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PALEONTOLOGY

SHORT COMMUNICATIONS

CONTRIBUTIONS TO THE STUDY OF HETEROCERA (LEPIDOPTERA) FROM MEDIAŞ AND SURROUNDINGS (SIBIU COUNTY)

Sergiu-Cornel TÖRÖK*

Abstract. *222 Heterocera (Lepidoptera) species were recorded from the surroundings of Mediaş locality, a writable white spot in the Romanian lepidopterological picture. This paper also offers an ecological and zoogeographical description of the Lepidoptera from this area. In addition, it points out the endangered species, with the use of Romanian Red List study.* From the species present in this area the most remarkable are: *Phragmatobia luctifera (Denis & Schiffermüller, 1775), Dichagyris signifera (Denis & Schiffermüller, 1775), Thyris fenestrella (Scopoli, 1763), Proserpinus proserpina (Pallas, 1772); Acherontia atropos (Linnaeus, 1758); Hyles gallii (Rottemburg 1775), Eucarta virgo (Treitschke, 1835) and Eucarta amethystina (Hubner, 1803).*
Keywords*: Macrolepidoptera, Heterocera, Mediaş, Curciu, Bazna, faunistics, ecology, zoogeography*

Rezumat. *222 specii aparţinând subordinului Heterocera (Lepidoptera) au fost identificate din zona localităţii Mediaş, această zonă reprezentând o veritabilă "pată albă" în tabloul lepidopterologic românesc. Lepidopterofauna acestei zone este caracterizată din punct de vedere zoogeografic şi ecologic. Speciile periclitate sunt scoase în evidenţă prin analiza speciilor cuprinse în Lista Roşie a României. Astfel, printre speciile remarcabile prezente în această zonă se numără: Phragmatobia luctifera (Denis & Schiffermüller, 1775), Dichagyris signifera (Denis & Schiffermüller, 1775), Thyris fenestrella (Scopoli, 1763), Proserpinus proserpina (Pallas, 1772), Acherontia atropos (Linnaeus, 1758), Hyles gallii (Rottemburg 1775), Eucarta virgo (Treitschke, 1835) şi Eucarta amethystina (Hubner, 1803).*
Cuvinte cheie*: Macrolepidoptera, Heterocera, Mediaş, Curciu, Bazna, faunistică, ecologie, zoogeografie*

Introduction

Mediaş and his surrounding villages are located in the middle basin of Târnava Mare River, in the southern part of Târnavelor Plain. This region is characterized by average height hills (250 m – 500 m) divided by wide valleys with well-developed terraces (Sorocovschi 1992).

The soils of The Târnavelor Plain are very diverse, varying from brown forest soils to alluvial clay soils found on the riverbanks (Badea *et al.* 1981).

The climate of this region is temperate-continental with an average annual temperature spreading from 8.4°C at Dumbrăveni weather station (at 318 m altitude) to 9.2°C at Blaj weather station (at 334 m altitude) and an average amount of precipitations of 600 – 700 mm (Sorocovschi 1992).

The vegetation presents a great diversity of habitats. In the valley we encounter alder and willow associations, as well as hygrophilous grasslands. Going up, well-developed terraces are covered by mesohygrophilous and mesophilous grasslands. In a small proportion secondary steppe-like lawns are spread. At the tops of the hills, oak and beech forests and shrub associations as *Pruno spinosae-Crataegetum* Hueck, 1931 (Badea *et al.* 1981) are spread.

The first documented collection of Lepidoptera made in present day Mediaş was a series of Lepidoptera specimens collected by Daniel Czekelius, who at the end of the 19th century, in The First Catalogue of the Transylvanian Lepidoptera, cited two endangered species, *Daphnis nerii* (Linnaeus, 1758) and *Orgyia recens* (Hübner, 1819) (Czekelius 1897). He also made in 1912, 1913, 1917 and 1921 several trips to Bazna, citing from here, 11 species of Lepidoptera (Burnaz 1993).

After Czekelius, Ostrogovich outtlook a field trip in 1921 also at Bazna, and cited the presence of 19 species of Lepidoptera species (Popescu-Gorj 1964).

The most recent data is reported by Rákosy who sampled from Târnava Mare Valley, including Mediaş and Bane. Among the rare species from

* Babeş-Bolyai University of Cluj-Napoca, Romania, ser.torok@yahoo.com

this region, he mentioned: *Nola cristatula* (Hübner, 1793), *Yigoga signifera* (Denis & Schiffermüller, 1775), *Athetis furvula* (Hübner, 1808), *Sideridis turbida* Esper, 1790 and many others (Rákosy 1996).

This study also contains information regarding the Lepidoptera from Mediaş and Moşna found in Eckbert Schneider Entomogical Collection, part of the Entomological Collection of the Natural History Museum from Sibiu.

Overall, this region's lepidopterofauna is insufficiently investigated; as a result, one of the aims of this study is to add supplementary data to the Lepidoptera fauna from Mediaş area. Another purpose is to characterize this region's moth fauna from the zoogeographical and the ecological point of view.

Material and methods

The study of Macroheterocera species was carried out during 2008-2011. We used an entomological net for some day-flying moths and 125 W light traps and 8V portable traps for the night-flying Lepidoptera. Additional sugar traps (early in the spring and late in the autumn) were used in order to attract moths that are not (well) attracted to light. Forest edges (Mediaş: Vewern, Greweln, Binderbubi, Izvorul Dorului), clearings, damp meadows (Târnava Mare riverbank), ruderal areas (Curciu, village) and mezophilous grasslands (Curciu, Cărări Hill), were the main studied habitats.

The identification of the lepidopterological material was made using several identification keys: Rákosy (1996), Koch (1958, 1961), Malicky *et al.* (2000) and Szèkely (2010). The systematic list was compiled according to the one present in The Catalogue of the Romanian Lepidoptera (Rákosy *et al.* 2003) and Karsholt and Nieukerken (2011). The zoogeographical and ecological character was written using Romanian faunistics studies (Burnaz 1995, Rákosy 1996, Cremene *et al.* 2003, Dincă 2006, Szèkely 2006, Burnaz, 2008, 2009, Szèkely 2010).

The red list was made following the one proposed by Rákosy *et al.* (2003) according to IUCN 2001, which point out the conservation status of Lepidoptera species at the country's level.

Results and discussions

As the result of the Macroheterocera investigation, a number of 222 species were found at Mediaş and its surroundings (Bazna, Curciu, Moşna). The checklist of the recorded Macrolepidoptera with their zoogeographical, ecological and red list status is given in table 1.

The family spectrum of species collected by the light traps is shown in figure 1. Noctuidae (88 species) and Geometridae (68 species) are represented with the highest numbers of species, but the species of Erebidae, and Sphingidae showed a significant proportion as well.

The other aspect of the high species diversity is the occurrence of several faunal types. Their composition showed that 82.59% of the collected species are Eurasiatic (185 species, from the total number of species), 9.38% West-Asiatic Mediterranean, 2.68% Holarctic, 2.23% Subtropical, Cosmopolit and 1.34% Ponto-Mediterranean (Fig. 2).

The dominance of Eurasiatic elements represents the consequence of the geographical position of the study site and of Romania in general. This can also explain the presence of 21 West-Asiatic Mediterranean species (9.38%) which is a relative small number in comparison with the proportion from the Danube Delta, 28% (Szèkely 2006). In fact Dobrogea contains the highest proportion of West-Asiatic Mediterranean and West-Asiatic elements in Romania (Rákosy, Szèkely 1996, Dincă 2006).

The majority of species prefer the mezophilous habitats (47%). Many species prefer the deciduous forest or deciduous forest scrub associations from Vewern, Greweln, Binderbubi and Izvorul Dorului, like: *Aglia tau* (Linnaeus, 1758), *Cyclophora annularia* (Fabricius, 1775), *Selenia lunularia* (Hübner, 1788), *Lithophane ornitopus* (Hufnagel, 1766), *Orthosia cerasi* (Fabricius, 1775), *Orgyia antiqua* (Linnaeus, 1758) or *Spatalia argentina* (Denis & Schiffermüller, 1775). Others species such as *Macrothylacia rubi* (Linnaeus, 1758), *Laothoe populi* (Linnaeus, 1758), *Archanara neurica* (Hübner, 1808), *Archanara dissoluta* (Treitschke, 1825), *Furcula bifida* (Brahm, 1787), *Clostera curtula* (Linnaeus, 1758), *Eucarta amethystina* (Hubner, 1803), *Eucarta virgo* (Treitschke, 1835) are characteristic for the mesohygrophilous or hygrophilous pastures

(13.56%), found on the Târnava Mare riverbanks (Fig. 3).

On the south facing slopes, such as Viile Pusti (Curciu), we can find a high number of xerothermophilous, thermophilous, meso - thermophilous or mezoxerophilous species; these species represent 22.43% from the total species identified.

In this region are also present 15 species of migratory Lepidoptera. From these the most notable is the presence of subtropical sphingids, *Acherontia atropos* (Linnaeus, 1758), *Hyles gallii* (Rottemburg, 1775), *Hyles euphorbiae* (Linnaeus, 1758) and *Daphnis nerii* L. This last species has not been seen in the region from more than 50 years, the last sighting was made by Rákosy and Weber in Sighişoara in 1966 (Rákosy, Weber 1986).

The study of the Romanian Red List reveals (Rákosy *et al.* 2003) a high number of protected species, 33 of them being endangered at some level (Fig. 4).

The most important aspect is represented by the presence of two endangered species: *Phragmatobia luctifera* (Denis & Schiffermüller, 1775) and *Dichagyris signifera* (Denis & Schiffermüller, 1775), both found at Bazna and six vulnerable species, they are *Thyris fenestrella* (Scopoli, 1763); *Proserpinus proserpina* (Pallas, 1772); *Acherontia atropos* (Linnaeus, 1758); *Hyles gallii* (Rottemburg 1775); *Eucarta virgo* (Treitschke, 1835) and *Eucarta amethystina* (Hubner, 1803).

24 near threatened species are as well present in this area (Table 1, Fig. 1).

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LIST OF ILLUSTRATIONS

LISTA ILUSTRAŢIILOR

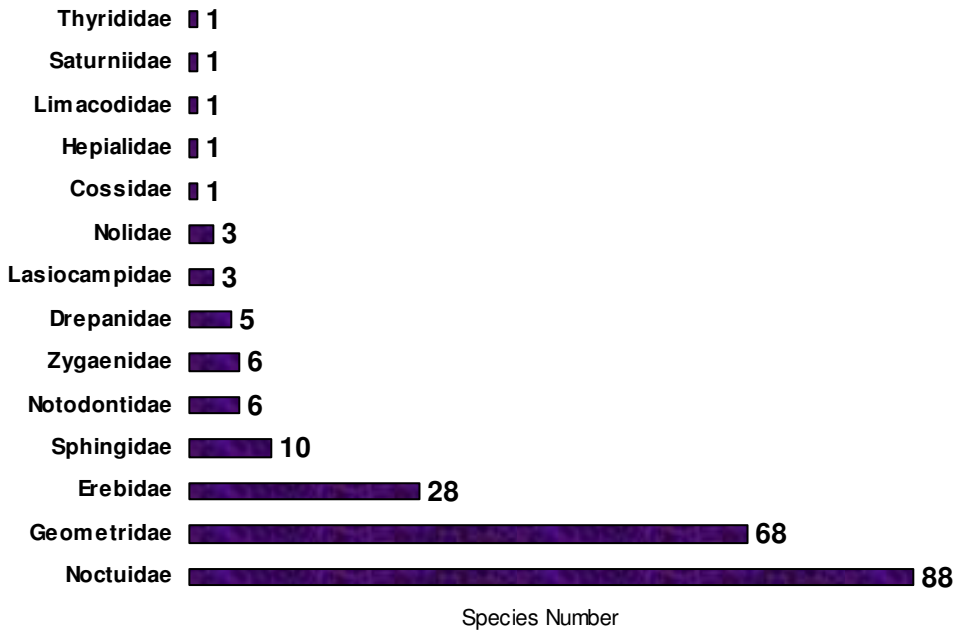

Fig. 1. The representation of the suborder Heterocera from Mediaş and surroundings

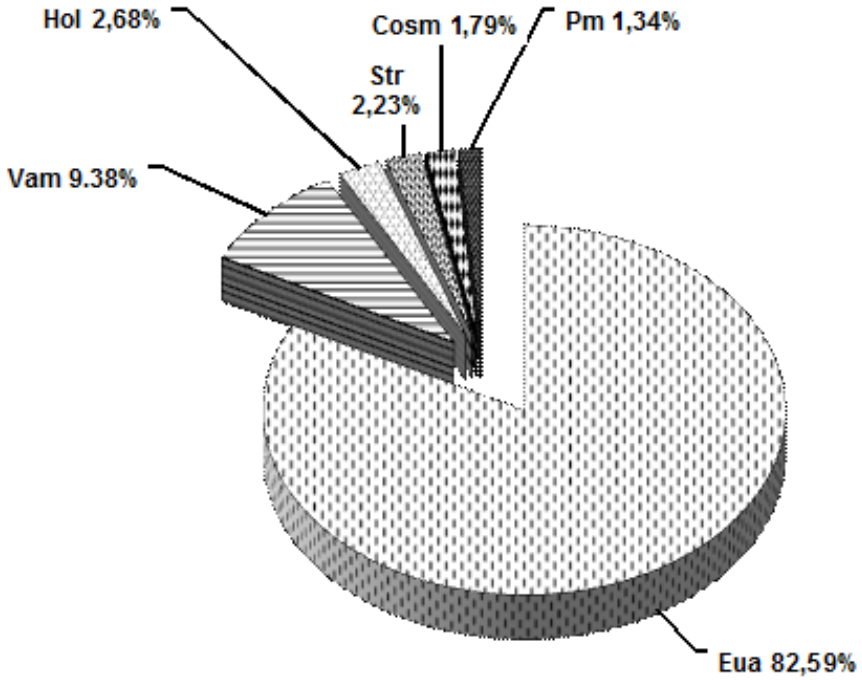

Fig. 2. Zoogeographical spectrum of the Lepidoptera species identified in Mediaş and surroundings

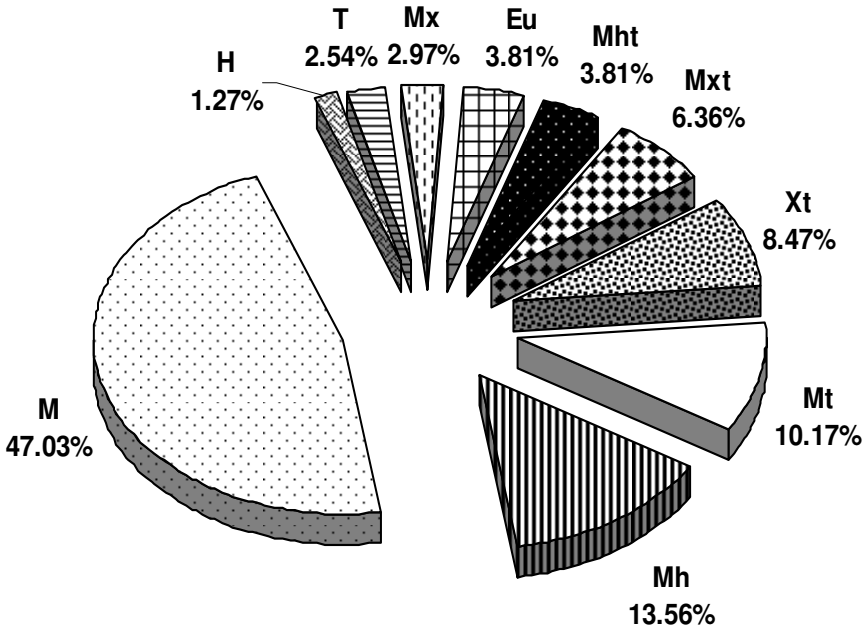

Fig. 3. Ecological spectrum of the Lepidoptera species identified in northern part of Sibiu County

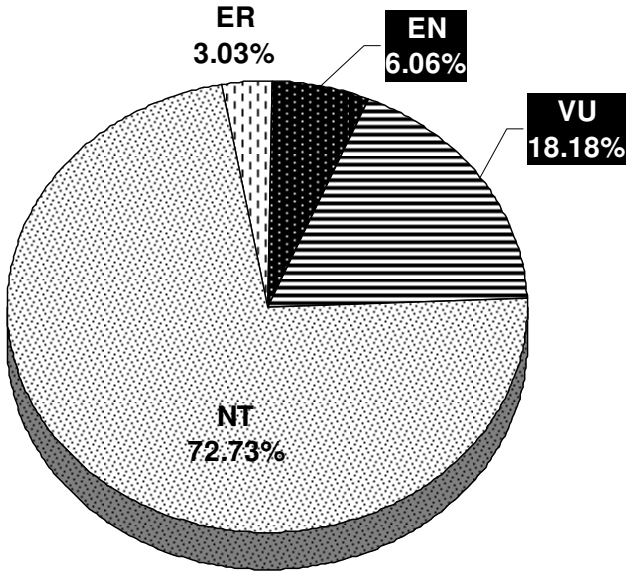

Fig. 4. The reprezentation of IUCN categories after Rákosy *et al.* (2003) for the Mediaş region

Table 1 – Systematic list of the Macrolepidoptera from Mediaş and surroundings (Sibiu County, Romania)

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
Superfamily Hepialoidea					
Family Hepialidae					
1	*Triodia sylvina* (Linnaeus, 1758)	Curciu (Viile Pusti),	Eua	M	
Superfamily Zygaenoidea					
Family Zygaenidae					
Subfamily Procridinae					
2	*Adscita statices* (Linnaeus, 1767)	Mediaş (Izvolul Dorului),	Eua	M	
Subfamily Zygaeninae					
3	*Zygaena carniolica* (Scopoli, 1763)	Mediaş (Izvolul Dorului, Târnava Mare bank), Curciu (Cărări Hill),	Eua	Mxt	
4	*Zygaena loti* (Denis & Schiffermüller, 1775)	Curciu (Cărări Hill),	Eua	M	
5	*Zygaena ephialtes* (Linnaeus, 1767)	Mediaş (Târnava Mare bank), Curciu (Cărări Hill),	Eua	Mxt	
6	*Zygaena purpuralis* (Brünnich, 1763)	Bazna (Burnaz, 1993),	Eua	Mxt	
7	*Zygaena filipendulae* (Linnaeus, 1758)	Bazna (Burnaz, 1993), Mediaş (Târnava Mare bank, Izvolul Dorului), Curciu (Cărări Hill),	Eua	M	
Family Limacodidae					
Subfamily Limacodinae					
8	*Apoda limacodes* (Hufnagel, 1766)	Mediaş (Binderbubi),	Eua	M	
Superfamily Cossoidea					
Family Cossidae					
Subfamily Zeuzerinae					
9	*Zeuzera pyrina* (Linnaeus, 1761)	Curciu (Cărări Hill, village),	Eua	Mh	
Superfamily Thyridoidea					
Family Thyrididae					
Subfamily Thyridinae					
10	*Thyris fenestrella* (Scopoli, 1763)	Mediaş (Târnava Mare bank),	Eua	Mt	**VU**
Superfamily Bombycoidea					
Family Lasiocampidae					
Subfamily Lasiocampinae					
11	*Macrothylacia rubi* (Linnaeus, 1758)	Bazna (Burnaz, 1993), Mediaş (Târnava Mare bank),	Eua	M; Mh	**NT**
12	*Lasiocampa quercus* (Linnaeus, 1758)	Curciu (Cărări Hill),	Eua	M	
Subfamily Pinarinae					
13	*Gastropacha quercifolia* (Linnaeus, 1758)	Curciu (village),	Eua	M	**NT**
Family Saturniidae					
Subfamily Agliinae					
14	*Aglia tau* (Linnaeus, 1758)	Mediaş (Binderbubi),	Eua	M	
Superfamily Sphingoidea					
Family Sphingidae					

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
Subfamily Smerinthinae					
15	*Laothoe populi* (Linnaeus, 1758)	Curciu (village),	Eua	Mh	
Subfamily Sphinginae					
16	*Agrius convolvuli* (Linnaeus, 1758)	Mediaş (Binderbubi), Curciu (village, Cărări Hill),	Str	Mg, Mx	
17	*Acherontia atropos* (Linnaeus, 1758)	Curciu (potato plantation, village),	Str	Mg, Mx	**VU**
Subfamily Macroglosiinae					
18	*Macroglossum stellatarum* (Linnaeus, 1758)	Mediaş (town, Izvorul Dorului, Târnava Mare bank), Curciu (village),	Eua	Mx, Mg	
19	*Daphnis nerii* (Linnaeus, 1758)	Mediaş (Czekelius, 1897),	Str	Mg	**ER**
20	*Proserpinus proserpina* (Pallas, 1772)	Curciu (garden),	Vam	Xt	**VU**
21	*Hyles gallii* (Rottemburg 1775)	Curciu (village),	Hol	Mxt, Mg	**VU**
22	*Hyles euphorbiae* (Linnaeus, 1758)	Curciu (village),	Eua	Mx, Mg	**NT**
23	*Deilephila elpenor* (Linnaeus, 1758)	Curciu (village),	Eua	Mh	**NT**
24	*Deilephila porcellus* (Linnaeus, 1758)	Mediaş (Târnava Mare bank), Curciu (Cărări Hill, village),	Eua	M	
Superfamily Drepanoidea					
Family Drepanidae					
Subfamily Thyatirinae					
25	*Thyatira batis* (Linnaeus, 1758)	Curciu (village), Mediaş (Târnava Mare bank, Binderbubi),	Eua	Mh	
26	*Habrosyne pyritoides* (Hufnagel, 1766)	Mediaş (Târnava Mare bank, Binderbubi), Curciu (Cărări Hill),	Eua	M, Mh	
27	*Tethea or* (Denis & Schiffermüller, 1775)	Curciu (village), Mediaş (Greweln),	Eua	Mh	**NT**
Subfamily Drepaninae					
28	*Cilix glaucata* (Scopoli, 1763)	Mediaş (Greweln, Târnava Mare bank), Curciu (village, Cărări Hill, Viile Pusti),	Eua	Xt	
29	*Sabra harpagula* (Esper, 1786)	Mediaş (Târnava Mare bank),	Eua	Mht	**NT**
Superfamily Noctuoidea					
Family Notodontidae					
Subfamily Notodontinae					
30	*Furcula bifida* (Brahm, 1787)	Curciu (village),	Vam	Mh	
31	*Ptilodon cucullina* (Denis & Schiffermüller, 1775)	Mediaş (Binderbubi),	Eua	Mh	
32	*Clostera pigra* (Hufnagel, 1766)	Curciu (village),	Eua	Mh	
33	*Clostera curtula* (Linnaeus, 1758)	Curciu (Cărări Hill),	Eua	Mh	
Subfamily Phalerinae					
34	*Phalera bucephala* (Linnaeus, 1758)	Curciu (village),	Eua	M	
Subfamily Heterocampinae					

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
35	*Spatalia argentina* (Denis & Schiffermüller, 1775)	Curciu (village),	Eua	Mt	
Family Erebidae					
Subfamily Lymantriinae					
36	*Calliteara pudibunda* (Linnaeus 1758)	Curciu (village),	Eua	M	
37	*Orgyia antiqua* (Linnaeus, 1758)	Mediaş (Greweln),	Hol	M	
38	*Euproctis chrysorrhoea* (Linnaeus, 1758)	Curciu (village),	Eua	M	
39	*Penthophera morio* (Linnaeus, 1758)	Curciu (Cărări Hill), Mediaş (Izvorul Dorului),	Eua (Pm)	M	**NT**
Subfamily Arctiinae					
40	*Miltochrista miniata* (Forster, 1771)	Curciu (village), Mediaş (Binderbubi, Târnava Mare bank),	Eua	M	
41	*Atolmis rubricollis* (Linnaeus, 1758)	Bazna (Burnaz, 1993),	Eua	M	
42	*Lithosia quadra* (Linnaeus, 1758)	Curciu (Cărări Hill, village), Mediaş (Târnava Mare bank),	Eua	M	
43	*Eilema sororcula* (Hübner, 1808)	Curciu (village), Mediaş (Greweln),	Eua	Mh	
44	*Eilema pygmaeola (Doubleday, 1847)*	Curciu (Viile Pusti),	Eua	M	
45	*Eilema complana* (Linnaeus, 1758)	Curciu (village),	Eua	Mt	
46	*Amata phegea* (Linnaeus, 1758)	Curciu („Râpi" forest edge), Mediaş (Izvorul Dorului, Târnava Mare bank),	Eua	M	
47	*Phragmatobia fuliginosa* (Linnaeus, 1758)	Curciu (Cărări Hill, village), Mediaş (Izvorul Dorului, Târnava Mare bank),	Eua	M	
48	*Phragmatobia luctifera* (Denis & Schiffermüller, 1775)	Bazna (Burnaz, 1993),	Eua	Mt	**EN**
49	*Spilosoma lubricipeda* (Linnaeus, 1758)	Curciu (Cărări Hill, village), Mediaş (Târnava Mare bank, Binderbubi, Greweln),	Eua	M	
50	*Spilosoma lutea* (Hufnagel, 1766)	Mediaş (Târnava Mare bank),	Eua	M	
51	*Diaphora mendica* (Cerck, 1759)	Curciu (village), Mediaş (Târnava Mare bank),	Eua	Mh	
52	*Diacrisia sannio* (Linnaeus, 1758)	Curciu (village), Mediaş (Târnava Mare bank),	Eua	M, Mh	
53	*Rhyparia purpurata* (Linnaeus, 1758)	Curciu (village),	Eua	Mxt	
54	*Arctia caja* (Linnaeus, 1758)	Bazna (Popescu-Gorj, 1964),	Eua	M	
55	*Euplagia quadripunctaria* (Poda, 1761)	Curciu (garden),	Eua	M	
Subfamily Erebinae					
56	*Catocala elocata* (Esper, 1787)	Curciu (village),	Vam	Mht	**NT**
57	*Euclidia glyphica* (Linnaeus, 1758)	Curciu (Viile Pusti, Cărări Hill), Mediaş (Târnava Mare bank,	Eua	Mt	

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
		Izvorul Dorului, Binderbubi, Greweln),			
58	*Lygephila pastinum* (Treitschke, 1826)	Mediaş (Târnava Mare bank),	Eua	T	
Subfamily Herminiinae					
59	*Polypogon tentacularia* (Linnaeus, 1758)	Bazna (Burnaz, 1993), Curciu, Mediaş (Târnava Mare bank, Izvorul Dorului),	Eua	M	
60	*Zanclognatha tarsipennalis* Treitschke, 1835	Bazna (Popescu-Gorj, 1964),	Eua	Mh	
Subfamily Aventiinae					
61	*Laspeyria flexula* (Germar, 1810)	Curciu (village), Mediaş (Greweln),	Eua	M	
Subfamily Hypeninae					
62	*Hypena proboscidalis* (Linnaeus, 1758)	Bazna (Popescu-Gorj, 1964), Curciu (village), Mediaş (Târnava Mare bank),	Eua	Mh	
63	*Hypena rostralis* (Linnaeus, 1758)	Bazna (Popescu-Gorj, 1964), Curciu (village, Cărări Hill), Mediaş (Vewern),	Eua	M	
Family Nolidae					
Subfamily Nolinae					
64	*Nola aerugula* (Hübner, 1808)	Mediaş (Târnava Mare bank),	Eua	Mh	
Subfamily Chloephorinae					
65	*Earias clorana* (Linnaeus, 1761)	Mediaş (Târnava Mare bank),	Eua	Mh	
66	*Pseudoips prasinana* (Linnaeus, 1758)	Curciu (village, Cărări Hill), Mediaş (Târnava Mare bank),	Eua	M	
Family Noctuidae					
Subfamily Pantheinae					
67	*Colocasia coryli* (Linnaeus, 1758)	Curciu (village)	Eua	M	
Subfamily Noctuinae					
68	*Agrotis segetum* (Denis & Schiffermüller, 1775)	Curciu (village, Cărări Hill),	Eua	M	
69	*Agrotis exclamationis* (Linnaeus, 1758)	Curciu (village, Cărări Hill), Mediaş (Târnava Mare bank, Binderbubi, Greweln),	Eua	Eu, Mg	
70	*Agrotis ipsilon* (Hufnagel, 1766)	Curciu (village),	Cosm	Eu, Mg	
71	*Axylia putris* (Linnaeus, 1761)	Curciu (village, Cărări Hill), Mediaş (Târnava Mare bank, Binderbubi),	Eua	M	
72	*Ochropleura plecta* (Linnaeus, 1761)	Curciu (Cărări Hill), Mediaş (Binderbubi, Târnava Mare bank),	Hol	M	
73	*Dichagyris signifera* (Denis & Schiffermüller, 1775)	Bazna (Rakosy, 1996),	Eua	Mxt, Xt	**EN**
74	*Noctua pronuba* (Linnaeus, 1758)	Curciu (village), Mediaş (Greweln),	Eua	M, Mg	
75	*Noctua fimbriata* (Schreber, 1759)	Curciu (village),	Vam	M, Mg	
76	*Xestia c-nigrum*	Curciu (village),	Cosm	Eu,	

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
	(Linnaeus, 1758)			Mg	
77	*Xestia ditrapezium* (Denis & Schiffermüller, 1775)	Curciu (village), Mediaş (Binderbubi),	Eua	M	
78	*Cerastis rubricosa* ([Denis & Schiffermüller], 1775)	Curciu (village),	Eua	M	
79	*Anarta trifolii* (Hufnagel, 1766)	Curciu (village),	Hol	Eu	
80	*Mamestra brassicae* (Linnaeus, 1758)	Curciu (village),	Eua	M, Eu	
81	*Melanchra persicariae* (Linnaeus 1761)	Curciu (Cărări Hill),	Eua	M	
82	*Thalpophila matura* (Hufnagel, 1766)	Curciu (village),	Vam	M	
83	*Lacanobia contigua* (Denis & Schiffermüller, 1775)	Curciu (Cărări Hill),	Eua	M	
84	*Lacanobia suasa* (Denis & Schiffermüller, 1775)	Curciu (village), Mediaş (Târnava Mare bank),	Eua	Mh	
85	*Lacanobia oleracea* (Linnaeus, 1758)	Curciu (village),	Eua	Mht	
86	*Hadena perplexa* ([Denis & Schiffermüller], 1775)	Târnava (Rakosy, 1996),	Eua	Xt	
87	*Tholera decimalis* (Poda, 1761)	Curciu (village),	Eua	M	
88	*Anorthoa munda* (Denis & Schiffermüller, 1775)	Curciu (village), Mediaş (Vewern, Greweln),	Eua	M	
89	*Orthosia incerta* (Hufnagel, 1766)	Curciu (village),	Eua	M	
90	*Orthosia cruda* (Denis & Schiffermüller, 1775)	Curciu (village),	Vam	M	
91	*Orthosia gracilis* (Denis & Schiffermüller,1775)	Curciu (village),	Eua	M	
92	*Orthosia cerasi* (Fabricius, 1775)	Curciu (village),	Eua	M	
93	*Orthosia gothica* (Linnaeus, 1758)	Curciu (village), Mediaş (Greweln),	Eua	M	
94	*Mythimna turca* (Linnaeus, 1758)	Bazna (Popescu-Gorj, 1964), Curciu (village, Cărări Hill), Mediaş (Târnava Mare bank, Binderbubi),	Eua	Mh	
95	*Mythimna pudorina* ([Denis & Schiffermüller], 1775)	Mediaş (Târnava Mare bank),	Eua	Mx	
96	*Mythimna ferrago* (Fabricius, 1787)	Curciu (village),	Eua	M, Mh	
97	*Mythimna vitellina* (Hübner, 1808)	Curciu (village),	Vam	Mxt, Xt, Mg	
98	*Mythimna l-album* (Linnaeus, 1767)	Curciu (village),	Eua	Eu, Mg	
99	*Mythimna pallens*	Curciu (village, Cărări Hill),	Vam	M,	

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
	(Linnaeus, 1758)	Mediaş (Târnava Mare bank),		Mh	
100	*Mythimna albipuncta* (Denis & Schiffermüller, 1775)	Curciu (village, Viile Pusti), Mediaş (Binderbubi, Târnava Mare bank),	Vam	M	
101	*Lithophane ornitopus* (Hufnagel, 1766)	Curciu (village),	Eua	M	
102	*Eupsilia transversa* (Hufnagel, 1766)	Curciu (village), Mediaş (Vewern, Greweln),	Eua	M	
103	*Agrochola helvola* (Linnaeus, 1758)	Curciu (village),	Eua	Mt	
104	*Agrochola circellaris* (Hufnagel, 1766)	Curciu (village),	Eua	M	
105	*Conistra vaccinii* (Linnaeus, 1761)	Mediaş (Vewern, Greweln),	Eua	M	
106	*Tiliacea aurago* ([Denis & Schiffermüller], 1775)	Curciu (village),	Eua	M	
107	*Polyphaenis sericata* (Esper, 1787)	Curciu (village),	Vam	M	
108	*Trachea atriplicis* (Linnaeus, 1758)	Curciu (village),	Eua	M	
109	*Euplexia lucipara* (Linnaeus, 1758)	Curciu (village), Mediaş (Târnava Mare bank),	Eua	M, Mh	
110	*Phlogophora meticulosa* (Linnaeus, 1758)	Curciu (village),	Vam	M, Mh	
111	*Cosmia trapezina* (Linnaeus, 1758)	Bazna (Col. Schneider),	Vam	M	
112	*Actinotia polyodon* (Clerck, 1759)	Curciu (village),	Eua	Mxt	
113	*Apamea monoglypha* (Hufnagel, 1766)	Curciu (village),	Eua	Eu	
114	*Apamea sordens* (Hufnagel, 1766)	Mediaş (Târnava Mare bank),	Eua	Eu	
115	*Oligia strigilis* (Linnaeus, 1758)	Curciu (village),	Eua	M	
116	*Oligia latruncula* (Denis & Schiffermüller, 1775)	Curciu (village),	Eua	Mh	
117	*Oligia versicolor* (Borkhausen, 1792)	Curciu, Mediaş (Târnava Mare bank),	Eua	M	
118	*Mesoligia furuncula* ([Denis & Schiffermüller], 1775)	Bazna (Popescu-Gorj, 1964),	Pm	M	
119	*Elaphria venustula* (Hübner, 1790)	Curciu (Cărări Hill), Mediaş (Târnava Mare bank, Binderbubi),	Eua	Mt	
120	*Mesapamea secalis* (Linnaeus, 1758)	Curciu (village), Mediaş (Târnava Mare bank),	Eua	M	
121	*Charanyca trigrammica* (Hufnagel, 1766)	Curciu (Cărări Hill), Mediaş (Greweln),	Vam	M	
122	*Athetis furvula* (Hübner, 1808)	Mediaş (Rakosy, 1996),	Eua	Mxt	
123	*Archanara neurica* (Hübner, 1808)	Mediaş (Czekelius, 1917),	Eua	H	
124	*Archanara dissoluta* (Treitschke, 1825)	Mediaş (Binderbubi),	Pm	H	

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
125	*Sideridis turbida* Esper, 1790	Mediaş (Rakosy, 1996),	Eua	Mxt	
126	*Hoplodrina ambigua* (Denis & Schiffermüller, 1775)	Curciu (Cărări Hill),	Vam	Mt	
127	*Hoplodrina octogenaria* (Goeze, 1781)	Curciu (village),	Eua	M	
128	*Egira conspicillaris* (Linnaeus, 1758)	Curciu (village),	Eua	M	
Subfamily Condicinae					
129	*Eucarta virgo* (Treitschke, 1835)	Curciu (village, Cărări Hill), Mediaş (Târnava Mare bank),	Eua	Mh	**VU**
130	*Eucarta amethystina* (Hubner, 1803)	Curciu (Cărări Hill), Mediaş (Târnava Mare bank, Greweln),	Eua	T-Hg	**VU**
Subfamily Cuculliinae					
131	*Shargacucullia verbasci* (Linnaeus, 1758)	Curciu (village),	Eua	Mt	
Subfamily Amphipyrinae					
132	*Valeria oleagina* (Denis & Schiffermüller, 1775)	Mediaş (town),	Vam	Mxt	
133	*Amphipyra pyramidea* (Linnaeus, 1758)	Curciu (village),	Eua	M	
134	*Amphipyra livida* (Denis & Schiffermüller, 1775)	Curciu (village),	Eua	Mt	
Subfamily Oncocnemidinae					
135	*Lamprosticta culta* (Denis & Schiffermüller, 1775)	Curciu (village),	Vam	T	
Subfamily Acronictinae					
136	*Acronicta euphorbiae* ([Denis & Schiffermüller], 1775)	Curciu (village),	Eua	Xt	
137	*Acronicta rumicis* (Linnaeus, 1758)	Curciu (Cărări Hill)	Eua	M	
138	*Craniophora ligustri* (Denis & Schiffermüller, 1775)	Curciu (village),	Eua	Mth	
Subfamily Heliothinae					
139	*Heliothis peltigera* (Denis & Schiffermüller, 1775)	Curciu (village),	Cosm, Str	T	
140	*Helicoverpa armigera* (Hübner, 1808)	Curciu (village),	Cosm, Str	T	
141	*Pyrrhia umbra* (Hufnagel, 1766)	Curciu (Cărări Hill),	Hol	M	
Subfamily Acontiinae					
142	*Acontia trabealis* (Scopoli, 1763)	Mediaş (Târnava Mare bank, Binderbubi, Greweln), Curciu (Cărări Hill),	Eua	Mt	
143	*Acontia lucida* (Hufnagel, 1766)	Mediaş (Târnava Mare bank),	Eua	Xt	
Subfamily Eustrotiinae					
144	*Deltote bankiana* (Fabricius, 1775)	Mediaş (Târnava Mare bank, Binderbubi),	Eua	Mh	
145	*Deltote (Protodeltote) pygarga* (Hufnagel 1766)	Mediaş (Târnava Mare bank),	Eua	Mh	
Subfamily Plusiinae					
146	*Abrostola asclepiadis*	Curciu (Cărări Hill),	Vam	Mt	

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
	(Denis & Schiffermüller, 1775)				
147	*Abrostola triplasia* (Linnaeus, 1758)	Bazna (Popescu-Gorj, 1964),	Eua	M	
148	*Diachrysia chrysitis* (Linnaeus, 1758)	Curciu (village, Cărări Hill), Mediaş (Târnava Mare bank),	Eua	M	
149	*Macdunnoughia confusa* (Stephens, 1850)	Curciu (Cărări Hill),	Eua	Mt, Mg	
150	*Autographa gamma* (Linnaeus, 1758)	Curciu, Mediaş (Târnava Mare bank, Binderbubi),	Eua	Eu, Mg	
Subfamily Metoponiinae					
151	*Tyta luctuosa* (Denis & Schiffermüller, 1775)	Curciu (Cărări Hill), Mediaş (Târnava Mare bank),	Eua	Xt	
Subfamily Scoliopteryginae					
152	*Scoliopteryx libatrix* (Linnaeus, 1758)	Curciu (village), Mediaş (Vewern),	Hol	M	
Subfamily Rivulinae					
153	*Rivula sericealis* (Scopoli, 1763)	Bazna (Popescu-Gorj, 1964), Curciu (village), Mediaş (Binderbubi),	Eua	Mh	
Subfamily Phytometrinae					
154	*Phytometra viridaria* (Clerck, 1759)	Curciu (Cărări Hill), Mediaş (Binderbubi),	Eua	M	
Superfamily Geometroidea					
Family Geometridae					
Subfamily Geometrinae					
155	*Pseudoterpna pruinata* (Hufnagel, 1767)	Curciu (Viile Pusti),	Eua	Xt	
156	*Thetidia smaragdaria* (Fabricius, 1787)	Bazna (Popescu-Gorj, 1964), Mediaş (Târnava Mare bank), Curciu (village),	Eua	Xt	
157	*Chlorissa viridata* (Linnaeus, 1758)	Curciu (Cărări Hill),	Eua	T	
158	*Chlorissa cloraria* (Hübner, 1813)	Mediaş (Târnava Mare bank), Curciu (Cărări Hill),	Eua	Mt	**NT**
159	*Thalera fimbrialis* (Scopoli, 1763)	Bazna (Popescu-Gorj, 1964), Mediaş (Târnava Mare bank), Curciu (Cărări Hill),	Eua	Mt, Xt	
160	*Hemistola chrysoprasaria* (Esper, 1795)	Curciu (village),	Eua	Mt	
Subfamily Sterrhinae					
161	*Cyclophora annularia* (Fabricius, 1775)	Curciu (village),	Eua	Mt	**NT**
162	*Cyclophora linearia* (Hübner, 1799)	Curciu (village),	Eua	M	
163	*Timandra comae* (Schmidt, 1931)	Mediaş (Târnava Mare bank), Curciu (village, Cărări Hill),	Eua	Mt	
164	*Scopula immorata* (Linnaeus, 1758)	Curciu (Cărări Hill), Mediaş (Târnava Mare bank, Binderbubi),	Eua	Mt, Mht	
165	*Scopula ornata* (Scopoli, 1763)	Mediaş (Târnava Mare bank, Binderbubi), Curciu (village, Cărări Hill),	Eua	Mt	
166	*Scopula rubiginata* (Hufnagel, 1767)	Mediaş (Greweln, Târnava Mare bank), Curciu (village),	Eua	Xt	

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
167	*Scopula immutata* (Linnaeus, 1758)	Bazna (Popescu-Gorj, 1964), Mediaş (Târnava Mare bank), Curciu (Cărări Hill),	Eua	Mh	
168	*Scopula nemoraria* (Hübner, 1799)	Mediaş (Binderbubi),	Eua	M	
169	*Scopula virgulata* (Denis & Schiffermüller, 1775)	Curciu (Cărări Hill, Viile Pusti),	Eua	Xt	
170	*Idaea serpentata* (Hufnagel, 1767)	Mediaş (Târnava Mare bank), Curciu (Cărări Hill),	Eua	Xt	**NT**
171	*Idaea ochrata* (Scopoli, 1763)	Curciu (Cărări Hill),	Eua	Mxt, Xt	
172	*Idaea aureolaria* (Denis & Schiffermüller, 1775)	Mediaş – Moşna (Col. Schneider),	Eua	Mx	
173	*Idaea biselata* (Hufnagel, 1767)	Mediaş (Binderbubi),	Eua	Mht	
174	*Idaea humiliata* (Hufnagel, 1767)	Mediaş (Binderbubi),	Eua	Mxt	**NT**
175	*Idaea politaria* (Hübner, 1799)	Mediaş (Binderbubi),	Vam	Xt	**NT**
176	*Idaea rusticata* (Denis & Schiffermüller, 1775)	Curciu (Cărări Hill),	Eua	Mt	**NT**
177	*Idaea aversata* (Linnaeus, 1758)	Bazna (Col. Schneider), Mediaş, Curciu (Cărări Hill),	Eua	M	
178	*Idaea straminata* (Borkhausen, 1794)	Curciu (Cărări Hill),	Eua	Mt	
179	*Idaea seriata* (Schrank, 1802)	Bazna (Popescu-Gorj, 1964)	Vam	Xt	**NT**
180	*Idaea muricata* (Hufnagel, 1767)	Curciu (Cărări Hill),	Eua	Mht	**NT**
181	*Rhodostrophia vibicaria* (Clerck, 1759)	Curciu (village), Mediaş (Binderbubi, Târnava Mare bank),	Eua	Xt	
182	*Lythria purpuraria* (Linnaeus, 1758)	Curciu (Viile Pusti),	Eua	Mth, Mt	
183	*Scotopteryx mucronata* (Scopoli, 1763)	Curciu (Viile Pusti),	Eua	Mxt	
Subfamily Larentiinae					
184	*Xanthorhoe ferrugata* (Clerck, 1759)	Bazna (Popescu-Gorj, 1964), Curciu (Cărări Hill), Mediaş (Târnava Mare bank, Binderbubi),	Eua	M, Mh	
185	*Xanthorhoe quadrifasiata* (Clerck, 1759)	Bazna (Popescu-Gorj, 1964),	Eua	M	
186	*Xanthorhoe fluctuata* (Linnaeus, 1758)	Curciu (village),	Eua	M	
187	*Epirrhoe alternata* (Müller, 1764)	Mediaş (Târnava Mare bank),	Eua	Mht	
188	*Camptogramma bilineata* (Linnaeus, 1758)	Curciu (village, Cărări Hill), Mediaş (Izvorul Dorului),	Eua	M, Mh	
189	*Pelurga comitata* (Linnaeus, 1758)	Curciu (village),	Eua	M	**NT**
190	*Thera variata* (Denis & Schiffermüller, 1775)	Bazna (Popescu-Gorj, 1964),	Eua	M	
191	*Colostygia pectinataria* (Knoch, 1781)	Curciu (village, Cărări Hill),	Eua	M	

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
192	*Horisme vitalbata* (Denis & Schiffermüller, 1775)	Curciu (Cărări Hill),	Eua	M	
193	*Melanthia procellata* (Denis & Schiffermüller, 1775)	Bazna (Popescu-Gorj, 1964), Curciu (village, Cărări Hill), Mediaş (Târnava Mare bank),	Eua	M	
194	*Perizoma flavofasciata* (Thunberg, 1792)	Bazna (Burnaz, 1993),			**NT**
195	*Perizoma alchemillata* (Linnaeus, 1758)	Curciu (village),	Eua	Mx	
196	*Eupithecia centaureata* (Denis & Schiffermüller, 1775)	Bazna (Popescu-Gorj, 1964),	Eua	M	
197	*Minoa murinata* (Scopoli, 1763)	Curciu (village),	Eua	M	
		Subfamily Ennominae			
198	*Abraxas grossulariata* (Linnaeus, 1758)	Mediaş (Izvorul Dorului), Curciu (village),	Eua	M	**NT**
199	*Lomaspilis marginata* (Linnaeus, 1758)	Mediaş (Târnava Mare bank), Curciu (village, Izvorul Dorului),	Eua	M	
200	*Ligdia adustata* (Denis & Schiffermüller, 1775)	Bazna (Popescu-Gorj, 1964), Curciu (village), Mediaş (Binderbubi),	Eua	M	
201	*Macaria alternata* ([Denis & Schiffermüller], 1775)	Curciu, Mediaş (Târnava Mare bank),	Eua	M	
202	*Chiasmia clathrata* (Linnaeus, 1758)	Mediaş (Târnava Mare bank, Binderbubi), Curciu (village, Cărări Hill),	Eua	M	
203	*Tephrina arenacearia* ([Denis & Schiffermüller], 1775)	Curciu (village), Mediaş (Târnava Mare bank),	Eua	Xt	**NT**
204	*Heliomata glarearia* (Denis & Schiffermüller, 1775)	Curciu (Cărări Hill), Mediaş (Binderbubi),	Vam	Xt	
205	*Plagodis pulveraria* (Linnaeus, 1758)	Curciu (village),	Eua	M	
206	*Plagodis dolabraria* (Linnaeus, 1758)	Mediaş (Buzd forest edge),	Eua	M	
207	*Therapis flavicaria* ([Denis & Schiffermüller], 1775)	Curciu (Cărări Hill),	Vam	Mt	**NT**
208	*Pseudopanthera macularia* (Linnaeus, 1758)	Mediaş (Izvorul Dorului), Curciu (Cărări Hill),	Eua	M	
209	*Ennomos erosaria* (Denis & Schiffermüller, 1775)	Curciu (village),	Eua	M	**NT**
210	*Selenia lunularia* (Hübner, 1788)	Curciu (village),	Eua	M	**NT**
211	*Apeira syringaria* (Linnaeus, 1758)	Curciu (village),	Eua	Mxt	**NT**
212	*Colotois pennaria* (Linnaeus, 1716)	Curciu (village),	Eua	M	
213	*Angerona prunaria* (Linnaeus, 1758)	Curciu, Mediaş (Binderbubi)	Eua	M	
214	*Biston betularia* (Linnaeus, 1758)	Curciu (village), Mediaş (Izvorul Dorului),	Eua	M	

No.	TAXON	LOC.	Z. El.	E. C.	R. L.
215	*Agriopis marginaria* (Fabricius, 1776)	Mediaş (Greweln, Binderbubi)	Eua	M	
216	*Hypomecis punctinalis* (Scopoli, 1763)	Curciu (village), Mediaş (Binderbubi)	Eua	M	
217	*Ascotis selenaria* (Denis & Schiffermüller, 1775)	Curciu (village, Cărări Hill), Mediaş (Târnava Mare bank, Binderbubi),	Eua	M	
218	*Ectropis crepuscularia* (Denis & Schiffermüller,1775)	Moşna (Col. Schneider), Curciu, Mediaş (Binderbubi)	Eua	M	
219	*Ematurga atomaria* (Linnaeus, 1758)	Mediaş (Izvorul Dorului, Târnava Mare bank), Curciu (village, Cărări Hill),	Eua	M	
220	*Cabera pusaria* (Linnaeus, 1758)	Curciu (village),	Eua	M	
221	*Campaea margaritata* (Linnaeus, 1767)	Mediaş (Izvorul Dorului), Curciu (village, Cărări Hill)	Eua	M	
222	*Siona lineata* (Scopoli, 1763)	Mediaş (Izvorul Dorului, Târnava Mare bank), Curciu (village, Cărări Hill),	Eua	M	

DATA REGARDING GENUS *PARNASSIUS* LATREILLE, 1804 (LEPIDOPTERA: PAPILIONIDAE) PRESERVED IN NATURAL HISTORY MUSEUM COLLECTIONS FROM SIBIU

Sergiu-Cornel TÖRÖK*
Gabriela CUZEPAN**

Abstract. *The aim of this study is to present the specimens belonging to the genus Parnassius Latreille, 1804 preserved in the collections of the Natural History Museum from Sibiu. The material analyzed counts 244 specimens belonging to the following species: Parnassius apollo (Linnaeus, 1758) with 2 subspecies: Parnassius apollo jaraensis Kertész, 1922 and Parnassius apollo transsylvanicus Schweitzer, 1912; and Parnassius mnemosyne (Linnaeus, 1758) with 2 subspecies: Parnassius mnemosyne distincta Bryk & Eisner, 1930 and Parnassius mnemosyne transsylvanica Schmidt, 1930. The four subspecies are endemic to Romania. Their distribution in Romania is given according to the collecting sites from the museum collections. The conservation status in Romania it is also presented for both.*
Keywords*: Parnassius sp., distribution, faunistics, museum collections.*

Rezumat. *Acest studiu prezintă genul Parnassius Latreille, 1804 din colecţia Muzeului de Istorie Naturală din Sibiu. Materialul analizat cuprinde 244 de specimene încadrate sistematic în 2 specii: Parnassius apollo (Linnaeus, 1758) cu 2 subspecii: Parnassius apollo jaraensis Kertész, 1922; Parnassius apollo transsylvanicus Schweitzer, 1912 şi Parnassius mnemosyne (Linnaeus, 1758) cu 2 subspecii: Parnassius mnemosyne distincta Bryk & Eisner, 1930; Parnassius mnemosyne transsylvanica Schmidt, 1930. Cele 4 subspecii sunt endemice pentru Romania. Locurile de colectare împreună cu statutul din cadrul Listei Roşii a Fluturilor din Romania sunt de asemenea prezentate.*
Cuvinte cheie*: Parnassius sp., răspândire geografică, faunistică, colecţii muzeale.*

Introduction

The first article on Lepidoptera published in Romania by Carl Fuss, was based on the material collected by Joseph von Franzenau from Săcărâmb (Hunedoara County, Romania). This paper appeared in the first edition of the Transylvanian Society of Natural Sciences Journal (*Verhandlungen und Mitteilungen des Siebenbürghische Vereins für Naturwissenschaften zu Hermannstadt*) from Sibiu (Popescu-Gorj 1970). The material included a list of 964 species and forms of Macro- and Microlepidoptera. The same paper confirms for the first time the presence in Romania of the species *Doritis* (*Parnassius) apollo* (Linnaeus, 1758) and *Doritis mnemosyne* Linnaeus, 1758 (Fuss, 1850).

Doritis is also mentioned by Josef von Franzenau in his work published in the third number of the Transylvanian Society Journal (1859), the specimens being collected from Kisbánya (today's Băişoara village, Cluj County, Romania) (Franzenau 1852, 1859).

During 1860 – 1866 Josef Mann from Vienna studied the fauna from the northern part of Dobrudja (at that time it was included in the Ottoman Empire) and he published several species, which remain the only citing in the Romania fauna (Mann 1866, Szèkely 2008).

Noticeable is the citing of *Doritis* (*Parnassius) apollo* (Linnaeus, 1758) in this region, considered uncertain, being the only mention of the species in the northern part of Dobrudja until today.

Regarding the distribution of *P. apollo* and *P. mnemosyne* in Romania, Constantin Hormuzachi and Daniel Czekelius wrote about these species in their articles published in the beginnings of the 20th century.

These two species are also mentioned in the first Catalogue of Lepidoptera from Romania, published by Aristide Caradja in 1895 (Caradja 1895), followed by Edmund Fleck's catalogue in

* Babeş-Bolyai University of Cluj-Napoca, ser.torok@yahoo.com
**Brukenthal National Museum, Natural History Museum, gabrielacuzepan@gmail.com, gabriela.cuzepan@brukenthalmuseum.ro

1904 (Fleck, 1904), and by Franz Salay's catalogue in 1910 (Salay 1910).

At the beginning of the 20th century the most important contributions to the distribution of *P. apollo* (Linnaeus, 1758) and *P. mnemosyne* (Linnaeus, 1758) were made by Daniel Czekelius in his catalogues of the Transylvanian Lepidoptera (Czekelius 1897, Czekelius, 1917). In the Transylvanian Society Journal from 1920, Daniel Czekelius dedicates an entire article to *Parnassius apollo* (Linnaeus, 1758) introducing new data concerning the subspecies and variations from Transylvania and their distribution (Czekelius 1922).

The Transylvanian Society Journal included a series of papers related to the distribution of *P. mnemosyne* and *P. apollo:* in number 62 (1908) Baron N. Charles Rothschild (London) identified *P. mnemosyne* at Mezőség (today's Transylvanian Plain, Romania) and in number 83-84, László Diószeghy made remarks about the presence of *P. apollo* in the Retezat Mountains (Rotschild 1912, Diószeghy 1933-1934).

In the post war period there were relatively few publications regarding these two species: the *Catalogue of Adriano Ostrogovich* written by Aurelian Popescu-Gorj in the year 1964 (Popescu-Gorj 1964), *Family Papilionidae* by Eugen Niculescu published in Fauna R. S. Romania (Niculescu 1961), in the *Catalogue of the Lepidoptera collection from The Banat Museum (Timişoara)* by Frederic König (König 1975) and in the *Catalogue of Nicolae Delvig from Braşov* by Victor Ciochia and A. Barbu (Ciochia, Barbu 1980).

In the last decades, The Red List of the Romanian butterflies shows the presence of two geographical distinct subspecies of *Parnassius apollo,* ssp. *transsylvanicus* and ssp. *jaraensis* (Rákosy 2003). Other studies suggest that in reality in Romania only one subspecies of *Parnassius (Parnassius a. transsylvanicus)* is present (Niculescu 1961, Ruşti, Dragomirescu 1991).

P. a. jaraensis seem to have been extinct from the Western Carpathians, while populations of *P. a transsylvanicus* have also disappeared (Mihuţ, Dincă 2006).

The decline was much accentuated during the last century, when the species seem to have disappeared from dozen of places where it had been recorded during the 19th century. Over-collecting might have been a significant role in the disappearance of the unique population of *P. a. jaraensis* from Răcătău (Western Carpathians), it is more than 20 years since this subspecies was citied (Mihuţ, Dincă 2006)

Victor Weindel presents new information regarding the distribution of *P. apollo* in Transylvania, and elaborates two hypotheses about the dispersion of *P. apollo* in Romania (Weindel 2000).

This study is intended to present data regarding *Parnassius* sp. preserved in the Lepidoptera Collection of the Natural History Museum from Sibiu.

Material and methods

The study is based on the Lepidoptera Collection of Natural History Museum from Sibiu. The investigated material was from: Daniel Czekelius Lepidoptera Collection from Transylvania, Victor Weindel Lepidoptera Collection from Transylvania, Eugen Worell Entomological Collection, Heinrich Hann von Hannenheim Entomological Collection, Rolf Weyrauch Entomological Collection and Eckbert Schneider Entomogical Collection.

From these 6 collections the oldest is Daniel Czekelius Lepidoptera Collection, the collection includes specimens from 1887 (Pascu, Schneider 1998), he began sampling from 1887. This collection is also the largest Lepidoptera Collection of the Natural History Museum from Sibiu, containing 7.162 specimens of Macrolepidoptera and Microlepidoptera from Transylvania, as well as 6.929 other Palearctic Lepidoptera specimens.

Daniel Czekelius received material from Emil von Silbernagel from Avrig, Sachsenheim and Karl Petri from Sighişoara, Friedrich Deubel from Braşov, Köntzei Geró, Ştefan Peterfi, Eugen Worell, Arnold Müller, Josef v. Mallász, Adriano Ostrogovich, Béla Kiss, Rolf Weyrauch and many others. In one of his field trips to Retezat Mountains he met the famous lepidopterologist Lászlo Diószeghy, with whom he started collaborating. Other important collaboration, during his work as an entomologist, was the one with Hans Rebel from the Museum of Vienna, who showed interest in the fauna from Transylvania and who took part in several trips in this region (Pascu, Schneider 1998).

Daniel Czekelius last papers, published between 1922 and 1943, brought new data on the distribution of the genus *Parnassius* (syn=*Apollo*), a genus in which he was very interested studying the species in detail.

Heinrich Hann von Hannenheim Entomological Collection contains over 1.902 lepidoptera specimens. Heinrich Hann von Hannenheim collected during 1920-1964, especially from Transylvania region, particularly from the following sites: Păltiniş, Bărcaciu, Poiana Neamţului, Avrig Lake, Podragu and Sâmbăta Valley (Schneider 2003).

Eugen Worell Lepidoptera Collection, part of the Eugen Worell general Entomological Collection (93.897 specimens), includes 10.923 specimens of Macrolepidoptera and Microlepidoptera. The foundations of this collection were set in 1920; the items were collected from Romania, and from other different areas such as Europe, Africa, Asia, North and South America. He collected materials from all over the country, and in Transylvania he collected specimens from Sibiu and its surroundings.

Victor Weindel Transylvanian Lepidoptera Collection contains 4.322 specimens of Macrolepidoptera and Microlepidoptera, which were collected by the author between 1900-1959, particularly from Southern Transylvania (Sibiu and its surroundings), but also from other geographical regions from Romania (Schneider 1984).

Rolf Weyrauch Lepidoptera Collection contains over 5.500 Lepidoptera specimens out of 16.436 items from his entire entomological collection, the Noctuidae and the Geometridae families being best represented. The majority of these items were collected from around Sibiu (Pascu, Schneider 1998).

The most recent collection preserved in the Natural History Museum of Sibiu is Eckbert Schneider Entomological Collection. His collection contains over 20.000 specimens. In 30 years of activity, he collected specimens from the whole country, especially from the southern part of Transylvania.

The material from these 6 collections is presented in the following pages. Each species is followed by the number of specimens, the collecting site, date of collecting and the abbreviation of the collector. For an easy identification of the collecting sites, the original citing is mentioned followed by the present name and is included in the specific region of Romania or county. The species synonyms are mentioned in square brackets according with the labels from collections.

Abbreviations used in this paper:

alt. = altitude; ANONYMOUS = anonymous collector; n. – number of the specimen according to Daniel Czekelius Lepidoptera Collection from Transylvania; spec. = specimen/s; leg. = collected by; det.= determinated in; Mt. / Mts. = mountain/s; / = or.

Collectors' name:
Béla Kiss = B.K.; Csab Béla = C.B.; Diószeghy László = D.L.; Adriano. Ostrogovich = A.O.; Arnold Müller = A.M.; Daniel Czekelius = D.C.; Eugen Worell = E.W.; Köntzei Geró = K.G.; Ştefan Peterfi = S.P.; Eckbert Schneider = E.S.; Emil v. Silbernagel = E.Silb.; H. Pelits = H.P.; Heinrich Hann von Hanenheim = H.H.; Josef v. Mallász = J.M.; Kuales = K.; Ladislaus v. Dobay = L.D.; N. Falmtius = N.F.; Rolf Weyrauch = R.W.

Results and discussions

Taxonomic Hierarchy (Rákosy 2003; Rákosy *et al.* 2003):

Genus *Parnassius* Latreille, 1804
(*Doritis* Fabricius, 1807)
Species *apollo* Linnaeus, 1758
Subspecies *jaraensis* Kertész, 1922
Subspecies *transsylvanicus* Schweitzer, 1912
syn. *rosenius* Fruhstorfer, 1923
Species *mnemosyne* Linnaeus, 1758
Subspecies *wagneri* Bryk, 1925
Subspecies *transsylvanica* Schmidt, 1930
syn. *dioszeghyi* Bryk, 1930
Subspecies *distincta* Bryk & Eisner, 1930
syn. *hungaricus* Rothschild, 1911
syn. *bischoffi* Bryk & Eisner, 1930
syn. *cibinensis* Dannehl, 1933
syn. *czekelii* Bryk & Eisner, 1934
syn. *distinctus* Bryk & Eisner, 1935

Daniel Czekelius Lepidoptera Collection from Transylvanian

Parnassius apollo (Linnaeus, 1758)

1 spec. (n.37) Ratosnya [Răstoliţa, Mureş County], leg. ANONYMOUS; 1 spec. (n.39/28) Borgo Bistritza [Bistriţa Bârgăului, Bistriţa Năsăud County], leg. ANONYMOUS; 1 spec. (n.40) Békás / Békás patak [Bicaz, Neamţ County], 16.07.1937, leg. ANONYMOUS; 3 specs. (n.41/9, n.42/10, n.43/11) Tölgyes – Putanapatak [Tulgheş, Harghita County], 23.07.1909 (?), leg. ANONYMOUS; 1 spec. (n.44/4) Gyewgyo st. Miklos [Gheorghieni, Harghita County], 28.07.1910, leg. ANONYMOUS; 5 specs. (n.45, n.46/5, n.47/8, n.48/7, n.49/6) Gyewgyo st.Miklos

[Gheorghieni, Harghita County], 24.07.1909, leg. ANONYMOUS; 1 spec. (n.72/97) Broos [Orăştie, Hunedoara County], leg. ANONYMOUS; 2 specs. (n.51, n.55) Bórnék [Borsec, Harghita County], 18.07.1911, leg. E.W.; 3 specs. (n.52, n.53, n.54) Bórnék [Borsec, Harghita County], 18.07.1911, leg. ANONYMOUS; 1 spec. (n.56) Bórnék [Borsec, Harghita County], 1.08.1921, leg. ANONYMOUS; 1 spec. (n.57) Bórnék [Borsec, Harghita County], 15.07.1922, leg. ANONYMOUS; 1 spec. (n.58/22) Bórnék [Borsec, Harghita County], 18.07.1911, leg. ANONYMOUS.

Parnassius apollo jaraensis Kertész, 1922

2 specs. (n.59, n.60) leg. Mărişel [Mărişelul, Gilăului Mts.], 03.07.1927, leg. S.P.; 1 spec. (n.61) without location, 24.07.1929, leg. ANONYMOUS; 3 specs. (n.62, n.63, n.64) Réketo [Răcătău, Cluj County], 14.07.1929, leg. ANONYMOUS; 1 spec. (n.50/47) Borgo-Bistritza [Bistriţa Bârgăului, Bistriţa Năsăud County], 12.07., leg. ANONYMOUS; 3 specs. (n.65, n.66, n.67) Colibitza [Colibiţa Lake, Bistriţa Năsăud County], 14.07.1930, leg. A.M.; 1 spec. (n.68) Colibitza [Colibiţa Lake, Bistriţa Năsăud County], 14.07.1930, leg. D.C.; 3 specs. (n.69, n.70/45, n.71/44) Retezat (Netiş?) [Retezat Mts], 29.08.1930, leg. C.B.; 1 spec. (n.314) - has only the right pair of wings sticked on a label, Retezat (Nyekistok?) [Retezat Mts.], 15.08.1930, leg. A.M.

Parnassius mnemosyne distincta Bryk & Eisner, 1930
[*Parnassius mnemosyne bischoffi* Bryk & Eisner, 1930]

1 spec. (n.115) Kuhhorn [Ineu Peak, Rodna Mts.] 03.06.1911, leg. ANONYMOUS.

[*Parnassius mnemosyne czekelii* (?) Bryk & Eisner, 1934]

1 spec. (n.74) Riu Sadu [Râu Sadu, Sibiu County], 06.1935, leg. D.C.; 1 spec. (n.75) Riu Sadu [Râu Sadu, Sibiu County], 06.1936, leg. A.O.; 1 spec. (n.76) Riu Sadu [Râu Sadu, Sibiu County], ??.07.1935, leg.A.O.; 1 spec. (n.77) Prejba [Prejba, Lotru Mts.], 27.07.1910, leg. H.H.; 2 specs. (n.78, n.79) Küküllovar [Cetatea de Baltă, Alba County], 09.05.1921, leg. K.G.; 1 spec. (n.80) Küküllovar [Cetatea de Baltă, Alba County], 19.05.1932 leg. K.G.; 2 specs. (n.81, n.82) Kukullburg [Kokelburg – Cetatea de Baltă, Alba County], 29.05.1932(?), leg. D.C.; 1 spec. (n.83) Kukullburg [Kokelburg – Cetatea de Baltă, Alba County], 29.05.1932(?), leg. K.G.; 1 spec. (n.84) Kukullburg [Kokelburg - Cetatea de Baltă, Alba County], 20.05.1921, leg. ANONYMOUS; 2 specs. (n.85, n.86) Schässburg [Sighişoara, Mureş County], 30.06., leg. D.C.; 1 spec. (n.87) Hadad [Hodod, Satu Mare County], 29.08.1932, leg. B.K.; 1 spec. (n.88) Kolosvar, Klausenburg [Cluj Napoca, Cluj County], 18.04.1919, leg. ANONYMOUS; 2 specs. (n.89, n.90) Nagyág [Săcărâmb, Hunedoara County], 2.06.1928, leg. J.M.; 2 specs. (n.91, n.92) Deva(?) [Deva, Hunedoara County], 1.06.1924, leg. J.M.; 2 specs. (n.93, n.94) Tuşnad [Harghita County], 21.04., det. 1932, leg. L.D.; 1 spec. (n.95) Kronstadt [Braşov, Braşov County], 04.1908, det. 15.05.1932, leg. E.Silb.; 1 spec. (n.96) Kronstadt [Braşov, Braşov County], 04.1908, det. 16.04.1932, leg. E.Silb.; 2 specs. (n.97, n.98) without data, leg. E.Silb.; 1 spec. (n.99) Hermannstadt, Michelsberg [Sibiu, Cisnădioara, Sibiu County], 24.05.1916, leg. D.C.

[*Parnassius mnemosyne distinctus* Bryk & Eisner, 1930]

1 spec. (n.100) Transilvania Butschetch [Transylvania, Bucegi Mts.], without data, leg. D.L.; 1 spec. (n.101) Honanstein, Kronstadt [Braşov, Braşov County], without data, leg. ANONYMOUS; 1 spec. (n.102) Schuler [Postăvarul Mts.], 14.06.1908, leg. D.C.; 2 specs. (n.103, n.104) Fedelesch [Chica Fedeleşului Peak, Făgăraş Mts.], 31.05.1909, leg. D.C.; 3 specs. (n.105, n.106, n.107) Götzenberg [Măgura Cisnădiei, Sibiu County], 05.1932, leg. A.M.; 1 spec. (n.108) Riu Sadu [Râu Sadu, Sibiu County], 06.1932, leg. A.O.; 2 specs. (n.109, n.110) Riu de Mori, Malomvíz [Râu de Mori, Hunedoara County], 30.06.1924, leg. J. M.; 1 spec. (n.111) Surul Berg [Suru Mts., Făgăraş Mts.], 11.06.1922, leg. H.H.; 1 spec. (n.112) Zibinsgeb., Valea Ştezii [Cindrel Mts., Valea Ştezii], 09.06.1930, leg. A.M.; 1 spec. (n. 113) Tălmatch, Kromwald Lands [Tălmaciu, Sibiu County], 26.05., leg. D.C.; 1 spec. (n.114) Kronstadt [Braşov, Braşov County], without data, leg. E.Silb.

[*Parnassius mnemosyne hungaricus* Rothschild, 1911]

1 spec. (n.73) Nagy-Kagya, Bihar [Cadea Mare, Bihor County], 04.06.1913, leg. ANONYMOUS.

Parnassius mnemosyne transsylvanica Schmidt, 1930

1 spec. (n.116) Retezat [Retezat Mts.], 03.06.1923, leg. D.L.; 3 specs. (n.117, n.118, n.119) Retezat, Campanula Schultz [Retezat Mts., Campanula Shelter], 06.1929, leg. J.M.; 2 specs. (n.120, n.121) Riu Sadu [Râu Sadu, Sibiu County], ??.06.1932, leg. A.O.

Victor Weindel Transylvanian Lepidoptera Collection

Parnassius apollo transsylvanicus Schweitzer, 1912

2 specs. Bârgău-Bistriţa [Bistriţa Năsăud County], 12.07., leg. D.C.; 1 spec. Borsec [Harghita County], 08.1914, leg. A.M.; 1 spec. Borsec [Harghita County], 29.07.1921, leg. ANONYMOUS; 6 specs. Borsec [Harghita County], 1.08.1921, leg. ANONYMOUS; 2 specs. Borsec [Harghita County], 2.08.1921, leg. ANONYMOUS; 1 spec. without data, leg. ANONYMOUS.

Parnassius mnemosyne distincta Bryk & Eisner, 1930
[*Parnassius mnemosyne distinctus* Bryk & Eisner, 1930]

5 specs. Măgura Cisnădiei [Sibiu County], 22.05.1904, leg. ANONYMOUS; 3 specs. Măgura Cisnădiei [Sibiu County], 22.05.1921, leg. ANONYMOUS; 1 spec. Braşov, Tâmpa [Braşov County], 15.05.1921, leg. ANONYMOUS; 1 spec. Ocna Sibiului [Sibiu County], 04.06.1924, leg. ANONYMOUS; 5 specs. Postăvaru [Postăvaru Mts], leg. ANONYMOUS; 5 specs. Măgura Cisnădiei – Schweinswiese [Sibiu County], 13.06.1954, leg. ANONYMOUS.

Eugen Worell Entomological Collection

Parnassius apollo (Linnaeus, 1758)

2 specs. Bucovina [Bucovina Region], leg. ANONYMOUS; 1 spec. Retezat(?), Netiş [Retezat Mts.], 29.08.1930(?), leg. C.B.(?); 1 spec. without location and data, leg. ANONYMOUS; 1 spec. Hăşmasu Mare [Hăşmaşu Mare Mts.], 07.1936, leg. K.; 2 specs. Mţii. Bârgău [Bârgău Mts.], 07.1036, leg. K.

Parnassius apollo jaraensis Kertész, 1922

4 specs. Reketo bei Cluj [Răcătău, Cluj County], 14.07.1929, leg. D.C.; 1 spec. Borsec [Harghita County], 4.08.1911, leg. D.C.

Parnassius apollo transsylvanicus Schweitzer, 1912

1 spec. Borsec [Harghita County], 15.07.1922, leg. ANONYMOUS; 2 specs. without location and data, leg. ANONYMOUS.

Parnassius mnemosyne transsylvanica Schmidt, 1930

3 specs. Götzenberg [Măgura Cisnădiei, Sibiu County], 14.05.1947 leg. E.W.; 2 specs. Götzenberg [Măgura Cisnădiei, Sibiu County], ??.06.1930, leg. E.W.; 1 spec. Götzenberg [Măgura Cisnădiei, Sibiu County], 06.09.1938, leg. E.W.; 2 specs. Götzenberg [Măgura Cisnădiei, Sibiu County], 17.06.1948, leg. E.W.

Heinrich Hann von Hannenheim Entomological Collection

Parnassius apollo transsylvanicus Schweitzer, 1912

1 spec. Rarău, M. Aramei [Rarău Mts., Aramei Mt.], 26.07.1959, leg. ANONYMOUS.

Parnassius mnemosyne distincta Bryk & Eisner, 1930
[*Parnassius mnemosyne distinctus* Bryk & Eisner, 1930]

1 spec. Götzenberg bei Hermannstadt, 1300m [Măgura Cisnădiei, Sibiu County], 14.05.1947, leg. E.W.; 1 spec. Podragu [Podragu Mt., Făgăraş Mts.], 30.06.1954, leg. ANONYMOUS; 1 spec. Podragu [Podragu Mt., Făgăraş Mts.], 10.07.1954, leg. ANONYMOUS; 1 spec. Hammersdorf [Guşteriţa, Sibiu County], 31.05.1964, leg. ANONYMOUS; 1 spec. Mănăstirea Sâmbăta [Sâmbăta Monastery, Braşov County], 08.07.1964, leg. ANONYMOUS.

Rolf Weyrauch Entomological Collection

Parnassius apollo jaraensis Kertész, 1922

7 specs. Valea Someş Rece [Cluj County], 1974, Răcătău [Cluj County], 25-28.07, leg. R.W.; 2 specs. Valea Someş Rece [Cluj County], 18.07.1971, leg. H.P.; 2 specs., Valea Someş Rece [Cluj County], 20-22.07.1976, leg. R.W.

Parnassius apollo transsylvanicus Schweitzer, 1912

1 spec. Borsec [Harghita County], 25.07.1921, leg. A.M.; 1 spec. Borsec [Harghita County], 1.08.1921, leg. ANONYMOUS; 1 spec. Borsec [Harghita County], 2.08.1921, leg. ANONYMOUS.

[*Parnassius apollo rosenius* Fruhstorfer, 1923]

1 spec. Zugreni [Bistriţa Năsăud County], 04.08.1974, leg. ANONYMOUS.

Parnassius mnemosyne (Linnaeus, 1758)

1 spec. without data, 05.05.1949, leg. R.W.; 6 specs. Hammersdorfer Berg (H.B.) [Dealul Guşteriţei, Sibiu County], 05.06.1965, leg. R.W.; 1 spec. without data, 05.1950, leg. R.W.; 1 spec. Hammersdorfer Berg (H.B.) [Dealul Guşteriţei, Sibiu County], 04.06.1967, leg. R.W.; 7 specs. Hammersdorfer Berg (H.B.) [Dealul Guşteriţei,

Sibiu County], 03.06.1964, leg. R.W.; 4 specs. Surul [Suru Mt., Făgăraş Mts.], 12.06.1966, leg. R.W.; 4 specs. Vânturariţa [Buila-Vânturariţa, Mts., Căpăţânii Mts.], 16/18.07.1960, leg. R.W.; 1 spec. Cozia [Cozia Mts.], 20.05.1966, leg. R.W.; 1 spec. Cozia [Cozia Mts.], 13.05.1967, leg. R.W.; 1 spec. Valea Sâmbăta [Braşov County], 12.5/6.1963 leg. R.W.; 2 specs. Tuşnad [Harghita County], 22.07.1954, leg. R.W.; 1 spec. Tuşnad [Harghita County], 01.07.1954, leg. R.W.; 2 specs. Domogled [Mehedinţi Mts.], 26.06.1964, leg. R.W.; 7 specs. Domogled [Mehedinţi Mts.], 30.06.1956, leg. R.W.; 5 specs. Domogled [Mehedinţi Mts.], 09.06.1970, leg. R.W.; 4 specs. Dobrogea, Canaraua Fetii [Dobrogea de Sud Plateau], 15-18.05.1975, leg. R.W..

Eckbert Schneider Entomogical Collection

Parnassius apollo (Linnaeus, 1758)

2 specs. without location, 30.VI.1962, leg. E.S.

Parnassius mnemosyne (Linnaeus, 1758)

6 specs. Hoia, Cluj [Cluj County], 06.1956, leg. E.S.; 1 spec. Valea Vinului, Rodna [Rodna Mts.], 29.06.1955 leg. E.S.; 1 spec. Hammersdorf [Guşteriţa, Sibiu County], 09.06.1954, leg. E.S.; 1 spec. Fântâna Rece, Guşteriţa, Sibiu [Sibiu County], 16.05.1973, leg. E.S.; 1 spec. Mţii. Făgăraşului, Poiana Neamţului [Făgăraş Mts.], 02.06.1978, leg. E.S.; 3 specs. Şeica Mare [Sibiu County], 22.05.1978, leg. E.S.; 1 spec. Saschiz [Mureş county], 29.05.1982, leg. E.S.; 1 spec. Mţii. Făgăraşului, Poiana Neamţului [Făgăraş Mts.], 17.05.1981 leg. E.S.; 6 specs. Mţii. Făgăraşului, Poiana Neamţului [Făgăraş Mts.], 29.05.1981, leg. E.S.; 1 spec. Rivasco, 20.06.1963, leg. E.S.; 2 specs. Retezat 1200m [Retezat Mts., 1200 alt.], 23.06.1957, leg. E.S.; 1 spec. Domogled [Mehedinţi Mts.], 29.07.1957, leg. N.F.; 1 spec. Butschetsch [Bucegi Mts.], 06.1949, leg. ANONYMOUS; 1 spec. Hammersdorf Berg [Dealul Guşteriţei, Sibiu County], 09.06.1954, leg. E.S.; 1 spec. Mţii. Făgăraşului, Poiana Neamţului [Făgăraş Mts.], 24.06.1964, leg. E.S.; 1 spec. Sibiel [Sibiu County.], 30.05.1982, leg. E.S.

The material analyzed consists of 244 specimens belonging to the following species: *Parnassius apollo* (Linnaeus, 1758) with 2 subspecies: *Parnassius apollo jaraensis* Kertész, 1922 and *Parnassius apollo transsylvanicus* Schweitzer, 1912; and *Parnassius mnemosyne* (Linnaeus, 1758) with 2 subspecies: *Parnassius mnemosyne distincta* Bryk & Eisner, 1930 and *Parnassius mnemosyne transsylvanica* Schmidt, 1930, of the Natural History Museum from Sibiu.

Parnassius apollo is represented in the Lepidoptera Collection by 67 specimens, from which 16 specimens are represented by the subspecies *Parnassius apollo jaraensis* and 21 specimens by the subspecies *Parnassius apollo transsylvanicus* (Fig. 1). The species *Parnassius mnemosyne* counts 177 specimens, having the highest percentage in the investigated Lepidoptera collections, followed by the subspecies *Parnassius mnemosyne distincta* with 84 specimens and the subspecies *Parnassius mnemosyne transsylvanica* with 16 specimens (Fig. 1).

P. apollo is present in the following collections: Daniel Czekelius Lepidoptera Collection from Transylvania, Eugen Worell Lepidoptera Collection and Eckbert Schneider's Entomogical Collection. *P. a. jaraensis* appear only in the following collections: Daniel Czekelius Lepidoptera Collection from Transylvania, Eugen Worell Lepidoptera Collection, Rolf Weyrauch Lepidoptera Collection, and *P. a. transsylvanicus* appears in: Victor Weindel Lepidoptera Collection from Transylvania, Eugen Worell Lepidoptera Collection, Heinrich Hann von Hanenheim Lepidoptera Collection and Rolf Weyrauch Lepidoptera Collection.

P. mnemosyne is present only in the collections of Rolf Weyrauch Lepidoptera Collection and Eckbert Schneider Entomogical Collection. The subspecies of *P. mnemosyne* respectively *P. m. distincta* is found in: Daniel Czekelius Lepidoptera Collection from Transylvania, Victor Weindel Lepidoptera Collection from Transylvania, Rolf Weyrauch Lepidoptera Collection; respectively *P. m. transsylvanica* is found only in: Daniel Czekelius Lepidoptera Collection from Transylvania and Rolf Weyrauch Lepidoptera Collection.

The collecting sites of *P. apollo* are: Răstoliţa [Mureş County], Bistriţa Bârgăului [Bistriţa Năsăud County], Bicaz [Neamţ County], Borsec; Tulgheş & Gheorghieni [Harghita County], Orăştie [Hunedoara County], Retezat Netiş [Retezat Mts.], Hăşmaşu Mare Mts., Bârgău Mts. and also from other locations that weren't noted on the labels. The largest numbers of specimens of *P. apollo* where sampled from Borsec region (Harghita County) (Fig. 2, Fig. 3).

The sampling sites of *P. a. jaraensis* are: Bistriţa Bârgăului and Colibiţa Lake [Bistriţa Năsăud County], Borsec [Harghita County], Retezat, Netiş [Retezat Mts.], Hăşmaşu Mare Mts., Răcătău & Someş Rece Valley [Cluj County], his distribution

range is in the north-east and south-west part of Transylvania (Fig. 3).

P. a. transsylvanicus was sampled from Bistriţa Bârgăului and Zugreni [Bistriţa Năsăud County], Borsec [Harghita County], Rarău Mts., Aramei Mt., showing that his distribution is restricted to the north-east part of Transylvania, especially in the north area of the Oriental Carpathians (Fig. 3).

Parnassius apollo (Linnaeus, 1758) specimens, which appear in the collections, were sampled between 1909 and 1976. More specifically, *P. apollo* was sampled for the first time in the year 1909, and in the years 1910, 1911, 1921, 1922, 1930, 1936, 1937, 1962. In 1962 was the last time when this species has been sampled, being collected by E. Schneider.

P.a. jaraensis was sampled in: 1911, 1927, 1929, 1971, 1974 and 1976 by R. Weyrauch from Someş Rece Valley [Cluj County]. Regarding the subspecies *P. a. transsylvanicus* the following years are mentioned: 1914, 1921, 1922, 1959 and 1974 collected by R. Weyrauch from Zugreni [Bistriţa Năsăud County].

There are two high points of sampling, one in 1921 and another in 1930 both with 13 specimens. A great number of specimens were collected in the years 1909, 1910 (7-8 specs.) and 1974 (8 specs.) (Fig. 4).

Dividing the period 1909-1976 in two parts, we concluded that the majority of specimens are collected before 1937, after this year only 16 specimens from the total of 67 specimens were collected. This may possible suggest that the number of specimens in the wild was starting to decline. The decline of this species in Romania is also mentioned and confirmed by different authors (Mihuţ, Dincă, 2006); this is why *Parnassius apollo* was included in *The Red Book of Romanian Lepidoptera*, with the status of Critically Endangered (Rákosy 2003).

This butterfly is also included in the Habitats Directive, Annex 3A and Annex 4A (Rákosy 2005).

At national level were established threats that had brought *Parnassius apollo* to his decline, like: climatic change; over collecting (killing or taking); isolation and fragmentation of habitat; deforestation on non-woodland habitats; overgrazing; abandonment and inappropriate habitat management, and others (Van Sway, Warren 1999).

In Romania only one conservation measure is taken that of the legal protection of habitats. Other countries have implemented many measures like: begin or improve monitoring, ecological research on species requirements, reintroduction, restrict recreational activities, avoid overgrazing, avoid natural deforestation, improve habitat management, stop development of mountain areas with sensitive populations and enforcement of measures proscribed by law (Van Sway, Warren 1999).

The specimens of *Parnassius mnemosyne* (Linnaeus, 1758) (Fig. 5), were sampled from Transylvania, especially from Sibiu County but also from Cluj County, Braşov County and Harghita County. A part of the *P. mnemosyne* specimens come from Rodna Mts., Făgăraş Mts., Retezat Mts., Căpăţânii Mts., Cozia Mts. and Mehedinţi Mts.

From Dobrogea, in the Schneider Entomogical Collection, 4 specimens from Canaraua Fetii Canyon sampled in 1975, are present.

The subspecies *P. m. distincta* was sampled form whole Transylvania, but the biggest part of it comes from Sibiu County (Fig. 5).

Concerning the endemic subspecies *Parnassius mnemosyne transsylvanica* the collecting sites were: Retezat Mts., Campanula Shelter also from Retezat Mts., Râu Sadu and Măgura Cisnădiei from Sibiu County. Therefore we can observe that the distribution range of this endemic subspecies of butterfly seams to be restricted to Transylvania (Fig. 5) (Rákosy 1997).

The analysis of collection years (Fig. 6) reveals that the specimens of *P. mnemosyne* were collected in the period between 1904 and 1982.

The earliest specimens were collected by V. Weindel in 1904 (5 specs.), more then one hundred years ago, after this date the number of specimens collected fluctuates homogeneously until 1982, when the last specimens of *P. mnemosyne* was sampled by E. Schneider.

In the 74 years, representing the collecting period of the *P. mnemosyne* specimens, there are three high points in 1932, 1956 (13 specs.) and 1964 (11 specs).

The numbers of specimens per year are equally distributed suggesting that there is stability in this butterfly population (Fig. 6).

Concerning the conservation status of *P. mnemosyne* it is included in *The Red Book of Romanian Butterflies* with the Status: Near

Threatened (Rákosy 2003). This species is also included in Habitats Directive, Annex 3A and Annex 4A (Rákosy 2005).

The threats in Romania are: destruction of woodland; isolation and fragmentation of habitat; change of woodland management; overgrazing and others (Van Sway, Warren 1999).

Although *P. mnemosyne* lives in isolated populations (Niculescu, 1961), it is a rather common butterfly, for this reason, there are no conservation measures proposed.

Acknowledgements

We would like to kindly thank Dr. Cristina Moise, Dr. Cornelia Chimişliu, Dr. Silvia Burnaz and Ioan Tăuşan for the help in reviewing the paper.

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Internet source — HTTP://ro.wikipedia.org/

LIST OF ILLUSTRATIONS

LISTA ILUSTRAŢIILOR

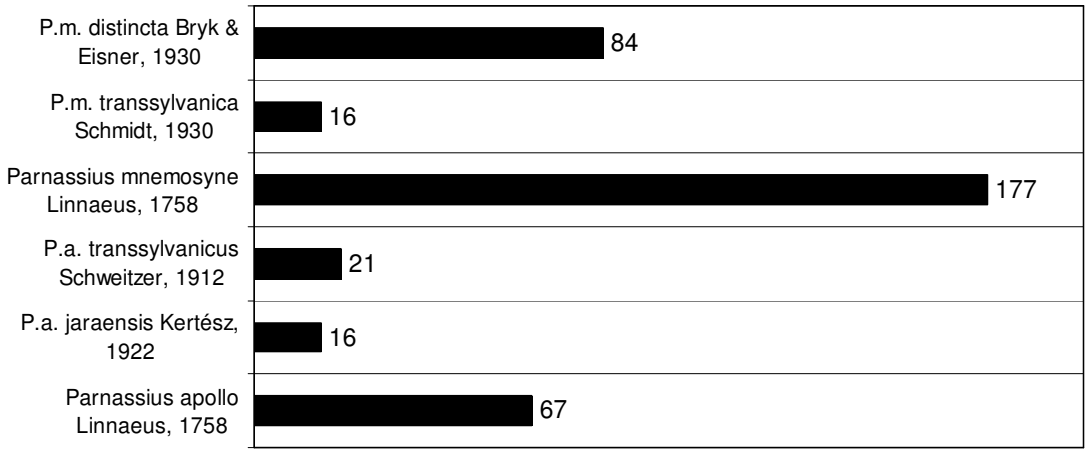

Fig. 1. The number of specimens from the genus *Parnassius* Latreille, 1804 preserved in the Natural History Museum Collection from Sibiu.

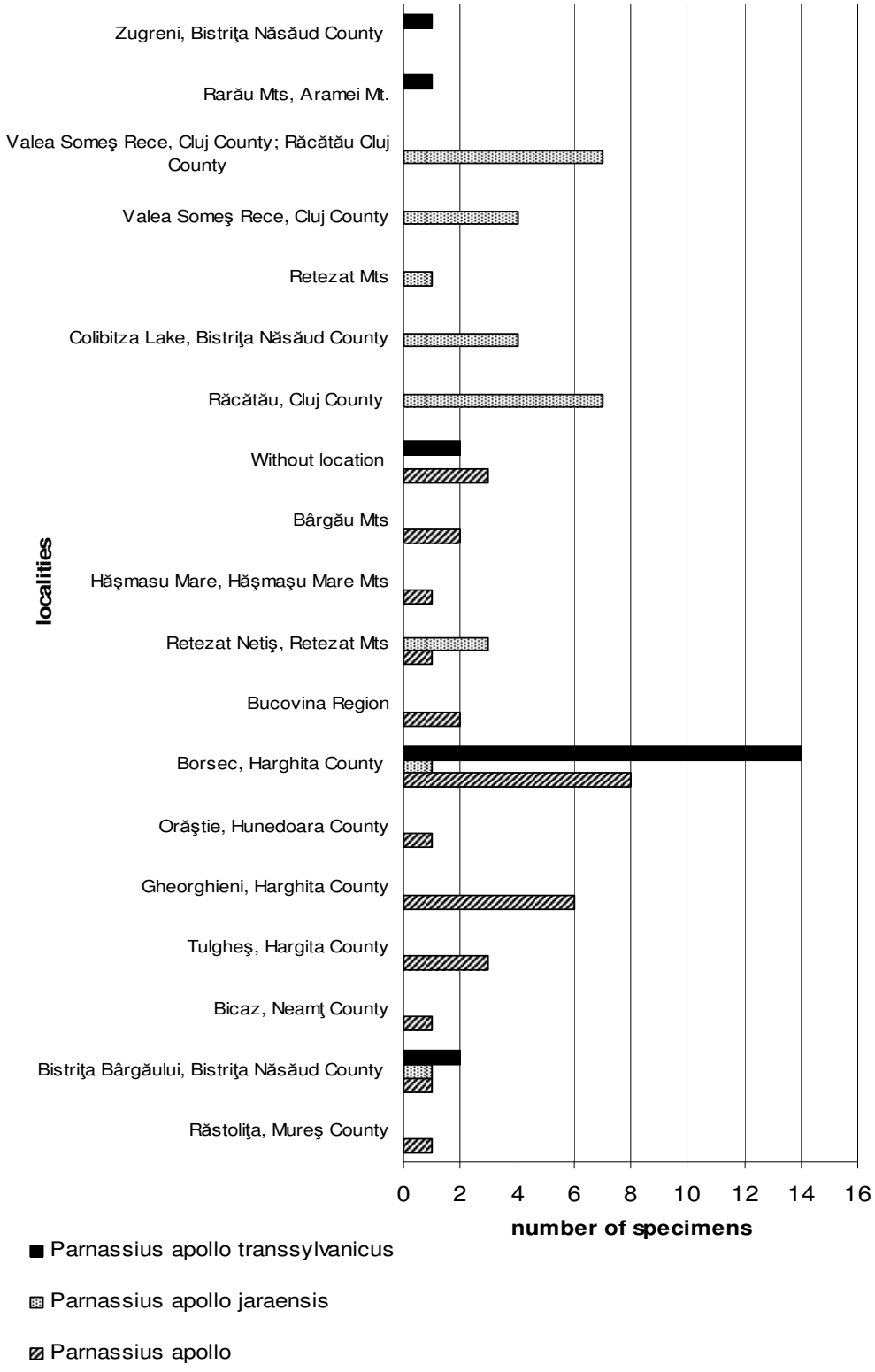

Fig. 2. The collecting sites of *Parnassius apollo* (Linnaeus, 1758) according to Natural History Museum Collection from Sibiu

Fig. 3. *Parnassius apollo* (Linnaeus, 1758) distribution according to Natural History Museum Collections from Sibiu; representations: square - *Parnassius apollo*; pentagon – *P. a. jaraensis*; circle - *P. a. transsylvanicus* (map source: http://ro.wikipedia.org/).

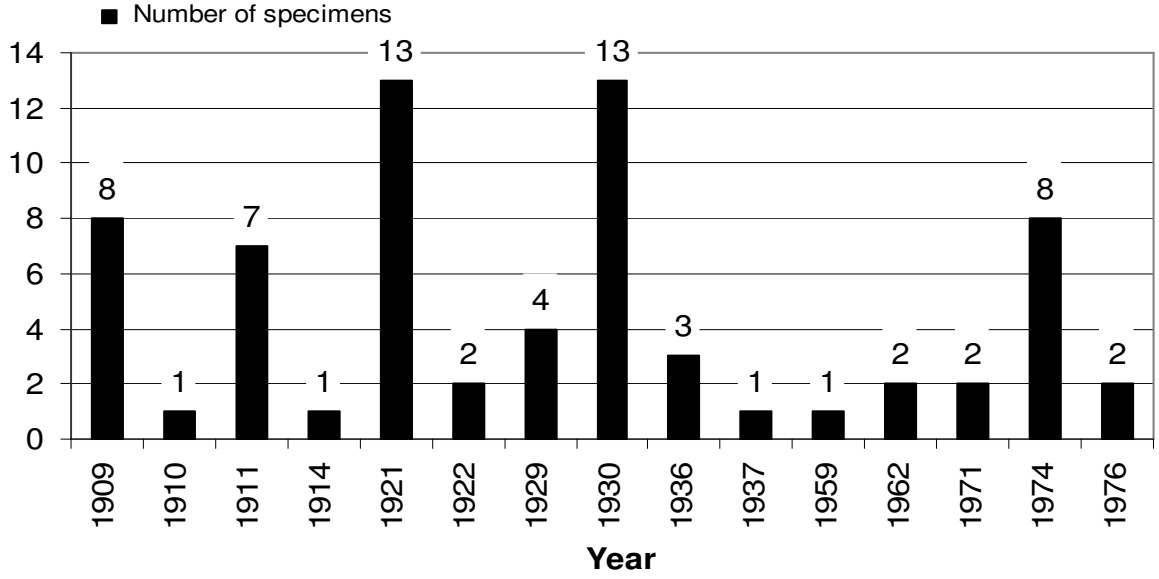

Fig. 4. The sample dates of *Parnassius apollo* (Linnaeus, 1758) according to the Natural History Museum Collection from Sibiu.

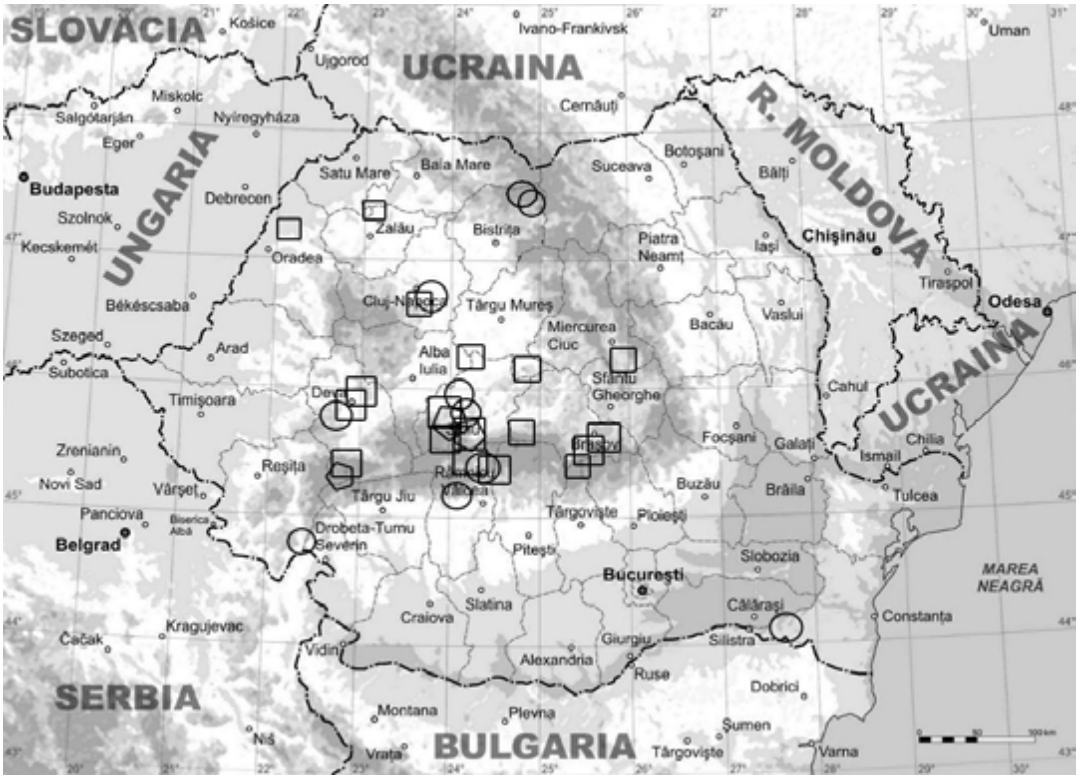

Fig. 5. *Parnassius mnemosyne* (Linnaeus, 1758) distribution according to the Natural History Museum Collection from Sibiu; representations: circle – *Parnassius mnemosyne*, square – *P. m. distincta*, pentagon – *P. m. transsylvanica* (map source: http://ro.wikipedia.org/).

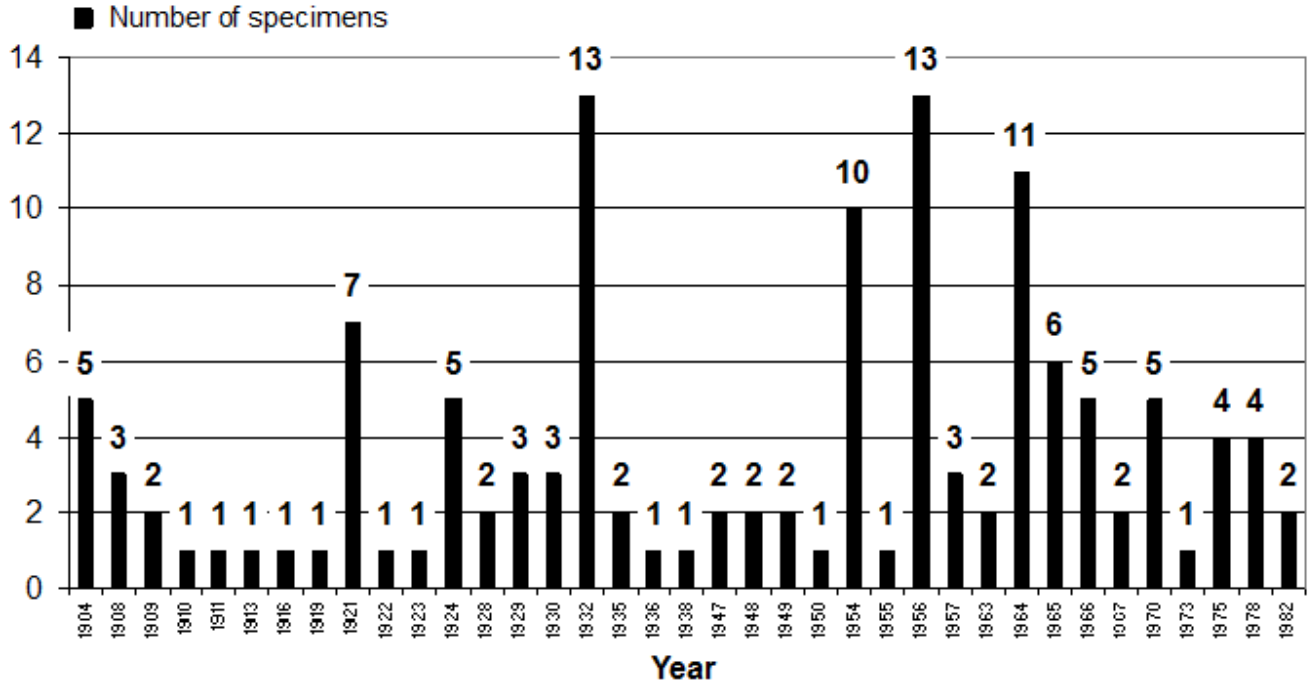

Fig. 6. The sample dates of *Parnassius mnemosyne* (Linnaeus, 1758) in the Natural History Museum Collection from Sibiu.

ASIOTMETHIS LIMBATUS (CHARPENTIER, 1845) (ORTHOPTERA: PAMPHAGIDAE) IN ROMANIA – SPECIFIC HABITATS

Gabriel LUPU[*]
Mihai DOROFTEI[**]

Abstract. *Observed for the first time in south-eastern Romania by Ramme in 1951 and described as a new subspecies from Cogealac (Constanţa County), Asiotmethis limbatus motasi (Ramme, 1951) is endemic for the Romanian territory, being known only from central and southern Dobrogea. The species was discovered in – situ by its calling song and body colour, two major elements in identifying this very mobile insect. There are three major NATURA 2000 habitat types where this taxa have been identified: Subpannonic steppe grasslands described as xerophilous feathergrass steppe grasslands, dry grasslands described as hill and plateau xero-mesophilous grassland, and limestone few fallow steppe grasslands from Dobrogea described as steppe grassland on hill limestone, with an average altitude oscillating between 100 and 150 meters a.s.l.*
Keywords*: Asiotmethis limbatus, Orthoptera, Romania, distribution, specific habitats.*

Rezumat. *Observată pentru prima dată în sud-estul României de Ramme în 1951 şi descrisă ca subspecie nouă din Cogelac (judeţul Constanţa), Asiotmethis limbatus motasi (Ramme, 1951) este endemică pentru teritoriului României, fiind cunoscută numai din Dobrogea centrală şi sudică. Specia a fost identificată în teren pe baza stridulaţiei şi a desenului corporal, două elemente majore în identificarea acestei insecte foarte mobile. Există trei tipuri de habitate NATURA 2000 unde acest taxon a fost identificat: pajişti de stepă sub-panonice descrise ca pajişti de stepă xerofile cu colilie, pajişti xerofile seminaturale descrise ca pajişti xero-mezofile de deal şi podiş, şi pajişti seminaturale calcifile de stepă din Dobrogea descrise ca pajişti de stepă pe dealuri calcaroase, cu altitudine medie ce oscilează între 100 şi 150 metri.*
Cuvinte cheie*: Asiotmethis limbatus, Orthoptera, România, distribuţie, habitate specifice.*

Introduction

Dobrogea territory is characterized by the presence of large mass of water, in the northern part – Danube Delta, and in the same time the presence of an important continental area represented by thermal extremes. The influence of the Black Sea proximity is significantly important both for climate and for influencing the presence and the distribution of the species and their characteristic habitats. Biologically the area is relatively isolated from the other Romanian regions, the presence of the *Bradyporus dasypus* (Illiger 1800) (Iorgu 2009, p.144) and *Asiotmethis limbatus motasi* (Ramme 1951) (Iorgu 2008, p.217) almost exclusively here being the evidence of this fact.

The eastern Balkan species, *Asiotmethis limbatus* (Charpentier, 1845), have been known as being present in Mangalia – Frey-Gessner, 1900, Tulcea – Frey-Gessner, 1902 and Murfatlar – Zotu, 1903 (Kis 1967, p.387). In the data published by the abovementioned author, the species was named as *Eremobia cisti* Brunner 1882 (Kis 1967, p.387).

* Danube Delta National Institute, Tulcea
*glupu@indd.tim.ro; **doroftei@indd.tim.ro

At the same time, the author indicates a new record point in Agigea, the specimen being collected by C. Mândru.

In Romania, *Asiotmethis limbatus* is represented by the subspecies *motasi*, described by Ramme in 1951 and collected from the surroundings of Cogealac, Constanţa County. Apparently this taxa is endemic to Romania. Previous records from literature indicate the subspecies presence in the southern part of Constanţa County in the Natural Reserve Hagieni Forest (Iorgu 2008); in the north-eastern part of the same County, we found a strong population near the Istria village (unpublished). In Tulcea County, the subspecies was reported from the southern part of Babadag forest (Iorgu 2008, p.217) while the northern point of signalization has been recorded in the surroundings of Agighiol village (unpublished), this being the northern known limit of distribution for these subspecies.

In 2005, Togănel and Chimişliu mentioned *Asiotmethis limbatus* as part of the entomological collection of Oltenia Museum's Natural Science section in Craiova. The authors indicate one male

specimen as being collected from Ciuperceni village, Dolj County, by Ioan Firu in August 1976. It is worth mentioning that the subspecies has not been determined at taxonomic level. Furthermore, in Dolj County there are two localities with Ciuperceni name, Ciupercenii Noi and Ciupercenii Vechi villages. For the moment, this record remains unclear for both taxonomical information and localization, being the only observation of this taxa outside of the Dobrogea territory.

Dobrogea's Orthoptera fauna was intensely studied during the past century, Kis being the one who performed complex investigations. He provided the most complete descriptions for *Asiotmethis limbatus* in Romania. Apart from that, the area is characterized by the presence of 113 taxonomical elements (Iorgu *et al.* 2008, p.122, 128) belonging to *Orthoptera* order. Biogeographically the area where the taxon was found is of great importance, because it combines European, Mediterranean and Eurasian Orthopthera elements. It is also the interference point of continental, submediterranean, wet area, steppic and marine climate types as well.
This study offers data concerning the present distribution of *Asiotmethis limbatus* species in Romania and its habitat preferences.

Material and methods

The field investigations were carried out by employing the itinerary method, according to both vegetal associations and landscape forms. The species was identified by means of stridulation and body color, two major elements in identifying these insects. The captures were made using specific entomological mesh. In investigating the distribution of this taxa, the habitat characteristics were a significant reference point. The data was collected during the following research projects: the investigation of Dobrogea's Orthoptera fauna, the elaboration of the atlas of Orthoptera species from Danube Delta, the reconsideration of the limits for the functional area within the Danube Delta Biosphere Reserve, and investigations regarding the climate change in this area. The entomofaunistic studies were conducted during 8 years (2004 - 2011) and provided a series of of interesting elements. The taxa were found in NATURA 2000 habitats and they were described according to the Romanian Grasslands report (Sârbu *et al*. 2004).

The images were taken with a Canon S5IS photo camera.

Results and discussion

Genus *Asiotmethis* belongs to the class *Insecta*, order *Orthoptera*, suborder *Caelifera*, infraorder *Acrididea*, superfamily *Acridoidea*, family *Pamphagidae*, subfamily *Prionotropisinae* (Iorgu *et al* 2008, p.128). Currently there are 24 species and subspecies known in to this genus, widely distributed in central and western Asia and southeastern Europe (Ünal 2007, p.191). It is recorded from eastern Siberia, southern Russia, northwest China, Kazakstan, Kyrgyzstan, Uzbekistan, northern Tajikistan, northern Iran, Azerbaijan, Armenia, northern Turkey, southern Ukraine, northern Greece, Macedonia and Romania (Ünal 2007, p.196). Most of the species are from central Asia.

Diagnosis. *Asiotmethis limbatus* has the metazona of pronotum short and narrow, less raised; hindwing yellow at base, its dark band short, never attaining basal part; inner side of hind legs orange or yellow; arolium small, reaching only to a half-length of claws or less; apical part of penis valves slender, their tips very narrow; posterior margin of epiphallus with a broadly rounded projection (Ünal 2007, p.192).

Ethology. Diurnal insect, *Asiotmethis limbatus* has xerophilous preferences and enjoys sunny places with low and sparse vegetation, generally in the vicinity of some wet areas. In spite of his medium to large corporal dimensions size, the calling song is somehow discreet.

Adults appear in late July and they can be seen until the end of September. It hibernates in egg stage and the larvae hatch in May.

Body length: male 25-28 mm (Fig. 1) (52 individuals measured); female 30-35 mm (Fig. 2) (74 individuals measured).

Habitats. *Asiotmethis limbatus* was observed in five collecting-sites in Dobrogea only (Fig. 5.):
- **Hagieni reserve (Constanţa County)** (43^{o} 47' 56" N, 28^{o} 28' 39" E)

In Hagieni area the Natura 2000 habitat is 6240 - Subpannonic steppe grasslands - and is described as xerophilous feathergrass steppe grasslands. The plant species composition is mainly characterized by *Stipa lessingiana*, *Agropyron cristatum* ssp. *pectinatum*, *Festuca valesiaca*, *Centaurea marschalliana*, *Bombycilaena erecta*, *Taraxacum serotinum*, *Euphorbia nicaeensis* and *Dichanthium ischaemum*, forming a plant association

Bombycilaeno - Botriochloetum Dihoru et Doniţă 1970.

The average altitude is 250 meters a.s.l., with a geological description of 65% - marl-clay deposits, 20% - grit-stone, 15% - sands. The climatic conditions for this flat area are 85% - warm and very warm, 15% - weak cold from temperature perspective, and from humidity point of view 85% - dry, 15% - few wet. The average cover of ligneous plants is 3 % (Sârbu *et al*. 2004, 31).

The second Natura 2000 habitat 4030 is in Hagieni area - Dry grasslands described as hill and plateau xero-mesophilous grasslands. The plant species composition is mainly characterized by *Achillea coarctata*, *Dichanthium ischaemum*, *Carex humilis*, *Convolvulus cantabrica*, *Dorycnium herbaceum*, *Festuca valesiaca*, *Tragopogon flocosus*, *Oxytropis pilosa*, *Stipa capillata*, *Iris pumila*, *Sedum sartorianum* ssp. *hillebrandtii*, *Centaurea trinervia*, *Salvia nutans*, *Dictamnus albus*, *Carpinus orientalis*, *Eryngium campestre* and *Goniolimon tataricum*, thus forming a plant association *Artemisio austriacae – Poetum bulbosae* Pop 1970.

The average altitude is 350 meters a.s.l., with a geological description of 45% - marl deposits, 15% - calcareous rocks and 10% - flysch. The climatic conditions for this flat area are 80% - warm and very warm, 20% - moderately cold from temperature perspective and from humidity point of view 80% - dry, 20% - moderately wet. The average cover of ligneous plants is 5 % (Sârbu *et al*. 2004, p. 30).

- **Istria village (Constanţa County)** (44^{o} 33’ 50” N, 28^{o} 42’ 23” E)

In Histria area (Fig. 3.) the Natura 2000 habitat type is 2130* - Fixed coastal dunes with herbaceous vegetation (grey dunes) (Schneider, Drăgulescu 2005, p. 51), and is described as dry continental dune grassland. The plant species composition is mainly characterized by *Achillea ochroleuca*, *Alyssum desertorum*, *Bassia laniflora*, *Bromus tectorum*, *Centaurea diffusa*, *Carex stenophylla*, *Chondrilla juncea*, *Dianthus diutinus*, *Festuca vaginata*, *Euphorbia seguieriana*, *Polygonum arenarium*, *Plantago arenaria*, *Koeleria glauca* and *Helichrysum arenarium*, thus forming a plant association *Brometum tectorum* Bojko 1934.

The average altitude is 50 meters a.s.l., with a geological description of 90% - sands, 10% - alluvial sands. The climatic conditions for this flat area are 84% - warm and very warm, 16% - cold from temperature perspective and from humidity point of view 84 - dry, 16% - moderately wet (Sârbu *et al*. 2004, 26).

- Southern part of **Babadag Forest (Tulcea County)** (44^{o} 48’ 29” N, 28^{o} 42’ 45” E)

In Babadag area the Natura 2000 habitat is 6110 - Limestone few fallow steppe grassland from Dobrogea and is described as steppe grassland on hill limestone. The plant species composition is mainly characterized by *Agropyron cristatum, Euphorbia nicaeensis*, *Dianthus nardiformis*, *Thymus zygioides*, *Pimpinella tragium* ssp. *lithophila*, *Scorzonera mollis* and *Teucrium polium* ssp. *Capitatum*, thus forming a plant association *Festucetum callierii*, Şerbănescu 1965.

The average altitude is 250 meters a.s.l., with a geological description of 55% - limestone rocks, 30% - conglomerate rocks, 15% - gritstone. The climatic conditions for this flat area are 85% - warm and very warm, 15% - moderately cold from temperature perspective and from humidity point of view 85% - dry, 15% - moderately wet. The average cover of ligneous plants is 2 % (Sârbu *et al*. 2004, p.33).

The second Natura 2000 habitat type found in Babadag area is 6240 - Subpannonic steppe grasslands and is described as xerophilous feathergrass steppe grasslands. The plant species composition is mainly characterized by *Stipa lessingiana, Festuca valesiaca, Bombycilaena erecta*, *Dianthus capitatus*, *Euphorbia nicaeensis*, *Dichanthium ischaemum*, thus forming a plant association *Bombycilaeno - Botriochloetum* Dihoru et Doniţă 1970.

The average altitude is 250 meters a.s.l., with a geological description of 65% - marl-clay deposits, 20% - grit-stone, 15% - sands. The climatic conditions for this flat area are 85% - warm and very warm, 15% - weak cold from temperature perspective and from humidity point of view 85% - dry, 15% - few wet. The average cover of ligneous plants is 3 % (Sârbu *et al*. 2004, p.31).

- In the surroundings of **Agighiol village (Tulcea County)** (45^{o} 01’ 26” N, 28^{o} 51’ 44” E)

In Agighiol area (Fig. 4.), the Natura 2000 habitat is 4030 - Dry grasslands from Dobrogea and is described as steppe grassland on hill and plateau xero-mesophilous grasslands. The plant species composition is mainly characterized by *Artemisia*

austriaca, *Dichanthium ischaemum, Festuca valesiaca, Cleistogenes serotina, Stipa capillata*, *Goniolimon tataricum, Oxytropis pilosa, Poa bulbosa* and *Medicago lupulina*, thus forming a plant association *Medicagini – Festucetum valesiacae* Wagner 1941, *Artemisio austriacae – Poetum bulbosae* Pop 1970.

The average altitude is 350 meters a.s.l., with a geological description of 45% - marl deposits, 15% - calcareous rocks, 10% - flysh. The climatic conditions for this flat area are 80% - warm and very warm, 20% - moderately cold, from temperature perspective and from humidity point of view 80% - dry, 20% - moderately wet. The average cover of ligneous plants is 5 % (Sârbu *et al*. 2004, p.30).

- In central eastern part of **Tulcea County – Movila Cazacului Hill** (in the southern part of **Peceneaga village**) (44^{o} 59' 39" N, 28^{o} 08' 19" E)

In Movila Cazacului area, the Natura 2000 habitat is 6110 - Limestone few fallow steppe grasslands from Dobrogea and is described as steppe grassland on hill limestone. The species composition is mainly characterized by *Festuca callieri*, *Agropyron cristatum* ssp. *brandzae*, *Pimpinella tragium* ssp. *lithophila*, *Thymus zygioides*, *Teucrium polium* ssp. *capitatum* and *Allium saxatile*, thus forming a plant association *Festucetum callierii* Şerbănescu 1965.

The average altitude is 250 meters a.s.l., with a geological description of 55% - limestone rocks, 30% - conglomerate rocks, 15% - gritstone. The climatic conditions for this flat area are 85% - warm and very warm, 15% - moderately cold from temperature perspective and from humidity point of view 85% - dry, 15% - moderately wet. The average cover of ligneous plants is 2 % (Sârbu *et al*. 2004, p.33).

Conclusions

Species with relative large distribution, known from the South-eastern part of Europe and Asian part of Istanbul, *Asiotmethis limbatus* presents some special characteristics in Romania:

- *Asiotmethis limbatus* subspecies *motasi* lives only in Romania, Dobrogea being apparently the single area where its presence has been manifested, the presence in Dolj County being in doubt;
- Being diurnal and predominantly thermophile species, it prefers open spaces with powerful insolation, and low vegetation, near wetland areas;
- There are three major NATURA 2000 habitat where these taxa have been identified: 6240 - Subpannonic steppe grasslands described as xerophilous feathergrass steppe grasslands, 4030 - Dry grasslands described as hill and plateau xero-mesophilous grasslands, and 6110 - Limestone few fallow steppe grasslands from Dobrogea described as steppe grassland on hill limestone, on average altitude oscillating between 100 and 150 meters a.s.l.

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Fig. 3. Specific habitat – Istria area (photo: Gabriel Lupu)

Fig. 4. Specific habitat – Agighiol area (photo: Gabriel Lupu)

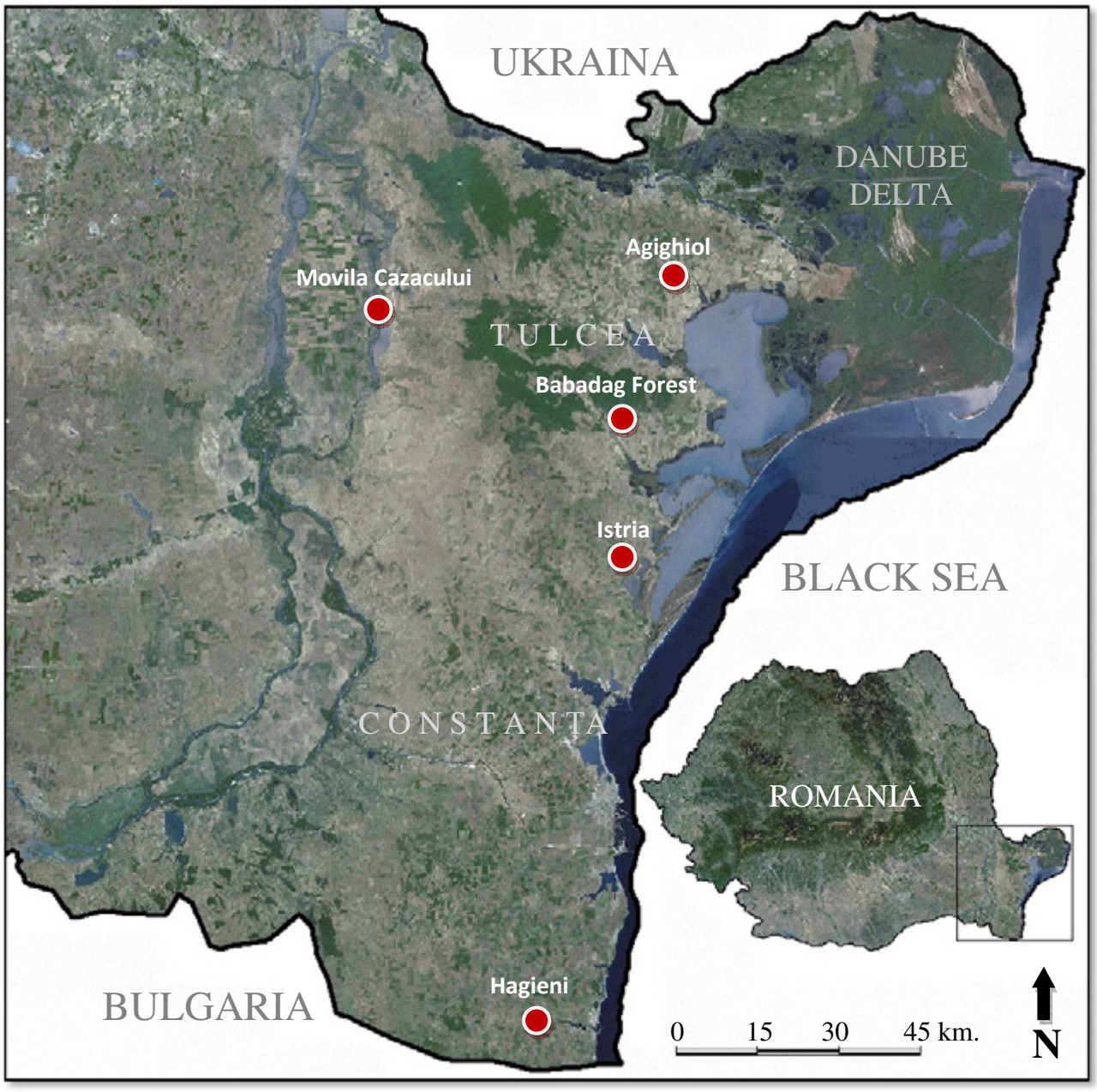

Fig. 5. Distribution of *Asiotmethis limbatus motasi* according to collecting sites (satellite image)

FIRST RECORD OF *ISOPHYA PIENENSIS* IN THE WESTERN ROMANIAN CARPATHIANS (ORTHOPTERA: PHANEROPTERIDAE)

Ionuţ Ştefan IORGU*

Abstract. *The bush-cricket Isophya pienensis Mařan, 1952 is recorded for the first time from the Western Romanian Carpathians. Minor acoustic and morphological variations were noticed between the four studied populations from Romania: Breaza (Suceava County), Bistricioara (Neamţ County), Baia Mare (Maramureş County) and the newly found one at Roşia Montană (Alba County).*
Keywords*: Isophya pienensis, bioacoustics, Carpathians, Romania*

Rezumat. *Cosaşul Isophya pienensis Mařan, 1952 este menţionat pentru prima data din Carpaţii Occidentali, România. Mici variaţii acustice şi morfologice au fost notate între cele 4 populaţii studiate din România: Breaza (judeţul Suceava), Bistricioara (judeţul Neamţ), Baia Mare (judeţul Maramureş) şi nou-găsita populaţie de la Roşia Montană (judeţul Alba).*
Cuvinte cheie*: Isophya pienensis, bioacustică, Carpaţi, România*

Introduction

Currently there are 45 species of *Isophya* Brunner von Wattenwyl in Europe and 17 of these have been found in Romania, 4 being endemic: *Isophya harzi* Kis, *Isophya dobrogensis* Kis, *Isophya sicula* Orci, Szövényi & Nagy and *Isophya ciucasi* Iorgu & Iorgu (Eades *et al.* 2012).

Isophya pienensis Mařan, 1952 is known to occur in Austria, Czech Republic, Slovakia, Poland, Ukraine and Romania (Heller 2012). In Romania, the species populates the mountain meadows of the Eastern Carpathians in Maramureş, Transylvania (Kis 1964, Kis, Vasiliu 1970, Szövényi, Orci 2008), Bucovina and Moldavia (Iorgu 2011). During author's regular field research in Orthoptera, the bush-cricket *Isophya pienensis* was surprisingly found in the Metaliferi Mountains, Western Romanian Carpathians.

This bush-cricket is characterized by a broad left tegmen, angularly convex at the tip of the stridulatory vein and gradually curved inwards cerci, with a detached tooth at the upper edge of the tip (Heller *et al.* 2004). Females have a short ovipositor, 9-10 mm long.

Two subspecies have been recently described from Slovakia, *Isophya pienensis austromoravica* Chládek, 2010 and *Isophya pienensis sudetica* Chládek, 2011.

* Grigore Antipa National Museum of Natural History, nusi81@yahoo.com

Material and methods

All the specimens were collected as adults in a single trip at Roşia Montană, on the 9th of July 2011. Acoustic signals were recorded with the digital recorder EDIROL R-09HR, whose built-in microphones have the sound frequency response between 20-40.000 Hz (96.000 Hz sampling rate). Sound analysis was performed with the software Audacity 2.

Song terminology used: syllable - the sound produced by one complete up (opening) and down (closing) stroke of the forewings; impulse - the highly damped sound impulse resulting from the impact of one tooth of the stridulatory file (Heller *et al.* 2004).

Photos were taken with a Canon EOS DSLR camera and two lenses attached: a Canon 2.8 100 mm 1:1 macro lens was used for habitus photos and a Canon MP-E 65 mm 5:1 macro lens for photos of the morphological details. Male wing movements have been video recorded with the same camera.

Results

Order Orthoptera
Family Phaneropteridae
***Isophya pienensis* Mařan, 1954**

Material. 6♂♂ 3♀♀, Roşia Montană, Metaliferi Mountains, Alba County, Romania, 2011.07.09, leg. I. Ş. Iorgu (Fig. 1)**.**

Comparative material. 2♂♂ 1♀♀, Breaza, Suceava County, Romania, 47°38'31.30"N

25°18'45.81"E, 2011.06.27 (Fig. 1); 7♂♂ 5♀♀ Izvoarele Sucevei, Suceava County, Romania, 47°45'36.59"N 25°12'29.31"E, 2011.06.27; 3♂♂ 4♀♀, Borsec Pass, Harghita County, Romania, 46°57'35.92"N 25°29'24.72"E, 2011.06.30; 2♂♂, Bradu, Neamţ County, Romania, 46°59'55.64"N 25°50'55.70"E, 2011.07.01; 3♂♂ 2♀♀, Bistricioara, Neamţ County, Romania, 47°03'14.13"N 25°56'33.87"E, 2011.07.01; 2♂♂, Baia Mare, Maramureş County, Romania, 47°40'43.42"N 23°34'59.55"E, 2012.06.07; 1♂ 1♀, Dorna Candrenilor, Suceava County, Romania, 47°21'22.34"N 25°17'16.61"E, 2012.06.15; 3♂♂ 1♀, Hăşmaşul Mare Mts., Harghita County, Romania, 46°41'14.87"N 25°49'33.11"E, 2012.07.12; 2♂♂ 2♀♀, St. Ana Lake, Harghita County, Romania, 46°07'16.46"N 25°54'08.47"E, 2012.08.06, leg. I. Ş. Iorgu (Fig. 2).

Audio recordings. 2♂♂ recorded in the field at Breaza, temperature 20°C, 2011.06.27; 2♂♂ recorded in the laboratory, Bistricioara, temperature 22°C, 2011.07.01; 3♂♂ recorded in the field at Roşia Montană, temperature 24°C, 2011.07.09; 1♂ recorded in the laboratory, Baia Mare, temperature 23ºC, 2012.06.07 (wave files, 24 bits/96 kHz).

Literature records: Borşa, Maramureş County, Romania (Kis 1964); Ţibleş Mountains, Rodnei Mountains, Bistriţa-Năsăud County, Romania; Borsec, Sovata, Mureş County, Romania; Harghita, Tuşnad, Harghita County, Romania (Kis, Vasiliu 1970); Săpânţa, Mara, Gutâi Pass, Poienile de Sub Munte, Maramureş County, Romania (Szövényi, Orci 2008) (Fig. 2).

Bioacoustics

The calling song consists of small groups of two or three syllables, repeated after several seconds or minutes, but isolated syllables have also been recorded. A syllable consists of a series of 75-115 impulses, lasting for about 250-500 ms at 20-24°C (Fig. 3). In the last 20-30 impulses, the amplitude of sound gradually decreases. All sounds are produced when the insect closes the tegmina.

The stridulatory file is 3.2-3.6 mm long and bears 205-220 teeth.

The spectrographic analysis reveals the most intense frequencies between 10-40 kHz, with the maximum amplitude at: 28 kHz (Baia Mare), 19 kHz (Bistricioara), 14 kHz (Breaza) and 23 kHz (Roşia Montană) (Fig. 3).

Habitat

At Roşia Montană, near Tăul Mare Lake, *Isophya pienensis* lives in mesophytic grasslands. The specimens were collected from broad leafs of *Urtica*, *Stachys*, *Rubus*, *Salvia*, *Centaurea* etc. The following bush-crickets and grasshoppers were found occurring simpatrically with *Isophya pienensis*: *Isophya stysi* Cejchan, 1957, *Tettigonia viridissima* (Linnaeus, 1758), *Decticus verrucivorus* (Linnaeus, 1758), *Metrioptera bicolor* (Philippi, 1830), *Pholidoptera transsylvanica* (Fischer, 1853), *Pseudopodisma transilvanica* Galvagni & Fontana, 1993, *Arcyptera fusca* (Pallas, 1773), *Euthystira brachyptera* (Ocskay, 1826), *Stauroderus scalaris* (Fischer de Waldheim, 1846), *Chorthippus parallelus* (Zetterstedt, 1821) etc.

Discussion

The bush-cricket *Isophya pienensis* was known in Romania only from the Central and Northern parts of the Eastern Carpathians and most probably the species has the Eastern distribution area limit near the lake Izvorul Muntelui (Bistricioara) (Fig. 2). The new collecting site from the Western Romanian Carpathians is relatively isolated from the other ones, located at more than 150 km from the nearest known locations. No major differences were revealed when we analyzed male acoustic signals, tegminae and cerci in 4 populations: Baia Mare, Breaza, Bistricioara and Roşia Montană (Figs. 3 and 4). However, the male from Baia Mare presents thinner cerci, while the ones from Breaza tend to have them less curved. The same males from Breaza have somewhat shorter wings, but the venation is constant in all populations. Syllables produced by males from Breaza are longer (340-500 ms) compared with the other studied populations (250-380 ms), but the same results were obtained by Heller *et al.* (2004) in individuals from Slovakia, Poland and Ukraine. The males from the newly discovered populations near Roşia Montană do not differ in any morphological or acoustical aspects from the ones in other populations.

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Biologists Mr. Călin Hodor and Dr. Cosmin Ovidiu Manci are acknowledged for making possible the trip to Roşia Montană and for excellent field work conditions. I am grateful to the anonymous reviewers that improved the paper.

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Fig. 1. *Isophya pienensis* habitus

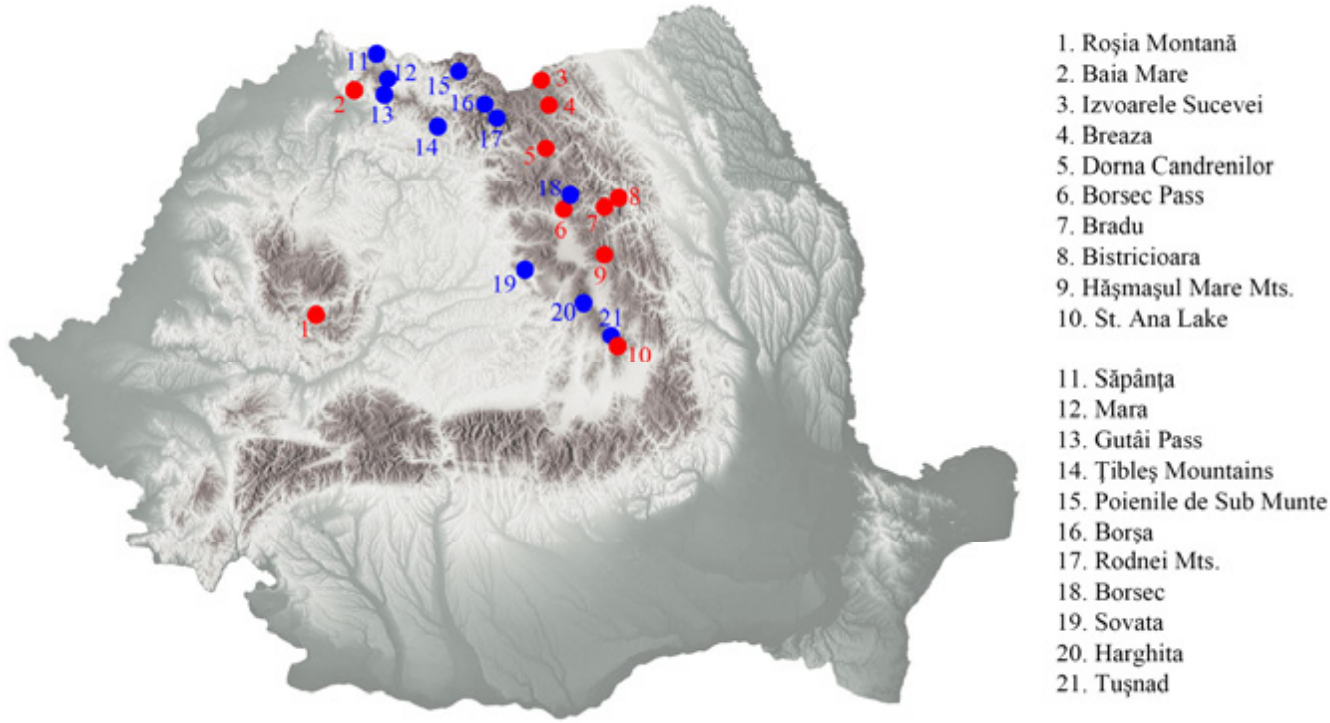

Fig. 2. Distribution of species *Isophya pienensis* in Romania (own data - red points, literature data - blue points).

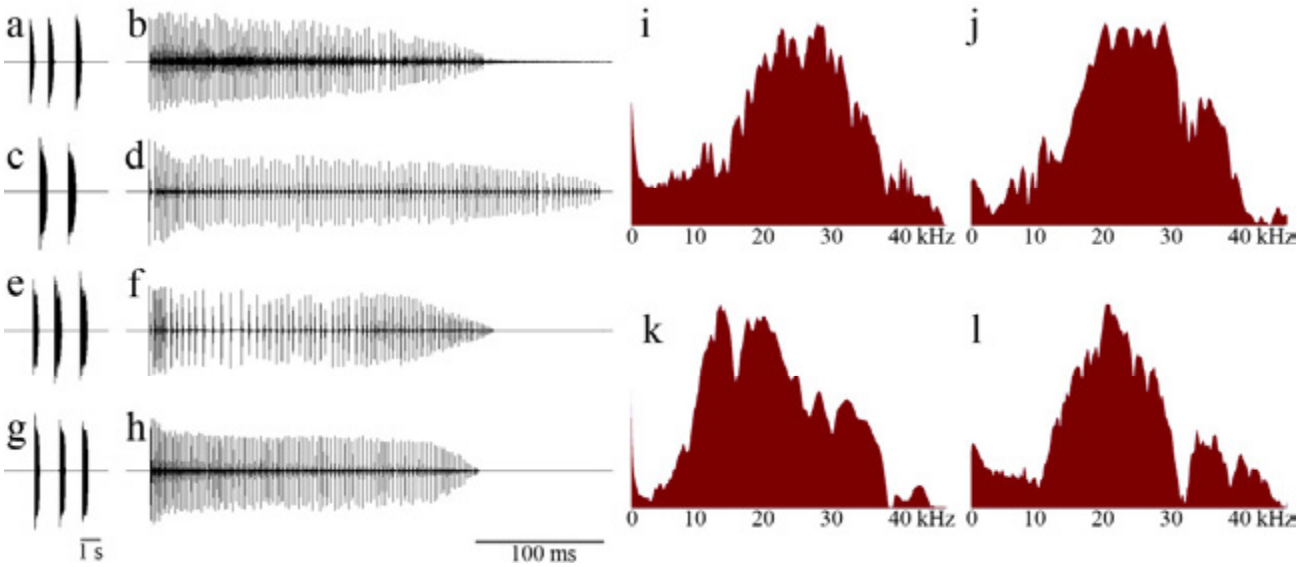

Fig. 3. Oscillographic (a-h) and spectrographic (i-l) sound analysis in *Isophya pienensis*: Baia Mare (a, b, i); Bistricioara (c, d, j); Breaza (e, f, k); Roşia Montană (g, h, l).

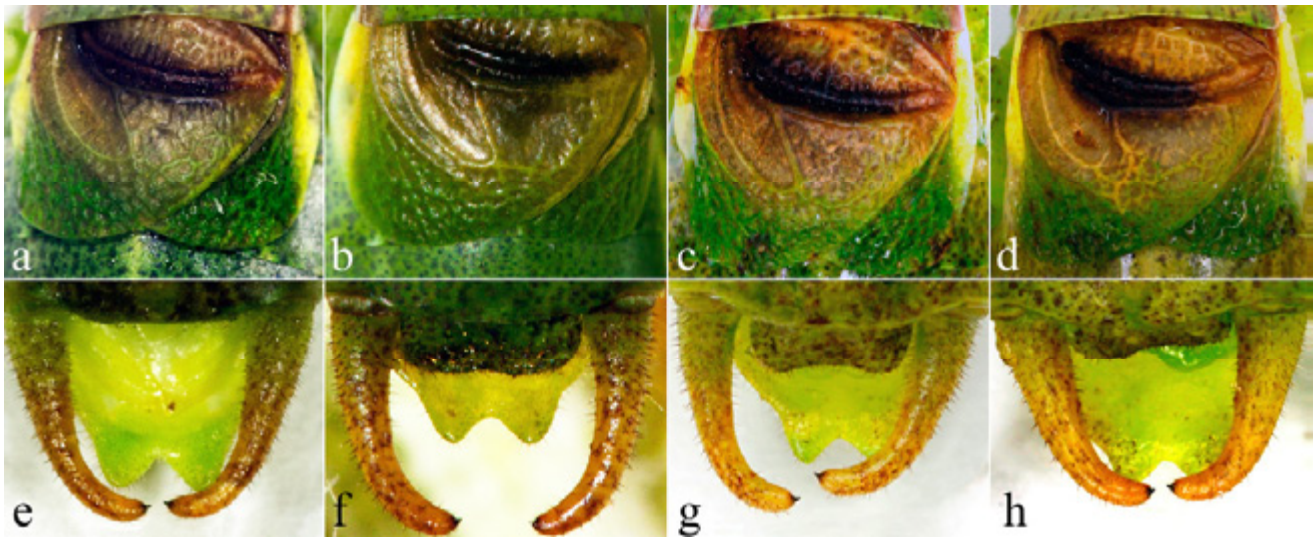

Fig. 4. *Isophya pienensis*: dorsal view of male wings (a, b, c, d) and cerci (e, f, g, h): Baia Mare (a, e); Bistricioara (b, f); Breaza (c, g); Roşia Montană (d, h).

ARMOURED CRICKETS (ORTHOPTERA: TETTIGONIIDAE, BRADYPORINAE) IN THE NATURAL HISTORY MUSEUM COLLECTIONS OF SIBIU (ROMANIA)

Alexandru Ioan TATU*
Ioan TĂUŞAN**

Abstract. *The present paper contains data regarding the armored crickets (Bradyporinae) from the collections of the Natural History Museum of Sibiu preceded by brief details about the subfamily and the collections. The distribution maps of the collecting sites for the identified species are also provided. The preserved material is part of the following collections: "Dr. Arnold Müller", "Rolf Weyrauch", "Dr. Eugen Worell" and "Dr. Eckbert Schneider".*
Keywords*: Bradyporinae, museum collections, systematical inventory, natural heritage.*

Rezumat. *În studiul de faţă, sunt oferite date asupra speciilor de Bradyporinae din colecţiile entomologice ale Muzeului de Istorie Naturală din Sibiu, împreună cu o serie de scurte informaţii legate de subfamilie respectiv de colecţii. Hărţile de distribuţie ale punctelor de colectare a speciilor identificate sunt de asemenea cuprinse în acest studiu. Materialul studiat face parte din următoarele colecţii: "Dr. Arnold Müller", "Rolf Weyrauch", "Dr. Eugen Worell" şi "Dr. Eckbert Schneider".*
Cuvinte cheie*: Bradyporinae, colecţii muzeale, inventar sistematic, patrimoniu natural.*

Introduction

The subfamily Bradyporinae comprises about 155 species (Eades *et al.* 2012). Its members are bulky, rather lazy bushcrickets with their forewings almost entirely covered by the pronotum, while the hindwings are absent. The antennae articulate below the eye level, closer to the clypeus rather than to the vertex (Harz 1969; Iorgu, Iorgu 2008). Their body colour varies from dark, metallic shining to light ochre or green with dark markings, "often with hieroglyph-like streaks or spots" (Harz 1969). For a more detailed description of their morphology see the aforementioned study. Concerning their distribution in Europe, they do not occur in the North, being limited to its central, southern and eastern parts (Fig. 1). Worldwide, according to Heller (2012), they can be found in the Near East and in the northern areas of Africa.

In Romania, several other papers exclusively concerning this subfamily have been undertaken by Vasiliu (1961), Kis (1962) and Iorgu (2009). Apart from these, the Orthoptera in the "Arnold Müller" collection have been researched by Vasiliu and Agapi who in 1958 published a catalogue of the collection.

* Babeş-Bolyai University of Cluj-Napoca, alex_tatu@ymail.com, ioan.tausan@ubbcluj.ro
**Brukenthal National Museum, Natural History Museum, itausan@gmail.com

The entomological collections hosted at the Natural History Museum of Sibiu are some of the oldest and most valuable collections in Romania, dating back to 1827 (Pascu & Schneider, 1998).

This study aims to give an account of the armoured crickets present in the collections of the Sibiu museum.

Material

The preserved material is part of the four collections described below.

The "Arnold Müller" collection of Transylvanian and Palearctic Orthoptera is part of the wider Transylvanian Society for Nature Science of Sibiu collection and comprises 5.133 specimens. There are 12 species of armoured crickets in this collection. The "Rolf Weyrauch" entomological collection contains 16.436 specimens, of which 155 belong to the order Orthoptera and two species to the subfamily Bradyporinae. The specimens were collected mainly from 1950 to 1965 from Transylvania, especially from the surroundings of Sibiu. The "Eugen Worell" entomological collection contains 93.897 specimens (1041 Orthoptera). Its great value is given not only by this numbers but also by the fact that many of the species are rare, little known and some even new (Pascu & Schneider, 1998). There are two species of Bradyporinae in this collection. The "Eckbert Schneider" collection comprises 20.000 insect

specimens collected from all over the country, but mainly from the southern area of Transylvania. As in the previous collections, two species of armoured crickets have been found. The collection is still in state of processing (Pascu & Schneider, 1998). All four collections contribute to the knowledge of the species' distribution.

For the nomenclature and systematical order, we followed Eades *et al*. (2012) and Heller (2012).

The following abbreviations will be used in this paper: BG - Bulgaria; DZ - Algeria; ES - Spain; FR - France, GR - Greece; HR - Croatia; RO - Romania; RS - Serbia; Mts. - Mountains; spec./specs - specimen/specimens.

Listing of the species

Order Orthoptera
Family Tettigoniidae
Subfamily Bradyporinae

"Arnold Müller" Collection

Bradyporus Charpentier, 1825
Bradyporus (Bradyporus) dasypus (Illiger, 1800)

1 spec., Bălcic (Balcic, BG), VII. 1926, leg. Lepşi; 1 spec., Balcic (BG), VIII.1927; 1 spec., Babadag, Tulcea (Tulcea County, RO), 25.VII.1928; 1 spec., Caliacra, Bolatasteppe, Eichenm. (Bolata, Kaliakra, BG), leg. Müller, 22.VII.1926; 2 specs., Kaliakra, Bolatastepe, Eichenm. (Bolata, Kaliakra, BG), leg. Müller, 22.VII.1926; 1 spec., Kaliakra, Bolatasteppe, Eichensteppe (Bolata, Kaliakra, BG), leg. Müller, 22.VII.1926; 1 spec., Kaliakra, Bolatasteppe (Bolata, Kaliakra, BG), leg. Müller, 22.VII.1926; 1 spec., Dobrudscha, Maciner Berge (Măcin Mts., Dobrogea, RO), leg. Müller, 12.VII.1927; 1 spec., Slava-Rusă, Tulcea (Slava Rusă, Tulcea County, RO), 5.VII.1928; 1 spec., Slava-Rusă (Slava Rusă, Tulcea County, RO), VII.1928.

Bradyporus (Callimenus) macrogaster longicollis (Fieber, 1853)

1 spec., Serbia, Nisch (Niš, RS), leg. V. Örtzen; 1 spec., Caliacra, Bolatasteppe, Eichenm. (Bolata, Kaliakra, BG), leg. Müller, 22.VII.1926.

Bradyporus (Callimenus) montandoni (Burr, 1898)

1 spec., Greci-Olt (Greci, Olt County, RO), 17.VI.1927; 2 specs., Plopşor, Dolju (Plopşor, Dolj County, RO), VII.1925;

Comments: The material is labelled as *Callimenus oniscus* in the collections, however the species is not found in Romania (Iorgu *et al.* 2008).

Bradyporus (Callimenus) oniscus (Burmeister, 1838)

4 specs., Kaliakra, Bolatasteppe, Eichenm. (Bolata, Kaliakra, BG), leg. Müller, 22.VII.1926; 1 spec., Balcic (Balcic, BG), VII.1927; 1 spec., Serbia, Nisch (Niš, RS), leg. Örtzen; 1 spec., Graecia, Atika (Attica, GR), leg. Örtzen.

Ephippiger Berthold, 1827
Ephippiger ephippiger (Fiebig, 1784)

2 specs., Caracal, Rümänien (Caracal, Olt County, RO), leg. Despaletz, 21.IX.1923; 1 spec., Herculesbad (Băile Herculane, Caraş-Severin County, RO), leg. Müller, 26.VIII.1925; 1 spec., leg. Müller, 26.VIII.1925.

Comments: The material is labeled as *E. vitium* in the collection, but this species is also not found in Romania (Iorgu *et al.* 2008).

Ephippiger diurnus cunii Bolívar, 1877

1 spec., Bulgarien, Pirin, Elteppe (Pirin Mts., BG), leg. Müller, 2.VIII.1931; 1 spec., Bulgarien, Pirin, Elteppe (Pirin Mts., BG), leg. Müller, 7.VIII.1931; 2 specs., Bulgarien, Pirin, Elteppe (Pirin Mts., BG), leg. Müller, 7.VIII.1931; 1 spec., Rivesaltes (FR), VI.1891.

Comments: The first four specimens, collected from Bulgaria cannot be *Ephippiger diurnus cunii*, as this species' distribution is limited to Spain and France (Eades *et al.* 2012).

Ephippiger provincialis Yersin, 1854
syn. *Ephippigera provincialis* (Yersin 1854)

1 spec., Collection Lucien Chopard 1919, Museum Paris, Banyuls (FR), det. Bolívar, 9.IX.1909; 1 spec., Museum Paris, St. Tropez (FR), leg. Bossavy, 1891.

Ephippiger discoidalis Fieber, 1853
syn. *Ephippigera sphacophila* Krauss, 1879

1 spec., Dalmaţia (HR), leg. Örtzen.

Uromenus Bolívar, 1878
Uromenus laticollis (Lucas, 1846-1849)

1 spec., ♀, Chabet el Ameur (DZ), 23.VI.1884.

Uromenus rugosicollis (Serville, 1838)

1 spec., Museum Paris, leg. Haury, 1907.

Steropleurus Bolívar, 1878
Steropleurus brunnerii (Bolívar, 1876-1878)

1 spec., Montarco Bei Madrid (Madrid, ES), leg. Ebner, 16.VII.1924; det. Ebner, 1925; 1 spec.,

Montarco Bei Madrid (Madrid, ES), leg. Ebner, 16.VII.1924; det. Ebner, 1925.

Lluciapomaresius Barat, 2012
Lluciapomaresius stalii (Bolívar, 1878)

1 spec., Sierra de Guadarrama, Cercedilla, Kastilien (Madrid, ES), leg. Ebner, 18-24.VII. 1924.

"Rolf Weyrauch" Collection

Bradyporus (Bradyporus) dasypus (Illiger, 1800)

2 specs., S.W. Dobr., V. Iortmac (Iortmac Lake, Lipniţa, Constanţa County, RO), leg. Weyrauch, 22/23.VI.1965; 1 spec., S.W. Dobr., V. Iortmac (Iortmac Lake, Lipniţa, Constanţa County, RO), leg. Weyrauch, 25.VI.1966; 1 spec., S.W. Dobr., V. Iortmac (Iortmac Lake, Lipniţa, Constanţa County, RO), leg. Weyrauch, 25.VI.1966.

Ephippiger ephippiger (Fiebig, 1784)

1 spec; 1 spec., H.B. (Băile Herculane ?, Caraş-Severin County, RO), 15.VII.1957; 1 spec., Talmasch (Tălmaciu, Sibiu County, RO), 7.VII.1955; 1 spec., Rah. B. ?, 27.VII.1955.

"Eckbert Schneider" Collection

Bradyporus (Bradyporus) dasypus (Illiger, 1800)

3 specs., Dobrogea, Babadag (RO), leg. Schneider, 21.VI.1972.

Ephippiger ephippiger (Fiebig, 1784)

1 spec., Zakelsberg (Dealul Zakel), Sibiu County, RO), det. Worell, 1.IX.1954; 2 specs., Hammersdf. Bg b. Hermannstadt (Guşteriţa, Sibiu County, RO), leg. Schneider, 10.X.1969; 1 spec., Hammersdf. (Guşteriţa, Sibiu County, RO), leg. Schneider, 24.IX.1965; 1 spec., Talmaciu, Deal. cu Pini (Tălmaciu, Sibiu County, RO), leg. Schneider, 21.IX.1975; 1 spec., Boiţa Wartberg (Boiţa, Sibiu County, RO), leg. Schneider, 26.IX:1967; 1 spec., Vânturariţa (Vâlcea County, RO), leg. Schneider, 25. VIII.1964.

"Dr. Eugen Worell" Collection

Bradyporus (Bradyporus) dasypus (Illiger, 1800)

1 spec., Kaliakra, Bolatasteppe, Eichensteppe (Bolata, Kaliakra, BG), leg. Müller, 22.VII.1926; 1 spec., Caliacra, Bolatasteppe, Eichenm. (Bolata, Kaliakra, BG), leg. Müller; 1 spec., Donaudelta (Danube Delta, RO), leg. v. Spiess, det. Worell; 1 spec., Livezi, Doljiu, (Dolj County, RO), VIII.1925.

Comments: The last specimen is in fact a specimen of *Callimenus montandoni*, as the species is limited to Dobrogea (Iorgu 2009).

Ephippiger ephippiger (Fiebig, 1784)

2 specs., Michelsberg, Bei Hermannstadt (Cisnădioara, Sibiu County, RO), leg. Worell, 6.X.1941; 1 spec., Zakelsberg, Stolzburg (Dealul Zakel, Slimnic, Sibiu County, RO), leg. Worell, 26.VII.1947; 1 spec., Zakelsberg, Stolzenburg (Dealul Zakel, Slimnic, Sibiu County, RO), leg. Worell, 8.IX.1947; 1 spec., Götzenberg, Hermannstadt (Măgura Cisnădiei, Sibiu County, RO), leg. Worell, 18.VIII.1946; 1 spec., Hermannstadt, Hammersd., BG (Guşteriţa, Sibiu County, RO), leg. Worell, 16.VIII.1943; 1 spec., Hermannstadt, Hammersd., BG (Guşteriţa, Sibiu County, RO), leg. Worell, 17.VII.1945; 1 spec., Hermannstadt, Hammersd., BG (Guşteriţa, Sibiu County, RO), leg. Worell; 2 specs., Herkulesbad (Băile Herculane, Caraş-Severin County, RO), leg. Worell, 9.VI.1942; 2 specs., without other data.

Results and discussions

There are 12 species of armoured crickets in the entomological collections of the Natural History Museum of Sibiu, most of them preserved in the "Arnold Müller" collection: *Bradyporus (Bradyporus) dasypus* (Illiger, 1800), *Bradyporus (Callimenus) macrogaster longicollis* (Fieber, 1853), *Ephippiger ephippiger* (Fiebig, 1784) and *Bradyporus (Callimenus) montandoni (Burr, 1898)* which are present in the Romanian fauna (Iorgu *et al.* 2008) as well as eight additional foreign species: *Bradyporus (Callimenus) oniscus* (Burmeister, 1838), *Ephippiger diurnus cunii* Bolívar, 1877, *E. provincialis* Yersin, 1854, *E. discoidalis* Fieber, 1853, *Uromenus laticollis* (Lucas, 1846-1849), *U. rugosicollis* (Serville, 1839), *Steropleurus brunnerii* (Bolívar, 1876-1878) and *Lluciapomaresius stalii* (Bolívar, 1878).

Most of the specimens were collected from Romania, Bulgaria, the Czech Republic, Serbia, Spain, Greece and Algeria; however, others were obtained through exchanges with other collectors or museums (e.g. *Ephippiger provincialis* and *Uromenus rugosicollis* with the Museum of Paris or *Steropleurus brunnerii* and *Lluciapomaresius stalii* with Ebner, all of them being part of the "Arnold Müller"collection).

The subfamily *Bradyporinae* is systematically difficult and re-identification of all the specimens should be undertaken. However, of the ones listed

above, eight were definitely inaccurately identified. In the "Arnold Müller" collection, the three *Callimenus oniscus* specimens collected in Plopşor and Greci are actually *Callimenus montandoni*, the former taxon not being present in the Romanian fauna (Iorgu *et al.* 2008). The situation is identical with one of the *Bradyporus dasypus* specimens from the "Eugen Worell" collection, which was found in Livezi, in Romania this species being limited to Dobrogea (Iorgu 2009). The presence of one specimen of *Bradyporus dasypus* in the Danube Delta (also from the "Eugen Worell" collection) is another interesting finding, unknown so far. It is not specified on the label whether the specimen was found strictly in the delta or outside of it, in other parts of the reserve such as the Razelm-Sinoe lakes where the species may be present. There is also the issue of the four specimens of *Ephippiger diurnus cunii* which are not present in the Bulgarian fauna. They could not be reidentified.

The collecting sites for all the specimens are displayed in Fig. 2 to 8.

Acknowledgements

The authors are grateful for the comments of Ionuţ Ştefan Iorgu and Gabriel Lupu, which significantly improved the first version of the manuscript.

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LIST OF ILLUSTRATIONS

LISTA ILUSTRAŢIILOR

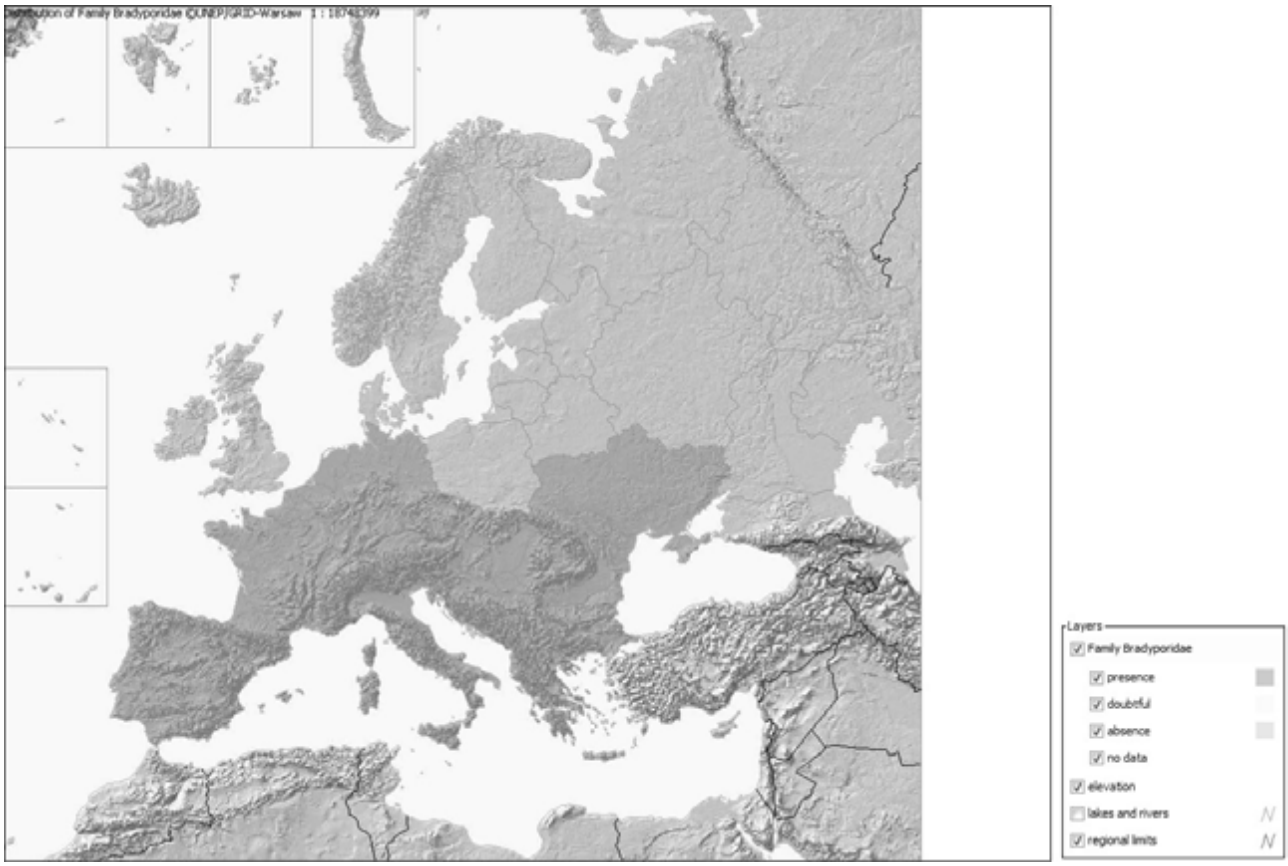

Fig. 1. Distribution of armoured crickets in Europe, according to Heller (2012)

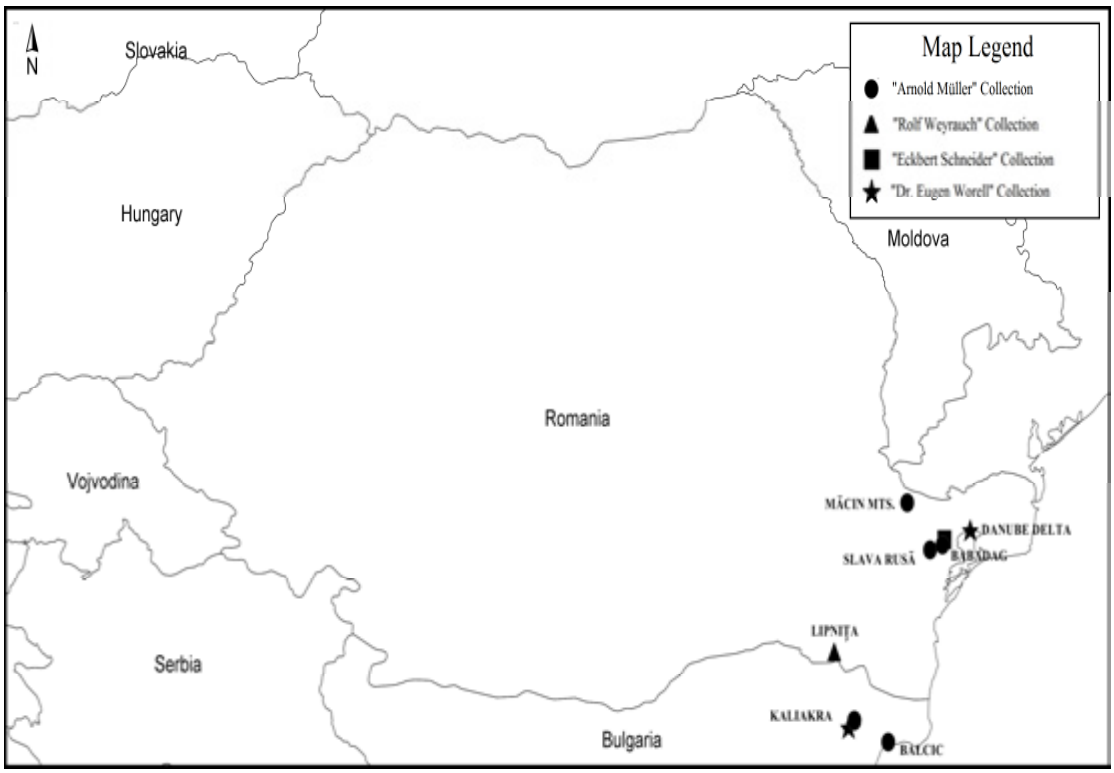

Fig. 2. Distribution of *Bradyporus (Bradyporus) dasypus* (Illiger, 1800) based on museum collections

Fig. 3. Distribution of *Bradyporus (Callimenus) macrogaster longicollis* (Fieber, 1853), based on museum collections

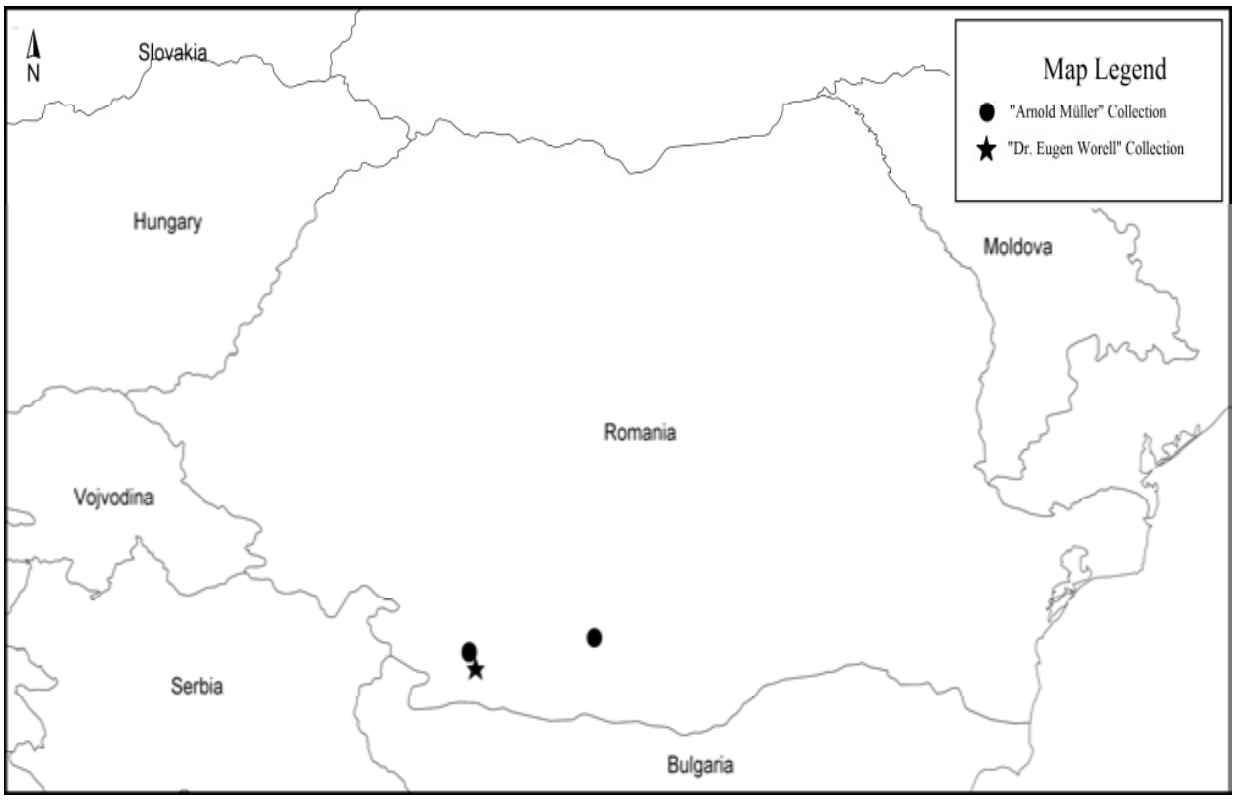

Fig. 4. Distribution of *Bradyporus (Callimenus) montandoni* (Burr, 1898), based on museum collections

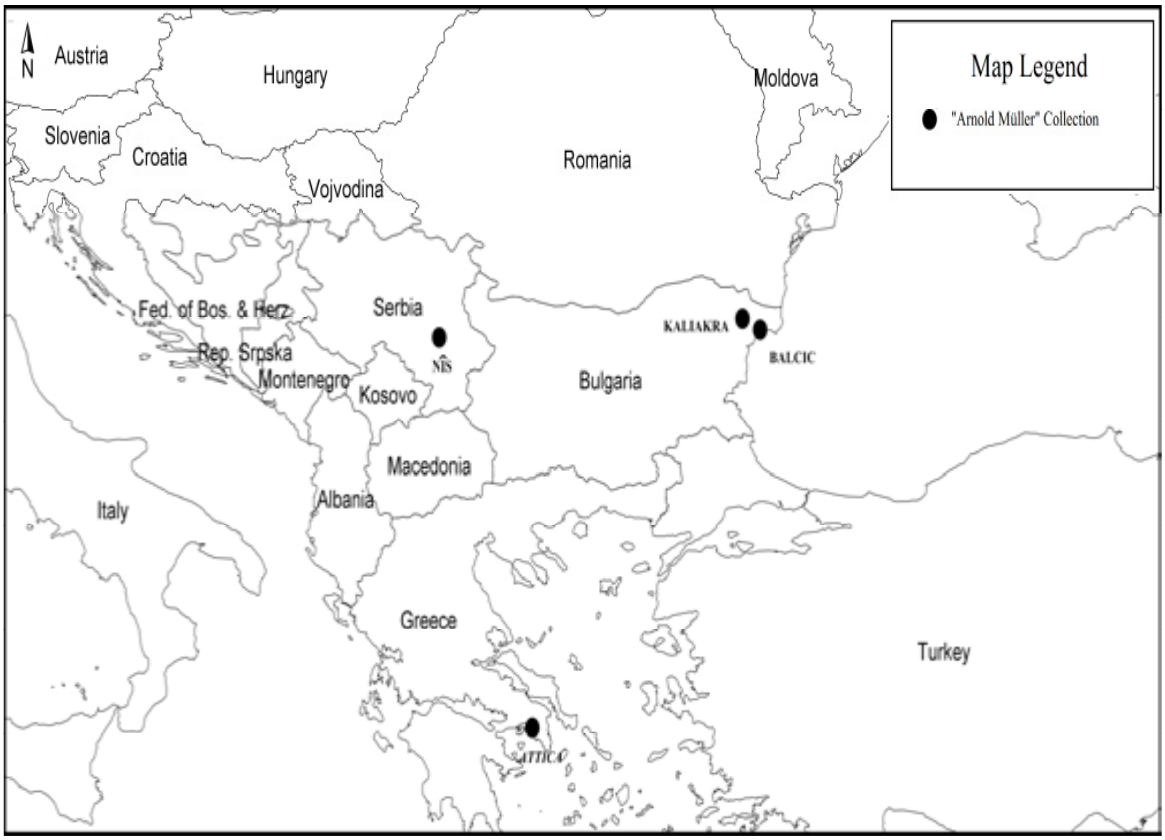

Fig. 5. Distribution of *Bradyporus (Callimenus) oniscus* (Burmeister, 1838), based on museum collection

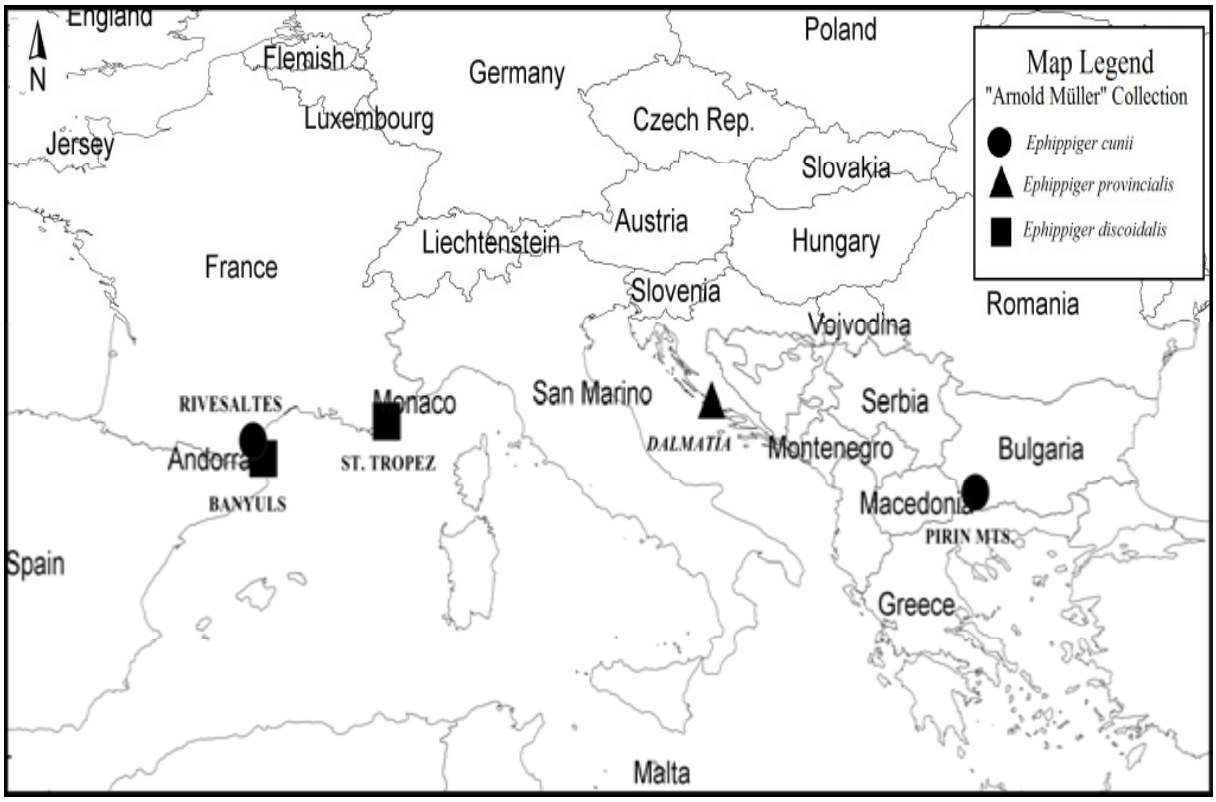

Fig. 6. Distribution of *Ephippiger diurnus cunii* Bolívar, 1877, *Ephippiger provincialis* Yersin, 1854 and *Ephippiger discoidalis* Fieber, 1853, based on museum collection

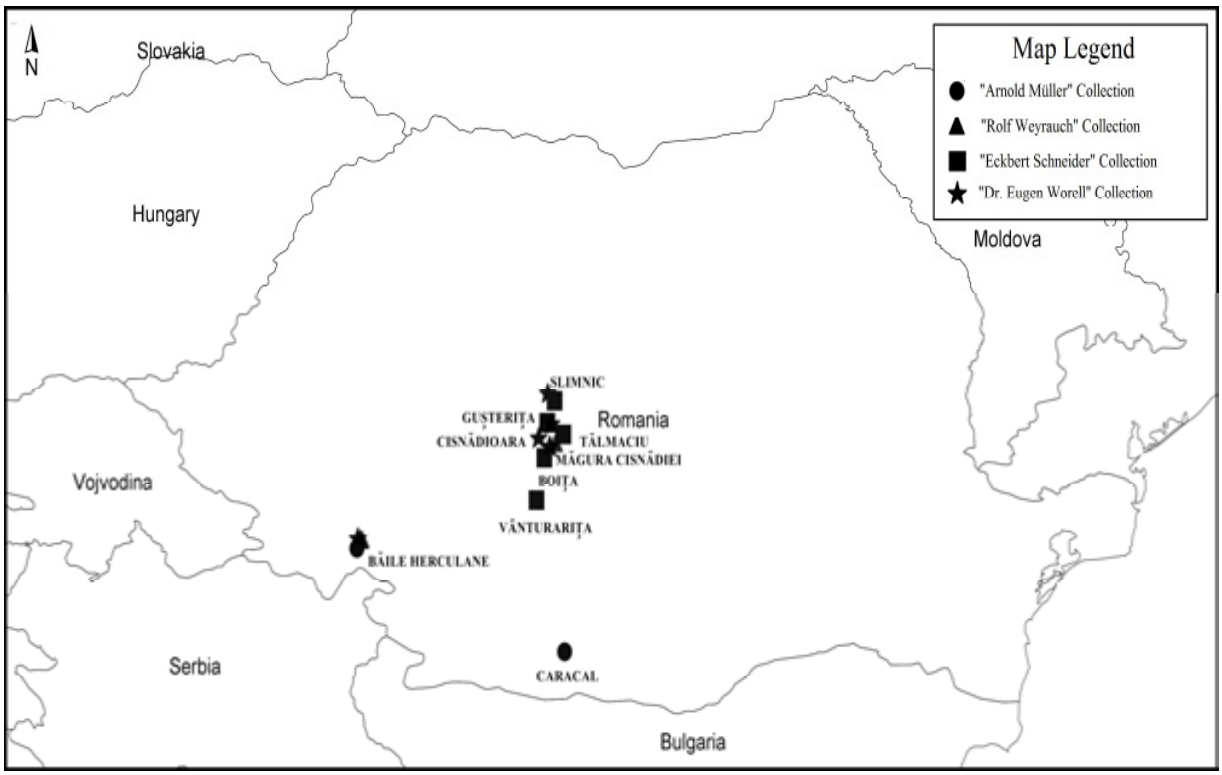

Fig. 7. Distribution of *Ephippiger ephippiger* (Fiebig, 1784), based on museum collections

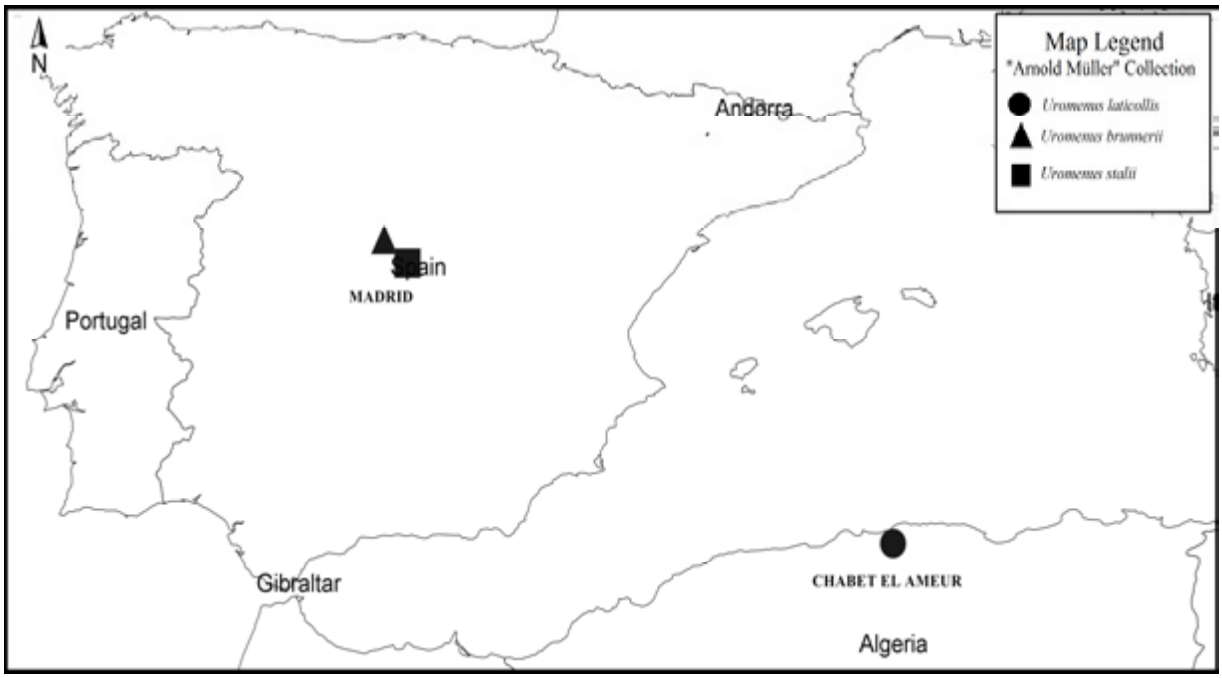

Fig. 8. Distribution of *Uromenus laticollis* (Lucas, 1846-1849), *Steropleurus brunnerii* (Bolívar 1876-1878), *Lluciapomaresius stalii* (Bolívar, 1877), based on museum collection

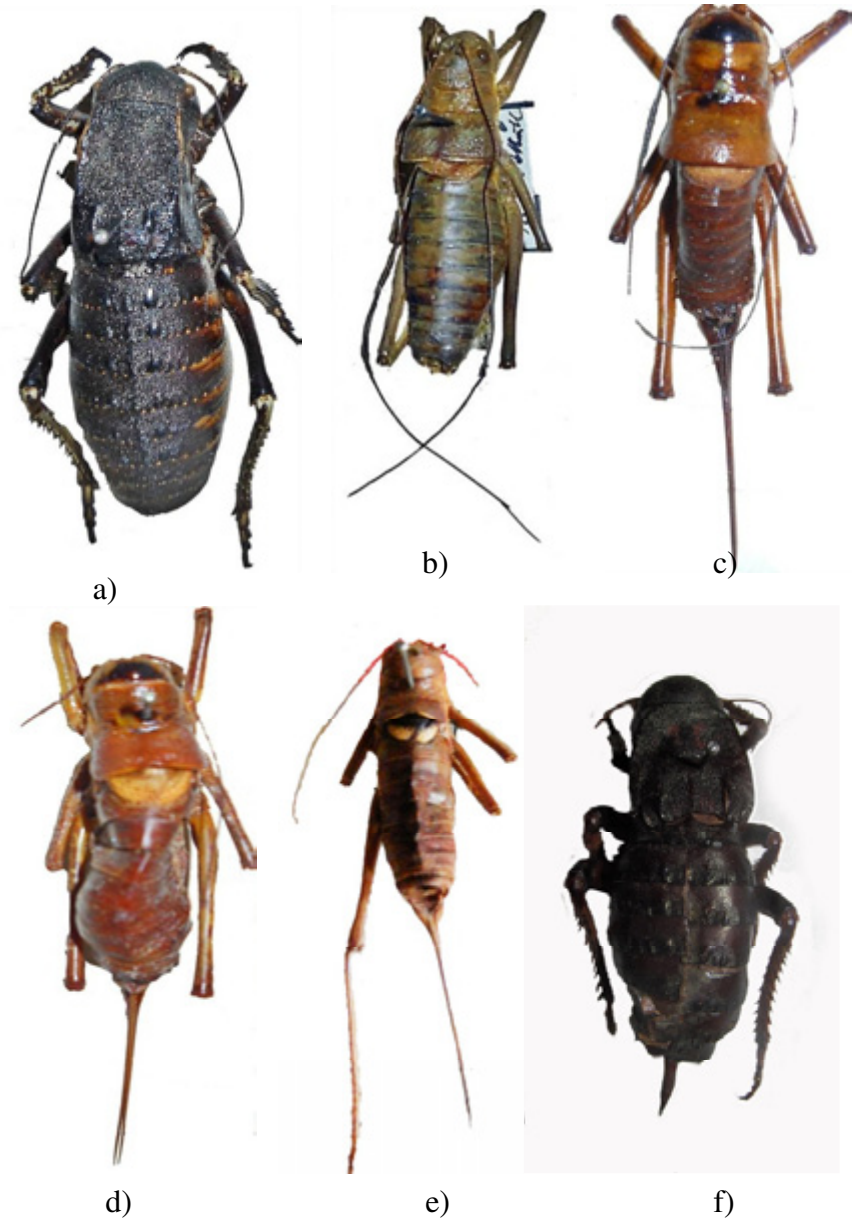

Fig. 9. a) *Bradyporus dasypus* (Illiger, 1800); b)*Ephippiger ephippiger* (Fiebig, 1784); c) *Ephippiger diurnus cunii* Bolívar, 1877 ; d) *Ephippiger provincialis* Yersin, 1854; e) *Ephippiger discoidalis* Fieber, 1853; f) *Bradyporus (Callimenus) montandoni* (Burr, 1898), specimens from the "Arnold Müller" collection

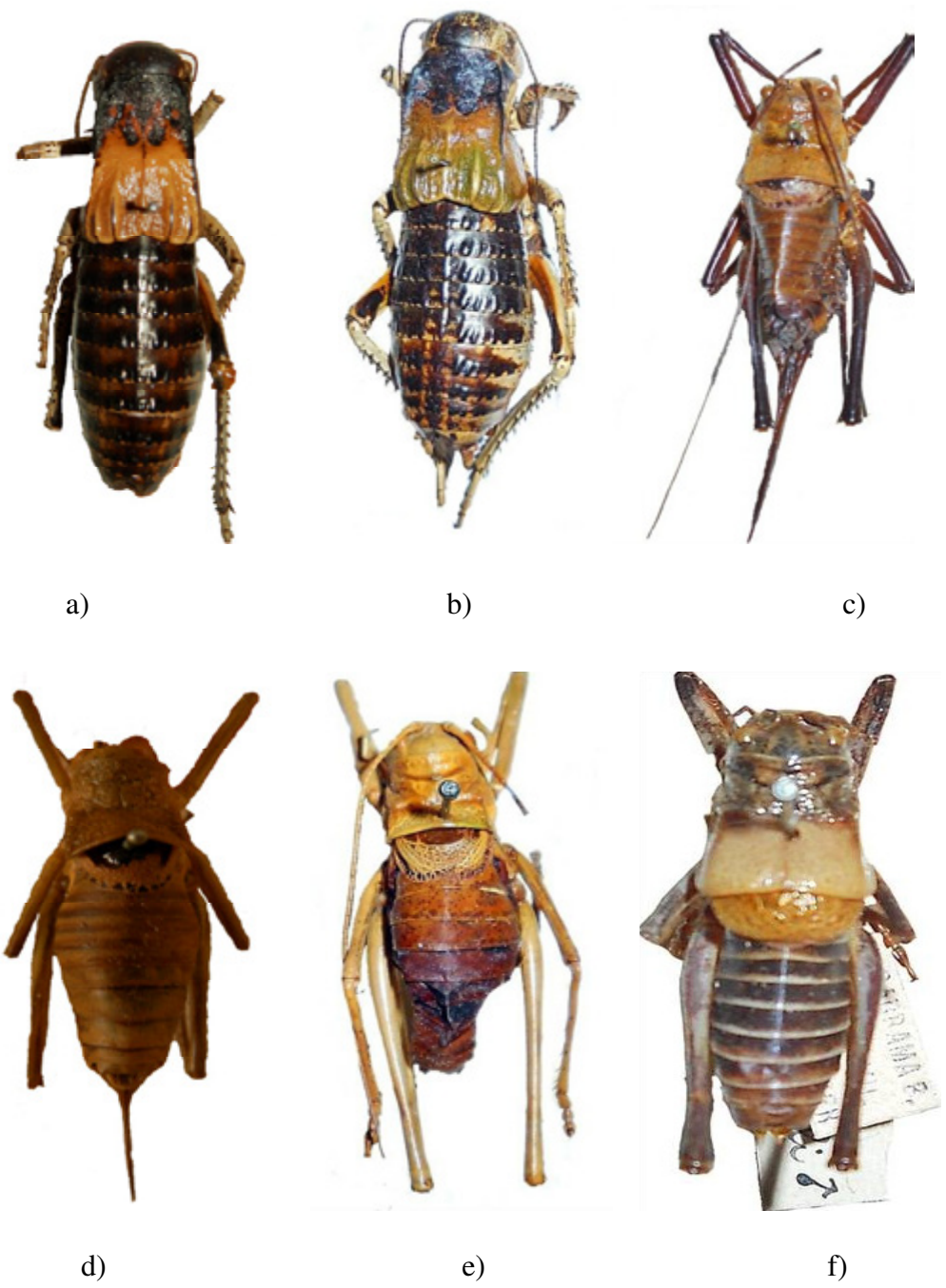

Fig. 10. a) *Bradyporus (Callimenus) macrogaster longicollis* (Fieber, 1853); b) *Bradyporus* (*Callimenus) oniscus* (Burmeister, 1838); c) *Uromenus laticollis* (Lucas, 1846-1849); d) *Uromenus rugosicollis* (Serville, 1838); e) *Steropleurus brunnerii* (Bolívar, 1876-1878); f) *Lluciapomaresius stalii* (Bolívar, 1878), specimens from the "Arnold Müller" collection

ANT FAUNA (HYMENOPTERA: FORMICIDAE) OF SIBIU COUNTY (TRANSYLVANIA, ROMANIA)

Ioan TĂUŞAN[*]
Mădălina Maria JERPEL[**]
Ioana Roxana PUŞCAŞU[**]
Cătălin SĂDEANU[**]
Roberta Elena BRUTARU[**]
Lavinia Ana RĂDUȚIU[**]
Valeria GIURESCU[**]

Abstract. *In the present paper, the authors give a first checklist of the ant species from Sibiu County. The data was compiled from published literature, unpublished data from museum collections and personal collectiongs. Altogether 70 species were recorded. Tapinoma subboreale Seifert, 2012 is new for the ant fauna of Sibiu. Distribution maps are given for all species.*
Keywords*: ants, checklist, new records, distribution, Sibiu.*

Rezumat. *În prezenta lucrare, autorii oferă prima listă a furnicilor din județul Sibiu. Datele au fost compilate, din literatura existentă, date nepublicate din colecții muzeale şi din colectări personale. În total au fost identificate 70 de specii. Tapinoma subboreale Seifert, 2012 este nouă pentru fauna județului. Aditițional, sunt prezentate hărți ale distribuției speciilor.*
Cuvinte cheie*: furnici, listă faunistică, noi semnalări, distribuție, Sibiu*

Introduction

The ant fauna of Romania has been studied in the last decade (Markó *et al.* 2006) and 109 ant species are now known from Romania (Ionescu-Hirsch *et al.* 2009, Markó *et al.* 2006, Markó 2008a, b, Moscaliuc 2009, Czekes *et al.* 2012). Comparatively with other neighbouring countries, the number appears low: Hungary – 125 species (Csősz *et al.* 2011), Bulgaria – 163 species (Lapeva-Gjonova *et al.* 2010), Montenegro – 135 (Karaman 2004, 2008), Serbia – 141 (Petrov 2006). Due to intensive myrmecological investigations the number is expected to grow.

The entomofauna of Sibiu was studied in particular, due to the scientific activity of the Transylvanian Natural History Society of Sibiu (Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt – 1850 – 1946). The bases of the Transylvanian Society Collection of Natural Sciences were established by Karl Fuss, considered to be the father of entomology in Transylvania (Pascu, Schneider 1998).

* Babeş-Bolyai University of Cluj-Napoca and Brukenthal National Museum, Natural History Museum, itausan@gmail.com, ioan.tausan@brukenthalmuseum.ro
** Lucian Blaga University of Sibiu, Faculty of Sciences,

The entomological collections, of great scientific value, preserved in the Natural History Museum of Sibiu proves that important steps were made, regarding the research in the Romanian entomology field (Bucşa, Tăuşan 2011).

Despite that the ant fauna of Sibiu County was rather well studied (Paraschivescu 1975, Markó, Csősz 2002, Csősz, Markó 2005, Tăuşan, Markó 2009, Tăuşan *et al.* 2011, Tăuşan *et al.* 2012) no ant check list is available.

This study renders the first ant checklist with sampling data and the distribution map of the species recorded in Sibiu County.

Study area, material and methods

Having a surface of 5575 km^2, Sibiu County is situated in the central part of Romania. The geographic position of the County at the limit between the Southern Carpathians (which occupies the southern part of the county) and the Transylvanian Depression (which occupies the central and northern part) and its large extension in the two tectonic-structural units give the aspect of an amphitheatre opened northwards (Fig. 1). The landform's evolution is subdued to the Carpathian chain represented on the county's territory by

Făgăraş, Cindrel and Lotru Mountains (Costea 2011).

Using published and unpublished records, we have compiled the ant fauna of Sibiu County. In addition we used unpublished data from the Natural History Museum of Sibiu collections.
The ant material of the Natural History Museum of Sibiu, consisting of 1577 specimens (Markó, Csősz 2002; Csősz, Markó 2005), is made up of two separate collections: that of the former Transylvanian Natural History Society of Sibiu (Siebenbürgisches Verein für Naturwissenschaften zu Hermannstadt) mostly arranged by Arnold Müller and containing Paul Röszler's types, and Dr. Eugen Worrell's personal collection, which was acquired by the Museum in 1957 (Paraschivescu 1975). Additional, the museum hosts also Eckbert Schneider's collection, 330 specimens, almost all of the specimens being unidentified.

The identification of ant species was carried out on the basis of several available identification keys (Czechowski *et al.* 2002, Seifert 2007, Markó *et al.* 2009). The following codes are used in the paper: w – worker; m – male; q – queen; coll. Schneider – Dr. Eckebert Schneider's collection, coll. Tăuşan – Ioan Tăuşan's collection; in square brackets the Romanian name of the sampling place.

List of species

Family Formicidae
Subfamily Dolichoderinae
Tribe Dolichoderini

Dolichoderus quadripunctatus (Linnaeus, 1767) (Fig. 2)
Published records: Cisnădie, Sibiu, (Markó, Csősz 2002).
New records: 1 w, Transsilv. merid. Hamba, Sibiu, 4-16.08.1973, leg. E. Schneider, coll. E. Schneider.

Tapinoma erraticum (Latreille, 1798) (Fig. 2)
Published records: Dealul Cetăţii, Tălmaciu, Guşterița, Cisnădioara, Petiş, Cisnădie (Markó, Csősz 2002).
New records: 2 w, Transsilv. merid. Şura Mare, 23.05.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012.

Tapinoma subboreale Seifert, 2012 (Fig. 2)
New records: 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al., coll. Tăuşan.

Subfamiliy Formicinae
Tribe Camponotini

Camponotus aethiops (Latreille, 1978) (Fig. 3)
Published records: Sibiu, Guşterița (Csősz, Markó 2005).
New records: 2 w, Şura Mare.7.8.1971 leg. E. Schnieder, as [*Camponotus silvaticus* Ol.], det. Tăuşan et al. 2012; 1w, Transsilv. merid., Şura Mare, 23.05.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012.

Camponotus fallax (Nylander 1856) (Fig. 3)
Published records: Sibiu (Csősz, Markó 2005).
New records: 1 w, the garden of NHMS, 06.06.2012, leg. Brutaru & Tăuşan, coll. Tăuşan.

Camponotus herculeanus (Linnaeus, 1758) (Fig. 4)
Published records: Păltiniş, Cindrel Mountains, Prislop-Răşinari (Csősz, Markó 2005).
New records: 1 w, Mts. Cibin, 1300-1400 m a.s.l., 11.08.1957, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, V. Sebeşului, 27.08.1966, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012.

Camponotus ligniperdus (Latreille, 1802) (Fig. 4)
Published records: Păltiniş, Cisnădioara, Măgura Cisnădioarei, Cisnădioara, Sibiu, Guşterița, Rîu Sadu (Csősz, Markó 2005); Cisnădioara (Tăuşan *et al.* 2012).
New records: 1 q, Poplaca b. Hermannstadt, 11.09.1969, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 4 w, Hammersdorf [Guşterița], 25.06.1970, leg. E. Schneider; 1 w Transsilv. merid. Şura Mare, 20.04.1973, leg. E. Schneider coll. E. Schneider, det. Tăuşan et al. 2012; 1 w Transsilv. merid. Şura Mare, 13.06.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 3 w, Hammersdorf Bg. [Dealul Guşteriței], 22.09.1974, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 4 w, Transsilv. merid. Cisnădioara, 3.08.1975, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w Transsilv. merid. Podu Olt, 7.05.1977, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Mt. Cibin, Valea Sadului, 8.08.1980, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 2 w, Podu Olt, 18.05.1984, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Racoviţa, 06.06.2009, leg. G. Mărginean, det. Tăuşan et al. 2012, coll. Tăuşan.

Camponotus piceus (Leach, 1825) (Fig. 5)
Published records: Şura Mare, Guşterița (Csősz, Markó 2005).

New records: 1 w, Sibiu, Veştem, 3.10.1969, b. Hermannstadt [Sibiu], leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1w, Hammersdorf Tal. [Guşteriţa], l9.06.1970, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Transsilv. merid. Şura Mare, 23.05.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012.1w, Trassilv. merid., Ocna Sibiului, 13.07.1973, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 2 w, Transsilv. merid. Şura Mare, 20.07.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 2 w, Trassilv. merid., Ocna Sibiului, 19.05.1974, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 1 w, Dealul Guşteriţei, 4.10.1974, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 q, 1 w, Transsilv. merid. Ocna Sibiului, 30.05.1976, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 2 w, Racoviţa, 26.09.2010, leg. G. Mărginean, det. Tăuşan et al. 2012, coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Camponotus truncatus (Spinola, 1808) (Fig. 3)
Published records: Sibiu, Cisnădie (Csősz, Markó 2005).

Camponotus vagus (Scopoli, 1763) (Fig. 5)
Published records: Sibiu, Cisnădie, Dealul Cetăţii, Tălmaciu, Cisnădioara, Măgura Cisnădioarei, Cisnădioara (Csősz, Markó 2005).
New records: 1 w, Transsilv. merid. Şura Mare, 28.04.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1w, Transsilv. merid. Şura Mare, 23.05.1973, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 2 w, Porumbacu de Sus, Carpat. Merid. 8.07.1973, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 2 w, Transilv. Sibiu, D. Guşteriţa, 18.05.1975, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012.

Tribe Formicini

Formica cinerea (Mayr, 1853) (Fig. 6)
Published records: Guşteriţa/Szenterzsebet, Sibiu], 28.10.1918, leg. Müller, coll. NHMS; 6 w, Hammersdrof [Guşteriţa], 05.1910, leg. Anonymous, coll. NHMS (Csősz, Markó 2005); Dumbrava (Tăuşan, Markó 2009); Cisnădioara (Tăuşan et al. 2012).
New records: 1 w, V. Sadu, Cînăia, 1700 m a.s.l., 3.10.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 11 w Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan, 6 w Racoviţa, 31.10.2010 leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Formica clara Forel, 1886 syn. *Formica lusatica* Seifert, 1997 (Seifert, Schultz 2009) (Fig. 6)
Published records: as *Formica lusatica* Seifert, 1997, Guşteriţa (Tăuşan, Markó 2009).
New records: 2 w, Sibiu, 4.04.1970, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 2 w, Transsilv. merid. Şura Mare, 23.05.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan.

Formica cunicularia (Latreille, 1798) (Fig. 6)
Published records: Sibiu, Guşteriţa, Bungard (Csősz, Markó 2005); Cisnădioara (Tăuşan, Markó 2009; Tăuşan *et al.* 2012).
New records: 1 w, Dealul Guşteriţei, Sibiu, 04.04.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan, 2 w, 14.10.2010, Racoviţa, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al., coll Tăuşan.

Formica fusca (Linnaeus, 1758) (Fig. 6)
Published records: Păltiniş, Măgura Cisnădioarei, (Csősz, Markó 2005).
New records: 3 w, V. Sadu, Cînăia, 1700 m a.s.l., 3.10.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Şura Mare, 30.04.1972, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Transsilv. merid. Şura Mare, 28.04.1973, leg. E.Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Transsilv. merid. Şura Mare, 23.05.1973, leg. E.Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Munţii Cibin, R. Sadului Val. Vîrjoghii (Cibin Mountains), 28.09.1975, leg. E.Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 1 w. Sadu valley, 06. 2010 leg. Tăuşan et al., coll. Tăuşan, 1 w, 2010 leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan ; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al., coll Tăuşan.

Formica gagates (Latreille, 1798) (Fig. 7)
Published records: Guşteriţa, Agârbiciu (Csősz, Markó 2005).

Formica lemani (Bondroit, 1917) (Fig. 6)
Published records: Sibiu, Guşteriţa, Păltiniş, Cindrel (Csősz, Markó 2005).
New records: 5 w, V. Sadu, Cînăia, 1700 m a.s.l., 3.10.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012;1 w Sadu valley, 06. 2010

leg. Tăuşan et al. coll. Tăuşan; 1 w Racovița, 21.08.2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al., coll Tăuşan.

Formica polyctena (Forster, 1850) (Fig. 8)
Published records: Sibiu, Răşinari, Măgura Cisnădioarei (Csősz, Markó 2005).
New records: 2 w Racovița, 31.10.2010 leg. G. Mărginean, det. Tăuşan et al., coll. Tăuşan.

Formica pratensis (Retzius, 1783) (Fig. 8)
Published records: Dumbrava Sibiului, Sibiu, Dealul Cetății-Tălmaciu, Turnu Roşu, Măgura Cisnădioarei, Cristian (Csősz, Markó 2005).
As *Formica nigricans* Emery, 1909, Măgura Cisnădioarei, Cisnădioara, Cindrel, Guşterița in (Csősz, Markó 2005).
New records: 5 w, Şura Mare, 10.10.1971, leg. E. Schneider, coll. E. Schneider; 1 q, Şura Mare, 24.8.1972, leg. E. Schneider, coll. Schneider; 1 q, Transsilv. Merid. Şura Mare, 20.07.1973, leg. E. Schneider, coll. E. Schneider; 1 w Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan.

Formica rufa (Linnaeus, 1758) (Fig. 7)
Published records: Cristian (Csősz, Markó 2005).

Formica rufibarbis (Fabricius, 1793)
Published records: Cisnădie (Csősz, Markó 2005); Cisnădioara, Guşterița (Tăuşan, Markó, 2009).
New records: 2 w, Hermmanstadt Reussbachwiesen, 26.04.1969, leg. E. Schneider, Coll. E. Schneider; 1 w, Slimnic, D. Zakel, 24.08.1972, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 1 w, Trassilv. merid., Ocna Sibiului, 19.05.1974, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 2 w, Transilvania merid. Şura Mare, 23.5.1975, leg. E. Schneider, Coll. E. Schneider, det. Tăuşan et al. 2012; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 1 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan; 3 w, Racovița 26.09.2010 leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan;

Formica sanguinea (Latreille, 1798) (Fig. 7)
Published records: Guşterița, Dealul Cetății-Tălmaciu (Csősz, Markó 2005).
New records: 4 w, V. Sadu (Cânaia), 1700 m a.s.l., 3.10.1971, leg. E. Schneider, coll. E. Schneider; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 1 w, Sadu valley, 06. 2010, leg. Tăuşan et al. coll. Tăuşan.

Polyergus rufescens (Latreille, 1798) (Fig. 7)
Published records: Bungard, Sibiu (Csősz, Markó 2005).
New records: 2 w, Ocna Sibiului, 25.07.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 3 w, Dumbrăveni, 07.2011, leg. Tăuşan et al. coll Tăuşan; 3 w, Pădurea Dumbrava, 9.07.2012, leg. Tăuşan, coll. Tăuşan.

Tribe Lasiini

Lasius alienus (Förster, 1850) (Fig. 9)
Published records: Cisnădie (Csősz, Markó 2005).
New records: 1 w Racovița, 21.08.2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan.

Lasius bicornis (Förster, 1850) (Fig. 9)
Published records: Viile Sibiului Sibiu (Csősz, Markó 2005).

Lasius brunneus (Latreille, 1798) (Fig. 10)
Published records: Ocna Sibiului, Sibiu, Rîu Sadu Măgura Cisnădioarei, Dumbrava Sibiului, Turnu Roşu, Cisnădie, (Csősz, Markó 2005); Cisnădioara (Tăuşan, Markó 2009).
New records: 1 w, Dealul Guşteriței (Guşterița Hill), 28.07.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 4 w Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan, 6 w, Racovița, 2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Lasius citrinus Emery, 1922 (Fig. 9)
Published records: as *Lasius afinis* Sibiu (Csősz, Markó 2005).

Lasius distinguendus (Emery, 1916) (Fig. 9)
Published records: Cindrel (Csősz, Markó 2005).

Lasius emarginatus (Olivier, 1922) (Fig. 9)
Published records: Sibiu (Csősz, Markó 2005).
New records: 5 w Racovița, 06.10.2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan ; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Lasius flavus (Fabricius, 1781) (Fig. 10)
Published records: Păliniș, Cindrel, Cisnadie, [Dealul Cetății-Tălmaciu, Cisnădie (Csősz, Markó 2005); Cisnădioara (Tăuşan et al. 2012).
New records: 4 w, Sibiu, 11. 04.1971, Dumbrava, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Munții Cibin, Răşinari Buru, 3.05.1975, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 6 w, Cornățel, Caşolț,

24.04.1983, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan.

Lasius fuliginosus (Latreille, 1798) (Fig. 10)
Published records: Sibiu, Guşteriţa, Slimnic, Turnu Roşu, Cisnădioara (Csősz, Markó 2005); Cisnădioara, Guşteriţa (Tăuşan, Markó, 2009).
New records: 4 w, Sibiu, 28.03.1971, Dealul Guşteriţei, leg. E. Schneider, coll. E. Schneider; 3 w, Racoviţa, 31.10.2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Lasius niger (Linnaeus, 1758) (Fig. 11)
Published records: Guşteriţa, Sibiu, Cisnădie, Tălmaciu, Dumbrava Sibiului (Csősz, Markó 2005); Cisnădioara (Tăuşan, Markó 2009; Tăuşan *et al.* 2012); Gusteriţa, Seviş (Tăuşan, Markó 2009).
New records: 3 w, Hermannstadt, Reussbachwiesen, 26.04.1969, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 2 w, Transsilv. Merid. 23.05.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 2 w, Pasul Turnu Roşu Lotrioara, 24.03.1974, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 4 w, Cornăţel, Caşolţ, 24.04.1983, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 15 w, Racoviţa 06.2009 leg. Tăuşan et al. coll. Tăuşan;10 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan, 3 w Racoviţa, 06.10.2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Lasius paralienus (Seifert, 1992) (Fig. 11)
Published records: Sibiu, Guşteriţa, Turnişor (Csősz, Markó 2005); Cisnădioara (Tăuşan *et al.* 2012).
New records: 1 w, Hammersdorf, Sibiu [Guşteriţa, Sibiu], 19.06.1970, leg. E. Schnider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 3 w, 21.08.2010, Racoviţa, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan.

Lasius platythorax (Seifert, 1922) (Fig. 11)
Published records: Cisnădie, (Csősz, Markó 2005).
New records: 1 w, Racoviţa, leg. G. Mărginean, det. Tăuşan et al., coll. Tăuşan; 2 w, Sibiu, Hammersdorf Tal. [Dealul Guşteriţa], 19.06.1970, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 06.2009; 4 w Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan.

Lasius umbratus (Nylander, 1846)
Published records: Păltiniş (Csősz, Markó 2005).

Prenolepis nitens (Mayr, 1853) (Fig. 12)
Published records: Viile Sibiului, Cristian (Csősz, Markó 2005).

Tribe Plagiolepidini
Plagiolepis pygmaea (Latreille, 1798) (Fig. 12)
Published records: Sibiu (Csősz, Markó 2005).
New records: 1 w, Sibiu, Hammersdorf Tal. [Dealul Guşteriţei], 19.06.1970 leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Şura Mare, 10.10.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 2 w, Transsilv. merid., Şura Mare, 23.05.1973, leg. E.Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Trassilv. merid., Ocna Sibiului, 13.07.1973, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012.

Plagiolepis taurica Santschi, 1920 – Senior synonym of *P. vindobonnensis* Lomnicki, 1925 (Radchenko, 1989) (Fig. 12)
Published records: Guşteriţa, Cisnădie (Csősz, Markó 2005).

Subfamily Myrmicinae Lepeletier, 1836
Tribe Crematogastrini
***Crematogaster schmidti* (Mayr, 1852)** (Fig. 13)
Published records: Păltiniş (Markó, Csősz 2002).

Tribe Formicoxenini
Formicoxenus nitidulus (Nylander, 1846) (Fig. 14)
Published records: Dealul Cetăţii-Tălmaciu, Sibiu (Markó, Csősz 2002).

Leptothorax acervorum (Fabricius, 1793) (Fig. 14)
Published records: Măgura Cisnădiei (Markó, Csősz 2002).
New records: 1 w, Şura Mare, Sibiu, 10.10.1971, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012.

Temnothorax affinis (Mayr, 1855) (Fig. 14)
Published records: as *Leptothorax affinis*, Guşteriţa, Cisnădie (Markó, Csősz 2002).

Temnothorax corticalis (Schenck, 1852) (Fig. 14)
Published records: as *Leptothorax corticalis* Sibiu (Markó, Csősz 2002).

Temnothorax clypeatus (Mayr, 1853) (Fig. 14)
Published records: as *Leptothorax clypeatus*, Cisnădie (Markó, Csősz 2002).

Temnothorax crassispinus (Karavajev, 1926) (Fig. 14)
Published records: as *Leptothorax crassispinus*, Cisnădie (Markó, Csősz 2002); as *Temnothorax crassispinus*, Cisnădioara (Tăuşan *et al.* 2012).
New records: 1 w, Transsilv. merid. Şura Mare, 23.05.1973, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan

Temnothorax unifasciatus (Latreille, 1798) (Fig. 14)
Published records: as *Leptothorax unifasciatus*, Cisnădie, as *Leptothorax tuberum* var. *interrupta* det. Müller, Cisnădie (Markó, Csősz 2002).

Tribe Myrmicini

Manica rubida (Latreille, 1802) (Fig. 15)
Published records: Păltiniş, Mun□ii Cibinului (Markó, Csősz 2002).
New records: 3 q, 4 m and 9 w, V. Sadu, Cînăia, 1700 m a.s.l., 3.10.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012.

Myrmica constricta Karawajew, 1934 (Fig. 18)
Published records: Gu□teri□a (Markó, Csősz 2002); Media□ (Seifert *et al.* 2009).

Myrmica gallienii Bondroit, 1920 (Fig. 18)
Published records: Ocna Sibiului (Czekes *et al.* 2012).

Myrmica lobicornis Nylander, 1846 (Fig. 15)
Published records: Cibin Mts. (Paraschivescu 1975).
New records: 1 w, Sadu Cânaia, 11.09.1969; 2 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan; 1 w Racoviţa, 31.10.2010, leg. G. Mărginean, det. Tăuşan, coll. Tăuşan.

Myrmica lonae Finzi, 1926 (Fig. 18)
Published records: □erbota Valley (Făgăra□ Mts.) (Markó, Csősz 2001).

Myrmica rubra (Linnaeus, 1758) (Fig. 16)
Published records: Sibiu, Păltiniş, Sibiu (Markó, Csősz 2002); Dumbrava Sibiului (Tăuşan, Markó 2009).
New records: 1 q and 1 m, Dl., 28.07.1971, leg. E. Schneider, coll. E. Schneider; 2 w, Mts. Cibin, Michelsberg (Cisnădioara), 1.05.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Transsilv. Merid. Şura Mare, 23.05.1973, leg. E. Schneider, det. as [*M. rugulosa*]; 4 w, Pasul Turnu Roşu Lotrioara, 24.03.1974, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1w, 2 q, Transsilv. merid. Cisnădioara, 3.08.1975, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 9 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan; 9 w Racoviţa 2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan.

Myrmica ruginodis Nylander, 1846 (Fig. 16)
Published records: Măgura Cisnădiei, Cisnădie, Dealul Cetăţii-Tălmaciu, Sibiu (Markó, Csősz 2002); Dumbrava Sibiului (Tăuşan, Markó, 2009), Cisnădioara (Tăuşan *et al.* 2012).
New records: 1 w, Poplaca, 11.09.1969, leg. E. Schneider, coll. E. Schneider; 1 w Sibiu, Hammersordf [Sibiu, Guşteriţa], 23.06.1970, leg. E. Schneider, coll. E. Schneider; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 3 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan, 1 w 2010 Racoviţa, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Myrmica rugulosa Nylander, 1849 (Fig. 15)
Published records: Sibiu, Guşteriţa (Markó, Csősz 2002).
New records: 1 w, Poplaca b. Hermannstadt [Poplaca, Sibiu], 11.09.1969, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012.

Myrmica sabuleti Meinert, 1860 (Fig. 17)
Published records: Dealul Cetăţii-Tălmaciu, Sibiu, Guşteriţa (Markó, Csősz 2002).
New records: 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 1 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan, 2 w Racoviţa, 26.09.2010 leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 1 w, Transsilv. Merid. Şura Mare, 23.05.1973, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012.

Myrmica scabrinodis Nylander, 1846 (Fig. 17)
Published records: Sibiu, Guşteriţa, Păltiniş, (Markó, Csősz 2002); Cisnădioara (Tăuşan et al. 2012)
New records: 1 m, Hermannstadt [Sibiu], 27.09.1969, leg. E. Schneider, coll. E. Schneider; 1 q, Hermannstadt, Salzburger Bg., 27.09.1969, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 4 w, Sibiu, 11. 04.1971, Dumbrava, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al.

2012; 3 w, V. Sadu, Cînăia, 1700 m a.s.l., 3.10.1971, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 2 w, Trassilv. merid., Ocna Sibiului, 19.05.1974, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan;1 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan, 5 w Racoviţa, 21.08.2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan;

Myrmica schenki Emery, 1894 (Fig. 15)
Published records: Guşteriţa, Sibiu, Dumbrava Sibiului (Markó, Csősz 2002).
New records: 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 1 w, Racoviţa, 31.10.2009, leg. G. Mărginean, det. Tăuşan et al. 2012, coll. Tăuşan; 2 w, Sadu valley, 06. 2010 leg. Tăuşan et al. coll. Tăuşan;

Myrmica slovaca Sadil, 1952 (Fig. 15)
Published records: as *Myrmica salina*, Mediaş, Rîu Sadu (Markó, Csősz 2002).

Myrmica specioides Bondroit, 1918 (Fig. 15)
Published records: Sibiu, (Markó, Csősz 2002); Cisnădioara (Tăuşan et al. 2012)
New records: 2 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan.

Myrmica sulcinodis Nylander, 1846 (Fig. 18)
Published records: Cibin Mts. (Paraschivescu, 1975).

Tribe Myrmecinini

Myrmecina graminicola (Latreille, 1802) (Fig. 13)
Published records: Sibiu, Dealul Zakel-Slimnic, (Markó, Csősz 2002); Cisnădioara (Tăuşan *et al.* 2012).
New records: 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Tribe Pheidolini

Aphaenogaster subterranea (Latreille, 1798) (Fig. 19)
Published records: Dumbrăveni (Tăuşan *et al.* 2011)

Messor* cf. *structor sensu Schlick-Steiner et al. (2006) (Fig. 19)
Published records: Agârbiciu, Guşteriţa, Slimnic, Ocna Sibiului, (Markó, Csősz 2002).
New records: 3 w, Sibiu, Hammersdorf Tal. [Dealul Guşteriţei], 27.09.1970, as *Messor barbarous*, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 w, Racoviţa, 21.08.2010, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan.

Tribe Solenopsidini

Solenopsis fugax (Latreille, 1798) (Fig. 13)
Published records: Dealul Guşteriţei, Guşteriţa, Sibiu (Markó, Csősz 2002); Cisnădioara (Tăuşan *et al.* 2012).
New records: 5 w, Hermannstadt, Reussbachwiesen, 26.04.1969, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 1 q, Slimnic, D. Zackel, 24.08.1972, leg. E. Schneider, coll. E. Schneider; 3 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Monomorium pharaonis (Linnaeus, 1758) (Fig. 13)
Published records: Sibiu (Tăuşan, Markó 2011)

Tribe Stenammini

Stennama debile (Förster, 1850) (Fig. 13)
Published records: Dumbrava Sibiului (Tăuşan, Markó 2009)
New records: 1 w, Racoviţa, 06.2009, leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Tribe Tetramoriini

Tetramorium* cf. *caespitum (Linnaeus, 1758) (Fig. 19)
Published records: Agârbiciu, Guşteriţa, Păltiniş, Răşinari, Rîu Sadului (Markó, Csősz 2002).
New records: 3 w, Hermannstadt, Reussbachwiesen, 26.04.1969, leg. E. Schneider, coll. E. Schneider, det. Tăuşan et al. 2012; 4 q, Poplaca, b. Hermmanstadt, 11.09.1969, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 1 w, Trassilv. merid., Ocna Sibiului, 13.07.1973, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 4 w, Trassilv. merid., Ocna Sibiului, 19.05.1974, leg. E. Schneider, coll. E.Schneider, det. Tăuşan et al. 2012; 9 w, Ocna Sibiului, 07.2009, leg. Tăuşan et al. coll. Tăuşan; 9 w, Racoviţa, 21.08.2010 leg. G. Mărginean, det. Tăuşan et al. coll. Tăuşan ; 3 w, Dumbrăveni 07.2011, leg. Tăuşan et al. coll Tăuşan.

Tetramorium ferox Ruzsky, 1903 (Fig. 19)
Published records: Sibiu (Tăuşan, Markó 2009)

Tetramorium* cf. *impurum (Förster, 1850) (Fig. 19)
Published records: Sibiu (Markó, Csősz 2002).

Subfamily Ponerinae Lepeletier, 1836
Tribe Ponerini

Ponera coarctata (Latreille, 1802) (Fig. 20)
Published records: Sibiu (Markó, Csősz 2002).

Ponera testacea Emery, 1895 as P*onera coarctata* var. *testacea* Emery, 1985 (Fig. 20)
Published records: Sibiu (Markó, Csősz 2002).

Comments

Altogether 70 species were identified, one being exclusively indoor species. This number is quite high, considering that it represents 76.3 % of the Romanian myrmecofauna. A possible explanation could be the high diversity of habitats (mountains, hilly areas, lowlands, rivers meadows etc.) and the temperate climate. Nevertheless several myrmecological studies were undertaken in this area. Thus other species can occur, but the number cannot increase spectacularly. Though the presence of *Crematogaster schmidti* in mountain areas such as Păltiniş is questionable, the proof material is available. One species is new for the ant fauna of Sibiu County, namely *Tapinoma subboreale.* It was described by Seifert (2012), replacing the formerly known *Tapinoma ambiguum* Emery, 1925. *Tapinoma subboreale* is widespread in north and central Europe (Seifert, 2012).

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LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Fig. 1. Map of Sibiu County limits

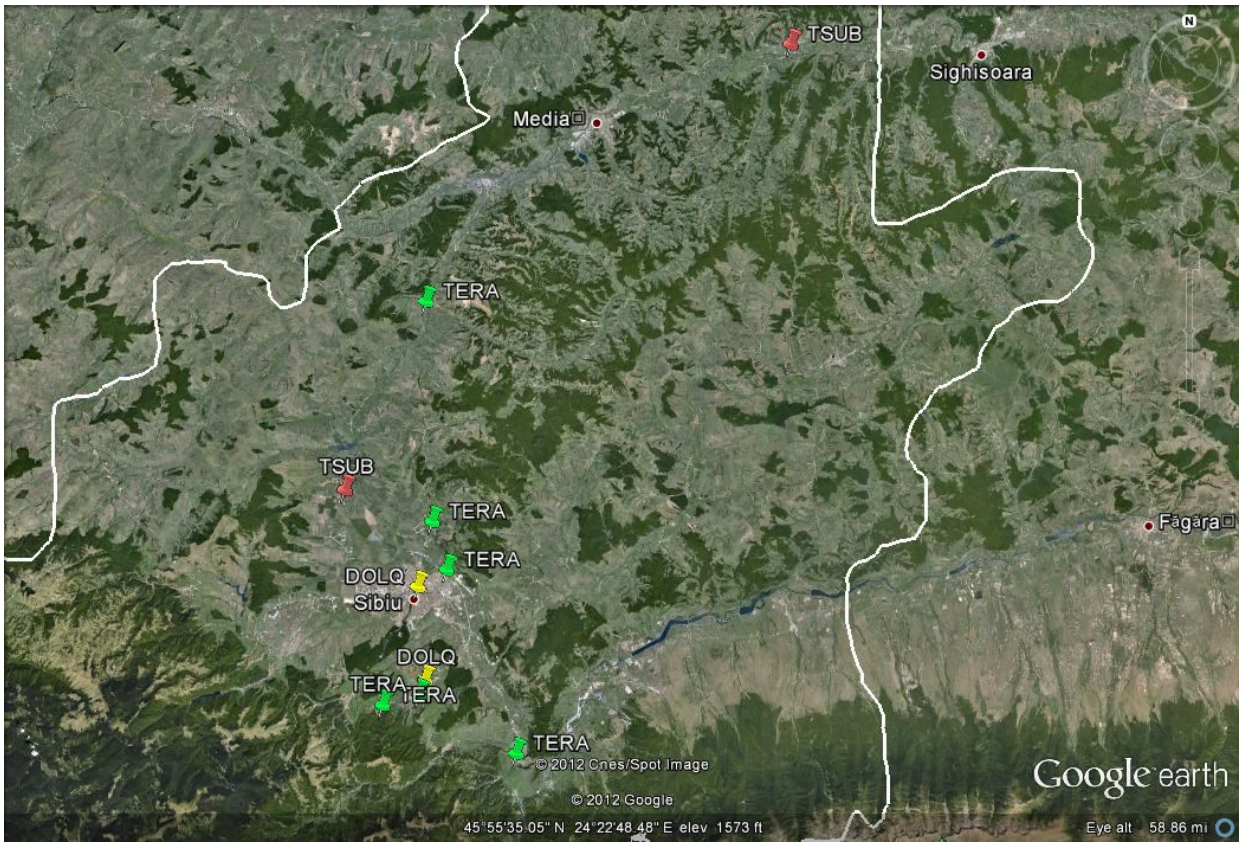

Fig. 2. Distribution of *Dolichoderus quadripunctatus (Dolq)*, *Tapinoma erraticum (Tera)* and *T. suboreale (Tsub)*

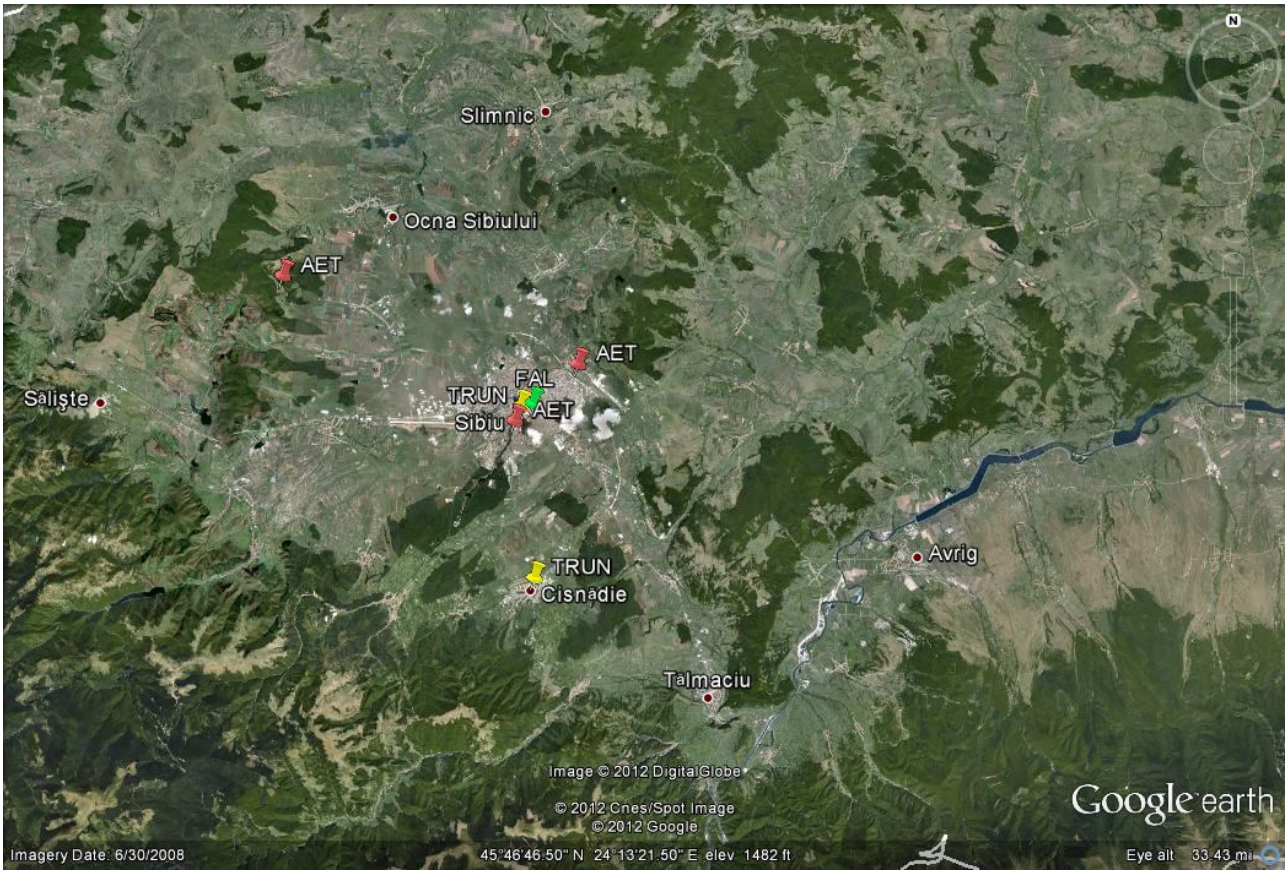

Fig. 3. Distribution of *Camponotus aethiops (aet)*, *C. fallax (fal)* and *C. truncatus (trun)*

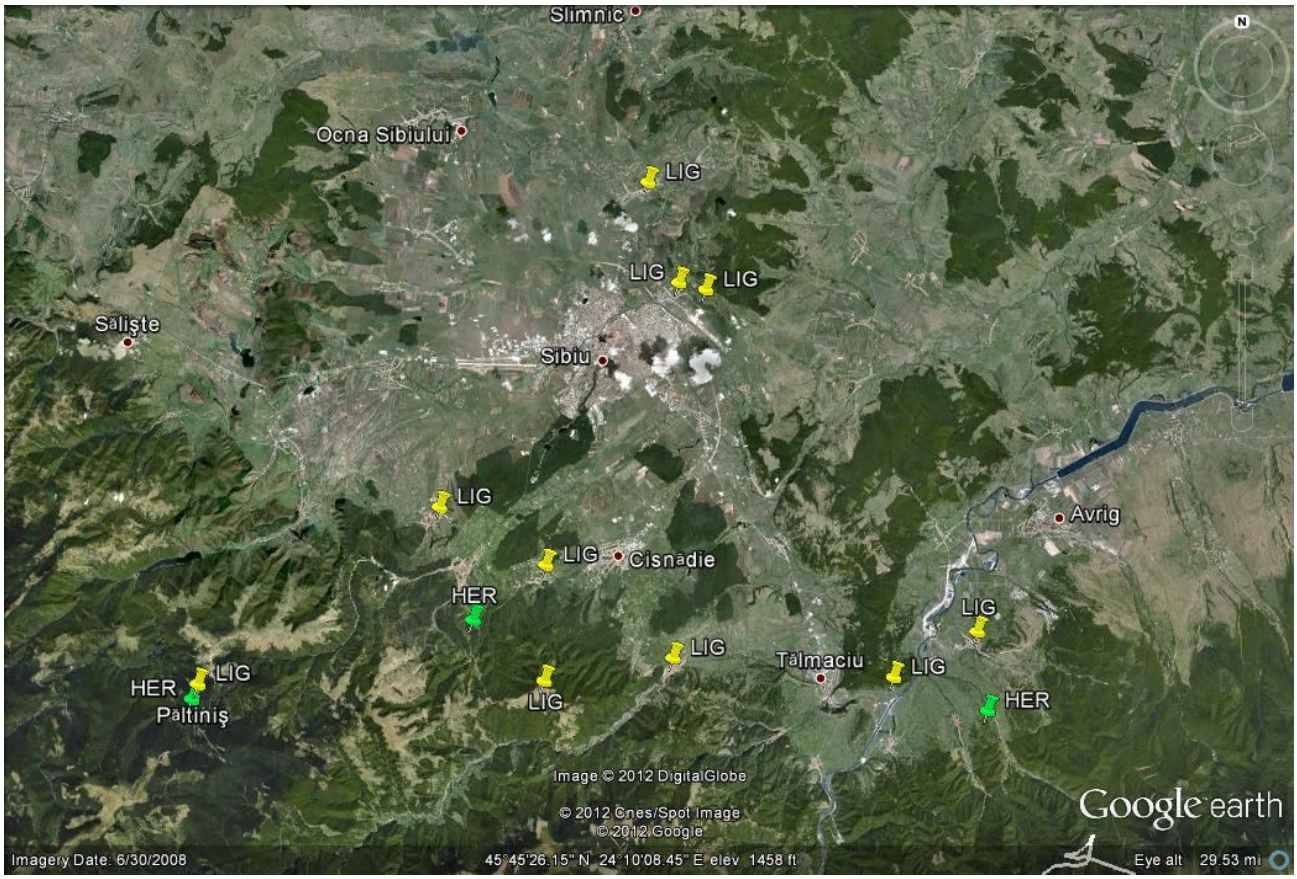

Fig. 4. Distribution of *Camponotus ligniperdus (lig)* and *C. herculeanus (her)*

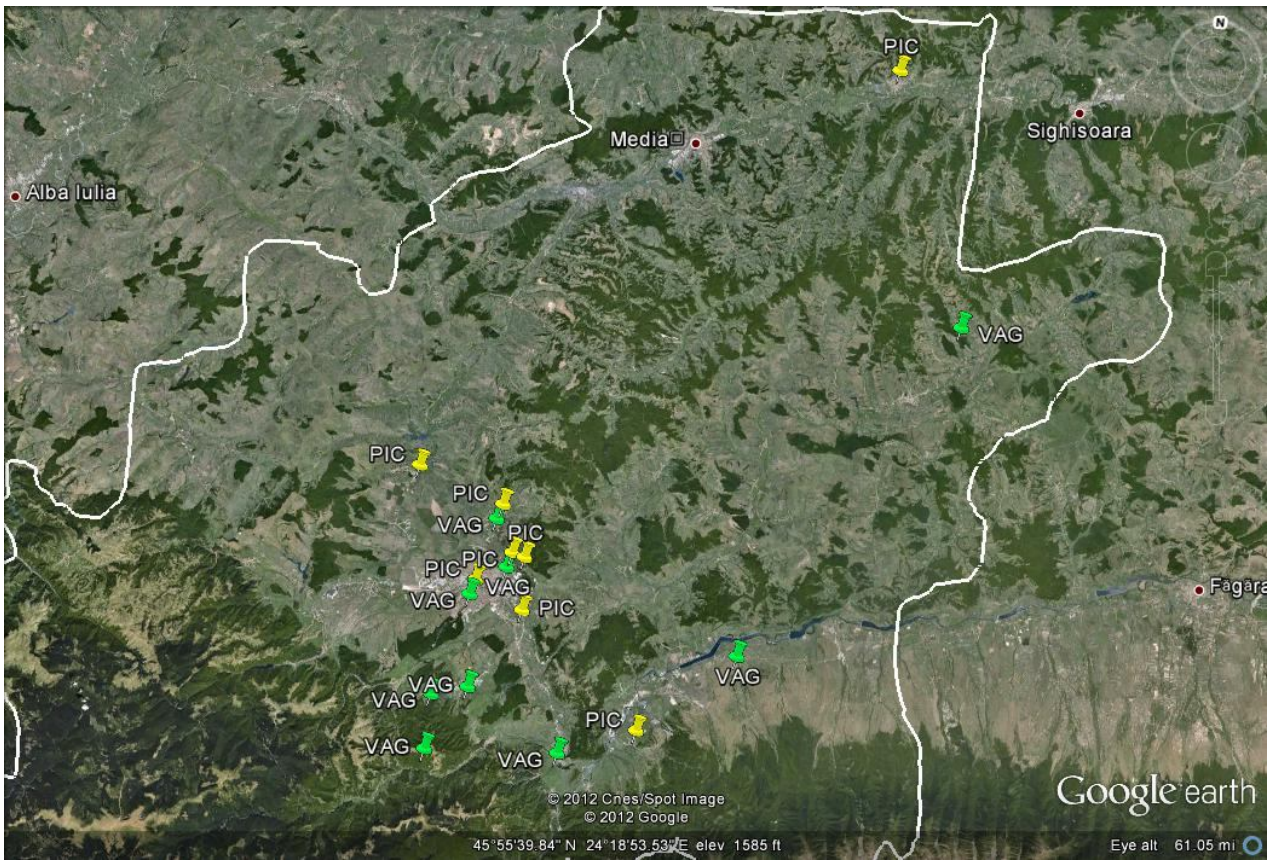

Fig. 5. Distribution of *Camponotus piceus (pic)* and *C. vagus (vag)*

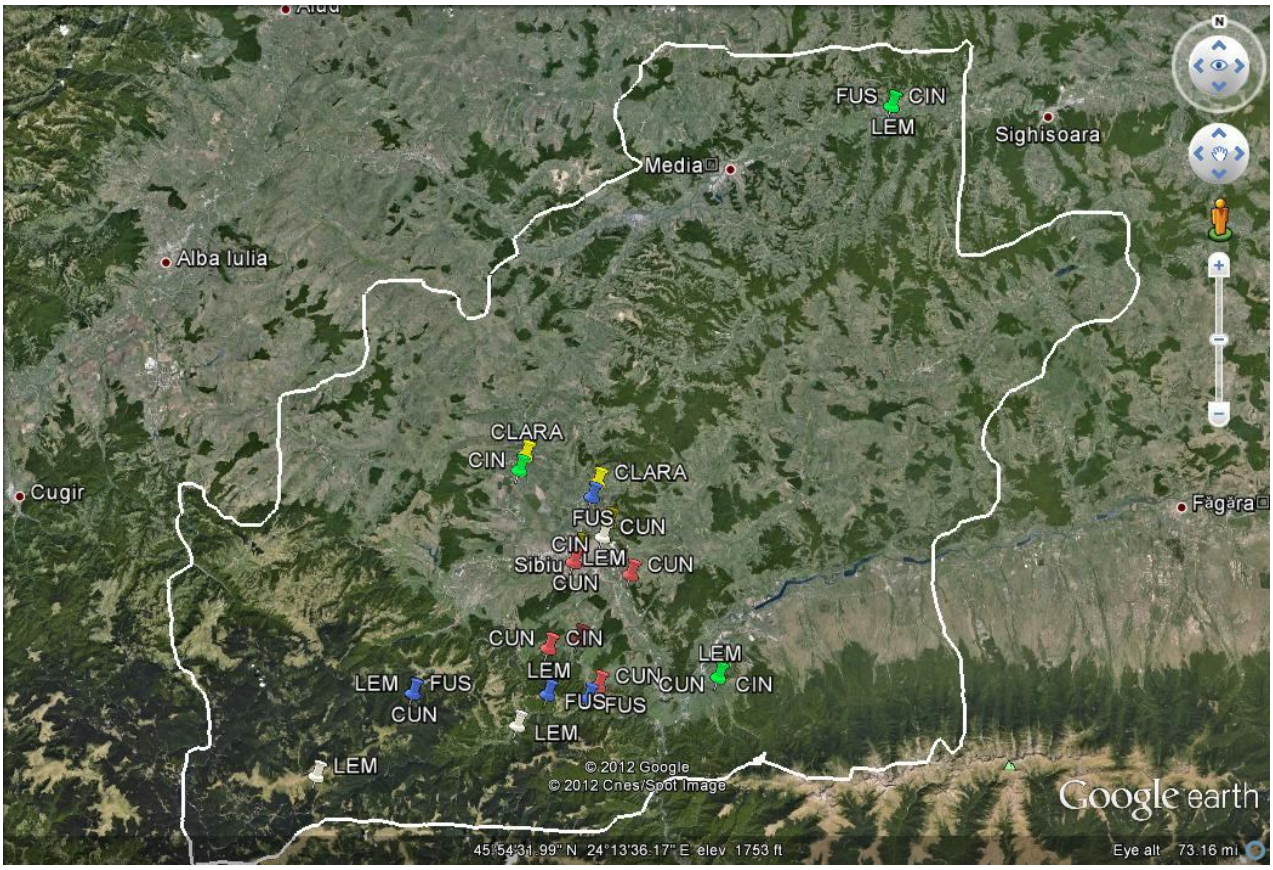

Fig. 6. Distribution of *Formica cinera (cin), F. cunicularia (cun), F. fusca (fus), F. lemani (lem)* and *F. clara (clara)*

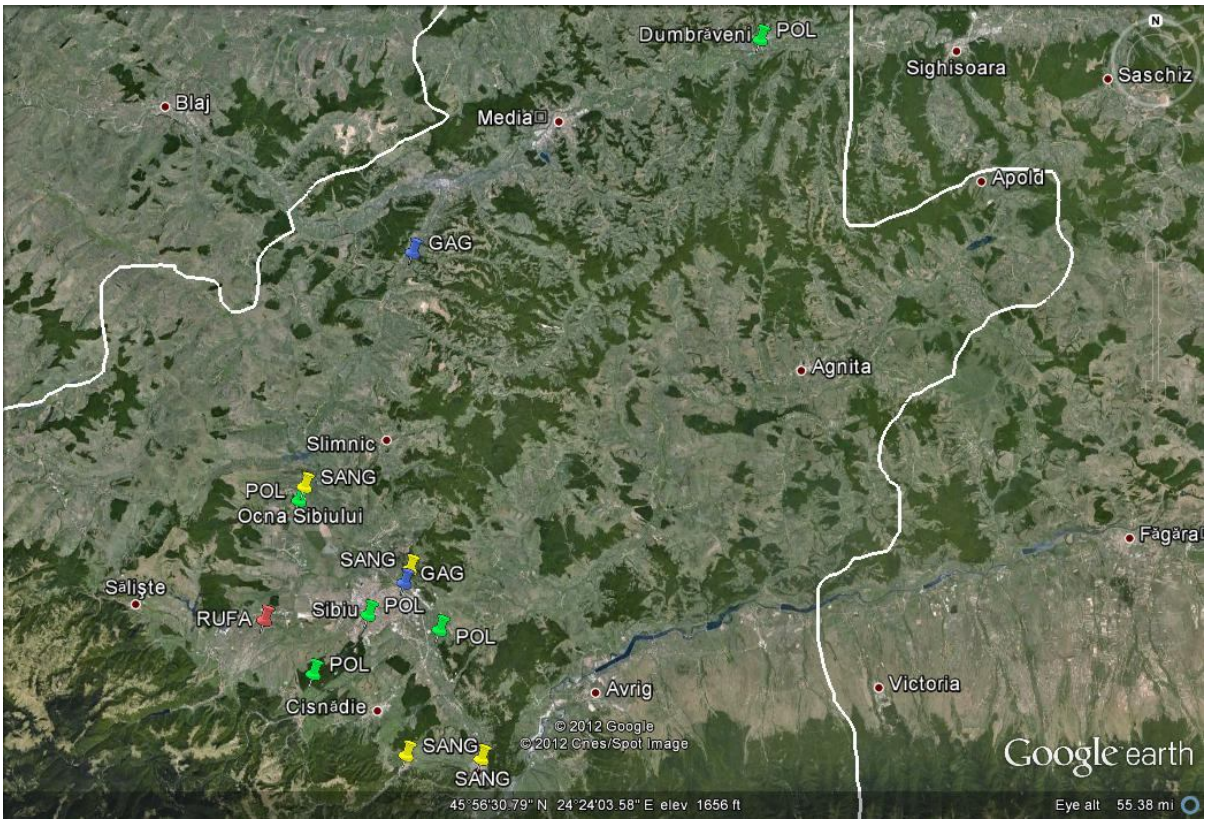

Fig. 7. Distribution of *Polyergus rufescens (pol), Formica sanguinea (sang), F.rufa (rufa)* and *F. gagates (gag)*

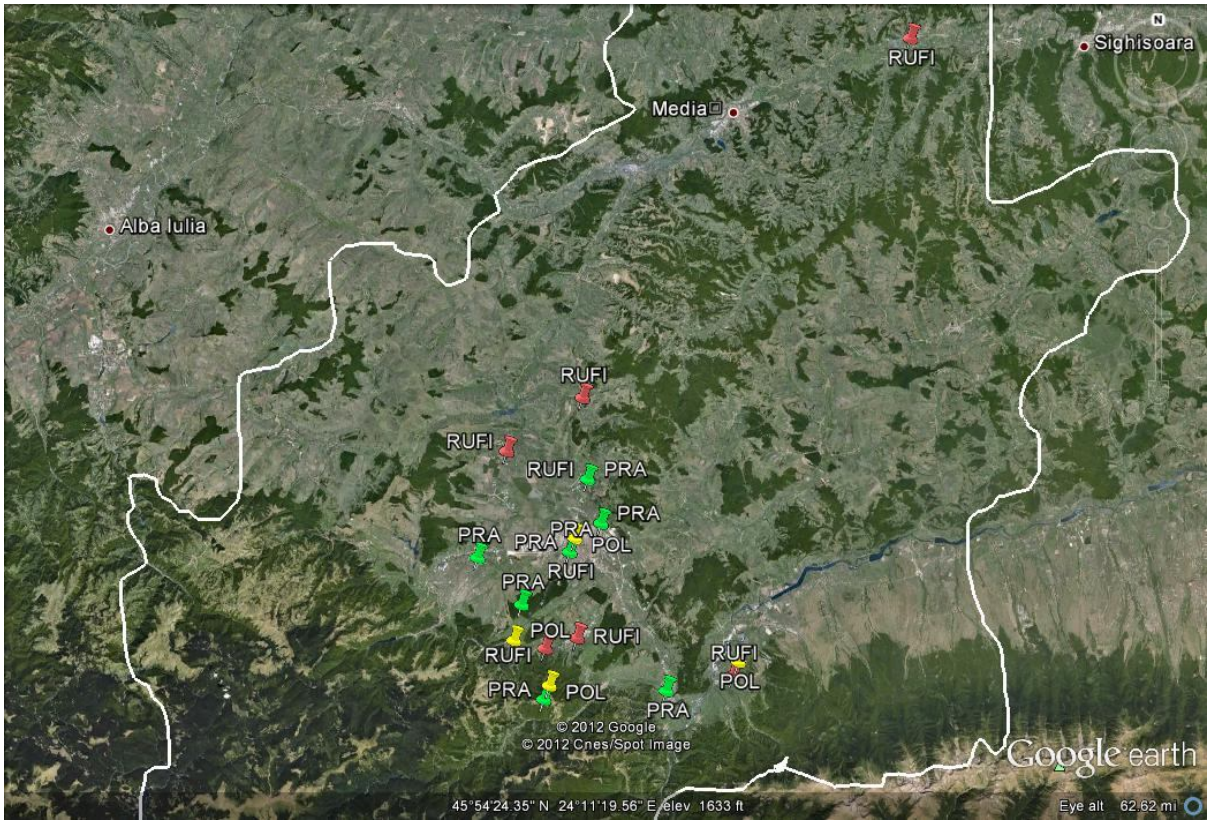

Fig. 8. Distribution of *Formica polyctena (pol), F. pratensis (pra)* and *F. rufibarbis (rufi)*

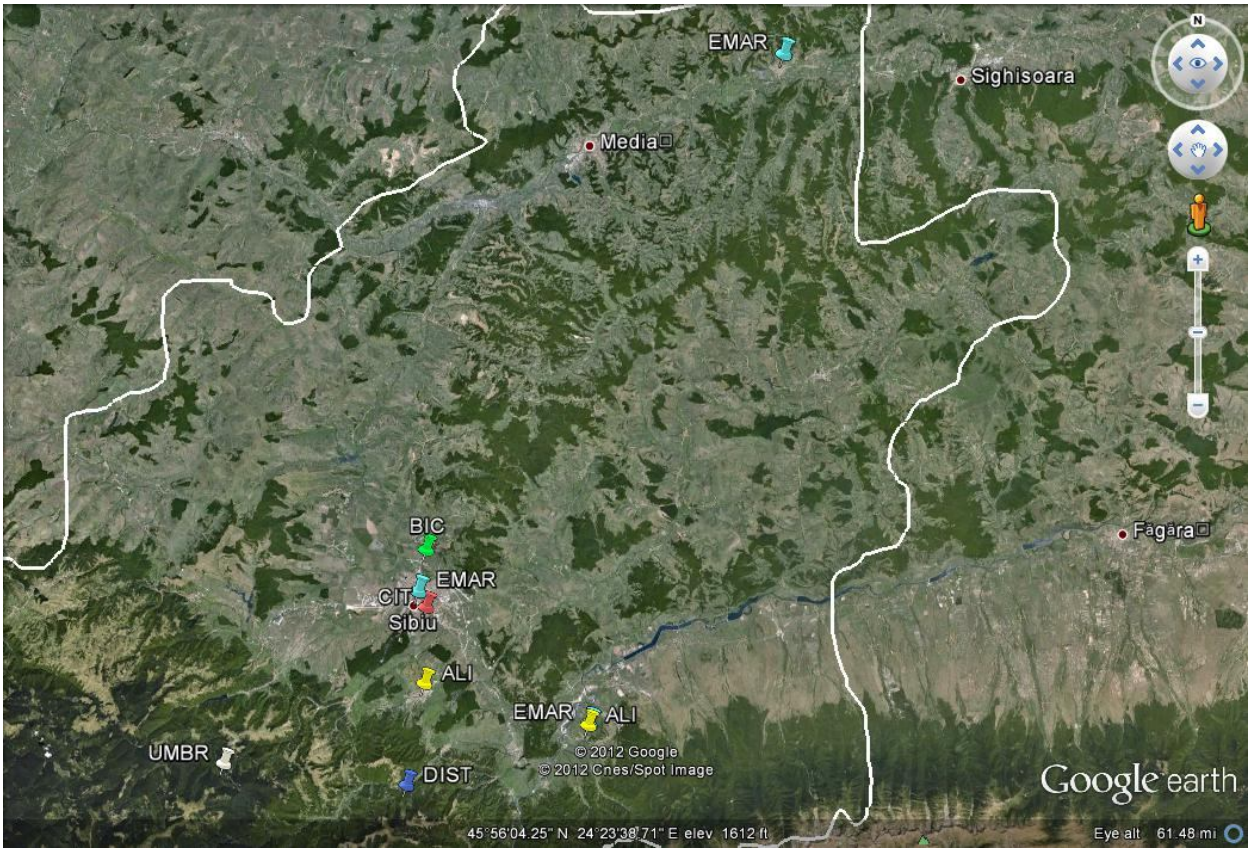

Fig. 9. Distribution of *Lasius alienus (ali), L. bicornis (bic), L. citrinus (cit), L. distingendus (dist), L. emarginatus (emar)* and *L. umbratus (umbr)*

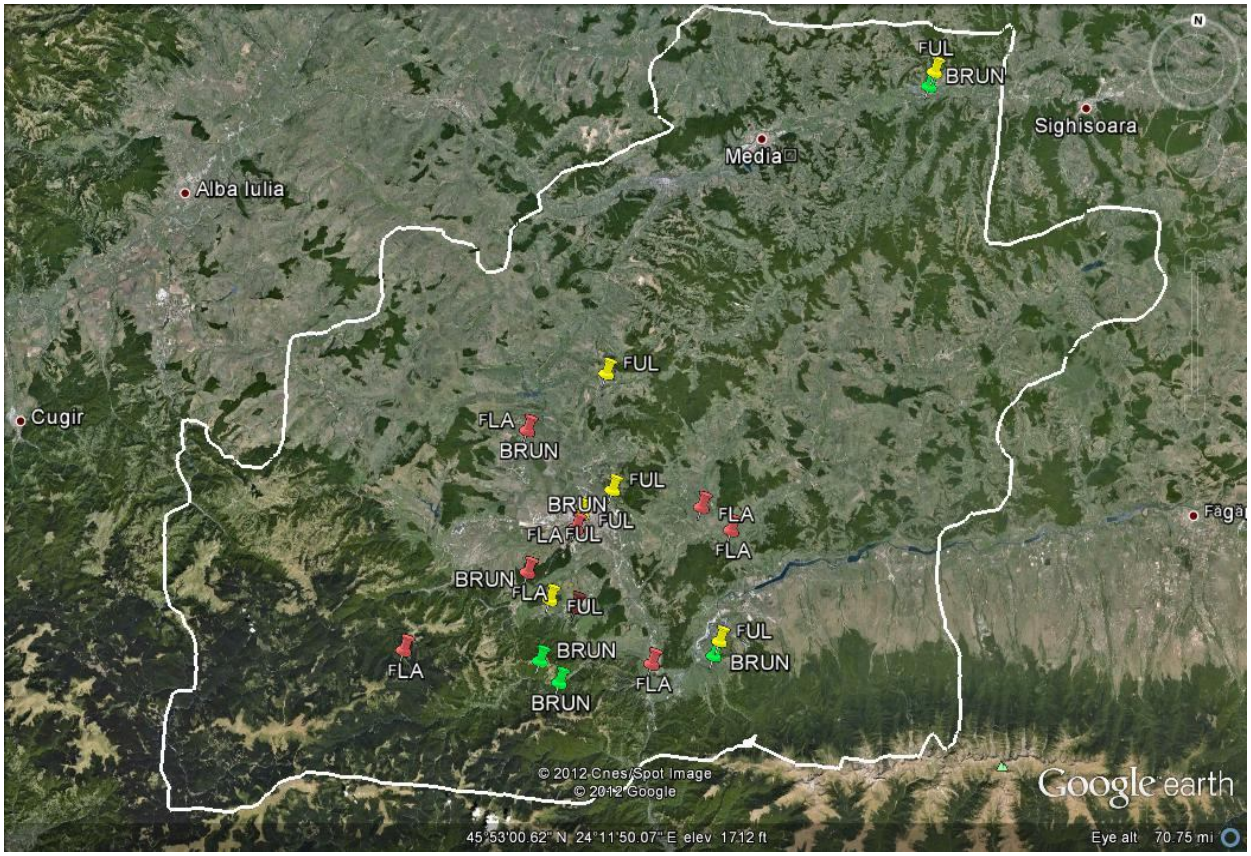

Fig. 10. Distribution of *Lasius fuliginosus (ful), L. flavus (fla)* and *L. brunneus (brun)*

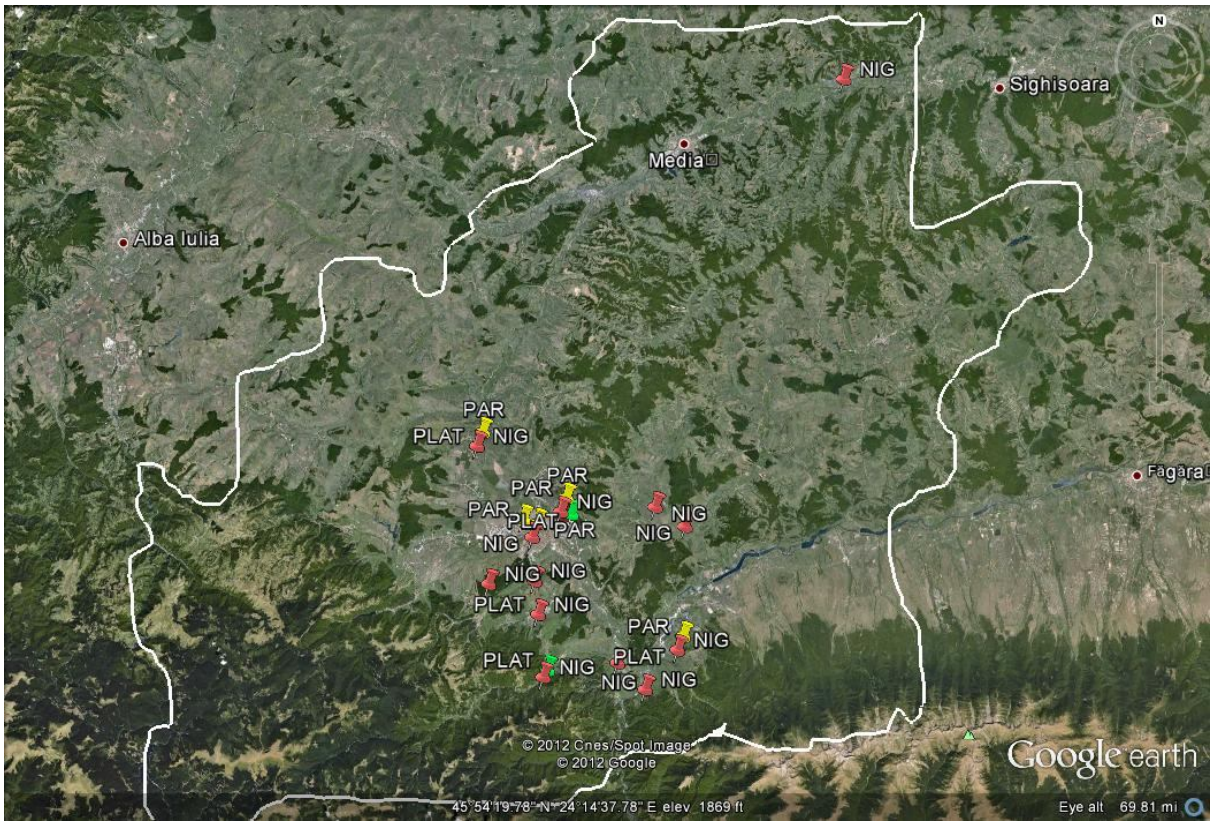

Fig. 11. Distribution of *Lasius platythorax (plat), L. paralienus (par)* and *L. niger (nig)*

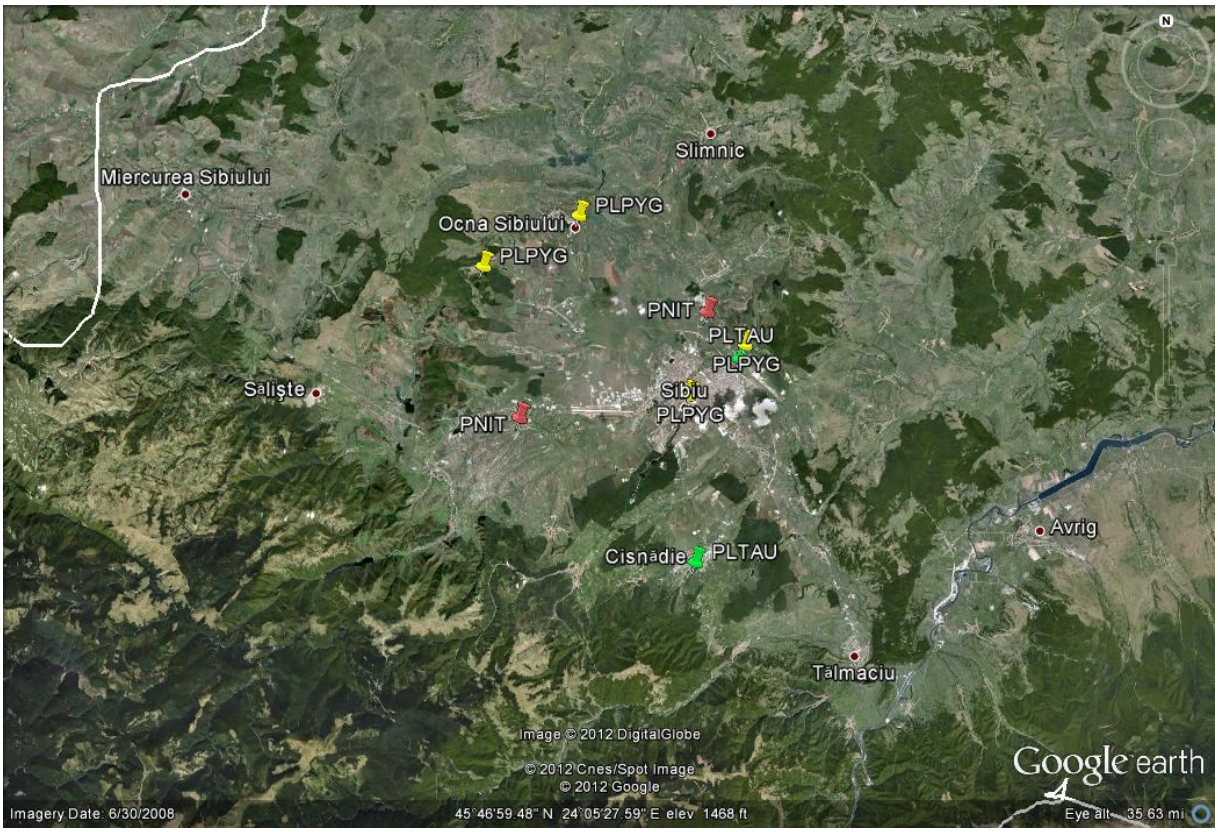

Fig. 12. Distribution of *Plagiolepis pygmaea (plpyg), P. taurica (pltau)* and *Prenolepis nitens (pnit)*

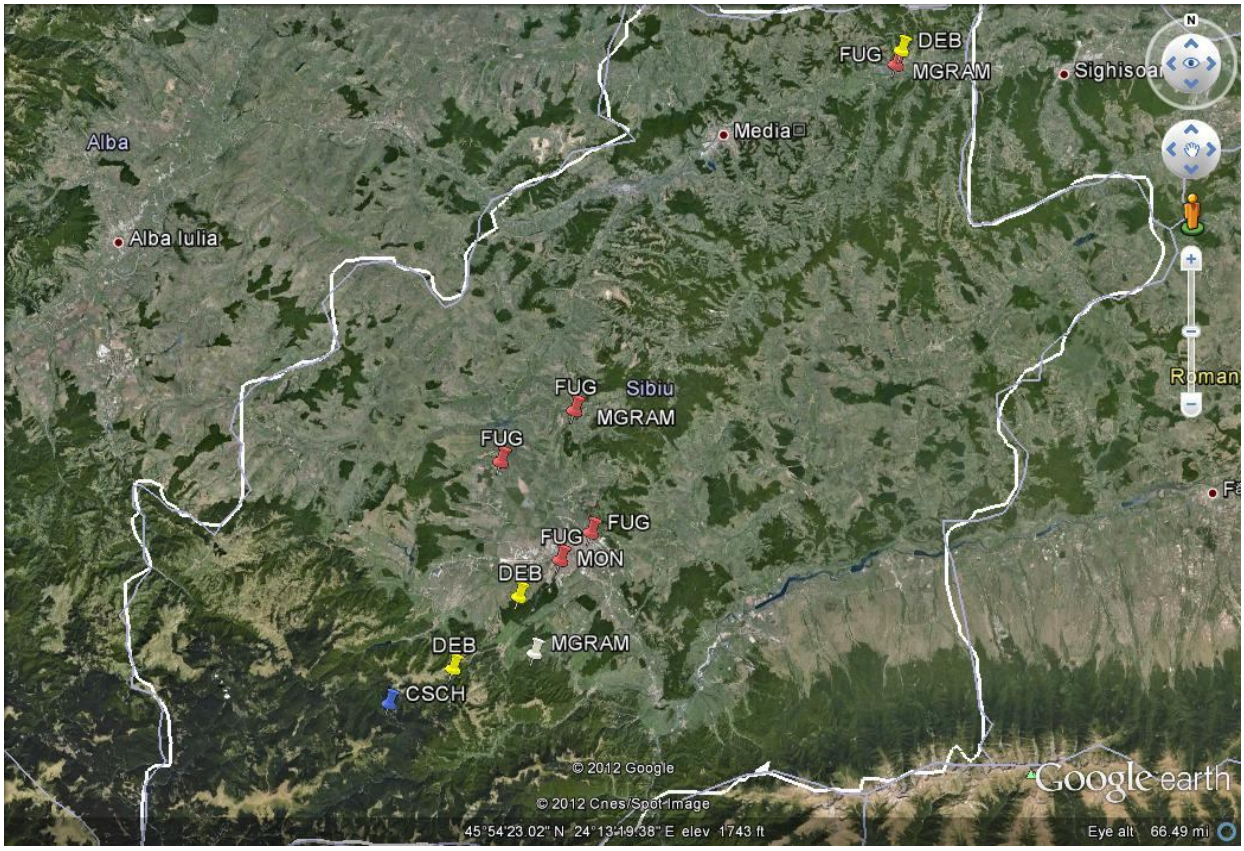

Fig. 13. Distribution of *Stennama debille (deb), Crematogaster schmiditi (csch), Solenopsis fugax (fug), Monomorium pharaonis (mon)* and *Myrmecina graminicola (mgram)*

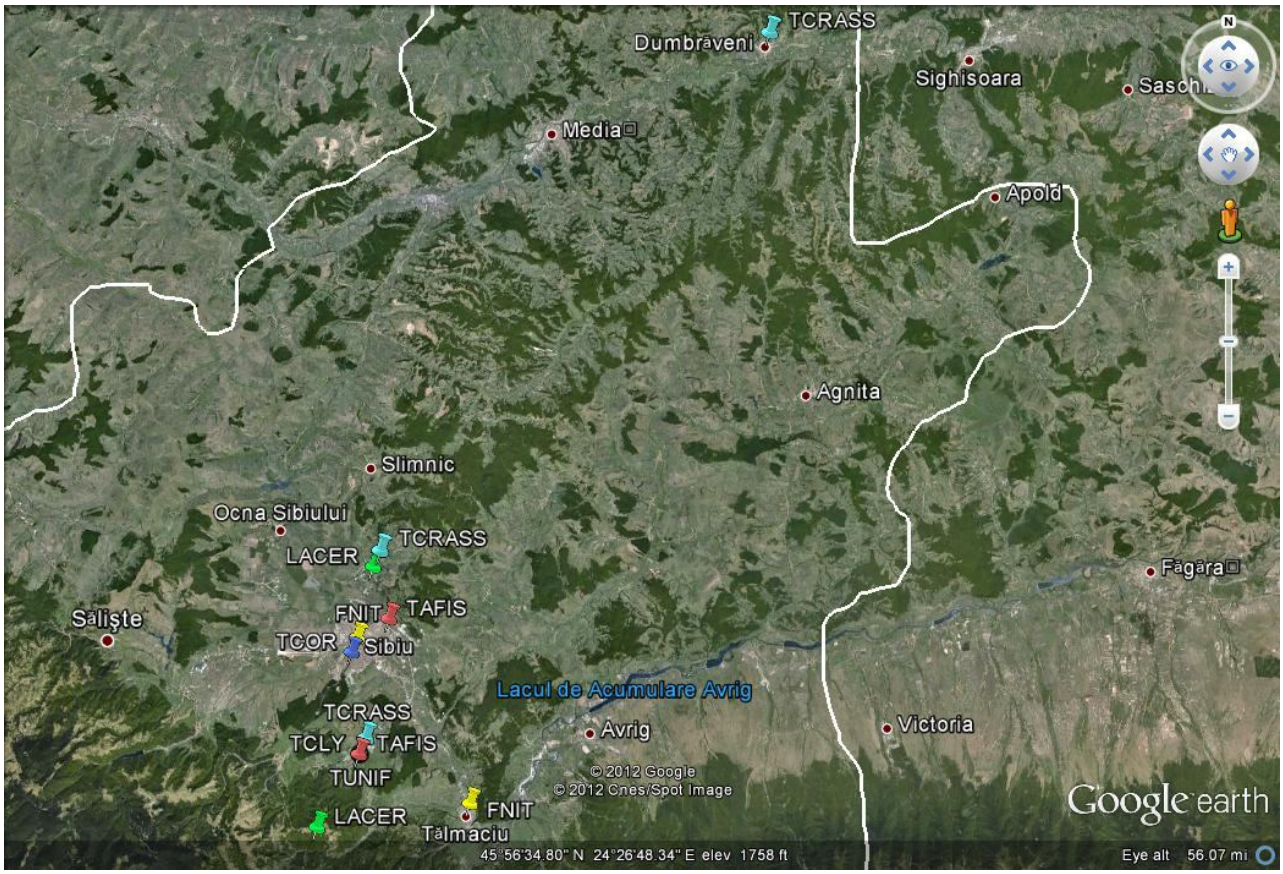

Fig. 14. Distribution of *Formicoxenus nitidulus (fnit), Leptothorax acervorum (lacer), Temnothorax affinis (tafis), T. corticalis (tcor), T. crassispinus (tcrass), T. unifascitatus (tunif)* and *T. clypeatus (tcly)*

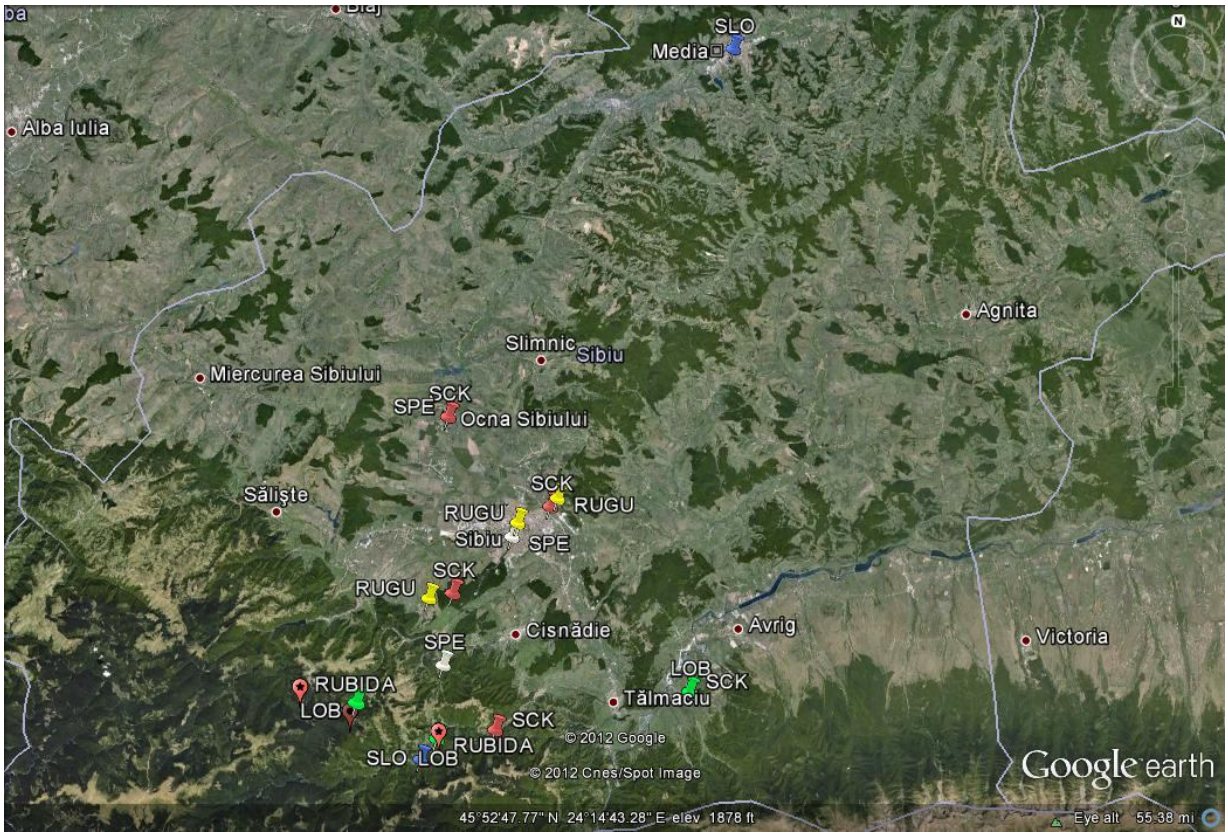

Fig. 15. Distribution of *Manica rubida (rubida), Myrmica slovaca (slo), M. rugulosa (rugu), M. specioides (spe), M. schenki (sck)* and *M. lobicornis (lob)*

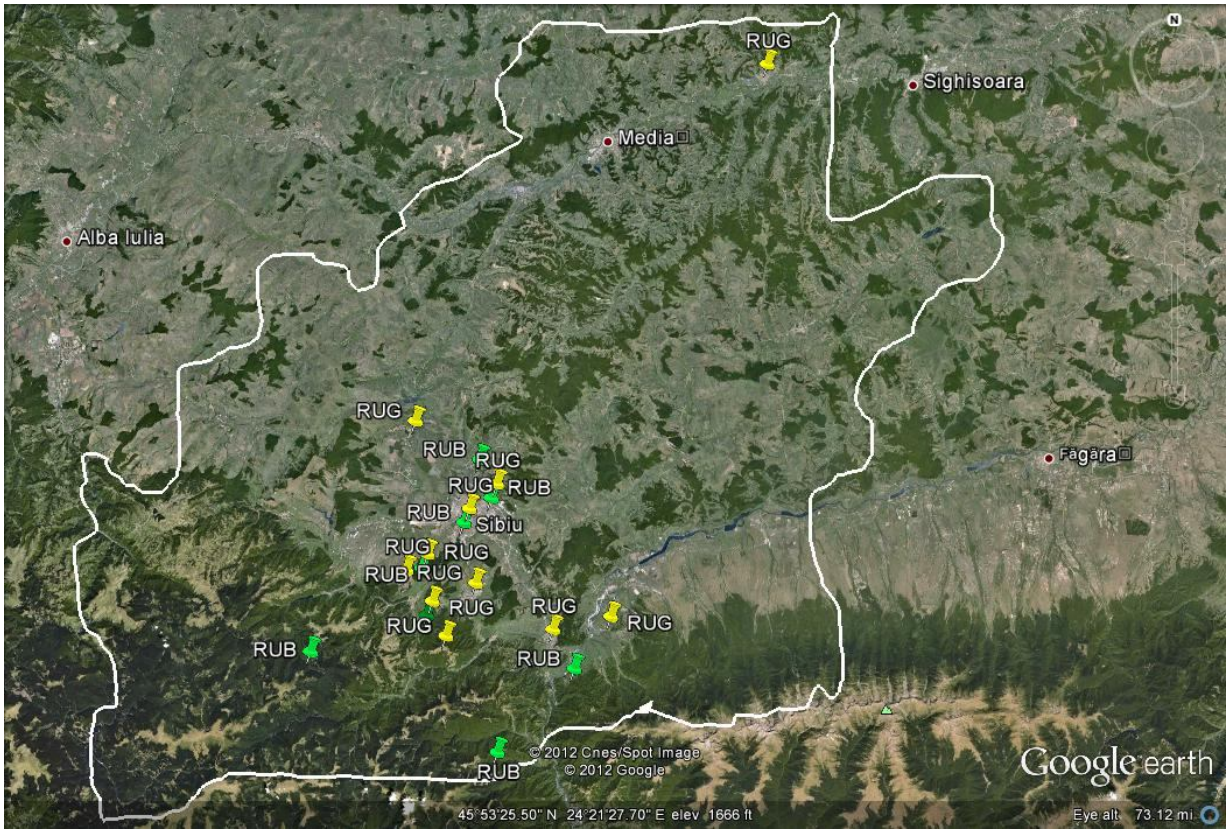

Fig. 16. Distribution of *Myrmica ruginodis (rug)* and *Myrmica rubra (rub)*

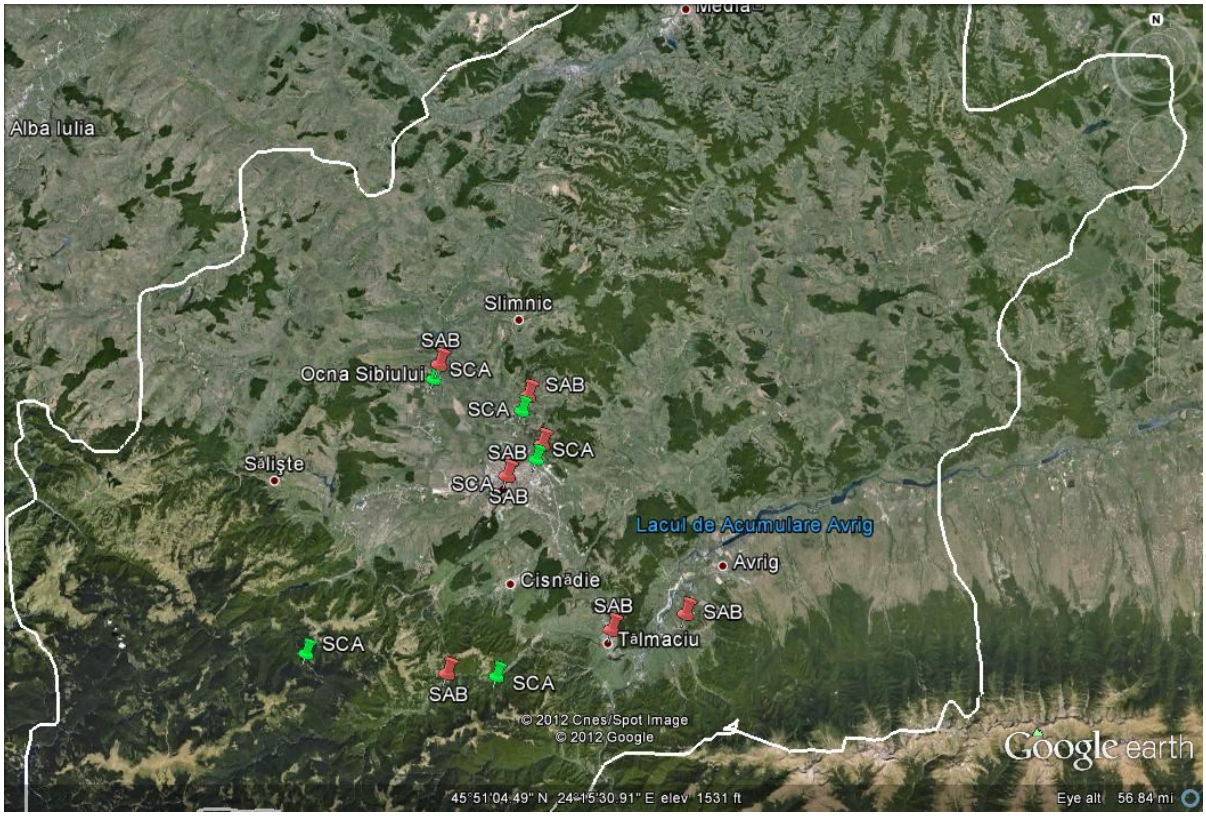

Fig. 17. Distribution of *Myrmica scabrinodis (sca)* and *M. sabuleti (sab)*

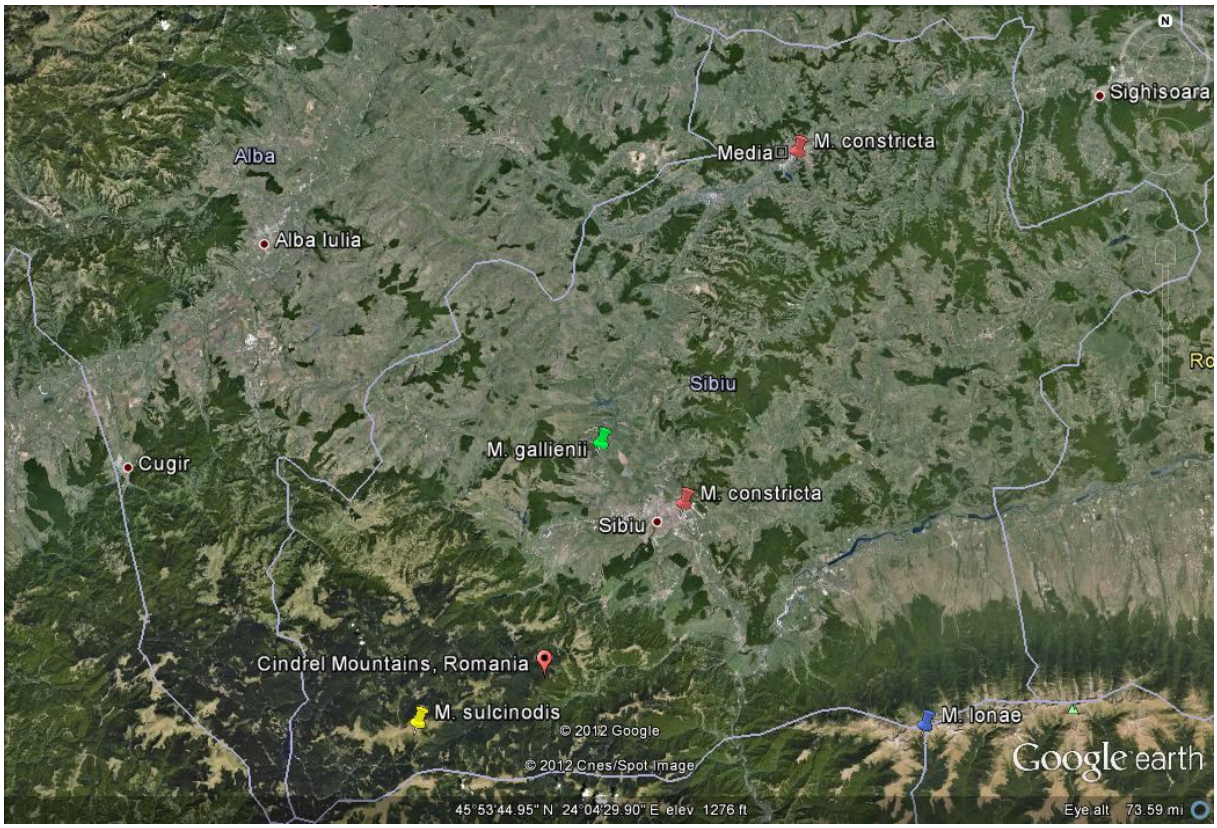

Fig. 18. Distribution of *Myrmica constrica*, *M. lonae*, *M. gallieni* and *M. sulcinodis*

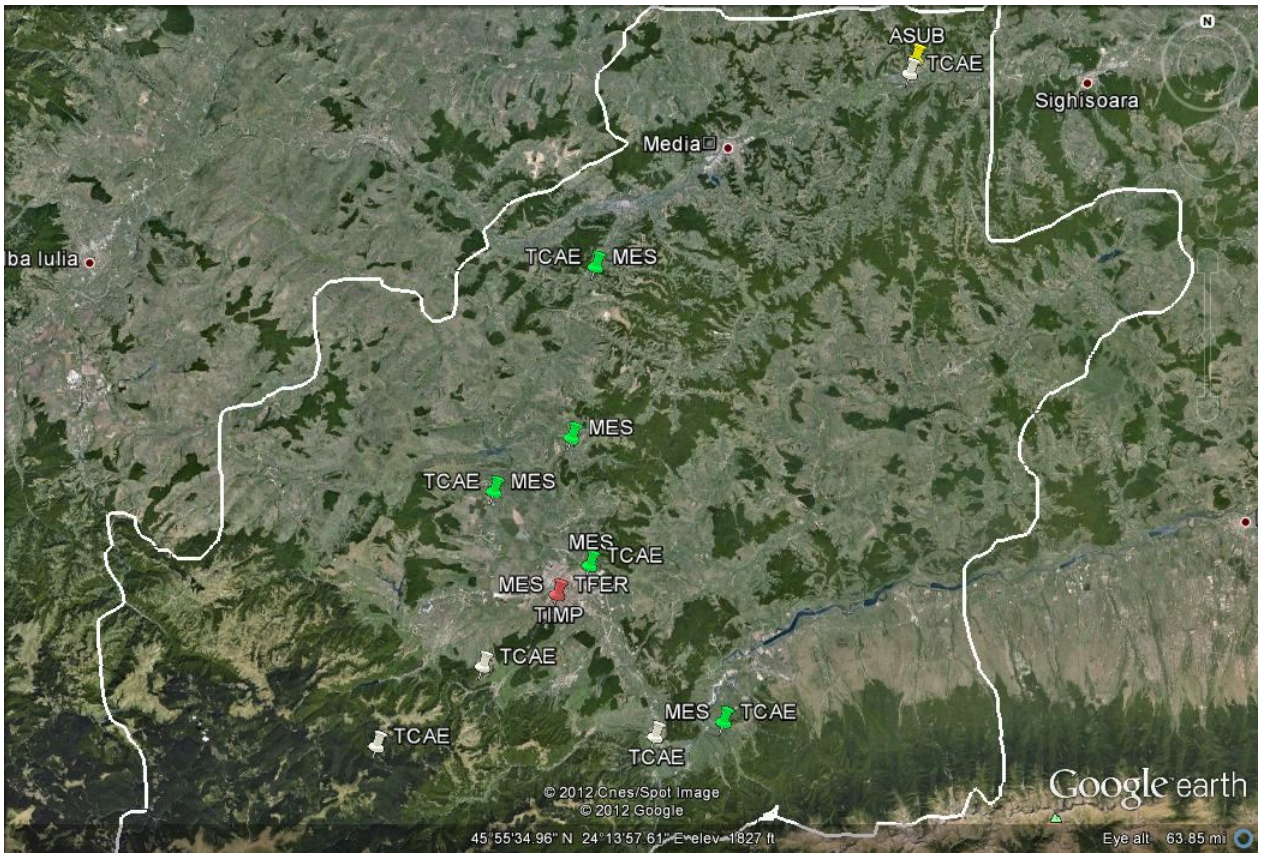

Fig. 19. Distribuion of *Aphaenogaster subterranea (asub), Messor* cf. *structor (mes) and Tetramorium* cf. *caespitum (tcae), T.* cf. *impurum (timp)* and *T. ferox (tfer)*

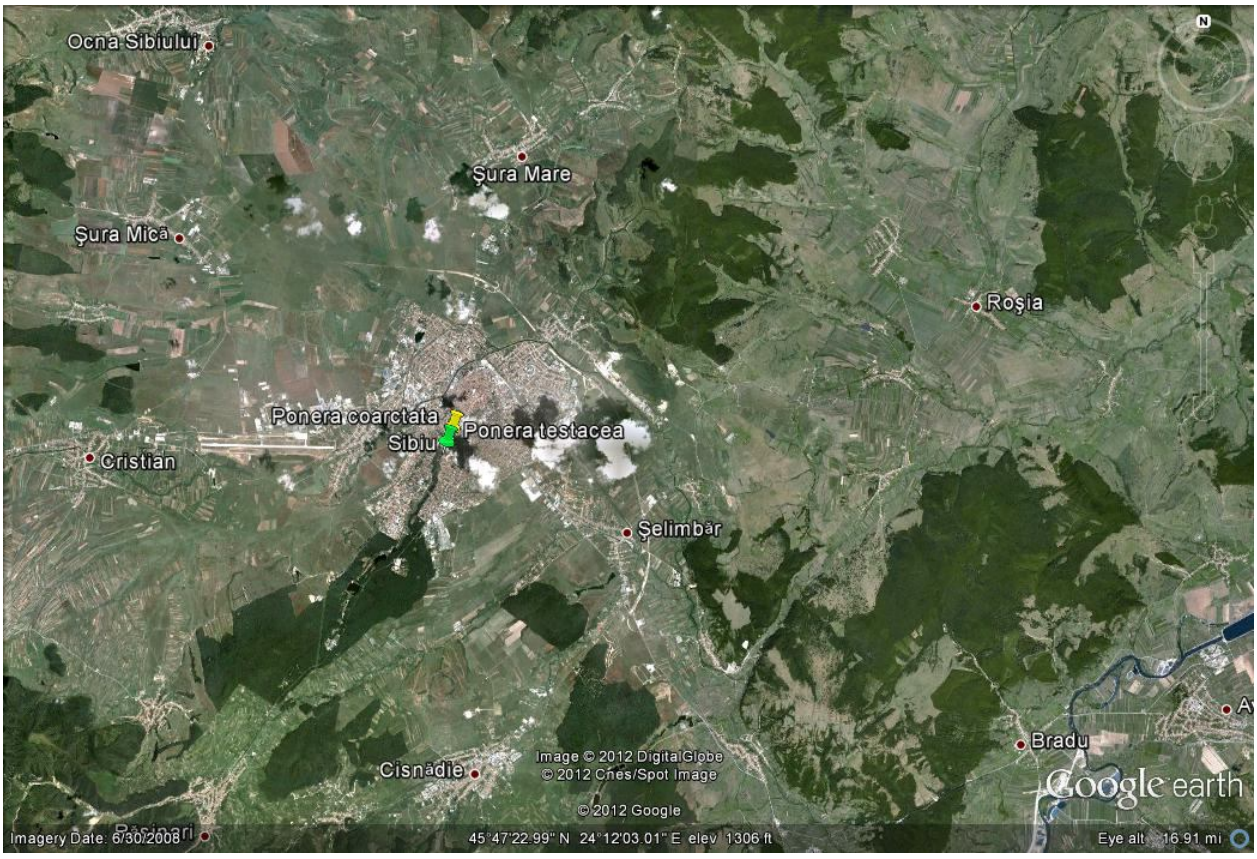

Fig. 20. Distribution of *Ponera coarctata* and *P. testacea*

THE BIELZ MALACOLOGICAL SLUG COLLECTION FROM THE NATURAL HISTORY MUSEUM IN SIBIU

Ana-Maria MESAROŞ[*]
Raluca STOICA[**]

Abstract. *75 slug specimens belonging to the Bielz Malacological collection from the Natural History Museum in Sibiu were listed and studied. Because of the general storage conditions and the lack of staff, during time, the majority of the slug specimens found in the Bielz collection dried up. The authors registered the specimens and their conservation aspects in order to identify the proper curatorial methods that should be appointed to these particular museum pieces. Active research is necessary to support passive conservation measures in order to stop further degradation to the wet Malacological collection.*
Keywords*: slug collection, museum specimen conservation, Natural History Museum from Sibiu*

Rezumat. *Au fost inventariate 75 specimene de limacomorfe aparţinând colecţiei malacologice Bielz din cadrul Muzeului de Istorie Naturală (Sibiu). Datorită condiţiilor generale de depozitare şi a lipsei personalului calificat, de-a lungul timpului, majoritatea specimenelor de limacomorfe din colecţia Bielz conservate în lichid s-au uscat. Autorii au inventariat specimenele şi au studiat aspectele de conservare cu privire la aceste piese muzeale cu scopul de a identifica care sunt metodele optime ce ar trebui aplicate acestora. Cercetarea activă a stării actuale de deteriorare este necesară pentru a stabilii măsurile de restaurare viitoare ce pot fi aplicate specimenelor şi pentru a oprii degradarea altor preparate umede din colecţia Malacologică a muzeului.*
Cuvinte cheie*: colecţia de limacşi, conservarea specimenelor muzeale, Muzeul de Istorie Naturală Sibiu*

Introduction

The Natural History Museum from Sibiu was founded in 1895 by the Transylvanian Society for Natural Sciences from Sibiu (*Siebenbürgischer Verein für Naturwissenschaften zu Hermannstadt*). The collections were initiated in 1849 long before the museum was open to the public.

The Malacological collection from the Natural History Museum in Sibiu gathers today 515.147 specimens, and the value of the collection consists not only in its numbers but also in its historical background, offering many opportunities in approaching systematic, ecological, biogeographic and biodiversity assessment studies of different time scale (Mesaroş 2010, 649).

The Malacological collection of the museum includes the Kimakowicz collection (305.431 specimens) and the Transylvanian Society for Natural Sciences of Sibiu Malacological collection (209.716 specimens).

*Brukenthal National Museum, Natural History Museum,
*ana.mesaros@yahoo.com,
ana.mesaros@brukenthalmuseum.ro;
**ralucastoicas@yahoo.com,
raluca.stoica@brukenthalmuseum.ro

The Transylvanian Society for Natural Sciences of Sibiu Malacological collection originated in 1852 when Johann L. Neugeboren, founding member of the Society, donated 210 mollusc shells.

The Bielz Malacological collection, counting over 200.000 pieces, was initiated by Michael Bielz (1787-1866), one of the founding members of the museum and the first director of the Transylvanian Society. Edward Albert Bielz (1827-1898), his son, president of the Society for many years also, shared this passion for natural sciences and Malacology.

The collection was donated in 1927 to the Society by Julius Bielz (1884 – 1958) the grandson of Eduard Albert Bielz.

The material found in the Bielz Malacological collection was mainly collected and identified by Eduard Albert Bielz. The results of his Malacological studies were published in the Society journal *Verhandlungen und Mittheilungen des siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt* from 1850 until 1865 as short papers and later all the data from these communications was gathered in a volume entitled *Fauna der Land - und Süsswasser*

Mollusken Siebenbürgens published in 1863. Eduard Albert Bielz described and listed, in the journal and in the volume published in 1863, the specimens collected and included in the collection but not with inventory numbers.

The Bielz Collection has two main categories: wet and dried specimens. The slug collection is part of the wet collection.

Unfortunately, because of the general storage conditions and the lack of staff, during time, the majority of the slug specimens dried out. After listing the museum specimens one of the objectives was to stop further degradation

Material and methods

Curatorial aspects

The entire Transylvanian Society Malacological collection holds 103 slug specimens, from which 75 belong, according to their labels, to the Bielz Collection, the rest were collected by museum curators between 1952 and 1959.

As the Bielz Malacological collection was donated to the Society, it is since 1927 included, by the general accounting inventory books, in the Transylvanian Society for Natural Sciences of Sibiu Malacological collection. All donations that entered the museum, in that period, were included in the Society collection. These collections were not kept separately, as they were received, but each specimen was given an inventory number and stored together with the other specimens of the same genera and species. The inventory numbers changed and the specimens were moved by museum curators during time.

Regarding the Bielz Malacological collection the unit-level data is included on old original labels which in many cases are incomplete or hard to read, or even more disturbing some specimen's labels are missing. The recording of the collecting data associated to the specimens was not a priority to collectors, because the number of specialists and museum staff was reduced and the Society members were collecting natural specimens belonging to different scientific areas. For example, the museum includes both a mineralogical and molluscan Bielz collection. Also, the Society did not benefit from a true headquarter until the museum was opened in 1895, and the collections were moved from one place to another and thus, we presume that a lot of written information was lost. That is why the authors, consider, that this might be the reason why there are no written inventory records by Michael or Eduard Albert Bielz regarding their Malacological collection. There were identified in the museum archive some donation letters for specimens but none of them are related to slug specimens.

In order to gather more information for the slug specimens, to complete the data missing from the original labels the Society scientific journal *Verhandlungen und Mittheilungen des siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt* and E. A. Bielz's *Fauna der Land- und Süsswasser Mollusken Siebenbürgens* were used.

Slug specimens are mentioned for the first time in the paper written by Michael Bielz in 1851 and published in the museum journal, in which the author mentioned the species, the collecting sites but not the total number of specimens or an inventory number. The species collected were: *Arion empiricorum var ater* Férussac, 1819 and *A. empiricorum var rufus* (Linnaeus, 1758) synonym *Arion ater* (Linnaeus, 1758) collected from Hermannstadt meaning Sibiu (Sibiu County), *Arion albus* Linnaeus synonym *Arion ater* (Linnaeus, 1758) collected from Gurariu am Valye plaje mening Gura Râului (Sibiu County) on the river bank, *Arion subfuscus* (Draparnaud, 1805) no collecting sites received from A. Szombath, *Arion hortensis* Férussac, 1819 collected from Hermannstadt meaning Sibiu (Sibiu County), *Limax cinereus* O. F. Müller, 1774 today *Limax maximus maximus* Linnaeus, 1758 in many varieties as the author mentioned collected from Hermannstadt, Sibiu, *Limax agreste* Linnaeus, 1758 today *Deroceras agreste* (Linnaues, 1758) collected from Hermannstadt, Sibiu and *Limax coerulans* M. Bielz, 1851 synonym *Bielzia coerulans* (M. Bielz, 1851) described for the first time by the author in this paper, collected on May 24, 1847 from Draguscher und Arpaser Gebirge, Rotunde bey Kapnikbánya meaning Drăguş (Braşov County), mountain area near Arpaşu (Sibiu County), Pasul Rotunda between Cavnic and Budeşti (Maramureş County) (Bielz, 1851, 14-15).

Eduard Albert Bielz in the first chapter of *Beitrag zur kenntniss der siebenbürgischen Land- und Süsswasser mollusken* mentioned the same species but without the collecting dates or sites and in the second subchapter entitled *Bemerkungen zu dem Verzeichnisse der Siebenbürger Land- und Süsswassermollusken nebst der Beschreibung der neuen Arten* he included *Daudebardia brevipes* Draparnaud, 1805, no collecting sites or date (Bielz, 1853, 113). In the 1856 December number of the museum journal the same author listed the following species without mentioning the

collecting area and dates: *Arion empiricorum* Férussac, 1819 [*Arion ater* (Linnaeus, 1758)], *Arion albus* Linnaeus, 1758 [*Arion ater* (Linnaeus, 1758)], *Arion subfuscus* (Draparnaud, 1805), *Arion hortensis* Férussac, 1819, *Limax cinereus var. coerulans*, *Limax agrestis* Linnaeus, 1758 [*Deroceras agreste* (Linnaeus, 1758)] and *Daudebardia brevipes* Draparnaud, 1805 (Bielz, 1856, 225).

The numbers 9 and 10 of the museum journal from 1859 included general observations regarding the genuses *Arion* Férussac, 1819 , *Limax* Linnaeus, 1758 and *Daudebardia* Hartmann, 1821 and the first description of the species *Daudebardia transsilvanica* E. A. Bielz, 1859 synonym *Cibinia transsilvanica* (E.A. Bielz, 1859), collected from Transylvania, several localities, also near Braşov (Bielz, 1859, 214).

In *Fauna der Land- und Süsswasser Mollusken Siebenbürgens*, E. A. Bielz listed the following slug species: *Daudebardia transsilvanica* E. A. Bielz, 1859 synonym *Cibinia transsilvanica* (E.A. Bielz, 1859), *Arion olivaceus* Kotula, 1884 synonym *Arion subfuscus* (Draparnaud, 1805), *Arion hortensis* Férussac, 1819, *Limax cinereus* O.F. Müller, 1774 synonym *Limax maximus* Linnæus, 1758, *Limax marginatus* Draparnaud 1805 synonym *Milax rusticus* Millet, 1843, *Limax variegatus* Draparnaud, 1801 synonym *Limax flavus* Linnaeus, 1758, *Limax agreste* Linnaeus, 1758 synonym *Deroceras agreste* (Linnaeus, 1758), *Limax silvaticus* Goldfus, 1856 synonym *Lehmannia marginata* (Müller, 1774) (Bielz, 1863, 25-32).

The last paper published in the museum journal in which E.A. Bielz mentioned slug species is the *Catalogus molluscorum terrestrium et fluviatilium Imperii Austrici* in which the author enumerated the slug species found in the Austrian Empire including Romania (Bielz, 1865, 139).

For the inventory list the authors compared the specimen scientific names and the collecting sites from the labels to those included in the written work in order to narrow down the periods when the specimens were collected and who was the collector.

As a general observation the specimens found in the collection were gathered mainly from Romania (Fig. 1, Tab. 1).

The Bielz collection slug specimens are held in glass jars (Fig. 2 a, b, c). The majority of the jars are closed with cork and covered with paper. The collector wrote on the paper covering the jar's cork the name of the species and the collecting sites (Fig. 3 a, b).

In general the slug specimens belonging to the Bielz Collection have personalized labels with the name of Eduard Albert Bielz printed on them. The labels are glued to the jars making it easy to recognize and separate them from other donations (Fig. 4 a, b).

From a curatorial point of view it is important that the original data included on the labels should be mentioned for each specimens followed by the appropriate translations, where it is necessary. The information written on the labels from each jar was computerized, the specimens were taken out of the jars photographed and their general conservation aspects evaluated.

Conservation aspects

The Natural History Museum building was constructed in 1894 and its main design and purpose was to store the Society's collections and function as a museum.

The entire Bielz collection is held in a basement room of the museum together with other Malacological donations, bought dried and wet pieces are stored here.

The room is part of the museum storage area, which is effectively a series of rooms that open in a hallway. The storage area insulation is the same for the whole building and it is limited to brick walls, there are no modern modifications.

The Malacological collection storage room communicates through a door with the Mineralogy collection room.

The Malacological collection room lacks special climate controls. Thick orange drapes are fitted to the one window present here, in order to minimize solar gain. The room is exposed during the day to sun light especially at noon.

Heating in the storage area is provided by one radiator with thermostatic valve. The radiator is turned of from April until November. There is no controlled ventilation and the air enters underneath the door and through the window when it is opened. Also air exchange or associated dust movement through the floorboards is not prevented.

Being of smaller size and packed with wood cabinets, the room is prone to heat up quickly from radiant heating on the outside wall of the building, especially during summer.

The Malacological specimens are deposited in wooden boxes held in wood cabinets. The wood

cabinets, very old, are used to deposit dried and wet collection pieces together. The Bielz slug collection is stored in such conditions (Fig. 5 a, b).

The slug specimens are held in glass jars sealed with cork and covered with ordinary paper. The specimens are whole animals that were preserved in an unknown conservation fluid.

The Bielz wet Malacological collection was not checked periodically to top off the conservation liquid if necessary and now the liquid completely evaporated and the specimens dried out.

Results and discussion

Curatorial aspects

The slug specimens found in the collection were collected by Eduard Albert Bielz. The years when the specimens were collected are not mentioned on the label for each specimen.

The list with the slug specimens found in the Bielz collection, including the inventory number (Inv. No.), number of pieces found at that inventory number, the original identification done by E.A. Bielz, today's synonym, the collecting sites as written on the label and the collecting period if mentioned:

- Inv. No. 9274, 1 specimen, *Limax arboretum* probably *Limax arborum* Boughard, 1838, synonym to *Lehmannia marginata* O.F. Müller 1774 (Grossu 1983, 280), Hermannstadt Spital meaning the hospital in Sibiu, 9. XI. 1890;

- Inv. No. 66024, 66025, 66026, 66027, 66028, 66029, 6 specimens, *Arion subfuscus transilvanicus* Simroth synonym *Arion subfuscus quadrifasciata* Jensen synonym *Arion subfuscus* (Draparnaud, 1805) (Grossu, 1983, 47), Békéscsaba (Hungary);

- Inv. No. 66030, 66031, 66032, 66033, 66034, 66035, 66036, 66037, 66038, 66039, 66040, 66041, 12 specimens, *Limax marginatus* Draparnaud 1805 synonym *Milax rusticus* Millet, 1843 (Grossu, 1983, 220), Freckes Gebirge Transilvania meaning Avrig (Sibiu County), mountain area, Transylvania;

- Inv. No. 66042, 1 specimen, *Limax cinereus* O.F. Müller, 1774 synonym *Limax maximus maximus* Linnaeus, 1758 (Grossu, 1983, 242), Michelsberg meaning Cisnădioara, (Sibiu County);

- Inv. No. 66043, 66044, 66045, 66046, 4 specimens, *Limax agrestis* synonym *Limax agreste* Linnaeus, 1758 synonym *Deroceras agreste* (Linnaeus, 1758) (Grossu, 1983, 334), Hermannstadt, Gutenwaisenhaus, meaning Sibiu, orphanage;

- Inv. No. 66047, 66048, 66049, 66050, 66051, 66052, 66053, 7 specimens, *Arion subfuscus transilvanicus* Simroth synonym *Arion subfuscus quadrifasciata* Jensen synonym *Arion subfuscus* (Draparnaud 1805) (Grossu, 1983, 47), Klausenburg Bükk. meaning Cluj-Napoca, Bükk. with no correspondence;

- Inv. No. 66054, 66055, 2 specimens, *Limax agrestis* synonym *Limax agreste* Linnaeus, 1758 synonym *Deroceras agreste* (Linnaeus, 1758) (Grossu, 1983, 334), Bihargebirge Branisora bis Stenisora meaning Bihor Mountains, from Bănişoara to Stănişoara;

- Inv. No. 66056, 1 specimen, *Limax maximus var Bielzii* Seibert, 1873 synonym *Limax bielzii* Seibert, 1873, St. Gotthard bei Graz, Steiermark meaning the Castle St. Gotthard, north Graz, Steiermark, Austria;

- Inv. No. 66057, 66058, 2 specimens, *Arion olivaceus* Kotula, 1884 synonym *Arion subfuscus* (Draparnaud, 1805), Freckes Gebirge, Transsilvan. meaning Avrig (Sibiu County), mountain area, Transylvania;

- Inv. No. 66059, 1 specimen, *Limax cinereoniger* Wolf, 1803, Hermannstadt, Transilv. meaning Sibiu, Transylvania;

- Inv. No. 66060, 1 specimen, *Limax unicolor* Heynemann synonym *Limax maximus var. unicolor* Heynemann (Grossu, 1983, 246), Transylvania;

- Inv. No. 66061, 66062, 66063, 66064, 4 specimens, *Arion subfuscus transilvanicus* Simroth synonym *Arion subfuscus quadrifasciata* Jensen synonym *Arion subfuscus* (Draparnaud 1805) (Grossu, 1983, 47), Hohe Rinne, meaning Păltiniş, Cindrel Mountains;

- Inv. No. 66065, 66066, 2 specimens, *Amalia marginata* Draparnaud 1805 synonym *Milax rusticus* Millet, 1843 (Grossu, 1983, 220), Gödesberg in Schloss, meaning Gödesberg castle, in Bad Gödesberg, Bonn (Germany);

- Inv. No. 66067, 1 specimen, *Limax transilvanicus* Hazay, 1883 synonym *Bielzia coerulans* (M. Bielz, 1851) (Grossu, 1983, 304), Karzisoara Transsilvanien meaning Cârţişoara (Sibiu County), Transylvania;

- Inv. No. 66068, 66069, 66070, 3 specimens, *Limax marginatus* Draparnaud, 1805 synonym *Milax rusticus* Millet, 1843 (Grossu, 1983, 220), Hohe Rinne, meaning Păltiniş, Cindrel Mountains;

- Inv. No. 66071, 66072, 66073, 66074, 66075, 66076, 6 specimens, *Limax cinereoniger* Wolf, 1803, Mühlbahthal, Colonie Bisztra, meaning Sebeş, Bistra (Alba County);

- Inv. No. 66077, 66078, 2 specimens, *Arion subfuscus transilvanicus* Simroth synonym *Arion subfuscus quadrifasciata* Jensen synonym *Arion subfuscus* (Draparnaud 1805) (Grossu, 1983, 47), Klausenburg meaning Cluj-Napoca;

- Inv. No. 66079, 1 specimen, *Limax cinereoniger* Wolf, 1803, Graz (Austria);

- Inv. No. 66080, 1 specimen, *Limax cinereoniger* Wolf, 1803, Klausenburg meaning Cluj-Napoca;

- Inv. No. 66081, 66082, 2 specimens, *Arion subfuscus transilvanicus* Simroth synonym *Arion subfuscus quadrifasciata* Jensen synonym *Arion subfuscus* (Draparnaud 1805) (Grossu, 1983, 47), Hermannstadt, Hallerweise, meaning Sibiu, meadow area;

- Inv. No. 66083, 66084, 2 specimens, *Arion hortensis* Férussac, 1819, Transylvania;

- Inv. No. 66085, 66086, 2 specimens, *Limax agrestis* synonym *Limax agreste* Linnaeus, 1758 synonym *Deroceras agreste* (Linnaeusm 1758) (Grossu, 1983, 334), Hidegszamos, meaning Someşul Rece River;

- Inv. No. 66087, 1 specimen, *Limax cinereoniger* Wolf, 1803, Hercules Bad meaning Herculane Baths,;

- Inv. No. 66088, 1 specimen, *Limax cinereoniger* Wolf, 1803, Bullea – See, meaning Bâlea Lake, Făgăraş Mountains;

- Inv. No. 66089, 1 specimen *Arion subfuscus* (Draparnaud 1805), Schnee grube Riascus, no equivalent;

- Inv. No. 66090, 66091, 66092, 66093, 66094, 5 specimens, *Limax marginatus* Draparnaud 1805 synonym *Milax rusticus* Millet, 1843 (Grossu, 1983, 220), collected by E. A. Bielz from Bullea-Sea, meaning Bâlea Lake, Făgăraş Mountains;

- Inv. No. 66095, 1 specimen, *Limax cinereus var. coerulans*, *Bielzia coerulans* (M. Bielz, 1851) Bihargebirge, Banisor bei Stanişoara, meaning Bihor Mountains, Stănişoara, Bănişor (Sălaj County);

- Inv. No. 66096, 66097, 2 specimens, *Arion subfuscus transilvanicus* Simroth synonym *Arion subfuscus quadrifasciata* Jensen synonym *Arion subfuscus* (Draparnaud 1805) (Grossu, 1983, 47), Klausenburg, Sigmundgarten, meaning Cluj-Napoca, Sigmundgarten.

As the specimens are dried out (Fig. 6 a, b) it is impossible, with the current museum means, to confirm that the names of the species written on the original labels are correct.

Conservation aspects

Fundamentally, the temperature and humidity regimes of collections spaces are architectural issues, and it is the nature of the building in which collections are housed that will determine the levels of control able to be applied to the collections space (Padfield, Larsen 2004, 131).

The chamber where the collection is held is not a proper museum storage unit. There is no ventilation, there are no devices to measure the external factors that influence the specimen conservation status not even the temperature. Temperature affects the state of the preserving fluid. Over time, even small fluctuations in temperature will cause most closure to fail, and evaporation will occur. As the temperature rises, the vapor pressure within the storage container increases putting stresses on the storage containers and their seals. Temperature increases also increase the rates of reaction (Carter 2003, 101-102).

Viscri *et al.* (2006, 94) considered that manual control of temperature in an effort to reduce humidity fluctuations in a poorly scaled building, with inadequate levels of staffing, is an inefficient and ineffective use of human resources. At the Museum of Natural History in Sibiu climate control in the storage area has to be done using limited resources in an antiquated building. Unfortunately the storage conditions of these specimens can not be changed because of the lack of space and founding.

The current museum conservation technician has sheltered the listed slug specimens from light exposure during storage. Light caused permanent, irreversible damage to specimens (the effect is cumulative).

The container used to store a specimen, and the fluid preservative, surrounding the specimen constitute a micro-environment. If place in a good, stable storage environment and maintained well, fluid-preserved specimen should last for hundreds of years. This micro-environment is affected by the macro-environment (light, temperature, and handling). Wet collections require constant maintenance and monitoring (Carter 2000, 19).

The wood cabinet in which the Bielz collection slug specimens are stored are opened often as some of the material held in them are often used for temporary exhibits and specimens are extracted to be studied for scientific papers. The cork sealing could have been damaged by the vibration produced as the cabinet was often opened. As the jars cork seals are broken and highly fluctuating temperatures caused the liquid to evaporate. Evaporation happens especially with older and dried-out sealing material.

The original jars in which the specimens were held have to be completely changed or at least the cork should be avoided when closing the jars, our specimens being the perfect example of what happens when the jar is closed with cork. It tends to be acidic and decomposes over time and also cork, a compressible material, reacts with preservative fluid and looses their compressibility.

In a perfectly sealed storage container the relative humidity should have little effect, but in our case the jars were not perfectly sealed. Most storage containers found in the Malacological wet collection have imperfect seals leading to fluid loss through evaporation and hence open to being affected by relative humidity levels. Even in the Society collection slug specimens collected during 1952 and 1959, even if the liquid did not evaporate and the jars are sealed better there can be observed the reduction of the liquid levels. However the seals on storage containers are rarely completely airtight, and many of the materials used for the construction of jar lids, are themselves very permeable to oxygen. The provision of oxygen into the fluid preservative can have numerous effects (Carter 2003, 103). As an example many of our museum wet specimens are preserved in formaldehyde. Oxidation can promote the pH of formaldehyde solutions to fall, and can degrade lipids, amino acids and pigments.

The paper used to cover the cork seals is not acid free and so it became yellow and is decomposing. Even so it is a positive aspect, as in many other wet collection specimens found in the museum collections the original labels inserted in the jars disintegrated, making it impossible for the curator to extract the data associated to the specimens.

In the Bielz slug collection there are specimens that are severally deteriorated, for example the inventory numbers: 66042 (Fig. 7, a) and 66059 (Fig. 7 b,c).

However, if the tissue dried out it may not be useless. Strum and Mayhew (2006, 24) mention the name of scientists that have written a couple of papers based on anatomical data drawn from dried soft parts found inside old shells from museum collections, some of them more than 40 years old. For example, Houbrick (1992, 2) extracted radulae from museum *Cerithium* Bruguière specimens dried in their shells.

Strum (2006, 55) considers that if the preservative has evaporated and left behind desiccated tissue, rehydrating solutions are not always the best. If the specimen was stored in alcohol and it is now dried out then it should be left like that.

Rehydration is a possibility in the case of our collection dried out slug specimens. In order to select a less invasive method to rehydrate the specimens the authors consulted the scientific studies conducted in this area until today.

Studies show that the specimen can be soaked in 0,5% aqueous solution of trisodium phosphate (Van Cleave, Ross 1947, 318).

Thompson *et al.* (1966, 109) used a method that involved soaking the dried specimen in a mixture of 50% ethylene glycol and 50% water.

Carter (2000, 23) offers the following method for rehydrating specimens:

- first a solution of Decon 90 detergent and water is prepared in approximate concentration 1: 20, as the phosphates in the detergent penetrate the cells allowing water to osmose into them;

- the solution is added to the dried up material making sure that no labels are affected as detergent causes serious damage to paper and script;

- the specimen is left for an average of 3 days, checking daily to ascertain if the solution needs to be changed or renewed. The material is then rinsed thoroughly in running cold water before re-immersing.

- after rehydration is complete, the specimen is rinsed in running cold water for at least 10 minutes and introduced in alcohol (usually 80%) with information that it has been rehydrated.

The final material has to be checked for a further week. If the appearance of the alcohol changes it means that the material needs a further rinsing in water.

Another step towards a better conservation of the slug collection is a good record keeping

The procedures used to collect each specimen should have been noted, along with the methods used in preparing, preserving and using the specimen. If a specimen deteriorates, these records

can tell us why, may allow us to repair damage, and prevent it from happening to other museum specimens. Our museum did not benefit from such records from the past curators. The museum conservation technician has started conservation records for the museum specimens including the Bielz slug collection.

The way forward in caring for the Bielz slug collection, in the current conditions, is by controlling the specimen microenvironment and by constant monitorization.

Acknowledgements

The authors are grateful to Dr. Heike Riese from the Senckenberg Museum für Naturkunde Görlitz (Germany) and to Dorina Golban, conservation specialist from the Țării Crișurilor Museum, Oradea (Romania) for the scientific and constructive remarks.

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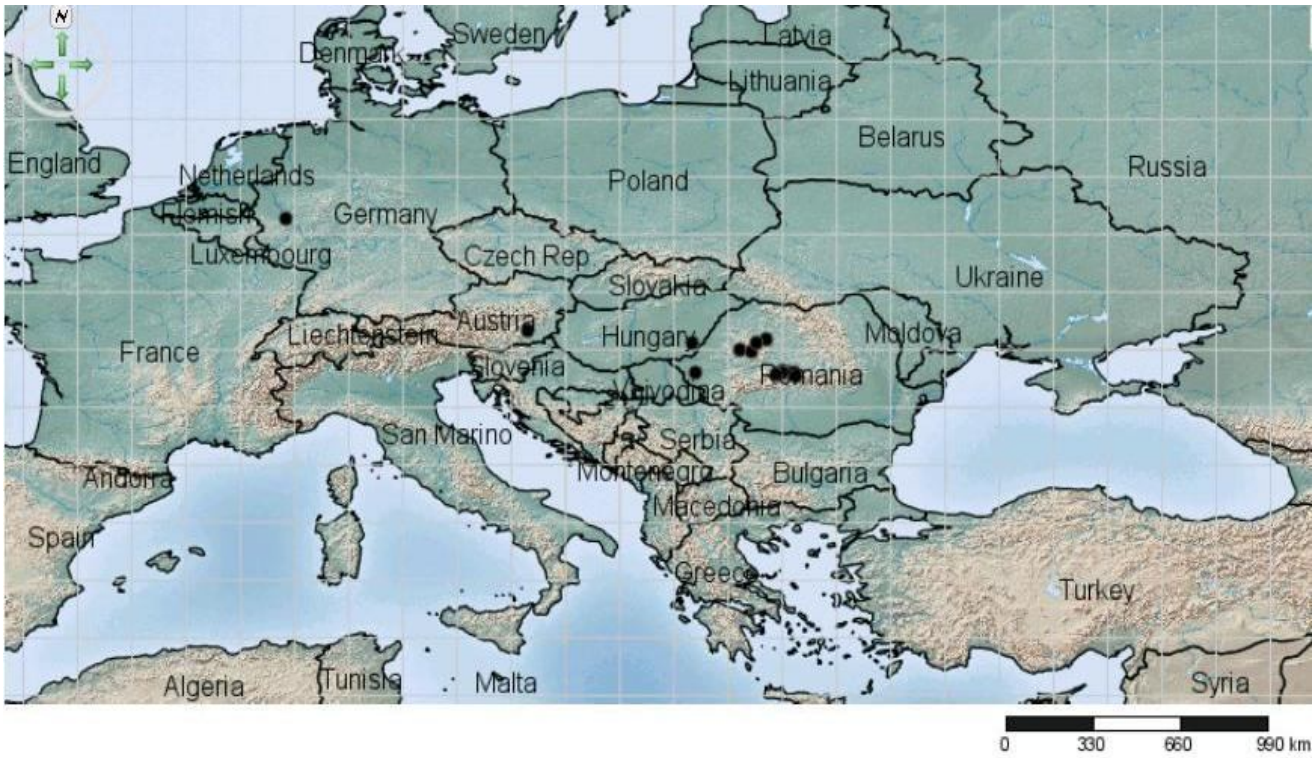


Fig. 1. The areas from which the slug specimens were collected (edited using http://www.simplemappr.net/ [accessed May 2012])

a. b. c.

Fig. 2 a, b, c. General aspect of the glass jars in which the specimens are held inventory number 66042 (a), 66041(b), 66054-66055 (c).

a. b.

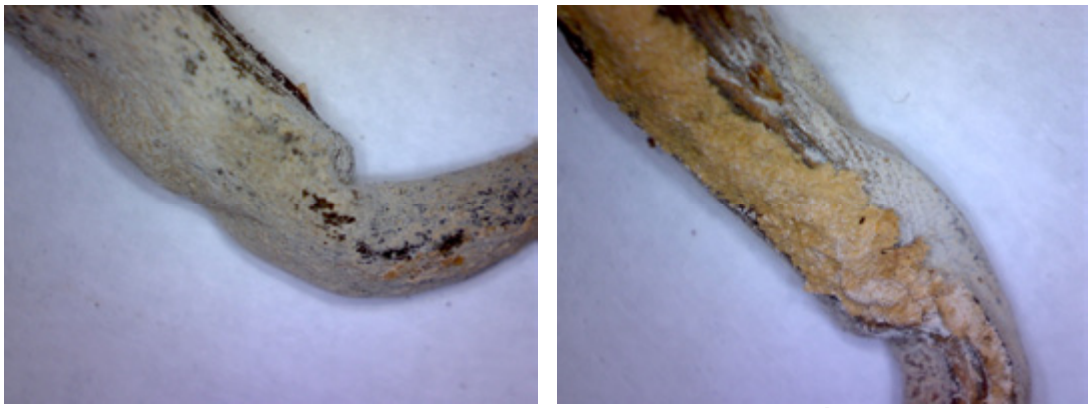
Fig. 3 a, b. The original hand writing from the jars paper tops

a. b.

Fig. 4 a, b. Personalized original labels from the Bielz Collection

a. b.

Fig. 5 a, b. The general storage area (a) and the wooden boxes in which the jars with slug specimens were held (b – circled area)



a. b.

Fig. 6 a, b. Close up aspects of a dried up specimen (inventory number 66088)

a. b. c.

Fig. 7 a, b, c. Deteriorated dried up specimens

Tab. 1. The slug species found in the Bielz collection, the collecting sites and number of specimens

Species	Collecting sites	Number of specimens
Lehmannia marginata O.F. Müller, 1774	Sibiu (Sibiu County, Romania)	1
Arion subfuscus (Draparnaud, 1805)	Békéscsaba (Hungary)	6
	Cluj-Napoca (Cluj County, Romania)	7
	Avrig (Sibiu County, Romania) mountain area	2
	Păltiniş (Sibiu County, Romania) Cindrel Mountains	4
	Cluj-Napoca (Cluj County, Romania)	4
	Sibiu (Sibiu County, Romania)	2
Milax rusticus Millet, 1843	Avrig (Sibiu County, Romania) mountain area	12
	Gödesberg Castle, Bad Gödesberg, Bonn (Germany)	2
	Păltiniş (Sibiu County, Romania) Cindrel Mountains	3
	Bâlea Lake, Făgăraş Mountains (Romania)	5
Limax maximus maximus Linnaeus, 1758	Cisnădioara (Sibiu County, Romania)	1
Deroceras agreste (Linnaeus, 1758)	Sibiu (Sibiu County, Romania)	4
	Bihor Mountains from Bănişoara to Stănişoara (Sălaj County, Romania)	2
	Someşul Rece River (Romania)	2
Limax bielzii Seibert, 1873	Castle St. Gotthard, north Graz (Austria)	1
Limax cinereoniger Wolf, 1803	Sibiu (Sibiu County, Romania)	1
	Sebeş, Bistra (Alba County, Romania)	6
	Graz (Austria)	1
	Cluj-Napoca (Cluj County, Romania)	1
	Herculane Baths (Caraş-Severin County, Romania)	1
	Bâlea Lake, Făgăraş Mountains (Romania)	1
Limax maximus var. unicolor Heynemann	Transylvania	1
Bielzia coerulans (M. Bielz, 1851)	Cârţişoara (Sibiu, County, Romania)	1
	Bihor Mountains from Bănişoara to Stănişoara (Sălaj County, Romania)	1
Arion hortensis Férussac, 1819	Transylvania	2

HELICIDS IN LAND SNAIL COMMUNITIES FROM SECONDARY GRASSLANDS OF SOUTHERN TRANSYLVANIA

Voichiţa GHEOCA*

Abstract. *Terrestrial land snail communities from secondary grasslands and the importance of helicid snails in these communities was analyzed from 120 quantitative samples taken in four grasslands. The main goal of the study was to analyze the qualitative structure of the community as well as the degree of association between land snail species and their affinity for the habitat. A number of 14 species were identified. The representative species for these communities are V. excentrica, C. tridens and C. vindobonensis. Helicids are an important component regarding number of individuals and the major component from the perspective of biomass.*
Keywords*: helicids, land snails communities, secondary grassland fauna, Transylvania.*

Rezumat. *Lucrarea prezintă comunităţile de gastropode terestre caracteristice pajiştilor secundare şi rolul helicidelor în cadrul acestora, prin analiza unui număr de 120 de probe cantitative prelevate în patru pajişti. A fost testată structura calitativă a comunităţilor, gradul de asociere dintre specii precum şi gradul de afinitate pentru habitat. Au fost identificate 14 specii de gastropode. Speciile reprezentative pentru acest tip de pajişti sunt V. excentrica, C. tridens, C. vindobonensis, helicidele fiind o componentă importantă din punct de vedere numeric şi componenta dominantă din punctul de vedere al biomasei.*
Cuvinte cheie*: helicide, comunităţi de gastropode terestre, fauna din pajişti secundare, Transilvania.*

Introduction

In Transylvania most of the Subcarpathian hills (400-700 m altitude) were originally covered with forest. The consequence of deforestation was a replacement of primary vegetation with secondary grasslands, i.e. xeromezophylous herbaceous vegetation. Depending on the slope, their xerophylous character is more or less striking. These grasslands were originally vegetal associations like *Festucetum rupicolae* and *Agrostio tenuis – Festucetum rupicolae,* with a Central – European toward continental, character. Some of the characteristic species are: *Festuca rupicola, Asperula cianachica, Gallium mollugo, Scabiosa ochroleuca, Salvia pratensis,* but also mezophylous species, weeds, and in micro depressions there can be found even hygrophylous coenoses, with *Phragmites australis* (Fig.1).

Generally, these are more or less fragmented grasslands, limited by clumps of trees, shrubs or cultivated lands. Unlike the calcareous grasslands, which are known to have an extraordinary high diversity of plants and invertebrates, including land snails (Baur *et al*. 2007, Kirby 2001, Wallis De Vries *et al*. 2002), the land snail fauna of these number of species as in number of individuals. These kinds of grasslands have restrictive conditions for most land snail species, among them are the aridity and the vegetation. Most of the land snail species cannot live in dry conditions (Cameron 1970), as for the vegetation the dominance of Poacea in grasslands limits the food resource for herbivorous snails, which are known to not prefer grass species due to the high silica and fiber content of the leaves (Iglesias, Castillejo 1999), and to their toughness (Dirzo1980, Speiser, Rowell-Rahier 1991, Boschi, Baur 2007, Rathcke 1985). Although it was proved that poacea are part of their food, even if they are not preferred (Chevalier 2001, Silva, Teresa 1992).

The present paper will set forth an analysis of land snail community of grasslands from Sibiu and Braşov counties in southern Transylvania.

* Lucian Blaga University of Sibiu, Faculty of Sciences, vgheoca@yahoo.com

Methods

Qualitative samples of 0.625 cm^2 (25x25 cm) and 1 m^2 for the large species, were taken from four grasslands located in southern Transylvania in the interval 1995-2011. The location of sampling points is presented in figure 2. In each of four stations an equal number of 30 samples were taken, all the snails were collected from the grass

and soil, and a soil sample was also taken on 10 cm dept. The soil was sieved in laboratory and the biological material conserved. The identification was made according to Grossu (1981, 1983 and 1987), Kerney, Cameron (1979) and Bank (2011).

In order to describe the qualitative structure of land snail communities the abundance (A), the frequency (F) and the ecological significance index (Dzuba, W = (A x F) / 100) were used. The quantification of the degree of association between land snail species, was made using CCM contingency coefficient, Cole coefficient (C) for interspecific association and Fager affinity index (I_{AB}). The χ^2 and t tests were applied in order to analyze if the species are statistically significantly related to each other at 5% level of probability. The snail species' affinity for the habitat was tested with Fager affinity index.

Results and discussion

A number of 14 land snail species, from 6 families were identified (table 1). The number of species in each station ranges between 6 and 10. The registered density was ranged between 8 ind./m^2 and 24 ind./m^2 , while the biomass was 5.18 g/m^2 – 14.25 g/m^2

Analysing the relative abundance values for the 14 species the most abundant species are *Vallonia excentrica, Chondrula tridens, Cochlicopa lubricella* and *Cepaea vindobonensis.*

Regarding the frequencies, C. vindobonensis seem to be the most frequent, but elavated frequency values have also *C. tridens, C. lubricella, V. excentrica*. The ecologic significance index, register high values in all the sampling stations for *Vallonia excentrica, Chondrula tridens, Cepaea vindobonensis.*

Considering the values of relative abundance, frequency and ecologic significance, we can conclude that in this grasslands there is a community of xerophylous land snails with tree outstanding species *Vallonia excentrica, Chondrula tridens* and *Cepaea vindobonensis.*

The species' distribution on families considering the abundance of each species (Fig. 2) is dominated by Valoniidae (38.28%). High values have also Helicidae (18.04%), Enidae (16.8%), Cochlicopodae (12.91%), Hygromiidae (9.85), Ferussaciidae (2.11%) and Pupilidae (1.94%).

The Hygromiids are represented by two species *Monacha cartusiana* and *Xerolenta obvia*, and the helicids by three species *Cepaea vindobonensis*, *Helix pomatia* and *Helix lutescens*

The biomass does not observe the numeric model due to the difference in size between the representatives of different families. So in biomass the helicids (66.79 %), followed by Enidae (22.11%), and Hygromiidae (9.17%) (Fig. 3) are dominant.

For helicids, the three dominant species are the same, but the size of the two species of the Helix genus (*H. pomatia* and H. *lutescens*), is reflected in an increased biomass, and as a result a more equilibrated distribution between the three species (Fig. 4)

Let us mention that the presence of *H. pomatia* and *H. lutescens* is dependent on the existence of trees in these grasslands' vicinity.

For the association degree between the terrestrial gastropod species analyze, only eight species, the most common, were selected: *Cochlicopa lubricella, Vallonia excentrica, Chondrula tridens, Cecilioides acicula*, *Monacha cartusiana, Xerolenta obvia*, *Cepaea vindobonensis, Helix lutescens.* The Cole coefficient indicate significant association (p=0.05) between *Cochlicopa lubricella* and *Vallonia excentrica* (χ^2 = 11.409; CCM = 0.374; C= 0.87 ± 0.187).

We have also compiled a matrix of co-occurrences, and Fager's index of affinity was calculated (table 2). The highest level of association was found between *Vallonia excentrica* and *Chondrula tridens*, and these two species and *Cepaea vindobonensis* (Fig. 5).

Conclusions

The land snail community from secondary grasslands is relatively poor and made up of species characteristic of dry habitats, which are also present in calcareous grasslands as *V. excentrica, C. tridens, Granaria frumentum*, species that feed on fungi and debris, but do not form large populations here as in the conditions of an increased amount of calcium carbonate. Specific for these nutrient rich grasslands is the presence of other species that depend on the neighbouring trees and shrubs. The phytophagous species become essential elements in these communities, as is the case of *C. vindobonensis*, or occur more or less frequently (*H. lutescens* and *H. pomatia*), but enough, due to their dimension, to represent essential items in the nutrient cycle and food chains of these habitats.

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We would like to thank prof. dr. Constantin Drăgulescu, for his help in the description of the vegetation of the sampling areas.

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1- *Cochlicopa lubricella,* 2 – *Vallonia excentrica,* 3 – *Chondrula tridens,* 4 – *Cecilioides acicula*, 5 – *Monacha cartusiana,* 6 – *Xerolenta obvia*, 7 – *Cepaea vindobonensis,* 8 – *Helix lutescens.*

Tab. 1. List of land snails from grasslands: D – density (ind/m^2), A – relative abundance(%), F – frequency (%), W – Dzuba ecologic significance index; S* species with only shells.
Tab. 2. Matrix of the Fager affinity index values for the land snail species from grasslands (with hyphen are marked pairs of species for which the value of index is not significant).
The species' codification :
1- *Cochlicopa lubricella,* 2 – *Vallonia excentrica,* 3 – *Chondrula tridens,* 4 – *Cecilioides acicula*, 5 – *Monacha cartusiana,* 6 – *Xerolenta obvia*, 7 – *Cepaea vindobonensis,* 8 – *Helix lutescens*

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Fig. 2. Localizarea staţiilor de colectare
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Codificarea speciilor este următoarea :
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Tab. 1. Lista speciilor de gastropode terestre din pajişti: D – densitatea (ind/m2), A – abundenţa relativă (%), F – frecvenţa (%), W – indicele de semnificaţie ecologică Dzuba; S* specii preyente doar sub formă de cochilii.
Tab. 2. Valorile indicelui de afinitate Fager pentru speciile de gastropode terestre din pajişti (cu liniuţă sunt marcate perechile de specii pentru care valoarea indicelul Fager este nesemnificativă)
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Fig. 1. Grassland with weeds in Southern Transylvania – Nou Român

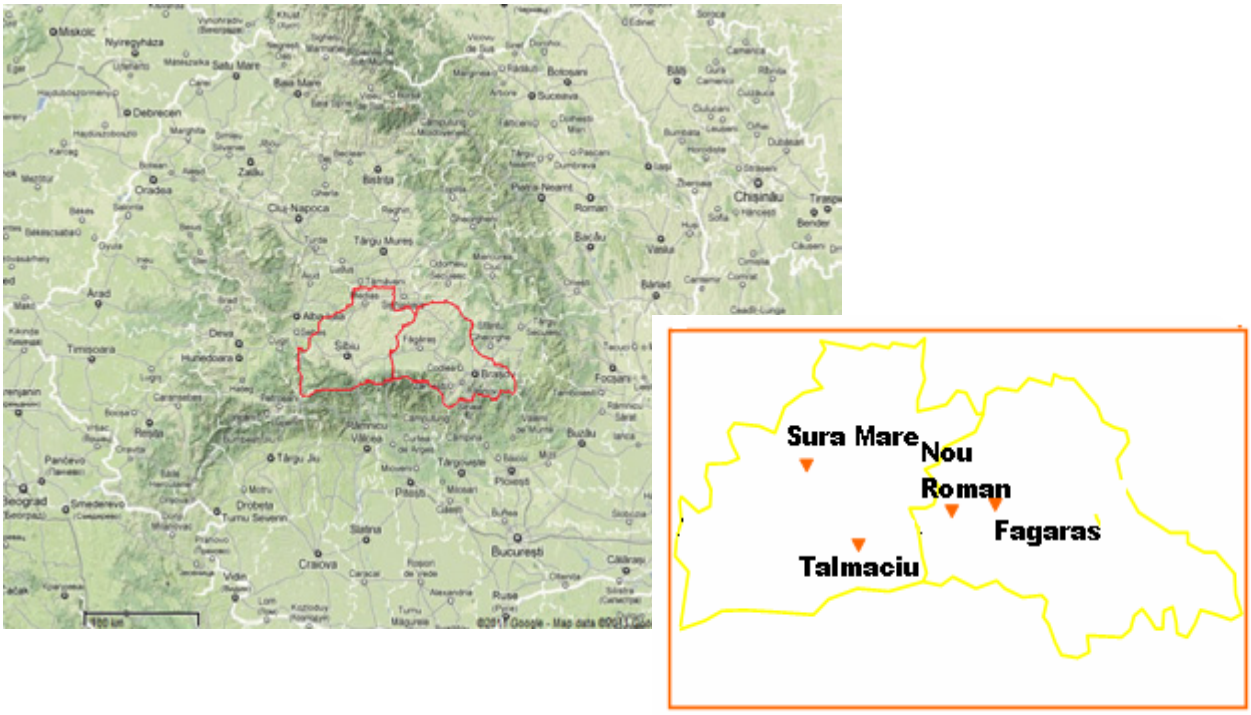

Fig. 2. Location of the four sampling sites

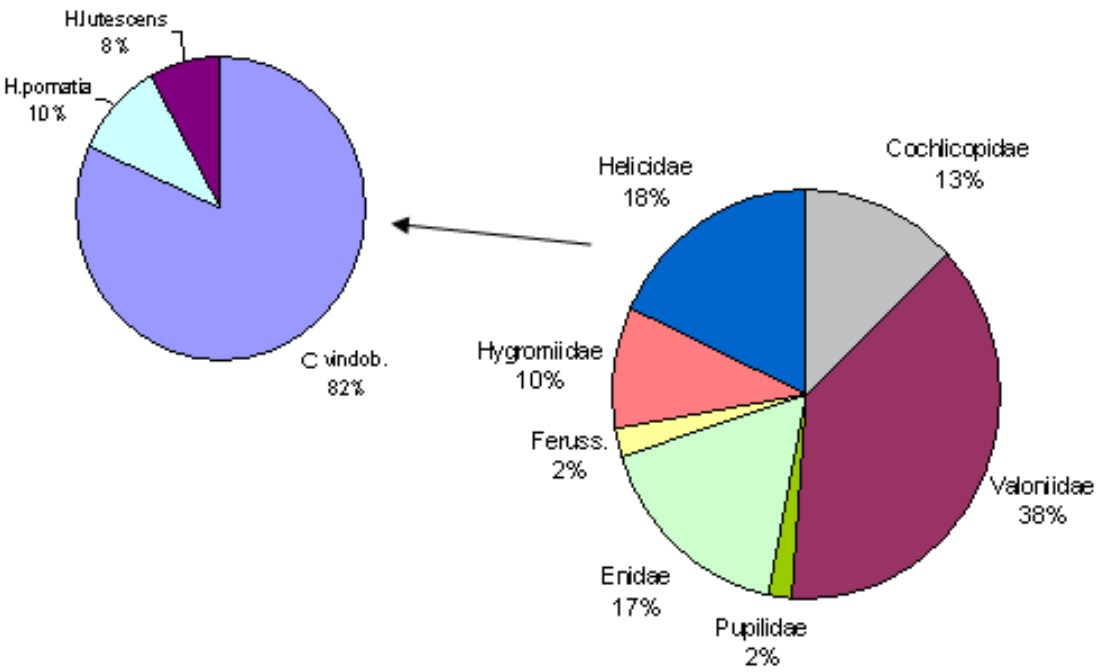

Fig. 3. Relative abundance of terrestrial gastropod families from grasslands; the percentage of different helicid species whitin the family

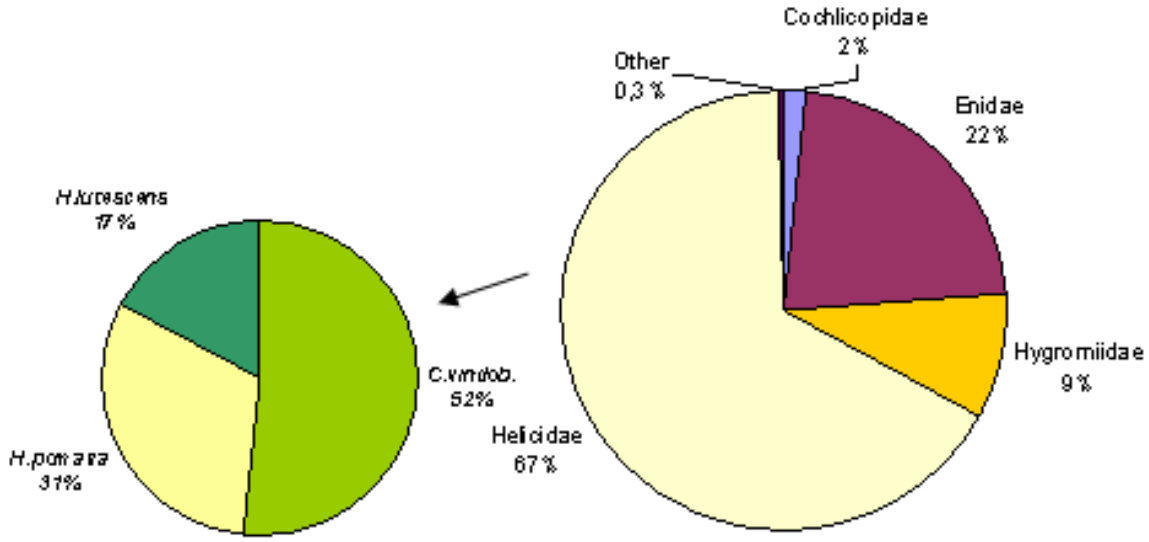

Fig. 4. Biomass of terrestrial gastropod families from grasslands;
the percentage of different helicid species within the family

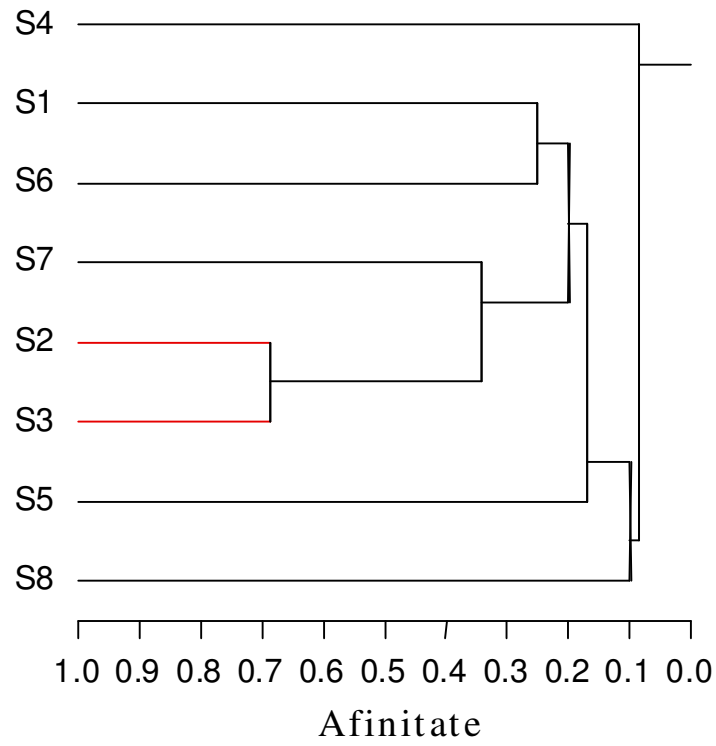

Fig. 5. Tree diagram of degree of cenotic affinity for the land snail species from grasslands (using the values of Fager affinity index).
The species' codification: 1- *Cochlicopa lubricella*, 2 – *Vallonia excentrica*, 3 – *Chondrula tridens*, 4 – *Cecilioides acicula*, 5 – *Monacha cartusiana*, 6 – *Xerolenta obvia*, 7– *Cepaea vindobonensis*, 8 – *Helix lutescens*.

Tab. 1. List of land snails from grasslands
(D – density (ind/m^2), A – relative abundance(%), F – frequency (%), W – Dzuba ecologic significance index, S* species with only shells.

Species	**Şura Mare**				***Tălmaciu***			
	D	**A**	**F**	**W**	**D**	**A**	**F**	**W**
Cochlicopidae								
Cochlicopa lubricella (Porro, 1838)	3.25	13.9	36.36	5.05	-	-	-	-
Cochlicopa lubrica (Müller, 1774)	-	-	-	-	-	-	-	-
Valloniidae								
Vallonia pulchella (Müller, 1774)	-	-	-	-	-	-	-	-
Vallonia costata (Müller, 1774)	0.5	2.15	18.18	0.39				
Vallonia excentrica (Sterki, 1892)	10.75	46.23	81.8	13.27	2	25.8	36.36	9.38
Pupillidae								
Pupilla muscorum (Linnaeus, 1758)	0.25	1.07	9.05	0.09	-	-	-	-
Chondrinidae								
Granaria frumentum (Draparnaud, 1801)	-	-	-	-	0.5	6.45	18.18	1.17
Enidae								
Chondrula tridens (Müller, 1774)	4.5	19.35	45.45	8.79	,	12.9	27.27	3.51
Ferussaciidae								
Cecilioides acicula (Müller, 1774)	1.75	7.52	54.54	4.10	-	-	-	-

Hygromiidae								
Xerolenta obvia (Menke 1828)	-	-	-	-	-	-	-	-
Monacha cartusiana (Müller, 1774)	0.5	2.15	18.18	0.39	0.75	9.67	18.18	1.75
Helicidae								
Cepaea vindobonensis (Pfeiffer, 1828)	1.75	7.52	63.63	4.78	3	38.7	81.81	38.66
Helix pomatia (Linnaeus, 1758)	-	-	-	-	0.5	6.45	18.18	1.17
Helix lutescens (Rossmässler, 1837)	-	-	-	-	-	-	-	-
	Nou Român				**Făgăraş**			
Species	**D**	**A**	**F**	**W**	**D**	**A**	**F**	**W**
Cochlicopidae								
Cochlicopa lubricella (Porro, 1838)	6.88	29	77.77	22.55	0.5	2.39	22.22	0.53
Cochlicopa lubrica (Müller, 1774)	1.55	6.37	22.22	1.46	-	-	-	-
Valloniidae								
Vallonia pulchella (Müller, 1774)	1.33	5.63	11.15	0.62	-	-	-	-
Vallonia costata (Müller, 1774)	S*				0.24	1.15	11.11	0.12
Vallonia excentrica (Sterki, 1892)	6.88	29	88.88	25.77	9	43.18	88.88	38.38
Pupillidae								
Pupilla muscorum (Linnaeus, 1758)	-	-	-	-	1.4	6.71	44.45	2.98
Chondrinidae								
Granaria frumentum (Draparnaud, 1801)	-	-	-	-	-	-	-	-
Enidae								
Chondrula tridens (Müller, 1774)	5.22	22.56	77.77	17.16	1.25	5.99	33.33	1.99
Ferussaciidae								
Cecilioides acicula (Müller, 1774)	0.22	0.93	11.15	0.1	-	-	-	-
Hygromiidae								
Xerolenta obvia (Menke 1828)	-	-	-	-	3	14.39	77.77	11.19
Monacha cartusiana (Müller, 1774)	-	-	-	-	2.75	13.19	77.77	10.26
Helicidae								
Cepaea vindobonensis (Pfeiffer, 1828)	1.1	4.69	66.66	3.12	1.5	7.19	55.6	4.00
Helix pomatia (Linnaeus, 1758)	-	-	-	-	0.2	0.95	11.11	0.106
Helix lutescens (Rossmässler, 1837)	0.44	1.87	33.33	0.62	1	4.79	22.22	1.06

Tab. 2. Matrix of the Fager affinity index values for the land snail species from grasslands (with hyphen are marked pairs of species for which the value of index is not significant)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	1							
2	**0.603**	1						
3	-	**0.686**	1					
4	0.2	0.226	-	1				
5	0.162	0.3	0.182	-	1			
6	0.25	0.182	0.154	0.091	0.138	1		
7	-	**0.682**	-	0.077	0.068	0.259	1	
8	-	0.157	-	-	0.08	0.2	0.16	1

CONSIDERATIONS REGARDING LAND SNAILS DIVERSITY IN URBAN AREAS. CASE STUDY - THE CITY OF SIBIU

Voichiţa GHEOCA*

Abstract. *During the past two decades the city of Sibiu developed in two directions, by extension of the inhabited surface in the suburban area and by construction of new buildings on nearly every available land patch. The consequence was the reduction of the green zones and the supplementary habitat fragmentation, process which is characteristic in urban areas. The present study aims to assess the terrestrial gastropod diversity in urban areas with different destinations by qualitative sampling in 35 points located in seven different areas of the city. A number of 39 species of terrestrial gastropod species were identified. Except Dumbrava Forest and Sub Arini Park, which still preserve conditions for these animals' development, the city presents very low diversity of terrestrial gastropods (between 2 and 9 species per station), underlying the importance of the conservation of areas with suitable conditions. We mention the presence in Dumbrava Forest of Chilostoma banaticum, species of community interest from Annex II of the EU Habitats Directive.*
Keywords*: land snail communities, biodiversity, urban areas, Sibiu, Transylvania*

Rezumat. *In ultimele două decenii, oraşul Sibiu s-a dezvoltat pe două direcţii, prin extinderea suprafeţei construite în zona periurbana şi prin construirea de clădiri pe practic orice suprafaţă disponibilă din perimetrul intravilan. Rezultatul a fost o diminuare drastică a zonelor verzi, accentuând şi mai mult fragmentarea habitatelor, caracteristică zonelor urbane. Lucrarea urmăreşte diversitatea gastropodelor terestre din perimetrul urban si periurban al orasului Sibiu, prin evaluarea cantitativa a faunei de gastropode din 35 de puncte localizate în şapte zone ale oraşului. Au fost identificate un număr de 39 de specii de gastropode terestre, şi exceptand Pădurea Dumbrava şi Parcul Sub Arini, care mai conservă condiţii pentru dezvoltarea acestor animale, în restul zonelor investigate diversitatea este extrem de scazută, fiind cuprinsă între 2 şi 9 specii, subliniind importanţa conservării spaţiilor în care se mai păstrează condiţii favorabile prezenţei acestor animale. Menionăm prezenţa speciei Chilostoma banaticum în Pădurea Dumbrava, specie de interes comunitar din Anexa II a Directivei Habitate.*
Cuvinte cheie*: gastropode terestre, comunităţi, biodiversitate, zone urbane, Sibiu, Transilvania*

Introduction

Often underestimated the analysis of terrestrial ecosystems biodiversity, gastropods represent a group whose importance is given by their contribution as a food source for a wide variety of animals, from small mammals to birds, reptiles and amphibians, and also as an important source of calcium for some animals, especially birds. The shells content in calcium carbonate is a critical supplement for the female birds or both parents during the raise of young (Kerney, Cameron 1979).

Recently, as new data on these animals' efficiency as bioindicators accumulate, the interest regarding terrestrial gastropods increases. There are a series of studies using land snail communities as models for different disturbances as anthropic activity and habitat fragmentation (Frest 2002, Dedov, Penev 2004, Gotmark *et al.* 2008, Kappes *et al.* 2009), while other studies use land snail species as accumulation indicators (Rabitsch 1996, Regoli *et al.* 2006).

The interest towards land snails from human settlements was mainly related to their effect as pests for many cultivates species (Baker 2002; Sanderson, Sirgel 2002). Only in the last years came into attention the loss of biodiversity in urban areas. Urbanization was shown to have a strong influence on biodiversity, several studies dealing with the effect of urbanization on the diversity of different groups (Gilbert 1989, Dedov, Penev 2000, Fernández-Juricic 2002, Smith *et al.* 2006a, 2006b, Knapp et *al.* 2008) some of them considering land snails (Tappert 1995, Horsák *et al.* 2009).

In the past two decades the city of Sibiu developed in two directions, by extension of the inhabited surface in the suburban area, and by construction of new buildings on nearly every available land

* Lucian Blaga University of Sibiu, Faculty of Sciences, vgheoca@yahoo.com

patch, with a consequent reduction of the green zones (especially private gardens). Sometimes the buildings and parking places represents in this newly build spaces over 80-90% of the entire surface, and the loss of natural and semi natural habitats is alarming. The present study aims to assess the diversity of terrestrial gastropod fauna from Sibiu, in urban areas with different destinations.

Material and methods

The study was conducted over six years (2007-2012), qualitative samples being taken from 35 points in seven locations which differ by the degree of human intervention: Dumbrava forest, at the western limit of the city, the main park, which is actually an extension of the forest in the city, the city center, one industrial area and three different residential areas. Fig.1 presents the location of the investigated areas.

Results and discussions

Habitat quality and terrestrial gastropod fauna

39 species of terrestrial gastropods belonging to 16 families were found in the investigated areas from Sibiu. The highest number of species was identified in the largest park (Sub Arini) of the city (25 species) and in Dumbrava Forest (24 species). 13 species are common for the two areas and some were found only in these two areas. Among them are *Clausilia dubia, Vestia elata* and *Aegopinella epipedostoma*. Another area that preserves some diversity of snail fauna is represented by the banks of Cibin River, where some patches of willows were left. In the rest of the city the diversity of land snail fauna is much lower, only 2 to 7 species being found. Tab. 1 presents the list of land snail species and the number of species in each area.

Analyzing the preferences for humidity of the identified gastropod species, 64% are mesophylous and 13% are mesoxerophylous, due to the absence of humid habitats from the city (Fig. 2).

These results emphasize that public parks and gardens are refuges for biodiversity in urban areas, where the disappearance of private gardens limit the distribution of most animal species. The natural origin of the central park is emphasized by the presence of tree species from the former forest, as *Alnus glutinosa, Quercus robur, Carpinus betulus, Fraxinus excelsior*. Along these native species there are ornamental trees, planted beginning with the 19th Century. Created along the rivulet, consisting of an alder belt flanked by oak forest, the park is a continuation of Dumbrava Forest.

The faunistic composition of the park reflects partially the forests' fauna, especially in mobile groups, for which the interruption of the landscapes' continuity between the two elements, the forest and the park, by the residential area and associated facilities, is not an impediment for dispersal. Other groups, as it is the case of terrestrial gastropods, cannot surpass the barrier and local populations are developing in these fragmented habitats. Thus, their survival depends primarily on the preservation of suitable local conditions.

Land snail species of special interest

Among the land snail species *Drobacia banatica*, a Quaternary Carpathian relict, whose eastern distribution limit is Romania and Ukraine, requires special interest. For some invertebrate species, like land snails, the Carpathian mountain chain contains a significant number of endemic species, and can be considered the center of surviving and autochthonous postglacial evolution of some species with low mobility (Varga 2001). This is the case of *D. banatica*, species from Annex II of EU Habitats Directive. Its presence in Dumbrava Forest is a supplementary argument for the conservation of this area, and against the extension of residential buildings into the forest.

Another remarkable element is the presence of *Cepaea hortensis* (Fig 3) almost everywhere in Sibiu, in public parks and gardens, as well as in private gardens. *C. hortensis,* the smallest of the four species of the Cepaea genus, was mentioned for the first time in Romania by Csiki (1918), near Oradea, but its presence there was not confirmed later (Grossu 1983). In 1999 the species was identified in Sibiu (Gheoca 2004), its presence is considered the consequence of a deliberate introduction of this species, based on the shells from the Kimakowicz malacological collection from Sibiu Natural History Museum. This collection contains shells of *C. hortensis* originating from the same garden in Sibiu, with the mention Manheim on the labels. The population was apparently surveyed during the period 1911 – 1934.

C. hortensis is present in moister habitats than *C. vindobonensis*, and generally the two species are not found together. However, in one of the sampling areas they were found together. The populations from Sibiu are equally homomorphic and polymorphic, but the polymorphism was lower than known for this species.

Is possible that all the populations from the city area originated from a single founder population but their polymorphism is lower than that of the population studied by Kimakowicz at the beginning of the 20th Century. A later accidental introduction of this species in Sibiu is also not excluded (Gheoca 2004).

Whichever the species' provenience, its presence in Sibiu in the past Century is certain. In the condition of urban development and reduction of green spaces, its future in this isolated enclave is uncertain and dependent on the quality of suitable habitats.

Another mentionable species is *Lozekia transsilvanica*, one of two species of the genus Lozekia, genus with a relatively restricted distribution in the Carpathian-Pannonian region (Fehér *et al.* 2009). The type locality for *L. transsilvanica* is Sibiu, Dumbrava Forest, and its conservation in this habitat is important in the context of disputes over the intent of residential development in the area.

Conclusions

The diversity of land snail fauna from Sibiu is reduced and almost entirely dependent on the presence of the forest neighbouring the city and of the emergent park.

The conservation of these two habitats is essential for the local biodiversity, including terrestrial gastropods, but as demonstrated by Götmark *et al.* (2008), the microhabitat factors are not the only responsible for species richness and composition in land mollusks. These sedentary organisms seem to be substantially influenced by the surrounding landscape, which should be considered in conservation work and in future urbanistic plans. Habitat fragmentation is also a major cause for species loss and its effect on invertebrates with low active capacity of dispersal, as it is the case of land snails, is even more accentuated. The response to fragmentation seems to be specific, as demonstrated by Kappes *et al.* (2009), and to depend on habitat specialization and macroclimatic conditions. This is especially important in case of protected species like *Drobacia banatica*, whose management has to be a priority of conservation works.

For some species the exploitation can also be a factor of numerical reduction, as it is the case of edible snail *Helix pomatia*, a species collected from urban and rural areas, but also from natural habitats.

Acknowledgements

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LIST OF ILLUSTRATIONS

LISTA ILUSTRAŢIILOR

Fig. 1. Location of sampling areas

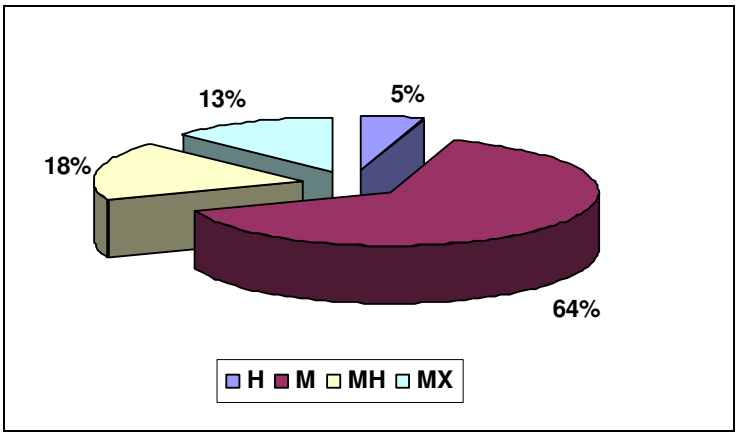

Fig. 2. Distribution of land snail species considering their demand towards humidity

Fig. 3. Some individuals of *Cepaea hortensis* from Sibiu (foto V. Gheoca).

Tab. 1. List of the land snail species from the nine analyzed areas of Sibiu city.

Species	**1. Sub Arini public parc**	**2. Dumbrava forest**	**3. Cibin river**	**4. Perifery of the town**	**5. Gusterita Hill**	**6. Garden Terezian**	**7. Turnisor resid. area**	**8. Tineretului park**	**9. Ceferistilor residential area**
Carichium tridentatum *(Risso, 1826*)			x						
Vallonia costata (Muller, 1774)							x		
Vallonia pulchella (Muller, 1774)						x			
Succinea putris (Linnaeus, 1758)	x	x	x						
Cochlicopa lubrica(Muller, 1774)	x	x							
Chondrula tridens (Küster, 1852*)*				x					
Columella edentula (Draparnaud, 1805)		x							
Cochlodina laminata (Montagu,1803)	x								
Ruthenica filograna (Rossmässler, 1836)	x								
Clausilia dubia (Draparnaud, 1805)	x	x							
Vestia elata (Rossmässler, 1836)	x	x							
Alinda biplicata (Montagu, 1803)		x							
Cecilioides acicula (Müller, 1774)						x			
Punctum pygmaeum (Draparnaud, 1801)		x							
Vitraea transsylvanica (Clessin, 1877)		x							
Vitrea cristallina (Müller, 1774)		x							
Euconulus fulvus (Muller, 1774)		x							
Zonitoides nitidus (Muller, 1774)	x	x	x						
Oxychillus draparnaudi (Beck 1837*)*	x	x		x				x	x
Oxychillus depressus (Sterki, 1880)		x							x
Aegopinella epipedostoma (Fagot, 1879)	x	x							
Aegopinella minor (Stabile, 1864)	x				x				
Vitrina pellucida (Müller 1774)	x								
Limax maximus (Linnaeus, 1758)	x		x						x
Limax cinereoniger (Wolf, 1803)		x							
Deroceras reticulatum (Müller, 1774)			x						x
*Arion subfuscus (*Draparnaud, 1805)		x	x						
Arion circumscriptus (Johnston, 1828)	x	x	x						x
Arion hortensis (Férussac, 1819)	x						x		
Fruticicola fruticum (Müller 1774)	x	x	x	x			x		x
Euomphalia strigella (Draparnaud, 1801)	x	x	x		x				
Monacha cartusiana (Müller, 1774)	x		x	x	x				
Lozekia transsilvanica (Westerlund, 1876)	x	x							
Pseudotrichia rubiginosa (A. Schmidt 1853)	x	x							
Perforatella bidentata (Gmelin 1788*)*	x								
Drobacia banatica *(Rossmaessler, 1838)*		x							
Cepaea hortensis (Muller, 1774*)*		x	x	x		x			x
Cepaea vindobonensis (Férussac, 1821)	x		x	x	x		x	x	
Helix pomatia (Linaeus, 1758)	x	x	x	x	x	x	x		x
Number of species	**25**	**24**	**9**	**7**	**4**	**4**	**5**	**2**	**7**

THE IMPORTANCE OF HOMOGENEOUS *VS*. HETEROGENOUS WETLANDS IN RALLID (RALLIDAE) PHENOLOGICAL SEASONS

Alexandru Nicolae STERMIN*
Liviu Răzvan PRIPON*
Alin DAVID*

Abstract. *Seven rallid species inhabit the European homogenous and heterogeneous wetlands. Analyzing the presence and absence of rail species in one homogenous (Sic Reed beds) and one heterogeneous (Sucutard Pond) wetland from Romania in Sic Reed beds we found six rail species during the migration season and two during the breeding season while at Sucutard Pond four species were located in both seasons. We conclude that homogeneous reed beds are the typical habitats used by rails during migration as important travel corridors and buffer zones.*
Keywords*: lifetime seasons, travel corridors, conservation, habitat preference, spatial distribution.*

Rezumat. *Şapte specii de ralide ocupă zonele umede, omogene sau heterogene din Europa. Analizând prezența sau absența acestor specii în zonele umede omogene (Stufărişurile de la Sic) şi în cele heterogene (Heleşteele de la Sucutard) din Romania am constatat că la Stufărişurile de la Sic au fost prezente şase specii de ralide în timpul migrației de primăvară şi două în perioada de reproducere iar pe Heleşteele de la Sucutard patru specii în ambele perioade. Am concluzionat că stufărişurile omogene sunt habitate tipice pentru ralide, fiind folosite de acestea ca importante coridoare de migrație.*
Cuvinte cheie*: sezoane fenologice, coridoare de migrație, preferința de habitat, distribuție spațială.*

Introduction

The optimization theory assumes that adaptive traits of species have evolved to maximize evolutionary success (Brooks, McLennan, 1991; Price *et al.* 1997, Adamik *et al.* 2003). According to this, one may expect species-specific preferences for a particular habitat type as a consequence of a historical relationship between species and their environment (Adamik *et al.* 2003) but, if wetlands in a region are spatially diverse and temporally variable, wildlife may require the use of several different wetlands during a phenological season (Haig *et al.* 1997, Joyal *et al.* 2001, Neugle *et al.* 2001, Roe, Georges 2007).

Originally inhabiting forests, rails are nowadays widely distributed, occupying many habitat types, from forests to wetlands and grasslands, both natural and artificial (Taylor 1998). However, this remains one of the most poorly represented groups in ornithological research (Brambilla, Jenkins 2009). This situation is unfortunate because the number of extinct species is high in this group: since the 1600s 16 species became extinct from a total of more than 150 species (Robinson, Horsfall 2004). The main threats for rail species are habitat loss (e.g. as a consequence of wetland draining), agricultural intensification and deforestation (Collar *et al.* 1994, Taylor, 1998, Jenkins, Ormerod, 2002).

Seven rallid species (Eurasian Coot *Fulica atra*, Moorhen *Gallinula chloropus*, Water Rail *Rallus aquaticus*, Spotted Crake *Porzana porzana*, Little Crake *Porzana parva*, Baillon's Crake *Porzana pusilla* and Corncrake *Crex crex*) are inhabiting the European wetlands (Taylor 1998). Depending on the plant communities, water level and management, wetland habitats are heterogeneous or homogeneous having the possibility to evolve from one to another. Heterogeneous habitats are conservation priorities, being important not only for generalist but also for specialized species.

In this context, the aims of our study are: (i) to illustrate the difference in rallid species composition regarding the use of both heterogeneous and homogeneous habitats during two phenological seasons (spring migration and breeding season), (ii) to reveal the importance of

* Babeş-Bolyai University, Department of Taxonomy and Ecology, Cluj-Napoca, Romania,
sandu.stermin@yahoo.com.
liviu.pripon@gmail.com
adavid.ubb@gmail.com

each of the two wetland types in the species ecological necessities.

Study areas

The research was carried out in Sucutard Pond (SP) and Sic Reed beds (SR), two wetlands located 13 km apart from each other, in the central part of the Transylvanian Plane, Romania (24°10' E; 46°50' N) (David 2008). SP is an anthropogenic wetland with an area of 46 ha, covered 50% by open water, 15% by Reed (*Phragmites australis*) and 35% by Cattail (15% dominated by *Typha latifolia* and 20% by *Typha angustifolia*) (Fig. 1). The spatial distribution and the structure of different plant communities make this pond a heterogeneous wetland.

With an area of 252.68 ha which is in 98% covered by Reed, SR is the largest reed bed from the Transylvanian Plane being a homogeneous habitat (Stermin *et al.* 2011). It has a length of around 4 km with a maximum compact reed width of 550 m. For our studies we selected a 40 ha area part of SR (Fig. 1), here the density of the vegetation is around 400 plant stems per square meter and the water level does not exceed 1.5 m, generally ranging between 20 and 50 cm (Stermin *et al.* 2011).

Methods

We selected 10 observation points inside each study area (Fig. 1). In SR the points were located 100 m apart from each other, in a transect which crosses the reed bed from one edge to another (Fig. 1). In addition, we selected 10 points inside SP, situated 50 m apart from each other, distributed to cover all habitat types (Fig. 1). Six points were located at different distances to the edge in a habitat dominated by *T. angustifolia*, two points in habitats dominated by *T. latifolia*, one in Reed and one in open water (Fig. 1). Because the habitat dominated by *T. angustifolia* has many different characteristics (located near to the shore, near to the reed or to the open water) we selected six points to record all these specific situations. As the other habitats have more constant characteristics across the SP wetland we selected only one or two points located in each one, according to the habitat surfaces and visibility (in open water only one point was necessary to have a wide view).

To detect the species in spring migration, observations were conducted at each point between 23-26 April 2010 (on SR) and 17-21 April 2011 (on SP) during three days, three times during a day (6:00-9:00, 13:00-16:00 and 20:00-23:00). We selected the end of April because this is the time when the migration period of all European rallid species overlaps (the end of migration period for Coot, Moorhen, Water Rail and Little Crake and the first part of migration period for Spotted Crake, Bailon's Crake and Corncrake) (Taylor 1998, Cramp 1980). In order to detect the species during the breeding season, we selected one day (19.07.2010 on SR and 15.07.2011 on SP) during which three observation times (6:00-9:00, 13:00-16:00 and 20:00-23:00) were conducted.

Considering that during the migration period the structure of the species communities from a specific habitat is changing continuously, we selected in this period three observation days to record these possible changes. Because during the breeding period the bird communities are more stable we performed the observation only one day, when the weather conditions were favourable.

To detect species presence, in each point, the spontaneous activity of each species was recorded for five minutes, after that we performed the Moorhen's, Water Rail's, Little Crake's, Spotted Crake's, Baillon's Crake and Corncrake's playbacks (from 20 to 30 seconds each one). After each playback, during 30 seconds we noted the presence or absence of a rallid species.

Results

A total of 90 observations, during spring migration and 30 during breeding season were conducted in each wetland. On SR, during the migration period we recorded five rallid species (Moorhen, Water Rail, Little crake, Spotted Crake and Corncrake). We mention that on May 3rd 2010, near to the first observation point on SR a Baillon's crake was also detected (Stermin, Pripon 2011). Considering this data, we have a total of six rail species located in SR during the spring migration, while on SP four species were recorded (Coot, Moorhen, Water rail and Little Crake).

The observation frequencies defined as number of observations for a single species/ total number of observations reveals a distinct presence of each rallid species considering both the type of habitat and phenological season (Tab. 1). During the breeding season, at SR two species were recorded (Water Rail and Moorhen) and in SP four species (Coot, Moorhen, Water rail and Little Crake), with different observation frequency (Tab. 1).

Taking into account only the species recorded during the breeding season, we calculated the percentage of species present in different types of habitats. In this way, in 80% of cases Coots were recorded in habitats dominated by *T. angustifolia* and 20% in open water; Moorhen was observed 88% inhabiting reed and 12% on open water. On the same criteria Little Crake was observed in 50% of cases in habitat dominated by *T. angustifolia* and 50% in *T. latifolia*, while Water Rail was recorded 91% in reed, 6% in *T. angustifolia* and 3% in *T. latifolia* (Fig. 2).

Discussions

We have chosen to study the presence-absence of rails only during the spring migration and breeding season, because during the post-breeding season many of the species (Water Rail, Little Crake, Spotted Crake and Baillon's crake) are less active vocally, being difficult to detect in dense vegetation (Taylor 1988).

According to our results, during the spring migration, all European rail species, except Coot were located on SR while in SP only four species were located. Species from SP remain there during the breeding season. Considering the ecological necessities of all rallid species recorded in SR during the spring migration only two of them remain there to breed.

Because Corncrake, which is a typical grassland rail and usually avoids marsh areas and reed beds during the breeding season (Taylor 1998) was recorded in SR, we conclude that this species is using the edge of reed beds during spring migration as a safety habitat for resting and optimal for feeding (Roe, Georges, 2007, Lougheed *et al.* 2008). Studies in areas from Southern Transylvania show that 32.32% of singing males were recorded in microhabitats represented by weed, sedge, small bushes as well as reed (Moga *et al.* 2010). A study from western Scotland reveals that in May or early June the birds are selecting the places with tall developed vegetation, like *Urtica dioica*, *Phragmites australis* or *Phalaris arundinacea*, the meadows being used only from the second part of June, when the grass is well developed (Cadbury 1980). These cases show the importance and implication of this homogenous wetland type in the grassland rail species migration and dispersal.

Also for Spotted Crake and Baillon's Crake, the homogenous reed beds are not specific; these birds being more dependent, during the breeding season, on *Carex, Juncus, Scirpus* and *Typha* dominated habitats (Taylor 1998). During the spring migration these two species found optimal resting and feeding condition in the large reed beds (Tab. 1).

Even being one of the most specialized rails recorded in our study area during the breeding seasons (using only habitats dominated by *Typha angustifolia* and *T. latyfolia*), Little Crake was also found in large reed beds during the spring migration (Tab. 1).

From all the recorded rails, Water Rail and Moorhen are the most generalist ones, nesting in homogeneous and heterogeneous wetland (Tab. 1). Moorhen, observed both in reed and open water, is using all types of wetland habitats monitored here (reed, cattail and open water). Water Rail is also using all wetland areas, except open waters, neither species being dependent on open water during spring migration or breeding season.

Regarding this, Coot is the most aquatic rail species, depending on open water not only in the breeding season but also during spring migration, it has not been detected in homogeneous reed beds.

Even considering that the large and homogeneous reed beds are untypical habitats for many rails (Spotted Crake, Little Crake, Baillon's Crake and Corncrake) (Cramp 1980, Taylor 1998) we assumed that this habitat is a typical one being used by species during a phenological season (spring migration) as important travel corridor and buffer zone. This proves that a homogeneous habitat can have, during migration seasons, higher rail diversity then a heterogeneous one.

Heterogeneous habitats are acknowledged as very important in rail conservation, being considerable areas in rail breeding. However, our results show that homogeneous habitats are also significant and necessary, being typical habitats in rail migration and dispersal. On a large landscape scale, the homogenous habitats, like large reed bed areas are stop-over points for all European rallids, being, during spring, dispersal points to the breeding habitats, having in this way an important role in rallid phenological seasons and wetlands networks.

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LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Tab. 1. The observation frequency of rail species in Sic Reed beds (SR) and Sucutard Pond (SP) during spring migration and breeding season.

	SR		SP	
	Observation frequency during spring migration	Observation frequency during breeding period	Observation frequency during spring migration	Observation frequency during breeding period
Coot	0	0	**0.25**	**0.33**
Moorhen	**0.40**	**0.23**	**0.07**	**0.03**
Water rail	**1**	**0.96**	**0.12**	**0.16**
Spotted crake	**0.02**	0	0	0
Little crake	**0.02**	0	**0.14**	**0.06**
Baillon's crake	**0***	0	0	0
Corncrake	**0.01**	0	0	0

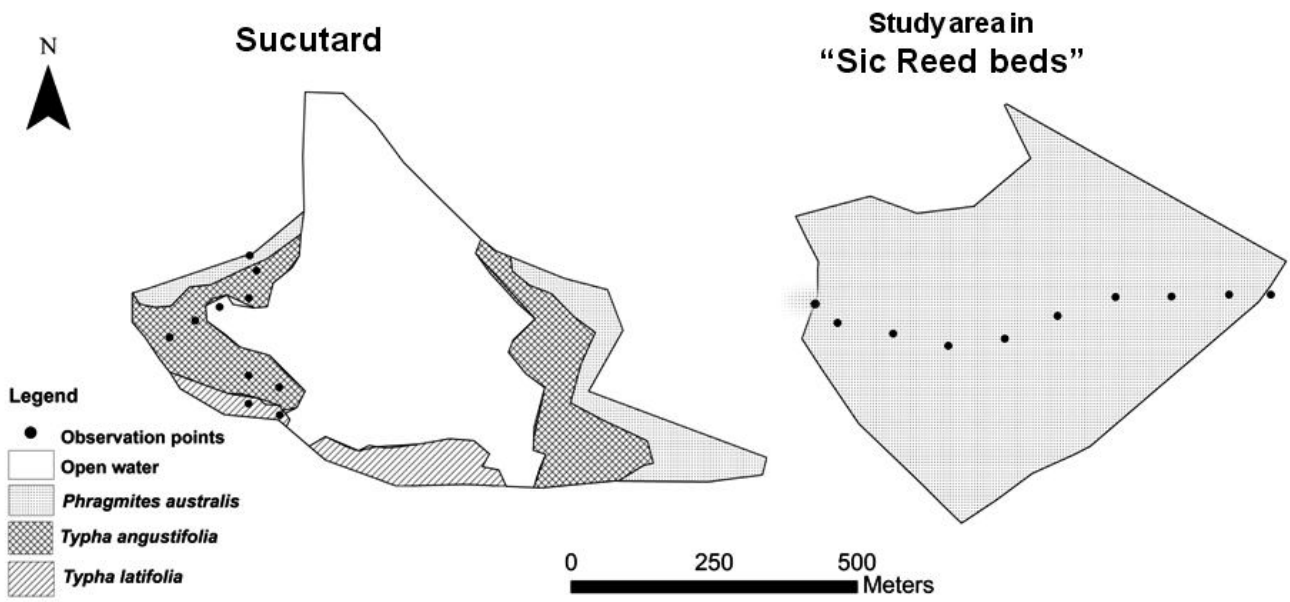

Fig. 1. The location of observation points and distribution of habitats in Sucutard Pond (SP) and Sic Reed beds (SR).

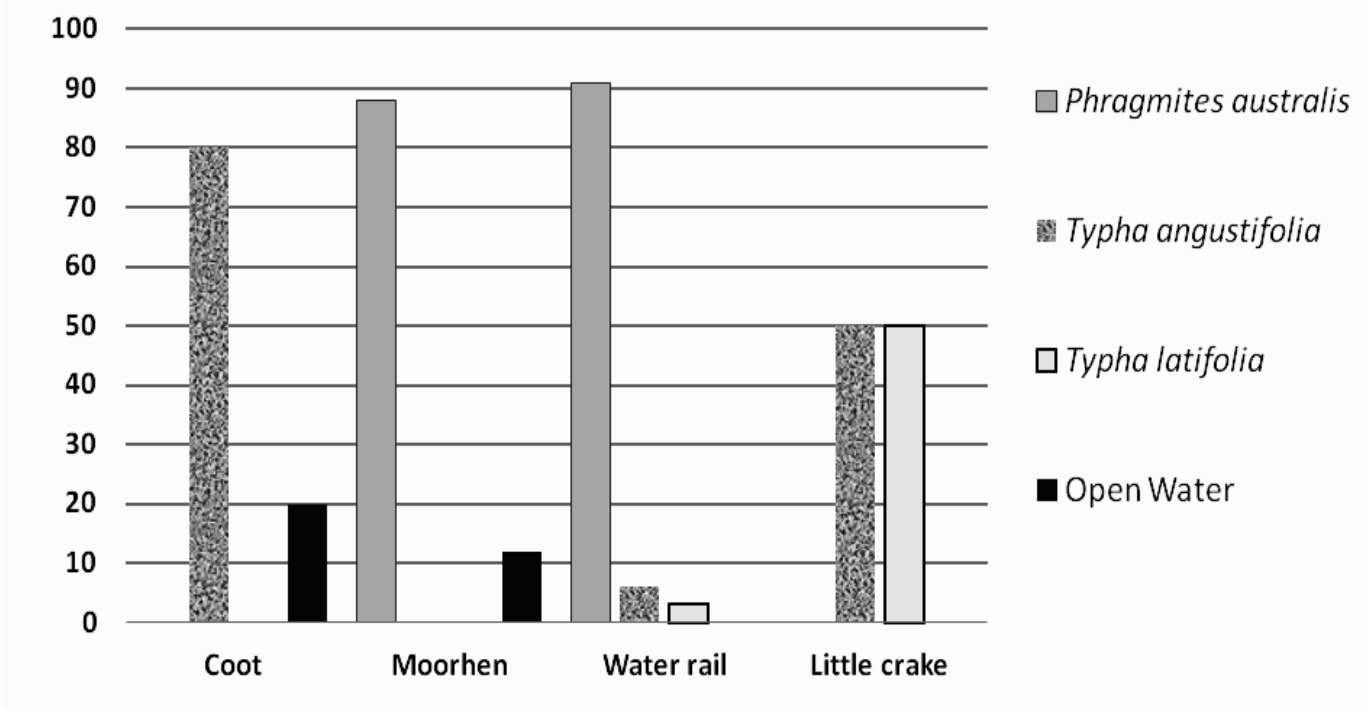

Fig.2. Percentages of different habitats used by rail species during the breeding season.

SMALL MAMMALS (MAMMALIA: RODENTIA ET INSECTIVORA) FROM THE UPPER TISA RIVER BASIN (ROMANIA)

Ana Maria LAZĂR*
Ana Maria BENEDEK**
Georgiana MĂRGINEAN**

Abstract. *During two field campaigns in August 2009 and May-June 2011 a series of investigations using live trapping was carried out in 5 stations along the rivers Vişeu and Iza, in the Tisa River Basin. The researches aimed to draw up a chorological list for the small mammal species and to characterize the community's structure and a similitude analysis of the research stations from this area. Up to the present 28 species are known from Upper Tisa River Basin, among them 8 insectivores and 20 rodents, one rodent (Rattus rattus) being probably extinct from the area.*
Key words: *insectivores, rodents, chorology, community structure, cluster analysis.*

Rezumat. *Pe parcursul a două campanii de teren, în august 2009 şi lunile mai-iunie 2011, am întreprins o serie de investigaţii pe baza capturării animalelor vii, urmărind obţinerea unei liste privind răspândirea acestora şi o analiza de similitudine intre staţiile investigate in aceasta zona. Până în prezent, sunt cunoscute 28 de specii din această arie, şi anume 8 insectivore şi 20 rozătoare. Dintre acestea un rozător (Rattus rattus) este probabil dispărut din zonă.*
Cuvinte cheie: *insectivore, rozătoare, corologie, structura comunităţii, analiză ierarhică*

Introduction

The Upper Tisa River Basin covers in Romania the Maramureş region, including Maramureş Mountains, the northern slopes of Rodna Mountains, and Maramureş Depression. The tributaries of Tisa in Maramureş are: Vişeu, Iza, and Săpânţa rivers, the first one having the largest basin.

The first data on the fauna of Maramureş region belong to Hanák (1848 ap. Szilágyi 1876), who describes the observation of *Marmota marmota* in Maramureş Mountains, as well as its whistling in Pietrosul Rodnei. The first faunistic list for Maramureş, including also mammals, was elaborated by Frivaldsky (1875). In 1960 Szabó published a paper on small mammals from the north-western part of Romania, including also data from Valea Vinului (Rodna Mountains). More recently some papers were published including data on the small mammal species from different areas of Maramureş region: Ardelean (1993) - Vaser Valley, Murariu and Răduleţ (1998) - Maramureş Depression. The description of the habitat where one specimen of *Sicista betulina* was captured from Faţa Pietrosului Rodnei, along with a synthesis on the current knowledge on this species in Romania are presented by Murariu (1997). In a paper concerning the genus *Arvicola* in Romania (Murariu *et al.* 1997) information from Maramureş depression is also presented. Wagner (1974) published a PhD thesis on small mammals from the Inner Carpathian Basin, including data from Rodna Mountains. However, as there are no details concerning the sampling points, it is possible that at least some of the data come from the southern part of Rodna Mountains, outside the Tisa River Basin. Thus, we did not consider the information from this paper. In 2000 Ardelean and Béres published a synthesis on the vertebrate's fauna from Maramureş. In volume dedicated to the Maramureş Mountains Nature Park of the "Transylvanian Review of Systematically and Ecological Research" (Sibiu, 2008), Gurzău *et al*. published a paper on small mammals. In the same journal, in the volume dedicated to Rodna Mountains National Park (2010) two other papers were published on small mammal's fauna (Nae *et al*. 2010) and on the present distribution of *Marmota marmota* (Szabo 2010). Data concerning the distribution of the population of reintroduced marmots from Rodnei Mountains were previously published (Almăşan 1981; Pânzariu 1993; Nădişan 2000).

*"Transylvania" University of Braşov and University of Bucharest, Faculty of Biology, anagurzau@yahoo.co.uk.
** Lucian Blaga University of Sibiu, Faculty of Sciences, benedek_ana@yahoo.com, georgiana.marginean@gmail.com

The present study is based on a series of field investigations carried out by the authors in several sites from the Upper Tisa River Basin, but also on the data collected and published by other authors. The faunistical data available up to the present from this area allows us to draw up a chorological list of the small mammals species from the Upper Tisa River Basin and to do a similarity analysis of the small mammal communities from different sites in the river basins of the three tributatries of Tisa River, namely Vişeu, Iza, and Săpânța.

Research area and methods

Investigations were carried out by live-trapping using hand-made Polish wooden box-traps (Fig. 1) and Fitch traps built according to the model described by Rose (1994). The traps were set either in a rectangular net (in forests) or in transect (along river banks), at 10 m distance one from another. They were baited using sunflower seeds and apple pieces. No pre-baiting was performed. Traps were checked twice a day, in the night and at dawn.

Captured animals were determined according to Pucek (1981), Murariu (2000), and Popescu, Murariu (2001), based on external morphological features. Individuals were marked by cutting their fur in different parts of the body, and then released.

The studies were accomplished during two field campaigns carried out in August 2009 and May-June 2011. Five research stations were established in the Upper Tisa River Basin. The sites were chosen in order to have a good geographical coverage of the area (considering also the data from the literature), both in terms of and altitude. Within a site one ore more habitats were chosen to be researched, depending on the heterogeneity of the environment in the station.

1. Repede River (Rodnei Mountains, Vişeu River Basin) – the trapping area was situated at about 900 m altitude, in the spruce forest area. The traps were along the river bank, at 2 kilometres from entrance in Rodnei Mountains Nature Park, in a habitat with the herbaceous layer dominated by *Telekia speciosa, Urtica dioica* and *Petasites* sp., grasses and ferns.

2. Pietrosu weather station (Rodnei Mountains, Vişeu River Basin) – situated at 1760 m altitude, in the subalpine area. The traps were placed among the *Juniperus* shrubs in the vicinity of Rodnei Mountains Park Administration' chalet. No small mammal was captured in this station.

3. Săliştea de Sus (Iza Valley) - situated at about 670 m altitude. Traps were set along Iza River bank a heterogeneous habitat, a sector with black elder (*Sambucus nigra*), blackberry (*Rubus sp*.) and other shrubs, one along the forest edge and the last with high vegetation dominated by grasses. Another transect was set in a wooded grassland with hawthorn (*Crataegus monogyna*) and wild cherry bushes (*Prunus avium*).

4. Bârsana village (Iza River Basin) – is located at 320 m altitude. Traps were placed in a mown hayfield. No small mammal was captured here.

5. Prislop Pass (Vişeu River Basin) – situated at 1413 m altitude in a coniferous woodland area.

Results and discussions

During the two field campaigns carried out in the Upper Tisa River Basin in August 2009 and May-June 2011, five trapping stations were established. Small mammals were captured only in three of the stations.

A synthesis of the trapping effort and the capture results is presented table 1.

A total of 507 trap nights (283 in 2009 and 224 in 2011) yielded 54 captured specimens belonging to 6 species: two shrews among insectivores - *Sorex araneus* and *Neomys fodiens*, and 4 mice among rodents - *Apodemus flavicollis, A. sylvaticus, A. agrarius*, and *Mus musculus*. Other two species, *Talpa europaea* and *Arvicola terrestris*, were identified based on visual observations. Among the captured individuals 8 were recaptured – four *A. agrarius* (in Săliştea de Sus), three *A. flavicollis* (two in Repede Valley and one in Săliştea de Sus), and one *A. sylvaticus* (from Repede Valley). The only species found in all the three sites where small mammals were captured is *A. flavicollis*. This result is consistent with other data from the literature (Hamar 1958, Wagner 1974) and from our previous studies (Benedek *et al*. 2002, Benedek, Drugă 2005, Benedek *et al*. 2005, Benedek 2006, Benedek 2008, Gurzău *et al.* 2008), indicating the wide distribution and high frequency of the yellow-necked mouse in mountain forested areas.

Up to the present 28 species of small mammals are known from the Maramureş Depression, 8 insectivores and 20 rodents. The faunistical and chorological catalogue is presented below. It represents an update of the list presented by (Ardelean, Béres 2000), adding the results of more

recent studies carried out by different authors (Nae *et al*. 2010; Szabo 2010), our present data and previously published (Gurzău *et al.* 2008) as well as the species *Clethrionomys glareolus,* overlooked in the older catalogue. The systematic is given according to Fauna Europaea version 2.5 (Bogdanowicz 2012).

Ord. **Insectivora** Bowdich 1821

Fam. Erinaceidae Bonaparte 1838

1. *Erinaceus concolor* Martin 1838 - was cited in Maramureş (Kardos ap. Szilágyi 1876, Călinescu 1931), but without mentioning the localities. Ardelean and Béres (2000) mention it as a common species in Maramureş Depression.

Vişeu River Basin: one specimen collected from Crasna, near Hei Valley (Murariu, Răduleț, 1998), one individual was observed in the Coşnea - Poienile de Sub Munte area (Gurzău *et al.* 2008).

Fam. Soricidae Gray, 1821

2. *Sorex araneus* Linnaeus 1758 - first cited from Maramureş by Kardos (Szilágyi, 1876), is a relatively frequent species in this area (Ardelean, Béres, 2000).

Vişeu River Basin: cited from Repedea, Izvorul lui Dragoş – Faţa Pietrosului Rodnei area (Murariu, Răduleț 1998), Coşnea - Poienile de Sub Munte (Gurzău *et al*. 2008). During our study one specimen was captured on Repede Valley.

Săpânța Basin: encountered at Colibi (Murariu, Răduleț 1998).

3. *Sorex minutus* Linnaeus 1766

Vişeu River Basin: collected from Izvorul lui Dragoş – Faţa Pietrosului Rodnei area (Murariu, Răduleț, 1998). In the same area the pygmy shrew was captured in 2006 from the vicinity of the laboratory house (Nae *et al*. 2010).

Iza River Basin: cited from Poiana Brazilor, Vidraşca, Stedea, Runcului Valley (Murariu, Răduleț 1998).

Săpânța Basin: collected from Brustani (idem).

4. *Sorex alpinus* Schintz 1837

Vişeu River Basin: one specimen collected from Izvorul lui Dragoş – Faţa Pietrosului Rodnei area (Murariu, Răduleț 1998).

5.*Neomys fodiens* (Pennant 1771) – first cited in Maramureş by Kardos (Szilágyi 1876).

Viseu River Basin: mentioned from Repedea, Izvorul lui Dragoş (Murariu, Răduleț 1998),

Iza River Basin: collected from Mara Valley (idem).

6. *Neomys anomalus* Cabrera 1907

Vişeu River Basin: collected from Hei Valley (Murariu, Răduleț, 1998), during our study an individual was captured in August 2009 in Repede Valley from Rodnei Mountains.

Iza River Basin: found at Poiana Brazilor (idem).

Săpânța Basin: collected from Colibi and Brustani (idem).

7. *Crocidura suaveolens* (Pallas 1811) - was collected by Béres from Sighetu Marmaţiei, Borşa, Mara, and other localities that are not mentioned (Ardelean, Béres 2000).

Fam. Talpidae Gray, 1825

8. *Talpa europaea* Linnaeus 1758 - was first cited from Maramureş by Kardos (Szilágyi 1876), is a very frequent species in Maramureş region, being spread from the depression area to the subalpine vegetation level (Ardelean, Béres 2000).

Vişeu River Basin: in Maramureş Mountains Nature Park its presence was noted based on the mole hills found in several areas (Gurzău *et al.* 2008). During our study the presence of moles was observed at Sălişţea de Sus, also based on the mole hills.

Iza River Basin: During our study the presence of moles was observed at Sălişţea de Sus, also based on the mole hills.

Săpânța Basin: collected from Colibi and Brustani (Murariu, Răduleț 1998).

Ord. **Rodentia** Bowdich 1821

Fam. Sciuridae Gray 1821

9. *Sciurus vulgaris* Linnaeus 1758 – was first cited from Maramureş by Szilágyi (1876). In present it is considered common and abundant in Maramureş (Murariu, Răduleț, 1998), including the localities (e.g. Sighetu Marmaţiei in Grădina Morii park), up to the limit of the spruce forest (Ardelean, Béres, 2000).

Vişeu River Basin: Călinescu (1931) mentions the red squirrel from Făina forest range and Botizu, on Vaser Valley, localities cited later by Ardelean (1993). One specimen was observed on Vaser Valley, upstream Bardău forest range (Gurzău *et al.* 2008).

10. *Marmota marmota* (Linnaeus 1758)

Vişeu River Basin: was reintroduced in Pietrosul Rodnei Reserve in 1973. Two years later the marmots were dispersed in 10 colonies above Iezer Lake and around Buhăescu Lakes, up to the slopes of Buhăescu Peak (Almăşan 1981). In July 1995 the species was observed on the Pietrosul Rodnei slope, above Iezer Lake (Murariu, Răduleț 1998). In the present the marmots are well established in

the subalpine vegetation level from several areas of Rodnei Mountains (Nădișan 2000). Above Iezer Lake the number of colonies increased from 4 to 7 (Szabo 2010). Four specimens were observed by the authors in August 2009 on the north-eastern slope of Pietrosul Rodnei, in the same area.

Fam. Muridae Gray 1821

11. *Clethrionomys glareolus* (Schreber 1780)
Vişeu River Basin: collected from Hei Valley and Izvorul lui Dragoş – Fața Pietrosului Rodnei area (Murariu, Răduleț 1998). Several specimens were captured on Vaser Valley at Bardău and Făina and one specimen was found on Bistra Valley and Valea Neagră (Gurzău *et al*. 2008). From the vicinity of Fața Pietrosului Rodnei Laboratory House the bank vole was encountered also more recently (Nae *et al.* 2010).
Săpânța Basin: found at Colibi and Brustani (Murariu, Răduleț 1998)

12. *Arvicola terrestris* (Linnaeus 1758) - in Maramureş the species was cited for the first time from Sighetu Marmației by Vasiliu and Sova (1968).
Vişeu River Basin: one specimen was observed in Coşnea - Poienile de Sub Munte area (Gurzău *et al.* 2008).
Iza Basin: found at Vidrişca (Murariu, Răduleț 1998). During our study the presence of *A. terrestris* was observed in a seed bed from Sălişte a de Sus, based on the galleries and the information from local people.
Săpânța Basin: an important population of *A. terrestris scherman* is mentioned in the surroundings of Colibi Forest Range, in the Runcu Mare Valley, in the Colibi stream and Brustani Clearing (Murariu *et al.* 1997, Murariu, Răduleț 1998).

13. *Microtus subterraneus* (de Selys-Longchamp 1836)
Vişeu River Basin: collected from Izvorul lui Dragoş (Murariu, Răduleț 1998).
Săpânța Valley: captured at Colibi (idem).

14. *Microtus agrestis* (Linnaeus 1761)
Vişeu River Basin: two individuals were captured in August 2007 on Vaserului Valley, at Făina and another was found in May 2008 (Gurzău *et al.* 2008).
Iza Basin: captured from Poiana Brazilor and Stedei Valley (Murariu, Răduleț 1998).
Săpânța Basin: found at Colibi (idem).

15. *Microtus arvalis* (Pallas 1778) – first cited from Maramureş by Kardos (Szilágyi, 1876), the common vole is considered a frequent species in Upper Tisa River Basin, from the river valleys to Pietrosul Rodnei Peak (Ardelean, Béres 2000).
Vişeu River Basin: collected from Izvorul lui Dragoş (Murariu, Răduleț 1998).
Săpânța Basin: found at Colibi and Brustani (idem).

16. *Microtus tatricus* (Kratochvil 1952)
Vişeu River Basin: was first mentioned from Romania by Flousek *et al.* (1985), who collected in 1984 several specimens from the surroundings of Borşa locality.
Iza River Basin: was collected by Murariu and Răduleț, in 1998 from Runcului Valley, a tributary of Mara River.

17.*Ondatra zibethicus* (Linnaeus 1766) - according to Ardelean and Béres (2000) it was first mentioned from Maramureş in 1963, when a specimen was captured on Tisa River bank, and another from Sighetu Marmației. Between 1960-1970 the species recorded an important expansion of its range, reaching Moisei (Vişeu Valley) and even the brooks from Poienile de sub Munte, followed by a significant retreat caused by drought in the 1980's. In present only a small population still inhabits the area, mainly the wetlands from Tisa River floodplain (idem).
Vişeu River Basin: it was observed at the confluence of the stream Bistra with Vişeu River (Murariu, Răduleț 1998).

18.*Rattus rattus* (Linnaeus 1758) - was mentioned in Maramureş by Kardos, cited by Szilagyi (1876). In present it is probably extinct from the area, due to the competition with *R. norvegicus*.

19.*Rattus norvegicus* (Berkenhout 1769) - is a widely distributed species in the area, inhabiting especially human settlements. It was observed in all the researched localities, as well as in the railway stations and forest ranges in the vicinity of villages (Murariu, Răduleț 1998).
Vişeu River Basin: One specimen was found dead in the vicinity of Coşnea - Poienile de Sub Munte (Gurzău *et al.* 2008).

20.*Mus musculus* Linnaeus 1758 - is first mentioned from Maramureş by Kardos (Szilágyi 1876). In present the house mouse is very frequent in Maramureş Depression (Ardelean, Béres 2000).
Iza Basin: captured from the vicinity of Sighetu Marmației (idem), one specimen encountered at Sălişte a de Sus, in June 2011.

Săpânța Basin: found at Colibi (Murariu, Răduleț 1998).

21. *Apodemus agrarius* (Pallas 1771) - was captured by Béres in 1967 in several areas from Maramureş, up to 800-1100 m altitude, but the localities are not mentioned (Ardelean, Béres 2000).
Vişeu River Basin: captured at Bistra, Valea Neagră, Paltinul (Gurzău *et al.* 2008).
Iza Basin: collected from Vidrişca, Poiana Brazilor, and Mara Valley (Murariu, Răduleț 1998). During our study 25 specimens were captured at Sălişte a de Sus.
Săpânța Basin: found at Brustani (idem).

22. *Apodemus flavicollis* (Melchior 1834) - is a widespread species, being encountered in most of the researched stations.
Vişeu River Basin: collected from Făina, on Vaser Valley (Ardelean 1993) and by Béres in 1967 from several localities that were not mentioned (Ardelean, Béres 2000). Murariu and Răduleț (1998) collected 50 specimens from Izvorul lui Dragoş – Fața Pietrosul Rodnei area, Repedea, Hei Valley. Several specimens were captured by Gurzău *et al.* (2008) from Coşnea, Bistra Valley, Valea Neagră, Bardău, and Repedea. From the vicinity of Fața Pietrosului Rodnei Laboratory House the yellow-necked mouse was mentioned also more recently by Nae *et al.* (2010). 7 specimens were captured by the authors from Repede Valley in Rodnei Mountains in August 2009, and a specimen was captured in Prislop Pass in May 2011.
Iza Basin: encountered at Poiana Brazilor, Tătaru Chalet, Runcu and Mara valleys (Murariu, Răduleț 1998). 14 specimens were captured by the authors in May 2011 from Sălişte a de Sus.
Săpânța River Basin: found at Colibi and Brustani (idem).

23.*Apodemus sylvaticus* (Linnaeus 1758) – was first mentioned in Maramureş by Szilágyi in 1876. The wood mouse was collected in 1967 by Béres from different areas (Ardelean, Béres 2000).
Vişeu River Basin: cited from Vaser Valley (Ardelean 1993), several specimens were collected from Izvorul lui Dragoş – Fața Pietrosul Rodnei area, Repedea, Hei Valley (Murariu, Răduleț 1998), one specimen was captured in a beech forest near Vişeu de Sus town in May 2008 (Gurzău *et al.* 2008). From the vicinity of Fața Pietrosului Rodnei Laboratory House the wood mouse was mentioned also by Nae *et al.* (2010). During our study four individuals were captured in August 2009 from Repede Valley in Rodnei Mountains.
Iza Basin: collected from Rona de Sus, Vidrişca, Tătaru Chalet, Stedei, Runcu and Mara valleys (Murariu, Răduleț 1998).
Săpânța River Basin: found in Colibi and Brustani (idem).

24. *Apodemus uralensis* (Pallas 1811)
Iza River Basin: four specimens were collected in 1967 by Béres from the Iza River terrace, at 350 m altitude (Ardelean, Béres 2000).

25. *Micromys minutus* (Pallas 1771)
Iza River Basin: one specimen was collected from Mara Valley (Murariu, Răduleț, 1998), found in a cultivated field at Dobăieş (Sighetu Marmației) (Ardelean, Béres 2000).

Fam. Myoxidae (Thomas 1897)
26. *Glis glis* Linnaeus 1766 – was first mentioned from Maramureş by Kardos (Szilágyi 1876)
Vişeu River Basin: the species was mentioned from the Vaser Valley (Ardelean 1993) and Repedea (Murariu, Răduleț 1998). Direct evidences of their presence in the area (broken tails) were found at Bistra, where it is trapped as a pest (Gurzău *et al.* 2008).

27. *Muscardinus avellanarius* (Linnaeus 1758) – according to Ardelean and Béres (2000) it is a common species in Maramureş, but rarely observed.
Vişeu River Basin: recorded in the literature from Vaser Valley (Ardelean, 1993), Izvorul lui Dragoş – Fața Pietrosului Rodnei area and Repedea (Murariu, Răduleț 1998).
Iza Basin: cited from Coştiui and Agriş (Ardelean, Béres 2000).
Săpânța Basin: Câmpulung la Tisa (idem).

Fam. Dipodidae Gray 1821
28.*Sicista betulina* (Pallas 1779)
Vişeu River Basin: the species is known from the area based on a female specimen captured at Fața Pietrosului Rodnei, at 1375 m altitude (Murariu, 1997, Murariu, Răduleț 1998). The species is considered a glacial relict, in Romania having a reduced distribution in high montane and subalpine areas.

Due to the relatively low trapping effort, short capture sessions, and the random choice of sites we can not build a sound image on the small mammals community structure, and assess its dependence on different time (year) and space (river basin, site, altitude) variables. Besides, using only one capture method reduces the span of captured species. However, some characteristics of small mammal

communities may be revealed by the results of the present study.

The highest number of small mammals was captured in the lowest station from the three stations where they were captured (Săliştea de Sus), situated at 670 m, while at Prislop Pass, located at 1400 m, only one specimen was found. At higher altitudes, in the subalpine vegetation level (Pietrosu weather station - 1760 m) no small mammal was captured. As the trapability of small mammals is unlikely to be significantly influenced by altitude, we consider that there is a decrease in the abundance of small mammal community along with the increase in altitude. This tendency was observed also in other mountain areas from the Romanian Carpathians (Ceahlău – Simionescu 1968; Retezat and Lotru mountains – Benedek 2008).

The increase in altitude influences not only the total abundance of the small mammal community, but also its specific structure and the density of particular populations. *Apodemus flavicollis* is the only species captured in all the three stations situated in the wooded area. It is a typical sylvic rodent, inhabiting all types of forests, both from lowlands and mountains. Its presence above the tree line is limited to the subalpine shrubs, and especially to the mugo pine (*Pinus mugo*). However, according to our previous results from Retezat Mountains and Râul Şes River Basin (Benedek 2008), its presence in the subalpine area is temporary, confined to the high density years.

The increase in altitude causes a shift in the specific structure of small mammal communities.

In Săliştea de Sus, from Iza River Basin, situated in the beech forest area, the community is dominated by *Apodemus agrarius* (62.5%) (Fig. 2). The low altitude and the vicinity of the water course appear to favour the striped field mouse. In several mountain areas from Romanian Carpathians where studies on small mammals were carried out - Ceahlău Mountains (Simionescu, 1968); Retezat, Gurghiu, Harghita, and Gilău mountains (Wagner 1974); Retezat and Apuseni mountains, Râu Şes River Basin (Benedek 2008) - *A. agrarius* was not encountered. Wagner (1974) mentions it only from Rodna Mountains, at altitudes between 600 and 800 m a.s.l. Hamar (1958) notes the striped field mouse from Bâlea Valley in Făgăraş Mountains only in moist places in the vicinity of water courses, up to 600-650 m.

Mus musculus is another element characteristic for lower altitudes. Related to human settlements, although it can be present in inhabited buildings even above the tree limit, it is more frequent in lowlands, where it can survive also in natural habitats. Wagner (1974) found the house mouse in a building at 650 m, but it was absent from another at 1350 m. As we researched a natural habitat, the ratio of *M. musculus* is low, representing only 2.5% (one specimen) of the captured specimens. Due the low altitude of this station and the vicinity of the beech forest *A. flavicollis* records the highest abundance among the researched stations, but it is outnumbered by *A. agrarius*, which is favoured on the river bank by the high humidity. Thus, *A. flavicollis* represents in this habitat only 35% of the captured specimens.

In Repede Valley from Rodnei Mountains (Fig. 3), four species were captured, two rodents (*A. flavicollis* and *A. sylvaticus*) and two insectivores (*S. araneus* and *N. anomalus*), each of them with one specimen (7.7%). The community is dominated by rodents, and among them *A. flavicollis* represents more than half of the captured specimens (53.8%). In Făgăraş and Retezat Mountains (Hamar, 1968) the yellow-necked mouse populates the whole forested area. According to our previous results from other mountain areas (Benedek *et al*. 2002; Benedek, Drugă 2005; Benedek *et al*. 2005; Benedek 2006, Benedek 2008) *A. flavicollis* is the dominant rodent from mountain forest in the Romanian Carpathians. În Repede Valley the forest habitats which cover most part of the slopes provide favourable conditions to the yellow-necked mouse.

A. sylvaticus represents 30.8% of the community. The relatively high ratio of the wood mouse is in concordance with the results of Wagner (1974), who captured from Rodna Mountains 28 specimens of *A. flavicollis* and 19 specimens of *A. sylvaticus*. Murariu and Răduleț (1998) found the wood mouse (116 captured individuals) being more abundant in Maramureş Depression than the yellow-necked mouse (50 individuals). These results are probably due to the difference in the mean altitude of the research area in the two studies, Murariu and Răduleț focusing on the mountain valleys. During our previous studies in Maramureş, we encountered the wood mouse only in one station, near Vişeu de Sus (Gurzău *et al*. 2008). However, in other mountain areas from the Carpathians *A. sylvaticus* was not encountered at all by the authors, neither along the mountain valleys, nor on the slopes (Benedek *et al*. 2002;

Benedek, Drugă, 2005; Benedek *et al*., 2005; Benedek 2006; Benedek 2008). The presence and relatively high abundance of *A. sylvaticus* along the valleys from the Upper Tisa River Basin, in the Maramureş and Rodna Mountains, is most likely due to the great changes occurred in the mountain landscape from this area, the expansion of human settlements along the valleys, and especially the massive forest cuttings which lead to large corridors of meadows and shrubs, *A. sylvaticus* usually avoiding compact forests (Hamar 1968).

Using our field data as well as the data from previously published faunistical studies (Murariu, Răduleț 1998, Gurzău *et al.* 2008, Nae *et al*. 2010), a cluster analysis was done between the 23 stations along the main rivers from Upper Tisa Basin researched by different authors, based on the small mammal community structure. A synthesis of the investigated sites and habitats during previous studies, used for the cluster analysis, is presented in Tab. 2.

Due to the differences in the trapping technique, as well as in the trapping effort used in the various studies, we considered only presence-absence data. Besides, we considered only the small mammals species that enter traps set on the ground. Thus, we did not include in the analysis *E. concolor, T. europaea, S. vulgaris, M. marmota,* and *R. norvegicus,* which were identified based on direct or indirect visual observations. Among the dormice only the smallest species (i.e. *M avellanarius*), which enters more frequently the traps for terrestrial small mammals, was included in the analysis. Among the research stations the three sites with no captured species were not included in the analysis. Table 3 contains the presence-absence data used for the cluster analysis.

The location of the 26 research stations (23 with captures and 3 blank), as well as their cluster are indicated in Fig. 4.

The terrestrial small mammals fauna from the Upper Tisa River Basin, as revealed by the trapping results is very heterogeneous, the similarity between the researched sites being low. Most of the stations join at a distance of 0.5 or greater (Fig. 5). Considering 0.7 as the cutting similarity level, the dendrogram illustrates six major groups. The most distinct research station (I), grouped at a distance of 0.91 in terms of Jaccard index, is Paltinul Chalet, on a river bank in beech forest, where only one species was captured, in this case *A. agrarius* (Gurzău *et al.* 2008). The second cluster (II) is also distinct. It is formed of three sites. Among them, Vişeu de Sus and Rona de Sus, situated in mixed forest, in the vicinity of localities, have a 100% similarity, as only the wood mouse was captured (Murariu, Răduleț, 1998; Gurzău *et al.* 2008). They are joined at a relatively great distance (0.66) by Vidrişca. Group III includes two stations from Iza River Basin, namely Valea Stedei and Poiana Brazilor, separated by a small distance, sharing half of their species (*S. minutus, M. agrestis,* and *A. agrarius*). The most diverse faunas are sheltered by the sites joined in group IV. It comprises the two localities from Săpânța River Basin (Colibi and Brustani) and Izvorul lui Dragoş. The high diversity from the first two sites (10 and respectively 8 species) is probably due to the lower human impact in this area (Murariu, Răduleț, 1998), while the great number of species (11 – the highest among all the research stations) from Izvorul lui Dragoş is also an effect of the higher capture effort. This is the only station where three field campaigns were carried out (idem). Another factor contributing to the increase in the number of captured species is the use of snap traps along with life traps. Cluster V is formed of 7 sites from Iza and Vişeu river basins characterised by the co-occurrence of *A. sylvaticus* and *A. flavicollis*. The last group (VI) joins 7 stations researches by the authors during the present study or previously. They are typical forest sites, with low specific diversity and *A. flavicollis* as the common element. Another characteristic is the absence of *A. sylvaticus*. Among these localities Bistra and Valea Neagră, from Vişeu River Basin, have a 100% similarity, all the three captured species being the same (*C. glareolus, A. agrarius,* and *A. flavicollis*). They are located at a small distance one from another, in similar habitats, consisting of river banks in beech forest (Gurzău *et al.* 2008). Bardău, in the mixed forest, and later Făina, in the spruce forest, are joined based on the presence of *C. glareolus*. Other two stations from this group, Prislop and Sălişte, have only the yellow necked mouse in common.

Conclusions

Up to the present 28 species of small mammals (8 insectivores and 20 rodents) are known from the Upper Tisa River Basin. One of them, *Rattus rattus*, is probably extinct. 6 species were captured during our research and other two were noted based on indirect observations.

The small mammals communities from the investigated area are dominated by the rodents belonging to *Apodemus* genus. *A. agrarius*, a

hygrophilous species inhabiting mainly open habitats along rivers in lower areas, and *A. flavicollis*, a typical forest species. *A. sylvaticus* has also an important share in the communities, indicating a change in the natural forest landscape from the Upper Tisa River Basin, especially through deforestation.

The grouping of research stations based on the small mammals fauna is influenced mainly by altitude and habitat type, but also by the trapping effort and research method. Stations from the same river basin are sometimes joined together (Colibi and Brustani from Săpânța River Basin, Poiana Brazilor and Valea Stedei from Iza Basin), usually as an effect of small distance and habitat homogeneity.

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LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Fig. 1. Polish wooden box-trap used in the research

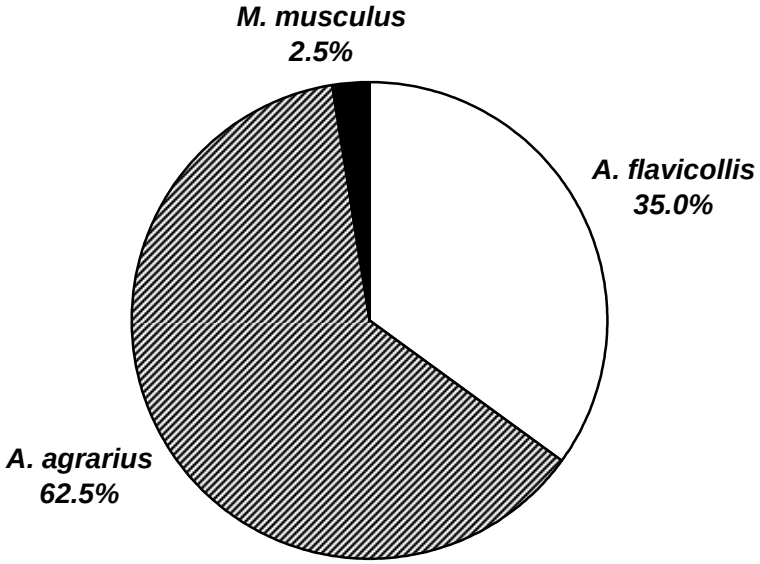

Fig. 2. Specific structure of small mammal communities from Sălişte a de Sus, Iza River Basin, expressed in terms of relative abundance (%).

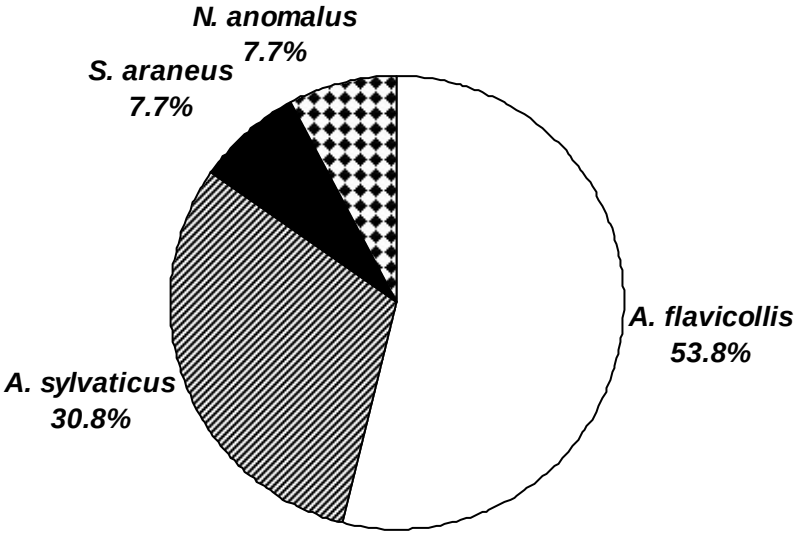

Fig. 3. Specific structure of small mammal community from Repede Valley, Rodnei Mountains, Vişeu River Basin, expressed in terms of relative abundance (%).

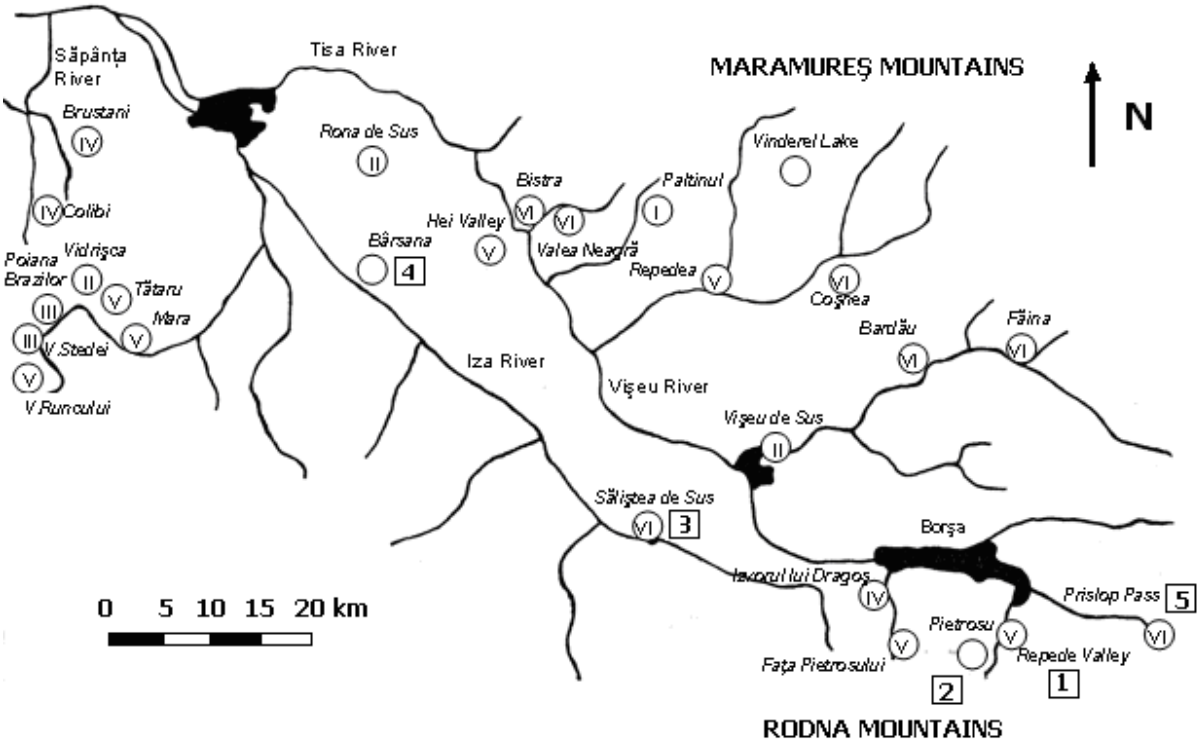

Fig. 4. Position of the 26 research sites from Upper Tisa River Basin and the results of the cluster analysis (the roman figure indicates the cluster for each site, the empty circle is for the sites with no captures; the squares with arabic figures indicate the sites trapped during this study)

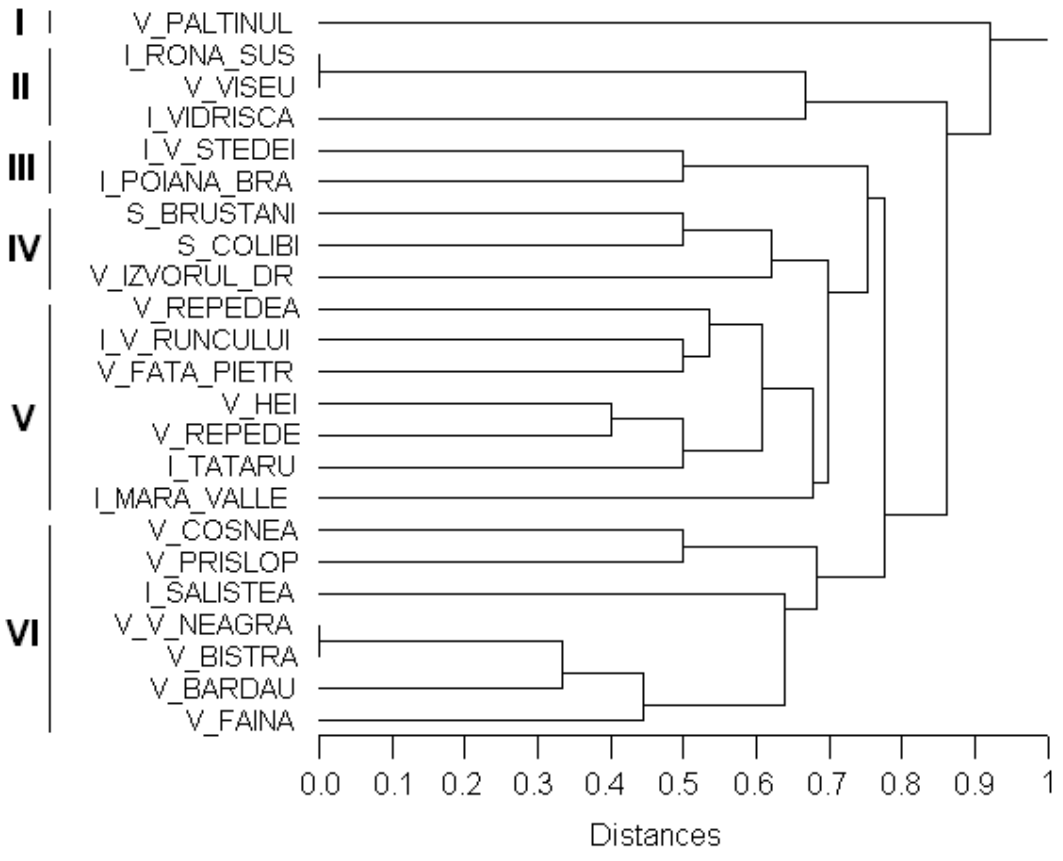

Fig. 5. Cluster analysis of the research stations, based on Jaccard index, average linkage clustering (The stations from Vişeu River Basin have the V letter preceding their name, the stations from Iza Basin, the letter I, and those from Săpânța Basin, the letter S)

Tab. 1. The trapping effort and number of specimens of the small mammals species encountered in the investigated habitats, during the field researches in 2009 and 2011.

Station	Habitat	Date	Trapping effort (traps*nights)	Species	No. ind.
Repede Valley	river bank	August 2009	52*5 = 260	*A. flavicollis*	7
				A. sylvaticus	4
				S. araneus	1
				N. anomalus	1
Pietrosu Rodnei	subalpine shrubs	August 2009	23*1 = 23	-	-
Sălişte a de Sus	river bank	May 2011	60*2 = 120	*A. flavicollis*	14
				A. agrarius	25
				M. musculus	1
	wooded grassland	May 2011	34*1 = 34	-	-
Bârsana	hayfield	May 2011	40*1 = 40	-	-
Prislop Pass	coniferous forest	June 2011	30*1 = 30	*A. flavicollis*	1
TOTAL			507 trap-nights		54

Tab. 2. Investigated sites and habitats and capture method used during previous studies

Author	Capturing method	Site	Investigated habitat types
Murariu, Răduleț (1998)	snap traps and life traps, some specimens being caught by hand (*Erinaceus concolor, Muscardinus avellanarius, Sicista betulina*),	Izvorul lui Dragoş	not specified
		Colibi	
		Brustani	
		Repedea	
		Hei Valley	
		Tătaru Chalet	
		Rona de Sus	
		Vidrişca	
		Poiana Brazilor	
		Valea Stedei	
		Runcu Valley	
		Mara Valley	
Gurzău *et al.* 2008	live trapping using Polish box traps and Fitch traps set 10 m apart, in line (along rivulets) or rectangular net (in forests)	Paltinul Chalet	beech forest, bank
		Repedea	beech forest edge, swamp, meadow
		Vinderel Lake	meadow, shrubs
		Coşnea	beech forest, bank
		Bărdău	mixed forest, bank, meadow, spruce forest
		Făina	spruce forest, bank, meadow
		Bistra	beech forest
		Valea Neagră	beech forest, bank
		Vişeu de Sus	mixed forest, bank
Nae *et. al.* 2010	box traps set in line	Faţa Pietrosului Laboratory House	spruce forest, spruce forest edge, grazed pasture,

Tab. 3. Presence-absence data for the captured species in the research sites

	Izvorul lui Dragoș	Fața Pietrosului	Repedea	Repede Valley	Hei Valley	Bistra	Valea Neagră	Paltinul	Coșnea	Vișeu de Sus	Bardău	Făina	Prislop	Tătaru Chalet	Rona de Sus	Vidrișca	Poiana Brazilor	Stedei Valley	Runcului Valley	Mara Valley	Sălișstea de Sus	Colibi	Brustani
S. araneus	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-
S. minutus	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	-	-	+
S. alpinus	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. fodiens	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
N. anomalus	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	+
C. glareolus	+	+	-	-	+	+	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	+	+
A. terrestris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+
M. subterraneus	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
M. agrestis	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	+	-	-	-	+	-
M. arvalis	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
M. tatricus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
M. musculus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
A. agrarius	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	+	+	-	+	+	-	+
A. flavicollis	+	+	+	+	+	+	+	-	+	-	+	+	+	+	-	-	+	-	+	+	+	+	+
A. sylvaticus	+	+	+	+	+	-	-	-	-	+	-	-	-	+	+	+	-	+	+	+	-	+	+
M. minutus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
M. avellanarius	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. betulina	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

HERBARIUM VIVUM: A HISTORICAL COLLECTION OF MEDICINAL PLANTS FROM THE NATURAL HISTORY MUSEUM (SIBIU, ROMANIA)

Ghizela VONICA[*]
Aurelia HOROTAN [**]

Abstract. *The herbarium book with medicinal plants - Herbarium Vivum, is one of the oldest herbarium from the Natural History Museum in Sibiu, dated at the beginning of the 19th century. The herbarium was organized by the chemist Joseph Oberth from Aiud (Alba Iulia County, Romania). The dried plants collection was a prerequisite to finish the pharmaceutical study and was intended to help the chemist in identifying plants from the wild flora. Oberth J., was the owner of the "Golden Star" Pharmacy (Aiud), and the tutor of the young chemist Ludwig Binder, to whom he gave his own herbarium with medicinal plants for further support in his practice. The dried plant collection was kept by Binder until 1910, when he passed it on to Karl Pissel. Following the Ministerial Decree (1949), the historical heritage from all the pharmacies around Romania, including the herbarium, was moved to Sibiu under inventory and stored at Pharmacy no. 20. After a short time, following another Ministerial Decree, the Herbarium Vivum, together with other pharmaceutical historical pieces, was moved to the Brukenthal National Museum from Sibiu, in order to keep and maintain a collection dedicated to the history of pharmacy. Today this pharmaceutical herbarium book is included in the botanical collection from the Natural History Museum of Sibiu. The Herbarium contains 130 pressed plants, and it has a scientific importance regarding the ethopharmacological flora from Romania.*
Keywords*: plant collection, dried specimens, medicinal properties, history of pharmacy.*

Rezumat. *Colecția cu plante medicinale de tip carte - Herbarium Vivum, este un ierbar de la începutul secolului al XIX-lea, realizat de farmacistul Joseph Oberth, propietarul farmaciei "Steaua de Aur" (1857-1891) din Aiud. Ulterior acesta îi dăruieşte ierbarul lui Ludwig Binder pentru a-l sprijini în stagiul său ca farmacist. Ierbarul este păstrat de Binder până în anul 1910, după care este înmânat lui K. Pissel, propietar al farmaciei „La Coroana" din Sibiu şi preşedinte al asociației „Gremiul farmaciştilor din Transilvania", districtul Sibiu. În urma unui Decret Ministerial (1949), tot patrimoniul unităților sanitare şi farmaciilor trec în subordinea statului, inclusiv Herbarium Vivum. După o scurtă perioadă de timp, printr-un alt decret ministerial, Herbarium Vivum împreună cu toate vestigile farmaceutice au fost cedate Muzeului Național Brukenthal în vederea realizării unei colecții de acest gen. În prezent acest ierbar de tip carte, cu 60 de coli se află în inventarul colecției de botanică din cadrul Muzeului de Istorie Naturală din Sibiu. Ierbarul conține 130 de specii, dintre care, mai mult de jumatate, sunt specii care nu se mai regăsesc în practicile farmaceutice şi tradiționale de astăzi. Materialul ierborizat constituie o adevarată valoare pentru farmacişti şi botanişti deoarece redă în parte cunoştințele şi practicile farmaceutice ale acelor timpuri.*
Cuvinte cheie*: ierbar, plante presate, proprietăți farmaceutice, istoria farmaciei.*

Introduction

In the 17th century, plants were studied by chemists and physicians who have contributed to the development of Botany as a science. In fact, the early botanical phytotherapy records are from the 17th century, when the first pharmacies were opened. Also, during that period, the first herbaria in the history of Botany were recorded. Transylvania's flora was also studied over time by famous chemists or physicians as: Fr. Kladny, G. Kaysser, J. Bielz, J Römer, etc.

The chemist's main priority in achieving these herbaria was the preservation of as many plant parts as possible in order to facilitate the recognition of the species and to harvest more accurate the plants from the wild flora. Many of them, passionate botanists, have bequeathed to the Natural History Museum in Sibiu their own herbaria or collections of drugs. These herbaria are scientific proofs regarding Romanian ethnopharmacology and phytopharmacology because today's industrialized pharmacies do not use anymore many of this curative herbs. The

* Brukenthal National Museum, Natural History Museum, aghizela@yahoo.com; ghizela.vonica@brukenthalmuseum.ro
** Terezianum High School, Sibiu,

existence of these medicinal herbaria is also essential for plant taxonomy, species distribution, threatened species study and for the history of pharmacy and botany.

The aim of this paper is to assess the contribution of Oberth's *Herbarium Vivum* in the study of Romania's present-day flora from a botanical point of view and its importance to ethnopharmacology and pharmaceutical history. This paper clarifies also why there are two names attached to the *Herbarium Vivum* and who is the real author.

Materials and methods

All specimens were identified using the monographic work "Flora României" (Ciocârlan, 2009), updated with the Plant List (www.theplantlist.org) and NCBY- Taxonomy Browser (http://www.ncbi.nlm.nih.gov). To find out more about the curative properties of the plants, the authors revised recent literature on medicinal plants (Alexan *et al.* 1988, Oroian 2011, Panțu, 1929), ethnoiatry papers (Drăgulescu 1976, Oroian 2009, Pop, Olos 2004) and the Romanian Pharmacopoeia from 1993. The medicinal plants included in the herbarium were compared with the Pharmacy History Museum Collection inventory book and phytopharmacological literature (Ban 2007, Crișan 1996). The Romanian National Archives from Sibiu County (Archiv- Sibiu Direction) and pharmaceutical history literature were consulted in order to extract bibliographical data on the chemists, their scientific and professional activity (Acker 1970; Fabritius 1986; Gheorghiu 1981; Orient 1926, Paveleanu 2004; Roth 1970, 1973, 1976, manuscript).

Results and discussions

The Natural History Museum in Sibiu Botanical heritage includes numerous medicinal plants herbaria, one of these being Oberth's *Herbarium Vivium* (Fig.1.). At first this herbarium was a puzzle because its source was not known. The only evidence was the size of the book covers and the handwriting on it. The herbarium book covers are typical for the 18-19th century. Inside there are 130 species attached to 60 sheets of paper, all in a good conservation status (Fig.1.). On the front cover of the *Herbarium Vivum*, there is a small, black, handwritten note: "*Herbarium Vivum*", "Joseph Oberth" and the year "1839", meaning that the specimens were probably collected by Joseph Oberth (Fig.2.). On the inside of the cover and on the first sheet handwritten with red "*Apotheke zum Adler des Ludwig Binder in Mühlbach*" (Ludwig Binder' "Eagle Pharmacy" from Sebes) and on top of sheet is noted with black ink (other than the cover) "*Ludwig Binder, Apotheker in Mühlbach, 28.02.1910*" (Fig.3.). The scientific name of each species is written with the same ink as on the front cover and this confirmed that the herbarium was prepared by Joseph Oberth (Fig. 4.). Starting from Joseph Oberth and Ludwig Binder's "Eagle Pharmacy" from Sebes the authors could find out the history of this herbarium and, in chronological order, the events that led to its presence in the Natural History Museum heritage.

Paveleanu (2004) describes with details the history of Pharmacy in Transylvania, the development of the pharmacies in the area, the chemists' activities starting with the 1700. According to Paveleanu (2004), Joseph Oberth (Iosif Oberth) was also a chemist as Ludwig Binder. He was the owner of the "Golden Star" (Aranycsillag) pharmacy from Aiud (Alba County). The pharmacy was founded in 1750 and was led by Oberth from 1857 until 1891(Fabritius 1986). Comparing the year written on the front cover of the herbarium to the period in which he was practicing as a chemist in Aiud the authors concluded that the *Herbarium Vivium* was attained during his apprentice pharmacist period, as the herbarium was a necessary and required condition to finish the studies (Fig.2.). In that period, the private pharmacies were seen as a business and could be passed on from one generation to another and so Oberth J. left the pharmacy to his son Oberth J. Erben. The latter became the owner of the pharmacy between 1891-1912, but Oberth Erben could not practice the profession, probably due to the lack of a bachelor's degree (Fabritius 1986). Each owner could hire an apprentice or chemist assistant to help him in his work. Probably this is the reason why Joseph Oberth hired the young Ludwig Binder as an apprentice and later as an assistant. Unfortunately, no document that substantiates this assumption of the association, but the fact that the two chemists worked together or came in contact with each other at one point is proven by the herbarium inscriptions.

It was known that students were admitted to pharmaceutical school after obtaining the gymnasium certificate, at the age of 14 or 15. After concluding the studies they would become debutants and work under the supervision of a certified chemist in his pharmacy until they got acquainted with the practical aspects of the profession. At the end of the debutant period they were examined by a pharmaceutical board and received their final certificate (Gheorghiu 1981). It seems that Ludwig Binder completed his debutant period at the "Golden Star" pharmacy. Probably

Binder J. Ludwig received the medicinal plant collection from his supervisor to facilitate his work in the future.

A newly licensed chemist in order to exercise his profession, in his one pharmacy, needed to send a petition to the Hungarian Ministry and the petition had to be approved by three doctors (concession no. 1296/1878). For example, the Sebeş town's chemist Edward Müller submitted in 1874 the documentation for a second pharmacy in town. The three doctors did not concur and the opening was delayed. Also the negotiation with the Hungarian Ministry to open a second pharmacy in the area outlasted four years (Fabritius 1986; Roth 1976). On the other hand pharmacies in rural areas or small towns were a necessity. Ludwig Binder, native to Mediaş (Mediasch, Sibiu County) received on April 4th, 1878, from the Hungarian Internal Ministry, the authorization to open his one pharmacy with personal rights (no. 21.2525/1878) in Mediaş (Acker, 1970). The „Eagle" Pharmacy („Zum Adler") was officially opened on November 11, 1878, in a small house on, that period, Lenin Street, number 44. Binder practiced for 32 years, until 1910 and he sold the pharmacy to chemist Walter Metz with the approval of the Hungarian Internal Ministry (no. 14005, 21st of February 1910) (Acker 1970; Fabritius 1986; Paveleanu 2004; Roth 1973). It seems that the medicinal herbarium received from Oberth Joseph has not been left to the new owner, as would be thought, as the data found in the herbarium does not mention Walter Metz (Inventory Book). Binder was an active member of the Chemists Association from Budapest (Pest Gremial), until he sold his pharmacy (Sibiu Archives). The Chemists Associations (Chemists Gremial) was founded in 1809 with the aim of providing a more serious and professional training to students, to oversee the pharmacies and drugstores operations and restrict the number of pharmacies especially in the urban areas (Roth 1976). For the same purposes, the Romanian authority divided Transylvania area into six regions across twenty-four districts and later in four districts without considering the administrative division of the country. Each region had a Gremial President and each district headquarters or branch-association was led by a secretary or Registrar (Roth 1976). Ludwig Binder was a member of the Medias Gremial association, Sibiu district administrated by the pharmacist Karl Pissel. The numerous association meetings held at district level, tied a friendship between pharmacist Ludwig Binder and the president of the association Karl Pissel, confirmed by the correspondence between the two (Sibiu Archives). Karl Pissell was between the years 1903 and 1934, the owner of the "Crown" („Zur Krone") in Sibiu.

The friendship between the two is what brought the medicinal herbarium in Sibiu. Perhaps, this Herbarium was a gift made by Binder to Pissell, when he reached the retirement age and sold his pharmacy. No document specifies when exactly the medicinal plant collection was brought to Sibiu, but it is very likely that Binder held it until 1918, when, because of the historical events in Romania, the association was dissolved. In the museum inventory books is noted that the herbarium did not come from the State Pharmacy no. 20, as many other historical pharmaceutical pieces did, but from the old "Crown" pharmacy, mentioned above (Inventory book). The „Crown" pharmacy was, in chronological order, the fourth opened in Sibiu with private owner (no. 25032), later on, with the implementation of the 1949 nationalization decree, it became a state pharmacy (Paveleanu 2004).

After the nationalization the Ministry of Health decided that during 1950 and 1951, all the historical pieces from the pharmacies or other health institutions from the country to be sent to the Brukenthal Museum from Sibiu. Thus, along with other pharmaceutical artifacts that became on 10.06.1951 part of the museum heritage, the *Herbarium Vivum* was assigned the inventory number F 2351/ F 817 (Inventory Book). In the museum inventory book at the origin of the herbarium is mentioned the "The Eagle" Pharmacy from Sebeş. Oberth's *Herbarium Vivum* remained in storage for 20 years, in the basement of the Brukenthal National Museum. In 1972 the Museum of Pharmacy was inaugurated in Sibiu, and the herbarium was transferred to this new location. Although herbarium was transferred in 1961 from the pharmacy museum's inventory to the Botanical collection inventory according to the accounting note 48/61, it still remained in the pharmaceutical collection. The inventory of the pharmaceutical collection done on the 30th of April 1970 registers the herbarium as part of the pharmaceutical history collection. After a period of reorganization the herbarium was officially handed to the Natural History Museum.

Conclusions

Herbarium Vivum is a medicinal herbarium from the 19th century that was used, at that time, as a medicinal plant guide. The Herbarium Book contains 130 medicinal plant species belonging to 35 families and 100 genera (tab.1.). The predominant plant families in this herbarium are *Fabaceae* and *Asteraceae*. Checking and updating

the scientific names of the medicinal plants revealed that most species are also present in Romania and a very small number are characteristic to other geographical areas. The plant species collected from other areas are: *Crepis discoridis* L. *Ferula communis* L., *Succisa kamerunensis* Engler ex Mildbraed and *Hesperis inodora* L., *Pseudolysimachion spurium* (L.) Rauschert.

Approximately 60% of the herbarium's plants are no longer used in today's traditional medicine, and future studies of these plants are recommended. The species identified in the herbarium whose medicinal use in unknown are: *Medicago prostrata* Jacq., *Lappula squarrosa* (Retz.) Dumort., *Cytisus nigricans* L., *Bifora testiculata* (L.) Spreng., *Monotropa hypopitys* L., *Cephalanthera longifolia* (L.) Fritsch, *Serattula tinctoria* L., *Leontodon hispidus* L., *Veronica anagallis – aquatica* L., *Gymnadenia odoratissima* (L.) Rich., *Trifolium ochroleucon* Huds., *Triglochin maritima* L., *Trifolium rubens* L., *Trifolium alpestre* L, *Lathyrus niger* (L.) Bernh., *Rhinanthus glacialis* Personnat., *Silene viscaria* (L.) Jess., *Inula hirta* L, *Campanula patula* L., *Pyrola media* Sw., *Cerinthe minor* L. *Vicia pannonica* Cranz, *Anthericum ramosum* L., *Veronica austriaca* subsp. *teucrium* L., *Nigella arvensis* L., *Dianthus carthusianorum* L., *Vicia cracca* L., *Galium glaucum* L., *Platanthera bifolia* (L.) L.C.Rich, *Persicaria bistorta* (L.) Samp., *Hypochaeris maculata* L., *Astragalus monspessulanus* subsp. *monspessulanus* L., *Plantago maritima* L., *Hesperis inodora* L., *Isopyrum thalictroides* L., *Tanacetum corymbosum* (L.) Sch.Bip., *Campanula spatulata* Sm., *Iris sibirica* L., *Melampyrum arvense* L., *Orobanche caryophyllacea* Sm., *Salvia pratensis* L., *Lysimachia punctata* L., *Dactylorhiza incarnata* subsp. *incarnata* L. (Soó)., *Barbarea vulgaris* R.Br., *Sisymbrium strictissimum* L., *Pseudolysimachion spurium* (L.) Rauschert, *Lathyrus vernus* (L.) Bernh., *Myosotis sylvatica* Hoffm.).

Due to the pharmaceutical industry development in artificially synthesizing substances that in the past were obtained only from plants and because of the quantitative reduction of species from the wild flora, 31, 53 % of the herbarium species are no longer used today. The following species were identified also in the Museum of Pharmaceutical History collection: *Dorycnium pentaphyllum* Scop. *Alyssum alyssoides* (L.) L., *Gladiolus communis* L., *Chaerophyllum bulbosum* L. *Chamaecytisus hirsutus* (L.) Link., *Leucanthemum vulgare* Lam., *Centaurea scabiosa* L., *Ornithogalum narbonense* L., *Lathyrus pratensis* L., *Veronica spicata* L., *Medicago falcata* L., *Stachys recta* L., *Sanicula elata* Buch.-Ham. ex D. Don., *Geranium pratense* L., *Prunella laciniata* (L.) L., *Anthriscus cerefolium* (L.) Hoffm., *Thalictrum aquilegiifolium* L., *Filipendula vulgaris* Moench, *Anthemis tinctoria* L., *Scrophularia nodosa* L.

This high percentage includes plants used in skin diseases followed by plants used in digestive and respiratory diseases (Fig. 5).

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Archives- Sibiu Direction	Arhivele Naționale de Stat, Direcția Județeană Sibiu, Colecția Brukenthal, KK 1-31, no. 217
The Plant List	*The Plant List* (2010). Version 1. Published on the Internet; http://www.theplantlist.org/ (accessed 15th May, 2012).
Taxonomy browser	NCBI Taxonomy browser- http://www.ncbi.nlm.nih.gov/ (accessed 15th of May 2012).

LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Tab. 1. List of plant genera from *Herbarium Vivum*

Family	Genera	Sp.no.	Family	Genera	Sp.no.
Asclepiadaceae	*Vincetoxicum*	1		*Chamaecytisus*	20
Hyacintaceae	*Ornithogalum*	1		*Dorycnium*	
Asparagaceae	*Anthericum*	1		*Genista*	
Asteraceae	*Achillea*	17		*Lathyrus*	
	Anthemis			*Medicago*	
	Calendula			*Ononis*	
	Centaurea			*Trifolium*	
	Chrysanthemum			*Vicia*	
	Crepis		*Fumariaceae*	*Corydalis*	1
	Eupatorium		*Geraniaceae*	*Geranium*	2
	Hypochaeris		*Iridaceae*	*Gladiolus*	2
	Inula			*Iris*	
	Leucanthemum		*Juncaginaceae*	*Triglochin*	1
	Knautia		*Lamiaceae*	*Marrubium*	
	Leontodon			*Mellitis*	8
	Matricaria			*Prunella*	
	Serattula			*Salvia*	
	Tanacetum			*Scutellaria*	
	Tragopogon			*Stachys*	
	Tussilago		*Malvaceae*	*Althaea*	1
Apiaceae	*Anthryscus*	7	*Orchidaceae*	*Anacamptis*	5
	Bifora			*Cephalanthera*	
	Chaerophyllum			*Dacthilorhyza*	
	Ferula			*Gymnadenia*	
	Heracleum			*Platanthera*	
	Pimpinella		*Orobanchaceae*	*Melamphyrum*	3
	Sanicula			*Orobanche*	
Berberidaceae	*Berberis*	1		*Rinanths*	
Boraginaceae	*Cerinthe*	6	*Papaveraceae*	*Fumaria*	1
	Echium		*Plantaginaceae*	*Digitalis*	7
	Lappula			*Veronica*	
	Myosotis			*Pseudolysimachion*	
	Pulmonaria		*Plumbaginaceae*	*Limonium*	1
	Symphytum		*Polygonaceae*	*Persicaria*	3
Brassicaceae	*Alyssum*	7		*Rumex*	
	Barbarea		*Primulaceae*	*Lysimachia*	2
	Capsella		*Ranunculaceae*	*Anemone*	7
	Hesperis			*Clematis*	
	Sinapis			*Helleborus*	
	Sisymbrium			*Isopyrum*	
Campanulaceae	*Campanula*	3		*Nigella*	
Caryophyllaceae	*Dianthus*	5		*Ranunculus*	
	Silene			*Thalictrum*	
	Stelaria		*Rosaceae*	*Filipendula*	1
	Succisa		*Rubiaceae*	*Galium*	3
Chenopodiaceae	*Chenopodium*	1	*Scrophulariaceae*	*Scrophularia*	3
Cornaceae	*Cornus*	1		*Verbascum*	
Ericaceae	*Monotropa*	2	*Solanaceae*	*Hyoscyamus*	1
	Pyrola		*Valerianaceae*	*Valeriana*	1
Euphorbiaceae	*Euphorbia*	3	*Violaceae*	*Viola*	1
Fabaceae	*Anthyllis*		**Total***:* 35	100	130
	Astragalus				

Fig. 1. The Herbarium Book from Natural History Museum- Sibiu.

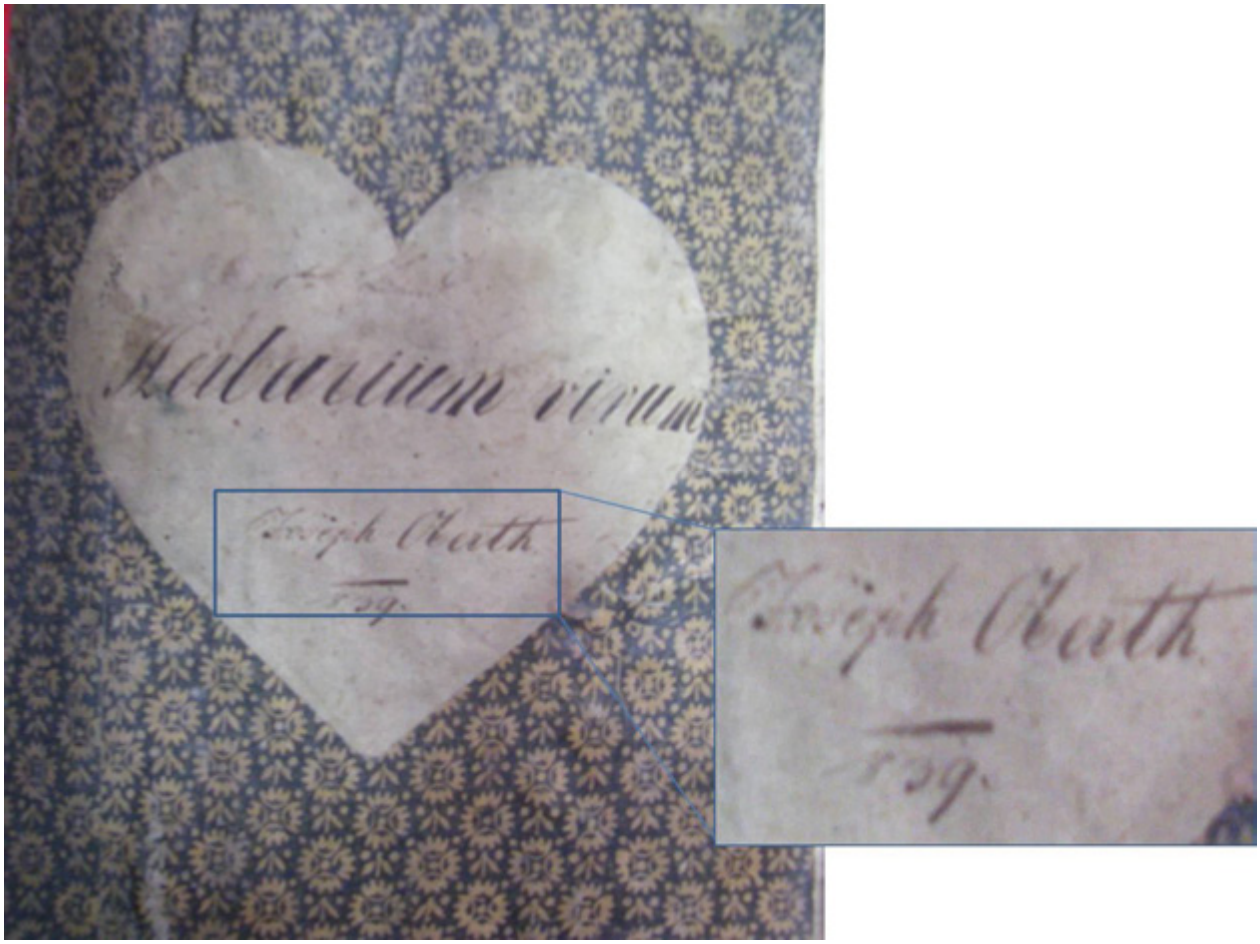

Fig. 2. Herbarium's cover- the year and the name of the collector can be seen.

Fig. 3. The herbarium's inside note.

Fig. 4. *Medicago prostrata* Jacq.- plant from Herbarium used in traditional medicine.

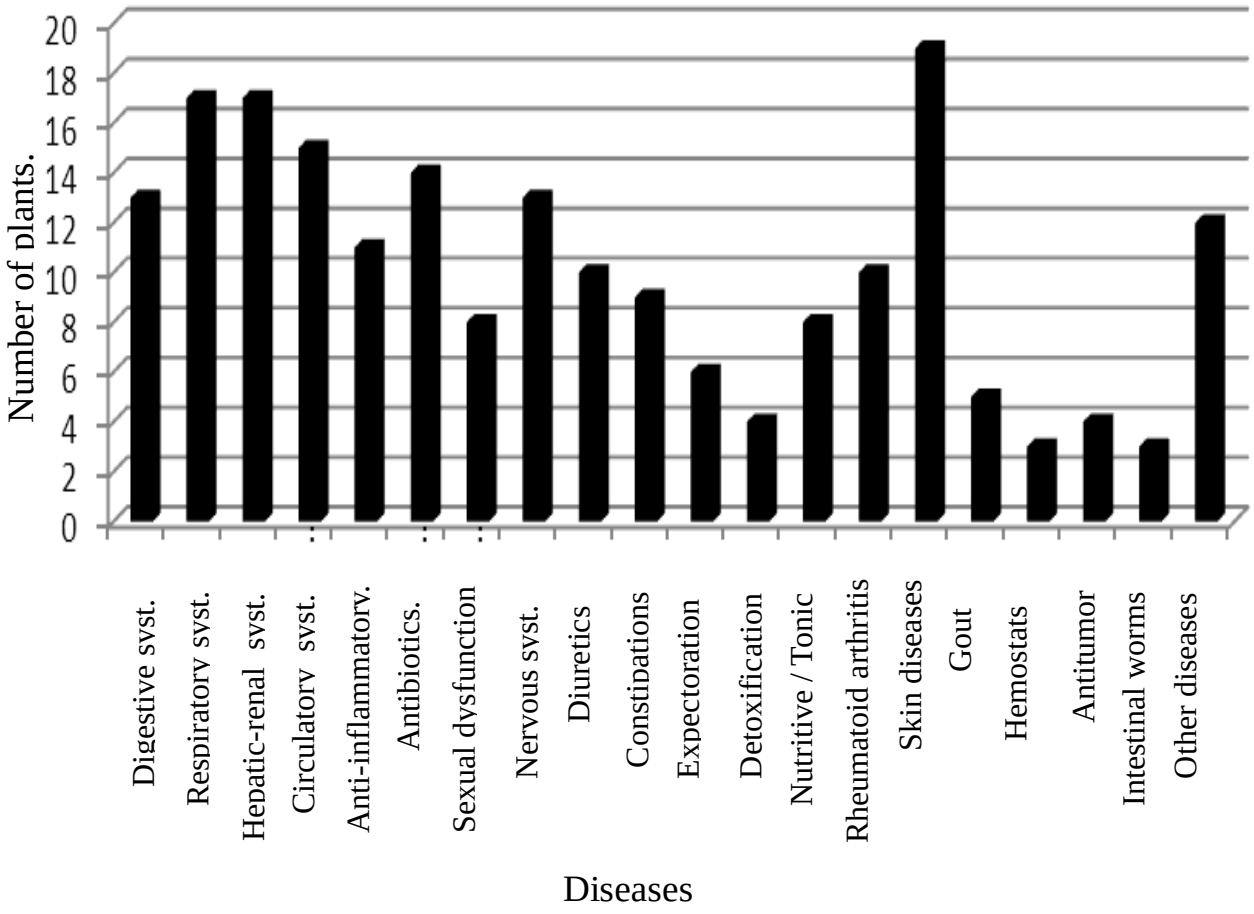

Fig. 5. The diseases for which were used the plants found in the herbarium.

PROTECTED CULTURE STUDY OF CHINESE CABBAGE (*BRASSICA CAMPESTRIS* VAR. *PEKINENSIS*) VARIETIES AND HYBRIDS COLLECTION GROWN IN THE TRANSYLVANIAN TABLELAND SPECIFIC CONDITIONS

Enikő LACZI*
Alexandru Silviu APAHIDEAN*

Abstract. *The Chinese cabbage (Brassica campestris var. pekinensis) collection of varieties and hybrids was established in the spring of 2011, in the polyethylene tunnel which belongs to the Vegetable Growing Department from the University of Agricultural Sciences and Veterinary Medicine from Cluj-Napoca. In this collection were studied and analyzed four hybrids (Michihli, Kingdom 80, Nepa F1 şi Vitimo F1) and a variety (Granat). During the vegetation period, measurements were made regarding the growing and the development of these plants and upon the obtained yield. Using the recorded data was fallowed the evolution of plants height, diameter and number of leaves from planting until harvest, were analysed the interactions between the studied characteristics, but also the influence of hybrid upon the yield of Chinese cabbage. The processing of recorded data at harvest shows that the obtained yield varied between 77.40 and 110.40 t/ha, the Kingdom 80 hybrid reaching the highest yield. The obtained yields are satisfying, considering that the culture was an ecological one, no chemical products such as fertilisers or substances for prevention and control of pests and diseases were used.*
Keywords*: heading Chinese cabbage, protected culture, Chinese cabbage varieties, Chinese cabbage hybrids, Transylvanian Tableland.*

Rezumat. *Colecţia de soiuri şi hibrizi de varză chinezească (Brassica campestris var. pekinensis) a fost înfiinţată în primăvara anului 2011, într-un solar care aparţine Disciplinei de Legumicultură din cadrul Universităţii de Ştiinţe Agricole şi Medicină Veterinară din Cluj-Napoca). În colecţie s-a studiat un număr total de cinci cultivaruri, dintre care patru erau hibrizi, unul fiind un soi. Pe tot parcursul perioadei de vegetaţie s-au realizat măsurători în ceea ce priveşte creşterea şi dezvoltarea plantelor, dar şi asupra producţiei obţinute. Utilizând datele înregistrate, s-a urmărit evoluţia înălţimii şi diametrului plantelor, a numărului de frunze de la plantare la recoltare; s-au analizat posibilele corelaţii care puteau exista între caracteristicile studiate, dar şi influenţa hibridului asupra producţiei de varză chinezească. Prelucrarea datelor înregistrate la recoltare, arată faptul că producţia a variat între 77.40 şi 110.40 t/ha, cea mai mare producţie fiind realizată de către plantele aparţinând hibridului Kingdom 80. Producţiile obţinute sunt satisfăcătoare având în vedere caracterul ecologic al culturii, nefolosindu-se îngrăşăminte chimice sau diferite substanţe pentru prevenirea sau tratarea bolilor sau a dăunătorilor.*
Cuvinte cheie*: varza chinezească de căpăţână, cultură protejată, soiuri de varză chinezească, hibrizi de varză chinezească, Podişul Transilvaniei.*

Introduction

Chinese cabbage (*Brassica campestris* var. *pekinensis,* syn. *Brassica rapa* var. *pekinensis*) (Fig. 1 and Fig. 2), is a delicious vegetable that has been used extensively in Asian cooking for centuries. Large savoyed leaves with thick succulent midribs possess a sweet taste and crisp texture when eaten raw and it has a flavour somewhat milder than cabbage when cooked (Shattuck, Shelp 2004).

The development of Chinese cabbage in China was parallel with the European cabbage; both have evolved by cultivation from wild ancestors, both have been important foods since the remote past, and both now exist in numerous varieties which can be bought all the year round (Davidson, Jaine 2006).

Heading Chinese cabbage is a cold season, annual vegetable. It grows best under temperatures of 15–20°C degrees (Kalb, Chang 2005).

* University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, eniko.laczi@yahoo.com

These plants are amongst the fastest growing of all leafy vegetables, in favourable conditions heads can be cut ten weeks after sowing loose-headed types two to three weeks sooner, while seedlings four to five weeks after sowing (Larcom 2003).

The yield varies between 30 to 50 t/ha (Toxopeus, Baas 2004) or even between 40 to 100 t/ha (Choux, Foury 1994) according to the used hybrid and time and place of the culture).

Even if in our country is a less known vegetable, the Chinese cabbage is well known around the world and often used in western cuisine. The demand for this species, in Romania, could increase with the growth of the Asian population percentage (Ciofu *et al*. 2007), so it is very important to find an appropriate culture system for this species.

Material and method

The research took place in the polyethylene tunnel from the experimental field which belongs to the Vegetable Growing Department from the University of Agricultural Sciences and Veterinary Medicine Cluj - Napoca, in the spring of 2011.

The main purpose of this experiment was to study the behaviour of some of Chinese cabbage varieties in the Transylvanian Tableland specific conditions.
To achieve the objectives of this experiment a collection of varieties and hybrids was organized, which involved the following varieties:

- Michihli
- Kingdom 80
- Granat
- Nepa F1
- Vitimo F1

Each variety was placed into three repetitions.

The seeding was made in 25th February, the seeds were sown, one by one, in small nutrient pots and were transplanted in bigger pots in stage of 3-4 true leaves, in 21st of March, while planting was realized in 30th of the same month in the polyethylene tunnel.

During the vegetation period, there were not necessary any treatments or fertilizations. Harvest was realized in 18th of May at Granat variety and Nepa F1 and Michihli hybrids, in 26th of the same month at Kingdom 80 and 1st June at Vitimo F1 hybrid.

During growing season observations were made regarding plants growth and development (these were made at planting, at one month after planting and at harvesting), and on obtained production to.

Results and discussions

Seedlings development degree at planting

Fig. 3 shows that Michili hybrid registered the highest values of height (15.33 cm), diameter (19.00 cm), number of leaves (in average 7.67) and plants weight (10.67 g). On the other side is situated Vitimo hybrid, with the lowest height (10.67 cm) and plants diameter (19.00 cm). Seedlings from hybrids Kingdom 80, Nepa and Granat had an average weight of 10.17 g.

Plants development at one month after planting:

Measurements made one month after planting reveals the fact that plants height varied between 23.17 cm (at Kingdom 80 hybrid) and 43.83 cm (at Michihli hybrid), while their diameter between 46.50 cm (at Vitimo hybrid) and 58.33 cm (at Nepa hybrid). At this point of the vegetative period plants had between 14 (Nepa hybrid) and 21 leaves (Kingdom 80 hybrid) (Fig. 4).

Plants development before harvest

The highest plants (with an average height of 62.17 cm) and in the same time the fewest leaves (in average only 24.83) were measured at Michihli hybrid. Plants from Kingdom 80 hybrid formed the highest number of leaves, most than 51 leaves per plants, these being the most heaviest plants from the experiment (with an average yield of 1.69 kg).

Vitimo hybrid revealed with a low height (33.83 cm) and diameter (46.83 cm) but a high weight (an average of 1.32 kg) and a significant number of leaves (most than 49 leaves per plants) (Table 1).

Correlation between total weight and total number of leaves

The correlation coefficient in this case has a value of 0.82, which is lower than p (5%), so there is no relationship between the two studied factors. This means that the plants weight doesn't depend on the number of leaves, from statistical point of view (Fig. 5).

Cabbage heads development at harvest

The height of the harvested cabbage heads varied between 33.33 cm (at Vitimo hybrid) and 60.50 cm (at Michihli hybrid), the diameter between 29.17 cm (at Vitimo hybrid) and 43.33 cm (at Nepa hybrid).

The highest head weight was registered at Kingdom 80 hybrid (1.38 kg), in the other side with the lowest weight being situated hybrid Nepa, with an average weight of only 0.91 kg.

Regarding the number of leaves, it can be observed that a high number of leaves were formed by plants which belonged to Kingdom 80 hybrid (an average of 43.33 leaves), while with only 19.83 leaves stand out Michihli hybrid.

These results underlines the fact that Kingdom 80 and Vitimo hybrids forms very compact heads, which are not very tall, but are heaviest, than the other ones, the so called loose headed types (Table 2).

Correlation between head weight and height, diameter and number of leaves from the head

The value of p (5%), for five studied cases, is 0.88. Due to the fact that the correlation coefficient values are 0.45 (at the correlation between weight and height), 0.22 (at the correlation between weight and diameter), and 0.62 (at the correlation between weight and number of leaves), all of them being lower than 0.88, between these characteristics there is no interaction from the statistical point of view, therefore the plants weight does not depend on the plants height, diameter or the number of leaves (Fig. 6).

Comparison between total plants weight and heads weight

In Fig. 7 can be observed that between total plants weight and the head weights are differences ranging between 120 g, at Granat variety and 320 g, at Vitimo hybrid. This is a very important characteristic because after harvest only the compact heads can be send to market, so the outer leaves are cut away, therefore the total yield depends on the size of this lost.

Correlation between total and cabbage head weight

The correlation coefficient between the two studied characteristics had a value of 0.94. By comparing this value to the values of p (5%)=0.88, respectively p (1%)=0.96, the conclusion is, that between the two weights exists a very significant positive correlation, which indicates a strong dependence between the studied factors. With other words, with the increasing of the total weight, the head weight is increasing to (Fig. 8).

Leaf layout

The total number of leaves varied between 24.83 (at Michihli hybrid) and 51.83 (at Kingdom 80). The rosettes were formed in average from 4.67 leaves, at Granat variety and 9.00 leaves, at Vitmo hybrid.

The number of leaves which formed the heads varied according to the used variety, thereby at hybrid Michihli, the cabbage heads were formed by only 19.33 leaves, while those from Kingdom 80 had more than 43 leaves (Fig. 9).

Results regarding the bolting of the plants

The average bolting percentage, at one month after planting was 4.17%. The highest number of bolted plants was registered at hybrids Michihli and Nepa, where, at this moment, already 8.33% of the plants have bolted.

At harvest, more than 54.17% of the plants flowered at Michihli hybrid, which was followed by Granat variety, with a bolting percentage of 37.50%. Best results from this point of view were registered at Vitimo hybrid, where no plants emitted flowering stalks in the vegetative period.

The average bolting percentage, at harvest, was 24.17% (Fig. 10).

The cultivar influence upon the obtained yield

Data presented in table 3 shows that, in this experience, the yield of the five used cultivars varied between 72.40 t/ha, at Nepa hybrid and 110.40 t/ha, at Kingdom 80 hybrid. Compared to Granat variety, which was taken as control variant, only Kingdom 80 hybrid realized a higher yield. The difference, 22.27 t/ha, is very significant positive from the statistical point of view. Hybrids Michihli and Nepa realized lower yields than the control variant, with 10.93 and 15.73 t/ha, differences which are significant and distinct significant negatives.

The average yield of the five studied cultivars was 85.63 t/ha. Compared to this, a very significant positive difference was recorded at Kingdom 80 hybrid, where the yield increase was 28.9%. The lowest yield, 72.40 t/ha, was obtained at Nepa hybrid, this was lower with 13.23 t/ha than the average production, the difference being distinct significant negative.

Conclusions

The best developed seedlings were those which belonged to the Michihili variety, while at harvest those from Kingdom 80 hybrid registered the highest values considering the weight and number of leaves

By analyzing the interaction between some characteristics, the conclusion is that there exist a strong correlation only between head and total weight.

The loose headed cultivars had higher heights, while those which form a more compact head had higher weights and more leaves.

The average bolting percentage was almost 25%, while at hybrid Vitimo no plant emitted flowering stalks.

The obtained yields varied between 72.40 t/ha (at Nepa hybrid) and 110.40 t/ha (at Kingdom 80 hybrid).

The conclusion of this experiment is that Chinese cabbage can be easily cultivated in this area, in protected cultures.

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LISTA ILUSTRAŢIILOR

LIST OF ILLUSTRATIONS

Fig. 1. Chinese cabbage (*Brassica campestris* var. *pekinensis,* syn. *Brassica rapa* var. *pekinensis*)

Fig. 2. Chinese cabbage (*Brassica campestris* var. *pekinensis,* syn. *Brassica rapa* var. *pekinensis*)

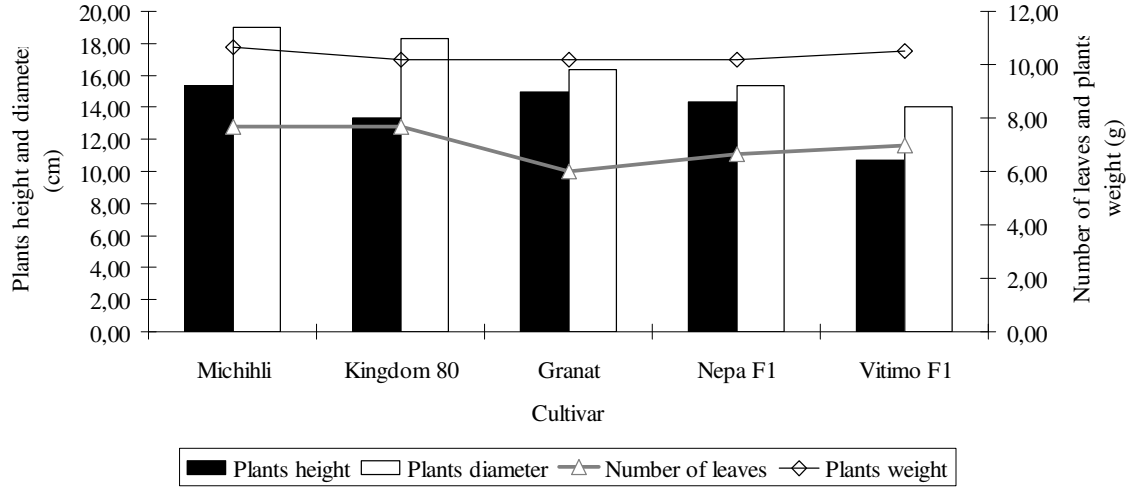


Fig. 3. Seedlings development at planting

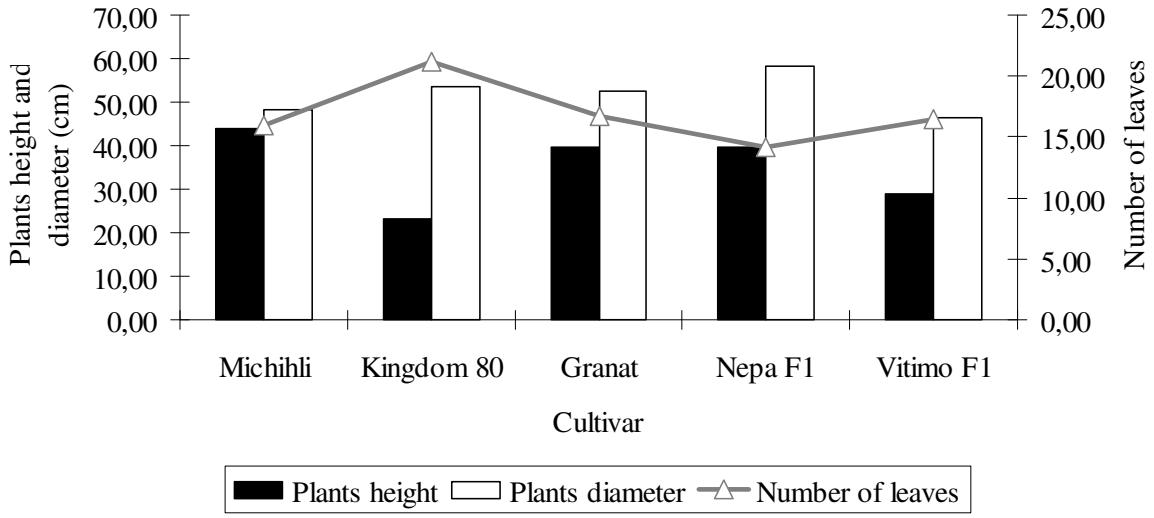


Fig. 4. Plants development one month after planting

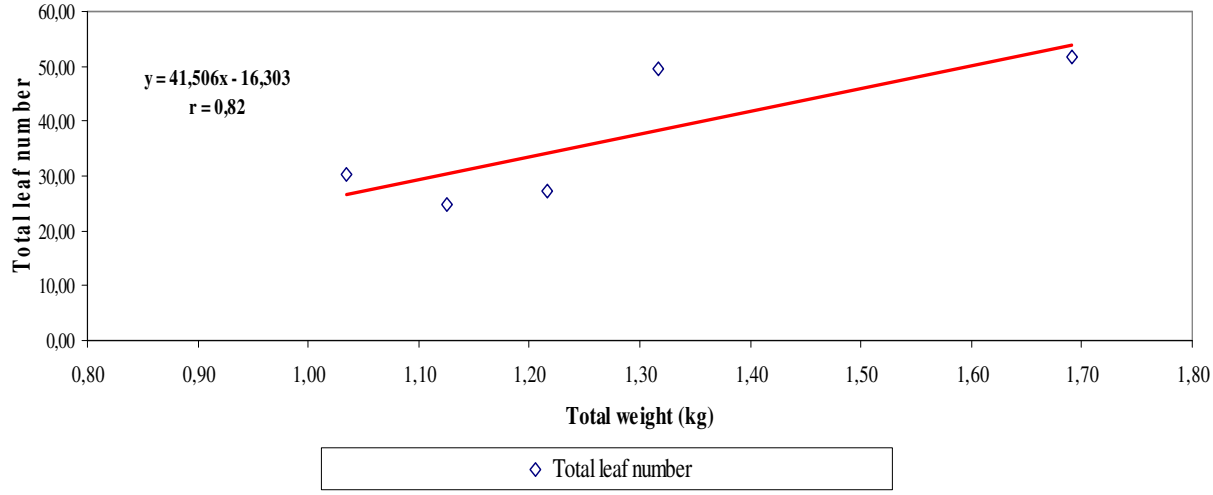


Fig. 5. Correlation between total number of leaves and total plants weight (p (5%)=0.88, p (1%)=0.91)

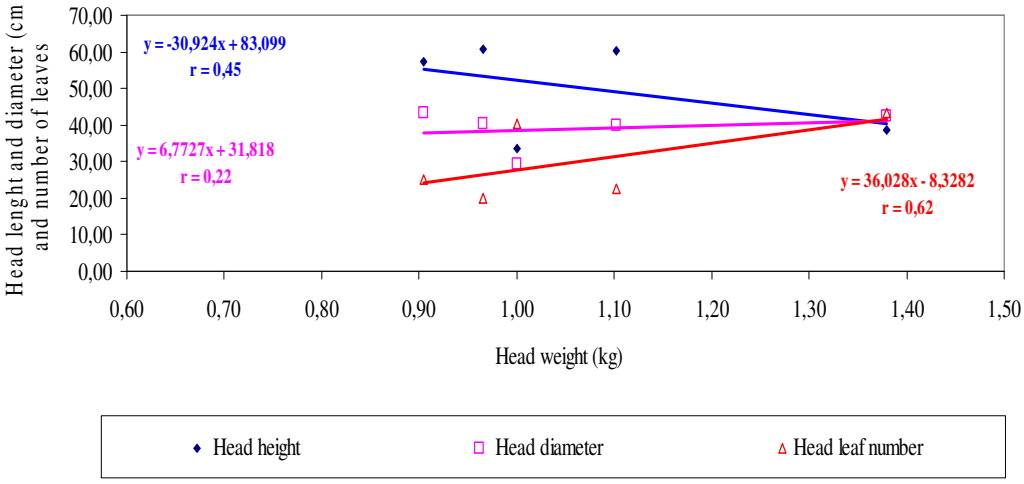


Fig. 6. Correlation between head weight and height, diameter and total leaf number from cabbage head (p (5%)=0.88, p (1%)=0.91)

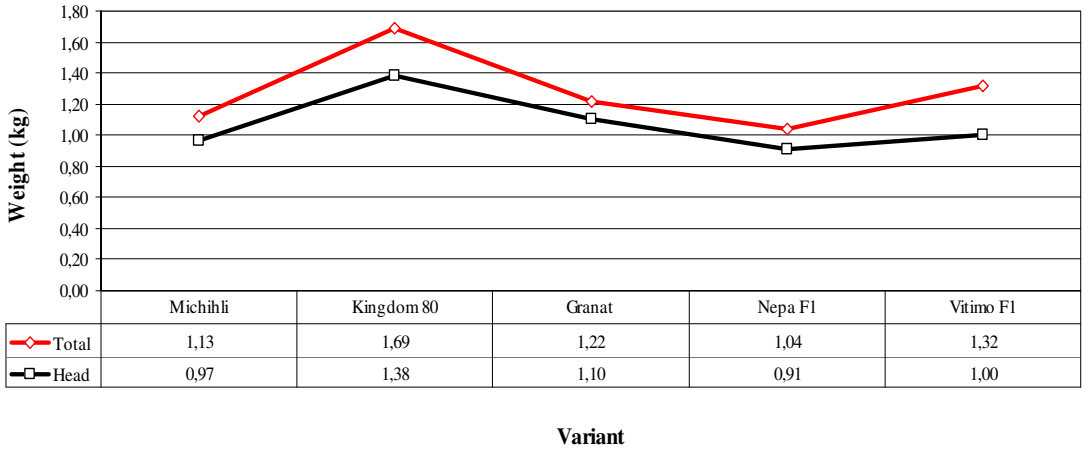


Fig. 7. Comparison between total plant and head weight

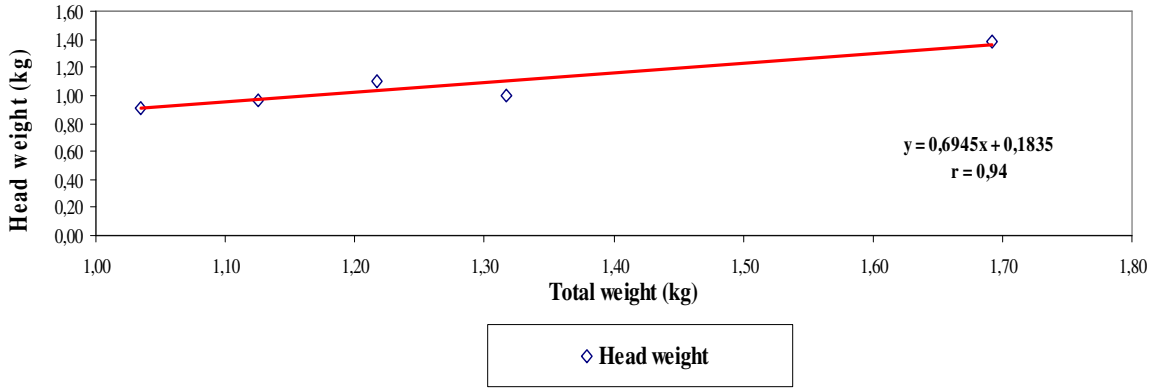
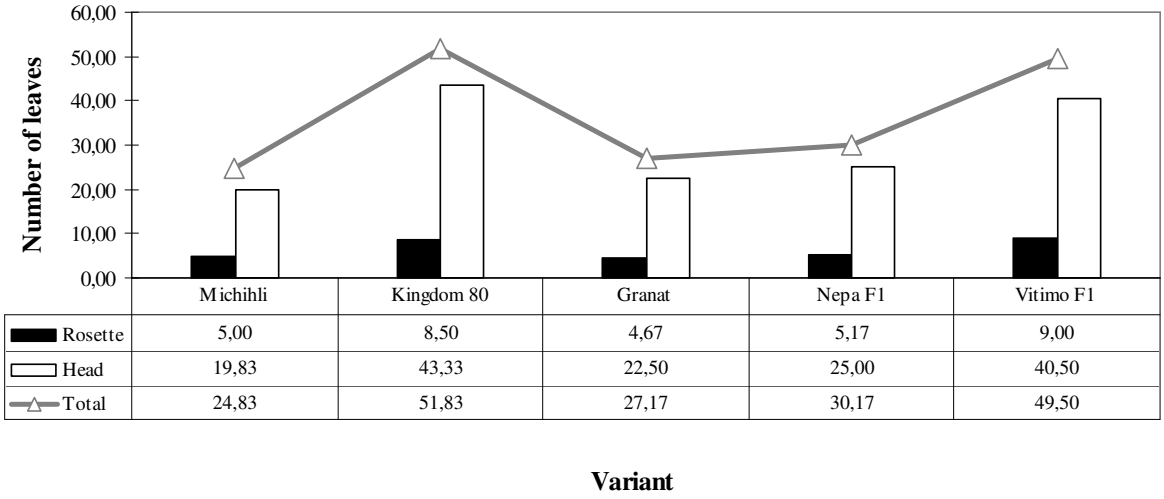


Fig. 8. Correlation between total plant and head weight



	Michihli	Kingdom 80	Granat	Nepa F1	Vitimo F1
Rosette	5,00	8,50	4,67	5,17	9,00
Head	19,83	43,33	22,50	25,00	40,50
Total	24,83	51,83	27,17	30,17	49,50

Fig. 9. Leaf layout on plants

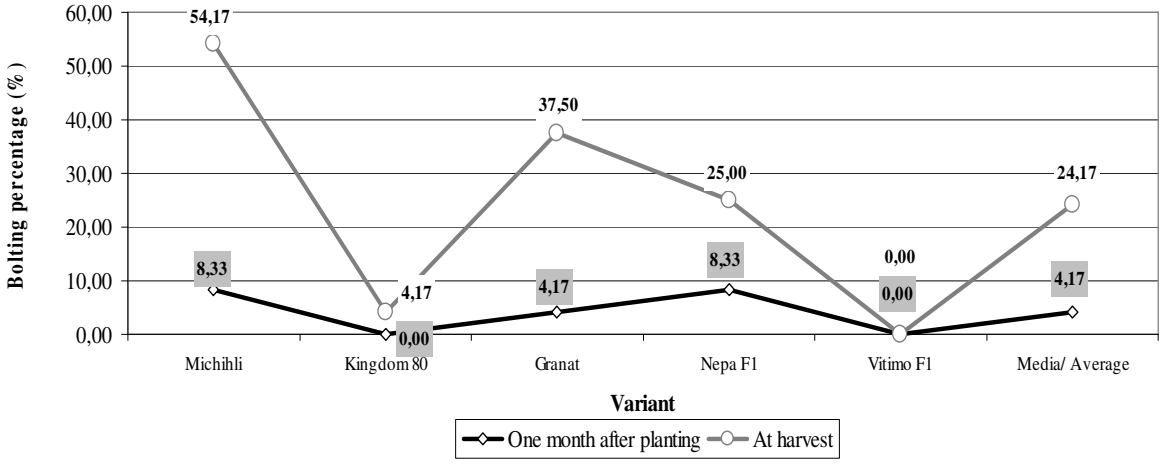


Fig. 10. Bolting percentage

Tab.1. Plants development before harvest

Variant		***Plant***			
No.	***Variety / Hybrid***	***Height* (cm)**	***Diameter* (cm)**	***Total weight* (kg)**	***Number of leaves***
1	Michihli	**62.17**	68.17	1.13	***24,83***
2	Kingdom 80	35.50	61.00	**1.69**	**51,83**
3	Granat	55.00	58.67	1.22	27,17
4	Nepa F1	56.17	**69.00**	***1.04***	30,17
5	Vitimo F1	***33.83***	***46.83***	1.32	49,50
Average		**48,53**	**60.73**	**1.28**	**36.70**

Tab. 2. Cabbage heads development at harvest

Variant		**Cabage head**			
No.	***Variety / Hybrid***	*Height* (cm)	D*iameter* (cm)	*Total weight* (kg)	*Number of leaves*
1	Michihli	**60.50**	40.33	0.97	***19,83***
2	Kingdom 80	38.67	42.50	**1.38**	**43,33**
3	Granat	60.17	40.00	1.10	22,50
4	Nepa F1	57.33	**43.33**	***0.91***	25,00
5	Vitimo F1	***33.33***	***29.17***	1.00	40,50
Average		**50,00**	**39.07**	**1.07**	**30.23**

Tab. 3. The influence of cultivar upon the Chinese cabbage yield

Variant / ***Variety / Hybrid***	***Average yield*** **(t/ha)**	***Relative yield*** **(%)**	***Difference*** **(t/ha)**	***Significance***	***Relative yield*** **(%)**	***Difference*** **(t/ha)**	***Significance***
Granat	88.13	100.0	0.00	Ct.	102.9	2.50	-
Kingdom 80	110.4	125.27	22.27	***	128.9	24.77	***
Michihli	77.20	87.60	-10.93	o	90.2	-8.43	-
Nepa F1	72.40	82.15	-15.73	oo	84.6	-13.23	oo
Vitimo F1	80.00	90.77	-8.13	-	93.4	-5.63	-
Average	85.63	-	-	-	100.0	0.00	C.t.
LSD (p 5%)				8.88			8.88
LSD (p 1%)				12.92			12.92
LSD (p 0,1%)				19.38			19.38

THE FLORA OF THE BREITE WOOD-PASTURE (SIGHIŞOARA, ROMANIA)

Kinga ÖLLERER*

Abstract. *The Breite wood-pasture located on a plateau nearby Sighişoara (Schäßburg, Romania) is considered one of the most representative sites for this type of habitat in Central-Eastern Europe. As a result of the field study begun in 2005, a list of 476 vascular plant species and subspecies is provided together with considerations on their ecology, and a small discussion regarding dynamics, distribution and biodiversity conservation issues.*
Keywords*: vascular plants, Breite, wood-pasture, biodiversity conservation, Romania.*

Rezumat. *Pajiştea cu stejari seculari de pe platoul Breite de lângă Sighişoara (Schäßburg, România) este considerată una din cele mai reprezentative pentru acest tip de habitat din Europa Centrală şi de Est. În urma studiilor de teren începute în anul 2005, a fost întocmită o listă cuprinzând 476 specii şi subspecii de plante vasculare, prezentată împreună cu date privind ecologia acestora şi o scurtă discuţie privind aspecte de dinamică, distribuţie şi conservarea biodiversităţii.*
Cuvinte cheie*: plante vasculare, Breite, pajişte împădurită, conservarea biodiversităţii, România.*

Introduction

Wood - pastures represented one of the determinant land-use practices across Europe throughout centuries, but nowadays these sites are prone to degradation and disappearance mainly because of the abandonment of traditional practices, a threat affecting semi-natural habitats across the world (Bergmeier *et al.* 2010).

Wood-pastures are bearers of a characteristic biodiversity and living documents of land-use and cultural history. These deliberately shaped semi-natural habitats require specific management, its seizure or modification leading to major changes in their character (Rois-Díaz *et al.* 2006, Bergmeier *et al.* 2010). From the perspective of their conservation, the issues that are characteristically addressed target mainly the (veteran, standing or fallen) trees and the associated flora and fauna (Kirby *et al.* 1995, Rich *et al.* 2005, Stiven 2009). The ground vegetation is most often neglected, despite the fact that where not agriculturally improved, it can also be of considerable significance, increasing the biodiversity of the site, and the survival of the trees (Crofts, Jefferson 1999). It is therefore important to consider also the ground vegetation of wood-pasture habitats, addressing issues like the small-scale impacts, disturbance, grazing, browsing *etc*., besides the common research and monitoring usually focused on the trees. The first phase of such studies has to be a qualitative evaluation, including the identification of the species present in a specific site, which is also the topic of this paper.

While the flora and vegetation of the Sighişoara area is well documented due to several botanical works (Baumgarten 1816, 1846, Fronius 1858, Fuss 1866, Schur 1866, Simonkai 1886, Höhr 1914, Csűrös, Kovács 1962, Sanda *et al*. 1976), there are only a few studies discussing the Breite specifically. Out of these, the earliest is *Flora von Schäßburg*, published by Friedrich Fronius in 1858, in which the author provides a list of 1204 species, including 43 from the Breite. Heinrich Höhr, teacher and naturalist from Sighişoara, collected some plant species from the Breite, which are kept in his herbarium, publishing also several papers regarding this area (Höhr 1914, 1930, 1949).

In the last years the Breite and also other wood-pastures from the area benefited of biodiversity conservation initiatives and an increased scientific interest on which occasion several data were published (*e.g.* Bucşa 2007; Moga *et al.* 2007; Moga *et al.* 2009; Hartel, Moga 2010; Uhde 2011). A part of these studies included some aspects regarding the vegetation, while other papers and reports provided partial data regarding the vascular plants specifically (Akeroyd 2003, Mihai Eminescu Trust 2005, 2007, Mititiuc 2006, Csergő 2007, Muică 2009, Öllerer 2009, 2010, 2012, Öllerer *et al*. 2008a, b). Despite all these

* Institute of Biology – Romanian Academy, Ecology, Taxonomy and Nature Conservation Department
kinga.ollerer@gmail.com

contributions, the flora of the Breite remained only partially known. Other naturalists, including Eckhard Hügel (1908-1977) and more recently Erika Schneider-Binder and Hedwig Deppner wrote on different occasions about the biodiversity values of the Breite, mentioning also a few plant species.

The aim of this study was therefore to obtain a detailed view regarding the ground vegetation of the Breite, providing an up-to-date list of present plant species and make a baseline evaluation in order to understand plant species dynamics and distribution.

Study area and methods

Based on the data provided by Bergmeier *et al*. (2010) regarding wood-pasture habitats from Europe, the Breite is one of the largest and most representative enclosed wood-pastures in Central and Eastern Europe.

The Breite is situated on a 500 m (504 m in the northern part and 530 m in the southern part) elevation plateau bearing the same name, which is reflecting very well the open character of this habitat (*Breite* = „wideness" in German) nearby the town of Sighişoara (Schäßburg, Romania, center point coordinates: lat. 46.2011, lon. 24.7606). The 133 ha open area, with over 630 scattered or locally grouped mature oaks (*Quercus robur* and *Q. petraea*), out of which around 400 are several centuries old, is surrounded by a mixed deciduous Sessile Oak and Hornbeam with Beech forest (Mihai Eminescu Trust 2005, 2007, Fig. 1). The wood-pasture was formed partially from the opening of this forest and most probably also from maintenance plantings, which was a widespread land-use practice in this part of Transylvania since the Middle Ages (Oroszi 2004), reflected also by the relatively high number of such habitats in Southern Transylvania (Hartel, Moga 2010; Öllerer *et al.* 2010).

The Breite plateau is part of the Transylvanian Tableland and is located in the middle section of the Târnava Mare River. The soil types on the plateau are: brown forest soils, podzols and clayey soils, clayey-illuvial and alluvial (Mihai Eminescu Trust 2007). The high clay content and increased debasification rate resulted in a very compact and almost impermeable soil on the Breite. This explains the fact that the Breite was a humid, even marshy area in the past (Siegmund 1948). This character is kept nowadays only in its southern part due to the significant water loss following the construction of a drainage system in the 1970s, that also resulted in the formation of small sites with excessive humidity in the drainage ditches (Mihai Eminescu Trust 2007).

The climate in this area is temperate continental; the annual mean temperature is 8.2°C, while the thermal amplitude between the minimum in January (-4.3°C) and the maximum in July (18.6°C) is 22.9°C. The nebulosity is high especially during winter and spring and precipitations are not uniform, being more abundant in April-October, when 70 % of the total annual rainfall is recorded. The rainiest months are May and June, with 90-100 l/sqm (Mihai Eminescu Trust 2007).

Besides the general threats that affect wood-pastures across Europe (lack of tree regeneration, change of use, abandonment and the resulting modifications of the vegetation and of the overall species composition - Bergmeier *et al.* 2010), the Breite was also affected by the results of improper management interventions that targeted the transformation of the area into a military airport and later into a crop field (Mihai Eminescu Trust 2007).

After the recognition of its scientific and historical values in the mid-1970s, the Breite became gradually protected, while its overall management for conservation purposes became an issue only in 2005 (Mihai Eminescu Trust 2005, 2007). Nowadays 70 ha of the Breite are considered as nature reserve under the name „Stejarii seculari de la Breite" (The Breite ancient oak tree reserve), being listed in the position 2.635 in the Romanian Law 5/2000 regarding protected areas. The entire plateau is included in the Natura 2000 European network of protected areas, in the Sighişoara-Târnava Mare SCI and the larger Podişul Hârtibaciului SPA sites, the latter partially overlapping the former. In 2005, the Romanian Academy, through the Commission for the Protection of Natural Monuments approved the extension of the protected area in order to cover the entire 133 ha of the plateau.

The study of the ground vegetation cover started in 2005, including both field studies and consulting historical and bibliographical data (*e.g.* Fronius 1858; Oroszi 2004; Teşculă, Goţa 2007, ordinance surveys). The aim was to obtain a clearer view of the history of this site and of other wood-pastures in the area that might help to explain the presence and distribution of plant species and formulate recommendations for further management from a biodiversity conservation perspective.

In the following, the resulting list of species is provided including only those present in the wood-pasture (open) area of the Breite plateau. Plant species were identified with the help of illustrated guides in use for the Romanian flora (Săvulescu 1952-1976, Ciocârlan 2009). Nomenclature follows Flora Europaea (2001). Systematics follows Ciocârlan (2009). Data regarding the ecological characteristics of species were obtained from Ciocârlan (2009).

Results

List of species

PTERIDOPHYTA – ferns and horsetails
Equisetaceae
1. *Equisetum arvense* L.

Dennstaedtiaceae
2. *Pteridium aquilinum* (L.) Kuhn – HH (1914)[1]

Aspleniaceae
3. *Athyrium filix-femina* (L.) Roth
4. *Dryopteris dilatata* (Hoffm.) A. Gray (*Dryopteris austriaca* Woyn.)
5. *Dryopteris filix-mas* (L.) Schott

SPERMATOPHYTA
PINOPHYTINA (*Gymnospermae*) – conifers
Pinaceae
6. *Larix decidua* Mill. cult.
7. *Picea abies* (L.) H. Karst. cult.
8. *Pinus nigra* J.F. Arnold cult.
9. *Pinus sylvestris* L. cult.

MAGNOLIOPHYTINA (*Angiospermae*) – flowering plants
Cls. Magnoliopsida (*Dicotyledonatae*)
Ranunculaceae
10. *Anemone nemorosa* L.
11. *Anemone ranunculoides* L.
12. *Ranunculus acris* L.
13. *Ranunculus auricomus* L.
14. *Ranunculus bulbosus* L.
15. *Ranunculus ficaria* L. s. l.
16. *Ranunculus polyanthemos* L.
17. *Ranunculus repens* L. s. l.
18. *Ranunculus strigulosus* Schur

Papaveraceae
19. *Chelidonium majus* L.

Urticaceae
20. *Urtica dioica* L.

Juglandaceae
21. *Juglans regia* L.

Fagaceae
22. *Fagus sylvatica* L. – HH herb. (1908) [2]
23. *Quercus petraea* (Matt.) Liebl. – FF (1858) [949] (under *Q. sessiliflora* Salisb.) [3]
24. *Quercus robur* L. – FF (1858) [950] (under *Q. pedunculata* Ehrh.)

Betulaceae
25. *Betula pendula* Roth – HH herb. (1909)

Corylaceae
26. *Carpinus betulus* L. – HH herb. (1908)

Caryophyllaceae
27. *Arenaria serpyllifolia* L.
28. *Cerastium fontanum* Baumg. subsp. *fontanum* – FF (1858) [175] (under *Cerastium vulgatum* L.)
29. *Cerastium glomeratum* Thuill.
30. *Cerastium pumilum* Curtis subsp. *pumilum*
31. *Dianthus armeria* L. subsp. *armeria* – HH herb. (1910)
32. *Dianthus carthusianorum* L.
33. *Dianthus deltoides* L.
34. *Gypsophila muralis* L.
35. *Lychnis flos-cuculi* L. – FF (1858) [160]; HH herb. 1908
36. *Moehringia trinervia* (L.) Clairv.
37. *Myosoton aquaticum* (L.) Moench (*Stellaria aquatica* (L.) Scop.)
38. *Sagina procumbens* L.
39. *Scleranthus annuus* L.
40. *Scleranthus perennis* L.
41. *Silene latifolia* Poir. subsp. *alba* (Mill.) Greuter & Burdet
42. *Silene noctiflora* L.
43. *Stellaria graminea* L.
44. *Stellaria holostea* L.
45. *Stellaria media* (L.) Vill. s.l.
46. *Stellaria nemorum* L.
47. *Stellaria uliginosa* Murray (*Stellaria alsine* Grimm)

Amaranthaceae
48. *Amaranthus powellii* S. Watson
49. *Amaranthus retroflexus* L.
50. *Spergularia rubra* (L.) J. Presl & C. Presl

Chenopodiaceae
51. *Atriplex patula* L.
52. *Chenopodium album* L.

Polygonaceae
53. *Fallopia dumetorum* (L.) Holub
54. *Polygonum aviculare* L. s. l.
55. *Polygonum bistorta* L.
56. *Polygonum hydropiper* L.
57. *Polygonum lapathifolium* L.
58. *Polygonum minus* Huds.
59. *Polygonum persicaria* L.
60. *Rumex acetosa* L.
61. *Rumex acetosella* L. s. l. – HH herb. (1912)

62. *Rumex conglomeratus* Murray – MM (2006)[4]
63. *Rumex crispus* L.
64. *Rumex obtusifolius* L. s. l.
65. *Rumex sanguineus* L.

Crassulaceae

66. *Sedum sexangulare* L.

Rosaceae

67. *Agrimonia eupatoria* L. – OS (2009)[5]
68. *Crataegus monogyna* Jacq. – HH herb. (1908)
69. *Filipendula ulmaria* (L.) Maxim. subsp. *ulmaria*
70. *Filipendula vulgaris* Moench
71. *Fragaria vesca* L.
72. *Geum urbanum* L.
73. *Malus sylvestris* Mill. – HH herb. (1908)
74. *Potentilla anserina* L.
75. *Potentilla argentea* L.
76. *Potentilla erecta* (L.) Rausch.
77. *Potentilla recta* L.
78. *Potentilla reptans* L.
79. *Prunus cerasifera* Ehrh.
80. *Prunus spinosa* L.
81. *Pyrus pyraster* Burgsd.
82. *Rosa canina* L. – FF (1858) [352]; OS (2009)
83. *Rosa micrantha* Borrer ex Sm.
84. *Rosa obtusifolia* Desv.
85. *Rubus caesius* L.
86. *Rubus hirtus* Waldst. & Kit.
87. *Rubus histrix* Weihe & Nees
88. *Rubus idaeus* L.
89. *Rubus macrophyllus* Weihe & Nees
90. *Sanguisorba officinalis* L.

Fabaceae (Leguminosae)

91. *Anthyllis vulneraria* L. s. l.
92. *Astragalus glycyphyllos* L.
93. *Chamaespartium sagittale* (L.) P.E. Gibbs (*Genistella sagittalis* (L.) Gams) – FF (1858) [240]
94. *Coronilla varia* L.
95. *Galega officinalis* L.
96. *Genista tinctoria* L. subsp. *tinctoria*
97. *Lathyrus hirsutus* L.
98. *Lathyrus pratensis* L.
99. *Lathyrus vernus* (L.) Bernh.
100. *Lotus corniculatus* L.
101. *Medicago lupulina* L.
102. *Medicago minima* (L.) Bartal.
103. *Medicago sativa* subsp. *falcata* (L.) Arcangeli (*Medicago falcata* L.)
104. *Melilotus alba* Medik.
105. *Melilotus officinalis* (L.) Pall.
106. *Ononis arvensis* L.
107. *Robinia pseudacacia* L.
108. *Trifolium arvense* L.
109. *Trifolium aureum* Pollich
110. *Trifolium campestre* Schreb. – FF (1858) [271]
111. *Trifolium dubium* Sibth.
112. *Trifolium fragiferum* L. s. l.
113. *Trifolium hybridum* L. s. l.
114. *Trifolium medium* L. subsp. *medium*
115. *Trifolium montanum* L.
116. *Trifolium ochroleucon* Huds.
117. *Trifolium pratense* L. s. l.
118. *Trifolium repens* L.
119. *Vicia cracca* L.
120. *Vicia hirsuta* (L.) S.F. Gray
121. *Vicia sativa* subsp. *nigra* (L.) Ehrh. (*Vicia angustifolia* L.)
122. *Vicia sepium* L.
123. *Vicia tetrasperma* (L.) Schreb.
124. *Vicia villosa* Roth

Lythraceae

125. *Lythrum portula* (L.) D.A. Webb
126. *Lythrum salicaria* L. – MM (2006)

Onagraceae

127. *Circaea lutetiana* L.
128. *Epilobium angustifolium* L.
129. *Epilobium montanum* L.
130. *Epilobium palustre* L. – MM (2006)
131. *Epilobium tetragonum* L. subsp. *lamyi* (F.W. Schultz) Nyman

Cornaceae

132. *Cornus sanguinea* L. – HH herb. (?)

Loranthaceae

133. *Viscum album* L. – HH herb. (1908)
134. *Loranthus europaeus* Jacq.

Celastraceae

135. *Euonymus europaeus* L.
136. *Euonymus verrucosus* Scop.

Euphorbiaceae

137. *Euphorbia amygdaloides* L.
138. *Euphorbia angulata* Jacq.
139. *Euphorbia cyparissias* L.
140. *Euphorbia epithymoides* L. – FF (1858) [925]
141. *Euphorbia exigua* L.
142. *Euphorbia helioscopia* L.
143. *Euphorbia platyphyllos* L.
144. *Euphorbia serrulata* Thuill.

Rhamnaceae

145. *Frangula alnus* Mill.

Aceraceae

146. *Acer campestre* L.
147. *Acer negundo* L.
148. *Acer platanoides* L.
149. *Acer pseudoplatanus* L.
150. *Acer tataricum* L. – HH herb. (1913)

Oxalidaceae

151. *Oxalis acetosella* L.

152. *Oxalis fontana* Bunge (*Oxalis europaea* Jord.) – HH herb. (1908)
153. *Oxalis stricta* L. (*Oxalis dilenii* Jacq.)

Geraniaceae

154. *Erodium cicutarium* (L.) L'Hér.
155. *Geranium pratense* L.
156. *Geranium pusillum* L.
157. *Geranium robertianum* L. – HH herb. (1941)

Balsaminaceae

158. *Impatiens noli-tangere* L.

Polygalaceae

159. *Polygala comosa* Schkuhr
160. *Polygala major* Jacq.
161. *Polygala vulgaris* L.

Apiaceae (Umbelliferae)

162. *Aegopodium podagraria* L. – HH herb. (1913)
163. *Angelica sylvestris* L.
164. *Anthriscus cerefolium* (L.) Hoffm.
165. *Anthriscus sylvestris* (L.) Hoffm.
166. *Carum carvi* L.
167. *Chaerophyllum aromaticum* L.
168. *Chaerophyllum bulbosum* L.
169. *Chaerophyllum temulentum* L.
170. *Daucus carota* L. subsp. *carota* – MM (2006)
171. *Eryngium campestre* L.
172. *Eryngium planum* L.
173. *Heracleum sphondylium* L.
174. *Pastinaca sativa* L. s. l.
175. *Pimpinella majo*r (L.) Huds.
176. *Pimpinella saxifraga* L.
177. *Sanicula europaea* L.
178. *Selinum carvifolia* (L.) L.
179. *Torilis arvensis* (Huds.) Link s. l. – MM (2006)

Hypericaceae

180. *Hypericum hirsutum* L. – FF (1858) [201]
181. *Hypericum humifusum* L.
182. *Hypericum perforatum* L.

Malvaceae

183. *Alcea pallida* (Willd.) Waldst. & Kit.

Violaceae

184. *Viola arvensis* Murray
185. *Viola canina* L.
186. *Viola hirta* L. – HH herb. (1908)
187. *Viola mirabilis* L.
188. *Viola reichenbachiana* Jord. ex Boreau

Cistaceae

189. *Helianthemum nummularium* (L.) Mill. subsp. *obscurum* (Čelak.) J. Holub

Brassicaceae (Cruciferae)

190. *Alliaria petiolata* (M. Bieb.) Cavara & Grande (*Alliaria officinalis* Andrz. ex Bieb.)
191. *Barbarea vulgaris* R.Br. – HH herb. (1909)
192. *Capsella bursa-pastoris* (L.) Medik.
193. *Cardamine flexuosa* With.
194. *Cardamine impatiens* L.
195. *Cardamine pratensis* L. subsp. *pratensis*
196. *Cardaria draba* (L.) Desv. (*Lepidium draba* L.)
197. *Cardamine bulbifera* (L.) Crantz
198. *Descurainia sophia* (L.) Webb ex Prantl
199. *Rorippa palustris* (L.) Besser
200. *Rorippa pyrenaica* (Lam.) Rchb.
201. *Rorippa sylvestris* (L.) Besser subsp. *sylvestris*
202. *Sinapis arvensis* L.
203. *Sisymbrium officinale* (L.) Scop.

Salicaceae

204. *Populus alba* L.
205. *Populus tremula* L.
206. *Salix alba* L.
207. *Salix caprea* L.
208. *Salix cinerea* L.
209. *Salix fragilis* L.
210. *Salix purpurea* L.
211. *Salix triandra* L.

Primulaceae

212. *Anagallis arvensis* L.
213. *Anagallis foemina* Mill.
214. *Lysimachia nummularia* L. – HH (1914)
215. *Lysimachia vulgaris* L.
216. *Primula veris* L.

Gentianaceae

217. *Centaurium erythraea* Rafn. subsp. *erythraea*
218. *Gentiana pneumonanthe* L. – HH herb. (1941)

Asclepiadaceae

219. *Asclepias syriaca* L.

Oleaceae

220. *Ligustrum vulgare* L. – HH herb. (1943)

Convolvulaceae

221. *Convolvulus arvensis* L.
222. *Cuscuta europaea* L.

Boraginaceae

223. *Echium vulgare* L.
224. *Myosotis arvensis* (L.) Hill subsp. *arvensis* – HH herb. (?)
225. *Myosotis discolor* Pers.
226. *Myosotis scorpioides* L.
227. *Myosotis stricta* Link ex Roem. & Schult.
228. *Myosotis sylvatica* Hoffm.
229. *Pulmonaria mollis* Wulfen ex Hornem.
230. *Symphytum officinale* L. subsp. *officinale*
231. *Symphytum tuberosum* L. – FF (1858) [708]

Verbenaceae

232. *Verbena officinalis* L. – HH herb. (1941)

Lamiaceae (Labiatae)

233. *Ajuga reptans* L.
234. *Ballota nigra* L.
235. *Clinopodium vulgare* L.
236. *Galeopsis bifida* Boenn.
237. *Galeopsis speciosa* Mill.
238. *Galeopsis tetrahit* L.
239. *Glechoma hederacea* L.
240. *Lamiastrum galeobdolon* (L.) Ehrend. & Polatschek – FF (1858) [836] (under *Galeobdolon luteum* Huds.)
241. *Lamium album* L.
242. *Lamium maculatum* L.
243. *Lamium purpureum* L.
244. *Lycopus europaeus* L.
245. *Lycopus exaltatus* L.f.
246. *Marrubium vulgare* L.
247. *Mentha arvensis* L.
248. *Mentha longifolia* (L.) Huds. – MM (2006)
249. *Mentha pulegium* L.
250. *Origanum vulgare* L.
251. *Prunella grandiflora* (L.) Scholler – MM (2006)
252. *Prunella laciniata* (L.) L.
253. *Prunella vulgaris* L. – OS (2009)
254. *Salvia glutinosa* L.
255. *Salvia pratensis* L.
256. *Salvia verticillata* L.
257. *Scutellaria galericulata* L.
258. *Stachys annua* (L.) L.
259. *Stachys officinalis* (L.) Trevis. (*Betonica officinalis* L.)
260. *Stachys sylvatica* L.
261. *Teucrium chamaedrys* L.
262. *Thymus glabrescens* Willd.

Callitrichaceae

263. *Callitriche palustris* L.

Plantaginaceae

264. *Plantago lanceolata* L. – MM (2006)
265. *Plantago major* L. s. l.
266. *Plantago media* L. s. l.

Scrophulariaceae

267. *Digitalis grandiflora* Mill. – HH herb. (1910)
268. *Euphrasia rostkoviana* Hayne – FF (1858) [791] (under *E. officinalis* L.)
269. *Euphrasia stricta* J.P. Wolff ex J.F. Lehm.
270. *Linaria vulgaris* Mill. – OS (2009)
271. *Melampyrum bihariense* A. Kern. – HH herb. (1943)
272. *Rhinanthus minor* L.
273. *Rhinanthus rumelicus* Velen.
274. *Scrophularia nodosa* L.
275. *Verbascum nigrum* L. subsp. *nigrum*
276. *Verbascum phlomoides* L.
277. *Veronica arvensis* L.
278. *Veronica beccabunga* L.
279. *Veronica chamaedrys* L. s. l.
280. *Veronica hederifolia* L. subsp. *hederifolia*
281. *Veronica officinalis* L.
282. *Veronica persica* Poir.
283. *Veronica polita* Fr.
284. *Veronica serpyllifolia* L. subsp. *serpyllifolia* – FF (1858) [769]; HH herb. 1912

Solanaceae

285. *Atropa bella-donna* L. – HH (1914); HH herb. (?)
286. *Solanum dulcamara* L.
287. *Solanum nigrum* L.

Campanulaceae

288. *Campanula patula* L. subsp. *patula*
289. *Campanula persicifolia* L.
290. *Campanula rapunculoides* L.
291. *Campanula trachelium* L.

Rubiaceae

292. *Cruciata glabra* (L.) Ehrend.
293. *Cruciata laevipes* Opiz – HH herb. (?)
294. *Galium album* Mill. s. l.
295. *Galium aparine* L.
296. *Galium mollugo* L.
297. *Galium odoratum* (L.) Scop. (*Asperula odorata* L.) – FF (1858) [474]; HH herb. 1908
298. *Galium palustre* L.
299. *Galium schultesii* Vest
300. *Galium verum* L.

Caprifoliaceae

301. *Lonicera xylosteum* L.
302. *Sambucus ebulus* L.
303. *Sambucus nigra* L.
304. *Viburnum opulus* L.

Valerianaceae

305. *Valeriana officinalis* L.

Dipsacaceae

306. *Dipsacus laciniatus* L.
307. *Knautia arvensis* (L.) Coult. – MM (2006)
308. *Succisa pratensis* Moench – HH herb. (1941)

Asteraceae (Compositae)

309. *Achillea collina* J. Becker ex Rchb.
310. *Achillea millefolium* L. – MM (2006); OS (2009)
311. *Achillea ptarmica* L.
312. *Anthemis ruthenica* M. Bieb.
313. *Arctium lappa* L.
314. *Artemisia absinthium* L.
315. *Artemisia vulgaris* L.
316. *Bellis perennis* L.
317. *Bidens tripartita* L. – HH herb. (1911)
318. *Carduus acanthoides* L.
319. *Carduus crispus* L.
320. *Centaurea jacea* L. – HH herb. (1908)

321. *Centaurea phrygia* L. subsp. *phrygia* (*C. austriaca* Willd.) – MM (2006)
322. *Chamomilla recutita* (L.) Rauschert (*Matricaria chamomilla*)
323. *Chamomilla suaveolens* (Pursh) Rydb. (*Matricaria discoidea* DC.)
324. *Cichorium intybus* L. – OS (2009)
325. *Cirsium arvense* (L.) Scop.
326. *Cirsium canum* (L.) All.
327. *Cirsium furiens* Griseb. & Schenk
328. *Cirsium oleraceum* (L.) Scop. – HH herb. (1943)
329. *Cirsium palustre* (L.) Scop.
330. *Cirsium rivulare* (Jack.) All. – OS (2009)
331. *Cirsium vulgare* (Savi) Ten. – MM (2006)
332. *Conyza canadensis* (L.) Cronq. (*Erigeron canadensis* L.)
333. *Crepis biennis* L.
334. *Crepis capillaris* (L.) Wallr.
335. *Erechtites hieracifolia* (L.) Rafin. ex DC.
336. *Erigeron annuus* (L.) Pers. subsp. *annuus*
337. *Erigeron annuus* (L.) Pers. subsp. *strigosus* (Muhl. ex Willd.) Wagenitz
338. *Eupatorium cannabinum* L.
339. *Filago vulgaris* Lam.
340. *Filaginella uliginosa* (L.) Opiz subsp. *uliginosa* (*Gnaphalium uliginosum* L.)
341. *Galinsoga parviflora* Cav.
342. *Hieracium aurantiacum* L.
343. *Hieracium cymosum* L. s. l.
344. *Hieracium murorum* L. s. l. – FF (1858) [646]
345. *Hieracium pilosella* L. s. l.
346. *Hieracium umbellatum* L. s. l.
347. *Hypochaeris radicata* L. – FF (1858) [625]
348. *Inula britannica* L. – MM (2006)
349. *Inula helenium* L.
350. *Lactuca serriola* L.
351. *Lapsana communis* L. subsp. *communis*
352. *Leontodon autumnalis* L. subsp. *autumnalis* – MM (2006)
353. *Leontodon hispidus* L.
354. *Leucanthemum vulgare* Lam.
355. *Logfia minima* (Sm.) Dumort. (*Filago minima* (Sm.) Pers.)
356. *Matricaria perforata* Mérat
357. *Mycelis muralis* (L.) Dumort.
358. *Omalotheca sylvatica* (L.) Sch. Bip. & F.W. Schultz (*Gnaphalium sylvaticum* L.)
359. *Picris hieracioides* L.
360. *Pulicaria dysenterica* (L.) Bernh.
361. *Pulicaria vulgaris* Gaertner
362. *Rudbeckia laciniata* L.
363. *Senecio aquaticus* Hill subsp. *barbareifolius* (Wimm. & Grab.) Walters (*Senecio erraticus* Bertol.)
364. *Senecio erucifolius* L.
365. *Senecio jacobaea* L.
366. *Solidago canadensis* L.
367. *Solidago gigantea* Aiton subsp. *serotina* (O. Kuntze) McNeill
368. *Solidago virgaurea* L.
369. *Sonchus oleraceus* L.
370. *Tanacetum vulgare* L.
371. *Taraxacum officinale* Weber
372. *Telekia speciosa* (Schreber) Baumg.
373. *Tragopogon pratensis* L. subsp. *orientalis* (L.) Čelak. (*Tragopogon orientalis* L.)
374. *Tussilago farfara* L.
375. *Xanthium strumarium* L. – OS (2009)

Cls. LILIOPSIDA (*Monocotyledonatae*)

Alismataceae

376. *Alisma plantago-aquatica* L. – HH herb. (1908)

Liliaceae s. l.

377. *Colchicum autumnale* L.
378. *Maianthemum bifolium* (L.) F.W.Schmidt
379. *Paris quadrifolia* L.
380. *Polygonatum latifolium* (Jacq.) Desf.
381. *Polygonatum multiflorum* (L.) All.
382. *Scilla bifolia* L. s. l.

Alliaceae

383. *Allium oleraceum* L.

Iridaceae

384. *Iris pseudacorus* L. – HH herb. (1908)

Orchidaceae

385. *Dactylorhiza incarnata* (L.) Soó
386. *Gymnadenia conopsea* (L.) R. Br.
387. *Listera ovata* (L.) R.Br.
388. *Orchis morio* L. subsp. *morio* – HH herb. (1908)
389. *Orchis ustulata* L.
390. *Platanthera bifolia* (L.) Rich.

Juncaceae

391. *Luzula campestris* (L.) DC.
392. *Luzula luzuloides* (Lam.) Dandy & Wilmott
393. *Juncus articulatus* L.
394. *Juncus bufonius* L.
395. *Juncus conglomeratus* L. – MM (2006)
396. *Juncus effusus* L.
397. *Juncus inflexus* L. – MM (2006)
398. *Juncus tenuis* Willd.

Cyperaceae

399. *Carex acuta* L.
400. *Carex acutiformis* Ehrh.
401. *Carex appropinquata* A. Schumach.
402. *Carex brizoides* L.
403. *Carex caryophyllea* Latourr.
404. *Carex cespitosa* L.
405. *Carex depressa* Link
406. *Carex divulsa* Stokes

407. *Carex elata* All.
408. *Carex hirta* L.
409. *Carex michelii* Host
410. *Carex nigra* (L.) Reichard
411. *Carex ovalis* Gooden.
412. *Carex pallescens* L. – FF (1858) [1107]
413. *Carex paniculata* L.
414. *Carex pendula* Huds.
415. *Carex pilosa* Scop.
416. *Carex remota* L.
417. *Carex spicata* Huds.
418. *Carex sylvatica* Huds. – FF (1858) [1106]
419. *Carex tomentosa* L. – FF (1858) [1113]
420. *Carex vesicaria* L.
421. *Carex vulpina* L.
422. *Eleocharis palustris* (L.) Roem. & Schult.
423. *Scirpus sylvaticus* L.

Poaceae (Gramineae)

424. *Agrostis canina* L.
425. *Agrostis capillaris* L. (*Agrostis tenuis* Sibth.)
426. *Agrostis gigantea* Roth subsp. *gigantea*
427. *Agrostis stolonifera* L. – MM (2006)
428. *Alopecurus aequalis* Sobol. – HH herb. (1943)
429. *Alopecurus pratensis* L.
430. *Anthoxanthum odoratum* L. – HH herb. (1908)
431. *Apera spica-venti* (L.) P. Beauv.
432. *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl & C. Presl subsp. *elatius*
433. *Brachypodium sylvaticum* (Huds.) P. Beauv.
434. *Briza media* L. – HH herb. (1911)
435. *Bromus commutatus* Schrad.
436. *Bromus erectus* Huds. s. l.
437. *Bromus hordeaceus* L.
438. *Bromus inermis* Leyss. – FF (1858) [1191]
439. *Bromus japonicus* Thunb.
440. *Bromus squarrosus* L.
441. *Calamagrostis arundinacea* (L.) Roth
442. *Calamagrostis canescens* (Weber) Roth
443. *Calamagrostis epigejos* (L.) Roth
444. *Cynosurus cristatus* L.
445. *Dactylis glomerata* L. subsp. *aschersoniana* (Graebn.) Thell.
446. *Deschampsia caespitosa* (L.) P. Beauv. s. l. – FF (1858) [1151] (under *Aira chaespitosa* Muhl.)
447. *Digitaria sanguinalis* (L.) Scop.
448. *Echinochloa crus-galli* (L.) P. Beauv.
449. *Elymus repens* (L.) Gould
450. *Eragrostis minor* Host
451. *Festuca arundinacea* Schreb. s. l.
452. *Festuca drymeja* Mert. et W.D.J. Koch
453. *Festuca gigantea* (L.) Vill.
454. *Festuca heterophylla* Lam.
455. *Festuca pratensis* Huds. subsp. *pratensis*
456. *Festuca rubra* L.
457. *Festuca valesiaca* Schleich. ex Gaudin
458. *Glyceria fluitans* (L.) R.Br.
459. *Holcus lanatus* L. – MM (2006)
460. *Holcus mollis* L.
461. *Hordelymus europaeus* (L.) Harz
462. *Leersia oryzoides* (L.) Sw.
463. *Lolium perenne* L. – HH herb. (1943)
464. *Melica nutans* L.
465. *Milium effusum* L.
466. *Molinia caerulea* (L.) Moench
467. *Nardus stricta* L.
468. *Phleum pratense* L.
469. *Poa annua* L.
470. *Poa compressa* L.
471. *Poa palustris* L.
472. *Poa pratensis* L.
473. *Poa trivialis* L.
474. *Setaria pumila* (Poir.) Schult.
475. *Trisetum flavescens* (L.) P.Beauv.

Lemnaceae

476. *Lemna minor* L.

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[1] Höhr H. (1914) *Schäßburgs Archegoniaten (Moos- und Farnpflanzen)*.

[2] Data regarding the species from the herbarium of Henirich Höhr (noted as *HH herb. year* in the list of species) were provided by Klaus Gross, and were not checked by the author (KÖ). (?) stands for unknown year.

[3] Fronius F. (1858) *Flora von Schäßburg*. Values in square brackets [ ] represent the position of the species in the list of Fronius.

[4] Mititiuc M. (2006) *Rezervaţia naturală „Stejarii seculari de pe platoul Breite”*.

[5] Oroian S. (2009) *Flora şi vegetaţia satelor săteşti din Transilvania.*

Besides those included in the above list, there are a few plant species mentioned by Fronius (1858) as existing on the Breite. Despite the fact that their actual presence in the open area is questionable, they are listed in the following. Species names and authors are given as in Flora Europaea (2001), while values in square brackets [ ] represent the position of the species in the list of Fronius.

1. *Alchemilla vulgaris* L. [360]
2. *Astrantia major* L. [404]
3. *Carex flava* L. [1120]
4. *Cerastium brachycephalum* Desp. (accepted name *Cerastium brachypetalum* Pers.) [176]

5. *Cipripedium calceolus* L. (accepted name *Cypripedium calceolus* L.) [1015]
6. *Clematis flammula* L. [2]
7. *Cytisus capitatus* Scop. (syn., accepted name *Chamaecytisus supinus* (L.) Link) [245]
8. *Erythronium dens-canis* L. (present on the Breite, but not seen by KÖ in the open area) [1042]
9. *Gentiana amarella* L. (probably *Gentianella amarella* (L.) Börner) [689]
10. *Gnaphalium dioicum* L. = *Antennaria dioica* (L.) Gaertn. [538]
11. *Helleborus purpurascens* Waldst. & Kit. (present on the Breite, but not seen by KÖ in the open area) [40]
12. *Hieracium praemorsum* L. (ext., accepted name *Crepis praemorsa* (L.) Walther.) [649]
13. *Iris caespitosa* Pall. ex Link (syn., accepted name *Iris ruthenica* Ker Gawl., and noted by Fronius as „=*" Iris graminea* L.) [1022]
14. *Linum flavum* L. [177]
15. *Melampyrum barbatum* Waldst. & Kit. ex Willd. [786]
16. *Orchideae maculata* L. (probably *Orchis maculata* L., syn., accepted name *Dactylorhiza maculata* (L.) Soó) [1000]
17. *Orobus niger* L. (syn., accepted name *Lathyrus niger* (L.) Bernh.) [310]
18. *Pimpinella magna* L. (syn., accepted name *Pimpinella major* (L.) Huds.) [414]
19. *Poa nemoralis* L. [1170]
20. *Scabiosa columbaria* L. [501]
21. *Srophularia glandulosa* Waldst. & Kit. (syn., *Scrophularia scopolii* Hoppe) [747]
22. *Vinca minor* L. (present on the Breite, but not seen by KÖ in the open area) [681]

Analysis of the flora of the Breite wood-pasture

Following the field studies begun in 2005, 476 species and subspecies belonging to 248 genera and 64 families were identified on the Breite. Additional species are to be expected based also on the unpublished list provided by Klaus Gross. The most abundant families (>5 %) are: Asteraceae (*Compositae*) – 14.08 %; Poaceae (*Gramineae*) – 10.92 %; Fabaceae (*Leguminosae*) – 7.14 %; Lamiaceae – 6.30 %; Cyperaceae – 5.25 % and Rosaceae 5.04 %, while 22 families are represented by only one species.

Considering their region of origin (geoelements), the identified plant species belong to the following groups: Eurasian (194 species: 40.76 %), European (74: 15.55 %), Circumpolar (52: 10.92 %) mainly Central European (49: 10.29 %; including for example species that are predominantly Central European but also Mediterranean), Cosmopolite (37: 7.77 %), while the remaining 70 species (Mediterranean, Pontic, Balcanic *etc*.) total 14.71 %. Out of this last category, 17 are adventive species, requiring special attention from a biodiversity conservation perspective. Most of these species can be found nearby the forestry road that crosses the plateau in its length, and especially around the football field, while they are most abundant in the SE part of the plateau, where in 2007 a clear-cut was done in the surrounding forest (Fig. 1). According to the classification used by Anastasiu, Negrean (2009), these 17 species can be included in the following groups from the perspective of their abundance on the Breite:

– Common: *Erigeron annuus* (L.) Pers. subsp. *annuus*; *Erigeron annuus* (L.) Pers. subsp. *strigosus* (Muhl. ex Willd.) Wagenitz; *Galinsoga parviflora* Cav.; *Juncus tenuis* Willd.
– Scattered: *Amaranthus powellii* S. Watson; *Amaranthus retroflexus* L.; *Chamomilla suaveolens* (Pursh) Rydb.; *Erechtites hieracifolia* (L.) Rafin. ex DC.
– Rare: *Acer negundo* L.; *Asclepias syriaca* L.; *Conyza canadensis* (L.) Cronq.; *Oxalis fontana* Bunge; *Oxalis stricta* L.
– Locally abundant: *Rudbeckia laciniata* L.; *Solidago canadensis* L.; *Solidago gigantea* Aiton subsp. *serotina* (O. Kuntze) McNeil; *Veronica persica* Poir.

In order to limit their presence and future spread on the Breite, the individuals of the following species have been manually removed (pulled out, including roots) on different occasions: *Asclepias syriaca* L.; *Rudbeckia laciniata* L.; *Solidago canadensis* L.; *Solidago gigantea* Aiton subsp. *serotina* (O. Kuntze) McNeil.

The identified plant species were grouped according to their predominant life form (Fig. 2) (*e.g.* a hemicriptophyte, but secondary chamaephyte species "H(Ch)" was considered as hemicryptophyte). Hemicryptophytes are the most abundant group, being represented by 236 species (49.58 %), followed by therophytes with 103 species (21.64 %) The two epiphyte species are *Loranthus europaeus* Jack. and *Viscum album* L.

Considering their life span, perennials are the most abundant group, being represented by 289 species (60.71 %), followed by annuals (76: 15.97 %), trees (27: 5.67 %), biennials and shrubs (19: 3.99 % each), while the rest of species, with secondary life span (*e.g.* annual-perennials) total 9.66 %.

The ecological characterization of the flora according to the humidity requirements (Fig. 3) shows an overall mesophilous character and a significant presence of hygrophilous and hydrophilous elements, reflecting the historical (humid, even marshy - Siegmund 1948, Mihai Eminescu Trust 2005) characteristics of the plateau. The xerophilous species were found mainly in the more open areas of the wood-pasture (especially in the northern part), but also in some spots of the southern part, probably as a result of the desiccation process and unusual lack of precipitations during 2006-2009 in comparison with the multiannual averages (personal observations). The two hemiparasite species are *Loranthus europaeus* Jack. and *Viscum album* L.

When considering the biodiversity conservation value of the ground vegetation, it can be stated that it is represented by its general character (semi-natural habitat, wood-pasture in particular), and by the few species whose presence is interesting in this area (ex. the mountainous-alpine *Potentilla erecta* (L.) Rausch. and *Hieracium aurantiacum* L. subsp. *aurantiacum*) rather than in the presence of species of conservation interest.

The species included in the National Red Lists are: *Achillea ptarmica* L. (Vulnerable - Oltean *et al.*, 1994; Rare - Negrean 2001); *Dactylorhiza incarnata* (L.) Soó (R - Oltean *et al.* 1994, Negrean 2001); *Gentiana pneumonanthe* L. (V - Boşcaiu *et al*., 1994; Negrean 2001); *Gymnadenia conopsea* (L.) R. Br. (R - Oltean *et al.* 1994); *Listera ovata* (L.) R.Br. (R - Oltean *et al*. 1994); *Orchis morio* L. (R - Oltean *et al*., 1994; Negrean 2001); *Orchis ustulata* L. (R - Oltean *et al*. 1994, Negrean 2001); *Pinus sylvestris* L. (R - Oltean *et al*. 1994, planted on the Breite); *Platanthera bifolia* (L.) Rich. (R - Oltean *et al*. 1994); *Rosa micrantha* Borrer ex Sm. (R - Oltean *et al*. 1994); *Senecio aquaticus* Hill (R - Oltean *et al*., 1994). Out of these, only *Dactylorhiza incarnata* (L.) Soó, *Gymnadenia conopsea* (L.) R. Br. and *Platanthera bifolia* (L.) Rich. are included in the European Red List of Vascular Plants (Bilz *et al.* 2011), all three as Least Concern. None of the species is listed in the Red Data Book of Vascular Plants for Romania (Dihoru, Negrean, 2009).

Discussion

The flora of the Breite wood-pasture contains a large number of species with very diverse ecological requirements, a situation explained probably by the special conditions created by the presence of the veteran trees (providing shadow and maintaining humidity), the closeness of the surrounding forest, the hydrological regime, but also by the numerous interventions and modifications in the land-use of the area that occurred throughout the years. Therefore in the current species composition several species that characteristically do not belong to this territory have a transitory presence, while others are still present despite the fact that the ecological conditions are not favourable for their existence any more (Van der Maarel 1996). Beside the specific dynamics and distribution determined by these conditions, the reintroduction of grazing in 2008 as part of the management plan (Mihai Eminescu Trust 2007) will most probably influence the distribution and presence of some species.

For the overall management, interventions aiming to restore the former hydrological regime are recommended, together with controlling the spread of adventive species and shrub encroachment. In order to meet this, the enclosure of the drainage ditches started in 2007, together with removal of Hornbeam saplings and, as mentioned before, removal of adventive species (Mihai Eminescu Trust 2007).

Because, following the abandonment in 2004, grazing was reintroduced in 2008 as part of the conservation management activities, in the following some specific recommendations are presented regarding this matter from the perspective of wood-pastures, and therefore relevant for this type of habitat in general.

Grazing must be applied through rotation, not more than three-four days in the same spot, followed by 10-14 days of resting (Földes 1895, Bíró 1910).

Where scything is applied, although this is not a characteristic practice in wood-pasture habitats (Crofts, Jefferson 1999; Oroszi, 2004), grazing must be avoided especially during the dry season (Bíró, 1910). Sheep grazing should be generally avoided during the dry season because on torrid days animals pull out the plants instead of grazing, causing severe loss in biomass and regenerative parts of plants (Zsarolyáni 1897).

Weeds that appear in more intensely grazed areas (*e.g.Cirsium arvense* (L.) Scop. and *C. vulgare* (Savi) Ten., species that had an expansion in 2009) must be cut with a spade or hoe twice a year (in June and August) before flowering. Cattle droppings should be left to dry out and later spread across the area in order to avoid the concentration of nutrients (Bíró 1910). Because fallen leaves have a high mineral content that is very important

for herbaceous plants, cattle should be left to walk across the area during humid days in late autumn in order to trample the leaves, helping in this way the formation of a thick humus layer (Zsarolyáni 1897).

Although interventions might be considered by many as contradictory with nature conservation principles, it is of key importance to keep in mind that wood-pasture habitats are dependent on such practices, being the result of human activities, the seizure of these leading to their disappearance in the long run (Introduction and Bergmeier *et al*. 2010 for a recent review on this topic).

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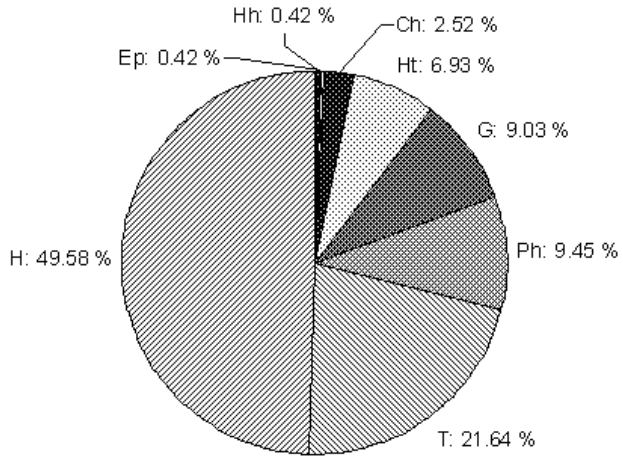

Fig. 2. The life form categories of vascular plants from the Breite wood-pasture

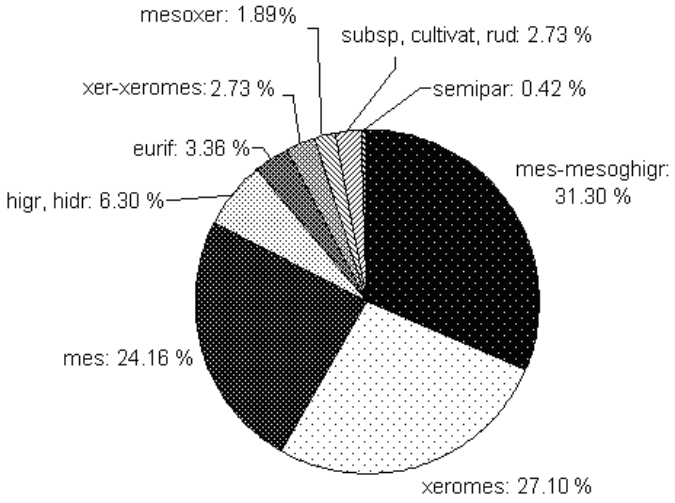

Fig. 3. The ecological categories of vascular plants from the Breite wood-pasture

GEOLOGICAL AND HYDROLOGICAL CONSIDERATIONS IN THE SECAŞUL MARE BASIN (SOUTH – WESTERN PART OF THE TRANSYLVANIAN DEPRESSION)

Marioara COSTEA[*]
Rodica CIOBANU[**]

Abstract. *In the current paper we intend to present the main geological factors leading to or restricting the evolution of the underground waters in the Secaşul Mare Basin (the structural and lithological characteristics of the Secaşul Mare basin), hydrological aspects of the store rocks and the underground waters resources in the given basin. Since the underground waters represent an important natural resource, their quality, mineralization degree and chemical content are all very relevant. Any form of natural water (rain fall waters, surface waters or subterranean waters) contains chemical substances, some of which may be harmful, either to man or to other living organisms. The modification of the water chemistry can be due to the mineral or rock dissolution phenomenon, as a result of the water – rock contact, as well as to the anthropic pollution. We also point out the necessity of permanent monitoring of the quality of underground waters, and especially of those used in agriculture, fish – farming, house management and consumption.*
Keywords*: Geology, Hydrology, Secaş Basin, Transylvanian Depression.*

Rezumat. *În lucrare ne propunem să prezentăm factorii geologici majori care concură sau restricționează evoluția apelor subterane în bazinul Secaşului Mare (caracteristicile structurale şi litologice ale bazinului Secaşului Mare), aspecte hidrogeologice ale rocilor magazin şi resursele de ape subterane din bazinul Secaşului Mare. În condițiile în care apele subterane reprezintă o resursă naturală importantă, calitatea acestora - gradul de mineralizare, conținutul chimic este foarte important. Orice apa naturală - apa din precipitații, apele de suprafață sau cele subterane conțin substanțe chimice dintre care unele sunt dăunătoare omului sau altor forme de viață. Modificarea chimismului apelor se poate datora atât fenomenului de dizolvare a mineralelor, rocilor la contactul rocă-apă, cât şi poluării antropice. Procesele chimice la contactul apă-rocă sunt necontrolabile, complicate şi de multe ori necunoscute. Evidențiem în lucrare necesitatea unei monitorizări permanente a calității apelor subterane, şi în special a celor utilizate în agricultură, piscicultură, gospodării şi în consum.*

Cuvinte cheie*: geologie, hidrologie, Bazinul Secaşului, Depresiunea Transilvaniei.*

Introduction

Regarded an important geospheres of the Earth, the lithosphere and the hydrosphere represent at the same time the environment and the compounding elements ensuring and realizing the material, informational and energetic network in the geosphere The study of bought the hydrosphere and of the lithosphere, especially of the organization and manifestation forms in the continental field, commonly points out the complex and at times – common genesis of the geological and hydrological processes and phenomena, and not only. In this context, the organization of the hydrological network, the current hydrological phenomena and manifestation forms, all require a cross – disciplinary approach and a correlative time – space analysis, particularly with regards to the geological conditions, as well as to other environmental elements (relief, weather condition, vegetation coverage degree, fields' utilization).

There are strong and at times complicated relations between water, in all its forms, and the rocks and geological structures, respectively tectonic structures of the lithosphere. The evolution of the geological and geomorphological processes from within and from the surface of the Earth crust is strongly connected to the presence of water. Water in its liquid state, is highly significant, on one hand, as a morphogenetic factor, as a factor for setting a hierarchy of the landforms, and on the other hand

* Lucian Blaga"University of Sibiu, Science Faculty, marioara_costea@yahoo.com
** Brukenthal National Museum, rodi_ciobanu2005@yahoo.com, rodica.ciobanu@brukenthalmuseum.ro

due to the economic significance it has based on its quality.

The presence and evolution of the underground water resources is influenced by the geological factors, both from a quantitative and qualitative point of view (due to the physical and chemical properties), as well as from the point of view of its accessibility and distribution. The rocks, the geological and tectonic structures which characterize them, are all in a continuous inter-conditional relation with water. The outcomes of this biunivocal relation take a concrete form both in what concerns the evolution of the hydro – geological resources, as well as that of the ancient and especially recent local or regional geology. The evolution and the spread of underground water resources are conditioned by the circulation of water within the rock, among rocks, on the stratification levels, reaching from the surface towards the inner part, through infiltration and in reverse, through capillarity. Equally important are the physical properties of the store rocks, the behaviour of the rock and the physical and chemical processes, taking place in the presence of water – all of which represent conditioning factors for the genetic characteristics passed on subsequently to the underground water.

In the current paper our goal is to present the major geological factors which contribute to or restrict the evolution of underground water in the Secaşul Mare basin.

The structural and lithological characteristics of the Secaşul Mare basin

In order to properly and correctly perform a geological analysis and to integrate the forming conditions of the studied region, in the tectonic and lithological background of southern Transylvania, our analysis is done in correlation to the regional context and is related to an area greater than the one within the limits of the hydrographic basin of Secaşul Mare.

The hydrographic basin of Secaşul Mare represents a geographic space of geological and geomorphological interference, in which the elements of the landform interact and are interdependent with the anthropic element, conditioning each other. It is from this interference that a complex of relations emerges, which individualizes and personalizes the hydrographic basin among the landform units partially entering its limits: the Cindrel Mountains in the south, the Sebeş – Apold depressionary passage in the center and the Secaşelor Plateau in the northern part of the basin (Costea 2006).

The genesis and evolution of the Secaşul Mare Basin have permanently been conditioned by its geographical overlapping an interference zone of two areas with diverse genetic and evolutionary tendencies: subsiding and accumulation in the Transylvanian Basin, while on the other hand – rising and erosion in the Cindrel Mountains. From a geologic point of view, the Secaşelor Plateau, the Apoldu Depression and the contact Depression Sebeş – Alba Iulia represent sub – units of the Transylvanian Depression, situated at its contact with the mountain ridge of the Southern Carpathians (Carpaţii Meridionali) and of the Western Mountains (Munţii Apuseni). The former came to be as a result of the following two phases: the basin phase – in which the Transylvanian Depression was formed and sedimented, and the sub aerial modelling phase – in which the landform of the Apoldu Passage and of the limitrophe areas is defined, evolving into the current general line (Sandu 1998, Ciobanu 2002).

The foundation of the region in the south – west of the Transylvanian Depression, a region upon which the Secaşul Mare Basin overlaps, is crystalline – Mesozoic, made up of: green sericite - calcarous schists, with quartz lenses, quartzites, paragneiss with muscovite and biotite and micaceous quartzite schists with granites. The pre – Laramie sediments [1] were deposited over the crystalline itself, which is covering the fundament and which date from Mesozoic times, belonging to two cycles: a Permian – Triassic one and a Lower Jurassic – Cretaceous one. The oldest sedimentary deposits belong to the Lower Permian[2] and can be encountered only in the eastern part of the Transylvanian Depression, while in the south - western part these such deposits are lacking.

The Triassic deposits are located along the regional Alba Iulia – Şeica Mare fault and are represented by: dolomite, calcareous marl, limestone and reddish conglomerate. This facies is also present on the southern side, at the contact point with the Sebeş Mountains, therefore appearing similar to the Triassic series of the "Codru" Domain (Ilie 1958). Following the deposit of the Transylvanian

[1]The pre-laramie sedimentary and the crystalline schists form the crystalline – Mesozoic foundation.

[2]Based on a paleontological approach, only the presence of the Aptian and of the Senonian were identified, but the geognostic approach reveals that the pre-laramie sediment includes also Permian deposits: breccia and conglomerates with crystalline schists elements.

Depression in Triassic, an exondation took place, lasting until the Lower Jurassic. In the Middle and Superior Jurassic, massive calcareous conglomerate were then deposited, along with greyish blackish or pink limestone and coralline limestone. The Lower Cretaceous is represented by Barremian – Aptian deposits (grey compact marl, blackish marl, reddish brown clay with gritstone intercalations, *Orbitolina lenticularis* limestone) and albian deposits (greyish – yellowish compact limestone, grit marl, greyish hard gritstone, greyish – greenish conglomerates, compact tectonic marl).

The proper sedimentary deposits of the Transylvanian Depression and of the south – western part of the depression belong to the sedimentation cycles, starting from Upper Cretaceous and until Quaternary, with certain stratigraphic lacunas due to the exondation suffered by the Transylvanian Block (Fig.1).

The Upper Cretaceous is present in the south – western part of the Transylvanian Depression in Senonian, Cenomanian and Vraconnian deposits. To the south of Sebeş-Alba, the Senonian lies transgressively over the crystalline: at the bottom of the deposits there is clay and greyish micaceous gritstone, with sand and light cemented grovel intercalations and small conglomerates, followed by rough micaceous sand, gritstone, conglomerates and greyish – greenish marls. The complex also contains coal lenses and sulphur efflorescence. The series is wrapped up by massive polygenic conglomerates, with rolled up quartzite elements, micaschists, gneiss and seldom crystalline blocks, whose diameter does not reach higher than 0.5 m. In the Cacova-Săsciori area, on the touch point line of the Sebeş-Alba Iulia Depression with the Şureanu and Cindrel Mountains, the cretaceous deposits reach the surface (Ciupagea *et al*. 1970).

The Cenomanian and the Vraconnian are present on the southern part of the Secaşul Mare basin, on the Poiana Sibiului – Rod – Apoldu de Sus alignment through: rough calcareous – micaceous gritstone with thin intercalations of greysh marls with foraminiferae, marly - limestone, light cemented gritstone. Towards the north of the Secaş hydrographical basin, the upper Cretaceous is to be found in flysch facies and the Cretaceous deposits outcrop, in the Gosau facies, on a 1,300 m wide area, similar to the one from Săsciori.

The Paleogene rises transgressively over the Upper Cretaceous and the crystalline. The Transylvanian Basin started to evolve as an inter – mountain accumulation basin towards the end of the Cretaceous, after the finalization of the Laramie climax. The basin was not unitary; emerging areas carried on evolving (towards the centre and eastern part of the depression, the Miocene deposits lay directly on top of the crystalline), and areas where sunken Paleogene deposits are present (the early accumulation basins). The deposits are marked by great facies and thickness variations, due to the Laramie and post – Laramie movements, which have influenced the sedimentation. The Paleogene is represented by Eocene and Oligocene deposits.

The Eocene appears transgressively in the Sebeş-Alba Iulia area over the Upper Cretaceous and is made up of gritstone, conglomerates, marl and clay with thin intercalations of organogenetic limestone with nummulites. The Eocene reaches 100 – 870 m in thickness in the Secaşelor Plateau and is represented by deposits of: reddish clay at the bottom, followed towards the upper level by grit limestone with nummulites, of the Porceşti type.

The Oligocene appears in the Alba Iulia area in: siliceous sands, fosiliferous gritstone and bituminous limestone. During the Eocene and Oligocene sedimentation, the Transylvanian Depression was continuously connected to the northern part of the Pannonian and of the Maramureş Basin. The Oligocene sedimentation phase was followed by an exondation and erosion phase, thus resulting in the absence of the Oligocene deposits from the higher areas of the Secaşelor Plateau.

Towards the southern and south – western part, the connection with the Pannonian Basin was interrupted ever since the Oligocene, when the exondation was stopped by strong erosion, thus making it possible for the Cretaceous deposits in the Sebeşului area to reach the surface.

The Lower Miocene is represented by deposits from the Aquitanian – Burdigalian stage. The Aquitanian deposits from the Sebeş-Alba Iulia are transgressively lying over the Cretaceous deposits in the eastern site of the Apuseni Mountains, or in patches over the Eocene deposits. The Burdigalian is present in gritstone with *Operculina* (Ciupagea *et al*. 1970) in the Alba Iulia – Sebeş region, on Secaşul Mare Valley and on its tributary streams on the right and transgressive gritstone over the red Aquintanian complex. The Helvetian emerges especially in the slopes of the Secaşelor Plateau, through a clayey marls complex with gritstone intercalations, sand and seldom, with gravel. Towards the north of Sebeş, Râpa Roşie, is an opening in the slope, highlighting an alternation of

grovel with rolled up quartzite of different colours, micaschists, diabase, porphyrite, jasper with red and white quartzite sand, brick – coloured and greenish clay (Fig. 2). By cementation, they developed a conglomerate appearance. The age of these deposits has been intensely discussed: Paucă (1971) attributes them to the Tortonian, while Mutihac (1990) is of the opinion that they belong to the Aquitanian.

The *Upper Miocene* deposits (*Badenian – Buglovian - Sarmatian*) are characterized by an extremely rich and varied fauna, similarly to the Sub Carpathian deposits of the same age; from the point of view of the succession, namely: tuff horizon at the bottom, salt horizon, schists horizon with radiolarians, marl upper horizon with *Spiralis*.

Towards the south – west of the Transylvanian Depression the dacite tuff horizon is replaced by the tuffaceous marls complex with *Globigerine*, with dacite tuff intercalations and calcareous marls. In the Alba Iulia – Sebeş zone, a conglomerate horizon of about 5 m in thickness was located under the horizon of this tuffaceous marls, and which was made up of calks elements with nummulites (the Porceşti calk) and of crystalline rocks (Ciupagea *et al*. 1970).

The salt horizon is very well developed towards the north and east of the hydrographical basin of the Secaşul Mare (Ocna Mureş, Ocna Sibiului) with variable thickness, which would later on become unnoticeable in the Miercurea Sibiului – Daia Română area, with no exploitation possibilities. Its presence is pointed out at the surface by the "salty water" springs (the springs from Miercurea Băi and the Slatina spring to the north of Daia Română). On top of the salt horizon there lie the Badenian deposits, which in the Sebeş – Apoldu de Sus area are transgressive and take the form of patches over the Upper Cretaceous ones, and even over the crystalline schists in the Cindrel Mountains. The Badenian patches are represented by tuffs and tuffaceous marls, blackish marls with gypsum efflorescence (Fig. 4). One notices the ever higher development of the Badenian in lagoon facies. There are lagoon deposits present, made up of gypsum, salty marls, salty springs (Ilie 1955), as well as in the constant debit and high salt level in the fountains.

To be noticed also the Badenian in reef coast facies, under the form of isolated limestone blocks, from Apold and Rod, as well as the shallow neritic facies (white greyish marls with *Globigerine*), accompanying the Aquitanian from Alba Iulia and the crystalline on the mountain edges. Likewise, in the Bişbocuț steep from Daia Română, there are brownish clays with sulfur and gypsum efflorescence and with yellowish – whitish sand intercalations, while at Cut there are greyish blackish marls.

This have a local spread in the Secaşul Mare basin, especially on the Slatina Valley (toponym indicating the presence of the salty horizons) and at Miercurea Sibiului, where the salt manifestations appear in the axle of several anticlines. Furthermore, there are salty efflorescence also at Apoldu de Jos, in the openings on the southern slope of the Potca hill (Fig.4), where there is also vegetation pointing towards this fact, composed of halophytic plants: *Salsola, Salicornia* and *Tamarix.* These efflorescences can be the result of a certain gradual thinning of the salt lenses from the Ocna Sibiului mountain or they can also be due to an intense capillary circulation of the water from the substratum, which ends up dissolving the salt from the salty lenses and then, as a result of intense evaporation, to be deposited under the form of an efflorescence on the stratified surfaces[3].

The Sarmatian emerges in the Sebeş – Apoldu de Sus area in Volhynian and Bessarabian deposits of marls and clays, with grit stone and sand intercalations. To the south of Miercurea Sibiului, as well as in the Dobârca – Câlnic area, the Sarmatian appears transgressively over the crystalline (Fig.1, 3), over the Senonian or over the Badenian, within conglomerate sandy facies, with marl intercalations. The Sarmatian sediments display various concretions, cuasi-spherical or ovoidal connected by limy cement, within the slightly cemented sand horizon (Vancea 1960). These deposits were brought to the light at Răhău, Reciu, Gârbova, Dobârca and Apoldu de Sus, and are covered by Pannonian deposits Apold. We are referring here to the fossil site on the Câlnicului Valley to the east of the fortress (grey and greyish – yellow sand, grey micaceous marl) and on the Dobârca Valley, to the north of the settlement (yellowish – grey sand), with a matching fauna, composed of *Ervilia, Cardium, Piranella etc.*

[3]The concretions are present in all the areas where there are saliferous horizons. One believes that the tectonic movements of minor scale, due to the movement of salt towards the surface, determine the modification of the passing direction of carbonated water through sand, thus resulting, by means of cementation, certain unusual forms – the trovants.

The Pliocene[4] is present in the area in the fossil sites of the Pontian (in the Miercurea Sibiului area, at Cunța and Șpring), which is highlighted in the Secaşelor Plateau, in the Arini ravine from Daia (micaceous sand, sand with clay intercalations, greyish or yellowish clay deposited in a torrential structure), as well as at the bottom of the Ghirbomului Hill, also at Daia, in an opening caused by a torrential organism (grey blackish clay), in which a *Melanopsis* and *Congeria* fauna was identified. Pontian deposits were also identified at Cunța (gravels with quartzite elements and greyish - violet marls with organic traces of *Limnocardium, Congeria* and *Melanopsis*), at Șpring (thoroughly rolled quartzite grovels with clay, sand and marls containing traces of *Congeria*), at Miercurea Sibiului on Morii Hill (grovels caught in a mass of ferruginous sands with traces of *Limnocardium, Congeria* and *Valenciennius*).

At the bottom of the Apold Depression, the Pontian deposits are further crumbled, so that at Apold and Sângătin one comes across fine grovel and white micaceous and ferruginous sand, displayed in a torrential structure. There is small gravel with sandy cement, with clay and grey marl enclaves, with ferruginous alterations, at Apoldu de Sus, on the Rod spring, transgressively over the sandy Sarmatian. The marl deposits are covered with a complex layer of gravel, with crystalline schists and quartzite elements, alternating with sand (Ilie 1955, Ciupagea *et al.* 1970).

The Quaternary deposits are of significant thickness in the touch point area, cross by Secaş and by its left side tributaries. [5] These are represented by sand and slightly rolled grovel, located in the glacis, terraces and river beds of the Sebeş and Secaşul Mare rivers, thus forming permeable strata with spring lines at the bottom of glacis and of the front parts of the terraces.

The morpho – tectonics of this sector completes the lithological and structural picture. Thus, the following anticline structures, on the north – east and south – west general orientation and with small variations from this direction, were identified by Dumitru (1992), quoted by Raboca (1995): the Daia Română anticline (Sarmatian and Pliocene deposits), the Slatina anticline, following the course of the Slatina Valley (Sarmatian deposits with salt occurrences), the Sebeş anticline (lower Miocene, Badenian and Sarmatian) and the Miercurea Băi – Doştat anticline (Pliocene deposits with salt occurrences). The orientation of the anticline structures generally follows the morphology of the landform, with their aksum being overlapped on the valley aisles, except for the Doştat – Sângătin – Miercurea anticline, which is not adapted to the morphology of the landform. These structures include synclines and are both part of the virgation folding system, located between Mureşului Valley, Cindrel Mountains and the Ohaba – Ocna Sibiului anticline (Ilie 1955, Ciupagea *et al.* 1970, Raboca 1995).

To sum up, the lithological formation and palaeo – geographic evolution of the Sebeş basin stand proof to a series of tight connections between the depressionary unit and the Carpathian mountain unit neighbouring the basin and occurring from Paleogene and until present day.

Hydrogeological aspects of the reservoir rocks

The existence and evolution of the water resources is connected to the water behaviour within the rock, to the processes taking place in the presence of water and depending on their formation or later on

[4] The latest research in the field reveal that only the Dacian and the Romanian belong to the Pliocene (Mutihac 1990) while the Meotian and the Pontian belong to superior Miocene, these levels being transgressively and not harmoniously located over the Sarmatian. In the southern part of the Transylvanian Basin, within the studied area, the Meotian was not identified, and Huică and his collab. (1972) pointed aut that the lower part of the Pannonian can be labelled with the superior Bessarabian, the Kersonian and the Meotion from the Euxino-Caspic basin, while the superior part can be labelled with the extra – carpathian Pontian.
Lubenescu (1977) pointed out that the Pannonian occupies the south – western part of the Transylvanian Basin, lying transgressively and unharmoniously on the sarmatian and badenian deposits, or even on the crystalline. This particular distribution can be noticed on the geological map (1: 200 000, ed. 1978), in the presence of the Pannonian in the western part of the Secaşul Mare basin, both to the north, as well as to the south of the hydrographic artery, being represented by thick packs of yellowish sands, alternating thinner clay and marl horizons, visible in the openings from Miercurea Sibiului, the Gorganu Drașov hill, at Sângătin, Ludoș and Doştat. Posea (2002) finds the Pannonian to be equivalent with the Pontian, while Mutihac (1990) notices that there is no Pannonian in the Transylvanian Depression.

[5] Downstrem, these rivers developed an orientation contrary to the Mureș mainstream. This orientation is due to a small block within the fundament having sunk in the area corresponding marginal threshold to the north – western part of Sebeş.

gained characteristics. Within the rocks, water is under the action of two universal forces – the *gravitational* force, under whose action water moves downwards, and the *molecular* attraction taking place between the molecules of the mineral (as component of a rock). The rock – water complex is under the influence of these forces, which impact both the flow of the water through the rocks, as well as their physical – mechanical characteristics.

According to the nature of the forces taking place between water and the mineral, the water can be *connected* or *free*. The quantitative existence and evolution of the chemically and physically *connected water* therefore depends on the mineralogical composition of the rock, on the environment conditions (endogenous – temperature, pressure and exogenous – the infiltration water). Within the analyzed area, We can notice that in the category of the physically connected water, the hygroscopic water has a decisive importance in inducing terrain degradation due to gravitational processes, such as the sliding. Thus, the quantity of hygroscopic water retained at the surface of the particles is of 10% for clay and of only 2% for sand. The quantity of connected water from the surface of the particles of clay depends on: the mineralogical composition, the cementation degree of the rock (the dispersion of the mineral granules), the presence of soluble salts in the water. Given the increase of humidity, the areas with clay deposits are considered to be "sensitive deposits", since the hygroscopic water covers the particles completely, thus slightly crossing into a plastic state (Ciocârdel 1957).

The unconnected (free) water is the water which is maintained in deposits, respectively in the rocks due to the gravitational and capillary forces. The movement of the gravitational water is done through the sub- capillary pores, cracks, fractures, while the capillarity is conditioned by the reduced dimensions of the pores and of the solid particles[6] Therefore, if the presence of the gravitational water and of the hydrodynamic processes connected to it is conditioned by the tectonic and geological structures, as far as the capillary water is concerned, the primary geological structures connected to the genesis of the rocks play a determinant role.

The hydrogeological characteristics of the aquifer strata depend, first of all, on the structure and texture of the reservoir rocks. Thus, in the Secaşul Mare basin, there are two types of rocks which can store water: rocks with pores/ interstitial and cracked rocks. The interstitial rocks are the sedimentary detritus and light cemented rocks, with granule of very varied forms and dimensions, closing within small gaps in the shape of pores, which can be occupied by water and gas, especially in the plateau side. The cracked rocks are the compact rocks developed in the southern part of the basin, hard and cracked, in which the most important gaps are connected to the presence of the open cracks.

Regarding the permeability, the rocks from the geologic substratum of the basin are both *permeable* (the porous rocks – sand, grovel, marl and those which are genetically impermeable but once cracked, become permeable) and *impermeable* (clay, clayey schists, marl, un – cracked metamorphic rocks, compact limestone, residual deposits, etc.) (Băncilă *et al.* 1980). The water circulation is enabled by the gravity force, by the capillarity, but also by the horizontal transmissibility. Water circulates through the cracks, by the separation sides of the strata to the plateau monocline structure (stratification level), on the separation levels between the crystalline fundament and the sedimentary cover (the Câlnic basin, Garbova, where the crystalline is very close to the surface or even outcrop at the surface). As for the deposits with fine granulation, the circulation of the water is done through the pores, which can communicate to each other, being in such close proximity.

The circulation of underground water within the rock is done first and foremost through the pores. The volume of the pores related to the volume of the rock is expressed by the quantifiable physical measure of the *porosity* (Zamfirescu 1997). The value of the porosity varies a lot for the different rock categories, as well as within the same category (Tab. 1).

The development of the underground water sources is directly dependent upon the character of the infiltration. In Secaşului Mare Basin, the geological factors – the structure and the lithology – are among the most important factors determining the character of the water infiltration in the alteration cover. The most permeable deposits are the quaternary ones, made up of the superficial sediments of macro – porous or cracked sand and grovel, which have a high capacity to

[6] By experimental means, we discovered the following capillar heights for different types of rocks: sand 0.1-0.5 m; loess 2-50 m; lutite rock 5-15 m; clay 20 and even over 50 m.

retain water and ensure the optimal conditions for infiltration. The Pliocene clay, the clay deposits, Sarmatian and Badenian marl deposits are limiting the infiltration process, therefore decreasing the contribution of surface water. The alternation of these deposits with sand, conglomerates, fine grovel lenses, etc. and the stratification both bring and extra permeability, as a result either of the infiltration in the stratification levels, or of the lack of rock homogeneity.

As a result, the macro – porous or cracked rocks foster the development of underground water resources, due to the increase of the infiltration water, such as the cracked limestone from the south – western part of the basin, the detritus un – cemented rocks, like the sand, gravel or cemented – such as the marl, the conglomerates, etc. which are to be found particularly in the Apoldu Depression and the piedmont hills. On the other hand, the water repellent rocks, the water repellent rocks are compact and without cracks, preventing the infiltration process: the clay, predominant in the plateau sector, the compact metamorphic rocks, in the shape of blocks, from the southern extremity of the basin, etc. (Fig.1).

Underground water resources in the Secaşului Mare basin

The distribution and characteristics of the underground water reserves are subject to the current relations between the alimentation through rainfall, infiltration, surface and underground leakage, the petrographic nature and the structure (*the geological location* - Romanescu 2003), differentiated by the two sectors of the basin: the sub - mountain sector and the plateau sector (Fig. 5).

In the southern part of the Secaşul Mare basin, which is taking the lower level of the Cindrel Mountains and the sub - mountain hills at their bottom, the underground water appears in the form an aquifer complex, whose formation is conditioned by the type of rock. In the Rod basin, the **aquifer complex of the metamorphic rocks** (crystalline schists, mica schists, micaceous gneiss, etc.) has the highest percentage (Trufaş 1978; Trufaş, Ştef 1998). These rocks are part of the Getic Nape and are practically impermeable, however, the complex system of faults, cracks and schist planes, some of which are open and unclogged, of clayey material, allowing the infiltration and the underground gravitational circulation of snow and rainfall.

The epimorphic complexes situated on the northern part of the Cindrel Mountains (at the touch point with the Apoldu Depression) have, generally, the same characteristics, except for certain areas reduced in surface, situated in the south – western part of the Secaşul Mare basin, which is dominated by limestone and gritstones. Thus, in the Săsciori – Piatra Varului - Sebeşel - Petreşti sector, the **calcarous - gritstone aquifer complex**, which was formed due to infiltration on the diaclase lines and on the stratification planes of water coming from rainfall and from snow melting, according to a permeability coefficient of 0,2 – 0,5 m/day (I.S.P.H. 1998). The hydrogeological importance of these deposits is limited, and the accumulation possibility for large volumes of underground water is low. The hydrologic regime of the springs is conditioned by the rainfall regime, most of the appearances being situated at the touchpoint of the geologic elements and having a low debit: 0,1 – 0,2 l/s. the diluvia, the coluvia and the proluvia formed as a result to the rock alteration have a high permeability coefficient (20–25 m/day) and allow the quartering and swift circulation of the sheets and lenses of phreatic water, which is supplying the springs.

In the Apoldu Depression, the phreatic water appears in the form of continuous sheet in the **river meadow** of Secaşul Mare and its affluents, the **alluvial deposits** and discontinuously **in the terrace deposits.** In the river meadows, the level of the phreatic water is close to the surface (0,50 m), thus resulting under light drainage into swamp areas. The direct or indirect tributaries of Secaşul Mare fragment the glacis and the terraces, thus revealing, by means of erosion the ground water from the aquifer horizons. The thickness of the phreatic strata differs according to the local conditions: the inclination angle of the strata, the report to the hydrographic surface arteries, the volume of water carried by the rivers, the length of the course upstream, the climatic conditions, etc. the level oscillations of the grounds water from the southern part of the Secaşul Mare Basin are under the direct incidence of the pluvial and pluvio – nivale alimentation regime, with significant increases of the level due to the meltdown of snow and heavy rainfall (during spring time) and an inward withdrawal in the summer and autumn months.

At the northern border of the Cindrel Mountains there lies the **aquifer complex of the piedmont deposits**, with aquifer strata captive at depths of 10 – 15 m, with a basic pH (7,4) and a yellowish

colour, highlighted in the drinkable water springs on the Câlnic – Dobârca direction (Trufaş, Ştef 1992). The petrographic constitution is given by gravel and blocks of rocks of large dimensions, encompassed in a sandy and clay – sandy composition, with a high permeability. The permeability coefficient of the alluvial deposits on the Rod and Poienii Valley was registered at 300 – 400 m/ day (I.S.P.H. 1998), while the hydrostatic level of ground water was identified of the delluvio – proluvial deposits at depths of over 4 m.

The hydrogeological characteristics are completely different in the hills in comparison to those from the plateau, due to the geological constitution, formed of sedimentary rocks: marl, clay, gravel and sand. The Secaş Plateau is over all lacking underground water reserves and has a few accumulations in a **clayey marls aquifer complex**, with waters manifesting upwards, in an artesian form. These belong to the monocline marginal sub - unit of the Transylvanian Depression (the peripheral monocline, Ujvari 1972) and can be characterized by strong mineralisations and hydrocarbon content (Geografia României, vol. I, 1983). The drillings done by C.Z.M.H. Sibiu (1970) do not indicate the presence of significant aquifer deposits. The petrographic constitution, mainly clay with a low infiltration coefficient concerning the saturation of clay, as well as the little rainfall in the plateau area (compared to the southern part of the basin) both create weak accumulation conditions for underground water in the Badenian, Sarmatian and Pliocene deposits; the only exception is the Quaternary deposits.

Compared to the sub – mountain frame to the Secaşul Mare Basin the density of the plateau springs is further reduced. Their debits are conditioned by the regime of the rainfall and the impermeability of the saturated clay. The reduced slope of the mountain sides from the discharge area of the springs confers them a swamp character. These springs are present between Sebeş and Daia Română (on the Slatina Valley), at Draşov, and at Miercurea Sibiului.

From a qualitative point of view, the natural waters always have several substances dissolved in them, even the rain water contains a solution of substances and gas (carbon dioxide and oxygen). The dissolved substances, especially the gases, increase its dissolution capacity. The chemical composition of subterranean water is fairly varied in the Secaşul Mare basin. The basic processes of the forming, of the evolution and of spreading the mineralisation of the waters in the geological substratum are governed by hydrogeological and hydrochemical laws. Changes in the waters chemical composition, of their quality depends mainly on the rocks lithology under the chemical substances and the substance exchange between the water – the universal dissolvent – and the parental rock. The direction of the chemical reactions, products of the diverse exogenous chemical processes, but especially of the endogenous ones, depends on the other environmental conditions.

The subterranean waters have a poor quality in the plateau, as a result of the high mineralisation and of the rich NaCl content, caused by the washing of salty horizons on the edges of the diapir structures laid on the Ocna Mureş – Miercurea Sibiului - Ocna Sibiului direction. The emerging springs brought up by erosion in the cuesta of the Secaş Plateau have low debits (0,2 l/s) and are frequently salted. Marosi (1980), points out that in the axial area of the Daia Română – Ocna Sibiului anticline, the tortonian deposits, rich in salt, almost reach the surface and influence the salinity and the type of mineralisation of underground waters. The same author points out, based on several chemical analyses of the drilling waters and of the studies done in this area by Vancea (1960), that contrary to the cholorosodic waters on Daia Valley, which are "simple levigation waters of the tortonian salt (M tot. = 18,1 – 36,7 g/l), the shallow drilling water and those captured in the basins from Miercurea Sibiului (M tot. = 19,3 – 40,2 g/l, type Cl – Na) have a relatively high content of Ca^{++}, Br^{-}, I^{-} and NH_4^{+}, which indicates the mixture of tortonian levigation water with the waters of the Miocene deposits, or even the predominance of the fossil waters components in the hydro – chemical total of these waters. The few methane gas traces, identified in the superficial capture points of the respective water, also plead in favour of the mixed genesis". According to the chemical composition, one will find in the Secaşul Mare Basin ferruginous, sulphate, bicarbonate and sodic waters at Vingard [7], sodic chlorate water at Daia, Miercurea Sibiului and sodic chlorate water enriched with other chemical elements at Cunţa and Cut (Preda, Marosi 1971; Pricăjan 1985). The presence of gas-bearing deposits in the substratum is signaled by the emanations which encounter

[7] The water has a low mineralisation (Mtot = 11,1 g/l), of pure sulphatic – sodium type, with a high level of Ca and Mg as a result of the presence of diagenetic gypsum and of the lack of upward alimentation of the horizons in the pannonian deposits by the tortonian water (Marosi 1980).

lenses of phreatic line in their way, pushing towards the surface. The latter soften the clay in they upward movement and contribute to the surface appearance of the Boz – Sarata basin muddy volcanoes.

The anthropic intervention in the Secaşul Mare basin, mainly by setting up the fish farming exploitations on the Daia valleys (Slatina and Boz) have had and keep on having a significant impact on the hydrogeological natural regime (Costea 2005, Ştef, Costea 2006). This impact can be seen in the following aspects identified based on the visual observations and on the information provided by the locals:

- the dynamics of the phreatic level in the slope and interfluve deposits in the vicinity of the accumulation lakes and from their area of influence, is conditioned by the rainfall regime and the downstream transfer;
- the oscillations of the ground water within the main river meadow of Secaşul Mare downstream from Daia and its alimentation are depend on the rainfall regime and on the variation of the debits of the hydrographic artery;
- the water storage in the accumulation lakes lead to: the reduction of the water flow downstream from the lakes, the decrease of the water level from the aquifer stratum and therefore to the decrease of the hydrostatic level with up to 1.5 m in the main river meadow and in its area of influence, especially at the bottom of the slopes;
- the water level in the fish – farming lakes on the Daia and Boz Valleys influences the dynamic of the ground water and its circulation in the slope deposits, as well as in the alluvial deposits form the merging upstream, through their permanent alimentation circuit from the lake;
- the decrease of the phreatic line can also be noticed in the plateau area, where the locals resorted to capturing the springs from the bottom of the slopes and building water accumulation basins – "troughs" – on the pastures and on the streets of the settlements;
- at the bottom of the depression there is also a direct hydrodynamic report between the ground water from the alluvial deposits and the hydrographic arteries, with rises of the piezometric level highlighted by the increased level of fountain water (1m) and by the basements touched by dampness; to all these, the water surplus from the rainy periods is to be added.

Conclusions

The hydrogeological analysis requires a fine tuning of the genetic and evolutionary aspects of underground water to the palaeogeographical evolution, as well as a permanent correlation to the geological elements of the studied region. The geological elements condition the evolution of the landform and its modulation, and therefore represent the key element of several hydrogeological inter conditioning relations, due to the typology of the aquifer deposits present within the landform elements. Given this context, the lithological diversity, the structure and the tectonics are all elements which explain the distribution and evolution of underground water; namely, the following aspects have been identified in the Secaşul Mare basin:

- the petrographic influence, to which the base level, triggering off the erosion - determined by the Transylvanian Depression, respectively by the Mureş Passage - are strong arguments for the morphogenetic shaping of underground water;

- the degree of mineralization, the chemistry of underground water depends on the physical – chemical characteristics of the rocks in the geological substratum;

- the physical properties of the rocks and the stratification manner, the slopes, the compactness, etc.- all determine the intensity of the hydrodynamic exchanges among the rock deposits, the aquifer and surface water;

- the petrographic differentiations are reflected in the landform at various levels storage levels of the underground water, which generate by association, a series of elementary or complex geomorphological processes at the surface, leading to the degradation of the fields (saltness, streaming, gorging, torrentiality, gravitational sliding);

- the previously described paleogeographical conditions have led to a deferential preservation of the landform elements and of the underground water resources: the level surfaces in the plateau, where the phreatic water is to be located at higher depths, the accentuated fragmentation and the springs discharge, permeable piedmont accumulations with significant aquifer resources, but also with active drainage, and the loss of underground water due to the increased infiltration enabled by the friability of the rocks;

- the geological element influences the sliding of the slopes (we quote slope figures between 15 – 75 degrees on the monocline structure) and the

emergence of springs on cuesta fronts or on structural surfaces;

- the hardness, the compactness and high impermeability of the rocks in the Carpathian area explain the low presence of underground water, while the high porosity and low permeability of clay on the lower part of the basin explain the intense dynamic of underground water in the plateau region, which, when associated with thermic processes and lack of rainfall in the drought years, leads to the decrease of underground water resources;

- the geological elements (due to the impermeability of the saturated clay) reduce the infiltration and increase the surface leakage, as well as the accumulation of significant debits, which enables the utilization of the hydrographic network in the plateau for piscatorial purposes, through the setting up of ponds.

Regarding the mineralization, underground water reflects, from a chemical point of view, the entire geological evolution of a certain structural unit. The passing of the minerals from the rocks, by means of levigation (partially) and/or the dissolution, are due not only to the chemical composition of the mineral, but also to several complex chemical processes taking place at the ion level. Any form of natural water – rainfall water, surface or underground water all contain chemical substances, some of which are harmful to humans or any other life forms.

The modification of water chemistry might be due to the dissolution phenomena undergone by minerals and rocks when in contact with water, as well as to the anthropic pollution. The chemical processes taking place at the water – rock contact cannot be controlled, are complicated and often unknown. For example, a significant percentage of the water used for irrigations dissolves the chemical manure from the soil and by means of infiltration it can then reach the rocks, leading later on to unpredictable chemical reactions, rarely beneficial for the quality of the phreatic water. Therefore a permanent monitorization of the quality of underground water, especially of the water utilized in agriculture, fish-farming, households and consumption, is more than necessary.

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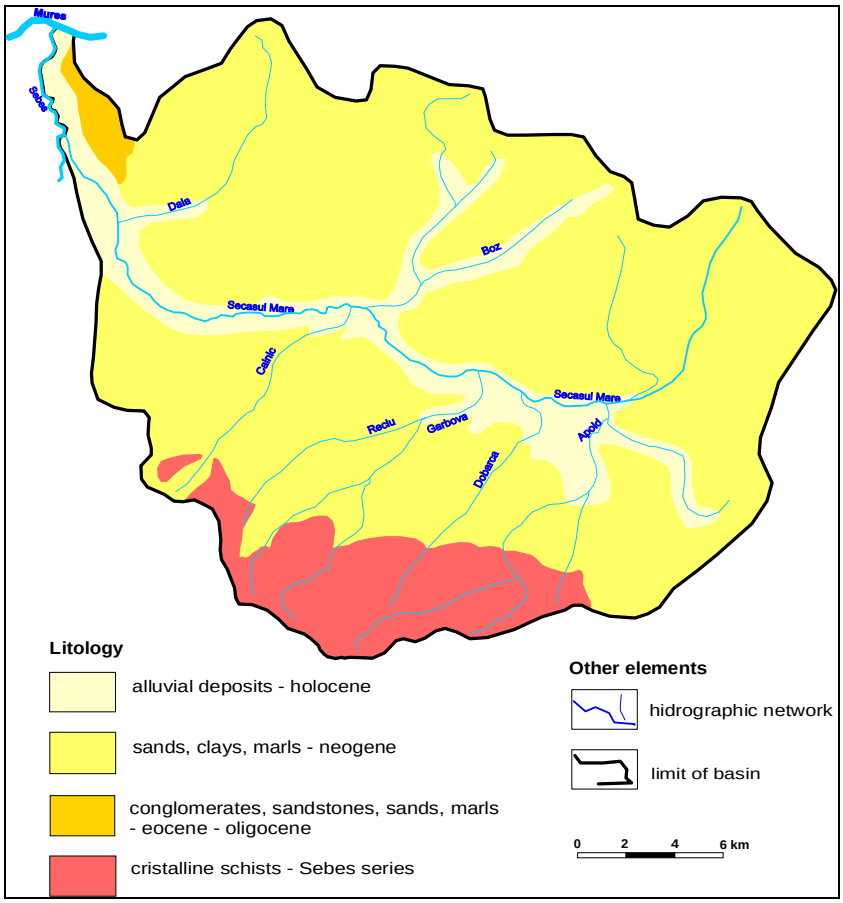

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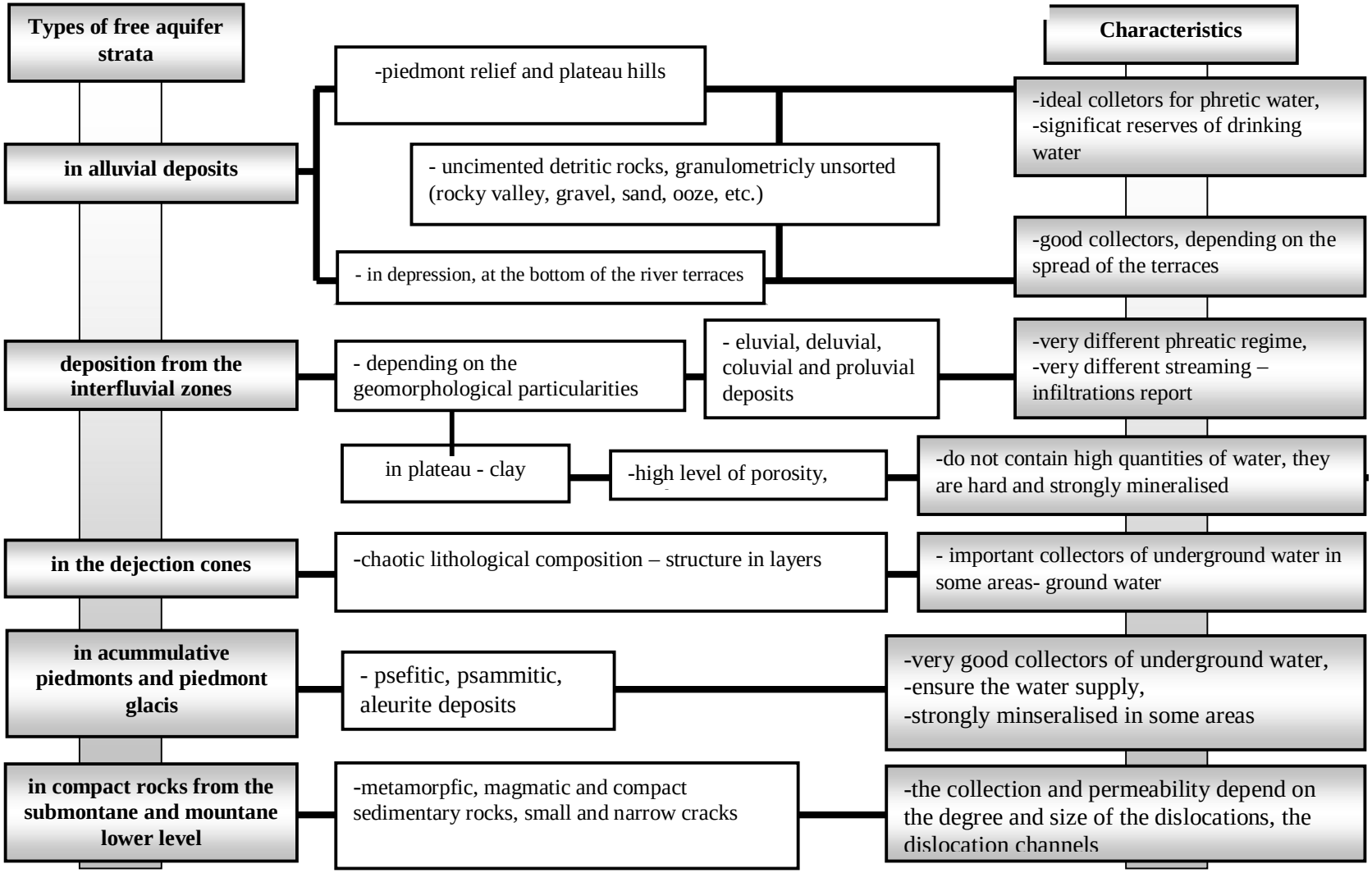

Tab. 1 The variation of porosity depending on the type of rock

Type of rock/ soil	**Observations**	**P%**
Soil	The porosity depends on the soil components.	30-50
Clay	*Very porous* rocks, made up of small particles, with very numerous spaces between them, but so small that the capillary forces retain the water which can no longer flow around the rock – *very low permeability*	10-50
Sand	The porosity varies to a great extent, according to the purity and cementation level, namely: -uncemented sands – with the highest porosity (30-33%), - the particle content from clay decreases the porosity by 18-24%, - cemented sands – the porosity decreases down to 3-10%.	18-47
Grovel	High porosity increasing by the size of the size of the granules.	
Sandstone	The porosity of the gritstones depends on the nature of the cement (its resistance to the action of the water), of the matrix and of the structure, if they are part of strongly tectonic structures, the splitting degree is high and increases the porosity.	5-15
Limestone	They are not porous rocks, but the tearing discontinuities such as the lithoclases increase the permeability of the rocks.	2,5-20
Quartzite	The finely grained rocks with a low porosity; generally, the alteration of the silicates contributes to the increase of porosity.	0,5-1

MORPHOLOGICAL AND HYDROLOGICAL DYSFUNCTIONS IN THE URBAN SPACE OF SIBIU MUNICIPALITY

Marioara COSTEA*

***Abstract**: This paper emphasizes current dysfunctions of the urban system deriving from the relation between geological substrate-morphodynamic-hydrological processes and proposes a set of geographical space optimization solutions. Extant imbalances are caused by natural factors whose action is intensified by the anthropogenic factor framework. The geospatial arguments were presented with the purpose of advancing an urban development strategy for Sibiu Muncipality through the General Urban Plan 2009. Within this framework, we propose a set of measures for the prevention and reduction of the natural dysfunctions, geomorphologic and hydrological in the Sibiu area in order to capitalize in a balanced and durable manner its natural potential. These may be diminished by ensuring the appropriate exploitation of the geographical space, through a set of constant development and hydro-amelioration activities and controlled urban expansion.*
***Key words:** geomorphologic and hydrological dysfunctions, urban space, Sibiu.*

***Rezumat: Disfuncţionalităţi geomorfologice şi hidrologice în spaţiul urban al municipiului Sibiu.** Prin lucrarea de faţă urmărim evidenţierea disfuncţiilor actuale ale sistemului urban care derivă din relaţia substrat geologic – morfodinamică – procese hidrologice şi să propunem unele soluţii de optimizare a spaţiului geografic. Dezechilibrele existente la momentul actual sunt cauzate de factori naturali a căror acţiune este accentuată pe un fond puternic antropizat. Evidenţierea unor argumente geo-spaţiale temeinic fundamentate s-a realizat în vederea elaborării strategiei de dezvoltare urbană a municipiului Sibiu prin PUG 2009. În acest context propunem unele măsuri de prevenire şi diminuare a disfuncţionalităţilor naturale - geomorfologice şi hidrologice de pe teritoriul municipiului Sibiu, în vederea unei valorificări echilibrate şi durabile a potenţialului natural. Acestea pot fi diminuate în condiţiile unei exploatări corecte a spaţiului geografic, în condiţiile unor lucrări susţinute de amenajare şi hidroameliorare şi a expansiunii edilitare controlate.*
***Cuvinte cheie:** disfuncţionalităţi geomorfologice şi hidrologice, spaţiu urban, Sibiu.*

Introduction

The geographical space situated between the administrative limits of the Sibiu Municipality is a highly modified by human action; it is mainly stable, but there are areas characterized by slope imbalance and intensive exploitation. The anthropic transformations on the Sibiu Municipality administrative area have been gradual and in connection with key moments in Sibiu's social and economic development. The human impact side-effects in the Sibiu depression were the transformation of morphometric and morphographic features of the landform through cutting, levelling or soil stripping uncovering and a major impact through the acceleration of geomorphologic processes in certain areas, which rendered those areas hazardous and increased their risk rate. (Costea, Gherasim, 2011, p.24).

* "Lucian Blaga" University of Sibiu, Faculty of Sciences, marioara_costea@yahoo.com

The hydrographic network was anthropically altered through rectification, embankment, exploitation of building materials from the riverbed, etc.), the vegetation (massive deforestation, occurrence of ruderal species, extinction of spontaneous species), the soils (change in productivity through liming, drainage etc.) as well as on the climate conditions (by creating complex and basic new topoclimates) (Costea 2002). The most representative dysfunctions are those in the geomorphologic and hydrologic system. They are intricately connected with the geological conditions and space utilization.

Lithologic and structural particularities

Sediment deposits in the analyzed perimeter belong to young structures, being represented by Miocene, Pliocene and Quaternary sediments, differing in terms of their degree of cementation,

consolidation, resistance to environmental factors. Pannonian deposits occupy most of the area and contain clays, loamy sands, and marl, with a very low degree of cementation. They come into contact with crystalline formations and crop out currently in Guşteriţa Hill and on the face of the Hârtibaciu Plateau cuesta (Ciobanu *et al*. 2010), whose eastern and north-eastern part fall within the administrative limits of Sibiu Municipality. The Quaternary deposits are the most recent and they cover almost entirely administrative territory. They are represented by terrace deposits and proluvial deposits (dejection cones) from Pleistocene and differ from one another in terms of their genesis, thickness, and granulometric structure (gravels), tending to form conglomerates (sands included in clay mass) covered by a layer of soil with variable thickness, as well as current alluvial deposits (Holocene gravels, sands, silts) very frequent in the meadows of Cibin River and its tributaries.

Dysfunctions caused by the lithological structure and their negative effects upon the urban habitat consist in the following aspects:

- damping and swelling f the clayish substrate affecting the internal balance of the substrate and predispose the Hârtibaciu Plateau slopes and the terrace faces of the Cibin River to gravitation processes such as landslides;
- the friability and weak cementation of the rocks facilitate surface pluviodenudation and erosion processes, with aggressive manifestations such as streaming, ravening and torrential processes, especially on the Guşteriţa Hill slopes or the faces of the Cibin River terraces (Ciobanu, 2002);
- the high quantity of clayish silts in the alluvial deposits of Cibin River and its tributaries and their impermeability cause the groundwater level to rise in river meadows, with certain permanent or temporary ponding;
- unconsolidated terrace and meadow sediment deposits, associated with hydro-climatic oscillations and the pressure of their weight or of the weight of the buildings above which, in time, cause gravitational re-settlement and suffusion which may have negative effects upon the structure of those buildings;
- the swollen clays which compose the deposits due to over-humidification and the contracting of those clays during droughty periods cause deep fissures in the soil and geological formations; these fissures are access ways, through infiltration, for meteoric waters during rainy periods, which may cause infiltrations and dampness to walls, in the basement of the buildings or even the flooding of some open, unprotected spaces. Moreover, the water accumulated as aquifer deposits between clayish surface deposits, through the capillarity of the soil, infiltrates in the walls causing dampness.

Geomorphologic potential and relief dynamic

The landforms in the Sibiu Municipality area are characterized by morphometric and morphologic features which disclose, on the one hand, the geological influence and on the other, the present-day modelling conditions. The morphology of the Sibiu Municipality and its peri-urban area belongs to the sub-mountain depression and plateau morphogenetic type, differentiated according to the landforms. At the level of the entire Sibiu Depression, but especially between the administrative limits of the Sibiu Municipality, there is a clear landform asymmetry imposed by Cibin River's tendency to shift position north and north-east; this fact is revealed by an altitudinal decrease on the right-side riverbank, as landform steps (sub-mountain hills, piedmonts, terraces, meadows) and on the left-side riverbank by the Hârtibaci Plateau gully, affected by gravitational processes (Costea 2007).
Altitudes, in the analyzed sector, fall between 400 m in the Cibin River meadow on the administrative limit with the Şelimbăr Commune and 639 m in South-East Hamba Hill on the Hârtibaci Plateau cuesta, the average altitude being over 450 m. The 400 m isohypse circumscribes the Cibin River meadow in this sector and insinuates at the basis of the structural steep of the plateau. The density of fragmentation is characterized by values between 0 – 0.5 km/km^2 in the Cibin River's meadow and terraces and up to 2 – 2,5 km/km^2 on the front of the Hârtibaciu Plateau cuesta and on the terrace front. The landform energy varies depending on the landform form, with values from 0 - 10 m at the level of the Cibin River's alluvial plain, up to 80 - 140 m at the contact between meadow and the face of the cuesta. The slopes have differentiated values on the analyzed sector, from minimum values of 0 – 3 - 5° at the level of the major bed of Cibin River and its tributaries and on terrace bridges, values of 10 -15 - 35° typical of terrace faces, structural steep and its basic glacis, up to values of over 60° in the perimeter of the clay quarries in the Guşteriţa Hill. (Costea, Gherasim, 2011, p.19). The most frequent slopes are those ranging from 10 to 30°, values which facilitate pluviodenudation processes and gravitational soil slips (Costea 2002).
The current dynamic of the landform is induced mainly by natural factors: the lithologic and structural contact between the crystalline of and the two mountain units and the sediment deposits

of the Hârtibaci Plateau, climate with oceanic influences as well as the action of autochthonous and allochthonous hydrographic network, on a foundation consisting of gravels, sands, marls, and clays, with harder nuclei. Predominant are slope processes caused by pluviodenudation: surface soil running, streaming, ravinement, torrentiality (Grecu 1992, 1996). The erosion, transport, accumulation processes succeed one another in the allochthonous valley of the Cibin River with high flows, which discharged huge quantities of materials as huge piedmont dejection cones - the Cibin River Piedmont and glacises, which were taken on by the autochthonous hydrographic network - Valea Aurie, Valea Săpunului, with variable flows, contributing to the fragmentation of these cumulative structures and to the degradation of the of inter-river surfaces and versants by the regressive retreat of the sources on rank I and II hydrographic basins (Costea 2007, Costea, Gherasim, 2011).

The argillaceous clay component of the terrace deposits is responsible for the presence of aquiferous layers close to the surface and for the water infiltration. On the terrace faces and at their base, especially in extravilan, there are areas with swamps and springs. The third terrace in the Poplaca Pasture, beyond the northern skirt of the Dumbrava forest, is divided by the ravines, gaps, and short or torrential valleys (Valea Urzicarilor), tributaries of the Cibin River upstream Turnişor. These fragment the front of the terrace and deepening through regressive erosion in the bridge of upper terrace. The front of the terrace which makes the connection with the Cibin River meadow is highly degraded (Costea *et al*. 2011) through geomorphologic processes such as landslides and torrential processes (Fig.1).

In the bed of the Cibin River and its right-side tributaries - the Trinkbach creek (Valea Aurie) and Valea Săpunului, in the meandering sectors we witness phenomena such as accumulation of convex riverbanks and erosion of concave riverbanks, the latter undermining slopes and facilitating landslides and collapsing). The meadow of the Cibin River is under the direct incidence of the water flow and versant processes in limitrophe areas (the plateau cuesta), where the most frequent phenomena are superficial slides, collapses, torrentially, ravinement, etc.

Thus, in the Turnişor upstream sector, some of the meanders of the drained Cibin River maintain their connection with the riverbed, taking some of the flow volume when the water level rises, but others are entirely or partially clogged and are not connected with the river anymore. During rainy periods, these meander loops (rings) may become lacustrine or swamp areas. Nevertheless, the creeks which fragment the Cibin River terraces in this sector feed the meander rings forming ponds and swamps which, given the low slope and the silty substrate, do not drain very easily, preserving dampness and facilitating the development of hydrophytic vegetation. In addition, these torrential organisms discharge dejection cones in the Cibin River meadow which push the thalweg of the Cibin River and redirect processes to the riverbed (Costea 2007).

In addition, in the sector between the confluence with the Rozbav River and the south-eastern limit of the incorporated area has relative altitudes of 1 – 1.5 m and the dynamic manifestations which are typical to the meadow landform are: bank erosion, alluvial accumulations, phreatic moistening, and gleying. The accumulation processes are more active in this sector because on the section upstream-downstream of Guşteriţa, the Cibin River receives torrential tributaries with sources in the plateau: Valea Fărmândoala, with its tributary Valea Nepindoala, Valea Pe Remeţi. These carry and deposit in the collector the solid materials resulted from fluvial-torrential erosion. The accumulations in the riverbed are located laterally as beaches fixed on the vegetation, or centrally as islets totally or partially fixed on the vegetation, such as those near the Guşteriţa bridge, or as submerged deposits downstream Guşteriţa. The bridge legs are obstacles for alluvial deposits and they gradually influence the formation of submerged or emerged deposits on the riverbed.

Morphodynamic natural factors are amplified by anthropic factors, their role in modelling the landforms being very complex, in connection with the amplitude and diversity of the activities performed (Posea *coord*. 1987). Such activities are: agricultural, pastoral, industrial activities, deforestation, river management activities, drainage, plantations, urban expansion and land development for social, economic or amusement activities. Geomorphologic processes have been increased because of deforestation (forests cover today only 20% of the areas previously occupied by forest vegetation) and they affect the depression area especially the piedmonts and structural steeps which delimit the administrative area of the Sibiu Municipality.

Today, the abandonment of agricultural land and the building of sheepfolds around streams or in the middle of a wide field in the northern part of the built-up area are the main causes of soil

degradation through nitrification, of surface erosion and the destruction of the grass. The orchards from Guşteriţa Hill have been mostly abandoned and thus the area is subjected to moderate degradation but the process might intensify in the long term. Anthropogenic terraces are modelled by current geomorphologic processes which are constantly intensifying and which are reducing land productivity.

Excavations performed through the extraction of clay for brick production in Guşteriţa Hill (Sibiu) or for the building of the belt highway (in the Şura Mare Hill) are the premises for versant undermining and intensification of processes such as streaming, ravinement, sliding and collapsing and versant degradation. The diluvial contribution due to gravitational processes causes versant agglomeration and the formation of a highly unstable sliding glacis. Moreover, the presence of thick clay layers and their intensive exploitation for industrial use or road construction explain the slopes morphodynamic and the amount of colluvial and proluvial deposits in the riverbeds which fragment the cuesta (the Nepindoala Creek, Valea Fărmândoala, Valea Pe Remeţi).

The road and railway traffic cause certain imbalances due to mechanical stress (such as subsidence, sliding, collapses), the destruction of riverbank protection where hydrographic arteries are accompanied or crossed by roads intensely used (crossing the Cibin River), the building of bridge legs (over the Cibin River and its tributaries) which operate as obstacles for the alluvial deposits (Cibin River, the Guşteriţa bridge), as well as the undersized bridges and footbridges which cross the hydrographic network and over which there is frequent intense traffic.

Hydrodynamic phenomena - induced dysfunctions

Territorial hydrological dysfunctions are caused by stationary (excess humidity) and active (high-water, freshets, flooding) hydrodynamic processes (Fig.1).

The underground waters located near the surface cause excess humidity especially in river meadows and in the alluvial plain north of Sibiu. The low slope and the substrate facilitate water retention and gleying in the alluvial plain of the Rozbavului River, Valea Popilor and Valea Hamba. Here and there, swamps and marshy pastures have appeared. The draining activities performed in the early 20th century, continued between 1956 and 1975, producing a dense network of channels in this sector, 1.5 to 2 m deep, which contributed to the drainage of this area and the lowering of the groundwater level. Once certain plots have been resituated to their owners as private property, drainage projects were abandoned. Most of these channels are currently clogged, some were used as garbage pits or debris dumping places, so that in this area, during rainy periods, there is excess humidity and the groundwater level rises (Ştef, Costea 2006).

Regarding the active hydrodynamic processes, when the flow volume is high the meadows of the Cibin River and of its tributaries are vulnerable to flooding and the obstacles in the riverbeds facilitate this phenomenon. The development works carried out on the River Cibin at Gura Râului have restricted these hazardous phenomena by regulating flows and reducing flash floods. However, downstream, the Cibin River receives tributaries which may cause imbalances in the Sibiu Municipality area, due to torrential precipitation and inappropriate use of land (Sandu 1998). Several areas on the Cibin River are exposed to flooding: the Cibin River meadow upstream Turnişor, where garbage and debris clog the major riverbed and increase hydrological risks, the Cibin River meadow in the Guşteriţa area - the river takes an almost 90^{o} changing its direction; thus, the junction with the Fărmândoala creek, the bridge and the obstruction of the flow by islets are major hydrological risk factors.

Even though the Trinkbach creek has been harnessed, sometimes certain estates in the area are flooded. These phenomena are sometimes caused by the fact that accumulations are not performed according to the established parameters, but especially by the fact that this creek has been streamlined, its bed has been concreted and is undersized. When there are flash floods, the water in the minor riverbed infiltrates in the basement of nearby houses in the covered sector.

In conclusion, hydrological risks in the Sibiu Municipality area may be avoided through an appropriate exploitation of existing reservoirs during rainy periods and only if hydroamelioration measures are taken.

Reducing geomorphologic imbalance

As it is described above, geomorphologic imbalance is caused by external agents whose action is accelerated given the favourable geological circumstances and current land use. There are many factors of degradation taking place randomly all over the sector (Grecu, Sandu 2000). The preservation of landform forms as a support for the urban structure and the

decrease in negative effects of current morphodynamic require that the following measures be taken:
- attenuating the intensity of linear and deep erosion in the small hydrographic basins of the Hârtibaci Plateau: Valea Fărmândoala, Valea Nepindoala, Valea Pe Remeţi, Valea Hamba and on the ravines and torrents which fragment the faces of the terraces in the Poplaca Pasture through hydrotechnical, forestry and agrotechnical operations so as to transform linear into non-linear flow;
- improving the natural drainage of the substrate through hydro-ameliorative, pedo-ameliorative works (levelling, terracing) in areas affected by landslides in Guşteriţa Hill, Cocoşului Hill, Gumuşel's Hill, Fântâna Rece; we recommend landslide prevention through afforestation and by planting fruit trees;
- intercepting terrace and coast permanent springs through water catchment methods (wells, horizontal pipelines), canalization at terrace base or of the slopes in the plateau;
- eliminating excess water from terrace treads, where possible, by afforestation or grassland vegetation, to reduce moisture;
- stopping bank undermining through bank and slope stabilization operations
- rehabilitation of the areas populated with *Pinus sylvestris* at the source of the Nepindoala stream;
- stopping and reducing landslides by building reinforcement walls and buttresses;
- populating the area with small and medium sized species in order to compact the grassland vegetation and reduce surface and linear erosion;
- rehabilitate the orchards from Guşteriţa Hill in order to consolidate again the ground;
- build natural dams as small fences to reinforce drains, ravines and gaps and reduce deep and regressive erosion;
- ban plowing and reconsider agricultural techniques;
- avoid over-grazing in the torrents catchments (Nepindoala, Remetea);
- avoid excavations for communication path and roads at the base of the slopes in the Guşteriţa area;
- avoid and ban excavations and exports of clay material from the base of slopes in Guşteriţa Hill;
- ban the expansion of the clay quarry for brick manufacturing at the expense of forest areas;
- ban and stop building operations on slopes to landslides and torrentiality in the Guşteriţa Hill area and on the terrace faces in incorporated and unincorporated areas of the city (Low 350/2001);
- consolidate the Guşteriţa Hill front cuesta to prevent new collapses and slides facilitated by the heavy traffic on the belt highway;
- ban the construction of storeyed buildings on the terrace faces in built-up areas;
- ban the overloading of terrace edges with buildings;
- ban the building of housing facilities in the Calea Poplăcii neighbourhood - extension Izlazului in the unstable waste materials warehouse and populating the area with common trees and fruit trees;
- ban deforestation for building purposes in the piedmont area - the Cibin River Piedmont and third terrace as this facilitates landslides.

Hydrological phenomena prevention and reduction

The spatial durable development and evolution of the city of Sibiu requires thorough awareness of the hydrological regime of the area situated between its administrative limits, in unincorporated areas as hydrological flow supply and relieve area, but especially in incorporated areas as reception and transfer areas. The city is subjected to a natural hydrological regime through its hydrographical network (including lakes) which converges in the Cibin River, a river that crosses the city and collects tributaries especially in the eastern part of the city (Ştef, Costea 2006; Stănescu 1995).

The highly developed areas and the sewage transportation systems are elements which require good knowledge of the hydrological drainage regime, especially in built-up areas, where concreted, asphalted surfaces and undersized sewage systems may entail the flooding of the urban area. On the other hand, the fact that the city is located in an area with a moistened substrate and lower slopes, raise hydrogeological issues, issues related to the surfaces drainage towards the stable hydrographic network and the issue of Hydrological risk phenomena caused by hydrological stationary processes.
Within this framework, steps should be taken in order to harness rivers, optimize surface drainage, but also improve pluvial water drainage through the underground urban network and reduce hydrological risks. Thus, our recommendations aim at reducing the risk generated by both stationary and hydrodynamic processes through:
- building drainage canals on humid flat surfaces and rehabilitating the extant ones; the surface drainage systems in Şura Mică and Viile Sibiului and Lazaret neighbourhood should be deepened to the level of the aquiferous deposit;
- building depth drainage systems, performing hydro-ameliorative operations for underground

collection and drainage (wells, horizontal pipelines) to eliminate underground water surplus;
- monitoring the operation of the Gura Râului dam, so as to control the flow;
- harnessing small hydrographic basins and regulating the flows of the tributaries within city limits and regulating the Cibin River within the city limits and at the location where it leaves the city (Low 170/1996);
- building of parks and riverside coppice on the riverbanks of Cibin and its tributaries meant to use and redistribute the water surplus in the meadows;
- developing certain controlled wetlands in Lunca Mare meant to harness the abandoned meanders of Cibin river upstream Turnişor;
- optimizing underground drainage by changing the sewage system size depending on the average quantity of pluvial water and domestic and industrial consumption;
- building marginal canals and surface drainage systems (ditches, gutters), especially on the sloping streets, meant to ensure the transfer of the surplus water to natural collectors or underground drainage systems;
- populating the plateau area with common trees and fruit trees in order to ensure the transfer of pluvial water responsible for flash floods on creeks such as: Hamba, Valea Popilor, Valea Fărmândoala, Valea Pe Remeţi;
- taking measures to clear the Cibin River bed at the Guşteriţa bridge;
- banning the disposal of domestic waste or debris on the riverbanks of Cibin River or its tributaries ; these can be worn in riverbed and can clog the flow; the Trinkbach creek requires special attention, as it may flood the skating rink-Lazaret sector;
- preventing new bridge legs from being built in riverbeds and clearing the riverbeds;
- avoiding building undersized bridges and foot bridges which may be blocked and cause afflux phenomena, thus flooding upstream areas;
- banning the building of facilities in easily flooded areas of the Cibin meadow or that of its tributaries and avoiding the narrowing of minor riverbeds.

Conclusions

The development strategy of the city of Sibiu must aim at fortifying the urban territorial system by harmonizing both natural and anthropic factors for the durable development and optimum use of the land (PATN 1998; Ianoş 2000). The role of this strategy is to ensure environmental protection and preservation, especially to set the limits of anthropic intervention upon the environment through urban expansion and economic activities, so that this intervention might be beneficial to the society.

Therefore, the durable development strategy of the Sibiu Municipality must be based on the efficient and durable use of the natural framework, on the reconciliation between spatial evolution and the favourability and restrictions imposed by the physical-geographical framework, on promoting efficient environmental policies within the context of economic development, on the harmonization of functional zoning and space suitability for certain purposes, as well as on promoting an adequate and efficient management of unincorporated areas (Surd *et. al*. 2005; Low 557/2001).

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4. The 1st terrace of Cibin river at relative altitude of 5 – 10 – 15 m; a. Terrace surfaces with high stability and low-moderate morphodynamic caused by and pluvial denudation and compaction processes; b. Sharp of terraces with high morphodynamic caused by ravening, torrential and landslides processes;
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Fig. 1. Harta geomorfodinamică si riscurile induse de procesele geomorfologice şi hidrologice

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9. Glacis deluvio-coluvial şi de alunecare, cu stabilitate moderată şi morfodinamică moderată generată de procesele fluvio-torenţiale şi alunecări de mică profunzime, cu risc de accentuare generat de stresul mecanic;
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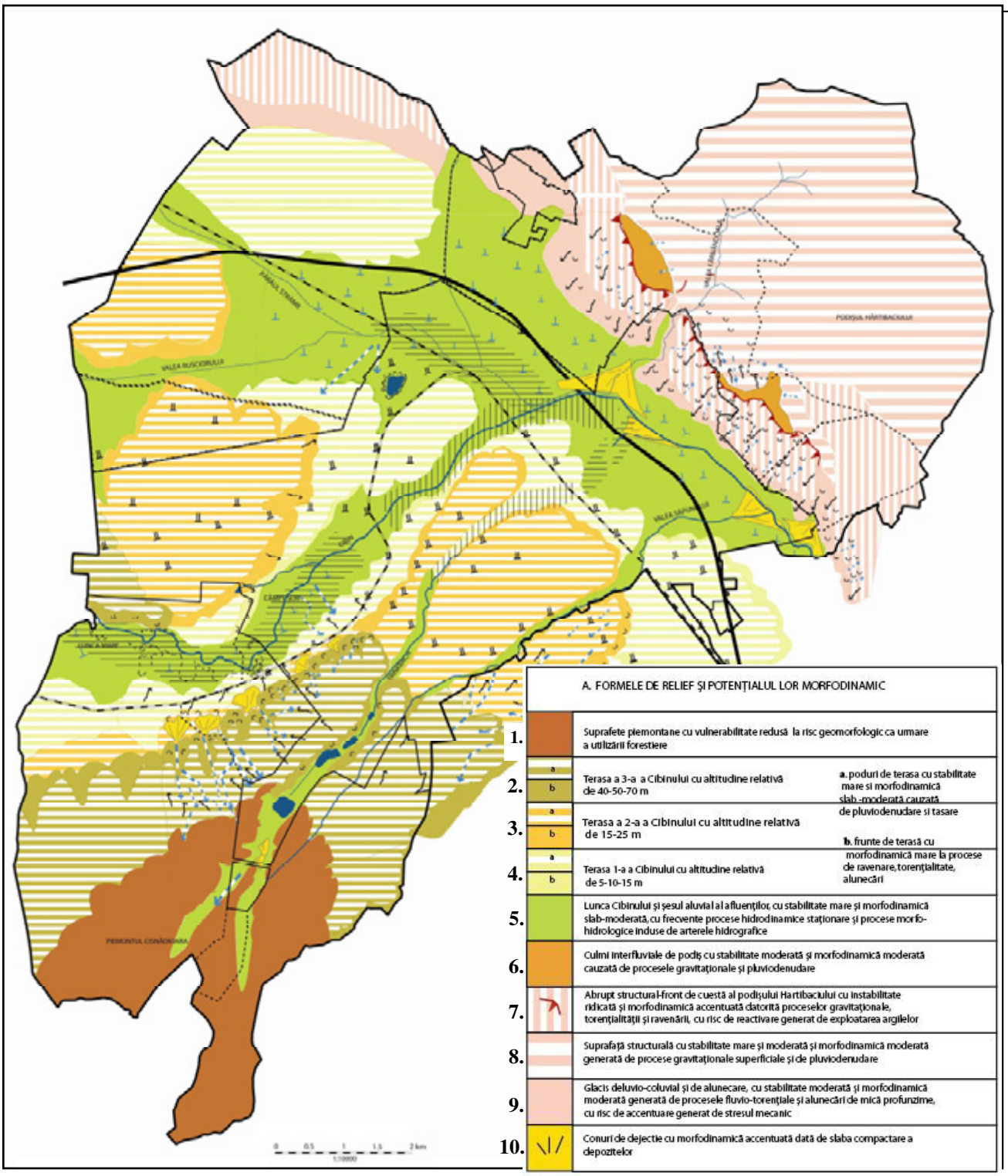

Fig.1. Geomorfodynamic map and risk induced by geomorphological and hydrological processes

DIODONTIDAE (OSTEICHTHYES) FROM „THE TURNU ROŞU (ROMANIA) EOCENE LIMESTONE" RESERVE

Rodica CIOBANU*
Nicolae TRIF

Abstract. *The present study is focused on fossil teeth of the family Diondotidae. The teleostean teeth studied belong to the paleontological collections (Richard Breckner's Collections) of the Natural History Museum from Sibiu and to the private collections (Trif Collections). The identification of the species even at the genus level posed difficulties since the studied teeth are isolated, rather than part of dental apparatus. The main criteria for diagnosis were the morphology of the teeth and the stratigraphical age of rock horizons where the teeth were found. Eleven teeth studied in this paper are referable to Progymnodon cf. hilgendorfi (Dames, 1883) and ?Progymnodon sp.*
Keywords*: teeth, Diodontidae, Upper Eocene, Limestone, Turnu Roşu Romania.*

Rezumat. *Lucrarea de față este focusată pe familia Diodontidae. Dinții de teleosteeni studiați aparțin colecțiilor paleontologice (Colecția Richard Breckner) ale Muzeului de Istorie Naturală din Sibiu şi colecțiilor private (Colecția Trif). Identificarea la nivel de gen şi specie prezintă dificultăți mai mari la dinții izolați decât la aparatele dentale. Principalul criteriu pentru diagnoză a fost morfologia dinților şi vârsta rocilor în care s-au găsit. Cei 11 dinți studiați în lucrare au fost determinați ca apar aparținând la Progymnodon cf. hilgendorfi (Dames, 1883) şi ?Progymnodon sp.*
Cuvinte cheie*: dinți, Diodontidae, Eocen superior, calcare, Turnu Roşu România.*

Introduction

The Eocene fossil fauna from Turnu Roşu (Sibiu) drew the attention of the researcher since the late 18th century. The members of the Transylvanian Society of Natural Sciences, founded in 1849 in Sibiu, were the most active in studying the fossil area Turnu Roşu (Porcești). They pointed out the importance of this habitat not only through the variety of the palaeofauna but also for palaeogeographical reconstructions of the Eocene stratigrapghy of the southern Transylvanian Basin (Ciobanu, 2004). In 1850, Ludwig Johann Neugeboren published in Sibiu his first systematic paper on the fossil sharks (teeth), in which the shark species were described for the first time in our country. From 19th century, Neugeboren's paper is the only one, within the current borders of Romania, which describes the shark teeth.

The work appeared shortly after the publication of a fundamental paper for the study of the paleoichtiofauna, which laid the foundation of modern research of fossil fish. I am referring to the work "Recherches sur les poisons fossiles" (1834 - 1844) published by the Swedish researcher Louis Agassiz. In the preface of the paper Neugeboren underlines the importance of Agassiz's paper to the study he carried on.

If in the 19th century fossil fauna research in Turn Roşu was at and European level and not only, it is due to the members of the Transylvanian Society of Natural Sciences and Neugeboren was also a member. The majority of the Natural History Museum heritage belonged until November 3rd, 1951 to the Society.

A member of the Society and curator of the paleontological collection was also for a short time Rischard Breckner, 7 teeth described in this study belong to his collection.. Considering the importance of the Breckner collection for the Ichthyo – Paleontological study in Romania and not only, I will provide a few brief details regarding Richard Breckner (1900-1979). According to Hienz (1995), Breckner was an art critic, journalist, literary secretary for the theatre and writer. Between 1933- 1938 he was a freelancer making a living by writing scientific papers on the fossil collection from Transylvania. Neither the dictionary nor any other bibliographical source make reference of these

* Brukenthal National Museum,
rodi_ciobanu2005@yahoo.com,
rodica.ciobanu@brukenthalmuseum.ro

about these papers or where the results of his scientific activity were published. Breckner's name appeared more and more often between 1937–1946 in the paper belonging to the Society, in the "Vereinsnachrichten" column, being praised for his work in registering and cataloguing (even re-determining the shark teeth) the collections, especially palaeontological ones. In 1938 Richard Binder, the chairman of the Society, congratulated the diligence and competence of the one who "worked for years on the Porceşti tertiary fossils especially the shark teeth". However, there are no details concerning his writing activity or his collection, which we believe, was created during this period (Ciobanu 2007, 2011).

Breckner's palaeontological collection, beside the teleostei fish teeth, contains fossils (molluscs) from Lăpugiu de Sus and 5,000 fish teeth, majority of shark, from Turnu Roşu (Porceşti). This collection was acquired in 1954 (according to the museum archives) from Heinrich Breckner (relative of Richard Breckner), a printer from Sibiu.

Material and methods

The paper describes 11 teeth collected from the palaeontological reserve "Calcarele eocene de la Turnu Roşu (Porceşti)".

These limestone rich in fauna are part of the Eocene shallow marine sequences lying north of the Făgăraş Mountains, belonging to the southern border of the Transylvanian Basin. Around Turnu Roşu, the Eocene formations emerge like a limestone "patch" area on the north-western ending of the Făgăraş Crystalline (Fig. 1).

The latest concept regarding the stratigraphy of the Turnu Roşu limestone was given by Mészároş (1996) who defined the Turnu Roşu Group, including Valea Nişului and Valea Muntelui formations (Table 1). The faunal analysis underlined the existence of almost all Eocene groups and up to recently they represent the largest deposits bearing isolated fish teeth. Environment reconstructions based on correlation between fossil fauna and recent representatives of the species, are indicating warm tropical-subtropical waters, rich in oxygen and fauna (Mészáros, Ianoliu 1972, 1973; Bucur, Ianoliu 1987; Ciobanu 2006).

Regarding the collecting site of fish fossils remains, we believe that it is Valea Nişului and Valea Caselor, for which there are written references (Fig. 2). Unfortunately, neither Neugeboren, nor other collectors – in our case Breckner – ever mentioned the exact location where they collected the fossils from. The sample of fish teeth collected in the last few decades is very small compared to the old collections.

In Romania, fossil remains - teeth type «*Diodon*» were described for the Upper Eocene formations from Transylvania.

In the limestone from Cluj, Şuraru, Şuraru (1966) from the outcrops: Pleşca Valley and Baciu quarries they described and illustrated a tooth determined as belonging *Scaroides gatunensis* Toula, 1908. From the Cluj limestone – „upper coarse limestone", Someş outcrop (area west of Cluj-Napoca), Şuraru *et al*. (1980) described teeth belonging to the species: *Progymnodus cf. hilgendorfi* (Dames), 1883, *Nummopalatus cf. multidens* (Munster), 1846 and *Scaroides gatunensis* Toula, 1908.

In the year 1987, Şuraru, Şuraru described the Priabonian outcrops from Valea Văratic (Turbuta Formations, Sălaj district) and from outcrops: Pleşca Valley and Baciu Quarries (Cluj Napoca area) *Progymnodus cf. hilgendorfi* and *Scaroides gatunensis* species. In the „Cluj limestone", upper Eocene, Codrea *et al*. (1997) also indicated the presence of the species *Progymnodon cf. hilgendorfi* in a faunal list.

Dica (2003, 2005) made recent observations regarding Diodontidae. In 2003, in the paper where he made the revision of the Diodontidae family from Transylvania, he wrote a review of the bibliographic observations regarding „diodon" teeth. Thus, he shows that Şuraru, Şuraru (1966, 1987) and Şuraru *et al.* (1980) incorrectly assigned the lower jaw to *Scaroides gatunensis* based on Toula`s viewpoint and the upper jaw to *Progymnodus cf. hilgendorfi*. In the same paper, Dica specifies based on older material (published) and on new collections that the teeth belong to *Chilomycterus hilgendorfi* and found to four distinct areas, upper Eocene. He pointed out the diagnostic characteristics (for this genus and species) distance between the minute teeth from biting edge and the triturating plates and also the large thin triturating plates. Later, Schulz (2006, p.36, fig.2) cites the species described by Dica (2002, pl.1, figs.1-2) for the *Progymnodon* type.

The first observations on the presence of fish remains (teeth) belonging to the Diodontidae family, in the limestone in Turnu Roşu (the teeth studied in this paper belong to the same outcrop) were made by Şuraru, Şuraru (1966) and assigned to the *Scaroides gatunensis*. The teeth were collected from the Valea Nişului. In the review of the Eocene Diodontids from Transylvania Dica

(2003) pointed out that he collected teeth from the Valea Nişului Formation without indicating the number of items collected and without illustrating them.

Systematic palaeontology

Order Tetraodontiformes Regan, 1929
Suborder Tetraodontoidei Berg, 1937
Family Diodontidae Bibron, 1855
Genus *Progymnodon* Dames 1883

1966 *aff. Scaroides gatunensis* Toula, in Şuraru, Şuraru, p.72-73, 77, figs. 12-14
1980 *Progymnodus* cf. *hilgendorfi* (Dames, 1883), in Şuraru, Strusievici, Laszlo, p.179, Pl. 1, fig. 4-11.
1987 *Progymnodus* cf. *hilgendorfi* (Dames, 1883), in Şuraru & Şuraru, p.128-129, Pl.1, fig.1a-b.
1987 *Scaroides gatunensis* Toula, in Şuraru, Şuraru, p. 129, Pl.1, fig.2a-b.
1997 *Progymnodus* cf. *hilgendorfi* (Dames, 1883), in Codrea et al., p.39.
2002 *Chilomycterus hilgendorfi* (Dames, 1883), in Dica, p.40-41, Pl.1, fig.1-2
2003 *Chilomycterus hilgendorfi* (Dames, 1883), in Dica, p., Pl.IV, fig.11.

Material: 9 isolated teeth from Breckner`collection and 2 recently collected teeth (Trif Collection)
Horizon and locality: Eocene limestone from Turnu Roşu (Porceşti)

Description

Progymnodon hilgendorfi (Dames, 1883)
(Figs.3, 4, 5, 6, 7, 8)

The teeth in figs. 3-8 have rounded to subtriangular anterior border of the package of plates (Fig.3). The connection area of the 2 dental plates is narrow, the two sides of the dental battery are approximately welded. Some of the samples present minute incisors (Figs. 6, 7). The number of triturated plates is difficult to predict because the dental batteries are not preserved wholly. The teeth in figs. 3, 4 and 7 present numerous pores on the occlusal surface, we assume that the enamel from the last triturated plate was not preserved. The teeth in figs. 3, 4 and 5 have the width / length ratio of the tooth battery approximately 2: 1.

?*Progymnodon* sp.
(figs.9, 10, 11, 12)

The teeth from figs. 9, 10, 12 are different from the others in the almost sinusoidal outline of the triturated plates. In fig. 11 we assume that there are several triturated plated from a dental battery.

Diagnostic features of Diodontid teeth

A diagnostic characteristic of the *Diodon* type dentition is the presence of a dental apparatus made of fused plates, whose triturated surface differs dimensionally and morphologically. The differentiation of various types of the Diodontidae teeth differs from one author to another; they are not very clearly presented and illustrated. Most authors do the differentiation based on criteria pertaining to: the number of plates, how the 2 stacks of plates are welded, the presence or absence of minute teeth in the frontal part, the distance between minute teeth from the biting edges and the triturating plates, and that between the 2 stacks of plates etc.

For example, the difference between *Chilomycterus* and *Diodon* is that in the latter the plates are less extended, a little thicker and more in number. (Dica 2003) Another diagnostic characteristic of this kind is the considerable distance between the minute teeth from the biting edge and the triturated plate.

Regarding the connection between morphology and the positioning of the isolated fossil teeth, as either upper or lower pharyngeal teeth, the authors did not specify clearly the differences.

Another diagnostic element would be, according to some palaeontologists, the presence or absence of teeth on the biting edges. Tyler (1980) (quoted by Dica 2002) believes that this characteristic is not relevant in the diagnosis because the conditions of fossilization, the degree of conservation of the material as well as wear can lead to the loss of marginal teeth,

Tyler (1980) considers that the difference between the *Progymnodon* and *Oligodiodon* represents an evolution in the structure of the dental apparatus. Thus, in the *Oligodiodon* genus, as in the recent genus, the biting edge and the triturating region are separate by a large layer.

Weems (1998) considers that the diagnostic characters for the *Progymnodon* are: "the groove separating the teeth of the trituration plate from the marginal jaw teeth is narrow, and the marginal jaw teeth are relatively large and stout". In addition, he observed that the width/length ratio of the tooth battery (approximately 2: 1) is quite comparable to the proportions of *Progymnodon hilgendorfi* (Dames, 1883) and defined them as belonging to the same genus.

Schultz (2006, p. 34) made a complex analysis of fossil representatives of the Diodontidae family in the study of the *Oligodiodon* from the Miocene (Badenian) of Styria (Austria). Thus, *Progymnodon*, known only in the Eocene has the dental apparatus made of 2 stacks of triturated plates separated by a wide space. *Oligodiodon* and *Chilomycterus* have fewer triturated plates. The number of triturated plates increases greatly reaching nearly 20 in the *Diodon* known since the Miocene. Regarding the *Scaroides gatunensis* he considers that it belongs to the Diodontidae family and the holotype indicates a synonymy with the *Chilomycterus*. Thus, *Progymnodon* whose triturated plates have a wide median joining area, is indicated only for Ecocene and for the *Chilomycterus*, whose triturated plates are united without any space between them, evolved from the Miocene and still exist in the present. Schultz (p. 35) showed that the genera *Progymnodon*, *Oligodiodon*, *Chilomycterus* have great morphological similarities.

Discussions

Few genera of Diodontidae form a compact family of Gymnodontidae, which have changed very little since the Eocene, when they appeared, except a decrease in size, and a slight rearrangement of the tooth dental structure.

The fossil Diodontidae are known through the dental remains that appear frequently in marine deposits and rarely through skeletons (complete skeletons have been found in Eocene from Monte-Bolca, Italy). Quite common in the Tertiary formations, dental remains appear as dental apparatus composed of triturated plates united in the form of a battery. Most of the time this type of fossil teeth is generically referred to "*Diodon*".

The nomenclature of fossil species and genera is disputed, and the criteria for distinction are unclear. Differentiations between species and genera are not major and can be done only when the fossil material is very rich and varied as species and also from diverse localities. The nomenclature of current species is not clarified as well and there are many synonymies.

Leis (2006) revised the nomenclature and distribution of the Diodontidae and specified that out of 70 nominal species (over 60% of which were described in the 100 years following Linnaeus) only 19 species, belonging to 7 or 8 genera, are valid. There are different opinions regarding the age of the first fossil remains of the Diodontidae family. Most authors consider that the Eocene represents the emergence of the family. But Weems (1998) brings to attention, for the first time, dental remains – *Progymnodon hilgendorfi* – in formations of Paleocene age. The first reported lower Eocene representative of the Diodontidae family is from India (Kumar and Loyal, 1987). The type of *P.hilgendorfi* is from Middle Eocene of Egypt (Priem 1914).

Based on dental structure, Tavani (1955) differentiated some new genera. Following the study of a rich fossil material, he differentiated different genera of the Diodontidae family by bone mass, present or absence of the biting edge, between teeth and triturated plates. He also considered that *Eodiodon* which does not show small teeth on the biting edges belongs to another family, namely *Eodiodontidae*. Tavani (1955) differentiated 4 genera: *Progymnodon* from Middle and Upper Eocene of Europe, *Kyrtogymnodon* from Pliocene of Europe, *Oligodiodon* from Oligocene and Miocene of Europe and North America and *Diodon* from Miocene of Europe and in modern seas. The evolution from *Progymnodon* to *Oligodiodon* highlights, in the opinion of the author, the change in dental structure, where the biting edge and the triturated teeth are well separated by a thick layer of bone, as in current forms.

Concerning the stratigraphic distribution of Diodontid genera, Schultz (2006, 33) noted that *Progymnodon* occurs only in Eocene, *Oligodiodon* lived from Oligocene to Miocene, and *Chilomycterus* and *Diodon* from Miocene up to the present.

Conclusions

The diodontid fossils described from the Eocene of Romania by Dica (2003) should be refferred to *Progymnodon* and not to the *Chilomycterus*.

In regard to the living environment, recent Diodontidae are marine and stenohaline in slightly deeper waters. They feed on invertebrates such as echinoderms, molluscs and crustaceans (Leis, 1984), food and environment that has been reconstructed for the coastal area of the Eocene sea in Turnu Roşu as well (Ciobanu 2006). In terms of biogeographical characteristics, the fish fauna from Turnu Roşu and throughout Transylvania presents tropical indo-pacific features (Şuraru, Şuraru 1966; Ciobanu 2006).

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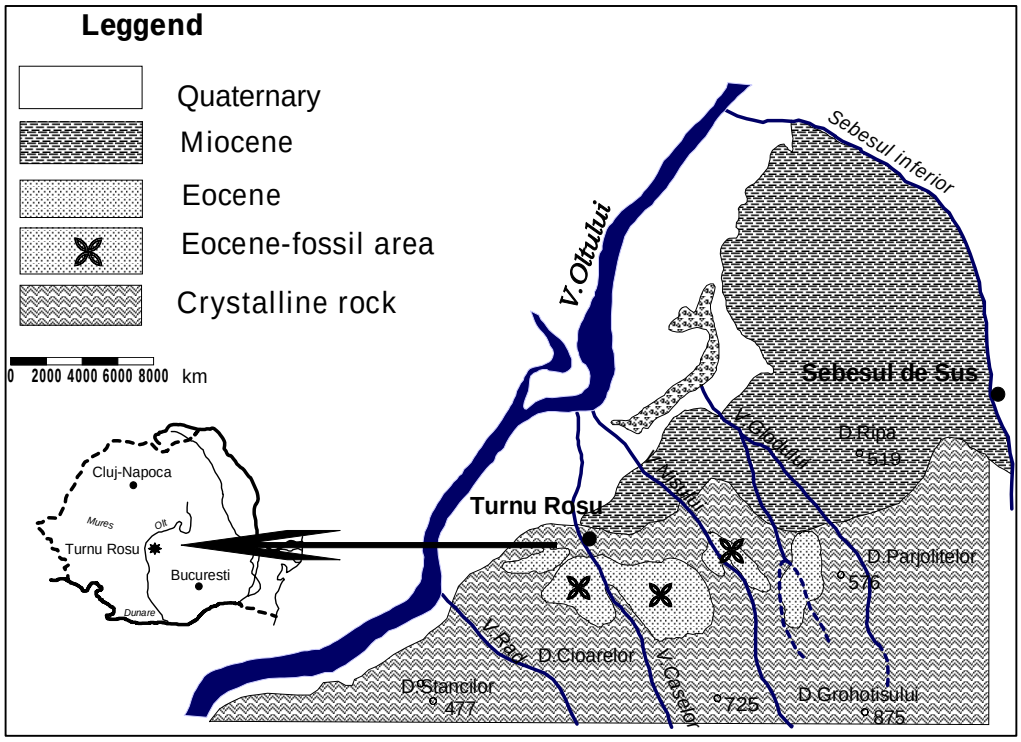
Valea Nişului Formation	Oligocen basal	Sandstone with fish scale
	Priabonian	Sandstone, calcareous sandstone, limestone with molluscs, selachian and bony fish teeth, crocodilian teeth, sirenian vertebrae, fossilized wood Conglomerate with *Nummulitesfabianii* and *Chlamys biarritzensis*
Strada Muntelui Formation	Lutetian-Priabonian	Calcare, calcare marnoase cu resturi de selacieni Limestone, Marl-limestone with *N. millecaput* and *Campanile*, fish teeth**,** sirenians vertebra Limestone with *Nummulites laevigatus, Nummulites distans* and molluscs Microconglomerate
Valea Satului Formation	Cuisian	Calcareous sandstone with molluscs and? shark teeth Conglomerate with *Ampullinopsis procensis* Sandstone, conglomerate and marl with *Nummulites planulatus* Clay with foraminifera



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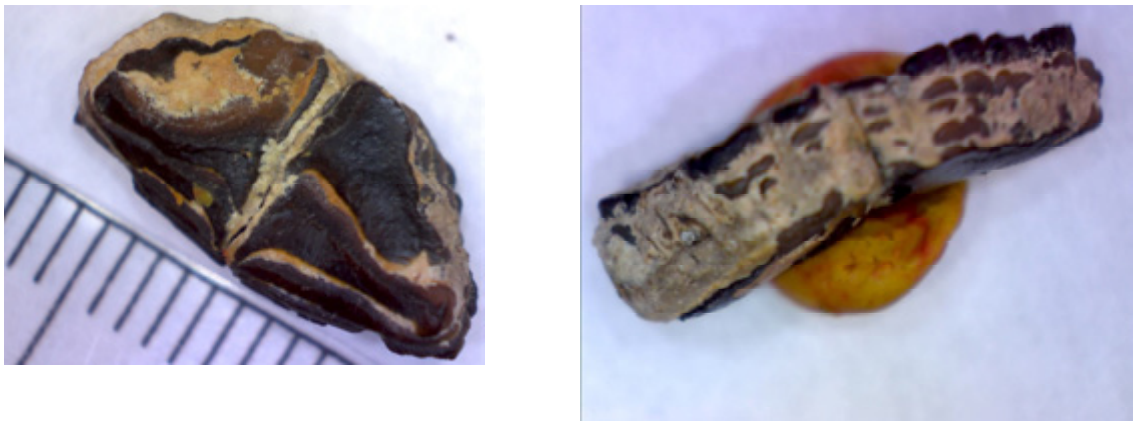

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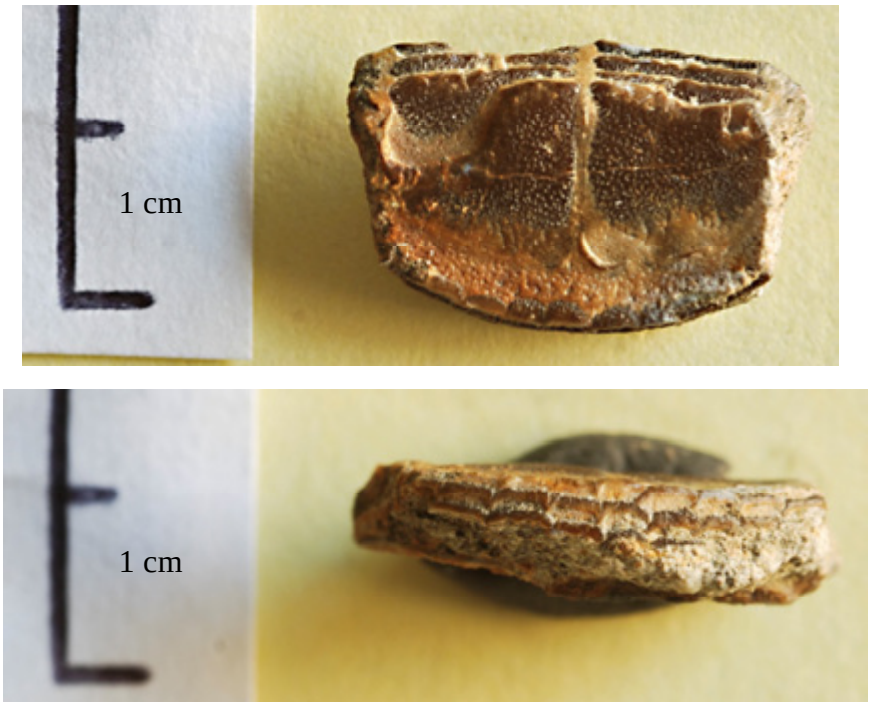

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Fig.8. *Progymnodon hilgendorfi* (Dames, 1883)

Fig.9. **?***Progymnodon* sp.

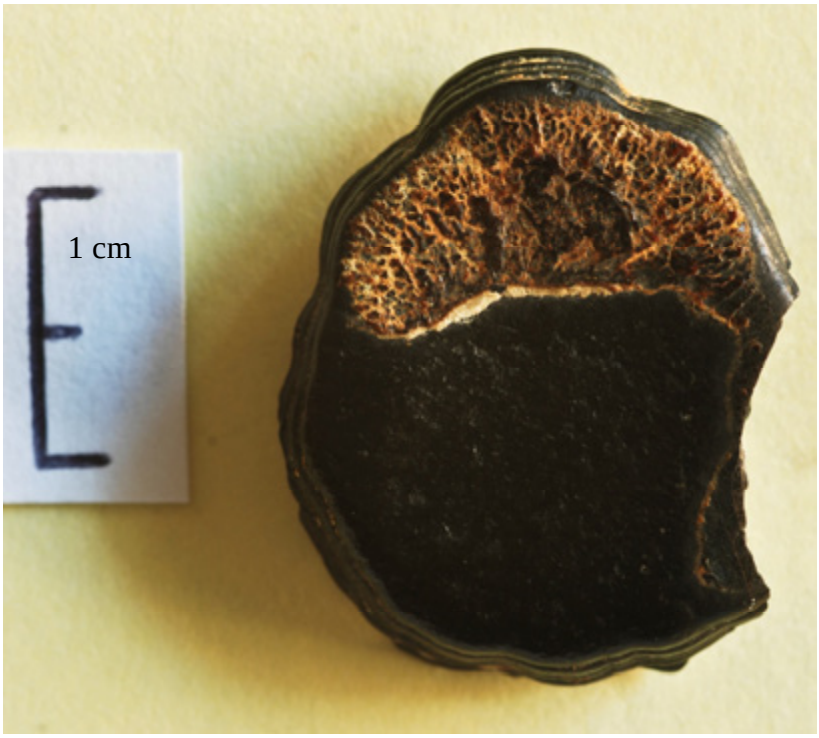

Fig.10. **?***Progymnodon* sp.

SCIENTIST OF HIS TIME – *JOHANN MICHAEL ACKNER* (1782-1862)

Rodica CIOBANU*

Akner's complex personality caught the attention of several researchers, both over the past centuries, as well as nowadays (Wollmann 1982, 1983; Schneider & von Killyen 2007; Ciobanu, 2005-2007). The goal of this short communication is to draw attention towards this remarkable Transylvanian personality from Sibiu, as in 2012 we celebrate 230 years from his birth but also we commemorate 150 years since his death.

Ackner played an important role in the evolution of the Transylvanian Society for Natural Sciences from Sibiu in the field of mineralogy and palaeontology. He was an important personality of the Society, distinguishing himself in various fields: education, mineralogy, paleontology, archaeology. He was loved and respected by his contemporaries as a "mentor and teacher of natural sciences and Transylvania's antiquities". Due to his vast knowledge – according to the ideals of the 18th century Age of Enlightenment, this implied that all the knowledge of the period should be understood - Johann Michael Ackner was a universally appreciated scholar.

Ackner was born on 25th January 1782 in Sighişoara. His father was Georg Ackner, a middle school teacher and later a priest in Meeburger. He attended the gymnasium of Sighişoara and Sibiu. At the age of 21, he left Transylvania to attend the university in Wittenburg.

After finishing his studies in Germany and after making several voyages to Renania, Italy and France, he came back to Sibiu with a great passion for archaeology and geology.

Returning to Transylvania, he did not settle, as was then customary, in his hometown Sighişoara, Instead he accepted a job as professor of philology and archaeology at the Evangelical Gymnasium in Sibiu. During 13 years of activity at the gymnasium, he won the students' attention through his graphic and scientific way of teaching. Conditioned by the lack of teachers J Michael Ackner continued to teach at the gymnasium, even when he was promoted as preacher (archdeacon) in Sibiu. In 1821, he was chosen by the community from Hammersdorf (today Guşteriţa) as priest.

There he continued the local chronicle already started in 1709. This contained, among others, short news about bad weather and crop results, notes about the country life adapted to the church calendar, information on the maintenance of the church and the parish, exceptional bad weather, floods and earthquakes are also mentioned, as well as epidemic outbreaks or a locust invasion.

In parallel with his ecclesiastical duties J. Michael Ackner dedicated himself to his various studies related to natural sciences. Guşteriţa village, situated in the south – east of the city of Sibiu, today a neighbourhood of the city, placed at the bottom of the Pădurea or Guşteriţa Hill, became famous among palaeontologists due to the fossils discovered here by Ackner, especially the quaternary vertebrates.

If we observe the complete work of the scientist, who was active until the end of his life, three different fields, in which Ackner was active, stand out. After a first stage that represents the study of physics and astronomy a second stage follows, which was devoted mostly to mineralogical, geological and paleontological studies. These were the 30s and 40s of the 19th century. In parallel there were also archaeological studies, which grew in importance in the 50s and were the highlight of his scientific activity until the end of his life. In this paper we will deal with his activity in the field of geology, linked to his activity as collector of minerals and fossils, and especially as member of the Society of Natural Sciences, which founded Natural History Museum – the institution that today houses Ackners's collection.

"The travel notes about a part of the southern Carpathians, that separates Transylvania from Lesser Wallachia" (*Reisebericht über einen Theil der südlichen Karpaten, welche Siebenbürgen von der Kleinen Walachei trennen*) (1838), which later, in 1852, appeared as "Geological-paleontological reports of the Transylvanian border mountains along Small Wallachia" (*Geologisch – paläontologisches Verhältnis des Siebenbürgisches*

* Brukenthal National Museum,
rodi_ciobanu2005@yahoo.com,
rodica.ciobanu@brukenthalmuseum.ro

Gränzgebirges längs der Kleinen Walachei) prove his intense activity in the geology field activity in the field of geology. The report includes an appendix with "a summary on the fossil remains and indications about the formations and mineral deposits found in the mountains along the border of Transylvania and Wallachia". Of great importance and a gain in knowledge from a mineralogical-geological point of view is also the mentioned journey to the Western Carpathians up to Rodna and through the Transylvanian Plateau. His publications were praised by the scientists of his time.

However, his most appreciated geological studies referred to the surroundings of Sibiu. He explored the cretaceous limestone rock and the schistose sandstone slate from Silverbachtal in Cisnădioara, the area around "Halben Stein", now protected by law. Ackner's paper "On the formations of sandstone nodules and their spread in the Transylvanian sandstones" (*Über die Sandstein – Kugelbildungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften)* published in *Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften* (1853) is still considered to be a fundamental study. In parallel with his mineralogical-geological studies he was engaged in paleontological studies. Some of these are included in "*Bericht über die zu Holzmengenim Harbachtale gefundenen vorweltlichen Tierreste und verschiedene ähnliche Funde aus Hammersdorf*„ which appeared in 1852 in Verhandlungen. The Eocene deposits of shark teeth and molluscs shells from Porceşti were also researched but Neugeboren is the one who studied and revaluated them scientifically.

The priest and royal counsellor, Ackner, was known especially through his collection and archaeological researches and was a member of the two Saxon cultural Societies of Sibiu: *Verein für Siebenbürgische Landeskunde* and *Siebenbürgische Naturwissenschaften zu Hermannstadt* (Neugeboren, 1866). Besides being the founder of the latter, he was one of its active members and an assiduous collector. This is proven by the often mentioning of his name in "Vereinsnachrichten" connected to the collecting activity of fossils for the Museum.

The collecting activity, started in the 20th decades of the 19th century and represented the materialization of his studies and researches undergone in the field of geology (mineralogy, paleontology). An important paper with paleontological subject is *Contribuţia la geognosia şi paleontologia fosilelor pietrificate* (1845) and for the first paper dealing with the ores from Trasylvania *Mineralogia Transilvaniei cu observaţii geognomice* (1855) Ackner received the award of "The Association for Transylvanian Geography" („Asociaţia pentru Geografia Transilvaniei").

The papers published in this field – paleontology - did not remain without any echoes. His contemporary L.J.Neugeboren, a member of the same Society having similar scientifically interests, appreciate Ackner's scientific attempts (Neugeboren 1852). The often trips to Cisnădie (Heltau), Cisnădioara (Mischelsberg), around Cluj (Klausenburg) and across the Carpathians (Wollmann 1982) represented occasions for Ackner to collect fossils. One can thus explain the fauna diversity of his collection. Compared to Neugeboren`s collection, Ackner`s is far richer considering the fossil type specimens and the collecting point such as: Agnita, Bruiu, Săcădate, Ilimbav, Daia.

The acquisition of the Ackner collection from Hermann Ackner, his eldest son, for the sum of 4,500 florins, was recorded in Vereinsnachrichten (1866) in 1866. C. Zekelius, caretaker of the paleontological collection of the Museum mentioned upon taking over the collection that it has a "strong Transylvanian character" and that the items of the Ackner collection were personally collected and obtained from other collectors through exchange or acquisition.

The catalogue of the Ackner collection, already renowned among the Transylvanian naturalists is published in the first issue of the Society journal (1850). By studying the catalogue one may notice that it contained fossil items from almost all of the systematic groups: Plants (Daia, Săcădate, Cornăţel, Glâmboaca, Băile Lăpuş), Sponges and corals (Săcele, Zărneşti, Braşov, Turnu Roşu, Dobârca), Echinoderms (Turnu Roşu, Cisnădioara, Cluj), Cephalopodes (Cisnădioara, Săcel, Braşov), brachiopods (Braşov, Turnu Roşu), Crustaceans (Turnu Roşu), Bivalves (Turnu Roşu, Dobârca)

In a paper referring to the mineralogical and paleontological collections from Transylvania, Neugeboren (1866), eulogistically talked about the Ackner collection and pointed out that it was bought with the support of the "National Saxon House and of the Societies: "the Transylvanian Society for the Study of Nature from Sibiu" (*Siebenbürghische Verein für Naturwissenschaften zu Hermannstadt*) and "the Society for the Study of Transylvania" *(Verein für Siebenbürgische*

Landeskunde) (Verhandlungen, 1867). In 1867, the duplicates from the Ackner collection were given to the Evangelic School from Sibiu (Verhandlungen, 1867, 1). The collection was enlarged at a short time after the acquisition.

Thus, Neugeboren, as caretaker of the paleontological collections, thanks in a meeting of the Society to Czekelius and Moekesch for the enlargement of the Ackner collection with fossils from the surroundings of Cluj and Alba Iulia (Verhandlungen, 1867:238). Neugeboren mentioned in 1866 that in the Ackner collection there were 3,791 items out of which 1,728 were fossils (geognostical items) in which the following were represented: the "diluvia from Guşteriţa, the petrified plants from Thalheim – Daia (tertiary), Sebeşul de Sus, Porceşti (lower tertiary), Cisnădioara (chalk formation and Gosau), Răşinari". The collection also included fossils belonging to the 1,315 species, the most valuable being those from Guşteriţa (mammal bones), from the Hârtibaciu Valley (plants, fossil fish, mammal bones), the Braşov area (certain corals), Săcădate (plants, tertiary fish), Turnu Roşu (Porceşti), Cisnădioara, Buituri, Racoş, Muncelul Mic, Lăpuşul de Sus, Cluj (Neugeboren, 1866).

The fossils discovered by Ackner in Gusterita Hill, while he was still a priest, drew the attention of other paleontologists towards this area. At the end of the 19th and the beginning of the 20th century the studies dedicated to the geological potential of Guşteriţa mentioned the fossil specimens found in the Ackner collection. The fossil area from Turnu Roşu is known, especially, due to the works and collection of Neugeboren, while Guşteriţa is renowned because of Ackner's discoveries and collections. The naturalist Ackner, unlike Neugeboren, did not work, outside volunteering as member of the Society, inside the museum, and obtained special performance in the field of archaeology. Neugeboren carried out a few studies related exclusively to the geological aspects and in his ad notations did not lose the opportunity to related to incorrect determinations, point to the fact that time was not on his side in going deep into this field. However, Neugeboren did not lose the opportunity to praise Ackner's collecting activity, mentioning that through his collection several fossil groups were completed and dedicated him a species of bivalve *Cardium acknerii* (Neugeboren 1851)

From the Vereinsnachrichten column records of the Verhandlungen journal one might notice the continuous increase of the Ackner collection after its acquisition by the museum. It was only in 1891, when Sachsenheim, the caretaker of the museum's collection during that period, worked on recording the collection. (Verhandlungen, 1891, XV). Unfortunately, this register was not kept and an inventory book made by Breckner at the beginning of the 20th century and kept at the Natural History Museum, does not point out the data referring to the Ackner collection but only the existence of isolated pieces donated by Ackner. The entire collection, as museum entity, used to exist in the museum before 1955. We conclude this from the fact that Ilie (1955) makes references to the Ackner collection when he presents the Pontian and the Pleistocene from Guşteriţa, in the geological research of the Alba-Iulia-Sibiu-Făgăraş-Rupea area, namely in the stratigraphic descriptions. Currently, the Ackner collection does no longer exist in its original form, but only as isolated pieces among the *"Old collection of the museum"* also called "the Society Collection".

Johann Michael Ackner's scientific achievements enjoyed all the recognition of his contemporaries. Thus, in April 1850 he became corresponding member of the Institute of Archeology of Rome. A year later Ackner was named a member of the Leopold-Caroline Academy of Naturalists from Breslau. He also became a corresponding member of the Society of Scholar from Cracow, as well as of the Central Committee for Research and Maintenance of Architectural Monuments and correspondent of the Geological Imperial Royal Institute of Vienna. As a sign of great recognition in 1854 he was honoured with the Gold Cross of Merit and in 1858 appointed to the Imperial Council. He was a member in the leading committee in both associations for regional studies and natural sciences. Ackner was also a honorary member of "Astra", but unfortunately he was unable to receive his diploma.

Although the collection does no longer exist as Ackner left it, important items from this collection are presented and scientifically rendered. Had there been drawings of the fossil items, the reconstitution of the entire collection would have been possible.

Acknowledgements. The authors are grateful to Ana-Maria Mesaroş for constructive comment on our manuscript and to Ioana Ciobanu for the useful suggestions improving the language for the text.

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Fig.1. Johann Michael Ackner (1782-1862) – with a mammoth femur collected from Guşteriţa (Sibiu), currently exhibited in Natural History Museum from Sibiu

Marioara COSTEA, ***MAPPING AND GEOMORPHOLOGIC ANALYSIS,*** Edited by Lucian Blaga"
University Sibiu Publishing House, Sibiu, 2011, 262 p., 92 fig., 5 appendices.

Rodica CIOBANU*

The geomorphologic analysis implies a complex study of the relief, the genesis and evolution of the landforms in their complexity, of the typology of geomorphologic processes that take place and of the impact that these geomorphologic processes have on the other components of the environment.

The results of any geomorphologic analysis are materialized in graphic and textual representations, which become geomorphologic maps that are realized through a complex geomorphologic mapping process.

In the present day context, when the technological development and the volume of information has grown substantially in all economic and scientific fields, the analysis of the relief, as main component of landscape, relies more and more on computer technology, with possibilities of fast processing, and on modern methods of complex analysis accomplished with the help of specialized software, which become more advanced and cheaper by the day.

The "Geomorphologic mapping and analysis" work was drawn up for the purpose of providing synthesized and systematic documentary teaching aids, which are necessary for the mastering of geomorphologic mapping, as well as for the assimilation of relief analysis knowledge.

The content of this volume dwells on general notions concerning the relief research methodology, the principles of graphic representation and geomorphologic mapping, as well as the content and structure of topographical and geological maps, used as basis for geomorphologic mapping and geomorphologic maps as end product.

The first part of the paper introduces several documented and scientifically augmented research methods used in geomorphology: general methods (inspection, comparison, analysis, prognosis) and specific ones (morphometric and morphographic methods). This part also describes graphic representation methods of statistic data for describing, comparing, causal and functional explaining of the different morphologic surfaces, morphologic indicators or geomorphologic phenomena, as well as cartographic representation methods for landforms.

The paper especially addresses geography students, but also those who study ecology or related specializations. In order to assure a faster documentation for students from other specializations of the environmental science field or for different experts who studied topography and geology, the author resorted to a detailed presentation of the basic elements used in geomorphologic mapping.

Particular emphasis is given to the use of topographic maps as mathematical support in creating geomorphologic maps, to highlighting the characteristics of the standardized and adopted cartographical projections for topographic maps, to the presentation of the sharing system on sheets and the creation of the map sheets' nomenclature, to the study of the content elements and to the meaning and ways of representation of the conventional signs.

The work also addresses the role of geological substrate in morphogenesis and presents the mapping principles and methods of the petrographic and structural relief, the analysis of the forms and how to interpret maps.

The geological analysis in interpreting structural tectonic and lithological forms (the geochronological and morphochronological scale, specific research methods applicable in geomorphology), types of rocks and their role in relief shaping, the petrographic and structural relief characteristics, the creation stages for morphostructural and morpholithological maps are all scientifically documented by the author and comply with the requirements of higher education. The difficulty of creating and interpreting them is supported by concrete examples.

*Brukenthal National Museum,
rodi_ciobanu2005@yahoo.com,
rodica.ciobanu@brukenthalmuseum.ro

Special attention is given to morphometrical and morphometrical maps, by presenting the methods of calculation and representation of the relief fragmentation density and of the energy of the relief, the methods for determining the terrain's declivity and for creating the map of the cliffs and of the slopes' exhibition, the principle and methods of compiling a morphographic map. The theoretical and methodological content is completed and argued with a wide range of case studies and mapping examples accompanied by competent explanations.

Synthetically representations are an important part of the work: the general morphologic map, the actual map of the geomorphologic processes and the geomorphologic risk map. The creation and interpretation of these maps requires a particular experience in cartographic representation and relief analysis, which is the reason for which the author presents map patterns and case studies.
The last part covers the study of modern digital mapping technology, summarizing principles, structure and methods of creating a geographical database and how to work with the program Map Maker and Surfer, in order to create digital geomorphologic maps. The presented topic of digital mapping, besides the scientific approach, has also a practical-applicability role for the bachelor and master students in their development of practical skills regarding the effective use of the mapping software when creating databases and maps.

The work is characterized by a lofty scientific level and by an appropriate approach towards the challenges of mapping and geomorphologic analysis. The basis for preparing the paper was the author's experience, alongside a rich bibliographical material.

Environmental science bachelor and master students, as well as those interested in the mastery and understanding of the mapping and geomorphologic analysis fields can find in each chapter not only the theoretical presentation of the problem, but also practical applicability of cartographic representations and the applicative context of the geomorphologic analysis.

THE *MIKLOS SZEKERES* DONATION TO THE MALACOLOGICAL COLLECTION FROM THE NATURAL HISTORY MUSEUM IN SIBIU

Ana-Maria MESAROŞ*

Abstract. *In 2012 an important donation was made by Miklos Szekeres to the Natural History Museum from Sibiu (Brukenthal National Museum). Szekeres donated to the Malacological Collection 9 paratypes belonging to 6 subspecies of the genus Alopia (H. et A. Adams). The museum received copies of the papers published by Szekeres including the original descriptions for each subspecies. The paratypes were collected from Romania between 1998 and 2008. To each specimen an inventory numbers was given and included in the museum Malacological collections.*
Keywords*: paratypes, donation, genus Alopia*

Rezumat. *În 2012 o importantă donaţie a fost făcută de către Miklos Szekeres Muzeului de Istorie Naturală din Sibiu (Muzeul National Brukenthal). Szekeres a donat colecţiei de Malacologie a muzeului 9 paratipi aparţinând la 6 subspecii ale genului Alopia (H. et A. Adams). Muzeul a primit o dată cu donaţia şi descreierea originală a specimenelor publicate de către Szekeres. Paratipii au fost colectaţi din România între anii 1998 – 2008. Exemplarele au primit numere de inventar şi au fost incluse în colecţiile malacologice ale muzeului.*
Cuvinte cheie*: paratipi, donaţie, genul Alopia*

Introduction

Miklos Szekeres, scientific advisor at the Biological Center of the Hungarian Academy of Sciences, donated in March 2012 to the Natural History Museum (part of the National Brukenthal Museum) from Sibiu 9 paratypes belonging to 6 subspecies of the genus *Alopia* (H. et A. Adams). The specimens were collected by scientific collaborators of Szekeres from Romania.

Each specimen entering the museum collection was measured, photographed and included in the DOCPAT 2000 museum data base with all the information sent by the donor: the description, collecting area and date, the names of the collectors. According to the cultural heritage categories in Romania section natural heritage these specimens can be classified at thesaurus (the highest category).

The paratypes donated by Szekeres, following the accounting note number 1 from 03.04.2012, are:
- inventory number 209.708, *Alopia glorifica sarkanyi* Szekeres, collected from Mateiaş Mountains, East - Northeast of Câmpulung, 1220 meters altitude, collected by L. Németh, 10.09.2003;
inventory number 209.709, *Alopia glorifica valeriae* Szekeres, collected from Dâmboviţa - Valley, 3 kilometers Northwest of Cetăţeni, 550 meters altitude, collected by L. Németh, 21.07.2006;
- inventory number 209.710, *Alopia glorifica valeriae* Szekeres, collected from Dâmboviţa Valley, 3 kilometers Northwest of Cetaţeni, 550 meters altitude, collected by L. Németh, 21.07.2006;
- inventory number 209.711, *Alopia subcosticollis majorosi* Szekeres, collected from Holocene cave sediment near the entrance of Peştera Polovragi, 670 meters, collected by G. Majoros and L. Németh, 22. 07.1998;
- inventory number 209.712, *Alopia subcosticollis tamasorum* Szekeres, collected from Cerna Valley, Bobotu Gorge North of Herculane Baths, 380 meters, collected by T. Deli, T. Domokos, J. Lennert and M. Szekeres, 14.08.2006;
- inventory number 209.713, *Alopia glorifica deceptans* Deli & Szekeres, collected from Piatra Craiului Mountains, Seacă Pietrelor Valley, 2 kilometers North of Brusturet Lodge, 1150 meters altitude, collected by L. Németh, 2-3.09.2005;
- inventory number 209.714, *Alopia glorifica deceptans* Deli & Szekeres, collected from Piatra Craiului Mountains, Seacă Pietrelor Valley, 2 kilometers North of Brusturet Lodge, 1150 meters altitude, collected by L. Németh, 2-3.09.2005;
- inventory number 209.715 *Alopia grossuana nemethi* Deli & Szekeres, collected from Vâlcan Mountains, Sohodol Valley, 8 kilometers North of

* Brukenthal National Museum,
ana.mesaros@yahoo.com,ana.mesaros@brukenthalmuseum.ro

the valley entrance, 450 meters altitude, collected by T. Deli, É. Horváth, J. Lennert, B. Páll-Gergely and P. Subai, 03.05.2008;
- inventory number 209.716 *Alopia grossuana nemethi* Deli & Szekeres, collected from Vâlcan Mountains, Sohodol Valley, 8 kilometers North of the valley entrance, 450 meters altitude, collected by T. Deli, É. Horváth, J. Lennert, B. Páll-Gergely and P. Subai, 03.05.2008.

The special *Alopia* collections from the Natural History Museum in Sibiu have been of interest to European scientific researchers because of the large number of species included. The majority of specimens are endemic to Romania, but the most important parts of the collections are the type specimens and varieties of some *Alopia* species collected by Eduard Albert Bielz (1827 – 1898), Moritz von Kimakowicz (1849 – 1921) and later his son Richard von Kimakowicz (1876 – 1973).

The specimens collected by these international renowned scientists are part of the Natural History Museum from Sibiu heritage. The specimens were described in the journal of the Transylvanian Society for Natural Sciences (*Verhandlungen und Mittheilungen des siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt*), the museum's founding Society.

The collected materials included 18 new species, for that period, belonging to the *Alopia* genus. From the 18 hollotypes Corocleanu (1968, 422 – 424) studied eight of these species. Also Corocleanu (1977, 213 – 223) published the 18.324 specimens belonging to the 2 genuses *Herilla* (H. et A. Adams, 1855) and *Alopia* (H. et A. Adams, 1855), in total 17 species and 43 varieties from the Bielz Collection.

The Special Alopia Kimakowicz Collection counts 73.321 specimens (from which 37.190 are doubles) collected and identified by Moritz and Richard von Kimakowicz. Bought Moritz von Kimakowicz and his son dedicated their studies in the field to this genus (Coan *et al*. 2011, 4). Because of the large number of specimens and the general scientific organization this collection is unique in our country. Corocleanu (1987, 275 – 295) published a list of 34.878 specimen of *Alopia* subspecies found in the Kimakowicz Collection, collected from Romania. The conclusion of the study was that there are 62 species and subspecies of the genus *Alopia* in the Kimakowicz Special Alopia Collection.

Even with this large number of species and subspecies, in our museum collections have not been identified until today specimens belonging to the 6 subspecies donated by Szekeres. Thru this donation the value of the Malacological Collections from the Natural History Museum in Sibiu has increased and once again it is confirmed that these collections are not only a national scientific heritage but an international one.

The Natural History Museum in Sibiu is profound honored to have received this donation from Miklos Szekeres.

The donation could not have been possible without the help of Ioan Sîrbu PhD, „Lucian Blaga" University, whom we would like to thank for his contribution.

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