kaatz, C. und Kaatz, M. (Eds.) (2001): 2. Jubiläumsband Weiβstorch - 2. Jubilee Edition White Stork, 8. u. 9. Storchentag 1999/2000. Tagungsbandreihe des Storchenhofes Loburg (Statliche Vogelschutzwarte im Landesamt für Umweltschutz Sachsen-Anhalt), 34-40.
13. Philippi, F., Popa, Gh., 1990 – Situaţia cuibăritului berzelor în anul 1989 în judeţul Sibiu. *Bul. de inf. S.O.R.* (3).
14. Salmen, H., 1980 – Die Ornis Siebenbürgens. Beitrage zu einer Monographie der Vogelwelt dieses Landes. Böhlau Verlag, Köln-Wien, Vol. I.:133-148.
15. Schulz, H., 1999a – The 5^{th} International White Stork Census 1994/1995 - Preparation, realisation and methods. In: Schulz, H. (ed.) (1999): Weißstorch im Aufwind? - White Stork on the up? - Proceedings Internat. Symp. on the White Stork, Hamburg 1996. - NABU (Naturschutzbund Deutschland e.V.), Bonn: 39-48.
16. Schulz, H., 1999b – The world population of the White Stork (*Ciconia ciconia*) – Results of the 5^{th} International White Stork Census 1994/95. In: Schulz, H. (ed.) (1999): Weißstorch im Aufwind? - White Stork on the up? - Proceedings Internat. Symp. on the White Stork, Hamburg 1996. - NABU (Naturschutzbund Deutschland e.V.), Bonn: 351-365.

THE IMPORTANCE OF THE RIPARIAN FOREST HABITAT FOR BIRD SPECIES RICHNESS IN THE TÂRNAVA MARE VALLEY (TRANSYLVANIA, ROMANIA)

*Cosmin Ioan MOGA** and *Kinga ÖLLERER***

* Babes-Bolyai University, Biology - Geology Faculty, 5-7 Clinicilor St., Cluj-Napoca, Cluj County, Romania, RO-400006, cimmoga@yahoo.com
** Institute of Biology - Romanian Academy, 296 Spl. Independenței, Bucharest, Romania, RO-060031, kinga.ollerer@ibiol.ro

KEYWORDS: Romania, Transylvania, Târnava Mare River, riparian forest, deciduous forest, avifauna.

ABSTRACT

In this study we present the importance of riparian forest habitat for bird species richness in one section of the Târnava Mare River.

The number of bird species was found to be higher in the riparian forest compared to the deciduous forest. A total of 76 bird species were recorded, 58 in the riparian forest and 49 in the deciduous forest. 31 species were found in both habitat types. There were fewer common species in the riparian forest (53.44 %), compared to other deciduous forest (63.26 %). The riparian willow-poplar forest has more exclusive species (27) than the oak-hornbeam deciduous forest (18).

ZUSAMMENFASSUNG Die Bedeutung der Auwaldhabitate für die Vielfalt an Vogelarten im Tal der Großen Kokel/Târnava Mare (Transylvanien, Rumänien).

Die Bedeutung der Auwaldhabitate für die Vielfalt an Vogelarten wird an einem Flussabschnitt der Großen Kokel /Târnava Mare dargestellt.

Dabei zeigt sich, dass die Zahl der Vogelarten im Auwald höher ist als in anderen zum Vergleich herangezogenen Laubwäldern. Es wurden 76 Arten erfasst, 58 davon im Auwald und 49 im untersuchten Laubwald außerhalb der Aue. 31 Arten wurden in beiden Habitattypen festgestellt. Die allgemein verbreiteten Arten sind im Auwald weniger vertreten (53.44 %), als im vergleichend untersuchten Laubwald (63.26 %). Der Auwald beherbergt mehrere ihm eigene Arten (27) als der Laubwald (18).

REZUMAT: Importanța habitatelor de pădure de luncă pentru bogăția de specii de păsări pe râul Târnava Mare (Transilvania, România).

Lucrarea prezintă valoarea habitatului de pădure aluvială pentru bogăția de specii avifaunistice, de pe o porțiune a râului Târnava Mare.

Numărul de specii de păsări este mai mare în pădurea aluvială, comparativ cu pădurea de foioase. În total au fost înregistrate 76 specii, 58 în pădurea aluvială şi 49 în pădurea de foioase. 31 specii de păsări sunt comune ambelor habitate. Speciile comune sunt mai puțin reprezentate procentual în pădurea aluvială (53,44 %), comparativ cu pădurea de foioase (63,26 %). Pădurea aluvială are mai multe specii, exclusiv semnalate aici (27), comparativ cu pădurea de foioase (18).

INTRODUCTION

Riparian forests have a diversity and abundance of invertebrate and vertebrate species that is superior to the surrounding habitats (Stauffer and Best, 1980; Knopf and Samson, 1994; Lachavanne and Juge, 1997), and also a higher number of breeding bird species than any of the surrounding habitats (Knopf, 1985). Major amounts of these forests have been degraded or destroyed completely, especially because of agricultural and industrial development, but also due to leisure activities (Shear et al., 1996). In accordance with the decrease in their areas, the capacity of these riparian forests to serve as habitats for the reproduction of bird species is diminished (Whitaker and Montevecchi, 1999).

In 2007, the Romanian Waters National Administration started a project during which 10 km of riparian forest situated along the Târnava Mare River will be cleared, starting downstream of Sighişoara (from Podul Venchi, crossed by the E60 road) to Daneş Commune.

In this study we present the species richness of breeding avifauna from this riparian forest, comparing it to the species richness of breeding birds from the other deciduous forests, mostly of oak and hornbeam, found in the vicinity of the Târnava Mare River.

MATERIAL AND METHODS

The study area is part of the Transylvanian Tableland physico-geographical unit, and its southern subunit, the Târnava Tableland (Pop, 2001). The riparian forest studied extends for a length of about 25 km, from upstream of Vânători Commune to Daneş Commune (Fig. 1).

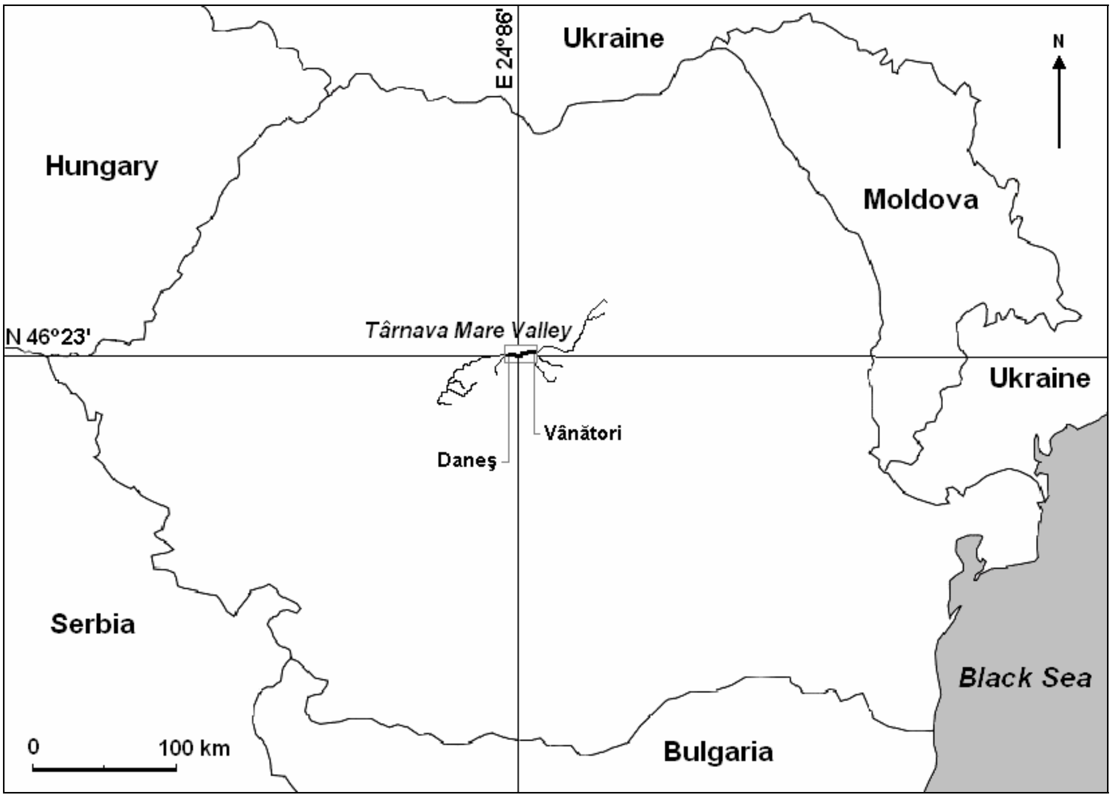


Figure 1. Location of the study area (highlighted).

This riparian forest can be included in the *Salix alba* and *Populus alba* galleries habitat type, with a well-represented tree layer, formed mainly by willows (*Salix* spp.) and poplars (*Populus* spp.), together with scarce individuals of *Alnus glutinosa* (native) and *Amorpha fruticosa* (adventive). The width of the riparian forest gallery (on one riverside) varies from 10 m to 50 m, most frequently being 20 - 30 m. Outside settlements, the forest is continuous, especially in the Sighişoara - Daneş sector, for approximately 10 km. With the exception of the sections found within the settlements, the riparian forest is mature, with several hollow trees. In the vicinity of the gallery forest, most of the area is occupied by arable land or abandoned arable land that are now invaded by weeds.

For inventories of birds, the linear transect method described by Bibby (2000) was used. The observations were made from sunrise until 11 a.m., between 20 April and 20 July 2007. Both in riparian forest and the other deciduous forest we have covered transects over 5 km.

For the study of similarities in bird species number between the two habitats, we have used the Jaccard coefficient: $Cj = j / (a + b - j)$, where j = the number of species found in both habitats, a = the number of species found in the riparian forest, b = the number of species found in the deciduous forest. In order to see if there is any significant difference regarding the number of birds species found in the two habitats, we used the Z-score test.

RESULTS

For both habitat types, we have registered 76 bird species. 58 species (76.31 %) were found in the riparian forest and 49 (64.47 %) in the other deciduous forest (Tab. 1, Fig. 2).

Table 1: The birds recorded in the two habitats. Underlined species are nesting in both habitat types. Species marked with [1] are protected according to the Birds Directive, Annex I.

Species	Riparian (alluvial) forest	Other deciduous forest
Ixobrychus minutus[1]	*	
Ardea cinerea	*	
Nycticorax nycticorax[1]	*	
Ciconia nigra		*
Anas platyrhynchos	*	
Aquila pomarina		*
<u>*Buteo buteo*</u>	*	*
Pernis apivorus		*
Accipiter gentilis		*
Accipiter nisus		*
Falco subbuteo	*	
Falco tinnunculus	*	
Phasianus colchicus	*	
<u>*Columba palumbus*</u>	*	*
Streptopelia turtur	*	
<u>*Cuculus canorus*</u>	*	*
Otus scops	*	
<u>*Bubo bubo*</u>[1]	*	*
Strix uralensis		*
<u>*Asio otus*</u>	*	*

Species	Riparian (alluvial) forest	Other deciduous forest
Strix aluco		*
Caprimulgus europaeus[1]	*	
Upupa epops	*	
Picus viridis	*	*
Picus canus[1]	*	*
Dendrocopos major	*	*
Dendrocopos syriacus[1]	*	*
Dendrocopos medius[1]	*	*
Dendrocopos minor		*
Dendrocopos leucotos		*
Dryocopus martius		*
Jinx torquilla	*	*
Lullula arborea[1]		*
Anthus trivialis	*	*
Lanius collurio[1]	*	
Lanius minor[1]	*	
Lanius excubitor	*	
Oriolus oriolus	*	*
Sturnus vulgaris	*	*
Garrulus glandarius	*	*
Pica pica	*	
Corvus corone cornix	*	
Corvus corax		*
Troglodytes troglodytes[1]	*	*
Locustella fluviatilis	*	
Acrocephalus palustris	*	
Sylvia borin	*	*
Sylvia atricapilla	*	*
Sylvia comunis	*	
Sylvia curruca	*	
Phylloscopus trochilus		*
Phylloscopus collybita	*	*
Phylloscopus sibilatrix		*
Ficedula albicollis		*
Ficedula parva		*
Muscicapa striata	*	
Phoenicurus phoenicurus		*
Erithacus rubecula	*	*
Luscinia luscinia	*	*
Turdus merula	*	*
Turdus philomelos	*	*
Turdus pilaris	*	

Species	Riparian (aluvial) forest	Deciduous forest
Parus palustris	*	*
Parus coeruleus	*	*
Parus major	*	*
Aegithalos caudatus caudatus	*	*
Aegithalos caudatus europaeus	*	*
Sitta europea	*	*
Certhia familiaris		*
Passer montanus	*	
Fringilla coelebs	*	*
Coccothraustes coccothraustes	*	*
Carduelis chloris	*	
Carduelis carduelis	*	
Carduelis cannabina	*	
Emberiza citrinella	*	
Total 76 species	58	49

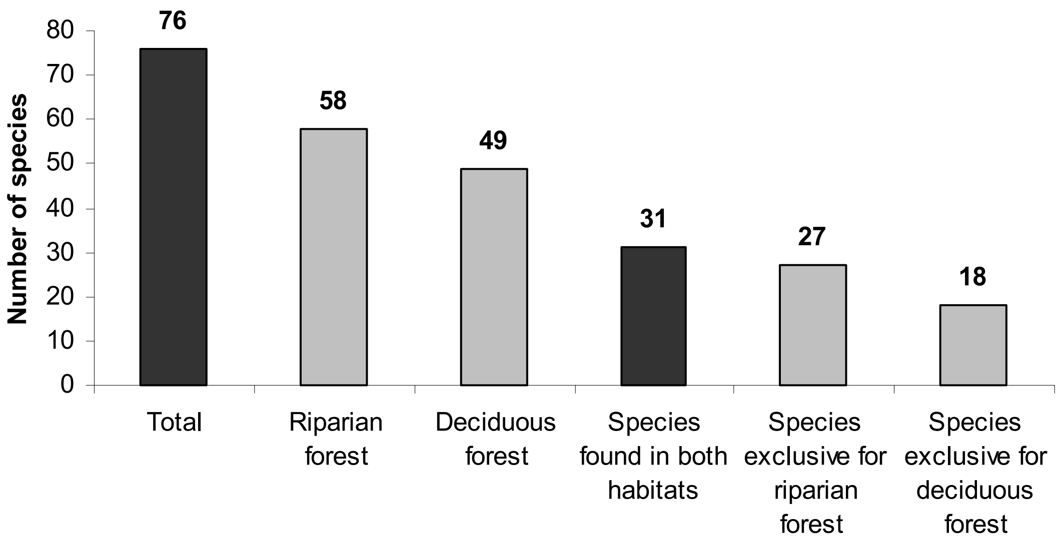


Figure 2: Species richness according to habitat type.

The difference between the number of bird species in riparian forest and other deciduous forest is close to statistical significance ($Z = 1.61$, $P = 0.107$). The value of the Jaccard similarity coefficient (Cj) is 2.45. The number of species common to both habitats is 31 (Fig. 2).

Out of the 58 species found in the riparian forest, 27 (46.55 %) were encountered exclusively in this habitat (Fig. 2). The common species (31) represent 53.44 % in this habitat.

Out of the 49 species found in the deciduous forest, 18 species (36.73 %) were recorded exclusively in this forest type, whereas the common species (31) represent 63.26 % in this situation (Fig. 2).

DISCUSSION

In our study we found that the riparian forest is richer in bird species than the other deciduous forest, which is in accordance with the findings of other authors (Knopf, 1985; Sallabanks et al., 2000).

The riparian forest has more exclusive species (46.55 %) than the other deciduous forest (36.73 %). Inman et al. (2002), in their study from North America, have obtained similar results, with 11 bird species recorded exclusively in the riparian forest and only four species in the deciduous forest. The high number of species found exclusively in the riparian forest can be explained by the higher structural heterogeneity of this habitat (Inman et al., 2002; Némethová and Tirinda, 2005) and by the large ecotone surface that it includes (Némethová and Tirinda, 2005). Therefore, in this habitat there are several species that are characteristic of open habitats, especially of woodlands, species that cannot be found in the deciduous forest (Tab. 1).

Regarding the species that are common to both habitats, 53.44 % of the species found in the riparian forest can also be found in the other deciduous forest, whereas the deciduous forest has 63.26 % of its species common to both habitats. The high number of species that can be found in both habitat types is also shown by the value of the Jaccard similarity coefficient (2.45).

Besides their importance for the breeding bird species, shown also in this study, riparian forest corridors have a major role in the dispersion of these birds (Bernstein et al., 2002). Also, Bernstein et al. (2002) show that these corridors are important buffer habitats for deciduous forest birds, especially in the current conditions of forest fragmentation and disappearance. There are two concepts in this sense, (1) according to the first one, these corridors are populated by species that are rejected from the deciduous forest massif, as a result of competition, some of them being therefore forced to nest in improper conditions, their habitat being in this case suboptimal; (2) the other concept sustains that the birds emigrate from here towards the forest massif when the population from the forest massif are declining. The stability of the bird populations in optimal habitats (the forest massifs) therefore depends on the presence of bird populations in the surrounding suboptimal habitats (the riparian forest).

Eleven of the recorded species (Tab. 1) are protected under the EU Birds Directive (79/409/CEE), Annex I, and therefore in need of special habitat conservation measures. Other species, such as *Falco tinnunculus, Streptopelia turtur*, *Cuculus canorus*, *Anthus trivialis* and *Sturnus vulgaris*, are well represented in the study area, while other European countries have experienced alarming population decreases (Raven et al., 2007).

Besides the bird species mentioned above, we have also found species that are not dependent upon the existence of the riparian forest corridor: *Charadrius dubius, Actitis hypoleucos, Riparia riparia, Alcedo atthis, Merops apiaster*. Also, in the last part of April, we have observed a male *Coracias garrulus* in the floodplain of the Târnava Mare River, but the nesting of this species there is not certain, and more observations are needed for confirmation.

The maintenance of the riparian forest along the Târnava Mare River is important for the conservation of the avifaunal richness in this landscape, being a shelter for a significant number of species, some of them characteristic of this habitat. The clearing of this forest between Sighişoara and Daneş is not justified because upstream of Sighişoara the Albeşti barrage and a dam system protects the town of Sighişoara and the river downstream from flooding, no such events being experienced since 1975, when this system was erected.

ACKNOWLEDGEMENTS
We are grateful to Mr. Tibor Hartel for his support and useful comments on earlier versions of the manuscript.

REFERENCES

1. Bernstein, C., Krebs, R. J. and Kacelnik, A., 2002 − Distribution of birds amongst habitats: theory and relevance to conservation. In: Perrins C. M., Lebreton J. D., Hirons G. J. M. Bird (Eds.) Population Studies. Oxford University Press, 317-345.
2. Bibby, C. J., Burgess, N. D., Hill, D. A., Mustoe, S., 2000 − Birds census techniques. Second Edition, Academic Press.
3. Inman, R, L., Prince, H. H. and Hayes, D. B., 2002 − Avian communities in forested riparian wetlands of southern Michigan, USA, Wetlands, 22 (4): 647-660.
4. Knopf, F. L., 1985 − Significance of riparian vegetation to breeding birds across and altitudinal cline, p. 105-111. *In* Johnson, R. R., Ziebell, C. D., Patten, D. R., Folliot, P. F. and Hamre, R. H., (tech. coord.). Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. U. S. Department of Agriculture, Forest Service, Washington, DC, USA. General Technical Report RM-120.
5. Knopf, F. L. and Samson F. B., 1994 − Scale perspectives on avian diversity in western riparian ecosystems. Conservation Biology, 8: 669-676.
6. Lachavanne, J. B. and Juge, R., 1997 - Biodiversity in land-inland water ecotones, UNESCO – Man and Biosphere Series, vol. 18.
7. Némethová, D. and Tirinda, A., 2005 – The influence of intersection and dead-ends of line-corridor networks on the breeding bird distribution, Folia Zoologica, 54 (1-2): 123-134.
8. Pop, G. P., 2001 − Depresiunea Transilvaniei. Presa Universitară Clujeană, Cluj-Napoca.
9. Raven, M. J., Noble, D. G. and Baillie, S. R., 2007 − The Breeding Bird Survey 2006. BTO Research Report 471. British Trust for Ornithology, Thetford.
10. Sallabanks, R. S., Walters, J. R. and Collazo, J. A., 2000 − Breeding bird abundance in bottomland hardwood forests: habitat, edge, and patch size effects, The Condor, 102: 748-758.
11. Shear, T. H., Lent, T. J. and Fraver, S., 1996 − Comparison of restored and mature bottomland hardwood forests of southwestern Kentucky, Restoration Ecology, 4: 111-123.
12. Stauffer, D. F. and Best, L. M., 1980 − Habitat selection by birds of riparian communities: evaluating effects of habitat alteration. Journal of Wildlife Management, 44: 1-15.
13. Whitaker, D. M. and Montevecchi, W. A., 1999 − Breeding bird assemblages inhabiting riparian buffer strips in Newfoundland, Canada. Journal of Wildlife Management, 63: 167-179.

SMALL MAMMALS (INSECTIVORA AND RODENTIA) FROM THE AGNITA - SIGHIŞOARA AREA (TRANSYLVANIA, ROMANIA)

Ana Maria BENEDEK *

* Lucian Blaga University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, 31 Oituz Street, Sibiu, Sibiu County, Romania, RO - 550337, benedek_ana@yahoo.com

KEYWORDS: Romania, Transylvania, insectivores, rodents, chorology, community structure, biodiversity.

ABSTRACT

The high variety of habitats of the Agnita-Sighişoara area determines a high diversity of communities of small mammals. Up to the present 19 species are known from here, and among them 13 were captured during our survey. The genus *Apodemus* was most abundant, and among its species, *A. flavicollis*. The high density of this species reflects the important role played by the forests in the area. The fauna of each locality researched depends on the types of habitats investigated. Most diverse and abundant communities are sheltered by the mixed broadleaf forests with rich shrub and herb layers. The various cultivated fields have a rich rodent fauna, but consisting mostly of common species, such as *A. agrarius* and *Mus spicilegus*. Here a more interesting faunistic element is represented by *A. uralensis*.

RÉSUMÉ: Petits mammifères (Insectivora et Rodentia) de la zone Agnita - Sighişoara (Transylvanie, Romanie).

La grande variété des habitats de la zone Agnita - Sighişoara détermine une diversité élevée des communautés de petits mammifères. Jusqu'au présent on connaît de cette zone 19 espèces, de quelles 13 ont été capturées durant cette recherche. Le genus *Apodemus* est le plus abondant et parmi ses espèces, *A. flavicollis*. La haute densité de cette espèce montre le rôle important des forêts dans la zone. La faune des localités recherchées dépend des habitats investiguées. Les plus diverses et nombreuses communautés sont abries par les forêts mixtes avec un riche soustrait arbustive et herbacé. Les différentes cultures agricoles ont une riche faune de rongeurs, formée d'espèces communes, comme *A. agrarius* et *Mus spicilegus*. Ici un élément faunistique plus intéressant est *A. uralensis*.

REZUMAT: Mamifere mici (Ordo Insectivora şi Ordo Rodentia) din zona Agnita-Sighişoara (Transilvania, România).

Marea varietate a habitatelor din zona Agnita - Sighişoara, determină o diversitate ridicată a comunităţilor de mamifere mici. Până în prezent, sunt cunoscute din această arie 19 specii, dintre care 13 au fost capturate, pe parcursul acestui studiu. Genul *Apodemus* este cel mai abundent, iar dintre speciile sale, *A. flavicollis*. Densitatea ridicată a acestei specii reflectă rolul important pe care îl au pădurile în zonă. Fauna localităţilor cercetate depinde de habitatele investigate. Cele mai diverse şi abundente comunităţi sunt adăpostite de pădurile mixte de foioase, cu strat arbustiv şi ierbos bogat. Diferitele terenuri cultivate au o faună bogată de rozătoare, formată, însă, din specii comune, ca *A. agrarius* şi *Mus spicilegus*. Aici un element faunistic mai interesant este reprezentat de *A. uralensis*.

INTRODUCTION

Although no published data are available on the small mammals from the Sighişoara-Agnita area, there is one study carried out there, during June - July 2002, in the communes of Laslea and Buneşti and on the Breite plateau, by Valck, Blondé, Vandendriesse and Jacobs. The aim of the research was an inventory of the entire fauna. Thirty species of mammals are mentioned in the area, both small and large mammals. A neighbouring area where a survey on small mammals was carried out by Petru Istrate between 1981 and 1997, is the Târnava Mică River Basin. The results were published in several papers (1998, 2000, 2005).

STUDY AREA AND METHODS

The study was accomplished between 29 August and 10 September 2003. Five stations and 19 habitats were investigated. They were chosen in order to research all the major types of habitat in the area. A short description of the research sites is given below:

1. Dealu Frumos. In this station traps were set in a relatively young hornbeam (*Carpinus betulus*) and oak (*Quercus robur*) forest, with no shrub and herb layer, but with a rich *Carpinus* seedling layer; next to this forest in an ancient clearing with rich and tall vegetation: *Carpinus* and *Quercus* seedlings, *Corylus avellana, Urtica dioica, Artemisia vulgaris, Galium aparine*, etc. Other traps were placed in a field where maize had recently been gathered and in the ditch along the road next to the cornfield, under trees (*Malus domestica, Pyrus piraster*) and shrubs (*Crataegus monogyna, Prunus spinosa*).

2. Brădeni. The traps were set in an oak (*Q. robur*) and hornbeam (*C. betulus*) forest with no shrub layer and few plants (*Asperula odorata, Viola* sp.) and on the edge of this forest, a strip about 3 m broad consisting of dense shrubs *of Crataegus monogyna, Cornus sanguinea* and *Ligustrum vulgare*. Another habitat investigated was a hayfield next to the forest. After the second night, the traps from the forest and from the hayfield were moved on to the bank of Hârtibaciu River, upstream of the last dam, half under the willows and half in the reed thicket.

3. Retiş. The main habitat investigated was the mixed broadleaf forest formed of *Quercus robur, Q. petraea, Carpinus betulus, Robinia pseudacacia, Pinus silvestris, Acer campestre, A. pseudoplatanus, Fraxinus excelsior, Tilia cordata, Cerasium avium* and a very rich shrub layer of *Prunus padus* and *Crataegus monogyna*, sometimes reaching the height and thickness of a tree, *Cornus sanguinea, Ligustrum vulgare, Sambucus nigra*. The herb layer also well-developed: *Urtica dioica, Galinsoga parviflora, Galium aparine*. The traps were placed near a dried-up stream. The forest skirt was also investigated. Another habitat investigated in this station was the bank of a small rivulet, with *Scirpus silvaticus* and *Juncus effusus*.

4. Şaeş. Four habitats situated next to the road to Sighişoara were studied: a relative short grass hayfield near the brook, a tall vegetation hayfield near the forest - besides the grass species, also *Salvia verticillata, S. pratensis, Dipsacus fullonum (silvaticus), Clematis vitalba, Artemisia vulgaris, Solidago canadensis,* etc.; the shrubs at the edge of the forest: *Crataegus monogyna, Rosa canina, Cornus sanguinea, Ligustrum vulgare, Clematis vitalba* and *Viburnum opulus*; and the reed thicket on the rivulet bank in the forest, delimiting the hayfield. Besides *Phragmites australis* were found *Cirsium oleraceum, Urtica dioica* and *Calystegia sepium.*

5. Ştejărişu. Traps were set along the Stejărişu rivulet, upstream of the village, in an area with small ponds, muddy soil and vegetation made up of *Salix alba*, with *Scirpus silvaticus* and *Cirsium oleraceum* in the herb layer; in a cornfield that was harvested; on the edge of a potato field with *Chenopodium* spp., *Atriplex* sp., *Artemisia vulgaris*; and in an area with isolated shrubs - *Crataegus monogyna, Prunus spinosa* and *Malus domestica* - on the hill.

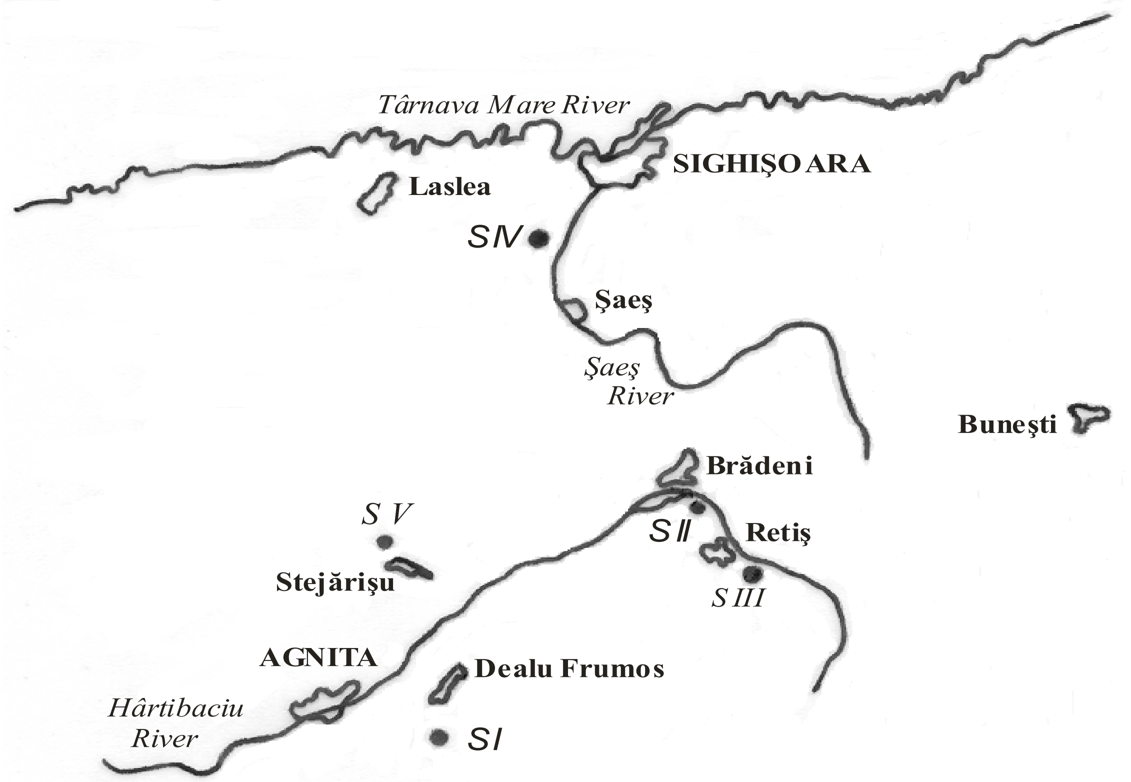


Figure 1: Position of the stations researched in the Agnita - Sighişoara area.

The investigations were carried out by live-trapping with 50 box traps made of wood. They were set either in a rectangular net (in forests, meadows and fields) or in a transect (along river banks), at 10 m distance from one another and baited using oil-soaked bread and meat. Traps were checked twice a day, in the night and at dawn. Captured animals were determined according to Pucek (1981), Murariu (2000) and Popescu and Murariu (2001), based on external morphological features. Their age and sex (in case of rodents) was noted. Individuals were measured and marked by clipping their fur in different parts of the body, and then released.

Community structure was expressed by means of relative abundance (RA%), and the species abundance in different localities and habitats, by means of capture index, as defined in a previous paper (Benedek, 2006). The frequency (F%) was calculated as the number of habitats where the species was captured divided by the total number of habitats investigated.

Diversity was expressed by the species number and the diversity indices of Margalef and Shannon-Wiener.

RESULTS

During our 12 days field campaign with a programme of 418 functional trap-nights, 13 small mammal species were captured (4 insectivores and 9 rodents); 10 species were mentioned in the area without exact location data by Blondé and Vandendriesse (unpublished data), among them five that were not captured by us; and two species were found in the mammal collection in the Natural History Museum of Sibiu. These species are listed below.

Ordo Insectivora Bowdich, 1821

Fam. Erinaceidae Bonaparte, 1838. 1. *Erinaceus concolor* Martin, 1838 - mentioned by Blondé and Vandendriesse.

Fam. Talpidae Gray, 1825. 2. *Talpa europaea* Linnaeus, 1758 - mentioned by the same source.

Fam. Soricidae Gray, 1821. 3. *Sorex araneus* Linnaeus, 1758 - was captured in all the stations investigated, in habitats with woody vegetation, most abundantly in the forest skirt at Brădeni. 4. *Sorex minutus* Linnaeus, 1766 - was found in the forest skirt at Brădeni and on the brook bank at Retiş, where it represented the only species captured. 5. *Neomys fodiens* (Pennant, 1771) - one specimen in the riverside coppice at Stejăriş. 6. *Crocidura leucodon* (Hermann, 1780) - was founded at Şaeş, in the reed-bed and at Stejăriş, among the shrubs.

Ordo Rodentia Gray, 1821

Fam. Sciuridae Gray, 1821. 7. *Sciurus vulgaris* Linnaeus, 1758 - was cited by Blondé and Vandendriesse.

Fam. Gliridae Thomas, 1897. 8. *Myoxus glis* (Linnaeus, 1766) - was found in the forest at Retiş and the forest skirt at Brădeni. Two specimens collected from Saschiz were found in the mammal collection in the Sibiu Natural History Museum. *M. glis* was also mentioned by Blondé and Vandendriesse. 9. *Muscardinus avellanarius* (Linnaeus, 1758) - was most abundant at Dealu Frumos, where it was encountered in all the habitats, except for the cornfield.

Fam. Arvicolidae Gray, 1821. 10. *Clethrionomys glareolus* (Schreber, 1780) - was captured at Dealu Frumos, Brădeni and Retiş. *C. glareolus* was also mentioned in the area by Blondé and Vandendriesse. 11. *Arvicola terrestris* (Linnaeus, 1758) - one specimen collected from Sighişoara was found in the mammal collection of the Sibiu Natural History Museum. 12. *Microtus arvalis* (Pallas, 1778) - was captured at Dealu Frumos, Brădeni and Şaeş, the highest abundance being recorded in the hayfield from Brădeni.

Fam. Muridae Gray, 1821. 13. *Apodemus sylvaticus* (Linnaeus, 1758) - was captured at Dealu Frumos (dominant in the clearing), Brădeni (dominant in the reed-bed) and at Retiş. *A. sylvaticus* was also mentioned in the area by Blondé and Vandendriesse. 14. *Apodemus flavicollis* (Melchior, 1834) - captured in all the stations, was the most abundant species at Retiş, both in the forest and its edge. It is interesting that at Dealu Frumos it was found in the open habitats (the cornfield and the neighbouring ditch) but not in the forest or in the clearing. *A. flavicollis* was also mentioned from here by Blondé and Vandendriesse. 15. *Apodemus uralensis* (Pallas, 1811) - was captured only at Dealu Frumos in the cornfield and the adjacent shrubby ditch. All these *Apodemus* species belong to the subgenus *Sylvaemus* and are appearantly similar, difficult to distinguish on the basis of external morphological characters. Many contradictions are thus found in the literature on these species, especially the first two, which is why we should present the characters considered for the identification of the *Sylvaemus* species. *A. flavicollis* is the largest. Although few identification keys note that the hind foot length is more than 24 mm, we found in many cases specimens with clear *flavicollis* characters, presenting a shorter foot, but not less than 22 mm. The colour of the belly is usually pure white, always clearly delimited from the variable colour of the back, which is most typically reddish-brown. It presents a large transverse yellow spot on the chest, sometimes a complete collar. In a few cases the spot may be small, but it is always present. During handling is usually agitated and aggressive. *A. sylvaticus* is smaller, hind foot lenght between 20 mm and 24 mm, the belly white or greyish-white, not clearly distinguished from the brown-greyish back. The yellow spot on the chest is smaller, sometimes absent, and it never has a complete collar. During handling it is less aggressive and agitated than *A. flavicollis*. *A. uralensis* is the smallest, the hind foot length less than 20 mm, the belly light greyish, gradually continuing into the darker back. There is no spot on the chest. When handled it is quiet. 16. *Apodemus agrarius* (Pallas, 1771) - was one of the most abundant species in the study area, captured at all the stations, clearly dominant at Şaeş, in the reed-bed, and at Stejăriş, in the potato field. It was also mentioned by Blondé and Vandendriesse. 17. *Mus musculus* Linnaeus, 1766 - usually synanthropic, found in most of the human settlements, was mentioned in the area by the same source. 18. *Mus spicilegus* Petenyi, 1882 - was captured in the cornfield at Stejăriş and at Dealu Frumos in the ditch bordering the cornfield. 19. *Rattus norvegicus* (Berkenhout, 1769) - was mentioned by Blondé and Vandendriesse.

The quantitative data are summarized in the table 1, which includes the number of individuals captured at each locality, the relative abundance of the species in the small mammal communities from the Agnita - Sighişoara area, and their frequency in the habitats investigated.

Tab. 1: Synthesis of the captures from the investigated localities.

Station / Species	Dealul Frumos	Brădeni	Retiş	Şaeş	Stejăriş	Total	RA %	F %
S. araneus	1	13	1	1	1	17	12.50	26.31
S. minutus	0	2	1	0	0	3	2.20	10.52
N. fodiens	0	0	0	0	1	1	0.73	5.26
C. leucodon	0	0	0	1	1	2	1.47	10.52
M. glis	0	2	3	0	0	5	3.67	10.52
M. avellanarius	3	0	0	1	0	4	2.94	21.05
C. glareolus	1	1	3	0	0	5	3.67	21.05
M. arvalis	3	4	0	5	0	12	8.82	36.84
A. sylvaticus	4	13	3	0	0	20	14.70	21.05
A. flavicollis	2	7	20	6	1	36	26.47	42.10
A. uralensis	3	0	0	0	0	3	2.20	10.52
A. agrarius	4	4	1	8	7	24	17.64	36.84
M. spicilegus	1	0	0	0	3	4	2.94	10.52
Total	22	46	32	22	14	136		
%	16.17	33.82	23.52	16.17	10.29		100.000	

DISCUSSIONS

The high variety of habitats (both natural and anthropogenic) of the Agnita - Sighişoara area is reflected also in the small mammal community structure. The species diversity is high and their percentages are relatively balanced (Fig. 2). The genus *Apodemus* is most abundant and among its species *A. flavicollis* (26.47%), as woodlands occupy an important part of the area and all the investigated stations were located in the vicinity of forests. The strong influence of this type of habitat in the area is illustrated also by the high frequency of *A. flavicollis*, found in almost half of the habitats investigated (42.1%).

High abundances were recorded also by *A. agrarius* (17.64%) and *A. sylvaticus* (14.7%).

Among insectivores, *S. araneus* was most numerous, representing 12.5% of the total number of captured individuals. It finds suitable conditions in the habitats with rich vegetation and sufficient humidity. Besides, 2003 was a peak year for this species, high population densities being recorded also in other areas, such as Râu Şes (Benedek and Drugă, 2005). The population densities are unevenly distributed among the localities, as most of the individuals (76.47%) were captured in the forest skirt at Brădeni, although it was encountered at all the investigated stations (recorded frequency - 26.31%).

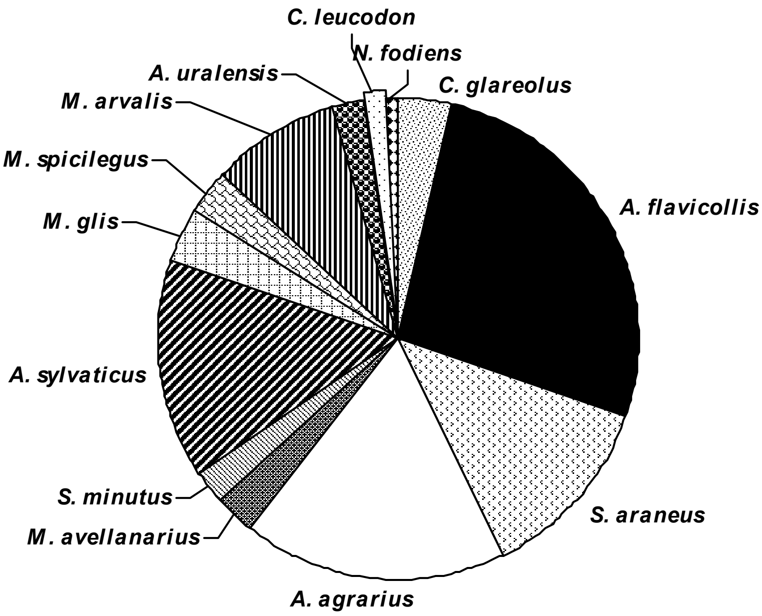


Figure 2: Specific structure of small mammals communities from Agnita - Sighişoara area.

A low abundance was recorded for *M. arvalis* (8.82%), although several open field habitats were investigated. This result is partly caused by the sampling effect. Because this study was designed as an extensive one, aiming to research as many habitats as possible, traps were maintained only for two nights in each habitat, with no pre-baiting. This method is suitable for forest or shrub species, which are used to sudden changes in their environment and enter the traps imediately after they are set. Open field species (*M. arvalis* is one of the most typical) avoid new objects appearing in their habitat. Thus, to capture them traps need to be left for a longer period in the same place, usually also with a pre-baiting period of several days. This fact was confirmed also by other researchers. Robert Rose (pers. comm.) obtained the same result in the case of *M. pennsylvanicus* from the southern USA. Another argument for this hypothesis is the high frequency of *M. arvalis* recorded in the investigated area (36.84%), only slightly lower than the highest value recorded (in the case of *A. flavicollis*).

C. glareolus, *M. glis* and *M. avellanarius* are strongly related to the forest. *C. glareolus*, frequently sympatric with *A. flavicollis*, even more abundant than this in some mountain areas, does not find in the lowland forests the optimal conditions, as revealed by the low value of its relative abundance (3.67%). In lowlands *C. glareolus* is widespread in forested areas (recorded frequency - 21.05%), but it does not develop dense populations. *M. glis* is probably more abundant in the woodlands from the area than the relative abundance (3.67%) shows, but is difficult to capture with traps placed on the ground. Its habitat requirements are higher than those of other forest species (frequency - 10.52%). *M. avellanarius* is a frequent species in the area (21.05%), being captured in most of the habitats with woody vegetation or in their vicinity (like at Şaeş, in the reed-bed). The lowest abundances are recorded by the other insectivore species: *S. minutus, C.leucodon* and *N. fodiens,* with less than 2%.

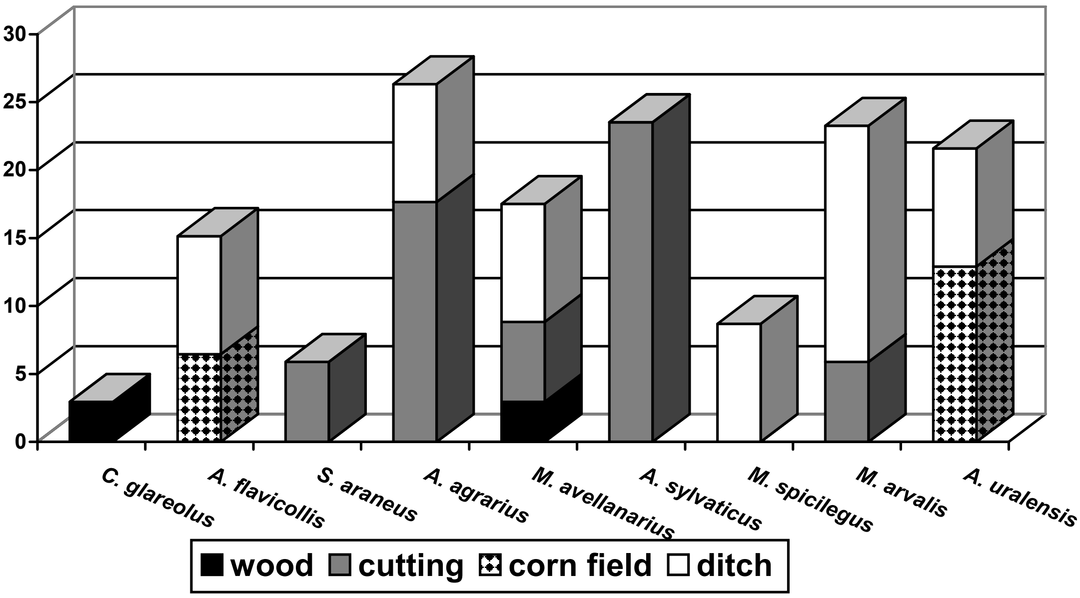


Figure 3: The abundance of the small mammal species in the habitats from Dealu Frumos, expressed by the capture index values.

The small mammal community from Dealu Frumos was most diverse, reflecting the great variety of environmental conditions offered by the different habitats in the area (Fig. 3). The *Carpinus* and *Quercus* wood was of lowest importance for small mammals among the habitats investigated. The absence of herbaceous and shrub layers, which represent important shelters for forest species, as well as the relative low humidity of the biotope, are restrictive conditions for small mammals. Only two species (*C. glareolus* and *M. avellanarius*) were captured, both recorded at low densities. Very interesting results were obtained in the forest cutting, where typical forest (*M. avellanarius*) and open land (*M. arvalis*) species were found together, beside intermediate species as *S. araneus* or *A. sylvaticus* (dominant in this habitat). A low diversity was observed also in the cornfield. The recent harvest of maize had a disturbing effect on the resident small mammals, some of them moving into the quiet neighbouring habitats. This explains the high diversity and abundance of animals in the roadside ditch. Like in the cutting, here was found a mixed fauna, formed of both forest (*A. flavicollis, M. avellanarius*) and open land (*A. uralensis, M. spicilegus, M. arvalis*) species.

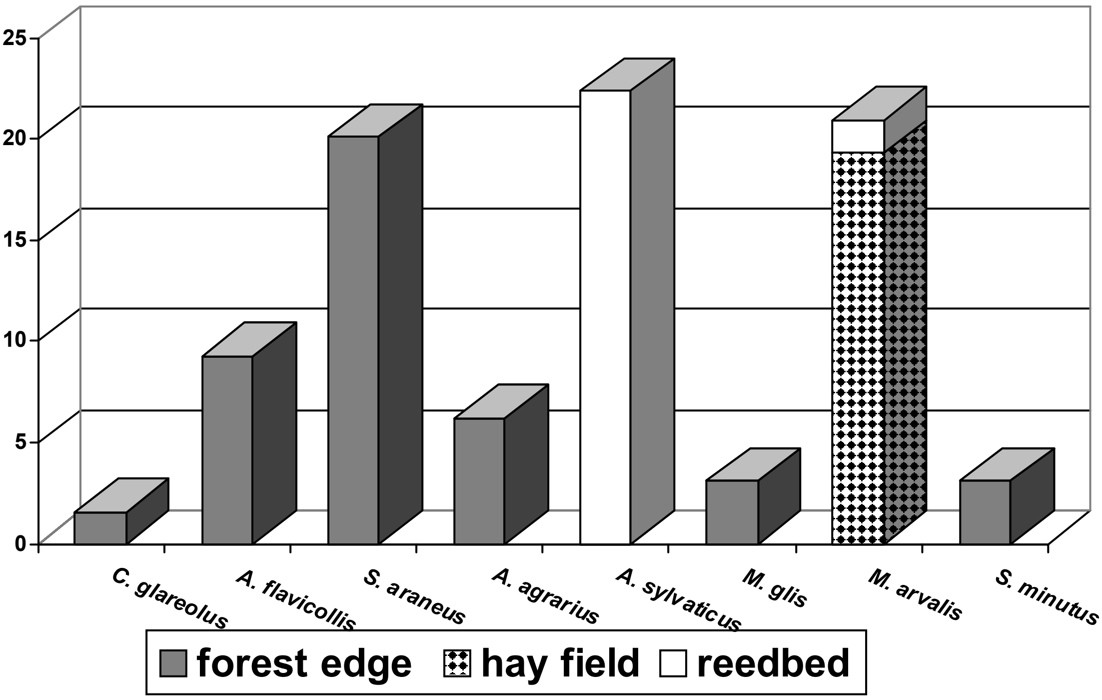


Figure 4: The small mammal species abundance in Brădeni area through the capture index values.

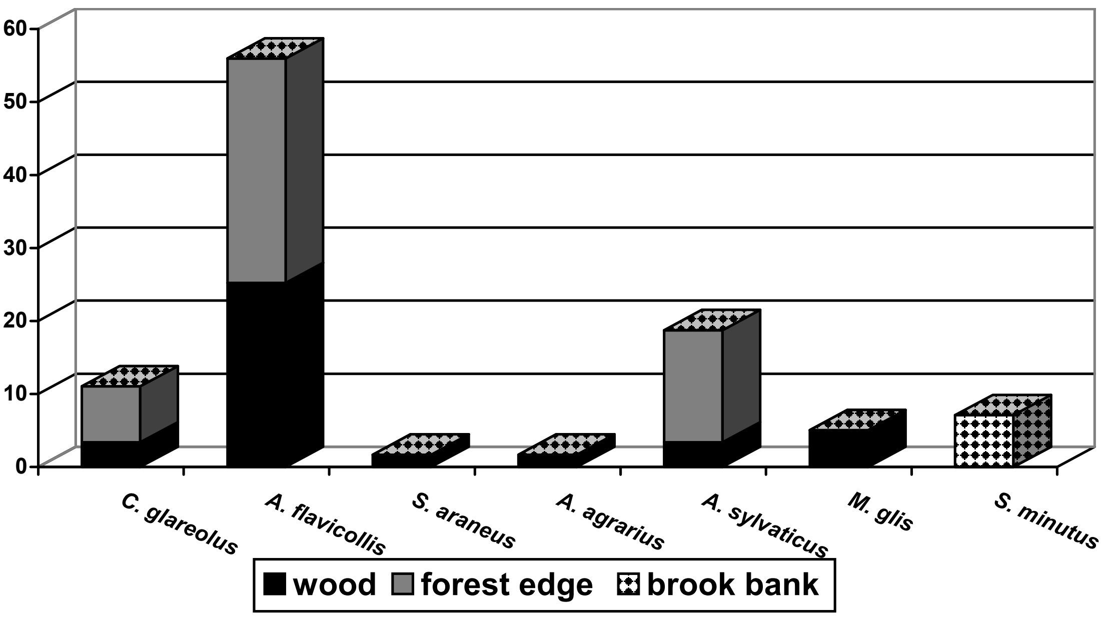


Figure 5: The small mammal species abundance in the Retiş area through the capture index values.

At Brădeni, each habitat presented a specific fauna, dominated by one different species (Fig. 4). Most characteristic is the hayfield, where only *M. arvalis* was encountered. The reed-bed was dominated by *A. sylvaticus* and, interestingly, no *A. agrarius* was captured, although it is a suitable biotope for this species. A rich small mammal community, dominated by *S. araneus*, is sheltered by the narrow shrub belt (the only habitat investigated where an insectivore was most abundant) bordering the forest, where no animal was encountered.

In contrast with the woods from Dealu Frumos and Brădeni, the mixed forest from Retiş, with rich shrub and herbaceous layers, is an important habitat for forest rodents in the area. *A. flavicollis* is clearly dominant, while the other species have low densities illustrated by the values of the capture index (Fig. 5). At this station no significant difference is observed between the structure of the small mammal community from the forest and its edge. Here the species number is lower, but their densitites are higher, especially in case of *A. sylvaticus*, which avoids compact woodlands. Due to its poor vegetation layer, the rivulet bank shelters few animals, one single *S. minutus* individual being found.

At Şaeş a rich community was found in the reed-bed (Fig. 6). This biotope offers suitable conditions for *A. agrarius*, which was found only here, at a very high density, shown by the capture index value. The other species with low abundance are not characteristic here. *M. avellanarius* comes from the neighbouring forest, probably also *S. araneus.* As expected, *A. flavicollis* was abundant in the forest skirt, while *M. arvalis* was found mainly in the hayfield.

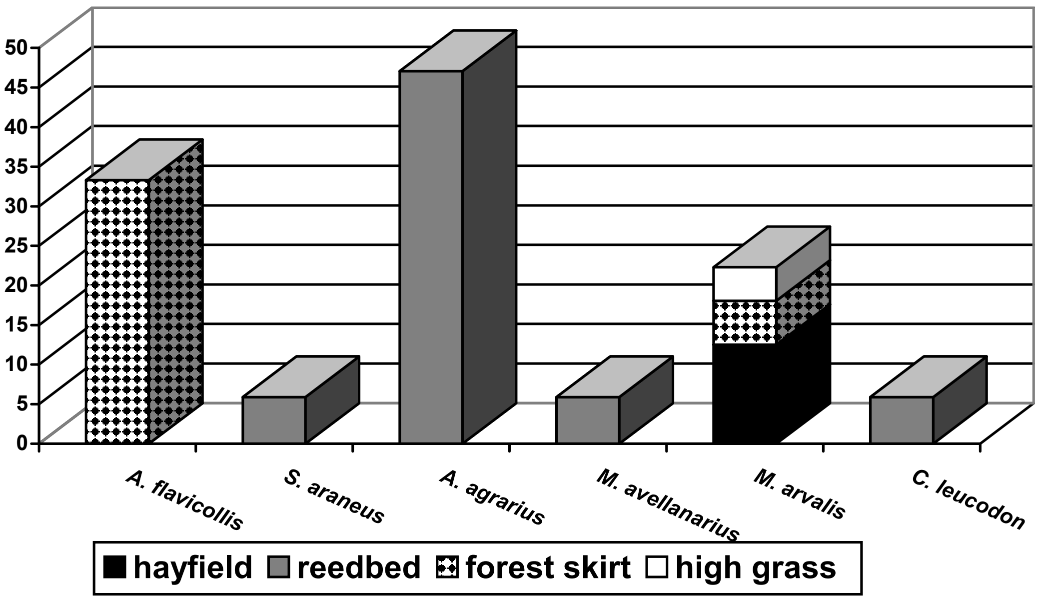


Figure 6: The small mammal species abundance in Şaeş area through the capture index values.

The potato and cornfields from Stejăriş, like most of the cultivated fields, especially with standing crops, support an abundant rodent community, formed of *A. agrarius* with a very high density in the potatofield, and *M. spicilegus*, found only in the cornfield (Fig. 7). The riverside coppice and the shrubs shelter a more diverse but less abundant small mammal fauna.

The number of captured individuals is strongly influenced by the duration of the trapping session. At Brădeni, the trapping effort was double that of the other localities (four nights instead of two). Considering this fact, the abundance of small mammals at Brădeni is comparable with that from Dealu Frumos and Şaes (Fig. 8). The highest density was recorded at Retiş, where the mixed woodland provides shelter and food resources for an abundant forest community. A high density of small mammals was recorded also at Stejăriş (here traps were set for one night only), where the main source of food was represented by the two crops.

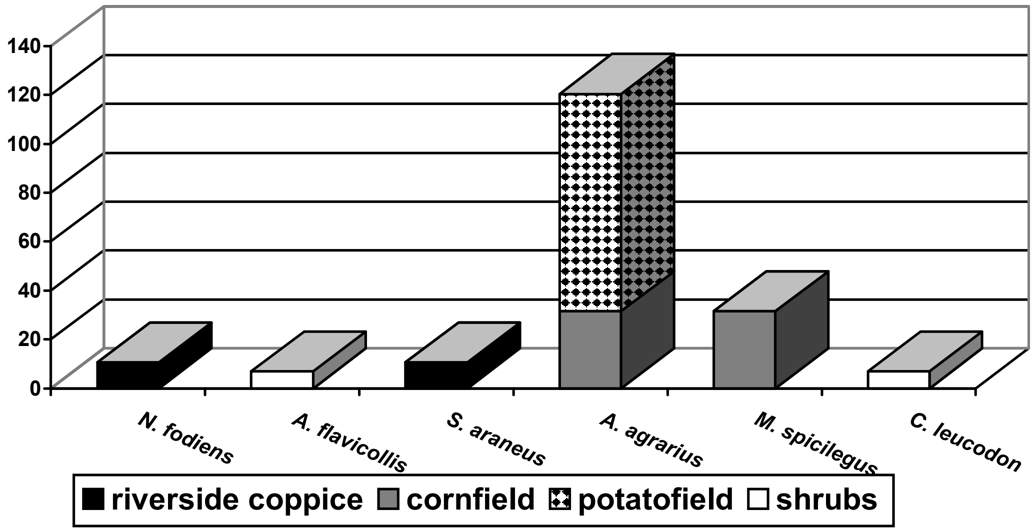


Figure 7: The small mammal species abundance in Stejăriş area through the capture index values.

The diversity of communities, is also influenced by the variety of environmental conditions. The highest number of species was encountered at Dealu Frumos (Fig. 8), where the traps were placed in a mosaic of very different habitats, from cultivated field to forest.

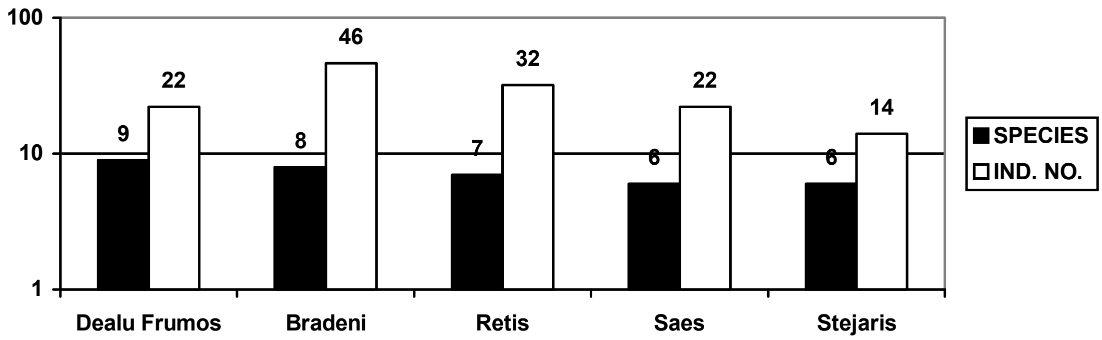


Figure 8: The number of species and individuals of the small mammals at the investigated stations.

The Margalef and Shannon-Wiener diversity measures present a similar variation (Fig. 9), the highest values being recorded at Dealu Frumos, and the lowest at Şaeş and Stejăriş.

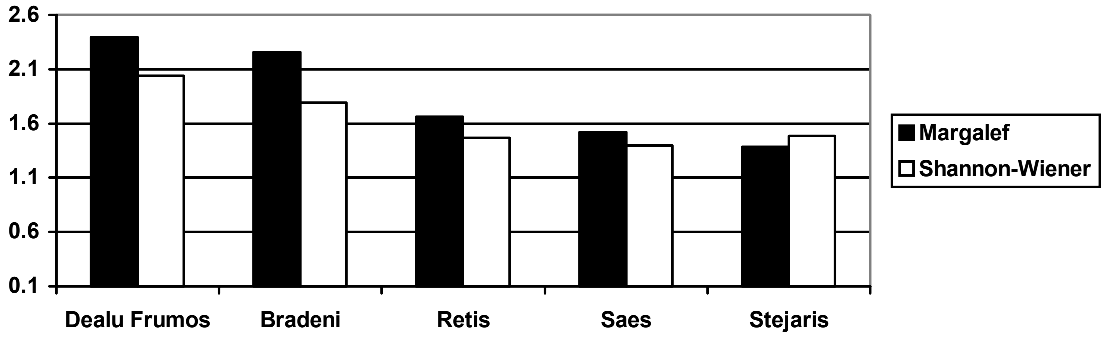


Figure 9: The diversity of the small mammals communities from the investigated stations, expressed by Margalef and Shannon-Wiener measures.

CONCLUSIONS

Up to the present, 19 species of small mammals (6 insectivores and 13 rodents) are known from the Agnita - Sighişoara area; among them 13 were captured during our survey. The genus *Apodemus* is dominant, and most abundant was *A. flavicollis*, as woodlands occupy an important part of the area and all the investigated stations were located in the vicinity of forests. High abundances were recorded also for *A.* station varies depending on *A. agrarius*, especially in the humid biotopes and cultivated fields, and *A. sylvaticus*. Among species of open land, the most numerous was *M. arvalis*.

The fauna of each locality researched depends on the types of habitats investigated. Forests with a rich shrub and grass layer appear to have higher mammal diversity compared with forests with no shrub layer, and mixed forests are more diverse than those made up of just one or two species of trees. The forest skirts with many shrubs tend to shelter a high number of species, especially if the forest is shrubless. This trend was very marked at Brădeni. In forests with a rich shrub layer, like Retiş, the edge does not appear as a distinct habitat. Another interesting habitat was represented by the clean Stejăriş rivulet, the single place where *N. fodiens* was encountered. The various cultivated fields have a relative rich small mammal fauna, but consisting mostly of common species, like *A. agrarius* and *M. spicilegus*. In this biotope a more interesting faunistic element is represented by *A. uralensis*.

ACKNOWLEDGMENTS

This study was carried out with the financial help of the NGOs Fundația ADEPT and Ecotur Sibiu. The field investigations were accomplished with the help of a post-graduate student, Marius Drugă, and my father, Francisc Benedek. To them I owe sincere gratitude.

REFERENCES

1. Benedek, A.M., 2006 − Dynamics of small mammals' communities (Insectivora and Rodentia) from Retezat Mountains National Park (Romania). *Trav. Mus. Nat. Hist. Natl. "Gr. Antipa",* 49: 401-409.
2. Benedek, A.M., Drugă, 2005 − Data regarding the terrestrial small mammal communities (Ord. Insectivora and Ord. Rodentia) from Râu Şes River Basin (Țarcu and Godeanu Mountains). *Trav. Mus. Nat. Hist. Natl. "Grigore Antipa"*, 48.
3. Istrate, P., 1998 − Mamiferele mici din Podişul Târnavelor, Transilvania. *Trav. Mus. Nat. Hist. Natl. "Gr. Antipa",* 40: 449-474.
4. Istrate, P., 2000 − Studiul calitativ şi cantitativ al faunei de mamifere mici din zona cursului inferior şi mijlociu al râului Târnava Mică, cu observații privind ecologia speciilor. *Marisia*, 16: 219-232.
5. Istrate, P., 2005 − Remarks on the habitat of *Muscardinius avellanarius* in the Târnava Plateau (Transylvania, România). *Tralsylv. Rev. Syst. Ecol. Res. "The Târnava River Basin"*, 2: 173 - 204.
6. Murariu, D., 2000 − Insectivora. Fauna României, XVI - Mammalia (1).
7. Popescu, A., Murariu, D., 2001 − Rodentia. Fauna României. XVI - Mammalia (2).
8. Pucek, Z., 1981 − Keys to Vertebrates of Poland - Mammals, Polish Scientific Publishers, Warszawa.

FUTURE LAND USE CHANGE IN A TRADITIONALLY FARMED LANDSCAPE IN EASTERN EUROPE (TRANSYLVANIA, ROMANIA)

Martha COWELL *

* Ruskin University, Life Sciences Department, East Road, Cambridge, CB1 1PT, United Kingdom, martha0000@hotmail.com

KEYWORDS: Romania, Transylvania, Saxon villages region, land use, vegetation mapping, GIS, farming, economic/social/political factors, future change.

ABSTRACT

Eastern European countries including Romania, which joined the EU in January 2007, hold a great wealth of semi-natural and natural habitats created and maintained by low intensity traditional farming. Many of these cultural landscapes are now threatened by abandonment and intensification. Techniques such as vegetation mapping using GIS are valuable tools to map vegetation types and land use, especially in areas predicted to change in the near future. In this study they have been applied in the village of Malâncrav to look at the different vegetation types and land uses. The landscape was found to be extremely heterogeneous, containing many different semi-natural and natural habitats created by a long history of low intensity management. The map created has then been used as a base on which to predict future scenarios based on economic, social and political factors driving change. These changes, based on a scenario of abandonment of less productive land, and intensification of fertile land, create a more homogeneous environment and many vulnerable habitats are lost. There are factors which may mitigate these changes if the area can be economically regenerated while allowing traditional farming techniques to continue.

ZUSAMMENFASSUNG: Zukünftige Bodennutzung Änderung in einer traditionell bewirtschafteten Landschaft in Osteuropa (Transylvanien, Rumänien).

Östliche europäische Länder einschließlich Rumänien, das kürzlich die EU im Januar 2007 angeschlossen hat, halten einen großen Reichtum halb natürlicher und natürlicher Lebensräume hat geschaffen und hat durch niedrige Intensität traditionelle Landwirtschaft beibehalten. Viele von diesen kulturellen Landschaften werden jetzt von Verzicht und Verstärkung bedroht. Verfahren wie zum Beispiel Vegetation zeichnend benutzend GIS ist wertvolle Werkzeuge auf, Vegetationentypen und Bodennutzung aufzuzeichnen, besonders in Gebieten hat vorausgesagt, bald zu ändern. In diesem Studium sind sie im Dorf von Malâncrav benutzt worden, die verschiedenen Vegetationentypen und Bodennutzungen anzuschauen. Die Landschaft wurde von einer langen Geschichte gefunden, äußerst heterogen in Charakter zu sein, den viele verschiedene halb natürliche und natürliche Lebensräume enthält, die die Leitung von niedriger Intensität geschaffen werden. Die Karte hat dann ist benutzt worden als eine Basis auf dem, zukünftige Szenare auf der Basis auf wirtschaftlichen, sozialen und politischen Faktoren vorauszusagen, treibend Änderung geschaffen. Diese Änderungen, auf der Basis auf einem Szenar des Verzichts von weniger ergiebigem Land, und Verstärkung fruchtbaren Lands, schafft eine homogenere Umwelt und viele verwundbare Lebensräume sind verloren. Es gibt Faktoren, die diese Änderungen verringern können, wenn das Gebiet wirtschaftlich erneuert werden kann, erlaubend, dass traditionelle Landwirtschaftverfahren fortsetzen.

REZUMAT: Schimbarea viitoare a utilizării terenurilor într-un peisaj agricol tradițional în estul europei (Transilvania, România).

Țările est europene inclusiv România, care au aderat în ianuarie 2007 la Uniunea Europeană, dețin o mare bogăție de habitate seminaturale şi naturale create şi păstrate datorită activităților neintensive a fermelor tradiționale. Multe dintre aceste peisaje sunt acum amenințate de abandon sau de intensificarea activităților antropice. Tehnici cum este cartarea GIS a vegetației sunt instrumente valoroase pentru cartarea tipurilor de vegetație şi a utilizării terenurilor, în special în arii care se prevede că se vor schimba în viitorul apropiat. În acest studiu această tehnică a fost utilizată în satul Mălâncrav în vederea unei analize a diferitelor tipuri de vegetație şi a utilizării terenurilor. Peisajul a fost găsit ca având un caracter extrem de heterogen, conținând multee şi diferite habitate seminaturale şi naturale create de-a lungul unei instorii îndelungate de activități agricole tradiționale. Harta creată a fost după aceea utilizată ca bază de predicție pentru scenarii viitoare, bazate pe factori de schimbare economici, sociali şi politici. Aceste schimbări, bazate pe un scenario legat de abandonarea terenurilor mai puțin productive şi intensificarea activităților umane pe cele fertile, crează un mediu mai omogen şi multe habitate vulnerabile se pierd. Există factori care pot să atenueze aceste schimbări dacă zona poate fi regenerată economic permițând continuarea utilizării tehnicilor agricole.

INTRODUCTION

In the last two years many Eastern European countries have become part of the expanding European Union, leading many observers to question the future of the culturally and biologically rich farming landscapes of these areas. Most highly developed European countries have lost much of their farmland biodiversity due to over-intensification of land use, which has been, in part, due to subsidies encouraging overproduction from the Common Agricultural Policy (CAP).

Although the focus of the CAP has now changed, leading to the decoupling of payments from production and linking them to best practice on the whole farm (Silcock et al., 2003), there is still concern for farmland biodiversity in Eastern Europe. This concern is related to the general pattern of change that is often seen within agricultural landscapes of countries experiencing rapid economic growth and political change, backed up by studies such as those of Donald et al. (2002), which indicate that the decline in biodiversity has been greater within the EU than in non-member states. The challenge now faced is how rural communities can obtain these higher standards of living and maintain viable businesses within the competitive environment of the EU, whilst still maintaining their diverse cultural farmland ecosystems.

Romania's accession to the European Community on 1st January 2007 brought another 14 million ha of agricultural land into the EU (Buffaria et al., 1998), much of it containing biodiversity which had been lost elsewhere in Europe. EU policies and schemes such as the revised CAP and the SAPARD initiative aim to support Romania's agricultural sector in becoming competitive within Europe whilst still conserving this biodiversity, although many remain sceptical towards the commitment decision makers within the EU have shown so far.

The aim of this study is to provide a tool which could be used by organisations working to preserve the rich heritage and biodiversity within Transylvania through Natura 2000 or Natural Park designations. The work was carried out in association with the Mihai Eminescu Trust, a Romanian/UK-based NGO which is working within the Saxon Villages region in the foothills of the Carpathian Mountains in south-central Transylvania, Romania (MET, 2004a). The Trust is working with local people, restoring village buildings and initiating economic and community projects (MET, 2002).

Before an area is designated it is important that a baseline survey is carried out (Wellens et al., 2000) to assist with land management and to identify important or vulnerable habitats and their associated species (Sickel et al., 2004). Baseline surveys often take the form of a vegetation or land use map, which can then be used to assess the area, e.g. by assigning vulnerability scales to different habitats and calculating percentages of different habitat types. The creation of vegetation maps is important in biologically rich areas where change is predicted to happen, as they can be used to monitor any changes that do occur and in some cases prevent damage to habitats that might otherwise have gone unnoticed.

The main drawback to using detailed vegetation mapping as a tool for conservation is its reliability and repeatability, as studies have recorded a major element of observer bias in vegetation mapping. One study carried out in order to improve data collection methods for the Habitat Survey of Wales gave an average agreement between surveyors of 76%. The modified land use categories had the highest agreement at 88%, semi-natural categories were 75%, and semi-improved were only 56% (Stevens et al., 2004). Another study showed an agreement between surveyors of only 25.6% (Cherrill and McClean, 1999). Both studies showed that related vegetation types are most often confused, especially when one grades into another.

It is possible to predict change to landscapes caused by factors such as declines in traditional management practices and re-structuring of agricultural policies (Aspinall, 1993; Howe et al., 2005), if enough is known about the area and its future influences. Factors to look at include socio-economics, community structure, land development patterns, natural resources, current and future policies, and climate and climate change. These predictions can be shown on the current vegetation and land use maps, but due to the complex nature of interacting factors, predictions should not be seen as an exact future, but should be used to manage the present situation and influence future decisions that will affect the area studied (Bouma et al., 1998).

The objectives of this study were to: 1. Map the land use and vegetation types in an area of traditionally farmed landscape in Transylvania, using GIS in the field and MapInfo software to create the map; 2. Collect data using questionnaires and available literature to assess how future drivers of change influencing the area could affect the vegetation types and land uses; 3. Use the map produced to indicate a scenario of future change.

MATERIALS AND METHODS

The Malâncrav Village is situated in one of many lowland valleys leading to the Târnava Mare river in the north-eastern foothills of the Transylvanian Alps in the Carpathians. The topography is varied but essentially consists of many small valleys; predominantly steep-sided with flat, wet areas in the valley bottoms, with a maximum altitude of *c.*500m.

The soils are deep, rich calcareous clays in the valley bottoms, and shallow but base-rich soils on the steeper slopes and hill tops where limestone is the underlying rock. Over localised sand deposits acid soils develop. The varied soil types are associated with and give rise to a diversity of vegetation types. The weather is continental, with cold winters and wet summers. The mean spring and summer temperature is 20–25°C, while the mean January temperature is below 0°C, and may fall as low as -25°C. There are often deep snow falls during winter, and the annual rainfall is *c.*700mm with most falling during spring and early summer when thunderstorms are frequent (Mountford and Akeroyd, 2005).

Floral and faunal biodiversity is rich due to the persistence of a number of natural habitats and many semi-natural habitats, created and maintained through centuries of traditional agricultural practice (Mountford and Akeroyd, 2005; Akeroyd, 2006; Akeroyd and Page, 2006).

The vegetation classification system used was based on the Europe-wide EUNIS system (EEA, 2005), with each category being assigned a group of identifying characteristics, a code and a colour/pattern (Tab. 1). After completion of the fieldwork it was realised that 'E2/mesic grassland' encompassed many different vegetation types and would have been better split into more detailed categories. It would also have been useful to have distinct vegetation categories for 'cultivated garden' and 'woodland pasture', included under 'arable/crop' and G1.A/mixed deciduous forest' respectively.

A handheld GPS unit was used in the field (settings: UTM coordinate system, WGS84 datum). An enlarged 1:25000 scale military map was used as a base map.

Table 1: Brief description of each vegetation type/land use tmapped in the study area.

Vegetation type/land use	Description
C2 - surface running water	free-flowing rivers and streams
D4 - base-rich fen	waterlogged areas, often with running water, normally hill slopes where there are springs and seepages; short vegetation with a rich diversity of rushes, sedges and mosses; key species include rushes (*Juncus*) and sedges (*Carex* and *Eriophorum*)
D5 - sedge and reed-bed	valley bottoms, with tall vegetation; species include big sedges (*Carex*) and reeds (*Phragmites*)
E1 - dry grassland	often steep, south-facing slopes, always dry and infertile with many fine thread-leaved grasses and a rich diversity of wild flowers; key species are fescue grasses (*Festuca*)
E2 - mesic grassland	widespread, often on gently sloping valleys, appearing more fertile than E1, with broader-leaved grasses; includes hay-meadows
E3 - wet grassland	valley bottoms in the same areas as D5, as created when D5 is regularly cut or grazed
E5 - woodland fringes, clearings and tall forbs	often on woodland edges, and along the side of tracks, a tall uncut and ungrazed habitat with a varied species composition.
F3 - temperate and Mediterraneo-montane scrub	on dry slopes and hills, around 1–5 m tall; key species include *Prunus spinosa*, *Crataegus monogyna*, *Ligustrum vulgare*, *Cornus sanguinea*
F9 - riverine and fen scrub	in valley bottoms, often in corridors along streams, 4 – 5m tall with willow species, including *Salix alba*, *S. caprea* and *S. cinerea*
G1.1 - riparian *Salix* spp., *Alnus glutinosa*, *Betula pubescens*	valley bottoms, often in corridors, as F9, 8–15 m tall with species including large willows such as *Salix alba* and *S. fragilis*, and alder (*Alnus glutinosa*)
G1.A - mixed deciduous forest (*Quercus* sp., *Carpinus betulus*, *Fraxinus excelsior*, *Tilia* sp., *Acer pseudoplatanus*, *Ulmus* sp.)	native woodland species still present on most high ground, often dominated by hornbeam (*Carpinus betulus*), but beech (*Fagus sylvatica*) may occur in separate stands
G5 - anthropogenic woodland	non-native plantations for commercial or aesthetic purposes
Cultivated:	orchards, arable, ploughed, mixed crops, cultivated gardens - built-up areas and roads

Fieldwork

Waypoints were taken using the GPS unit at key reference points e.g. the village church, at all places where there was a change of direction, and were also used to enclose parcels of vegetation.

Every waypoint was recorded on a waypoint record sheet and included the waypoint number, X and Y co-ordinates, elevation, the UTM zone and descriptive notes, including the location, vegetation type, land use and any points of interest. Using coloured pencils the vegetation types were drawn on to the map as accurately as possible, along with key waypoint numbers. Landscape photos were taken of all areas from high vantage points, to be used for reference and to aid in accurate digitising of the results; the location from which all photos were taken was also recorded.

Interview questions were designed whilst in the field, in collaboration with a local biologist, who then conducted interviews in Romanian with residents chosen at random from people on the street at the time the questionnaire was carried out.

An area of approximately 8 km^2 was mapped. Inconsistencies may have arisen from the fact that the smallest plot size to be recorded was never finalised, meaning it is possible some small plots were recorded and others weren't.

Digitising

A scanned copy of the map used in the field was used as the base map on to which the vegetation types were digitised. The Viteaz conversion spread sheet (Timár et al., 2004) confirmed that the system used to make the map was a Soviet system known as the Gauss Kruger system. The map was then opened in Map Info and the projection category set to UTM (WGS84) and category members set to UTM zone 35, Northern hemisphere. Points A-J were then geo-registered onto the map.

Points C and F were deleted as they both had a geo-registration error of approximately 50 pixels (1 pixel = 70cm/0.7m). It was not necessary to delete any more points as the mean error was now only 14 pixels equalling an error of 9.8m, and most GPS recordings are approximately accurate to 10m. Accuracy would have been improved if the base map had been scanned as one image, as opposed to four scanned and digitally joined images.

The waypoints were opened in MapInfo onto the geo-registered base map. Using a combination of the base map, waypoints and field notes the vegetation categories were then created as visual polygons and saved as a table. A thematic map was created of the land use table which gave each vegetation category a colour/pattern. The linear features (streams and village road) were saved in a separate table.

A workspace was created which saved all this information in a visual and easy to use format. The land cover in m^2 of each polygon and the total for each vegetation type or land use was calculated using the querying function within map info.

RESULTS

Summary of interviews with Malâncrav residents

All participants believed the area to be excellent for agriculture, with many possibilities for different types of farming; they also said it was a beautiful and clean area with no flooding problems.

Half of the participants were very unsure if there would be any changes to the area, the other half believed there would be no changes and did not want to see any.

All believed that the varieties of crops grown should remain traditional as they are healthy and taste good. All wanted the government to subsidise petrol for tractors as it is currently very expensive. Most were interested in using more herbicides if they became cheaper but were equally happy to continue weeding by hand. One elderly man stated that he was not interested in the use of chemicals and preferred to continue working the land manually.

Nearly all stated that the work on the local land was done manually and that the chemical fertilisers were only used sparingly on hay meadows. Most said they preferred to use natural fertiliser (animal dung) as it is cheap and good for the land. Herbicides and pesticides are used by most only on wheat and potatoes, but some would like to use more if they were cheaper.

DISCUSSION

Linking history to the current landscape

The dominant land uses and vegetation types in Malâncrav are mixed deciduous forestry (30%), arable (26%) and mesic grassland (16%) (Fig. 2). If all the woodland and scrub is combined the figure is 50% of total land use; similarly, for grassland the figure increases to 32%. This gives indication of how woodland and other semi-natural habitats still play a dominant part in the landscape compared to most farmland regions throughout the rest of Europe.

If a land-use map from 1638 of the Swabian Alb in Germany (Fig. 3) is compared to the present day land use and vegetation map of Malâncrav (Fig. 1), it can be seen how similar today's landscape is to how it was in the past. As Malâncrav in the 1600s was inhabited almost exclusively by ethnic Germans, farming practices were probably very similar in both regions.

This relatively unchanged pattern of land use can be attributed to the long history in the area of the Saxons. The village of Malâncrav is part of the unique Saxon Villages region of Transylvania and has been inhabited by Saxons, German immigrants from the Flanders and Luxembourg region, since approximately 1200 (Heli, 2003). Characteristic Saxon villages with associated farming systems and close-knit rural communities have been established throughout the region since that time (Akeroyd 2006; Wilkie, 2001).

Despite political upheaval and regime change, the lifestyle and farming practices have remained by and large traditional. During the latter half of the 20th century the control of farming by Romania's communist regime probably helped to maintain the landscape in its present condition. Although regime-controlled farming caused environmental damage in some areas, it left the more montane areas relatively untouched (Schwartz, 2006). After the fall of communism, the restitution of land in the early 1990s attempted to recreate ownership patterns that had not existed for 40 years (Sabates-Wheeler, 2002), leading to many small and fragmented family farms. Even now 73% of all farm holdings in Romania are below 3 ha in size (Fuchs, 2002). Many family agricultural groups formed at this time in order to collectivise land and share machinery, making farming and especially harvesting easier (Sabates-Wheeler, 2002). In Malâncrav the fragmentation of ownership may not be economically efficient but it has maintained the original field patterns and the heterogeneity of the rich cultural landscape.

Furthermore, the informal farming groups have encouraged the continuation of traditional farming practices, such as the communal grazing and shepherding of sheep and cattle. Also the lack of funds available to farmers has prevented widespread use of pesticides, fungicides, herbicides and artificial fertilisers, and the conversion to more mechanised ways of farming the land (Dragos, 2001). The continuation of traditional management practices since medieval times is extremely rare and has led to a cultural landscape rich in history and biodiversity, so that, despite its turbulent history, the area it has retained its characteristic features as what is thought to be one of Europe's last pristine functioning medieval landscapes (ADEPT, 2005; Akeroyd and Page, 2006).

Contemporary ecosystems

This stability of management has created a farmland ecosystem in dynamic equilibrium that maintains its ecological processes and contains many rare habitats and species. An example of a species which relies on this dynamic equilibrium is *Euphydryas aurinia* (Lepidoptera; marsh fritillary), which needs a complex mixture of habitats, including grazed pastures of differing heights, wet grassland and certain plant species. These conditions are always present, but due to the dynamic nature of the farmland habitat, suitable habitat rarely occurs in the same place every year (Bignal, 1998).

As ecological processes and basic human needs are both maintained, and have been so for many generations, the area can be thought of as sustainable. These processes are able to be maintained as thereare many connected patches of natural and semi-natural vegetation, and the soil, water, biodiversity and productivity are close to natural (Hladnik, 2005). The connected patches allow for the migration of organims, which mean that populations maintain their genetic variability and do not become isolated in fragmented habitat patches (Goverde, *et al* 2002).

The area is dominated by EU Habitats Directive Annex 1 and Annex 1 priority habitats, including forests derived from the primeval Transylvanian forests which are still linked to the Carpathian Mountains. This provides an important corridor for the movement of many species, and links semi-natural 'meadow-steppe' grasslands created by hundreds of years of human management. The species-rich vegetation is closely related to the natural vegetation that grew in the area prior to human impact (ADEPT 2005; CEI, 2001; Mountford and Akeroyd, 2005).

Contemporary problems

The immediate threats to the Saxon village region are mainly caused by the collapse of the rural economy as traditional farming methods have become unprofitable and the communist state farms, which provided the only employment in the village, have closed (ADEPT, 2006). This has led to high unemployment and dependency rates (60%) and abandonment of the area by many young people and the original Saxon population (MET, 2004a). The questionnaire results reinforce this, as nobody interviewed was under 40. The poor infrastructure, including the 13-km unsurfaced access road to the village, lack of adequate health and social services, and lack of a secondary school, increase these problems. Basic facilities such as telecommunications, running water and waste management also need upgrading as the expectations for standards of living are raised.

Farming in Malâncrav is a difficult way of life, increasingly less acceptable for the younger generation. The family-run farms are not viable businesses, as they are too small to be able to sell produce on the market and are mainly of a subsistence nature. Thus an informal exchange currency system has built up in the village, where individuals exchange produce. This lack of a market economy means there are few other employment opportunities in the village for those who do not wish to continue farming. All these factors, combined with a low trust in the government to improve conditions, could ultimately lead to abandonment of marginal lands and intensification of productive lands by those who choose to stay and exploit the agricultural opportunities (Dalton et al., 2003; MET, 2004a; ADEPT, 2005).

Drivers of change

The future of Malâncrav and its land uses and habitats, is determined by many factors. The major ones driving change are social, economic and policy, including the recent accession of Romania to the EU. EU accession and subsequent changes in agricultural policies will have major effects on the area: some may be positive in terms of promoting the continuation of traditional techniques, others may have negative impacts on the environment (Fig. 4).

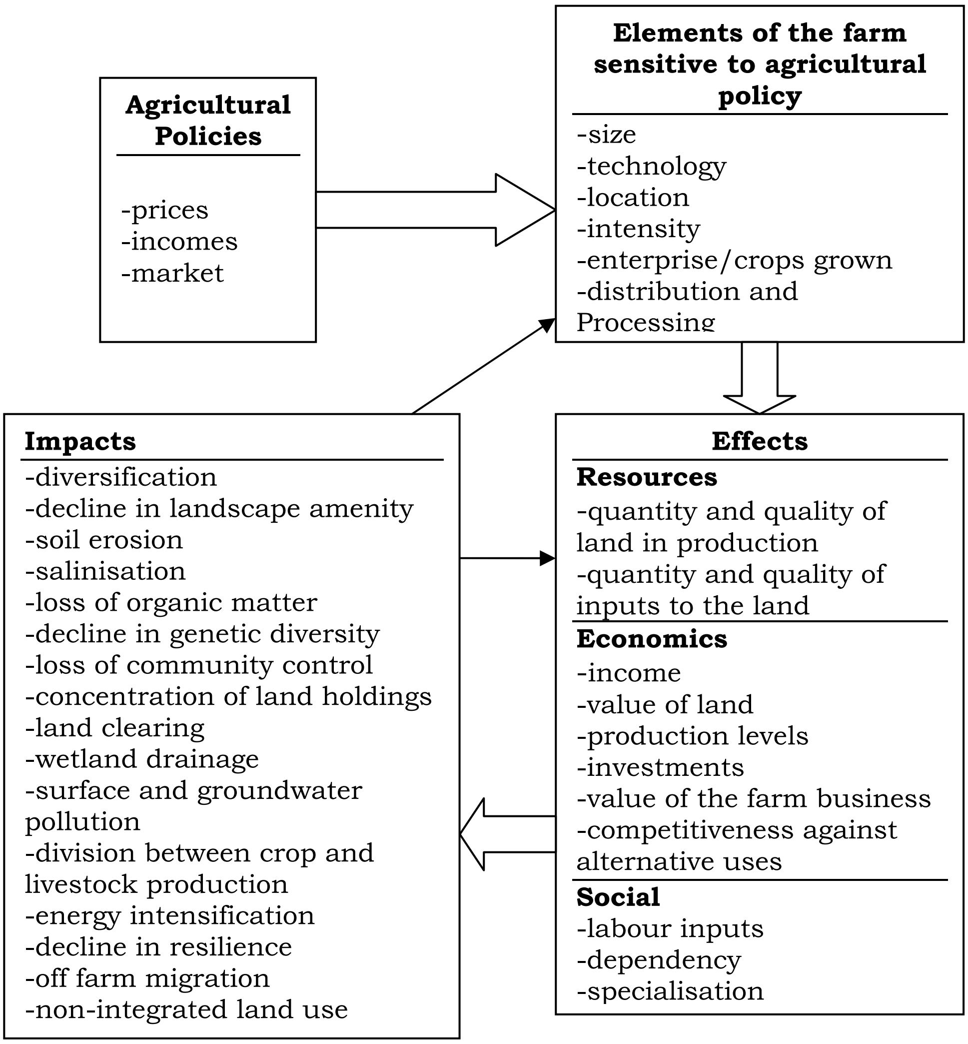


Figure 4: How agricultural policies affect the farm and cause negative changes to the environment and the continuation of traditional agricultural practices (Pierce, 1992 - modified).

The positive side of EU enlargement is the uniting of many countries which have been divided in the past by wars and opinions, and the creation of a stable single market for farmers to take advantage of. It will also provide real opportunities in the form of rural development funds and agri-environmental schemes, which could prevent the abandonment of isolated rural villages such as Malâncrav. Rural development funds should prevent social problems caused by the restructuring of agricultural businesses, although the truth is that most small farms, which are often older and less efficient, will simply not be able to compete in the long term within the competitive EU market. Many of these small farms currently play mainly a social role, allowing rural communities to survive in places such as Malâncrav (Toma, 2003).

The recent change to the Common Agricultural Policy (CAP) which was introduced in 2005, decoupled payments from production levels and introduced the new "single farm payment" scheme. This gives farmers more freedom to produce what the market wants and sets a higher environmental standard for farms to adhere to, known as “cross compliance”. These new measures should help to prevent the negative environmental changes that occurred in other new member states from occurring in Romania. For example throughout Western Europe, where production has been heavily subsidised by the CAP throughout the last 50 years, the impact of simplified and high input systems has had a catastrophic effect on farmland habitats and their biodiversity (Stoate et al., 2001).

Unfortunately, recent studies are showing that the effects of accession on the environment and economy of countries such as Poland which joined in 2004 are not all positive even under the new CAP. Polish farmers are being encouraged to invest substantially in modern farming techniques which are not always suitable, small farms have had to close as they cannot compete, and the market has been flooded with cheaper subsidised goods from countries such as Germany. As the pressures on the land increase in new member states, it becomes increasingly difficult to satisfy conflicting land requirements such as improved infrastructure and housing, economic activities including farming, cultural aspects, farmland biodiversity, natural processes such as flood defence, recreation and aesthetics (Dale et al., 2000).

On the positive side, the Romanian Ministry of Agriculture and EU DG-Agriculture have tailored the agri-environment measures under the National Rural Development Plan (NRDP) specifically to support High Nature Value (HNV) grasslands. Under the draft NRDP, awaiting formal acceptance by the European Commission in early 2008, only designated HNV areas are eligible for agri-environment grassland management payments. This is both an encouraging recognition of their European importance, and a practical and accessible measure which should attract more participants than agri-environment under SAPARD, which involved a more complex application procedure (Nat Page, pers. comm.).

To summarize, the situation in Malâncrav is dominated by the continued threat of rural depopulation from a cultural landscape rich in farmland biodiversity maintained through the continuation of the traditional agriculture. The landscape is dominated by mixed deciduous forests, arable land/cultivated gardens and mesic grasslands. A rich mosaic of other artificial, semi-natural and natural vegetation types and land uses make up the rest of the landscape (Fig. 2). The current pattern of land use is likely to change in response to the many factors that will affect the area in the future (Tab. 2).

Impacts of change on land use and vegetation types

The largest land use category is deciduous forest at nearly 30% of the total land use. Overall it is not considered likely that there will be a big change here. Although the areas in private management may be at risk of being clear cut for a quick gain, as some owners who may not even live in the village often feel no real attachment or understanding of the land due to the recent ownership since restitution (CEI, 2001). Most of the forest is in community ownership, which means it is owned by the Local Town Hall, but is managed by the National Forest Administration. A reserve of 20% must be left unexploited each year, and according to forest managers the total area of forest is growing in this region (Nat Page, pers. comm.).

26.5% of the land use is arable, ploughed, unmixed crops or cultivated gardens. It is not considered to be a vulnerable land use and could increase in size in the future (Tab. 2), as one man stated in the questionnaire results, “*in the past there was much more land cultivated than now*”, which shows there is suitable land for extension of arable areas.

When Romania joined the EU in January 2007, they opted for the simplified area payment scheme (SAPS). The amount per hectare has been calculated by dividing the total amount of money available for direct payments by the “utilised agricultural area”, which is classed as all arable land, permanent crops, permanent grassland and cultivated gardens which have been maintained in good agricultural condition since June 2003 (Strossman, 2004). It is paid at a flat rate per hectare and is not dependent on the crops produced, it also means the land is exempt from cross compliance measures until 2009, when Romania should ideally change to the single farm payment (SFP) if the administrative capacity is in place (Schroeer, 2004).

The decoupled direct payments from production should prevent intensification for high production to some extent, but the exemption from the cross compliance measures could potentially allow damage to occur to high nature value farmland until 2009 when it will apply.

The minimum holding size eligible for direct payments has been set at 1 ha, and the parcel at 0.3 ha (EC, 2005), this has been done despite the fact that approximately 40% of farm holdings in Romania cultivate less than 1 ha (Fuch, 2002), but is due to the high administrative burden of giving many payments of less than fifty euros (Strossman, 2004). Therefore some farmers in Malancrav who have farm holdings or parcels of land smaller than this will not be eligible for direct payments, which may force them to go out of business or sell land.

Small farms may also go out of business as now they are producing for subsistence, leaving nothing to sell on the market. These semi-subsistence farms will only be supported for 6 years by rural development measures in order to become competitive (Monros, 2005), after this date they will not receive support if they are not economically viable. Even if these small farms are able to produce food for the market they are very vulnerable as when exposed to competition they are unable to produce food as cheaply as bigger farms (Berry et al., 2006).

As the economy stabilises and different work opportunities arise, many land owners will be more willing to sell land as currently it provides security in an unstable economy (OECD, 2000). As more competitive farm holdings begin to buy smaller farmers land, fields are often amalgamated to form larger fields for more efficient farming. This can lead to the loss of many boundary features such as tall forb habitats, stands of trees and wetland areas (Tab. 2).

Table 2: The possible effects of drivers of change on the vegetation and land uses in Malancrav; it does not include measures taken to try and preserve the landscape as it currently is or the effect they may have.

Vegetation type/ land use	Drivers of change →	Causes of change →	Possible effects on vegetation type/land use
C2	EU policies, subsidies, economy	3, 4	L
		5	C
D4	EU policies, subsidies, economy	3, 4	L
		1	J
D5	EU policies, subsidies, economy	3, 4	L
		5	I
E1	EU policies, subsidies, economy	4	K
	EU policies, subsidies, economy	6	F
	Social	7, 8	E
E2	EU policies, subsidies, economy	4	K
	EU policies, subsidies, economy	1	K, L
	EU policies, subsidies, economy	6	F
	social	7, 8	E

E3	EU policies, subsidies, economy	1	J
		9, 10	B
E5	EU policies, subsidies, economy	2	H
	EU policies, subsidies, economy	3, 4	K, L
	EU policies, subsidies, economy	6	F
	social	7, 8	A
F3	EU policies, subsidies, economy	6	F
	social	7, 8	A
F9	EU policies, subsidies, economy	5	I
		1	J
G1.1	EU policies, subsidies, economy	5	I
		1	J
G1.A	EU policies, subsidies, economy	11	G
G5 – anthropogenic woodland	EU policies, subsidies, economy	13	A
	social	12	A
G5 - *Pinus sylvestris* plantation	EU policies, subsidies, economy	13	A
G5 - clear cut area	EU policies, subsidies, economy	11	A
- orchard	EU policies, subsidies, economy and social	1	D
- arable, ploughed, unmixed crops, cultivated gardens	EU policies, subsidies, economy	1	A
- built up areas and roads	EU policies, subsidies, economy	14	A

Note (Tab. 2) - causes of change: 1. conversion to arable land, 2. amalgamation of land uses, 3. increase in the use of chemicals on land, 4. increase in the use of artificial fertiliser, 5. extraction of water for irrigation, 6. increased or intensified stocking rates, 7. lack of grazing in marginal areas (villages abandonment), 8. lack of traditional scything in marginal areas (villages abandonment), 9. lack of traditional scything of wet meadows, 10. lack of grazing of wet meadows, 11. planting of exotic trees, 12. planting of exotic trees, 13. planting of commercial woodlands, 14. rural development measures to improve the infrastructure and social facilities; possible effects on vegetation type/land use: A - increase in area of vegetation type/ land use, B - conversion back to sedge/reedbed, leading to decrease in area of vegetation type/land use, C - lowering of stream level, D - loss of small orchards, decrease in area of vegetation type/land use, E - scrub encroachment, decrease in area of vegetation type/land use, F - increased grazing, decrease in diversity within vegetation type/land use and decrease in area of vegetation type/land use, G - cutting the forest and decrease in area of vegetation type/land use, H - loss of boundary features including tall forb habitats, decrease in area of vegetation type/land use, I - lowering of water table leading to territorialisation of wet vegetation types and decrease in area of vegetation type/land use, J - drainage leading to territorialisation of wet vegetation types and decrease in area of vegetation type/land use, K - loss of diversity within vegetation type, L - pollution from chemicals leading to loss of diversity within vegetation type/land use.

Reports on the accession of Romania state that removing constraints stopping people from leaving agriculture as employment is a major issue, as the current employment situation is not efficient enough to be competitive and there is a real "low risk/low return" cycle which needs to be broken (Scrieciu, 2004). Reports also state Romania will only be able to benefit from inclusion in the free market once levels of production have increased, the export market has been reformed, farm holdings have enlarged, and the levels of fragmentation of fields and land ownership has decreased (EC, 2004; Fuchs, 2002; Scrieciu, 2004; OECD, 2000).

Currently most farmers do not use chemicals due to their cost, not because they do not want to, as stated by one woman in Malâncrav: "*I use a little herbicide and pesticide but they are very expensive; I would use more if they were cheaper*". It would be unreasonable to expect farmers not to use nitrogen fertiliser on some areas, since the financial gain can be huge as productivity can rise from 2.5 tonnes per ha to 15 tonnes per ha (Younger, 2004). The increased use of nitrogen fertilisers may adversely affect many biologically diverse grassland habitats and may also affect wetland habitats as run-off (Tab. 2). Dry grassland and fen are vulnerable to increases in nitrogen fertiliser. Studies have shown that even if nitrogen fertiliser is used in a low quantity on grasslands it can decrease plant diversity by changing the soil system from one with many mycorrhizal associations to one dominated by bacteria (Smith, 2004).

As the market becomes more competitive some farmers may begin to specialise in crops not suited to the climate (Silcock et al., 2003). This can lead to further increases in chemical use, and in some cases irrigation, which can affect wetland habitats and streams (Tab. 2). In addition many wetland habitats may be lost through drainage as arable land is extended onto previous wetland habitats (Jones, 2000) (Tab. 2).

Intensification of farming may also take the form of increases in stocking rates or increases in areas of permanent pasture. Some farmers will choose to specialise in the more intensive production of livestock for economic reasons (Scrieciu, 2004), this can lead to widespread or localised overgrazing. Overgrazing can damage many habitats including dry grassland, mesic grassland, scrub and tall forb habitats (Tab. 2). In contradiction, one of the greatest threats to marginal areas is the abandonment of agricultural land that is no longer able to generate an income, leading to the cessation of grazing, or of other labour intensive forms of management (MacDonald et al., 2000). Across the whole of Europe the shepherding of livestock is rapidly becoming a socially unacceptable job due to the long and unsocial hours and poor returns, it is seen as being more economically viable to fence livestock into more productive permanent pastures, or in some cases to cease farming them as the market is flooded with cheaper imports (Poschlod and WallsDeVries, 2002).

Most farmers in Malâncrav only own a few animals, which are grazed communally during the day and return to the farm holding at night. Some may choose to stop farming them, as the laws of the '*aquis communautaire*', which is the legal document governing the EU are much stricter for livestock than previously. All animals will need registering and tagging, and the transport, welfare and feeding regulations are stringent (CEC, 2005).

All dairies, cheese-making facilities and abattoirs have to be approved by the date of accession, and as food safety standards are extremely high in the EU many will close if they cannot comply (Monros, 2005). In Malâncrav it is likely that all small producers are not yet at a high enough standard to sell their produce on the EU market, this is a major problem for successful rural development and could lead to many small farmers and producers choosing to discontinue this viable line of rural business.

The combined reasons for reducing livestock farming in marginal areas could lead to the loss of habitats and associated wildlife reliant on the complex ecological relationship that has evolved with pastoralism (Huband, 2003), including dry, mesic and wet grassland (Tab. 2). The same habitats could be lost through the discontinuation of traditional but labour-intensive scything (Tab. 2), especially on steep-sided valleys where any other form of management is impossible.

As other forms of employment become available the first workers to leave agriculture will be employed for hard but low-paid tasks such as scything. If the land owners are unable to pay them the wage they expect, then the management technique becomes economically unviable and ceases. Wet grassland and dry grassland, which is found almost exclusively on the steep sided valley slopes, are both created and maintained by the low intensity farming methods (Jones, 2000), and are at a high risk of being lost if traditional low intensity farming methods cease.

The actual likelihood of any one parcel of land changing in any way is dependent on many factors, including its sensitivity to change, its resilience and adaptive capacity, and what land use or vegetation type is surrounding the area and its management (Topp and Mitchell, 2003; Berry et al., 2006). The following map (Fig. 5) is an attempt to predict some of the changes in Tab. 2, taking into account the vulnerability of each land use/habitat, and the factors discussed.

The continuation of economically viable farming is crucial

When biodiversity-rich habitats created by low intensity farming are maintained as part of a living and economically viable landscape they are part of a sustainable system, but when the activities that maintain the habitats cease as they are no longer economically viable, the system is no longer sustainable. Any alternatives for managing biodiversity-rich habitats simply for their persistence in the landscape are disconnected from a way of life and cannot persist in the long run, especially seen as they have been created by farmers who have an understanding of the land and a great deal of traditional knowledge, meaning these dynamic systems are almost impossible to reproduce. Alternatives are also extremely expensive to maintain if they are not generating an income (MacDonald et al., 2000; Poschlod and WallisDeVries, 2002).

For these reasons it is important that any funding to maintain the rich biodiversity of the area concentrates on supporting the continuation of farming and does not seek to impose any western ideals of biodiversity management, as some farmers will see this as a threat to their way of life and their values placed on the land that is shaped by agricultural labour (Schwartz, 2006). Visitors who wish to conserve the area must take into account that the landscape has been created and conserved through hard labour and that the rich biodiversity is actually a by-product of this. So preservation of this landscape and its biodiversity can only be achieved if it brings long term economic benefits to the community (ADEPT, 2006).

Preservation of the current landscape

The current challenge in this area is to mitigate, or avoid, the negative effects that the current economic situation and the accession of Romania into the EU may have on the current High Nature Value land uses and vegetation types as seen in the figure 5 (Jones, 2000).

This challenge is being approached in different ways by NGOs and government bodies. The main government funding that will benefit Malâncrav is the rural development funds, which will account for 40% of the total agricultural funds available in Romania. The funding is broken down into four main areas. The first is improving the competitiveness of farming and forestry, which includes support to semi-subsistence farmers in order to become competitive, support for food quality schemes and developments to infrastructure which will improve the competitiveness of farming. The second is improving the environment and countryside, which includes payments to farmers in less favoured areas, Natura 2000 payments and agri-environment schemes. The third is improving quality of life and diversification, which includes diversifying to non agricultural activities, support for tourism and village renewal. The final area of funding is the LEADER element, which funds development projects initiated by the local communities (WWF, 2006). These payments should help to remedy some of the problems such as the poor infrastructure and lack of access to market which are currently causing people to leave the village. Malâncrav, and the commune of Laslea, are in the Târnava Mare Local Action Group and so are in line for LEADER funding.

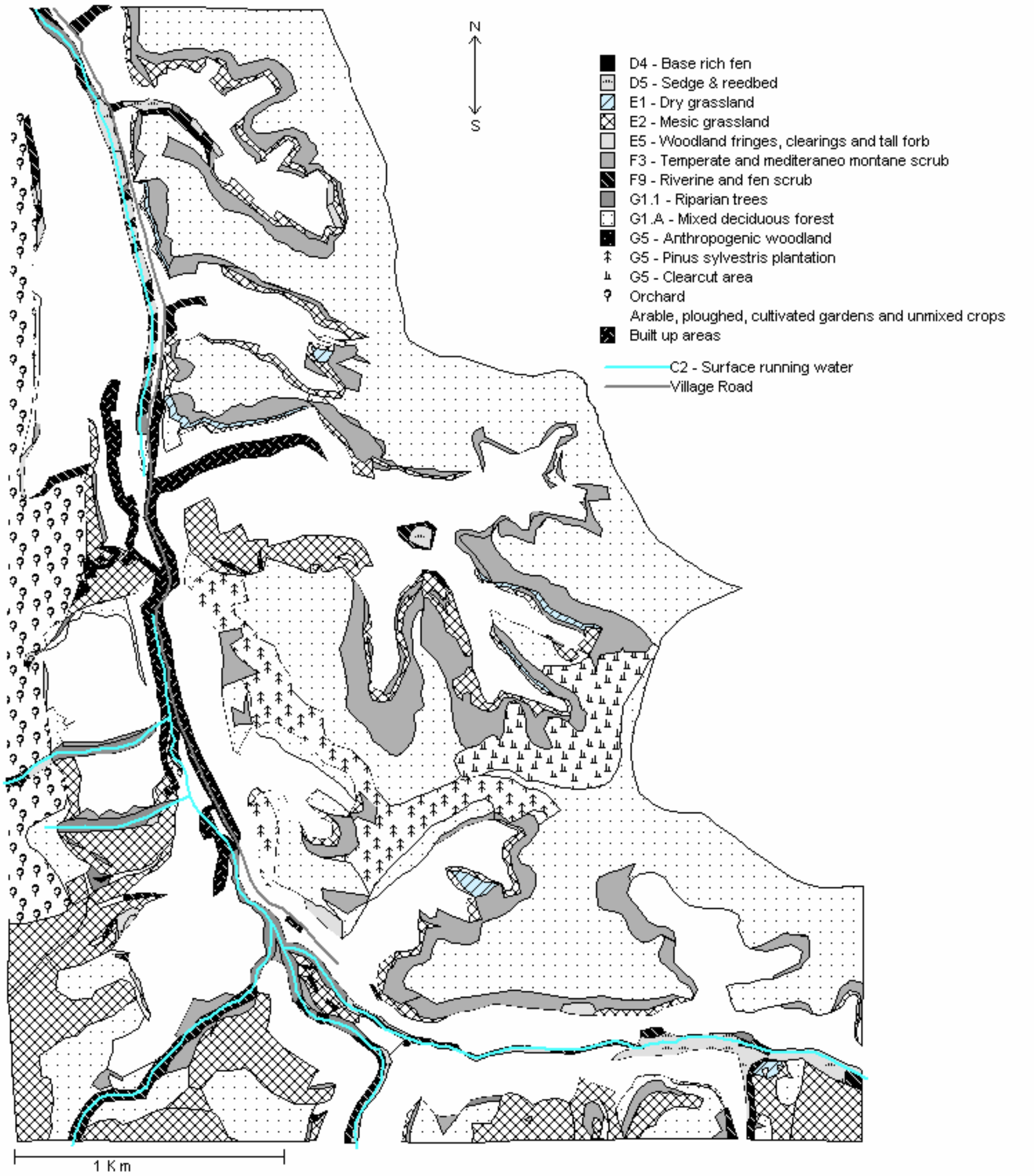


Figure 5: Land use and vegetation map of Malâncrav area, showing future changes that could occur to the local land uses and vegetation based on table 2 and the discussion above, '*impacts of change on land use and vegetation type,.*The landscape as compared to the current vegetation map (Fig. 1) is much more homogeneous, especially within the local arable area.

More targeted schemes, such as agri-environment payments, are then needed in order to effectively conserve the current habitats, or intensification of productive land and abandonment of marginal land will occur throughout the study area (MacDonald et al., 2000). At the time of the survey, CAP policies had not been sufficiently publicised to farmers: many participants in the questionnaire, when they were asked how accession into the EU would affect them, answered that they did not know how they would be affected. This may be an obstacle to successful uptake of any environmental payments, as studies have shown that when farmers are faced with these policies for the first time they are less likely to respond well (MacDonald et al., 2000). However, more recently progress has been made in making voluntary agri-environment measures better publicised and more accessible (N. Page, pers. comm.).

There are concerns that the CAP message is contradictory to farmers in new accession countries, as it is concurrently funding increased production and therefore intensification, and preservation of the current high biodiversity environment (MacDonald et al. 2000).

A pilot agri-environment scheme was applied to the area through the EU-funded SAPARD programme (Special Programme of Pre-Accession for Agriculture and Rural Development), set up to facilitate the accession of Romania's agricultural sector into the EU. Its priorities were to improve access to markets and competitiveness of agriculture, improve infrastructure, and develop rural economy and human resources. The pilot agri-environment scheme, under SAPARD measure 3.3, allowed landowners to register grassland for additional management controls (e.g. no artificial fertiliser, mowing compulsory but only after 1 June, stocking rates between minimum and maximum limits), and to receive €95 per ha for all registered land managed in line with the compliance measures (Nat Page, pers. comm.). This optional scheme has been promoted by a locally based NGO, ADEPT Foundation (Agricultural Development and Environmental Protection in Transylvania). In 2007, 170 farmers in the Saxon Villages area, managing a total area of 1800 ha of grassland, successfully applied for grants from SAPARD measure 3.3.

CONCLUSIONS

Due to the many factors driving changes to the Saxon villages region, the likelihood of the area retaining current patterns of land use and vegetation types is minimal. The measures designed to mitigate change that will apply to the area, including work being done by the government and NGOs, should prevent any major damage but, some change to the landscape may be necessary to achieve economic regeneration. The opportunities for regeneration arising from EU accession may be either beneficial or damaging to the environment depending on the projects funded (Baldock, 1998), but this should be seen as a real opportunity to develop the region in a sustainable manner and increase efficiency using modern integrated farming practices (Jones, 2000), rather than a move towards more intensive production.

Effective policies need to be flexible, have close links with science, and be open to reform if they are not working (Vickery et al., 2004). They also need to be directed and specific to certain areas, as some policies that, for example, are designed for lowland areas may not apply to mountainous areas (Goss, 1998). In the UK, Defra has a vision for a new CAP which will see agriculture as having a multifunctional role. This will only reward the farmers financially using government funds for producing societal benefits that the market cannot provide such as clean air, water, and environmental, biodiversity and heritage protection. It aims to eventually stop all direct payments including the single farm payment which encourage intensification and distort the market, giving unfair trade advantages to rich Western countries (MacDonald et al., 2000). Hopefully these policies will be introduced in the next 15 years, helping to prevent adverse environmental affects caused by changes to farming practices in many Eastern European countries including Romania.

The main conclusion reached from this study is that as the current landscape has been created and maintained by farming, the focus must remain on encouraging through effective policies and rural development, the continuation of traditional farming as a viable lifestyle.

An important future study would be to define the ecological limits of tolerance for vulnerable habitats, meaning that agricultural practices needing to be maintained could be determined, preventing adverse changes from occurring (Huband 2003). A useful way to look at change indicating intensification would be to assess any increases in levels of homogeneity (MacDonald et al., 2000), although the limitations caused by the problems of repeatability of vegetation studies would have to be taken into account.

ACKNOWLEDGEMENTS

This work was carried out as part of an undergraduate degree at Anglia Ruskin University, Cambridge, UK. Thanks goes to Franc Hughes from the Life Sciences Department, who supervised the project, and to Georges Droogman, Nick McWilliams and Steve Godby from the Geography Department who all gave assistance with GIS. Thanks also goes to Owen Mountford, Tibor Hartel, Cosmin Moga, Jenny Cowell, the Mihai Eminescu Trust, especially Luminița Holban and the office staff in Sighişoara, Doina Pieper and all at the Dracula Hotel in Daneş, John Akeroyd, Nat Page and Jim Turnbull (ADEPT Foundation), and Erica Stanciu (WWF Danube-Carpathian Programme).

REFERENCES

1. ADEPT (Agricultural Development and Environmental Protection in Transylvania) 2005 − The Saxon Villages: why is this landscape so important? http://www.adeptfoundation.org/index.html
2. ADEPT (Agricultural Development and Environmental Protection in Transylvania) 2006 − News and related activities: Darwin Initiative. www.adeptfoundation.org/index.html
3. Akeroyd, J. 2006 − *The historic countryside of the Saxon Villages of southern Transylvania.* Fundația ADEPT, Saschiz, Romania.
4. Akeroyd, J. R. and Page, N. 2006 − The Saxon Villages of southern Transylvania: conserving biodiversity in a historic landscape. In Gafta, D. and Akeroyd, J.[R.], eds (2006) *Nature Conservation: Concepts and Practice*, pp. 199–210. Springer Verlag, Heidelburg, Germany.
5. Aspinall, R. 1993 − Use of geographic information systems for interpreting land-use policy and modelling effects of land-use change. In Haines-Young, R., Green, D. R., Cousins, S. H. (eds) *Landscape Ecology and GIS.* Taylor and Francis.
6. Baldock, D. 1998 − Rural development and nature conservation with special attention to LFAs. In *Report on the Agenda 2000 and Prospects for the Environment Seminar.* EFNCP Occasional Publication No. 16.
7. Berry, P.M, Rounsevell, M.D.A., Harrison, P.A. and Audsley, E. 2006 − Assessing the vulnerability of agricultural land use and species to climate change and the role of policy in facilitating adaptation: *Environmental Science and Policy*, 9: 189-204.
8. Bignal, E. 1998 − The importance of livestock farming for nature – the ecology of pastoralism. In *Report on the Agenda 2000 and Prospects for the Environment Seminar.* EFNCP Occasional Publication Number 16.
9. Bouma, J., Varallyay, G. and Batjes, N.H. 1998 − Principal land use changes anticipated in Europe. *Agriculture, Ecosystems and Environment*, 67: 103-119.
10. Buffaria, B., Gomez, R.S. and Willems, E. 1998 − European Commission Directorate General for Agriculture, Working document. Agricultural Situation and Prospects in the Central European Countries: Romania.
11. Cherrill, A. and McClean, C. 1999 − The reliability of `Phase 1' habitat mapping in the UK: the extent and types of observer bias. *Landscape and Urban Planning*, 45: 131-143.

12. Commission of the European Communities (CEC) 2005 − Comprehensive monitoring report on the state of preparedness for EU membership of Bulgaria and Romania. CEC, Brussels.
13. Dale, V.H., Brown, S., Haeuber, R.A., Hobbs, N.T., Huntly, N.J., Naiman, R.J., Riebsame, W.E., Turner, M.G. and Valone, T.J. 2000 − Ecological Principles and Guidelines for Managing the Use of Land. *Ecological Applications*,10 (3).
14. Dalton, G., Slee, B. and Thomson, K.J. 2003 − Rural Development and Pre-Accession Strategy for Romanian Agriculture. In Davidova, S. and Thomson, K.J.(eds). *Romanian Agriculture and Transition towards the European Union.* Lexington Books.
15. Donald, P.F., Green, R.E. and Heath, M.F. 2001 − Agricultural intensification and the collapse of Europe's farmland bird populations. *Proceedings of the Royal Society: Sciences*, 268: 25-29.
16. Donald, P.F., Pisano, G., Rayment, M.D. and Pain, D.J. 2002 − Review: The Common Agricultural Policy, EU enlargement and the conservation of Europe's farmland birds. *Agriculture, Ecosystems and Environment*, 89: 167-182.
17. Dragos, A. 2001 − *Environment Preservation in Romanian Rural Development Context.* Institute of Agricultural Economics - Romania Academy, Bucharest.
18. EEA (European Environment Agency) 2005 − *EUNIS data* http://eunis.eea.eu.int/about.jsp
19. Fuchs, C. 2002 − Agricultural Situation in the Candidate Countries: Country Report on Romania. European Commission Directorate-General for Agriculture.
20. Gibon, A. 2000 − Agricultural abandonment in mountain areas of Europe: Environmental consequences and policy response. *Journal of Environmental Management*, 59: 47-69.
21. Goss, S. 1998 − *Policy options for livestock systems – area payments.* In *Report on the Agenda 2000 and Prospects for the Environment Seminar.* EFNCP Occasional Publication No. 16.
22. Goverde, M., Schweizer, K., Baur, B. and Erhardt, A. 2002 − Small-scale habitat fragmentation effects on pollinator behaviour: experimental evidence from the bumblebee *Bombus veteranus* on calcareous grasslands. *Biological Conservation*, 104: 293-299.
23. Heli, R. 2003 − *Transylvania Saxons.* http://www.genealogienetz.de/reg/ESE/7burg.html
24. Hladnik, D. 2005 − Spatial structure of disturbed landscapes in Slovenia. *Ecological Engineering*, 24, 17-27.
25. Howe, L., Blackstock, T., Burrows, C. and Stevens, J. 2005 − The Habitat Survey of Wales. *British Wildlife*, 16: 153-162.
26. Huband, S. 2003 − Gaps in understanding of European pastoralism. PASTORAL Project Information Note 7. European Integration.
27. Jones, T. 2000 − *Implementing the EU Water Framework Directive: A Seminar Series on Water. Synthesis Note from Seminar 1: Water and Agriculture*. WWF European Freshwater Programme and the European Commission.
28. Kieser, A. 1638 − Forstkartenwork. Herzogtum Württemberg. In Poschlod, P. and WallisDeVries, M.F. (2002). The historical and socio-economic perspective of calcareous grasslands - lessons from the distant and recent past *Biological Conservation*, 104: 361–376.
29. MET 2002 − The Mihai Eminescu Trust http://www.mihaieminescutrust.org.
30. MET (Mihai Eminescu Trust) 2004a − Project Information Sheet on Laslea and Bunesti Natural Parks: Pilot Project. MET Administration.
31. MET (Mihai Eminescu Trust) 2004b − A programme for the integrated development of Sighişoara and the Saxon Villages of Transylvania. MET Administration.
32. Monros, C. 2005 − EU–25 Agricultural Situation. Bulgaria and Romania Accession Agreements. USDA Foreign Agricultural Service GAIN (Global Agriculture Information Network) Report No. E35110.
33. Mountford, J. O. and Akeroyd, J.R. 2005 − A biodiversity assessment of the Saxon villages region of Transylvania. *Transylvanian Review of Systematical and Ecological Research*, 2: 31-42.
34. OECD (Organisation for Economic Co-operation and Development) 2000 − Review of Agricultural Policies: Romania. OECD Centre for co-operation with non-members.

35. Pierce, J. 1992 − The policy agenda for sustainable agriculture. In Bowler, I.R., Bryant, C.R. and Nellis, M.D. (eds). *Contemporary rural transitions in transition. Volume 1: Agriculture and Environment.* C.A.B. International.
36. Poschlod, P. and WallisDeVries, M.F. 2002 − The historical and socio-economic perspective of calcareous grasslands - lessons from the distant and recent past. *Biological Conservation*,104: 361-376.
37. Sabates-Wheeler, R. 2002 − Farm Strategy, Self-Selection and Productivity: Can Small Farming Groups Offer Production Benefits to Farmers in Post-Socialist Romania? *World Development*, 30 (10): 1737-1753.
38. Schroeer, L. 2004 − EU–25 *Agricultural Situation: Agriculture talks end for Romania and Bulgaria.* USDA Foreign Agricultural Service GAIN (Global Agriculture Information Network) Report No. E34028.
39. Schwartz, K.Z.S. 2006 − ''Masters in Our Native Place'': The politics of Latvian national parks on the road from Communism to ''Europe''. *Political Geography*, 25: 42-71.
40. Scrieciu, S.S. 2004 − *Assessing the Economic Impacts of Incorporating Romania's Agricultural and Food Sectors into EU's Customs Union: an Applied General Equilibrium Approach.* Institute for Development Policy and Management, University of Manchester.
41. Sickel, H., Ihse, M., Norderhaug, A. and Sickel, M. A. K. 2004 − How to monitor semi-natural key habitats in relation to grazing preferences of cattle in mountain summer farming areas: An aerial photo and GPS method study. *Landscape and Urban Planning*, 67: 67-77.
42. Silcock, P., Swales, V. and Manley, W. 2003 − *The Potential Environmental Impacts of the CAP Reform Agreement. Final Report for Department for Environment, Food and Rural Affairs.* GFA-RACE Partners Ltd.
43. Smith, R. 2004 − *Meadow management in the Pennine Dales.* Grassland management for nature conservation course, Losehill Hall, Peak District National Park Authority.
44. Stevens, J.P., Blackstock, T.H., Howe, E.A. and Stevens, D.P. 2004 − Repeatability of Phase 1 habitat survey. *Journal of Environmental Management*, 73: 53-59.
45. Stoate, C., Boatman, N.D., Borralho, R.J., RioCarvalho, C., de Snoo, G.R. and Eden, P. 2001 − Ecological impacts of arable intensification in Europe. *Journal of Environmental Management*, 63: 337-365.
46. Strossman, C. 2004 − *EU–25 Agricultural Situation: Enlargement of the Common Agricultural Policy.* USDA Foreign Agricultural Service GAIN (Global Agriculture Information Network) Report No. E34004.
47. Toma, L. 2003 − *Analysis of Environmental Impacts of Farming Systems in Romania. Agri-Environmental Indicators.* Policy Group – Department of Agriculture and Environmental Economics, K. U. Leuven and Agricultural Economics Institute - Romanian Academy.
48. Topp, C.F.E. and Mitchell, M. 2003 − Forecasting the environmental and socio-economic consequences of changes in Common Agricultural Policy. *Agricultural Systems*, 76: 227-252.
49. Vickery, J.A., Bradbury, R.B., Henderson, I.G., Eaton, M.A., Grice, P.V. 2004 − The role of agri-environment schemes and farm management practices in reversing the decline of farmland birds in England. *Biological Conservation*, 119: 19-36.
50. Younger, A. 2004 − *The agricultural management of grassland.* Grassland management for nature conservation course, Losehill Hall, Peak District National Park Authority.
51. Wellens, J., Millington, A. C., Hickin, W., Arquepino, R., Jones, S. 2000 − Mapping Humid Tropical Vegetation in Eastern Bolivia. In Alexander, R. and Millington, A. C. (eds). *Vegetation Mapping.* John Wiley and Sons Ltd.
52. Wilkie, K. 2001 − *The Saxon Villages of Transylvania, Romania: A Future for the Medieval Landscape.* Report prepared for HRH The Prince of Wales and The Mihai Eminescu Trust by Kim Wilkie Associates.

The series of this publication include in the **present**:

Transylvanian Review of Systematical and Ecological Research 1 - "The Upper and Middle Olt River Basin" (1999);

Transylvanian Review of Systematical and Ecological Research 2 - "The Târnava River Basin" (2005);

Transylvanian Review of Systematical and Ecological Research 3 - "The Retezat National Park" (2006);

Transylvanian Review of Systematical and Ecological Research 4 - "The Saxon Villages Region of southeast Transylvania" (2007);

The series of this publication will **continue** with the following volumes:

Transylvanian Review of Systematical and Ecological Research - "The Maramureşului Mountains Nature Park";

Transylvanian Review of Systematical and Ecological Research - "The Arieş River Basin";

Transylvanian Review of Systematical and Ecological Research - "The Upper and Middle Mureş River Basin";

Transylvanian Review of Systematical and Ecological Research - "Wetlands Diversity";

The **abstracts** of this publication, included in the ISI - THOMSON REUTERS data base (http://scientific.thomsonreuters.com/support/products/zr/zr-serials/t/) can be find at http://stiinte.ulbsibiu.ro/trser/

The Editors