Muzeul Județean Mureş

MARISIA

Studii şi materiale

XXXVI

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LICHENOINDICATION APLICATION IN THE ENVIRONMENTAL QUALITY ASSESSMENT

Adam BEGU
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Abstract: Most lichens are extremely sensitive to increased concentrations of SO_2, NO_x and other gases: the damage is reflected in reduced photosynthesis, necrosis and even thallus destruction. Currently, the lichen diversity of the Republic of Moldova comprises 197 species and varieties, and 40 species are recommended as reliable indicators. The paper presents a Lichens Toxi-tolerance Scale (LTS) towards SO_2 concentration in the air and Air Quality Assessment Scale (AQAS) with 6 gradations, taking into account the specific diversity, abundance and indicator species toxi-tolerance.

Keywords: lichens, toxi-tolerance, SO_2 pollution, scale, environmental.

Introduction

The use of bio-indicators started in the second half of the 19th century, and particularly developed as lichen indication [33], which was applied to monitor air pollution, especially sulphur dioxide as well as nitrogen oxides, ozone, fluorine, chlorine, etc.

The increased sensitivity of lichens to gases and fumes is explained by their slow regeneration, as compared to higher plants, which can renew damaged tissues rather quickly [23]. Under long-term water deficit, lichens become even more vulnerable to air pollution. Garrou & Castrogiovanni [22] explained lichen sensitivity to sulphur dioxide by the fact that the pollutant is converting chlorophyll into pheophytin, substituting one atom of magnesium with another of hydrogen.

The role of lichens as bio-indicators of air pollution in the Rocky Mountains (USA) was extensively studied by S. Simonson [39]. Mihailova & Vorobeicik [29] studied the dose-effect relationship in lichens in the forests of the Middle Ural region. They found significant changes in lichen sinuzia even at a slight exceeding of background pollution levels (1,5–2,3 times). Studies in the field were undertaken by researchers of the State University of Tartu (Estonia) leaded by Trass [43, 44, 45, 46], who proposed a list of test species and a 5-grade scale for air quality monitoring. He developed the Poleotoleration Index (IP) for spatial mapping of air pollution with sulphur dioxide. Blium [15] suggested that the elaboration of indication scales should take into consideration the sensitivity of lichens to different air pollutants (SO_2, NH_3, H_2S, CO, petrol vapors) established under laboratory conditions.

The application of lichen criteria in the assessment of air quality and mapping of urban pollution in industrial areas of Romania was considered by several authors [2, 3], [4], [18], [19], [20], [21], [31], [40], [41], [42]. Outstanding research was carried out by Bartók [2], who made an inventory of the lichen diversity of the Zlatna industrial area to determine the influence

of pollutants on lichen formations in different ecological niches. Later on, the same author [3] applied a quantitative method of mapping the intensity of air pollution based on lichens substrate coverage, frequency, abundance and tolerance, thus designating areas with different degree of pollution. Ştefănescu & Bartok [41, 42] undertook a joint research on lichen species from the Romanian industrial region of Baia Mare by mapping the intensity of air pollution.

It is well known that epilithic species have a mainly crustose structure and such species are not recommended for ecobio-indication because they remain practically indifferent to pollutants at moderate and high concentrations [32].

Recently, the bio-indicator features of lichens have become a research subject at the National Institute of Ecology. Over 80 meadow and hill forest ecosystems were studied (Fig. 1), targeting epiphytic lichen species, and bio-indicator species, in particular.

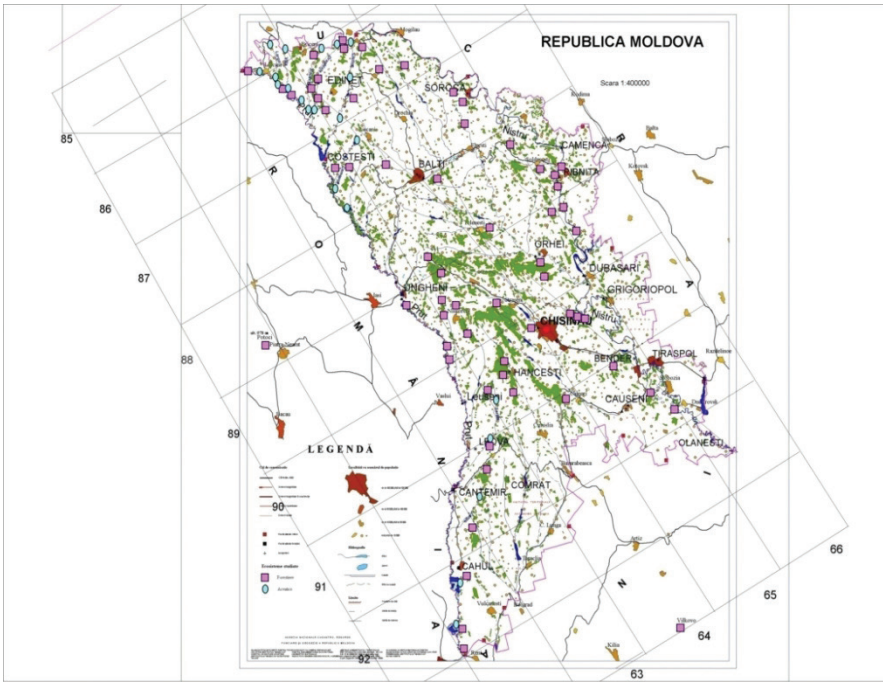

Fig. 1: Forest ecosystems were studied

For the first time have been described 23 species (Tab. 1). Lichen abundance, toxi-tolerance and diversity were studied, against air quality. The results were presented in a number of works by Begu [5, 6, 7, 8, 9, 10, 11, 12, 13].

Table 1: First time from Moldova described species

Name of species	***Name of forest ecosystems***
1. Arthonia dispersa (Schrad.) Nyl. (*A. epipasta* Körb. = *A. minutula* Nyl.)	Durleşti, Saharna, Cuhureştii de Sus
2. *Arthonia punctiformis* Ach. (*A. atomaria* Mass., *A. populina* Mass.)	Şoldăneşti, Burlăneşti
3. Buellia lauri-cassiae (Fee) Müll. Arg. (*B. triphragmia* Arn.)	Căpriana, Iabloana, Mândreşti
4. Caloplaca aurantiaca (Lightf.) Th. Fr. (*C. flavorubescens* (Huds.) J.R. Laundov /*Placodium aurantium* Vain.)	Plaiul Fagului
5. Caloplaca elegans Th. Fr.	Plaiul Fagului
6. Candelaria concolor (Dicks.) Stein.	Bălăneşti, Codri, Plaiul Fagului

Name of species	***Name of forest ecosystems***
7. Leptogium saturninum (Dicks.) Nyl.	Bahmut
8. Hypocenomyce scalaris Ach. Ex. Lilj Choisy *(Psora scalaris)*	Plaiul Fagului
9. Parmelia olivacea (L.) Nyl. (*Imbricaria olivacea* DC. *Lichen olivaceus*Hoffm.)	Lopatna, Păpăuţi, Căpriana, Iabloana, Lucăceni, Mândreşti, Şoldăneşti, Curchi, Cobac, Sărata Galbenă, Pogăneşti,
10.Phaeophyscia nigricans (Flk.) Stitzenb	Lopatna, Durleşti, Saharna, Cotul Morii,Păpăuţi, Şoldăneşti, Plaiul Fagului
11. Physcia tribacia (Ach.) Nyl.	Teţcani, Pererâta, Tohatin
12. Physcia ciliata (Hoffm.) Drietz (*Ph. obscura* Hampe)	Ciocana, Cărbuna, Congaz, Taraclia, Corneşti, Bahmut
13. Parmeliopsis ambigua (Wulf.) Nyl. (*Parmelia ambigua* Ach.)	Plaiul Fagului
14. Verrucaria fuscella (Turn.) Ach. (*V. areolata* Wallr.)	Lopatna (defileul Jiolnaia)
15. Xanthoria substellaris (Ach.) Vain (*X.fallax* Du Rietz = *X. ulophylla* Arn.)	Cuhureşti, Ciorna, « La Castel »
16. Aspicilia gibbosa	Lopatna
17. Ramalina pulvinata (Arnzi.) Nyl.	Iargara
18.Parmelia pseudolivertorum	Cobac, Sărata Galbenă
19. Parmelia subaurifera	Valea Mare
20. Parmelia subulata	Trebisăuţi
21. Evernia furfuracea (L.) Mann. – *Parmelia furfuracea* (L.) Ach.	Plaiul Fagului, Codri, Căpriana, Trebisăuţi
22. Microthelia atomaria (DC) Korb. – *(M. korberi* Trevis.*)*	Plaiul Fagului, Rubleniţa, Temeleuţi, Păpăuţi
23. Cladonia glauca Flörke	Briceni

Materials and methods

Of importance for theoretical science is as well the placement of lichen species into a systematic classification [35]. The classification system used follows several works [49], [14] and scientific names are according to Kondratyuk et al. [25].

Currently there is much information on disturbances to the vital activity of lichens caused by atmospheric pollutants [1], [16], [36], [44], [15], [29]. This has allowed some authors to specify gradations of SO_2 concentration [24], [26], [27]. The concentrations indicated vary greatly between authors, perhaps because some of the data were obtained in the laboratory, whereas others were obtained in field conditions; besides, such aspects as emission structure, climatic conditions, research methodology also differ. Most authors indicate a concentration of sulphur dioxide in the air of 0,05mg/m^3 as the threshold of the clean air zone. The harmful effects start occurring at 0,1–0,3mg/m^3, some indicating the concentrations > 0,3 mg/m^3 as very polluted air and the fatal concentration as being 0,5 mg/m^3.

Performing a large retrospective of phyto- and zoo-indication, Măciucă [28] proposed bio-monitoring as an important alternative to the traditional monitoring of forest ecosystems.

Results and discussions

The ecobioindication discussions within the RM, which was based on responsiveness and cumulative features of indicator organisms, such as lichens, less moss, fungi, and molluscs allowed us to argue the scientific viability of biologically passive and active monitoring in testing the quality of environment. In this context, the RM Lichen Flora Register, under contemporary classification system proposed by Hawkswort et al. (1995) and taxonomic nomenclature proposed by Kondratyuk et al. (1998) was developed. Out of approximately 200 already known species

and varieties for the RM, based on bibliographic sources, field research, laboratory testing and monitoring (by taking picture), lichen transplants responsiveness, 115 species have shown sensitiveness to pollution with SO_2, 35 species – to NO_x, 2 species – to *Cl*, 6 species – to *F*, 34 species – to environment *pH*, 38 species were calciphiles and 13 silicifiles. Proceeding the indicator species frequency within the forest, forest – petrofite and urban ecosystems, as genuine indicators in environmental monitoring of the forestry sector there were proposed 40 species (Fig. 2), of which 3 – with toxitoleration class/degree I, 16 – II degree, 16 – III degree, 3 – IV degree and 2 species – with toxitoleration degree V in respect to air pollution. Because many of proposed species are common for European space, they be can be applied in the European Network for the Assessment of Air Quality in forest, forest – petrofite and urban ecosystems equivalent to European Network program EMEP (50 × 50 km), promoted by the Convention on Long-range Transboundary Air Pollution (Geneva, 1979). The other studied groups of organisms partially satisfy these requirements: for instance *Bryophyta* – are valid for testing heavy metal accumulation during the last 2–3 years (8 species can be used for this purpose); *Erysiphales* – for testing the air pollution with SO_2, *Helix pomatia* – for testing pollution with heavy metals. *Gymnosperms* are underrepresented and are unevenly distributed in the country; *Angiosperms* are valid as indicators but only during the summer, making them less required within ecobioindication method.

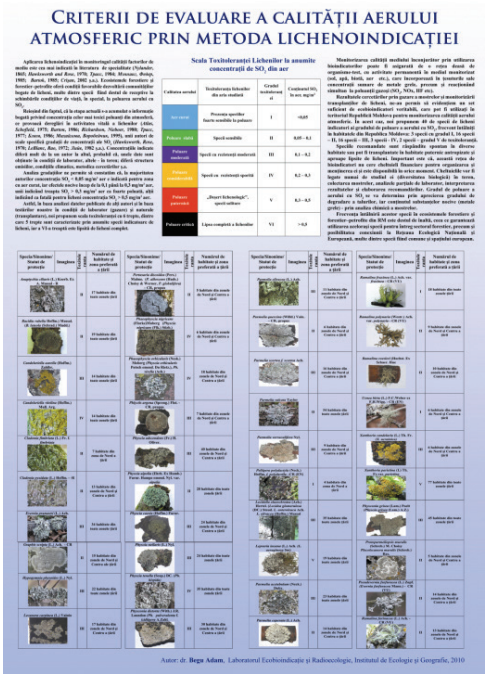

Fig. 2: Proposed species in environmental monitoring of the forestry sector

The synthetic analysis of 20 scales applied for assessing the air quality on the base of lichens indication proposed by different authors from Europe and North America, allowed us to emphasize the incompatibility of direct application of any mentioned above scale without an adequate adaptation to the RM conditions. Thus, the adaptations made by us were based on toxitoleration classes proposed by 20 authors, own research in the field, testing of transplants in the field and laboratory, as well as morphological – anatomical – biochemical changes established analytically. Proceeding from the conditions of the RM, the fact that lichen flora is represented by only about 200 species and varieties, and that there are no major pollution sources, the Lichens Toxitoleration Scale was proposed, which includes 6 – levels of air pollution with SO_2

(Tab. 2). Performing air quality land cadastre every 5 years in forest, forest – petrofite and urban ecosystems on the base of local ecobioindicators with the application of 6 levels scale, it will give an opportunity to collect extensive information on environment air quality and pollution trend effects.

Table 2: Gradations in air quality assessment based on abundance of lichens with different toxitolerance

SO_2 content in the air, mg/m3	Air quality	Toxitoleration degree	Lichens toxitoleration	Abundance of species with different toxitoleration degree,% of substrate surface
<0,05	Clean	I	Highly sensitive	I > 10 or I < 10 and II > 75
0,05–0,1	Slightly polluted	II	Sensitive	I – 0 –10 or II – 50–75
0,1–0,2	Moderately polluted	III	Moderately resistant	II – 10–50 or III > 50
0,2–0,3	Polluted	IV	Highly resistant	III – 10–50 or IV > 50
0,3–0,5	Heavily polluted	V	Desert zone	IV – 10–50 or V – 1–100
>0,5	Critically polluted	VI	Complete absence of lichens	Complete absence of lichens

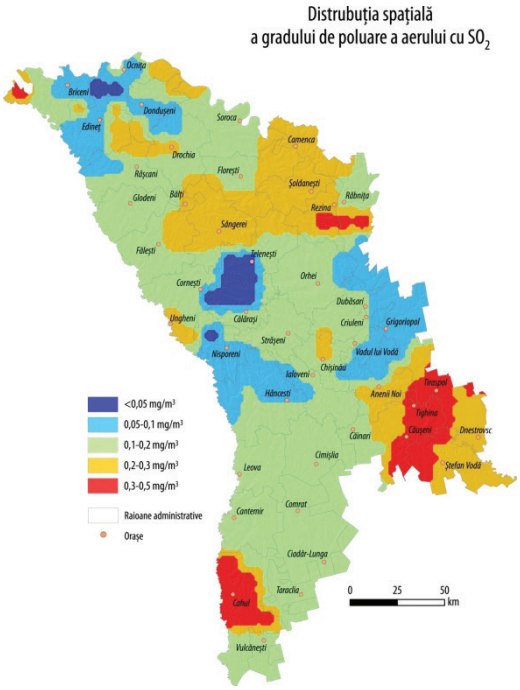

Fig. 3: The air quality on the base of lichens indication in the forest ecosystems

Practical application of these elaborations in testing the air quality in 60 forest ecosystems throughout the RM and 2 from abroad (Romania, Ukraine), revealed that in 4 ecosystems the air is highly polluted with SO_2, in 13 – the air is polluted, in 30 – moderately polluted, in 11 – low-polluted and in 4 – the air is clean (Fig. 3). These parameters are quite close to the Index of Atmospheric Purity (IAP) calculated on the basis of DeSloover et LeBlanc (1968) and Index of Poluotolerance of Trass (1985) formulas, but with some modifications suggested by us (i.e. – application of concrete percentage value of indicator substrate coverage and not of coefficients). Even if the degree of pollution of investigated forest ecosystems, assessed through different methods (IP, IAP, AQGS) ranged from clean air (<0.05 mg/m^3 air) to heavily polluted with SO_2

(0.3 – 0.5 mg/m^3 air), however in non of the ecosystems the pollutant exceeds the critical level (> 0.5 mg/m^3 air). The RM forest ecosystems have large reserves regarding the annual average, the duration of growing season and the critical level of pollution with SO_2 – 20 mg/m^3 air or even under the critical level for lichen communities – 10 mg/m^3 air. However, the intensification of industrial activities requires keeping this index under continuous supervision. Chemical analysis of water showed that precipitation from the N-NW and CE are relatively unpolluted with *S* and *N* ions, those from the NW are affected by NH_4^+ and NO_2, and particularly those from SW and S-SW are very polluted with NH_4^+, NO_2^-, NO_3^-, but also with enhanced content of SO_4 that influence their acidity (pH = 5,70) and pose toxic effect on vegetation.

The analysis of *briophyta, erysiphales* and *molluscs*, in terms of ecobioindication allows confirming that a number of chorological, morphological, anatomical and ecological peculiarities, that these organisms have, can be applied in ecobioindication method, enhancing the basic set of rules established through lichen indication.

Conclusions

1. The performed research lead to the establishment of ecobioindication application premises in the Republic of Moldova, expressed through: a) the presence of 40 indicator lichen species, which form certain associations sensitive to environment air pollution with SO_2, NO_x, etc., and accumulate increased concentrations of heavy metals b) partial application of mosses (*Bryophyta*) and molluscs (*Molusca)* as ecobioindicators, as well as for heavy metals (HM) accumulation and of fungi (*Erysiphales*) – for air pollution with SO_2.

2. Two criteria for the evaluation of the state of environmental components have been proposed: a Lichen Toxitolerance Scale (LTS) with 6 levels, taking into account the degree of air pollution by SO_2, the similarity of geographical conditions, and the results of own testing through applying gases, transplanting and studies in the field; and Gradations for Air Quality Assessment (GAQA) in forest ecosystems, based on indicator abundance/coverage, toxi-tolerance and correlation between different bio-indicator species.

3. *Parmelia sulcata* species, preponderant in forest ecosystems, has proved to be the most responsive to chemical air pollutants, particularly to SO_2, recording evident morphological and biochemical changes (changes in colour, degradation of thallus, degradation of photosynthetic pigments).

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APLICAREA LICHENOINDICAŢIEI ÎN TESTAREA CALITĂŢII MEDIULUI

(Rezumat)

Este prezentată o retrospectivă a cercetărilor lichenologice în Republica Moldova, începând cu anul 1934 şi până în prezent. Au fost elaborate criterii de evaluare a calităţii mediului, ca Scala Toxitoleranţei Lichenilor (STL) şi Gradaţii de Evaluare a Calităţii Aerului (GECA) faţă de SO_2 din aerul atmosferei, care au fost aplicate în testarea calităţii aerului din ecosistemele forestiere ale Republicii Moldova. Ţinând cont de diversitatea specifică, abundenţa şi toxitoleranţa speciilor indicatoare, sunt propuse 6 Gradaţii de Evaluare a Calităţii Aerului (GECA), care au fost aplicate în testarea calităţii aerului din 62 ecosistemele forestiere. De regulă, ecosistemele cu aer slab poluat sunt dispuse la altitudini de peste 200 m, iar cele cu aer poluat – sub 200 m, dar există şi excepţii, deoarece un rol prioritar îl poartă distanţa de la sursa de poluare şi direcţia dominantă a vânturilor. Este dată o analiză comparativă privind aplicarea GECA şi EMEP în RM. Sunt propuse 40 de specii indicatoare şi o specie standard (*Parmelia sulcata*) de licheni pentru monitorizarea calităţii mediului în condiţiile Republicii Moldova.

STÂRMINA FOREST. PHYTOSOCIOLOGIC CONSIDERATIONS

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Abstract: This article analyzed the phytocoenosis of *Quercetum farnetto-cerris* association identified in the ROSCI0173 Stârmina Forest in terms of bioforms, composition in the category ecological, genetic types (genetic structure), geoelements.

Keywords: phytosociology, plant association, Stârmina Forest

Introduction

The natural protected area Stârmina was declared natural, mixed reserve through Mehedinți County Council's Decision no. 26/1994 and also forest reserve of national interest by Law no. 5/06.03.2000 with regards to the approval Plan of improving the national territory – Section III protected areas, which was published in the Official Monitor no. 152/12.04.2000, with a surface of 100.3 ha. According to the Order of the Environment and Durable Development Minister no. 1964/13.12.2007 regarding implementing the natural, protected area regime to a site of communitary importance, as part of the Nature 2000 ecological European network in Romania, with the latest changes, ROSCI0173 Stârmina Forest has been declared a site of communitary importance (in Mehedinți: Devesel -<1%, Hinova – 2%) with a surface of 2769 ha.

Objectives (according to Nature 2000 Standard Form) [5]:

– preserving the habitats – 92A0 *Salix alba* and *Populus alba* galleries, 91M0 Pannonian Balkanic Turkey oak – sessile oak forest, 91F0 Riparian mixed forests of *Quercus robur*, *Ulmus laevis, U. minor, Fraxinus excelsior* or *F. angustifolia* along the great rivers (Ulmenion minoris);

– preserving the species within Annex II of Council's Directive 92/43/CEE – 1335 *Spermophilus citellus*, 1355 *Lutra lutra*, 1188 *Bombina bombina*, 1220 *Emys orbicularis*, 1217 *Testudo hermanni*, 1134 *Rhodeus sericeus amarus*, 1145 *Misgurnus fossilis*, 1089 *Morimus funereus*, 1088 *Cerambyx cerdo*.

ROSCI0173 Stârmina Forest presents connections with ROSPA0011 Blahnița.

Materials and methods

This research is based on field observation. The main method of study was the most frequent and appreciable of Montpellier School, the Braun-Blanquet method [1].

For each syntaxonomic unit, territorial spreading, floristical composition, biological structure, phytogeographic elements and ecological behavior correlated with plants' needs for humidity, temperature and soil pH are mentioned in the paper. A diploid and polyploid species graphic distribution was made as well.

Results and discussions

Cls. Quercetea pubescenti-petraeae (Oberd. 1948, 1857) Jakuc s 1961
Ord. Orno-Cotinetalia Jakucs 1961
Al. Quercion farnetto Horvat 1954
Ass. *Quercetum farnetto-cerris* Georgescu 1945, Rudski 1949 (Table 1)

Although the forest vegetation growing in our country was destroyed during the Würm glaciation, the *Quercus farnetto* and *Quercus cerris* populations have immigrated ever since the Boreal period and have reached their expansion climax during the Atlantic period. These thermophilic forests formed a compact area which stretched from South of Banat to Black Sea shore, and they can still be spotted in Varna (Bulgaria), on the Black Sea steep shore.

Once our agricultural terrains have extensive, the area where *Quercus cerris* and *Quercus farnetto* grew has been dislocated, however numerous clusters of various distensions have lasted.

Analyzing the bioform spectrum (Fig. 1), the hemicryptophytes predominance (46%) can be noticed, followed by yearly therophytes (12%). The fact that the hemicryptophytes grow in a wooden assortment emphasizes a disturbance of natural or antropic sort, and the dominant presence of therophytes suggests a high level of anthropic process [2].

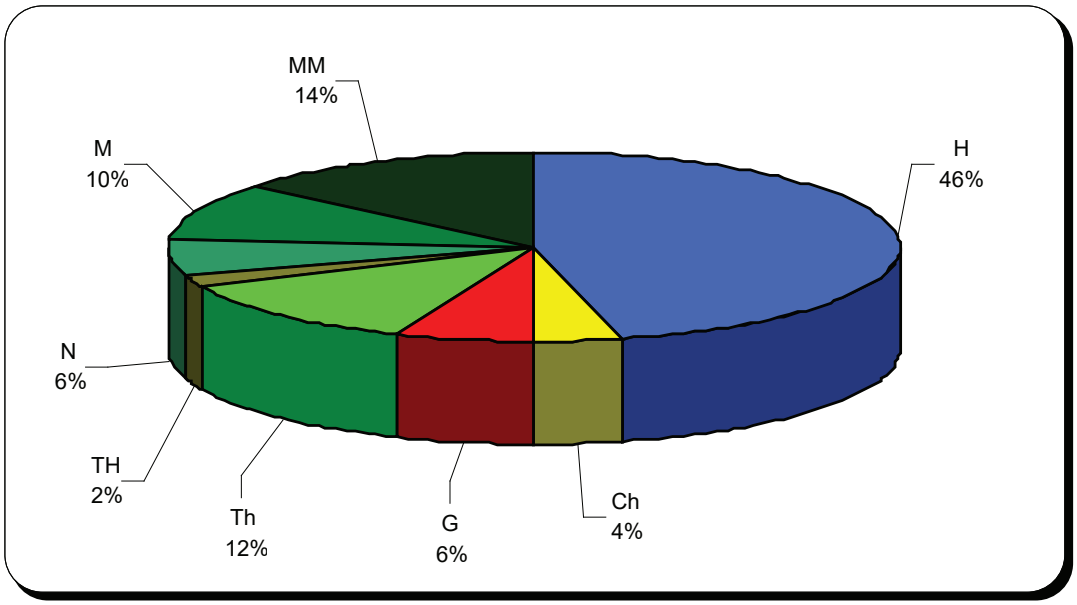

Fig. 1: Bioform spectrum of *Quercetum farnetto-cerris* association

Within the analysis on ecological categories (Fig. 2), the species' preferences have been taken into consideration with regards to the main ecologic factors: edaphic moisture (U), air temperature (T) and the soil reaction (R) [3]. Out of all the species ass. *Quercetum farnetto-cerris* (51 species), by edaphic moisture, 25 species are mesophilic and 22 species are xero-mesophilic, by the air temperature, 35 species are micro-mesotherms and 11 species are moderate-thermophilic, by the soil reaction, 27 species are low-acid-neutrophilous and 15 species are acid-neutrophilous.

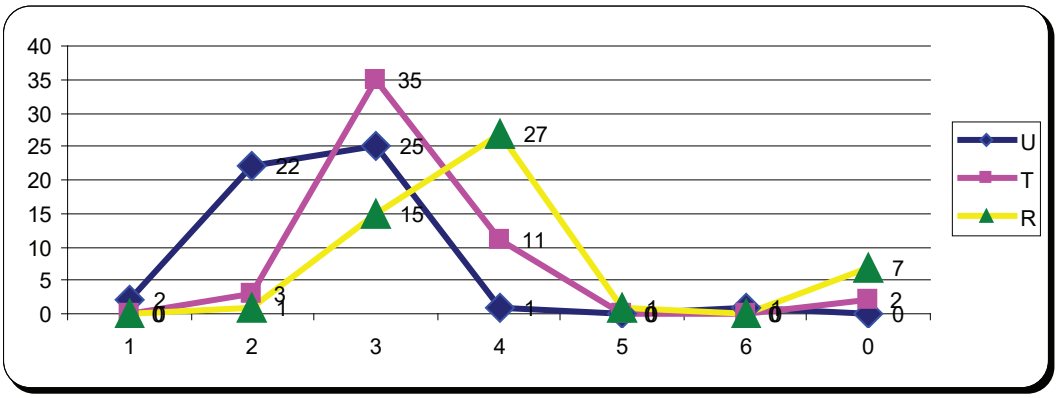

Fig. 2: Ecological indices of *Quercetum farnetto-cerris* association

Analyzing the karyological spectrum of ass. *Quercetum farnetto-cerris* (Fig. 3), a higher frequency of polyploid species (55.31%) has been observed, compared to the diploid species (40.42%) and diplo-polyploid species (4.25%). For ass. *Quercetum farnetto-cerris* the diploid index was calculated, which represents the rapport between the presences sum of all diploid species and the presences sum of all polyploid species. The value of diploid index (I.D.=0.729) is subunitary. The low value of diploid index shows that phytocoenosis are influenced by the pressures of disturbance factors.

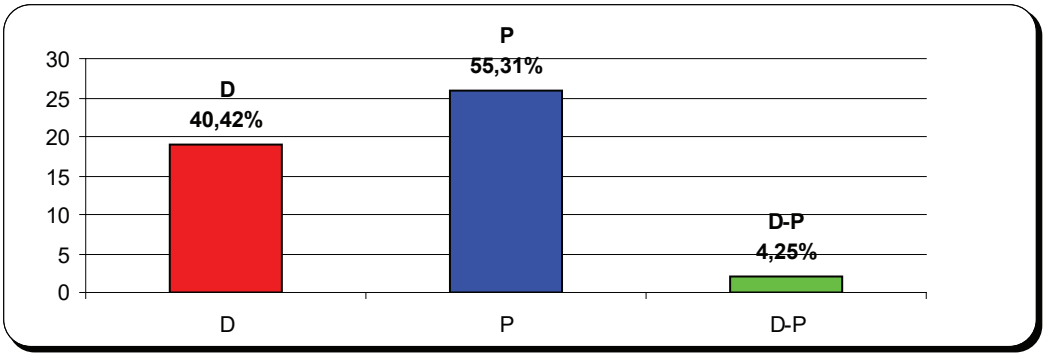

Fig. 3: Karyological spectrum of *Quercetum farnetto-cerris* association

The main categories of geo-elements of ass. *Quercetum farnetto-cerris* are (Fig. 4): Eurasian (23%), out of which 81% are Eua (Med); Mediterranean (23%), out of which 73% are Med, and 27% are Med-Atl, with a genesis in a temperate-oceanic climate with higher temperatures; European (16%), native from the regions with a temperate-moderate climate of Europe; Balkan (12%), with the genetic center in Balcani region, among which Balkan-Caucasian elements can be noticed, as well as Balkan-Pannonian; Pontic (10%), out of which 60% are Pontic-Mediterranean, whose genesis has been created within a temperate-warm climate with a summery hydrous deficit, specific for Mediterranean Sea and the Black Sea, to which we can add 20% Pontic-Mediterranean-Central European species and 20% Pontic-Pannonian-Balkan species, probably connected through the climate offered by the Pliocene lakes; Central-European (6%), with initially area in regions with a temperate-moist and gentle climate in Europe; Cosmopolitan (6%); Circumpolar-boreal (2%); Adventive (2%).

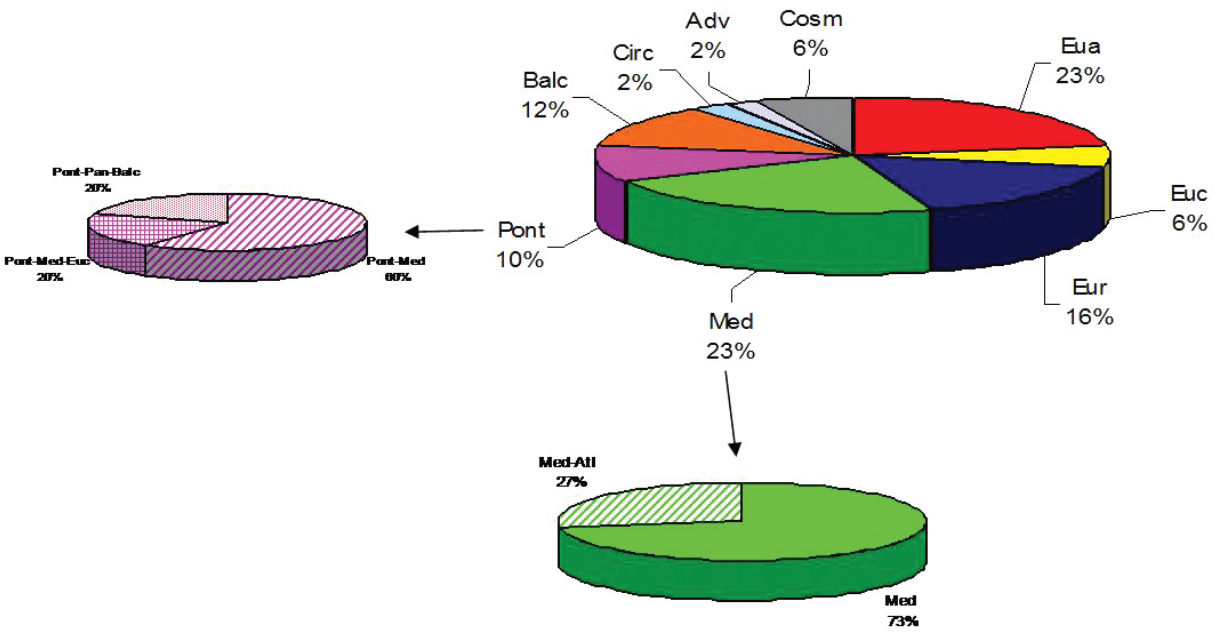

Fig. 4: Geoelements spectrum of *Quercetum farnetto-cerris* association

Table 1: *Quercetum farnetto-cerris* Georgescu 1945, Rudski 1949

F.b.	E.f.	Cyt.	Releve	1	2	3	4	5	6	K
			Exposition	V	V	V	V	SV	SV	
			Inclination (⁰)	45	45	30	30	10	10	
			Covering (%)	80	100	100	100	70	40	
			Surface (m²)	100	100	100	100	100	100	
			Quercion farnetto							
MM	Balc	-	*Quercus farnetto*	3	2	+	1	3	+	V
G-Ch	Pont-Med	P	*Ruscus aculeatus*	+	+	+	+	+	+	V
			Quercetea pubescenti-petraeae							
MM (M)	Med	D	*Quercus cerris*	2	3	3	4	2	2	V
M	Pont-Med-Euc	D-P	*Cornus mas*	+	1	2	2	+	+	V
H	Eua (Med)	P	*Brachypodium pinnatum*	-	+	+	+	+	+	V
H-G	Euc-Med	D	*Lithospermum purpureocaeruleum*	-	+	+	-	+	-	III
Ch	Euc-Med	P	*Teucrium chamaedrys*	+	-	-	+	+	-	III
H	Med	-	*Calystegia sylvatica*	-	+	+	-	-	+	III
			Orno-Cotinetalia							
H	Balc	P	*Helleborus odorus*	-	+	1	1	1	+	V
MM	Med	D	*Fraxinus ornus*	1	+	2	1	+	+	V
G	Med-Atl	P	*Tamus communis*	+	+	+	+	+	+	V
MM	Balc-Cauc	D	*Carpinus orientalis*	+	-	-	-	+	+	III
MM	Balc-Pan	D	*Tilia tomentosa*	-	+	-	+	-	-	II
H	Med	P	*Piptatherum virescens*	-	-	+	-	+	-	II
M	Eur (Med)	-	*Euonymus latifolia*	+	-	-	+	-	-	II
N	Med	P	*Rubus candicans*	-	+	-	+	-	-	II
			Syringo-Carpinion orientalis							
H	Balc	P	*Echinops banaticus*	-	+	+	+	+	+	V
			Querco-Fagetea s.l.							

F.b.	E.f.	Cyt.	**Releve**	**1**	**2**	**3**	**4**	**5**	**6**	**K**
			Exposition	V	V	V	V	SV	SV	
			Inclination (^{0})	45	45	30	30	10	10	
			Covering (%)	80	100	100	100	70	40	
			Surface (m^2)	100	100	100	100	100	100	
M	Eur	D	*Crataegus monogyna*	+	+	2	1	+	+	V
MM (M)	Eur	P	*Carpinus betulus*	+	1	+	+	-	+	V
N-E	Med-Atl	P	*Hedera helix*	+	+	+	+	1	1	V
H	Eua (Med)	P	*Geum urbanum*	+	+	+	-	+	+	V
H	Eua (Med)	D	*Brachypodium sylvaticum*	-	+	+	+	-	+	IV
MM-M	Eur	D	*Acer campestre*	+	+	-	+	+	-	IV
H	Pont-Med	D	*Lathyrus venetus*	+	+	+	+	-	-	IV
Ch	Eur (Med)	D	*Euphorbia amygdaloides*	-	+	+	-	+	+	IV
H (Ch)	Eua (Med)	P	*Sedum maximum*	-	-	+	+	+	-	III
M	Eur (Med)	D	*Staphylea pinnata*	-	-	+	+	-	+	III
H-Ch	Pont-Med	P	*Glechoma hirsuta*	-	+	+	+	-	-	III
H	Med-Atl	P	*Viola odorata*	-	-	+	+	-	+	III
Th (TH)	Eua (Med)	P	*Alliaria petiolata*	-	+	-	+	-	-	II
TH-H	Eur (Med)	D	*Anchusa officinalis*	-	-	-	+	-	+	II
M-MM	Eur	D	*Pyrus pyraster*	-	-	+	+	-	-	II
Th-TH	Cosm	P	*Geranium robertianum*	-	-	+	-	+	-	II
H	Cosm	P	*Cystopteris fragilis*	-	-	+	+	-	-	II
H	Eua (Med)	P	*Cruciata glabra*	-	+	-	-	+	-	II
Th	Eua (Med)	P	*Tanacetum corymbosum*	-	-	-	+	+	-	II
Th	Eua (Med)	D	*Bilderdykia dumetorum*	-	+	-	+	-	-	II
G	Pont-Pan-Balc	D	*Polygonatum latifolium*	-	-	-	-	+	+	II
H	Eua (Med)	D	*Campanula persicifolia*	+	+	-	-	-	-	II
			Variae syntaxa							
G	Euc	P	*Arum alpinum*	+	+	-	-	+	+	IV
H	Med	-	*Aremonia agrimonioides*	-	-	+	+	+	-	III
H	Med	D	*Parietaria officinalis*	-	-	-	+	+	+	III
H	Balc-Pan	D	*Achillea crithmifolia*	-	-	-	-	+	+	II
N	-	P	*Rosa micrantha*	-	+	+	-	-	-	II
H-Ch	Eua	D-P	*Glechoma hederacea*	-	-	+	+	-	-	II
Th (TH)	Med	P	*Lunaria annua*	+	-	+	-	-	-	II
Th	Circ (Bor)	P	*Galium aparine*	-	+	-	+	-	-	II
H (G)	Eua (Med)	P	*Ranunculus ficaria* ssp. *bulbifer*	-	-	+	-	+	-	II
H	Adv	P	*Phytolacca americana*	-	-	+	-	-	+	II
H (G)	Cosm	P	*Urtica dioica*	-	+	-	+	-	-	II
H	Eua	D	*Chelidonium majus*	-	-	-	-	+	+	II

Place and date of releve: 1–6 Stârmina Forest (14.05.2016)

Conclusions

The onsight observations, as well as phytocoenosis analysis ass. *Quercetum farnetto-cerris*, reveal a series of anthropic factors whielding pressure on the vegetation from ROSCI0173 Stârmina Forest.

According to the Integrated Management Plan (2015) [4], grazing within Stârmina Forest helps the soil settle, but also deteriorates bushes and shrubbery. DN56A passes through Stârmina Forest, which helps ruderal and invasive species spread, also plays a part in the death

of animals by collision. Collection the butcher's-broom (*Ruscus aculeatus*) represents a threat for the phytocoenosis of *Quercetum farnetto-cerris* association's stability. The chaotic dumping of waste, without an appropriate area to do so, have negative effects over the environment through ongoing pollution, degrading of landscape, spreading of ruderal species.

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5. *** *Formularul standard Natura 2000 al sitului ROSCI0173 Pădurea Stârmina.*

PĂDUREA STÂRMINA. CONSIDERAŢII FITOSOCIOLOGICE

(Rezumat)

În acest articol sunt analizate fitocenozele asociației *Quercetum farnetto-cerris* identificate în ROSCI0173 Pădurea Stârmina din punct de vedere al bioformelor, al compoziției pe categorii ecologice, pe tipuri genetice (structura genetică), al geoelementelor.

STATE OF PLANT SPECIES WITH PROTECTION POTENTIAL OF FOREST ECOSYSTEM "RACOVĂŢII DE SUD"

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Abstract: The work presents the results of the flora assessment within the ecosystem "Racovății de Sud", that shows the presence of species with limited distribution within Moldova, which are protected nationally and internationally. Some of them are registered for the first time within studied ecosystem.

Keywords: protection potential, rare plant species, forest ecosystem.

Introduction

The biodiversity evolved significantly throughout time along with changes and need to adapt to new living conditions. However, some species have gained a widespread within Terra others have disappeared or have remained in smaller territories. This phenomenon manifests itself in Moldova by destroying natural habitats, natural resources exploitation, and the indirect influence of pollutants, which results in diminution of abundance of flora and fauna species. The need to take urgent measures to conserve and restore habitats and ecosystems, protecting rare and endangered species is stipulated in international treaties, which are based on international agreements and conventions.

Materials and methods

As subject for study served the forest ecosystem "Racovății de Sud" from the forestry Soroca, Soroca State Forestry Enterprise in the Cereşnovăţ River basin (Fig. 1).

To achieve the aim of this study were conducted field and laboratory research in the period 2011–2015. Research in the field consisted of: the study of natural ecosystems in the main phenological phases of development of the ephemerals, annual, and perennial vegetation, inventory of rare species, evaluation of the abundance and state of valuable species [5]. Laboratory

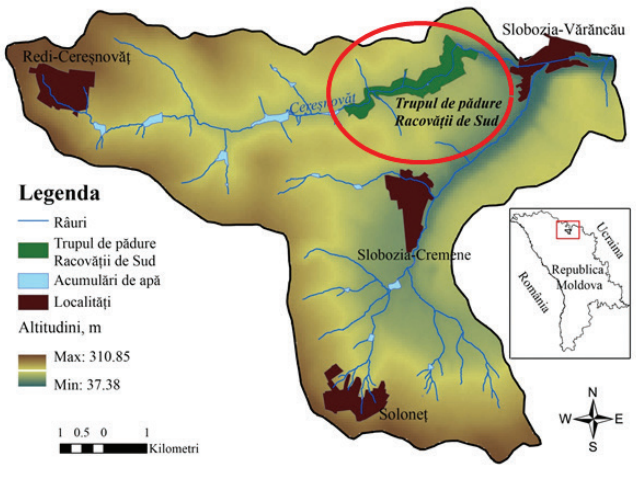

Fig. 1: Cereşnovăţ river basin

research included: the determination of systematic belonging and protection status of rare species, using literature [1, 2, 3, 4, 6, 7, 8].

Results and discussions

Forest ecosystem "Racovății de Sud" by the presence of forest elements, landforms, meadow elements and hydrographic elements (Cereşnovăţ r.) is represented and characterized by the interaction between these biotic and abiotic elements. Along with landscape elements formed by gorges, rocky geological formations, river meanderings, are registered valuable biotic elements too, represented by rare species of flora and fauna. Diverse landscape of forest ecosystem "Racovății de Sud" increases the chance of conservation of a number of threatened species and as result contributes to the growth of the biodiversity, having favorable conditions for mixtures of different types of vegetation, vegetation clumps of different structures, ecotons. It also represents a transition zone between different habitats, vegetation types of forest, meadow, marsh and aquatic, by the presence of ravines, river and lakes that are connected and flows into the river Nistru. Cereşnovăţ River crossing the forest ecosystem with frequent meanders and multiple thresholds provides more soil and air humidity and stimulates the creation of specific habitats for the animal and vegetation world, and also landscapes.

Plant propagation in a given area of land is subject to abiotic environmental factors and therefore the presence of certain plants, in a given territory, reflects the character of ecological factors in that territory.

Rich herbaceous layer composition (71 species) of the forest ecosystem "Racovății de Sud" includes species with normal yearly lifecycle as well as species with lifecycle restricted to vernal period, which must be protected. Species of prevernal flowering, indicating the existence of short vegetation period due to the short time period with favorable environmental conditions, and also the lack of competition with other species within this range are: (*Viola palustris*), (*Galanthus nivalis*), (*Crocus reticulatus*), (*Pulmonaria officinalis)*, (*Primula veris*), (*Convallaria majalis*) etc. (Tab. 1). Among the species of grass layer edifying characteristic to oak forests have been identified: (*Asparagus tenuifolius*), (*Melica uniflora*), (*Polygonatum latifolium*), (*Polygonatum multiflorum*). Under the canopy of trees persist sciophytes plant species (*Anemone ranunculoides*), (*Asarum europaeum*), (*Ficaria verna*), etc. In the meadow with higher level of moisture is present (*Aegopodium podagraria)*.

Within the studied forest ecosystem along with common species studied were recorded 17 species of plants with special conservation importance (Tab. 1), which are included in the Nomenclature of rare species of spontaneous flora of Moldova protected with law [6], expressed by national and international status of protection with a narrow tolerance range.

During spring on sunny slopes of studied aria is spread a carpet made of common snowdrop (*Galanthus nivalis*) vulnerable specie with highest frequency and with an abundance of 75% (Fig. 2). Bioecological forms – European (Mediterranean) geophyte; mesophyte specie, mesothermous, weakly acid-neutrophilic [4]. Status of protection – the Red Book of the Republic of Moldova (RBM) Red Book of Ukraine (RBU), Red List of the superior plants of Romania (RLR), CITES (II) (Tab. 1).

On the slopes, can be met fritillary (*Fritillaria montana*) a vulnerable specie (Fig. 3). Previously this specie was encountered in regions Edinet, Balti, Orhei, but for our territory is mentioned for the first time. Bioecological forms – European geophyte (Mediterranean); mesohygrophilous species, mesothermal, weakly acid – neutrophilic. [4]. Status of protection – RBM, RBU. (Tab. 1)

Fig. 2: ***Galanthus nivalis***

Fig. 3: ***Fritillaria montana***

Crocus *(Crocus reticulatus)*, endangered species grows within clearings of the given ecosystem with an abundance less than 5%. Bioecological forms – Ponto-Mediterranean geophyte; xero-mesophilic species, moderately thermophilic, acid-neutrophilic. Status of protection – RBU, RLR, protected of state.

Turk's cap lily (*Lilium martagon*), rare species is recorded with an abundance of 30% in our area. Bioecological forms – Eurasian geophyte; mesophilic species, amphitolerant weakly acid – neutrophilic. Status of protection – protected by the state, RRL, RBU, European Red List (ERL).

Broad Helleborine (*Epipactis helleborine*), a vulnerable species grow in studied area with a very low abundance less than 5%. Bioecological forms – central European geophyte; mesophilic species, mesothermal, weakly acid – neutrophilic. Status of protection – RRL, RBU, The European Red List (ERL), CITES (II).

Table 1: Checklist of species indicated in Red Lists found in forest ecosystem "Racovăţii de Sud"

Nr	Name	Abundance	Rare plants	RRM	RRL	URB	CITES	ERL
1	***Asparagus tenuifolius* Lam.**	10%	+					(LC)+
2	***Asplenium ruta-muraria* L.**	10%	+					
3	***Asplenium trichomanes* L.**	40%	+					
4	***Athyrium filix- femina* L.**	5%	+	(VU) +				
5	***Convallaria majalis* L.**	60%	+					
6	***Crocus reticulatus* Stev. ex Adams**	5%	+		+	+		(LC)+
7	***Cystopteris fragilis* (L.) Bernh**	30%	+					
8	***Dryopteris filix-mas* L.**	15%	+	(VU)+				
9	***Epipactis helleborine* (L) Crantz**	5%	+		+	+	(II)+	(LC)+
10	***Fritillaria montana* Hoppe.**	10%	+	(VU) +		+		(DD)+
11	***Galanthus nivalis* L.**	75%	+	(VU) +		+	(II)+	(NT)+
12	***Lilium martagon* L.**	30%	+		+	+		(LC)+
13	***Muscari neglectum* L.**	15%	+		+			

Nr	Name	Abundance	Rare plants	RRM	RRL	URB	CITES	ERL
14	***Pulmonaria officinalis* L.**	40%	+					
15	***Primula veris* L.**	15%	+					
16	***Viola palustris* L.**	50%	+		+			
17	***Veratrum nigrum* L.**	40%	+		+			

Cliff's cracks and limestone sectors of the ecosystem "Racovăţii de Sud", are populated by rare epilithic species (*Cystopteris fragilis*), (*Asplenium trichomanes),* (*Asplenium ruta-muraria*), (*Dryopteris filix-mas*) (Fig. 4), (*Athyrium filix-femina)*. The last two are included in RBM as vulnerable species, having an abundance of 15% and 5%. Limestone slopes, rock crevices are good habitat for maidenhair spleenwort (*Asplenium trichomanes*) (Fig. 5) that is encountered with an abundance of 50%. Bioecological forms – hemicriptophytes Cosmopolitan; mesophilic, amphitolerant species, weakly acid – neutrophilic. On wet rocks covered with moss of studied forest ecosystem grows with an abundance of 30% Brittle bladder fern (*Cystopteris fragilis*) (Fig. 6). Bioecological forms – hemicriptophytes Cosmopolitan; mesophilic species, amphitolerant, euryonic. Status of protection – protected by the state. Wall – rue (*Asplenium ruta- muraria*) unthreatening plant (Fig. 7), only growing on limestone and other calcareous stones with an abundance of about 10%. Bioecological forms – hemicriptophytes circumpolar; xerophilic specie, mesothermal, neutrobasophilic. Status of protection – protected by the state.

Fig. 4: ***Dryopteris filix-mas***

Fig. 5: ***Asplenium trichomanes***

Fig. 6: ***Cystopteris fragilis***

Fig. 7: ***Asplenium ruta-muraria***

Another species that prefer edges of this area on calcareous, stony, clay soil is lungwort (*Pulmonaria officinalis*), rare species, having an abundance of 40%. Bioecological forms – European hemicriptophytes; mesophilic species, mesothermal, acid-neutrophilic.

Black false hellebore (*Veratrum nigrum*), rare species with an abundance of 40% grows in shady places, prefers soils rich in calcium. Bioecological forms – Eurasian geophyte; xero-mesophilic, eurythermic, weakly acid – neutrophilic. Status of protection – protected by the state, RLR .

Lily of the Valley (*Convallaria majalis*) is a rare plant found within the country. In the studied area is found with an abundance of 60%. Bioecological forms – European geophyte; xero-mesophilic species, mesothermal, acid-neutrophilic.

Asparagus tenuifolius endangered species, also is present in ecosystem studied with an abundance of 15%. Bioecological forms – Ponto-Mediterranean geophyte; xero-mesophilic species, thermophilic, acid-neutrophilic. Status of protection – protected by the state [4].

Forest edge and glades forest ecosystem "Racovăţii de Sud", is populated by common cowslip (*Primula veris*), rare species with an abundance of 15%. This specie grows best on moist, well-drained soils. Bioecological forms – Eurasian hemicryptophyte; mesophilic species, microterm, neutrobasophilic.

Also at the forests edge grows with an abundance of 10% grape hyacinth (*Muscari neglectum*) rare species. Bioecological forms – geophyte Mediterranean-European central; xerophilic species, moderately thermophilic, neutrobasophilic. Status of protection –RLR.

In addition to superior plant species were recorded species of lichens and moss, which can serve as indicators of the degree of air pollution in the ecosystem, being also rare species with different protection status. The forest "Racovăţii de Sud", serves as habitat for various species of lichens including *Evernia prunastri, Cladonia fimbriata, Parmelia sulcata, Parmelia caperata, Parmelia olivacea, Parmelia acetabulum, Hypogymnia physodes Candelariella vitellina* – rare in our country, with an abundance below 25% and *Ramalina fraxinea* – included in RBM.

The base of dominant and subdominant tree stems are often covered with a carpet of pure sinuses or in association with other species of bryophytes, especially with: *Atrichum undulatum, Leskea polycarpa*, *Anamodon viticulosus*, *Mnium cuspidatum* – that serve as indicators of air pollution. The rocky sector of the Cereşnovăţ River is a good habitat for *Marchantia polymorpha*, which also have an important ecological indicator serving as air pollution.

Literature review on the distribution of rare species within geobotanical districts of our country, revealed new resorts in forest ecosystem "Racovăţii de Sud" development for: *Asparagus tenuifolius, Crocus reticulatus, Cystopteris fragilis*.

Due to the location of the RM at the crossroads of three biogeographical zones: Central European, Eurasian and Mediterranean and location of the forest ecosystem "Racovăţii de Sud" in the forest steppe zone, characteristic to the biogeographical Eurasian area, predominant species are Eurasian (56%), followed by the Mediterranean (13%), Pontic (13%), Cosmopolitan (12%) and the lowest share Circumpolar plant (6%) (Fig. 8).

The temperate continental climate influenced by Atlantic and temperate continental air masses from eastern Europe, with optimal moisture conditions, favored the dominance (44%) of the mesophilic spicies within the ecosystem "Racovăţii de Sud" (Fig. 9). Besides temperate continental climate – an important factor favoring the mesophilic spicies is the upper floor of the forest ecosystem, represented by broad-leaved tree species (species of oak, maple). Global warming trends have led to presence of xero-mesophilic species (25%), that like moderately wet-dry areas.

In the same way, the trends to aridity caused the presence of xerophilic species (19%) – plants adapted to moisture deficit. Mesohygrophilous species, which are represented by the

lowest percentage (12%), tolerates the area just because of the presence of the Cereșnovăț River (small river), which determines the presence of wet soils and wet rocks.

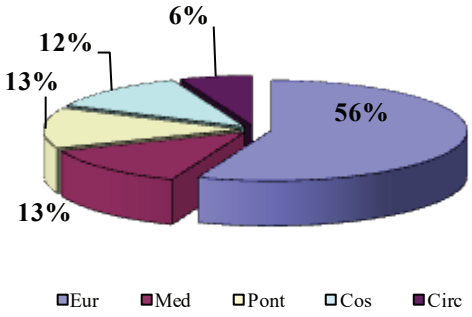

Fig. 8: Floristic spectrum

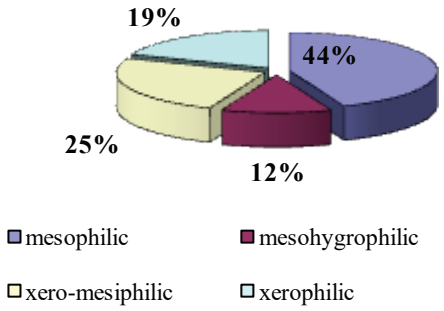

Fig. 9: Indices of humidity

As in the previous case, the temperate continental climate is the main factor determining the prevalence of species that prefer moderate mesothermal temperatures (44%), average temperatures during the growing season (from 15.5 – 21.0 C) in the studied area are perfect to increase this group of plants (Fig. 10). Climatic conditions of the studied area, more stable than in other regions of the country, are favorable for the growth and development of groups of plants with a wide ecological valence to variability of the environmental conditions, which are represented by moderately thermophilic (19%) and amfitolerante (19%). The influence of continental air masses that bring lower temperatures at the north of the country favors the presence of microtermal plants (12%) and the eurithermal species (6%).

Edaphical conditions of the ecosystem "Racovății de Sud" characterized by the optimum – very high level of humus supply and alkaline soil (7.3 to 8.4) favored the presence of neutrophils plants. Depending on the mentioned edaphical conditions is noticed the weight of species weakly acid-neutrophils (37%), followed by acid-neutrophils plants (25%) and the lowest weight of the neutro-baziphilic and euryonic species 19% each (Fig. 11). The last two are characteristic by a very broad ecological valence, with a slight adjustment to wide variations of the soil or water pH.

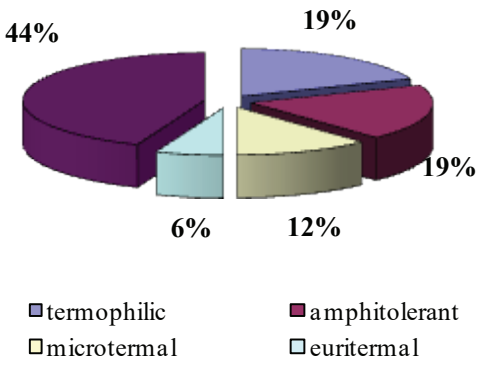

Fig. 10: Temperature indicators

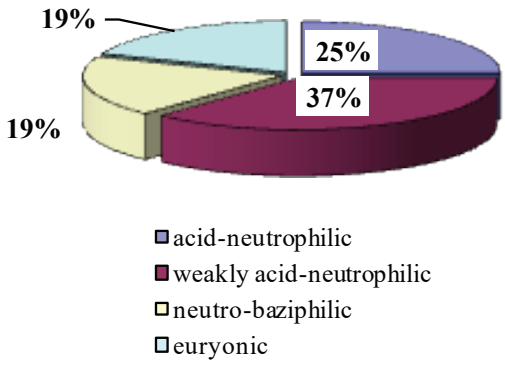

Fig. 11: Soil reaction indicators

Conclusions

Studied ecosystem's flora assessment results indicates the presence of 17 species with limited spread in the Republic of Moldova being under national regional international protection status species, that represents special scientific value.

Floristic value of forest ecosystem "Racovăţii de Sud" is characterized by a high diversity of rare and common species, where for rare species (*Asparagus tenuifolius, Crocus reticulatus, Cystopteris fragilis, Fritillaria montana*) the studied ecosystem serves as a new resort.

In order to optimize biodiversity conservation in the Republic of Moldova, by harnessing the biotic and abiotic potential of the forest ecosystem "Racovăţii de Sud", it can be proposed as a protected area taking into account the populations of rare plants and reprezentativ abiotic elements.

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STAREA SPECIILOR DE PLANTE CU POTENŢIAL DE PROTECŢIE ÎN ECOSISTEMUL FORESTIER „RACOVĂŢII DE SUD"

(Rezumat)

Lucrarea de faţă prezintă rezultatele evaluării florei din ecosistemul „Racovăţii de Sud", ce denotă prezenţa a 17 specii de plante superioare cu răspândire limitată pe teritoriul Republicii Moldova, ocrotite la nivel naţional şi/sau internaţional, incluse în Cartea Roşie a Republicii Moldova (4 specii), Lista Roşie a României (3 specii), Cartea Roşie a Ucrainei (6 specii) şi Anexa a II-a a Convenţiei de la Washington (1973) (2 specii). Unele dintre ele sunt înregistrate pentru prima data în ecosistemul cercetat. Astfel, ecosistemul studiat poate servi ca arie de studiu ştiinţific în domeniul biodiversităţii şi poate fi propus ca arie protejată.

THE ORCHIDACEAE FAMILY IN COLLECTIONS OF MUREŞ COUNTY MUSEUM, NATURAL SCIENCE DEPARTMENT

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Abstract: This paper presents a part of the plants' collection of the Mureş County Museum namely Orchidaceae family. A number of 184 herbarium sheets with plants belonging to this family were processed.

The research of botanical collection has identified a total of 42 taxa represented by 16 genera, 35 species, 3 subspecies and 4 varieties and forms belonging to the Orchidaceae family.

The specified data are mentioned for each species: date and place of collection, the name of whom collected it and of whom determined the plant, the sozological category and the conservation status. In brackets are also mentioned the inventory numbers of the herbarium sheets included in inventory registries Superior Plants (I, II and III) of the Department of Natural Sciences.

The species come from the collection of spontaneous flora, in many towns in the Mureş county and in different parts of Romania.

The oldest specimens come from Odor collection, dating from 1890–1891.

Among the species of orchid preserved in the herbarium of the museum are three species of Community interest listed in Annexes of the Habitats Directive (*Cypripedium calceolus, Liparis loeselii, Himantoglossum jankae*).

Introduction

The heritage of Natural Sciences Department of Mureş County Museum contains numerous collections, whose scientific and documentary value is indisputable. The museum Herbarium comprises about 20000 pieces coming from field research, donations and purchases.

More than 15000 herbarium sheets, seeds and fruits of wild and cultivated plants and woods, make up this collection. Among them many species of rare plants, relicts, endemic and natural monuments, mentioned in the national and international red lists are found.

The scientific value of this collection lies in the fact that there are herbarium sheet with rare species or collected from areas where those species have disappeared, and also that some were collected by the famous botanists.

Geographical area of collection was mostly our country, but there are sheets with plants collected from different countries in Europe.

Of particular importance is Nagy Ödön collection, numbering 4800 herbarium sheets and reflecting the flora of Târgu-Mureş surroundings and beyond.

By age and variety of species found in Museum's Herbarium this constitutes an outstanding scientific value data base.

Regarding the method of preserving plants in the scientific Herbarium, they were prepared by typically drying process, were pressed and then glued on herbarium sheets. These are kept in cardboard boxes placed on shelves and in wood cabinets in botanical store. Because preservation methods were appropriate plant material shows until today in a good state of conservation.

In this study we aimed to analyze the orchid species in the collection of Natural Sciences Department of the Mureş County Museum.

Materials and methods

A number of 184 herbarium sheets with plants belonging to the family Orchidaceae were processed.

Within the family, the plants have been listed in systematic order of genera and species [11]. Plant nomenclature was revised in accordance with the International Code of Botanical Nomenclature [7], Flora Europaea [12, 13], Ciocârlan V. [3] and Sârbu & al. [11].

For each species were mentioned: date and place of collection, the name of whom collected and determined the plant, the sozological category and the conservation status. In brackets are also mentioned the inventory numbers of the herbarium sheets included in inventory registries Superior Plants (I, II and III) of the Natural Sciences Department.

In determining endangered, rare or vulnerable species, National Red Lists [2, 5, 6, 9] were consulted, as well as the latest version of sozological categories published in the European red list of vascular plants [1]. Also we took in Consideration "The critical list of vascular plants in Romania" [10].

Results and discussions

The orchid family (Orchidaceae), has over 18000–19000 species in the world, consisting of herbaceous plants, terrestrial or epiphytic (prevalent in inter-tropical region). The beauty of their flowers makes the species belonging to this family to be by far the most popular [4].

Romania has, according to the literature [11], a total of 64 species and 20 subspecies of native orchids belonging to 26 genera. Wild orchids in our country are terrestrial species that grow in various habitats such as: grasslands, swamps, forests and clearings, forest fringes.

Orchids' presence indicates good conservation status of a habitat, and at the same time, is an indicator of high conservation value for biodiversity of the habitat so of the undisturbed and intra and inter-specific relationships.

Due to the specific biology and ecology orchids are a true indicator of the degree of "naturalness / wildness" of natural habitats.

Almost all species of Orchidaceae family that grow in continental area of Europe have small populations and under-represented, so collecting them in nature is strictly prohibited, they are protected by laws.

In Romania, some species are strictly protected by specific legislation and many species of orchids that grow in our country are listed in national red lists [2, 5, 9] and The Red Book of vascular plants in Romania [6].

The research of botanical collection of the Natural Sciences Department has identified a total of 42 taxa belonging to Orchidaceae family. They are represented by 16 genera, 35 species, 3 subspecies and 4 varieties and forms.

The species come from the collection of spontaneous plants, in many localities in the Mureş County and also in different parts of Romania.

The oldest items belong to Odor collection part of Nagy Ödön collection, sheets dating from 1890 and 1891.

A remarkable number of sheets belong to "Nagy Ödön" collection. Nagy Ödön was a biology teacher of "Bolyai Farkas" high school in Târgu-Mureş, and he has the merit of being studied the flora in the surroundings of Târgu-Mureş during the period of 1920–1950.

Also we mention the herbarium sheets purchased from the Botanical Garden "Alexandru Borza" Cluj-Napoca, some of them with plants collected by great personalities of Romanian botany: Al. Borza, N. Boşcaiu, C. Burduja, I. Gergely, G. P. Grinţescu, I. Hodişan, M. Răvăruţ, E. I. Nyárády, E. Ţopa etc.

Ord. ORCHIDALES
Fam. ORCHIDACEAE

Anacamptis pyramidalis (L.) Rich.
Sozological category: V/R [9], VU [10]
1941. 06. 27, B, leg. H. Höhr (5132)

Cypripedium calceolus L. – species protected by law as "nature monument" [11]
Sozological category: V [5], V/R [9]. E [2], VU [10], HD AN IIb BC (Natura 2000 code: 1902)
1891, CJ, Căpuşu Mic, B, leg. Odor (4768)
1972. 06. 14, MS, Orşova, Seci hamlet, B, leg. Sarkany Andrei (12584)
1979. 05, MS, Orşova, Seci hamlet, B, leg. Sarkany Andrei (12585)

Traunsteinera globosa (L.) Rchb. (syn. *Orchis globosus* L.)
Sozological category: NT [10]
1937. 07. 04, HR, Lacul Roşu, altit. 1350, B, leg. Nagy Ödön (12586)
1940. 08. 20, HR, Lacul Roşu, altit. 1400 m, B, leg. Nagy Ödön (12587)
1957. 07. 11, AB, meadows at "Berek", near Colţeşti village, B, leg. B, I. Gergely (8697)
1979. 05, MS, Orşova, Seci hamlet, B, leg. Sarkani Andrei, det. Mihaela Sămărghiţan (12588)

Goodyera repens (L.) R. Br.
Sozological category: R [5], NT [10]
1935. 07. 10, HR, Lacul Roşu, altit. 1000 m, B, leg. Nagy Ödön (12589)
1935. 08. 10, HR, Lacul Roşu, altit. 1000 m, B, leg. Nagy Ödön (12590)

Spiranthes spiralis (L.) Chevall.
Sozological category: R [9], NT [10]
1937. 08. 25, CV, Vîlcele Resort, B, leg. Ana M. Paucă (10081)

Liparis loeselii (L.) Rich.
Categorie sozologică: CR [6], R [5], R [9], NT [10], HD AN IIb BC (Natura 2000 code: 1903)
SB, Sibiu, B, leg. Odor offered by H. Höhr, E, (4745)

Limodorum abortivum (L.) Sw.
Sozological category: V [5], R [9], R [2], NT [10]
2004. 06. 02, MS, Criş, Daneş commune, B, leg. Mihaela Sămărghiţan (12591)

Neotia nidus-avis (L.) Rich.
Sozological category: R [9], NT [10]
1901. 05. 20, CS, Sasca Montană, "Tilva Samueli", B, leg. Odor (4746 B)
1901. 05. 20, SB, Sibiu, forest, B, leg. Odor (4746 A)
1937. 05. 10, MS, Târgu-Mureş Platoul Corneşti, B, leg. Nagy Ödön (503)
1939. 04. 14, MS, Târgu-Mureş Platoul Corneşti, B, leg. Nagy Ödön (504)
1946. 03., CJ, Făget, B, leg. Kyri Maria Margareta (7510)
1946. 03., CJ, Fânaţele Clujului, B, leg. Kyri Maria Margareta (7511)
1994. 06. 15, MS, Răstoliţa, Podirei, beech forest, B, leg. Silvia Oroian (11116)
1996. 05. 23, MS, Răstoliţa, Podirei, B, leg. Silvia Oroian, Mihaela Sămărghiţan (11125)
1996. 05. 23, MS, Răstoliţa, Podirei, beech forest, B, leg. Silvia Oroian (11125)
1996. 05. 25, MS, Răstoliţa, Podirei, B, leg. Silvia Oroian, Mihaela Sămărghiţan (11132)
1998. 06. 10, MS, Piatra Orşova, B, leg. Mihaela Sămărghiţan (12592)
2004. 06. 02, MS, Criş, Daneş commune, B, leg. Mihaela Sămărghiţan (12593)

Orchis morio L.
Sozological category: R [9], NT [10]
1891, CJ, Căpuşu Mare, B, leg. Odor (4759 A)
1900, CS, Sasca Montană, "Valea Radimna", B, leg. Odor (4759 B)
1908. 04. 24, MS, Târgu-Mureş, vine, B, leg. Bitai Arpad, Nagy Ödön collection (12594)
1937. 05. 06, BN, Mt. Căsaru, Mureşeni Bîrgău, B, leg. S. Forstner (10071)
1937. 05. 11, MS, Târgu-Mureş, B, Nagy Ödön (495)
1937. 05. 11, MS, Târgu-Mureş, bricks factory, 350 m altit., B, leg. Nagy Ödön (12595)
1937. 05. 13, IS, Bîrnova forest, B, leg. B, C. Burduja, M. Răvăruţ (10072)
1938. 05. 18, MS, Târgu-Mureş, brick factory, 350 m altit., B, leg. Nagy Ödön (12596)
1939. 05. 14, MS, Târgu-Mureş, Platoul Cornesti, B, leg. Nagy Ödön (494)
1946. 05., CJ, Făget, B, Kyri Maria Margareta, (7513)
1960. 06. 15, MS, Deda-Bistra Mureşului, Scaunul Domnului, B, leg. Konya István, (5752)
1960. 06. 15, MS, Deda-Bistra Mureşului, Scaunul Domnului, B, leg. Konya István, (5752)
1960. 06. 15, MS, Deda, Bistra Mureşului, Scaunul, B, leg. Konya I. (12597)
1967. 05. 08, MS, Gurghiu, B, leg. Konya Istvan, det. Mihaela Sămărghiţan (12598)
1967. 06. 01, CJ, Mera, B, leg. I. Gergely (8638)
1980. 05. 06, MS, Vălenii de Mureş, B, leg. Silvia Oroian (12599)
1980. 05. 06, MS, Vălenii de Mureş, B, leg. Sarkany Andrei (12600)
1981. 07. 01, MS, Zau de Câmpie jud. Mureş, B, leg. Eftenie Ioan (12601)
1982. 05. 20, MS, Sovata-Săcădat, B, leg. Szombath Zoltan, det. Silvia Oroian (12602)
1987. 05. 12, MS, Sînpaul, B, leg. Silvia Oroian (12603)
1991. 05. 04, MS, Gurghiu, pasture, B, leg. Silvia Oroian (7700)
1991. 06. 06, MS, Gurghiu, the hill near Poiana Narciselor reserve, B, leg. Silvia Oroian, (7690)
1991. 06. 06, MS, Poiana Narciselor Gurghiu reserve, B, leg. Silvia Oroian, det. Mihaela Sămărghiţan (12604)
1992. 05. 05, MS, Gurghiu Poiana Narciselor reserve, B, leg. Silvia Oroian, (7520)
1992. 06. 24, MS, Jabeniţa, near salty lake, B, leg. I. Eftenie (12605)
1995. 05. 22, MS, Săbed, grassland, B, leg. Silvia Oroian (12606)
1995. 06. 02, MS, Răstoliţa, Podirei, grassland, B, leg. Silvia Oroian, Mihaela Sămărghiţan (11135)

Orchis coriophora L.
Sozological category: R [9], NT [10]
1890, CJ, Mănăştur forest, B, leg. Odor (4757 C)
1901. 05. 28, CS, Sasca Montană "Padina Radimna", B, leg. Odor (4757 B)
1921. 06. 01, MS, Şîlea, B, leg. E. I. Nyárády (10074)
1941. 06. 02, B, leg. Heinrich Höhr (5211)
1967. 06. 14, CS, Moldova Veche, B, leg. I. Gergely (8637)
Collecting date unknown, SB, Sibiu, B, leg. Odor (4757A)

Orchis ustulata L.
Sozological category: R [9]
1936. 07. 14, HR, Lacul Roşu, B, leg. Nagy Ödön (12607)
1938. 07. 12, HR, Lacul Roşu, Făgetul Ciucului, altit. 1000 m, B, leg. Nagy Ödön (12608)
1939. 07, HR, Lacul Roşu, B, leg. Nagy Ödön (12609)
1939. 07. 10, HR, Csiki bükk, altit. 1050 m, B, B, leg. Nagy Ödön (12610)
Collecting date unknown, SB, Sibiu, B, Col: Odor (4754)

Orchis tridentata Scop.
Sozological category: R [9], NT [10]
1973. 05. 17, CJ, Hoia forest, near Cluj-Napoca, B, leg. I. Gergely, V. Farcaşiu et F. Lörinczi (8928)
SB, Guşteriţa, B, Hannich H. (4753)

Orchis purpurea Huds. (syn. *Orchis fusca* Jacq.)
Sozological category: R [9], NT [10]
SB, Guşteriţa, B, leg. Hannich H. (4756)

Orchis militaris L.
Sozological category: R [9], NT [10]
1972. 05. 02, AB, Scărişoara Belioara, B, leg. Florentina Togănel, det. Silvia Oroian (12611)

Orchis laxiflora Lam. **ssp. *elegans*** (Heuff.) Soó (syn *Orchis palustris* Jacq. ssp. *elegans* (Heuff.) Nyár., *Orchis elegans* Heuff.)
Sozological category: R [9], NT [10]
1911. 06. 02, CJ, Valea Someşului, near Apahida, Mus. Bot. Cluj (10076)
1920. 05. 28, AG, meadows in Argeşului River side near Copăceni, B, B, leg. G. P. Grinţescu (10075)
1933. 06. 02, BT, meadows between Dorohoi and Herţa, B, leg. E. Ţopa (10077)
1938, B, MS, Nagy Ödön (501)
1939. 06. 10, MS, Târgu-Mureş Halmok Hill, B, leg. Nagy Ödön (496)
1939. 06. 10, MS, Târgu-Mureş Halmok Hill, B, leg. Nagy Ödön (497)
1943. 06. 10, MS, Sângeorgiu de Mureş, B, leg. Nagy Ödön (499)
1943. 06. 10, MS, Sângeorgiu de Mureş, B, leg. Nagy Ödön (500)
1947. 06. 02, MS, Şardu Nirajului, B, leg. Nagy Ödön (502)
1948. 06. 08, MS, Târgu-Mureş, B, leg. Nagy Ödön (498)
1967. 06. 15, CS, Moldova Veche, B, leg. I. Gergely (8636)

1972. 06. 22, HR, between Mădăraş and Racu, B, leg. I. Gergely (8634)
1981. 05. 26, MS, Sîngeorgiu de Mureș, near salty bath, B, leg. Silvia Oroian, & Mihaela Sămărghițan (12612)
1982. 07. 06, HR, near Sîntimbru, B, leg. I. Gergely (9373)
1994. 06. 15, MS, Răstolița, meadow, B, leg. Silvia Oroian (11117)
1994. 06. 18, MS, Deda Bistra, meadow, B, leg. Silvia Oroian (11118)
2000. 06. 07, MS, Păuloaia, B, leg. Mihaela Sămărghițan (12613)
ssp. *palustris* (Jacq.) Bonnier & Layens (syn *Orchis palustris* Jacq.)
Sozological category: R [9]
1967. 06. 16, CS, Moldova Veche, B, leg. I. Gergely (8635)
1976. 06. 13, MS, Lacul Fărăgău, B, leg. Konya I. (5826)

Orchis mascula (L.) L. ssp. ***signifera*** (Vest) Soó
Sozological category: R [9], NT [10]
1901. 05, CJ, Feleacu "Valea Morii", B, leg. Odor (4758)
1910. 06. 05., B, leg. H. Höhr (5214)

Dactylorhiza sambucina (L.) Soó (syn. *Orchis sambucina* L.)
Sozological category: R [9], NT [10]
1901, CS, Sasca Montană, B, leg. Kristen M. (4760a)
1901, CS, Sasca Montană, B, leg. Kristen M. (4760b)
1929. 05. 20, HR, Dealu, B, leg. E. I. Nyárády (10073)
1956. 05. 20, CJ, Mt. Băişorii, B, leg. I. Hodişan (9457)
1979, MS, Orşova, Seci hamlet, B, leg. Sarkany A., det. Mihaela Sămărghiţan (12614)
f. *ochroleuca* Winterl
1958. 06., AB, Mt. Scărişoara-Belioara, B (9340)
f. *rubra* (Winterl) Hyl.
1958. 06., AB, Mt. Scărişoara-Belioara, B (9341)

Dactylorhiza maculata (L.) Soó (*Orchis maculata* L.)
Sozological category: R [9], NT [10]
1981. 05. 26, MS, Orşova Pădure, B, leg. Szombath Zoltán, det. Mihaela Sămărghițan (12615a) 1
1981. 05. 26, MS, Orşova Pădure, B, leg. Szombath Zoltán, det. Mihaela Sămărghițan (12615b)
1994. 05. 16, MS, Gurghiu, Poiana Narciselor reserve, B, leg. Silvia Oroian, det. Mihaela Sămărghițan (12616)
1994. 05. 18, HR, between Topliţa and Ciobotani, swamp, B, leg. Silvia Oroian (11121)
1994. 06. 03, MS, Orşova Pădure, B, leg. Silvia Oroian, det. Mihaela Sămărghițan (12617)
1998. 06. 10, MS, Orşova, B, leg. Mihaela Sămărghițan (12618)
SB, Sibiu, B, Col: Odor (4752)

Dactylorhiza saccifera (Brongn) Soó (syn. *Dactylorhiza maculata* L. ssp. *macostachys* (Tineo) Hayek)
Sozological category: -
1979. 05, MS, Orşova, Seci hamlet, B, leg. Konya I., det. Mihaela Sămărghițan (12619)

1994. 05. 18, HR, Topliţa – Ciobotani, swamp, B, leg. Silvia Oroian, Mihaela Sămărghiţan (11120)
1994. 06. 03, MS, Orşova Pădure, B, leg. Silvia Oroian, Mihaela Sămărghiţan (12620)

Dactylorhiza incarnata (L.) Soó, (syn. *Orchis incarnata* L.)
Sozological category: R [9], NT [10]
1901. 06. 70, CJ, close to Feleac, B, Col. Odor (10078)
1983. 06. 08, HR, near Sîntimbru, B, leg. I. Gergely (9527)
1998. 06. 10, MS, Orşova Pădure, jud. MS, B, leg. Mihaela Sămărghiţan (12621)

Dactylorhiza majalis (Rchb.) P. H. Hunt et Summerh. (syn. *Orchis latifolia* L. pro parte)
Sozological category: R [5], NT [10]
1982. 06. 10., HR,Senetea, B, leg. Konya I., det. Silvia Oroian (12622)
SB, Sibiu, B, leg. Odor (4755)
1910. 06. 05, B, H. Höhr (5213)

Dactylorhiza cordigera (Fries) Soó ssp. *cordigera*
Sozological category: R [9], NT [10]
1933. 08. 12, Mt. Retezat, Valea Bucurei, B, leg. Al. Borza, E. I. Nyárády (10079)

Himantoglossum jankae Somlyay, Kreutz & Óvári (under *Himantoglossum hircinum* (L.) Spreng.)
Sozological category: R [9], VU [10], HD AN IIb (Natura 2000 code: 2327)
1901. 06. 27, CS, Sasca Montană, "Tilva Samueli", B, leg. Odor (4763)

Gymnadenia conopsea (L.) R. Br.
Sozological category: R [9], NT [10]
1901, CS, Sasca Montană "Valea Radimna", B, leg. Odor (4764 B)
1901, SB, Sibiu, B, leg. Odor (4764 A)
1937. 07. 07, HR, Lacul Roşu, B, leg. Nagy Ödön (8237)
1937. 07. 07, HR, Lacul Roşu, alt. 1350 m, B, leg. Nagy Ödön, (8238)
1937. 07. 14, HR, Lacul Roşu, Suhardu Mic, altit. 1100 m, B, leg. Nagy Ödön, (8240)
1938. 07. 12, HR, Lacul Roşu, Suhardu Mic, B, leg. Nagy Ödön, (8239)
1938. 07. 15, HR, altit. 800 m, Bicăjel, B, leg. Nagy Ödön, (1938)
1938. 07. 15, HR, Lacul Roşu, Bicăjel, altit. 1000 m, B, leg. Nagy Ödön, (8246)
1940. 06, HR, Lacul Roşu, B, leg. Nagy Ödön (8245)
1941. 07. 08, HR, Făgetul Ciucului, altit. 1100 m, B, leg. Nagy Ödön, (8241)
1941. 07. 08, HR, Lacul Roşu, Făgetul Ciucului, B, leg. Nagy Ödön, (8242)
1941. 07. 19, HR, Lacul Roşu, Suhardu Mic, B, leg. Nemethy L., Nagy Ödön, (8243)
1942. 07, HR, Lacul Roşu, B, leg. B, Nagy Ödön (8247)
1946. 06., CJ, Fânaţele Clujului, B, leg. Kyri Maria Margareta, (7512)
1955. 08. 04, CJ, Mt. Făgăraş, Bîlea Lac, B, leg. I. Hodişan (9458)
1979. 05, MS, Orşova, Seci hamlet, B, leg. Sarkani Andrei, det. Mihaela Sămărghiţan (12623)
1994. 06. 03, MS, Orşova Pădure, B, leg. Silvia Oroian (12624)
1994. 06. 20, MS, Răstoliţa, Podirei, grassland, B, leg. Silvia Oroian (11122)
1994. 06. 20, MS, Răstoliţa-Podirei, grassland, B, leg. Silvia Oroian (11133)
1995. 07. 10, MS, Răstoliţa, B, Silvia Oroian, B, leg. Mihaela Sămărghiţan (11124)

1998. 06. 10, MS, Piatra Orşova, jud. Mureş, B, leg. Mihaela Sămărghiţan (12625)
1999. 06. 16, MS, Beica de Sus, B, leg. Mihaela Sămărghiţan (12626)
1995. 06. 04, MS, Stânceni-Meştera, Mt. Gurghiului, B, leg. Florentina Togănel, det. Mihaela Sămărghiţan (11131)

Gymnadenia odoratissima (Nath) L. C. Rich.
Sozological category: R [9], NT [10]
1901. 05. 18, CJ, Feleacu, B, leg. Odor (4765 A)
1901. 05. 18, CS, Sasca Montană, "Padina Radimna", B, leg. Odor (4765 B)
1937. 07. 14, HR, Lacul Roşu, Suhardu Mic, B, altit. 1100 m, B, leg. Nagy Ödön (12627)
1939. 07. 10, HR, Făgetul Ciucului, B, leg. Nagy Ödön (8235)
1941. 07. 14, HR, Lacul Roşu, Suhardul Mic, B, leg. Nagy Ödön, (8236)
v. alba (L.) Rich.
1937. 07. 14, HR, Lacul Roşu, altit. 1000 m, B, leg. Nagy Ödön (12628)

Platanthera bifolia (L.) Rich.
Sozological category: R [9], NT [10]
1901. 05. 28, CS, Sasca Montană, "Padina Radimna", B, leg. Odor (4766)
1936. 05. 16, MS, Târgu-Mureş Beşa forest, B, leg. Nagy Ödön (505)
1936. 05. 16, MS, Târgu-Mureş Beşa forest, B, leg. Nagy Ödön (506)
1936. 05. 28, MS, Tg-Mureş, B, leg. Nagy Ödön (512)
1937. 05. 14, MS, Târgu-Mureş Cocoşd forest, B, leg. Nagy Ödön (509)
1937. 05. 14, MS, Târgu-Mureş Cocoşd forest, B, leg. Nagy Ödön (510)
1939. 06. 06, MS, Târgu-Mureş Platoul Corneşti, B, leg. Nagy Ödön (507)
1942. 05. 28, MS, Târgu-Mureş Cocoşd forest, B, leg. Nagy Ödön (508)
1956. 06. 11, MS, Târgu-Mureş, Corneşti Valley, B, leg. Nagy Ödön, (511)
1994. 06. 03, MS, Orşova Pădure, B, leg. Silvia Oroian, Mihaela Sămărghiţan (12629)
1996. 07. 25, MS, Răstoliţa, B, leg. Mihaela Sămărghiţan (11130)
SB, Sibiu, Hannich H. (4767)

Platanthera chlorantha (Custer) Rchb.
Sozological category: R [9], NT [10]
1995. 06. 04, MS, Răstoliţa, Podirei, grassland, B, leg. Silvia Oroian, Mihaela Sămărghiţan (11123)

Listera ovata (L.) R. Br.
Sozological category: R [9], NT [10]
1902. 05. 26, CS, Sasca Montană, B, leg. Odor, (4747)
1994. 06. 03, MS, Orşova Pădure, B, leg. Silvia Oroian (12630)
1994. 06. 14, MS, Răstoliţa, Podirei, grassland, B, leg. Silvia Oroian (12631)
1996. 07. 25, MS, Răstoliţa, B, leg. Mihaela Sămărghiţan (11127)
1996. 07. 25, MS, Răstoliţa, B, leg. Silvia Oroian, Mihaela Sămărghiţan (11129)
SB, Sibiu, forest, B, leg. Odor (4748)
f. *stenoglossa* Peterman
1937. 07. 07, Basarabia, Lăpuşna district, "Stăşeni" forest, near Cojuşna village, altit. 25 m, B, leg. A. Arvat (10080)

Listera cordata (L.) R. Br.
Sozological category: R [9], R [2], NT [10]
1943. 07. 21, CS, Mt. Boicu at "Stâna din Ciungi la Iezer", B, leg. N. Boşcaiu (9864)

Cephalanthera rubra (L.) Rich.
Sozological category: R [9], NT [10]
1937. 07. 20, HR, Lacul Roşu, altit. 980 m, B, leg. Nagy Ödön (12632)
1941. 07. 14, HR, Lacul Roşu, Suhardu Mic, altit. 1100 m, B, leg. Nagy Ödön (12633)

Cephalanthera damasonium (Mill.) Druce
Sozological category: NT [9], LC [10]
2004. 06. 02, MS, Criş, Daneş commune, B, leg. Mihaela Sămărghiţan (12634)

Cephalanthera longifolia (L.) Fritsch
Sozological category: NT [9], LC [10]
1891. 05. 18, CS, Sasca Montană "Tilva Samueli", B, leg. Odor (4749)
1901, SB, Guşteriţa, leg. H. Hannich (4750)

Epipactis palustris (L.) Crantz
Sozological category: R [9], NT [10]
SB, Sibiu, B, leg. Odor, (4751)
1941. 07. 23, B, leg. H. Höhr (12635)
1926. 05. 19, leg. H. Höhr (5152)

Epipactis atrorubens (Hoffm.) Besser (syn. *Helleborine atrorubens* (Raf.) Sch. et Thell. in Viertelj)
Sozological category: R [9], NT [10]
1936. 07. 24, HR, Lacul Roşu, Cheile Bicazului, B, leg. Nagy Ödön (12636)
1936. 08. 16, HR, Lacul Roşu, B, leg. Nagy Ödön (12637)
1939. 07. 25, HR, Lacul Roşu, altit. 1000 m, B, leg. Nagy Ödön (8250)
1941. 07. 14, HR, Lacul Roşu, Suhardu Mic, B, leg. Nemethy L., Nagy Ödön (8248)
1943. 08. 03, HR, Suhardul Mic altit. 1100 m, B, leg. Nagy Ödön (8249)
1997. 08. 18, MS, Gurghiu, B, leg. Mihaela Sămărghiţan (12638)

Epipactis helleborine (L.) Crantz
Sozological category: R [9], NT [10]
1941. 07, HR, Lacul Roşu, B, leg. Nagy Ödön (12639)
1943. 08. 03, HR, Suhardu Mic, altit. 1100 m, B, leg. Nagy Ödön (12640)
1964. 08. 16, CJ, Borzăşti, B, leg. Chiş Viorica (9045)
1997. 08. 14, MS, Lăpuşna, B, leg. Mihaela Sămărghiţan (12641)
1999. 06. 15, MS, Răstoliţa, Podirei, beech forest, B, leg. Silvia Oroian (11119)
1999. 09. 21, MS, Păuloaia, B, leg. Mihaela Sămărghiţan (12642)

The orchids in museum's herbarium refer to 4 types of sozological categories. One of these species, namely *Liparis loeslii* is included in Red Book of vascular plants from Romania [6] as CR (critical endangered). The collection also includes three species of Community interest listed in Habitats Directive (*Cypripedium calceolus, Liparis loeselii, Himantoglossum jankae*) [14].

Table 1 : The sozological categories of orchids from museum's Herbarium

Sozologic category	CR	VU	LC	NT
Number of taxa	1	3	2	29
%	2. 86	8. 57	5. 71	82. 86

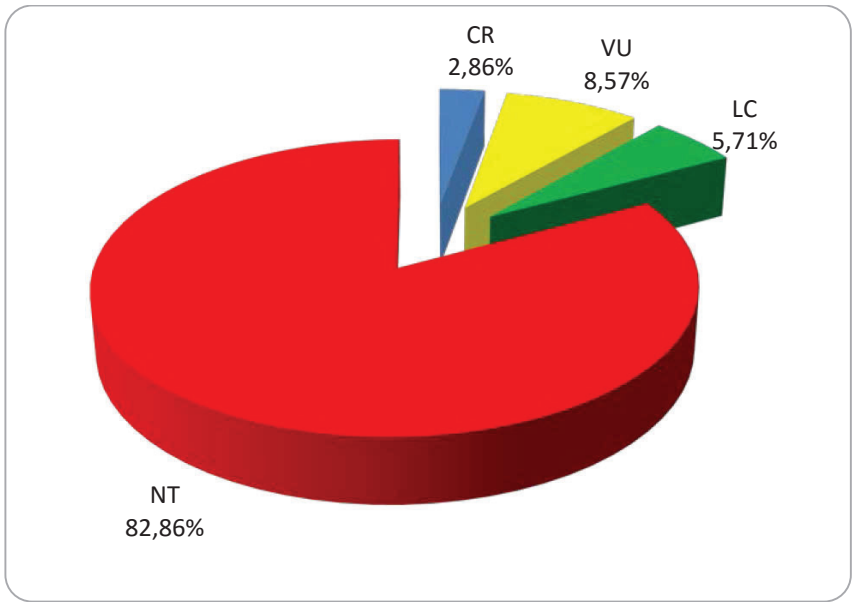

Fig. 1: The distribution of sozological categories

Abreviations:

leg. = legit (collected by)
det. = determined by
B = good state of conservation

Conclusions

A number of 184 herbarium sheets with plants belonging to the Orchidaceae family were processed.

The research of botanical collection of the Natural Sciences Department has identified a total of 42 taxa involved in Orchidaceae family. They are represented by 16 genera, 35 species, three subspecies and four varieties and forms.

Among the species of orchid preserved in the herbarium of the museum three species of Community interest listed in Annexes of the Habitats Directive (*Cypripedium calceolus, Liparis loeselii, Himantoglossum jankae*) were noted.

The orchids in museum's herbarium refer to 4 types of sozological categories (critical endangered, vulnerable, low concern and not threatened). One of these species, namely *Liparis loeslii* is included in Red Book of vascular plants from Romania as CR (critical endangered).

The collection has an important value, first of all, because it emphasizes a part of the patrimony of our museum, secondly, due to the fact that it completes the knowledge concerning the ecology and chorology of some orchids from Romania and finally, because of the antiquity of some species (for more than half a century) and the collector's notoriousness.

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FAMILIA ORCHIDACEAE ÎN COLECŢIILE MUZEULUI JUDEŢEAN MUREŞ, SECŢIA DE ŞTIINŢELE NATURII

(Rezumat)

Lucrarea prezintă o parte din colecţia de plante a Muzeului Judeţean Mureş și anume familia Orchidaceae. Au fost prelucrate 182 coli de herbar cu plante aparţinând acestei familii.

În urma cercetării colecţiei botanice a Secţiei de Ştiinţele Naturii a fost identificat un număr de 42 de taxoni reprezentaţi de 16 genuri, 35 de specii, 3 subspecii și 4 varietăţi și forme aparţinând familiei Orchidaceae.

Pentru fiecare specie se precizează: data și locul colectării, numele celui care a făcut colectarea și al celui care a determinat planta, starea de conservare, precum și categoria sozologică. În paranteze sunt menţionate și numerele de inventar sub care colile de ierbar figurează în registrele de inventar Plante Superioare (I, II și III) ale Secţiei de Ştiinţele Naturii.

Speciile din colecţie provin din flora spontană, din numeroase localităţi din judeţul Mureş, cât și din diverse zone din România.

Cele mai vechi exemplare provin din Colecţia Odor, coli datând din anii 1890–1891.

Dintre speciile de orhidee păstrate în herbarul muzeului 3 sunt specii de importanţă comunitară, listate în Anexele Directivei Habitate (*Cypripedium calceolus, Liparis loeselii, Himantoglossum jankae*).

IN VITRO ASSAY OF ANTIBACTERIAL ACTIVITY OF THREE MEDICINAL PLANTS: *EUGENIA CARYOPHYLLATA* THUNB., *JUGLANS NIGRA* L. AND *ARTEMISIA ABSINTHIUM* L., AGAINST MULTIDRUG-RESISTANT GRAM NEGATIVE BACTERIA

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Abstract: The incidence of infectious processes caused by resistant bacteria is today one of the major health risks. Despite the progress of the pharmaceutical industry, traditional medicine is starting to gain even more ground. The hydroethanolic extract of *Eugenia caryophyllata*, *Juglans nigra* and *Artemisia absinthium* were tested *in vitro* from a lot of MDR Gram negative bacteria isolated from renal infections. The identification of the main potential antibacterial compounds was performed by TLC method. Quercetin and gallic acid were present in all the extracts studied. Kaemferol was identified in *E. aryophyllata* and *J. nigra* extract and ferulic acid was identified only in *E. caryophyllata* extract. Chlorogenic acid was specific only to *A absinthium* extract. *E. caryophyllata* had the highest amount of polyphenols (equivalent gallic acid) and *J. nigra* highest amount of flavonoids (equivalent rutin). MIC of hydroethanolic extracts of herbs was between 7.8 and 500 mg / mL. The results demonstrate the high potential of the antibacterial activity of herbs due to their metabolic compounds.

Keywords: *E. caryophyllata*, *J. nigra*, *A. absinthium*, MDR Gram negative bacteria, phenolic compounds, TLC

Introduction

Infections remain one leading cause of death in the world, which amplify the global crisis that characterizes the health of the global population. For almost every existing antibiotic, bacteria have developed a resistance factor that protects them. Antimicrobial agents can not cover all these mechanisms and the development of antibiotic resistance is relentless [Davies & Davies, 2010]. *Eugenia caryophyllata* Thunberg 1788 (syn. *Syzygium aromaticum* Linn.) belonging to the *Myrtaceae* family is an aromatic tree, native to tropical area. [Mahmoud, et. al., 2001]. In traditional Asian and Australian medicine buds of *E. caryophyllata* (clove) are used in various diseases, such as asthma, gastrointestinal infections, headache [Singh et. al., 2012]. *Artemisia absinthium* L. (wormwood) is a herbaceous plants a perennial originating from the temperate Europe, including Romania. The plant extracts showed a strong antimicrobial activity, especially against Gram-positive pathogenic bacteria [Moslemi et al, 2012]. *Juglans nigra* L. belongs to the family Juglandaceae, being known as American walnut or black walnut, it is native in the eastern part

of North America. The only studies that would show the antibacterial activity of species from family Juglandaceae make reference to *J regia*. The antibacterial activity of extracts from leaves of *J. regia* was remarkable against Gram positive versus Gram negative bacteria which showed inactivity [Pereia et al, 2007].

Materials and methods

The strains MDR Gram negative were isolated from renal infections of patients hospitalized at "Theodor Burghele" Hospital, Bucharest. The identification of bacterial strains and antibiotic resistance profile were performed using a compact automated VITEK®2 system (BioMérieux Inc, Durham, NC) according to the manufacturer's instructions, in the hospital laboratory.

Obtaining hydroethanolic extract of herbs and antibacterial testing

The leaves of *A. absinthium* and of *J. nigra* were collected during the month of August 2014 from the Botanical Garden Bucharest. Buds of *E. caryophyllata* were purchased from an Arab spice grocery. The leaves were shade-dried for 10 days. 300 g of herbs were transformed into dust using a grinder. We poured over the powder, 700 mL solution (200 mL of distilled water and 500 mL ethanol). The solution thus obtained was kept in an amber glass container at a temperature of 4°C while stirring every day. After ten days the solution was placed in a rotary evaporator for 10–15 minutes after which the supernatant was removed using a Whatman no. 1 filter. Finally, we obtained stock solution of which serial dilutions were prepared. For the calculation of MIC (Minimum Inhibitory Concentration) we used sterile sets of disposable 96-well flat bottom plastic plates, containing 12 rows, with a capacity of approximately 300 µL/well. For columns 2–12, 100 µL of nutrient broth was distributed, and for the first column 180 µL per well were distributed. Of the stock solution obtained from extract of cloves, we distributed 20 µL per well in the first column, mixed it with 180 µL of medium, then we took in pipette 100 µL of mixes and we pipetted into next column, repeating the same operation up to the tenth column, then threw the 100 µL mixes. Those were the decimal dilutions. In the last two columns extract of clove was not pipetted. After this stage, 20 µL per well of bacterial suspension adjusted to 0.5 McFarland units were distributed in columns 1- 11, the last column (12) being negative control. The plates were placed in an incubator at 37°C for 24 hours. MCI was established macroscopically, as the last concentration at which no growth of the microbial environment was observed, and the appearance of turbidity was read spectrophotometrically as the absorbance at 620 nm.

Quantitative analysis of the antibacterial compounds of hydroethanolic extract of herbs

For the measurement of antioxidant activity we used ABTS (2,2'-azino-bis (3-ethylbenzothiazoline–6-sulphonic acid) assay, a method based on electron transfer reactions. The capacity to scavenge free radicals of hydroethanolic extract of cloves was evaluated by measuring the absorbance of the sample treated with radical cation $ABTS^{\bullet+}$. Calculation of the total content of phenolic compounds, was performed according to protocol Folin-Ciocalteu. The total flavonoids content of extracts was determined by treating 0.5 mL of extract appropriately diluted with distilled water with 0.4 mL of 25 g/L $AlCl_3$ solution, 0.5 mL of 100 g/L CH_3COONa solution and 4 mL distilled water. The absorbance measurements were performed using a

T80+ UV/VIS Spectrophotometer (PG-Instruments). Each experiment has been performed in triplicate.

Identification and separation of the major compounds of hydroethanolic extract of herbs by TLC (thin layer chromatography) method

The standard compounds with antibacterial activity (ferulic acid, gallic acid, chlorigenic acid, quercetin, rutin, kaempferol) were purchased from the Bucharest Chemical Company. We used a semiautomatic applicator (Linom 5 – CAMagic, Muttenz, Switzerland). The spraying was achieved using a plate spray device (Merck). Reading of the plates was performed using a device for TLC imaging (Digistore 2 – CAMagic), and the images were stored as JPEG files, without compression, to avoid losing image quality. The advantage of this method is that the detection by natural fluorescence or fluorescence quenching does not modify or destroy the compounds.

Results and discussions

From the lot of bacterial strains isolated from the kidney infection of hospitalized patients, *Klebsiella pneumoniae*, *Acinetobacter baumanii* and *Proteus mirabilis* strains have submitted the highest resistance to the antibiotics tested (Table 1). These strains were represented a greater interest in the analysis of antibacterial potency of the hydoethanolic extracts herbs.

Table 1: Antibiotic resistances of Gram negative bacteria

Strain	Antibiotic (R=resistance; S=susceptibility)										
	AMC	CAZ	FEP	CIP	CM	IMI	ERT	STX	TZP	CL	MEM
P. mirabilis$_{I1}$	R	R	R	R	R	R	R	R	R	R	R
A. baumannii$_{I5}$	R	R	R	R	R	R	R	R	R	R	R
P. aeruginosa$_{I11}$	R	R	R	R	R	R	R	R	R	S	R
K. pneumoniae$_{I14}$	R	R	R	R	R	R	R	R	R	S	R
K. pneumoniae$_{I15}$	R	R	R	R	R	R	R	R	R	S	R
A. baumannii$_{I22}$	R	R	R	R	R	R	R	R	R	S	R
P. aeruginosa$_{I24}$	R	R	R	R	R	R	R	R	R	S	R
A. baumannii$_{I25}$	R	R	R	R	R	R	R	R	R	R	R
P. aeruginosa$_{III12}$	R	R	R	R	R	R	R	R	R	R	R
P. aeruginosa$_{III15}$	R	R	R	R	R	R	R	R	R	S	R

(abbreviations: AMC – amoxicillin-clavulanic acid; CAZ – ceftazidime; FEP – cefepime; CIP- ciprofloxacin; GM – gentamicin; IPM – imipenem; ERT – ertopenem; SXT – sulfamethoxazole; TZP – piperacillin-tazobactam; CL – colistin MEM – meropenem;)

The antioxidant activity and total content of phenols and flavonoids are reflected in figure 1 being calculated according to the protocol submitted. Following the analysis of the results, *E. caryophyllata* had the highest antioxidant activity (expressed in mg ascorbic acid / g plant) and the highest polyphenol content (mg gallic acid equivalent / g plant) compared to the other plants. Instead, the content of flavonoids (mg rutin mg / g plant) had the lowest value.

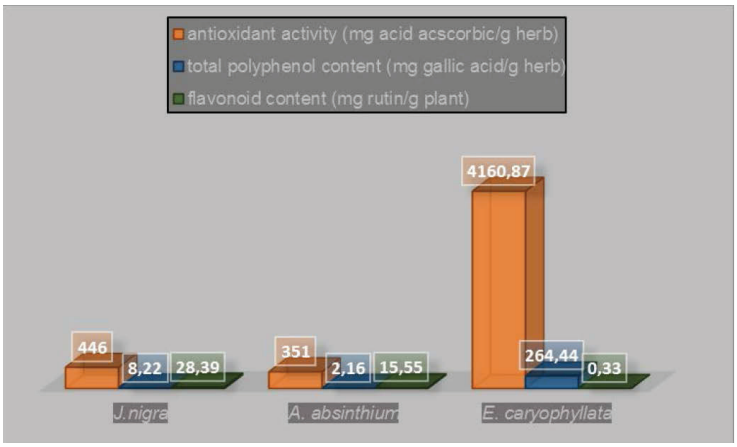

Fig. 1: Antioxidant activity and the total content of phenols and flavonoids of the hydroethanolic extract of herbs studied

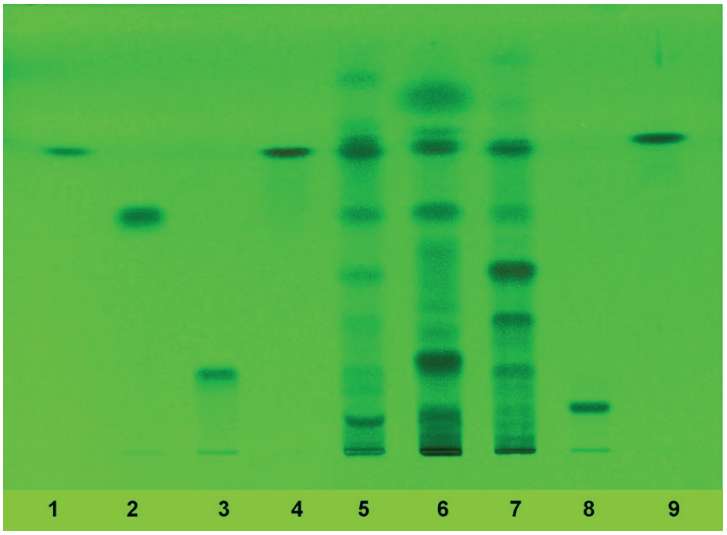

Fig. 2: Chromatographic fingerprint viewed at UV 254 nm. The sequencing of standard plates and extract compounds: 1- ferulic acid, 2- gallic acid, 3- chlorogenic acid, 4- quercetin, 5- hydroethanolic extract of *E. caryophyllata*, 6- extract of *A. absinthium*, 7. extract of *J.nigra*, 8- rutin, 9- kaempferol.

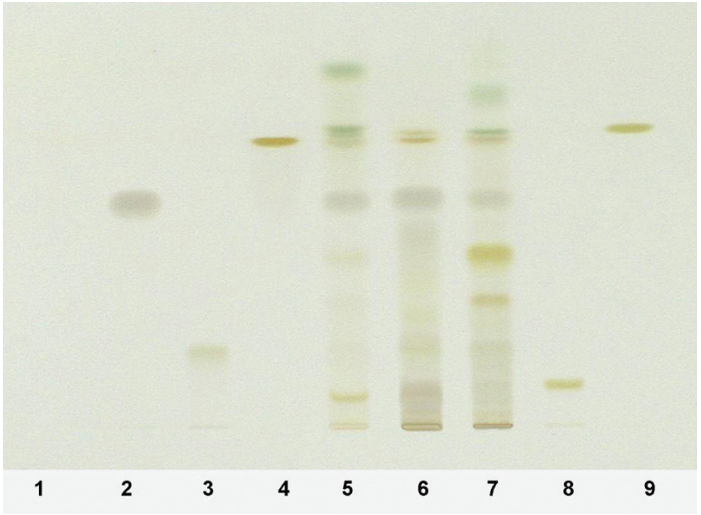

Fig. 3: Chromatographic fingerprint viewed at visible light. The sequencing of standard plates and extract compounds: 1- ferulic acid, 2- gallic acid, 3- chlorogenic acid, 4- quercetin, 5- hydroethanolic extract of *E. caryophyllata*, 6- extract of *A. absinthium*, 7. extract of *J.nigra*, 8- rutin, 9- kaempferol.

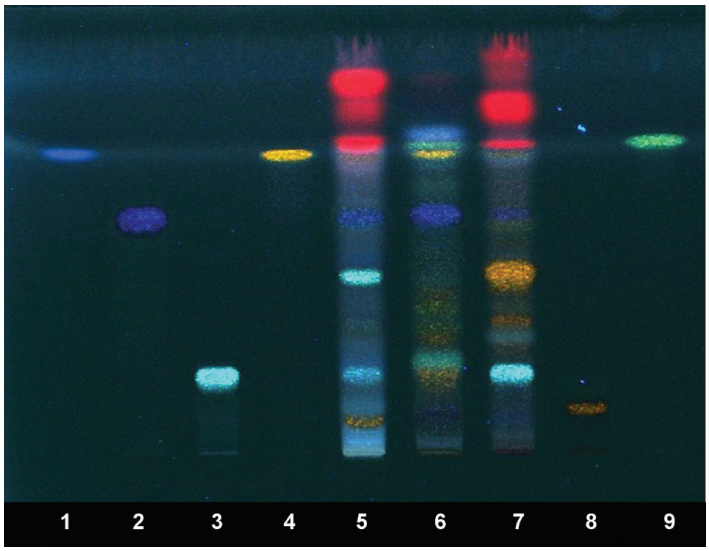

Fig. 4: Chromatographic fingerprint viewed at UV 366 nm. The sequencing of standard plates and extract compounds: 1- ferulic acid, 2- gallic acid, 3- chlorogenic acid, 4- quercetin, 5- hydroethanolic extract of *E. caryophyllata*, 6- extract of *A. absinthium*, 7. extract of *J.nigra*, 8-rutin, 9- kaempferol. Absorbance layer appears in dark color and spots fluorescente.

Following the analysis of the chromatographic fingerprints in hydro ethanolextract of *E. caryophyllata* were identified four synthetic compounds: ferulic acid, gallic acid, quercetin and kaempferol. In the extract of *J. nigra* were identified three compounds: gallic acid, quercetin and kaempferol and in *A. absinthium* extract, three compounds: gallic acid, chlorogenic acid and quercetin. Quercetin flavonoid and gallic acid phenol were present in all the extracts studied, kaempferol flavonol was identified in the extract of *E. aryophyllata* and *J. nigra* extract and ferulic acid phenol was identified only *E. caryophyllata* extract. Chlorogenic acid was specific only to *A. absinthium* extract.

From the chromatographic analysis that can observe that it using either the visible light or UV detection at 254 nm is not sufficient to extract the fingerprints. Only a few compounds can be detected in visible light and 254 nm UV. Almost all of the compounds absorbing at 254 nm can also be detected in visible light. More than this, the fingerprints obtained in visible light and at UV 254 nm, just as well, do not allow a good differentiation of evidence. The most complete information about the constituent compounds of the extracts was obtained by detection at UV 336 nm in fluorescence. The qualitative analysis by TLC is relatively simple, being a technique used in many laboratories for the separation of various mixtures of organic compounds. Another advantage of this technique would be that enables simultaneous separation of a large number of samples (samples 50–60).

Quantitative evaluation of the antibacterial activity of hydroethanolic extracts of *E. caryophyllata*

The antimicrobial activity of plant extracts is the first demonstrated pharmacological property for these. The medicinal plants have a great potential to produce new drugs of great benefit to mankind. Higher plants are capable of synthesizing unlimited numbers of highly complex and unusual chemical substances [Farnsworth, 1988]. The qualitative evaluation of antibacterial activity of plant extracts on solid media is an estimate because the extent of absorption of the compound by the medium is unknown. The calculation of MIC via dilution method in 96-well plates with the liquid media yielded values between 7.8 and 500 μg/ mL for

hydroethanolic extracts of *E. caryophyllata.* Figures 5, 6 and 7 shows the values of MIC read at an absorbance of 620 nm for MDR Gram negative bacteria.

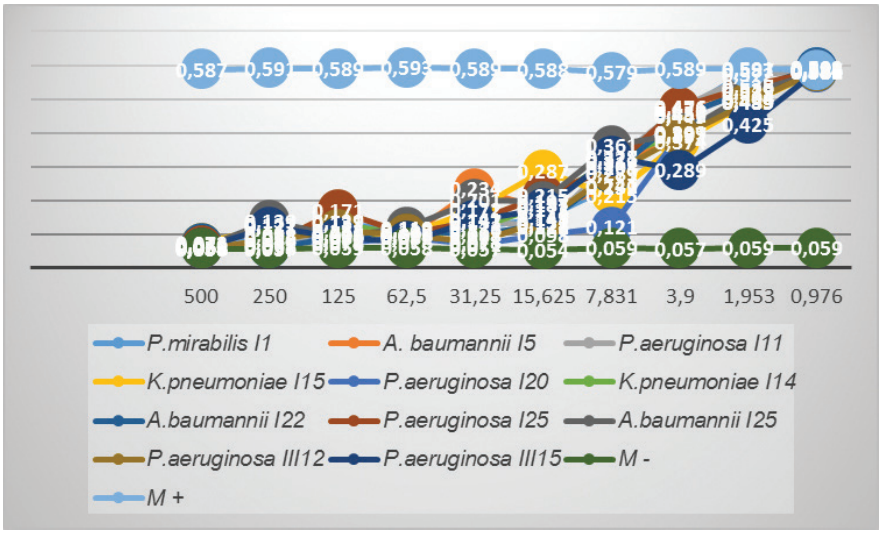

Fig. 5: MIC of ethanol extracts of *E. caryophyllata* against MDR Gram negative bacteria compared to the negative and positive control (M^-, M^+), measured via single-wavelength spectrophotometry at 620 nm

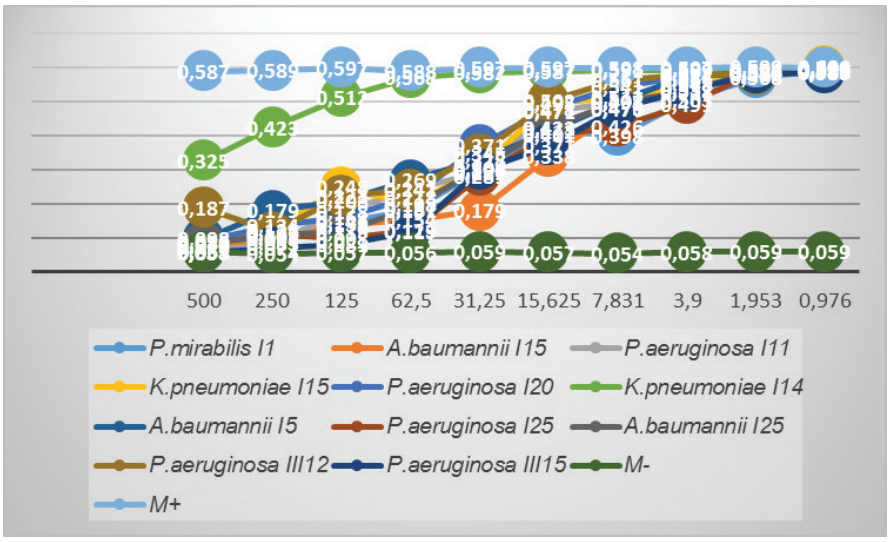

Fig. 6: MIC of ethanol extracts of *J. nigra* against MDR Gram negative bacteria measured via single-wavelength spectrophotometry at 620 nm

MIC of hydroethanolic extract of *J. nigra* ranged between 31.25 mg / ml and 500 mg / ml, having resistance to a single strain, *K. pneumoniae*$_{I14}$. MIC of hydroethanolic extract of *A. absinthium* ranged between 31.25 mg / ml and 500 mg / ml, and he had resistance to three strains: *P.aeruginosa*$_{I25,}$ *K. pneumoniae*$_{I14,}$ and *A. baumannii*$_{I25}$.

The therapeutic action of medicinal plants resulting from the combination of common and specific therapeutic properties of certain constituents, "secondary metabolites" (natural products) [Dias, 2012]. Phenols have a major role in protecting plants against herbivores and enzyme inhibitors. Thus, numerous studies have revealed their role in the resistance against fungi, bacteria and nematodes. In these interactions, it seems that the speed and duration novo biosynthesis of phenolics resistance is more important than the constituent concentrations

[Bennett & Wallsgrove, 1994]. Phenolic acids (for example ferulic acid, gallic acid) have been repeatedly implicated as natural antioxidants in herbs [Zheng & Wang, 2001]. Flavonoids

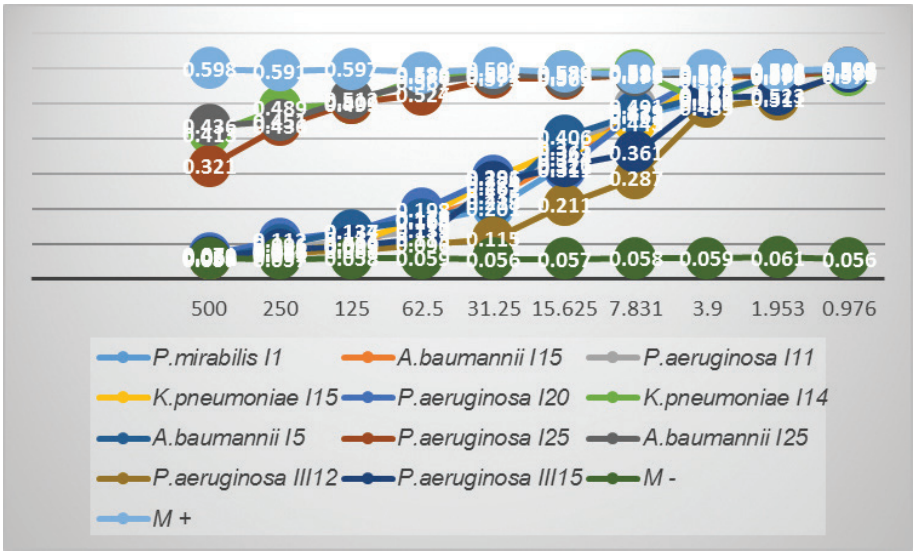

Fig. 7: MIC of ethanol extracts of *A. absinthium* against MDR Gram negativ bacteria measured via single-wavelength spectrophotometry at 620 nm

are known to be synthesized by plants in response to microbial attack by the hydroxylation of phenolic compounds fact which justifies efficacy against a wide range of microorganisms. The antibacterial activity is probably due to their ability to react with extracellular and soluble proteins bacterial cell wall leading hence leading to their disintegration [Idris, 2009]. Multiple hydroxyl groups of flavonoids they have higher antioxidant activities against peroxyl radicals than do phenolic acids. However, the flavonoid glycosides (including rutin) usually have low anioxidant activity [Zheng & Wang, 2001]. The results show that the degree of inhibition is variable depending on the type of extract against various microorganisms. Thus, the extract of *E. caryophyllata* which has the largest antioxidant activity, being maintenance and the highest content of phenolics, had antibacterial activity against all MDR strains. In addition, from the analysis of the profile of resistance of the MDR strain to antibiotics used, we can suggest that the activity of certain potential antimicrobial compounds in herbs extracted, to be achieved by different mechanisms from those of the antibiotics used. Though the extracts of *A. absinthium* and *J. nigra* have not had antibacterial activity against all strains analyzed, they are nevertheless medical interest. *J. nigra* has been reported for the first time in this paper as having antibacterial role against MDR Gram-negative strains.

Conclusions

The antibacterial activity of the herbs extracts is linked with the chemical composition of the synthesis of the compounds resulting from the secondary metabolism of plants and the concentration of these compounds. Thus, the antibacterial activity of the extract of *E. caryophyllata* can be attributed to the high content of phenols and extract from *J. nigra* to the flavonoid content which is predominant. The hydroethanolic extracts of *E. caryophyllata*, *J. nigra* and *A. absinthium* could pose a important support in the industrial production of the new drugs in the therapy of kidney infections caused by MDR Gram negative bacteria.

Acknowledgments

We express our gratitude to Prof. Maria Carmen Chifiriuc, Dr. Camelia Tudor and Prof. Bogdan Amuzescu for continued support.

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ANALIZA *IN VITRO* A ACTIVITĂŢII ANTIBACTERIENE A TREI SPECII DE PLANTE MEDICINALE: *EUGENIA CARYOPHYLLATA* THUNB., *JUGLANS NIGRA* L. ȘI *ARTEMISIA ABSINTHIUM* L., ÎMPOTRIVA BACTERIILOR GRAM-NEGATIVE REZISTENTE LA MAI MULTE TIPURI DE MEDICAMENTE

(Rezumat)

Incidența proceselor infecțioase cauzate de bacterii rezistente a devenit unul dintre cele mai mari riscuri pentru sănătate. În ciuda progresului industriei farmaceutice, medicina tradițională începe să câștige tot mai mult teren. Extractele hidroetanolice din *Eugenia caryophyllata*, *Juglans nigra* și *Artemisia absinthium* au fost testate *in vitro* pe un grup de bacterii Gram – negative MDR izolate din infecții renale. Identificarea principalilor compuși antibacterieni potențiali a fost făcută prin metoda TLC. Quercetina și acidul galic au fost identificați și izolați în toate extractele studiate. Kaemferol a fost identificat în *E. aryophyllata,* și extract de *J. nigra* iar acidul ferulic a fost identificat numai în *E. caryophyllata*. Acidul clorogenic a fost specific doar unui extract, *Artemisa absinthium*. *E. caryophyllata* a avut cea mai mare cantitate de polifenoli (echivalent în acid galic), iar *J. nigra* cea mai mare cantitate de flavonoide (echivalent în rutin). CMI calculată a avut valori cuprinse între 7,8 și 500 mg / ml. Rezultatele demonstrează potențialul ridicat al activității antibacteriene a celor trei plante studiate, datorită compușilor metabolici.

PHYTOSOCIOLOGICAL STUDY OF *LIGULARIA SIBIRICA* (L.) CASS. HABITATS FROM ZĂNOAGEI GORGES (BUCEGI MOUNTAINS), ROMANIA

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Abstract: Often plant communities provide mechanisms that can adapt or mitigate those changes caused by environmental factors. Climatic oscillations during glacial periods have led to the migration of a large numbers of plant species, looking for some optimal conditions for survivial. One of those species is the glacial relict *Ligularia sibirica* (L.) Cass.

The present paper aims to present the species of community importance, *Ligularia sibirica* (L.) Cass. in *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 plant association from Zănoagei Gorges, Scropoasa and Seven Springs Waterfall, all included in Bucegi Natural Park. The sporadic *Ligularia sibirica* species grows in Romania's habitats, such as eutrophic and oligotrophic marshes, meadows, wet soils or in hygrophilic communities on the riverbanks, in both bright spots and also in the shade of canopy trees. To achieve the aim of this paper was necessary to study the identified association in terms of biodiversity, taxonomy, bioforms, geo-elements and genetic structure analysis. Ellenberg indices analysis will complement this study as it can provide significant details regarding the structural evolution in time of the studied population from ecological point of view. Ellenberg indices analysis includes factors such as light, temperature, humidity, soil reaction and nitrogen content. The present paper also includes the degree of conservation and biodiversity offered by the studied association for *Ligularia sibirica* (L.) Cass. species.

Keywords: *Ligularia sibirica* (L.) Cass., plant associations, habitat, relict

Introduction

Ligularia genus includes many species in Asia and Europe, most of them, respectively 123 being found in China. [19] *Ligularia sibirica* (L.) Cass species arrived in Europe between glacial and interglacial period being now distributed in 11 countries such as: Russia, Estonia, Lithuania, Poland, Slovakia, Croatia, Austria, Romania, Bulgaria, France and Ukraine. In Romania, the species on interest is distributed in 32 Natura 2000 sites. [1] In our country the species was first identified in 1796 in Taul lui Dumitru swamp.[15] Berne Convention protects *Ligularia sibirica* relict species through Annex I – Strictly protected flora species (Bern treaty number 104). Moreover the degree of endangerment established by IUCN, consider the studied species as Data Defficient (DD). [2] The species of community interest is protected by the Habitats Directive, Annexes IIb and IVb, OUG 57/2007 (Law 49/2011). The *Carpathian Red List of Forest Habitats and Species* mentions the studied species in near threatened (NT) cathegory. [12]

Due to the high humidity of the area that surrounds the Ialomița River, in time was developed a hygrophyllic type of vegetation with a relict character, such as the species of

community importance *Ligularia sibirica* (L.) Cass., which increases the importance for sonservation of *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 plant asociation.

Materials and methods

Species description

In this paper is presented the species of community importance *Ligularia sibirica* (L.) Cass. (Syn.: *Cineraria cacaliiformis* Lam., *Cineraria sibirica* (L.) L, *Hoppea sibirica* (L.) Rchb., *Ligularia bucovinensis* Nakai, *Ligularia lydiae* Minderova, *Ligularia ucrainica* Minderova, *Othonna sibirica* L., *Senecillis sibirica* (L.) Simonk., *Senecio cacaliifolius* var. *cebennensis* Rouy, *Senecio cacaliifolius* Sch.Bip., *Senecio cacaliiformis* Rchb.f., *Senecio ligularia* Hook. f., *Senecio sibiricus* (L.) Clarke. [19]

According to the classical system of natural classification, proposed by A. Cronquist, A. Takhtajan and W. Zimmermann, adjusted later by F. Ehrendorfer, system used by most Romanian taxonomists, the relict species *Ligularia sibirica* (L.) Cass belongs in terms of taxonomy to the following: Domain Eukaryota, Regnum Plantae, Phylum Magnoliophyta, Class Magnoliatae, Subclass Asteridae, Superorder Asteranae, Order Asterales, Family Asteraceae. [9]

In Romania *Ligularia sibirica* (L.) Cass. grows sporadically, being encountered from sessile oak level till the spurce levels in depressions, meadows, grasslands and forests, as well as in eutrophic and oligotrophic swamps, springs and weeds along valleys, from mountain to the subalpine region. [14], [1] Taking into consideration the Ellenberg indices, the relict species is considered as an Eurasian-Boreal element, meso-hygrophilic species, that prefers bright areas partially shaded (L_7), being a widespread species in temperate zones (hills and submontan areas) (T_5), growing on constantly moist and well drained soils but not on excessively wet soils (U_7), with preference for moderate acidic soils and for the neutral ones; and from the nitrogen point of view, the studied species is eurinitrophile. [18]

Site description

Bucegi Natural Park is one of the areas protected by the Natura 2000 network in Romania (Bucegi ROSCI0013), located in the eastern Carpathians, being proposed for protection in 1936 and currently managed by Romsilva. Bucegi Natural Park was established in 2000, owning a total area of 32.497 ha and being on the administrative territory of three counties: Dâmbovița, Prahova and Brașov. The park ecosystems are considered to be some of the most complex in Europe, holding a high degree of conservation. Bucegi Natural Park includes many categories of protected areas, therefore the Zănoagei Gorges belong to the Zănoagei-Lucilă 2377 Reserve, located in Dâmbovița County and occupying an area of 259.40 ha. [20]

The Ialomița river, along which it was found the relict species *Ligulaia sibirica* (L.) Cass., also crosses the Zănoagei Mica Gorges, Zănoagei Mare, Scropoasa and Orzei Gorges. Relict species had been investigated in the Zănoagei Gorges, in the reservoir lake Scropoasa on the area of Dobrești power station, as well as at the Seven Springs Waterfall, situated in the proximity of Zănoagei Gorges. The Zănoagei Gorges are part of Zănoagei-Lespezi mountain system, with limestone rocks, owning a characteristic cool-wet climate type, with an average annual temperature of 4,9° C, where rainfall varies according to altitude. [20]

Plant association and Habitat

In the studied area *Ligularia sibirica* (L.) Cass.species was identified in *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 plant association.

The *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas is framed in: *MULGEDIO-ACONITETEA* Hadać et Klika in Klika et Hadać class that groups hygrophilic species such as tall mountain weeds from the upper montane level, having the characteristic species: *Rumex alpestris* and *Carduus personatus*; *ADENOSTYLETALIA ALLIARIAE* Br.-Bl. 1931 order which groups hygrophilic megaphorbiets; *Adenostylion alliariae* Br.-Bl. 1925 alliance that is found on moist and nutrient rich colluvial soils with characteristic species such as: *Alnus viridis*, *Geranium sylvaticum, Cortusa matthioli* and *Valeriana officinalis* ssp. *sambucifolia*. The present association is characteristic for eutrophic marshes, situated on acidophilic substrate. (Fig. 1.) [8], [10], [16]

The Natura 2000 habitats where the studied plant association is found is **6430 Hydrophilous tall herb fringes communities of plains and of the montane to alpine levels** (with the following correspondences: EMERALD: 37.7 Humid tall herb fringes, PALHAB: 37.716 Continental mixed riverine screens, EUNIS: E5.414 Continental river bank tall-herb communities dominated by *Filipendula*). [11, 14] Bucegi Natural Park, the association is encountered along the lower mountain valleys of the Ialomița river.

Fig. 1: ***Cirsio waldsteinii-Heracleetum transsilvanici*** **Pawl. et Walas 1949 and** ***Ligularia sibirica*** **(L.) Cass. in Zănoagei Gorges – Dâmbovița county**

Identification of *Ligularia sibirica* (L.) Cass. species in the plant association was conducted during 2015–2016 period, through phytosociological surveys in Zănoagei Gorges, Scropoasa and Seven Springs Waterfall.

To achieve the objective of the present paper it had been analysed the accompanying flora of the relict species. The synonyms and coenotic integration of studied species, were established using the *Flora Europaea* database [3], completed with the following bibliographycal sources: [4], [5], [13], [19]. As for genetic structure, byoforms and geo-elements analysis, was followed Flora cormofitelor spontane și cultivate din România [17].

Ellenberg indices for light, temperature, humidity, soil reaction and available nitrogen [7], [6], [18] were taken into account for the studied plant association. Also Ellenberg indices analysis had led to a more accurate description of the habitat in which is included the association.

Phytosociologycal surveys used for species inventory were conducted following the methodology developed by Zürich-Montpellier phytosociology school adapted to Romanian vegetation by Al. Borza. The habitat codes used in the present paper correspond to: NATURA 2000, Romanian classification system (EUNIS), and Carpathians Red List of habitats.

Results and discussions

1. Taxonomic analysis

Therefore from the taxonomic analysis conducted on *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 association, resulted 110 taxa included in 45 families. The families with the largest percentage are held by: *Asteraceae* (19%), *Rosaceae* (7.2%), *Ranunculaceae (*6.3%), Poaceae (5.4%) and Apiaceae (4.54%). (Fig. 2) (Tab. 1.). As a result the plant association is characterized by a signifficant diversity of plant taxa.

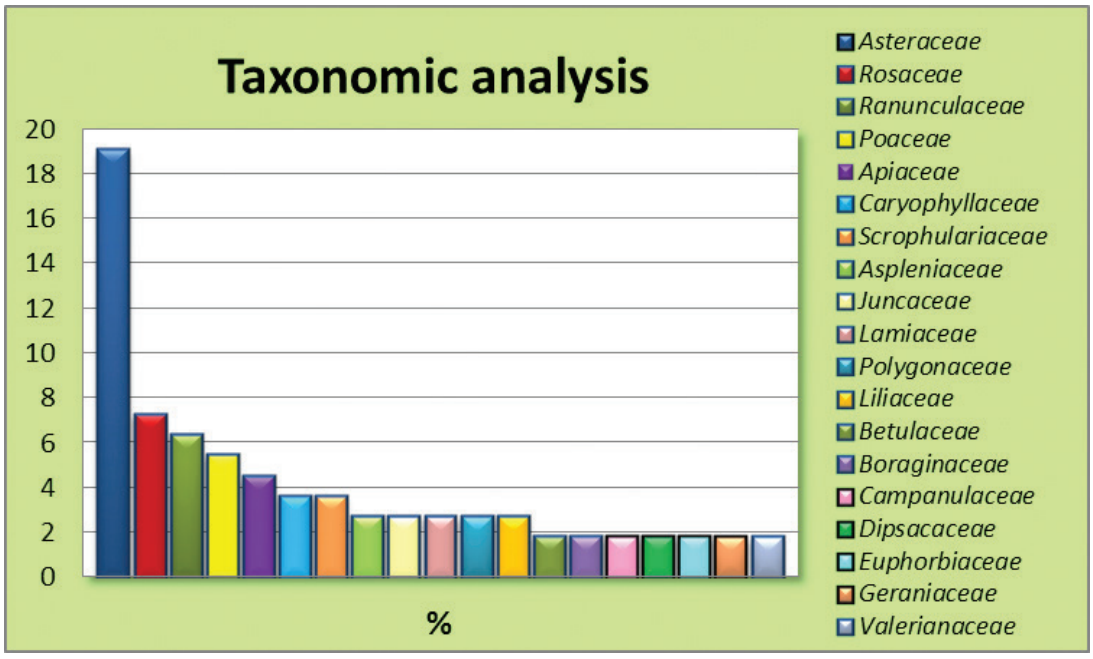

Fig. 2: Taxonomic analysis of *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 (%) – Zănoagei Gorges, Scropoasa, Seven Springs Waterfall – Dâmbovița county (Romania)

2. Bioforms analysis

From bioforms spectrum analysis of *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 association, it can be noticed that hemicryptophytes species are holding the largest share (69%), being followed by the rest of the bioforms with a smaller percentage, such as: geophytes (12%), megafanerophytes (5%) and microfanerophytes (4%). (Fig. 3).

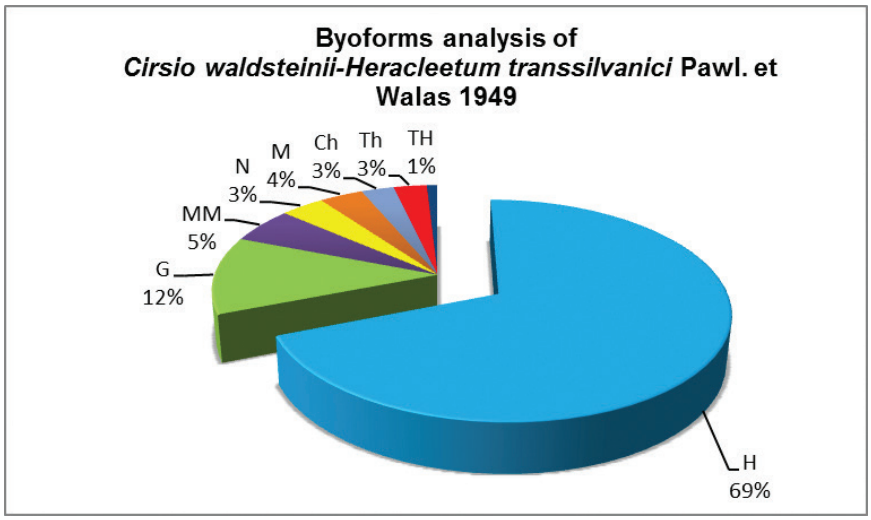

Fig. 3: Byoforms analysis of *Cirsio waldsteinii-Heracleetum transsilvanici Pawl. et Walas 1949* (%) – Zănoagei Gorges, Scropoasa, Seven Springs Waterfall – Dâmbovița county, (Romania)

3. Geo-elements analysis

The geographycal structure of the studied areas reveal the participation of numerous cathegories of geoelements. It can be observed that the floristic elements in *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 plant association are represented by Eurasian species (27.27%), folowed by European (20%) and Central-Europe (12.72%) species. (Fig. 4).

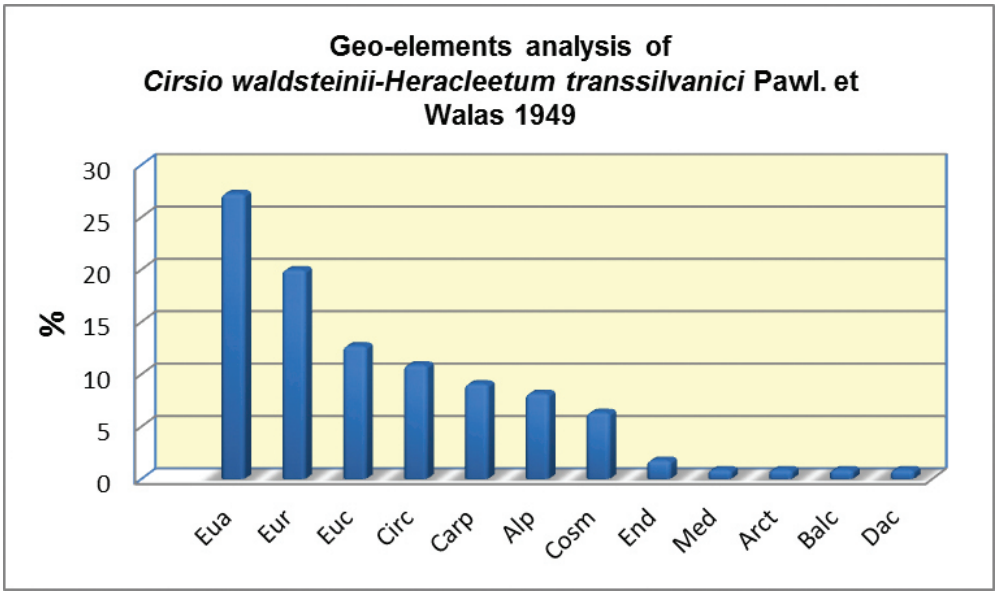

Fig. 4: Geo-elements analysis of *Cirsio waldsteinii-Heracleetum transsilvanici Pawl. et Walas 1949* (%) Zănoagei Gorges, Scropoasa, Seven Springs Waterfall – Dâmbovița county, (Romania)

4. Karyological analysis

Regarding karyological analysis, can be noted the high share of polyploid and diploid species, thus it can be concluded that the studied association includes relict elements resistant to extreme environmental conditions, being possible due to the high conservation degree of the site. (Fig. 5) The high percentage of polyploid species indicates the zoo-anthropogenic pressure

from the past decades. This fact proves that polyploid species are easily adaptable holding a high phytocenology capacity for competing. Both diploids and diplo-polyploids elements provide the plants genetic found, being necessary for the future plant evolution. The diploid index determined after Cristea et al. (2004), is almost unitary, reflecting the instability of plant formations from this areas, fully reflecting the stationary conditions of the studied plant formation.

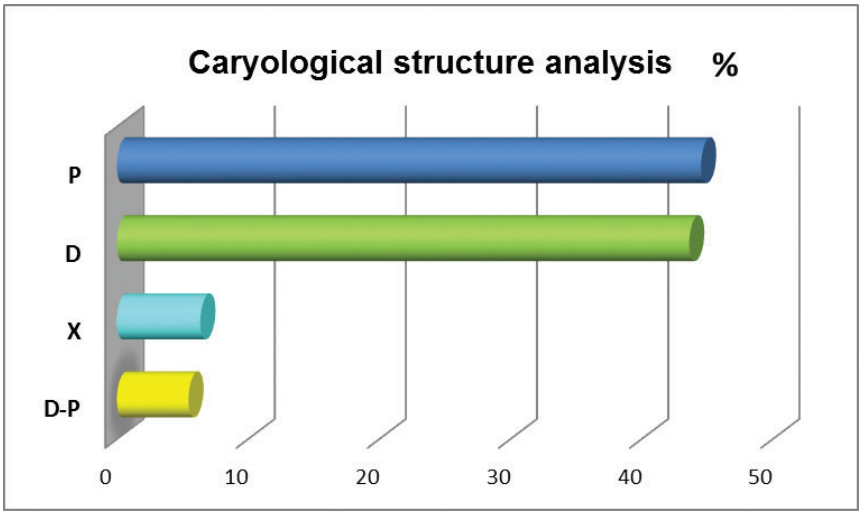

Fig. 5: Caryological structure analysis of *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949, Zănoagei Gorges, Scropoasa, Seven Springs Waterfall – Dâmbovița county, (Romania)

Analysis of ecological categories

The Ellenberg indices analysis for the *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 plant association, was made considering the following indicators: light (L), temperature (T), humidity (U), soil reaction (R) and the availability of nutrients such as mineral nitrogen (N).

According to the light factor, it can be observed the presence of light tolerant species, which can bearly resist in shade (L_7 = 24.5%), followed by the species that prefers relative shade or semi-shade areas (L_4 = 20%). (Fig. 6).

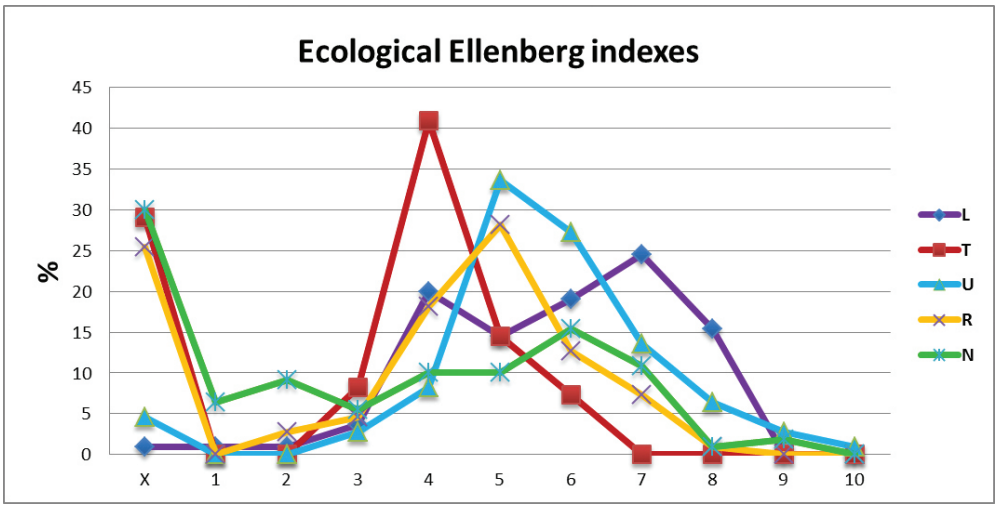

Fig. 6: Ecological Ellenberg indexes of flora of *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949, Zănoagei Gorges, Scropoasa, Seven Springs Waterfall – Dâmbovița county, (Romania)

Regarding the requirements to temperature, within the association prevails the widespread species in the montane and high montane levels (T_4 = 40.9%), followed by the eurithermal species (T_x = 29.09%) (Fig. 5).

In terms of humidity conditions required for the well development of plant association species, it can be noticed that the dominant species are the meso-hygrophilic ones (U_5 = 33.63%), wich prefers the moderate moist soils and are followed by species integrated in meso-hygrophilic – hygrophilic category (U_6 = 27.27%). (Fig. 5).

Reported to the tolerance of species to the soil reaction, an important category in the studied association is occupied by species that prefers moderate acid soils or neutral to basic soils (R_5 = 28.18%), being followd by species that prefers moderate acid and acid soils (R_4 = 18.18%), also a significant share is occupied by the euriionic species (R_x = 25.45%) (Fig. 5).

The species distribution regarding the amount of nitrogen in soil within the association, species that prefers soils with moderate to high content in N mineral are significant (N_6 = 15.45%), although the biggest percentage is held by eurinitrophile species. (N_x = 30%) (Fig. 5).

Conclusions

In the association *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949, it can be observed a high degree of biodiversity, due to the large number of species included in 45 families, mostly in the *Asteraceae* family.

Bioforms spectrum reveals the high percentage of hemicryptophytes. The analysis of the geoelements showed that the Eurasian and European elements are highly predominant.

From the karyologycal point of view, was noted that in the studied association both polyploides and diploides species had a high share. This reveals that with the climate changes, the biodiversity of the mentioned association may be reduced, due to their low diploid species adaptability to the new environmental conditions.

After analyzing the Ellenberg indices on the studied area, the light tolerant species are predominant being widespread in the montane and high montane floor, along with meso-higrophilic species on the moderate or low acid soils but also on neutral ones, with requirements for a moderate to high mineral nitrogen content.

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STUDIUL FITOSOCIOLOGIC AL HABITATELOR CU *LIGULARIA SIBIRICA* (L.) CASS. DIN CHEILE ZĂNOAGEI (MUNȚII BUCEGI) ROMÂNIA

(Rezumat)

De multe ori, comunitățile de plante oferă mecanisme care se adaptează sau care atenuează modificările produse de către factorii ecologici. Oscilațiile climatice din timpul perioadelor glaciare au dus la migrarea unui număr mare de specii de plante pentru a găsi condițiile optime de supraviețuire, una dintre aceste specii relicte este *Ligularia sibirica* (L.) Cass.

Lucrarea are ca obiectiv prezentarea speciei de importanță comunitară *Ligularia sibirica* (L.) Cass., prezentă în asociația *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 din Parcul Natural Bucegi, respectiv Cheile Zănoagei, Scropopasa, Cascada Șapte Izvoare. Scopul prezentei lucrări este studiul asociației din punct de vedere al biodiversității, taxonomie, bioforme, geoelemente și analiza din punct de vedere al structurii genetice. Analiza indicilor Ellenberg va veni în completarea acestui studiu, oferind un detaliu semnificativ asupra evoluției structurale din punct de vedere ecologic în timp al populațiilor cercetate. Analiza indicilor Ellenberg cuprinde factori precum: lumină, temperatură, umiditate, reacția solului și conținutul în azot. Lucrarea cuprinde și analizarea gradului de conservare și de biodiversitate oferit de asociația luată în studiu pentru specia relictă *Ligularia sibirica* (L.) Cass.

Tab 1: *Cirsio waldsteinii-Heracleetum transsilvanici* Pawl. et Walas 1949 – Zănoagei Gorges, Scropoasa, Seven Springs Waterfall

Bioforms	Geo-elements	L	T	U	R	N	Cyt.	Relevées	1	2	3	4	5	6	7	8	9	10	11	12	K
								Altitude (m s.m.)	1367	1381	1370	1365	1380	1375	1367	1367	1290	1295	1293	1298	
								Exposition	V	V	V	V	V	V	SE	SE	NE	NE	NE	NE	
								Slope (⁰)	50	30	25	45	30	20	60	80	90	45	70	45	
								Surface (m²)	15	15	15	15	15	15	15	15	25	25	25	25	
								Coverage of the herbaceous layer (%)	74	73.5	74.5	71	77	73	72.5	71	72.5	72.5	67.5	70.5	
								Characteristic species of the association													
H	End-Carp	7	4	7	4	x	D	*Heracleum sphondylium* ssp. *transsilvanicum*	2	2	3	3	3	3	3	3	2	2	2	2	V
H	Alp-Carp-Balc	7	4	7	4	x	P	*Cirsium waldsteini*	3	3	2	1	2	2	1	1	+	2	2	1	V
								Adelostylion alliariae													
G	Eur (mont)	5	4	6	5	7	P	*Doronicum austriacum*	+	+	+	+	+	+	+	+	1	1	1	2	V
H	Carp (End)	5	4	6	4	x	D	*Leucanthemum waldsteinii*	+	-	+	+	+	+	+	+	+	+	+	+	V
H	Circ	6	x	8	x	4	P	*Geum rivale*	+	+	+	+	+	+	+	+	+	+	+	+	V
H	Alp-carp	7	3	5	6	7	x	*Aconitum tauricum*	-	+	-	-	+	-	-	-	+	-	+	+	III
M	Alp-Eur	8	3	6	5	x	P	*Alnus viridis*	-	-	+	-	-	+	+	+	+	-	-	-	III
H	Euc (mont)	5	4	4	5	3	P	*Achillea distans*	+	-	+	+	-	+	-	-	-	-	-	+	III
H	Eur	4	5	7	5	7	D	*Stellaria nemorum*	+	+	+	+	+	+	-	-	-	+	-	-	III
G	Alp-carp-balc	8	4	6	5	7	x	*Doronicum columnae*	-	-	+	-	+	-	+	-	+	-	-	-	II
H	Carp-Balc	7	4	6	5	6	x	*Aconitum toxicum*	-	+	-	-	+	-	-	-	-	+	-	+	II
H	Alp-Carp-Balc	6	4	6	6	7	D	*Aconitum paniculatum*	-	-	+	+	-	-	-	-	-	-	-	-	I
								Adenostyletalia alliariae													
H	Eua	6	4	5	5	8	P	*Senecio nemorensis*	+	+	+	+	+	+	+	1	+	+	+	+	V
H	Eur (Mont)	7	5	8	5	x	D	*Crepis paludosa*	+	+	+	+	+	+	+	+	+	+	+	+	V
H	Euc (mont)	6	x	6	x	x	P	*Gentiana asclepiadea*	+	+	+	+	+	+	+	+	+	+	+	+	V
G	Eua	6	5	8	6	8	P	*Petasites hybridus*	+	+	+	+	+	+	+	+	1	1	1	1	V
H	Eur (mont)	8	4	8	5	8	D	*Carduus personata*	+	-	+	+	+	-	+	-	+	-	+	+	IV
H	Cosm	4	x	7	x	6	P	*Athyrium filix-femina*	+	+	-	+	+	-	-	-	-	-	-	-	II

H	Alp-Eur	7	3	6	4	8	P	*Epilobium alpestre*	+	+	-	+	+	-	-	-	-	-	-	-	II
H	Eua (Mont)	7	4	6	4	6	D	*Rumex alpestris*	-	+	+	-	+	-	-	-	-	-	-	-	II
H	Eua	7	4	6	3	6	P	*Veratrum album*	-	+	-	+	-	-	-	-	-	-	-	-	I
H	Eur	6	4	6	4	8	D	*Adenostyles allariae*	-	+	-	+	-	-	-	-	-	-	-	-	I
								Mulgedio-Aconitetea													
H	Eur	5	4	6	4	7	D-P	*Myosotis sylvatica*	+	+	-	+	+	+	+	+	+	+	+	-	V
H	Eur	4	x	5	x	4	D-P	*Viola biflora*	-	+	-	+	+	+	+	-	+	+	-	+	IV
H	Circ	5	4	6	5	7	P	*Athyrium distentifolium*	-	-	+	1	-	-	1	+	-	+	-	-	III
H	Eua (alp-bor)	6	4	6	6	7	P	*Geranium sylvaticum*	+	+	-	-	+	-	+	-	-	-	-	-	II
H	Eur (Mont)	6	4	6	4	8	D	*Cicerbita alpina*	-	+	-	-	-	-	-	-	+	-	+	+	II
G	Eua	4	4	5	4	x	D	*Polygonatum verticillatum*	+	-	-	+	-	-	+	-	-	-	-	-	II
H	Eur	7	4	8	6	5	P	*Valeriana officinalis ssp. sambucifolia*	-	-	+	+	-	-	-	-	-	-	-	-	I
G	Eua	5	x	4	5	5	D	*Lilium martagon*	-	-	-	-	-	-	+	+	-	-	-	-	I
								Calamagrostion villosae													
TH	Carp-Balc	7	4	6	4	3	D-P	*Campanula abietina*	-	+	+	+	+	+	-	-	+	-	+	+	IV
H	Daco-balc	7	5	4	5	-	x	*Hypericum richeri ssp. grisebachii*	-	-	-	-	-	-	-	+	+	+	+	+	III
H	Eur	4	x	5	x	4	D	*Luzula luzuloides*	+	-	+	-	+	-	+	+	-	+	-	+	III
H	Euc	7	5	5	5	5	P	*Digitalis grandiflora*	+	+	-	+	+	+	-	-	-	-	-	-	III
H	Circ	6	4	x	2	3	P	*Deschampsia flexuosa*	-	-	-	-	-	-	-	-	+	+	-	+	II
								Rumicion alpini													
H	Alp-Eur	8	3	6	5	9	D	*Rumex alpinus*	+	+	-	-	+	-	+	-	+	+	-	+	III
H	Euc (Mont)	8	4	5	4	3	D	*Poa chaixii*	-	-	-	-	-	-	-	-	+	-	-	+	I
								Petasition officinalis													
G	Carp-Balc	6	5	7	x	x	P	*Petasites kablikianum*	+	+	+	+	+	+	+	+	2	1	+	+	V
Th	Eua	4	5	7	7	6	D	*Impatiens noli-tangere*	-	-	-	-	-	-	+	+	-	-	-	-	I
								Fagetalia sylvaticae													
H	Euc (mont)	8	5	5	6	x	D	*Cirsium erisithales*	+	+	+	+	+	+	+	+	+	+	+	+	V
H-G	Circ	1	4	6	4	7	D	*Oxalis acetosella*	+	+	+	+	+	+	+	+	+	+	+	+	V
H	Euc (Med)	6	4	5	5	8	P	*Senecio ovatus*	-	+	+	+	+	+	+	-	+	+	-	-	IV
N	Circ	7	x	5	4	8	P	*Rubus idaeus*	-	+	+	+	-	+	-	+	+	-	+	+	IV

H	Circ	4	x	5	5	x	P	*Milium effusum*	+	-	-	-	+	-	-	-	-	-	-	-	I
								Variae syntaxa													
H	Eua	4	x	5	x	6	D	*Fragaria vesca*	+	+	+	+	+	+	+	+	+	+	+	+	V
H	Eua (bor)	7	5	7	6	x	P	*Ligularia sibirica*	+	+	+	+	+	+	+	+	+	+	+	+	V
M-N	Eua	5	4	5	x	x	P	*Spiraea ulmifolia*	+	+	+	+	+	+	+	+	+	+	+	+	V
H	Eua	4	x	5	x	6	D	*Succisa pratensis*	-	-	+	+	+	+	+	-	+	+	+	+	V
Th-TH	Cosm	4	x	x	x	7	P	*Geranium robertianum*	+	+	-	+	+	-	+	+	+	+	+	+	V
H	Cosm	x	x	6	x	8	D	*Urtica dioica*	-	+	+	+	+	-	+	+	+	+	+	+	V
H	Eua (Med)	7	x	5	x	8	D-P	*Anthriscus sylvestris*	+	-	+	+	-	+	+	1	+	1	1	1	V
H	Cosm	3	x	5	5	6	P	*Dryopteris filix-mas*	+	-	+	+	+	-	+	+	+	+	-	-	IV
H	Euc (mont)	3	4	5	5	x	D	*Veronica urticifolia*	-	-	+	+	-	+	+	+	+	+	+	+	IV
M	Eur (Alp)	5	3	5	4	7	D	*Ribes petraeum*	+	+	+	+	+	+	+	+	+	-	-	-	IV
H	Eua (Med)	4	x	5	7	6	D-P	*Brachypodium sylvaticum*	-	-	+	+	-	+	+	-	-	+	-	-	III
H	Carp (end)	7	4	7	6	x	P	*Campanula carpatica*	+	-	+	+	-	+	+	-	+	-	-	-	III
MM	Eur	7	4	5	4	x	D	*Picea abies*	-	-	-	-	-	-	+	+	-	+	+	+	III
H	Carp-Balc	4	4	6	5	x	D	*Pulmonaria rubra*	-	-	-	-	-	-	+	+	-	+	+	+	III
Th	Eua	8	5	6	6	2	D	*Rhinanthus angustifolius*	-	-	-	-	+	-	-	-	+	+	+	+	III
G	Circ	5	6	9	5	6	X	*Thelypteris palustris*	-	+	+	+	+	+	-	-	-	-	-	-	III
H	Carp (end)	7	4	6	4	x	D	*Achillea oxyloba ssp. schurii*	-	-	-	-	-	-	+	-	+	-	+	+	II
H	Eua	7	6	4	7	2	P	*Aconitum anthora*	-	-	-	-	-	-	-	-	-	+	+	+	II
H	Cosm	5	x	5	x	3	P	*Asplenium trichomanes*	-	-	-	-	-	-	+	-	+	-	+	-	II
H	Circ	4	4	7	8	x	P	*Asplenium viride*	-	-	-	-	-	-	+	-	+	-	+	-	II
H	Euc (Mont)	6	4	6	5	5	D-P	*Astrantia major*	+	+	-	+	-	+	-	-	-	-	-	-	II
H-G	Eua (cont)	6	5	5	5	5	P	*Calamagrostis arundinacea*	-	+	+	-	+	-	-	-	+	-	-	-	II
N	Eua	4	x	5	7	5	D	*Daphne mezereum*	-	-	-	-	-	-	+	+	-	+	-	-	II
H	Alp-Carp-Balc	8	4	5	6	x	D	*Euphorbia carniolica*	-	-	-	-	-	-	+	-	+	+	-	-	II
H	Med (Circ)	4	x	5	x	7	P	*Geum urbanum*	-	-	-	+	-	+	+	-	-	-	-	-	II
H	Euc (Mont)	6	4	8	5	7	D	*Chaerophyllum hirsutum*	+	-	+	-	+	-	-	-	-	-	-	-	II
G	Carp (end)	4	4	5	5	4	P	*Hepatica transsilvanica*	+	-	-	+	-	+	-	-	-	-	-	-	II
H	Euc	4	4	6	3	5	D	*Luzula sylvatica*	+	-	-	-	+	-	+	-	+	-	-	-	II
N	Euc-Mont	7	4	5	4	5	P	*Rosa penduliina*	-	-	-	-	-	-	-	+	+	+	-	-	II

M	Carp-Balc-Sudet	7	4	7	3	x	D	*Salix silesiaca*	-	-	+	-	-	+	-	-	+	-	-	+	II
H	Carp (end)	8	3	5	5	2	D	*Scabiosa lucida*	-	-	-	-	+	-	-	-	-	+	+	+	II
H	Euras	4	6	6	6	7	P	*Scrophularia nodosa*	-	-	-	+	-	+	-	+	-	-	-	-	II
H	Euras	6	x	7	x	7	D	*Poa trivialis*	-	-	-	+	-	+	-	+	-	-	-	-	II
MM-M	Eua	6	4	5	4	x	D	*Sorbus aucuparia*	-	-	-	-	-	-	-	+	+	-	+	+	II
Ch	Eur (Alp)	7	3	9	4	x	D	*Silene pusilla*	-	-	-	-	-	-	+	+	+	-	+	-	II
G	Eua	8	x	6	x	x	P	*Tussilago farfara*	-	-	-	-	-	-	+	-	+	+	-	+	II
H	Euc (mont)	6	4	5	5	2	D	*Valeriana tripteris*	+	-	-	+	-	-	-	-	-	-	+	+	II
H (G)	Eua	5	x	6	x	8	D-P	*Aegopodium podagraria*	-	-	-	-	-	-	+	-	-	-	-	-	I
MM (M)	Eur	6	4	7	5	x	P	*Alnus incana*	-	-	-	-	-	-	+	-	-	-	-	-	I
H	Circ	7	x	10	x	x	P	*Caltha palustris*	+	-	-	+	-	-	-	-	-	-	-	-	I
MM	Balc-Anat-Cauc	3	4	5	5	x	D	*Fagus sylvatica*	-	-	-	-	-	-	-	-	-	-	+	+	I
H	Eua	8	5	6	6	2	D	*Hypericum maculatum*	-	-	+	-	+	-	-	-	-	-	-	-	I
H	Eur	4	x	5	x	6	D	*Mycelis muralis*	-	-	-	-	-	-	-	-	+	+	-	-	I
H	Euras	8	x	5	x	x	D	*Plantago major*	-	-	-	+	-	-	-	+	-	-	-	-	I
G	Cosm	6	5	5	5	3	x	*Pteridium aquilinum*	-	-	-	+	-	+	-	-	-	-	-	-	I
Ch	Euc (mont)	6	3	6	4	x	D	*Saxifraga cuneifolia*	-	-	-	-	-	-	+	+	-	-	-	-	I
H	Eur	8	6	4	6	3	P	*Sedum telephium ssp. maximum*	-	-	-	-	-	-	-	-	+	-	-	+	I
H (Ch)	Eua	7	6	3	7	3	D	*Silene vulgaris*	-	+	-	-	+	-	-	-	-	-	-	-	I
H	Circ	5	x	5	x	5	D	*Solidago virgaurea*	-	+	-	-	+	-	-	-	-	-	-	-	I
Ch	Carp (End)	8	4	3	5	x	x	*Thymus pullcherimus*	-	-	-	-	-	-	-	-	+	-	+	-	I

Place and date of releveés: 1-3 Cheile Zănoagei (26.07-25.08.2015), 4-6 Cheile Zănoagei (7.08-16.09.2016), 7-8 Scropoasa (7.08-16.09.2016), 9-12 Cascada Sapte Izvoare (7.08-16.09.2016).

Species present in only one releveé: *Thalictrum aquilegifolium* (1): H, Eur, $L_5T_xU_8R_7N_8$, D; *Mercurialis perennis* (1): G (H), Eur, $L_2T_xU_xR_xN_7$, P; *Gymnocarpium robertianum* (7): G, Circ, $L_3T_4U_5R_6N_x$, P; *Soldanella hungarica* (7): H, Alp-Carp-Balc, $L_4T_3U_7R_3N_2$, P; Acer pseudoplatanus (7): MM, Euc, $L_5T_xU_6R_xN_7$, P; *Polypodium vulgare* (8): G, Circ, $L_5T_5U_4R_2N_2$, P; *Prunella vulgaris* (8): H, Cosm, $L_7T_xU_xR_xN_x$, P; *Asplenium adiantum-nigrum* (9): H, Eua (Med), $L_6T_5U_7R_2N_3$, P; *Cardamine pratensis* ssp. *matthioli* (9): H, Eur, $L_5T_xU_7R_xN_x$, D; *Carpinus betulus* (9): MM-M, Eur, $L_4T_6U_xR_xN_x$, P; *Achillea millefollium* (9): H, Eua, $L_4T_6U_xR_xN_x$, P; *Clematis alpina* (9): N, Arct-Alp-Eur, $L_4T_4U_5R_3N_2$, D; *Mentha aquatica* (9): H, Eur, $L_7T_6U_9R_7N_4$, P; *Scabiosa columbaria* (9): H, Eur (Med), $L_8T_5U_4R_5N_4$, X, *Tanacetum vulgare* (9): H, Eua, $L_8T_xU_4R_xN_5$, D; *Silene nutans* (12): H, Eua, $L_7T_6U_3R_7N_3$, D.

ZOOLOGY

THE PTEROSTICHINI (COLEOPTERA: CARABIDAE) OF JAMAICA BAY WILDLIFE REFUGE

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Abstract: The present paper presents the first comprehensive study of the the Pterostichini (Coleoptera: Carabidae) of Jamaica Bay Wildlife Refuge (JBWR) (Gateway National Recreation Area). From this refuge were recorded 14 species, belonging to genera *Poecilus* Bonelli (2 species), *Stereocerus* Kirby (1 species – *S. haematopus* (Dejean) and *Pterostichus* Bonelli (11 species), 13 of which are native species, and one adventive species (*Pterostichus melanarius* Illiger), introduced from Palaearctic. Many native species are well known in the North America. Were obtained original data about the biology and reproduction period of the *Poecilus lucublandus* Say*, Pterostichus caudicalis* Say*, Pterostichus corvinus* Dej.*, Pterostichus mutus* Say.

Keywords: Carabidae, Pterostichini, taxonomy, diversity, biology, ecology

Introduction

The Ground Beetles (Carabidae), with very attractive beetles, is one of the largest family of the order Coleoptera, with about 40,000 species presently known worldwide (Kryzhanovskij, 1965, 1983; Kryzhanovskij et al., 1995; Downie and Arnett Jr 1996; Arnett Jr and Thomas, 2000). Most species are black, but some are iridescent. Many of species are large in size, but the variation, even within a single species, is great. Both adults and larvae of ground-beetles are, with rare exceptions, predators. In general, these beetles are terrestrial and they are very abundant in moist areas. They hunt at night and hide under rocks, logs, and other ground cover during the day. The ground beetles are consumers at the highest level of the food pyramid of the small soil animals. Therefore they are important for the flow of energy and nutrients. The Carabidae Family was selected to analyse above problems since it is one of the most effective bio-indicator taxa belonging to the soil fauna. Previous research carried out in different areas from Europe suggested that the main individual biomass (MIS) of ground beetles could be used as a suitable measure to assess the environment stage. Many ground beetles are stenoecious and their mobility enables them to respond quickly to environmental modifications. Species like this are important bioindicators with a high indicator value (Thiele, 1977; Sharova, 1981). Small species are able to fly and move quickly so that they are often pioneers of instable habitats. Such sites are lowland floodplains, which are flooded from time to time. Species that cannot fly, mostly large beetles, are permanent residents. Carabid beetles is the group of insects which is successfully monitored in some European countries by researchers and by voluntary organizations. In the JBWR the insects has been poorly investigated till now, so, generally there is little information and literature on arthropods of this area, about all insects, ground beetles (Carabidae) inclusive. In JBWR were

collected 100 carabids species, 14% of wich (of the total catch) constituted species of the tribe Pterostichini. From 14 species of this tribe recorded in Refuge, 13 are native species, which are well known in the North America and one species is adventive *Pterostichus melanarius*, introduced from Palaearctic. This adventive species was first recorded in North America in 1926 in Nova Scotia (Lindroth, 1966). This species is known in 13 states of USA, in America North of Mexico distributed in 26 geographical entities (Downie & Arnet, 1996). *Pt.melanarius* introduced to North America has a wider distribution, but it is more frequently throughout the northern states and Canada. (Bousquet & Larochelle, 1993). The adults of this species was collected by author in pitfall traps in the autumn. This eurytopic species overwinter as larva, seldom as adult (Lindroth, 1961; 1992; Hurka, 1975; Tomlin, 1975; Sharova, 1981; Bousquet, 1999; Neculiseanu, 2003a, 2003b, 2013a, 2013b; Matalin, 2006). Some authors demonstrated that it mainly prefers open habitat, is well adopted to agricultural field conditions and is abundant in many agricultural fields (Kryzhanovskij, 1983; Shelton, et al. 1983; Chiverton, 1984; Lovei, 1984, Karpova, 1986, Desender & Alderweireldt, 1988; Matalin, 1992; Hendrix, 2006, et al). It was also confirmed by some authors that this species occur in the forests (Georgii, 1986; Sergeeva & Gruntal, 1990; Varvara & Zugravu, 2004) and in the gardens too (Hagley & Allen, 1988; Goulet et al. 2004;). Other authors showed that this species is caught either from agricultural habitats or from forests (Medvedev & Shapiro, 1957; Neculiseanu, 1991; Neculiseanu & Matalin, 2000; Matalin, 2006; New, 2007). In this work we were presented the pterostichini fauna and describe in detail the biology of some species: mating, oviposition periods, fecundity, the development period from eggs to adults, adult longevity, duration of each immature stage (egg-, larval-, pupal- stages), voltinism etc. Behaviour observation and ecological data as feeding, cannibalism, predation were also describe for some species.

Materials and methods

The studies were carried out in the Jamaica Bay Wildlife Refuge (JBWR) which is located in Queens, within the limits of New York City (Fig. 1: map). JBWR is one of the most important urban wildlife refuges in the United States, and is the largest bird sanctuary in the northeastern United States. Considered nationally and internationally area this refuge also is renowned as a prime birding spot where thousands of water, land and shorebirds stop during migration.

The Jamaica Bay Wildlife Refuge was initially "created" and managed by the New York City Department of Parks and Recreation. In 1951, the landscape of the Wildlife Refuge underwent a major change when then Park Commissioner Robert Moses ordered the creation of two large fresh water ponds, East Pond (100 acres) and West Pond (45 acres), which are still major features of the park today. In 1953 Park Department employee Herbert Johnson was transferred to the site and became the first refuge manager. To provide year-round food and shelter, under his capable supervision and dedication, were planted trees, shrubs and grasses and thus, the barren landscape was transformed into a paradise for birds and other wildlife. In 1972, the city transferred ownership of the Wildlife Refuge to the National Park Service, and the site became part of Gateway National Recreation Area. Encompassing 9,155 acres (20 square miles), it is comprised of diverse habitats including open fields, shrub thickets and developing woodlands, wet meadows and salt marsh, several fresh and brackish water ponds and an open expance of bay and islands. The refuge was managed to provide a variety of habitats for a wide variety of marine and terrestrial plants and animals. The refuge is also productive for the now rare native flora and fauna of the coastal areas. More than 325 species of birds have been recorded here during the last 25 years. Some authors showed that Jamaica Bay Wildlife Refuge, the only wildlife refuge

Fig. 1: Map – The Jamaica Bay Wildlife Refuge (JBWR) (Gateway National Recreation Area).

in the National Park System, is also home to an impressive array of native vertebrates. Many reptiles and amphibians call the park home. Mammals also prosper here, with evenings the best time to observe raccoons, opossums, and muskrats on their nightly forays (Cook & Pinnock, 1989). In spring, tree frogs such as Spring Peepers and Gray Tree Frogs, breed in shallow pools, while snakes such as the Black Racer, Garter Snake, and Brown Snake hunt the park woodlands. In refuge there is one of the largest populations of horseshoe crabs in the Northeast. A total of 81 fish species were recorded in Jamaica Bay. More than 60 species of butterflies (Lepidoptera, Insecta), belong to the families Papilionidae, Pieridae, Lycaenidae, Libytheidae, Nymphalidae, Satyridae, Danaidae, Hesperiidae, restricted to one or more habitat types have been observed by researchers in this refuge (Ingraham et al. 1989). The research was effectuated in variety types of habitats and in their microhabitats in the vegetative season of 2008–2009. During field work were used pitfall traps, consists of plastic jars (08 cm diameter by 10 cm deep) and some pitfall traps constructed by author, which were buried in the ground even with the soil surface and filled with a solution of white vinegar (100 ml. in each trap). These traps were installed in the spring, summer and autumn in wet and dry habitats and along the border of standing water. Beetles also were collected by sifter and by hand from a variety of habitats. Some adults and larvae come to bait, other were hand captured from mushrooms, margins of ponds, in leaf-litter,

under stones and logs, under back, on and in the soil and sandy. Immature stages of some species were collected from the field, while their eggs were obtained in the laboratory from field collected adults. Some species taken at light. In order to study their behavior, life cycle and type of reproduction many species, were grown in the laboratory (pair beetles). The adults and immature stages (larvae, pupae) collected in the field has been maintained in the containers and glasses with different diameter and deep with the soil from their habitats. The reproduction and life cycle for many species of some family were studied at temperature 25±3°C under laboratory condition. Collected material were preserved in 70% alcohol for further identification. Classification of the beetles are made after Lawrence and Newton (1995) and American Beetles (Arnett Jr. & Thomas (2000), and Arnett et al. (2002). The scientific works of Erwin (1974), Liebherr (1986), Noonan (1991), Bousquet, (2010) and Nomina Insecta Nearctica were used as the primary key to identify the majority of species. The following abbreviations are used in the text of this work: JBWR (Jamaica Bay Wildlife Refuge), LI (first instar), L2 (second instar), L3 (third instar). The Microscope MBS–9 (LOMO) was used for identification of species and separation by sex.

Results and discussions

In this study we identified the diversity and natural history of the beetles Pterostichini (Coleoptera, Carabidae) of the Jamaica Bay Wildlife Refuge. In the research periods in JBWR were collected 14 species of the tribe Pterostichini, which belong to 3 genera: *Poecilus, Stereocerus* and *Pterostichus.* Captured beetles of the genus *Pterostichus* were the most abundant, with a total of 11 species*: Pterostichus castor* Goul. and Bousq., *Pt. caudicalis* Say, *Pt. commutabilis* Motsch., *Pt. corvinus* Dej., *Pt. ebeninus* Dej., *Pt. femoralis* Kirby, *Pt. melanarius* Ill. *Pt. mutus* Say, *Pt. patruelis* Dej., *Pt. tenuis* Cas., *Pt. trinarius* Cas. Genus *Poecilus* include 2 species: *Poecilus chalcites*

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Say, *P. lucublandus* Say. The genus *Stereocerus* include only one species *S. haematopus* (Dej.). Were obtained original data about the natural history of Pterostichini and were describe in detail the biology of some species: mating, oviposition periods, fecundity of female, the development period from eggs to adults, adult longevity, duration of each immature stage (egg-, larval-, pupal-stages), duration of the entire life cycle, voltinism etc. aspects of feeding and behavior of the adults and of instars larvae L1-L3. The larvae of carabids have three instars in most taxa.

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1. ***Poecilus chalcites*** (10.5–13.0 mm) body is black, dorsum green or bronze, shining, mouthparts, and legs piceous;1–3 rufous antennomeres; convex pronotum along the entire side margin with a distinct bead**;** elytra of female markedly alutaceous, dull. Lives in damp woods near water. Beetles are attracted to light**. 2**. The second species ***Poecilus lucublandus*** (9–14 mm) is a monovoltine, spring-summer breeder. Eggs are laid singly or in groups of 4–6 in the soil on different depth. Eggs are white of cylindrical shape, their length of L2 1.5–1.6 mm, width – 0.6- 0.8 mm. The ovipositional period was 75–78 ds, from early May to late July. In laboratory we observed that one female continued laying eggs more than one month after male died, but only 60% of larvae hatched from these eggs. Fecundity of one female was more 90 eggs. The egg stage lasted – 4–5 ds. **3**. Larvae hatch from eggs and develop through three instars before pupating; the length of first instar (L1) is 5.0–6.3 mm**. 4**. The second instar (L2) has yellow body, with abdominal tergites brown and head capsule dark-brown; the length of the second instar is 10.0–10.5 mm. **5.** The third instar (L3) is elongated with more darker abdominal tergites, black head capsule and pronotum, golden-brown meso- and metanotum and all tergites of abdomen. The length of this instar on 13–14 ds is 17–19 mm. **6.** L3 before pupation becaming dark-brown in color**;** each larva is building in the soil its pupal chamber with a length of 20 mm and a width of 12 mm.

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Poecilus lucublandus (continued) **1**.In these chambers were found the larval exuviae**.** The total duration of the larval stage – 30–32 ds . Cannibalism was observed only for L2 and L3. **2**.The first pupa was observed in Mid- June, the last in early September. The length of pupa was 8.8- 9.2mm, its width was 3.8–4.0 mm **.** The pupal stage lasted 6–7 ds. New adults which usually emerged from the pupae from Mid- July to early September. The adults and larvae live along the edge of bodies of water, under stones, bark, logs. Both adults and larvae are predators. This species is known from North, Northeastern, Eastern, and Western North America. ***Pterostichus* Bonelli** is a large genus, varying from moderate to large size. The beetles are black, stout, with short appendages. Of the 40 species known from northeastern North America, 10 species occur in the JBWR. **3**.The ***Pterostichus melanarius*** (14–20 mm) is large carabid species, distinguished by denticulate hind pronotal angles, with sides of pronotum hardly sinuate and basal impression broad, foveate. Overwintering as larva, seldom as adult, was collected in pitfall traps in the autumn; This eurytopic, introduced (from Palearctic) predator species has a wider distribution also to North America, it well adopted to open habitat, in many agricultural field, but also occur in the forest and in the gardens. **4**.The ***Pterostichus commutabulis*** (7.0–9.0 mm) was found in moist leaf-litter under moss in autumn, but usually can be found in dead wood. Adults have black body, markedly shiny, reddish appendages, pronotum rounded from apex to base, sides on basal ½ explanate, deep, linear, parallel, impunctate basal impressions; elytra iridescent with deep, impunctate elytral striae. **5**.This is ***Pterostichus trinarius,*** a relatively small (11–14 mm) ground beetle, was taken under reed in dry habitat in October and November. Adults have black, shiny head and pronotum, purplish elytra, with 3 dorsal punctures. **6. *Pt. patruelis*** (6–8 mm). Black, somewhat shiny reddish brown, appendages with tibiae and antennomere base, of same, piceous. Collected in pitfall traps installed in the reed in Mid- August and under debris.

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1.Two specimens of ***Pt. ebeninus*** (14–17 mm) were collected in the august in wet meadow under logs. Like other member of this genus adults are black, with black appendage hardly paler, elytra iridescent and elytral striae, fine, continuous to apex, minutely punctuate. Canibalism is known for adults. Manual collected in wet meadow in Mid- August **2**. This black species is ***Pt. tenuis*** (8.2–9.5 mm) it has black head and pronotum, reddish- black or black, long parallel elytra, was collected by pitfall traps installed in reed in Mid – August. **3**.This small species ***Pt. femoralis*** (6.0–7.5 mm) usually lives in dry open habitats. Adults are piceous black, shiny, base of antennae, palpi, and legs reddish – brown; pronotum with sides only slightly sinuate before hind angles, right or obtuse basal impressions deep, linear, with few punctures on basal portion. A few specimens were collected by pitfall traps in the second half of August. **4.** The ***Pterostichus caudicalis*** (10–13 mm) is a monovoltine, spring-summer breeders species, overwinters as adults, starting to be active in Mid- April. **5**. Mating of this species observed only at night, usually after 11.00 pm; mating duration 10–15 min, but sometimes more than 3 hours. **6**. The first instar on 2–3 ds has length 4.2–4.4 mm, width of head capsule – 0.4–0.5 mm. For this instar observed the cannibalism.

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Pt. caudicalis (continued) **1**. L2 of this species is slender; head and thorax more chitinized than abdomen, their color are light brown; abdomen color is white. The length of second instar L2 on 9–10 ds. is 10.5–10.7 mm; width of head capsule 0.8–0.9 mm **2**.The L3 usually have more heavily chitinized head and thorax than abdomen; head with a fully developed dark brown colouring, but thorax color varies from light brown to dark brown; abdomen also varies in color from a milky white to creamy yellow. This instar L3 with hight voracity, has the length before pupation of 16.4–16.6 mm; width of head capsule 1.5–1.6 mm. The duration of the larval stage ranged from 23 to 27 ds. The larvae are predators. On the 10–12 ds before pupation the larvae L3 constructed especially pupal chamber. The length of pupa is 6.3–6.5 mm. width 2.0–2.2 mm . The pupal stage lasted 6–7 ds. **3.** The species ***Pterostichus corvinus*** (11–15 mm) has the following characteristic signs: color of adult is black, shiny, appendages slightly paler,

pronotum slightly constricted basally, hind angles right, blunt, basal foveae punctuated, elytra not iridescent. One female was captured in Mid- August on the border of a pond in a pitfall trap and confined in a vial; it subsequently laid 9 eggs. Few larvae were obtained in laboratory from the eggs and were reared to pupa about one month, but there were not obtained any new adults **4**. The larvae L1 hatched in Mid September, body is fusiform with wider head and thorax, length of first instar on the 1 st to 3 rd days is 4.5–4.9 mm.; width of head capsule is 0.6–0.7 mm. **5** This is L2 instar. The length of second instar on the 8–9 days is 9.2–9.6 mm, width of head capsule 0.8–0.9 mm. **6**. Like L2, L3 has a hight voracity. The head and thorax are dark brown, abdominal tergites with gray plates. The length of L3 on 14–15 ds is 12–13 mm. L3 before pupation is 16.5–17.0 mm. All larval stage duration are 24 to 27 ds. This species is frequent in the rich soil on the borders of standing water.

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1. ***Pterostichus mutus*** (Say). 10–13.5 mm is monovoltine, spring-summer breeders species. Overwintered adults emerge from hibernation in early April. Both adults and larvae are predators, taken under logs and wood, collected in leaf-litter and by pitfall traps. We believe that this species is xylophilous (growing or living on or in wood) and maybe feeding on wood (xylophagous). Copulation was observed a few times toward the end of May and July night after 1.00 AM. Duration of copulation – 10 to 15 min. **2**. Eggs were laid singly in the soil on different depth. Each female lay 45–57 eggs in its lifetime. Duration of egg stage – 4 to 6 ds. The length of egg is 1.2–1.4 mm; width is 0.7–0.8 mm. **3**. This photo shows the L1; the length of L1 on 2–3 ds is 4.5–5.5 mm., this instar lasted 5–6 ds, for L1 cannibalism was not observed. **4**. The second instar L2 were very active, cannibalism was observed two time. The length of L2 on 8–9 ds is 6.5–8.0 mm, this instar lasted 6–7 ds. **5**.Body of L3 is cylindrical; head and thorax dark brownish-rufous; abdomen tergites with light brown plates. The length of this mature larva on 16–18 ds is 12–14 mm., on 28–29 ds (before pupation) 16.2–16.7 mm with width of head capsule 1.8–1.9 mm. The duration of the larval stage –29–30 ds. **6**. Pupated in the soil in a specially constructed pupal chamber with a length 10–11 mm. and width 5–6 mm. The pupal stage lasted from 7 to 9 ds. The length of pupa is 7–8 mm, the width is 3.2–3.7 mm. The total development from the egg to adult lasted 40–44 ds. New adults began to emerge from Mid-July to late August. Adults with hight voracity could consume different kind of food. The old adults disappeared toward the Mid of August.

Conclusions

The results of research detected 14 carabid species of the tribe Pterostichini, belonging to genera *Poecilus* Bonelli (2 species), *Stereocerus* Kirby (1 species) and *Pterostichus* Bonelli (11 species). Native species represented 92.8% of all collected Pterostichini. One species is adventive *Pterostichus melanarius*, introduced from Palaearctic. This introduced to North America species has a wider distribution, but it is more frequently throughout the northern states and Canada. . It mainly prefers open habitat, is well adopted to agricultural field conditions and is abundant in many agricultural fields, occur in the forest and in the garden.

Were describe in detail the biology and ecology (mating, oviposition periods, fecundity, the development period from eggs to adults, adult longevity, duration of each immature stage (egg-, larval-, pupal- stages), voltinism, feeding, cannibalism, predation etc.) of species *Poecilus lucublandus, Pterostichus caudicalis, Pterostichus corvinus., Pterostichus mutus*. Three of these species *Poecilus lucublandus, Pterostichus caudicalis, Pterostichus mutus* are monovoltine, spring-summer breeders species, overwintered as adults (with spring-summer reproduction type), but *Pterostichus corvinus maybe* is a summer-autumn breeders species, overwintered as larvae (with summer-autumn reproduction type). Both adults and larvae of these species are predators; adults and larvae have a hight voracity and could consume different kind of food. Cannibalism was observed for first instar (L1) *(Pt. caudicalis*), for second instar (L2) and third instar (L3) (*Pt. ebeninus*, *Pt. mutus*) and for adults ((*Pt. ebeninus).* Mating of this species observed only at night, usually after 11.00 pm to 1.00 am; mating duration usually 10–15 min, but sometimes more than 3 hours *(Pt.caudicalis*).

These results demonstrated that JBWR is an important area for invertebrates animals, especially for insects. The carabids and other group of insects observed and found in the Jamaica Bay Wildlife Refuge during research period (Z.N., unpublished data) confirmed that this area has habitats with a good conditions for breeding, hibernation and for the maintenance of a high diversity and abundance.

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CARABIDELE PTEROSTICHINI (COLEOPTERA: CARABIDAE, PTEROSTICHINI) DIN REFUGIUL JAMAICA

(Rezumat)

Lucrarea de faţă reprezintă primul studiu cuprinzător al carabidelor din tribul Pterostichini (Coleoptera: Carabidae) din S. Refugiul Naturii Sălbatice Jamaica, de unde au fost colectate şi identificate 14 specii, ce aparţin genurilor *Poecilus* Bonelli (2 specii), *Stereocerus* Kirby (1 specie – *S. haematopus* (Dejean) şi *Pterostichus* Bonelli (11 specii), dintre care 13 specii sunt aborigene, iar specia *Pterostichus melanarius* Illiger este specie adventivă, introdusă din regiunea Palaearctică. Multe dintre speciile aborigene sunt bine cunoscute în America de Nord. Au fost obţinute date originale despre biologia şi reproducerea speciilor *Poecilus lucublandus* Say, *Pterostichus caudicalis* Say, *Pterostichus corvinus* Dej., *Pterostichus mutus* Say.

PRELIMINARY DATA ON BAT SPECIES HIBERNATING IN CUPCINI AND HORDINEȘTI STONE QUARRIES FROM THE NORTHERN ZONE OF THE REPUBLIC OF MOLDOVA

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Abstract: The studies have been performed in the stone quarries near Cupcini and Hordinești from the northern part of the Republic of Moldova at the end of January, 2015. A total of 6 km of underground passages were investigated. Bats were studied directly by visual observations, all observed individuals were identified. During the study 461 individuals from 3 species (*Myotis blythii, M. daubentonii, M. mystacinus*) have been registered in Cupcini quarries and 265 individuals from 5 species (*Rhinolophus hipposideros, M. blythii, M. daubentonii, M. mystacinus, Plecotus austriacus, P. auritus*) in Hordinești quarries. The community structure and species dominance was different in the studied mines. In Cupcini mines the most numerous were *M. blythii* (86.33%), in Hordinești – *M. daubentoni* (84.62%). All registered bat species belong to different areas of Palearctic zone. The found species have various category of rarity.

Keywords: bats, stone quarries, Cupcini, Hordineşti, hibernation, community structure, rarity criteria

Introduction

The geographic position of the Republic of Moldova and favorable ecological conditions contribute to the existence of rather rich and abundant bat fauna. Thus, among mammals the order Chiroptera is the second according to species richness after ord. Rodentia and comprises 21 species belonging to families Rhynolophidae (2 species) and Vespertilionidae (19 species). Many species hibernate in underground roosts, like stone quarries, mainly in the northern and central part of the republic. Such roosts are suitable for hibernation due to large surfaces, constant and favorable temperature and humidity conditions and presence of many galleries, cracks, hollows, corners etc.

The studies of bat wintering roosts started 60's–70's of the past century all over the republic, but mostly in the northern and central zones [1, 3, 4]. A t the end of 90's they continued by several researchers mostly in the central part of Moldova and in Nistru river valley [2, 9, 10). Since 2013 intense studies on bat species hibernating in various underground shelters from the northern part of Moldova have started, but mostly in Nistru river valley [6, 7, 8]. Some data on bat species occurrence in some areas form the northern zone can be found, including Edineț district, to which Cupcini and Hordinești villages belong [3, 4, 5]. The aim of the paper is the preliminary analysis of bat communities hibernating in two locations from the northern zone of the republic – Cupcini and Hordinești, situated in Prut river basin. Previously only Hordinești quarries have been studied, but no data have been published.

Materials and methods

The studies have been performed in the stone quarries near two localities from the northern part of the Republic of Moldova at the end of January, 2015. Stone quarries near Cupcini are situated at $47^0$41.797 N, $28^0$57.857 E at the altitude of 142 m. There are several entries, of which 2 are abandoned and the rest active. Stone quarries near Hordineşti are situated at $48^0$09.899^0 N, $27^0$08.968 E at the altitude of 166 m and have several entrances, of which 4 abandoned and the rest are active. Some parts of the mines were flooded. In both locations the entries are protected and the population has no access into the mines.

The quarries are machine-made, spacious, reaching 2–5 meters high and 5–7 meters wide. Their layout is quite correct: long parallel tunnels of about 300 m connected with lateral passages. Walls and ceilings of tunnels have long parallel slots with the width of 7–10 cm and the depth of 5–20 cm. in some places the ceiling collapsed and there are many cracks and holes of various sizes.

Temperature and humidity regime in both mines differ and vary depending on the distance from the entrance. Thus, in Cupcini mines the temperature and at 10 meters from the entrance was 7,4°C, the humidity – 44%; at 50 m from the entrance air temperature was 8,6°C, and the humidity – 52%. In Hordineşti mines the temperature at 10 meters from the entrance was 6.8°C, the humidity of 62%; at 70 m air temperature was 10.2°C, humidity – 68%. Thus, the microclimate in the tunnels from Cupcini mines is less humid, and the difference between the air temperature at the entrance and deep in the passages is less pronounced.

A total of 6 km of underground passages were investigated. Bats were studied directly by visual observations, all observed individuals were identified. Hibernation places were recorded, the distance from the entrance, crowding (single or in groups) of individuals, the number of individuals of each species were noted. Animals were not removed from the shelters, to not disturb the process of hibernation.

Results and discussions

During the study 461 individuals from 3 species (*Myotis blythii, M. daubentonii, M. mystacinus*) have been registered in Cupcini quarries and 265 individuals from 5 species (*Rhinolophus hipposideros, M. blythii, M. daubentonii, M. mystacinus, Plecotus austriacus, P. auritus*)

Fig. 1: Individuals of *M. blythii* found solitarily and in groups

in Hordinești quarries. Immediately after the entry into quarries, at about 3–5 m, the first specimens of bats were found. The individuals were found solitarily or in groups in cracks, niches, on the edges of ceiling, in the corners and just hanging from the ceiling. Only two species formed groups: *M. blythii* was observed in groups of 2 to about 30 individuals (fig. 1) and *M. daubentonii* was found in small groups of 2–4 individuals. Other species were found exclusively solitarily.

Near the entrances in quarries, at 3–4 m, were observed the first individuals of *M. blythii* and of *Plecotus* genus species. The *Plecotus* species prefer to hibernate near the entrances of underground roosts, it was found between the distance of 3 up to 12 m, while the lesser mouse-eared bat was found near the entrances, as well as deeper in the underground up to 100–120 m.

The community structure and species dominance was different in the studied mines (fig. 2). Thus, in Cupcini mines the most numerous were *M. blythii* with 86.33%, followed by *M. daubentonii* with 12.58% and *M. mystacinus* with 1.09%. In Hordinești quarries the most numerous were *M. daubentoni* with 84.62%, followed by *M. blythii* (11.92%), while the rest of species were registered in low number (*Rh. hipposideros* – 0.77%, *P. austriacus* – 1.54%, *P. auritus* – 1.15%). The dominance index (Naughton-Wolf) of *M. blythii* in Cupcini mines was of 0.99 and of *M. daubentoni* in Hordinești mines was of 0.96 that shows the absolute dominance of the respective species in hibernating bat communities from the studied quarries.

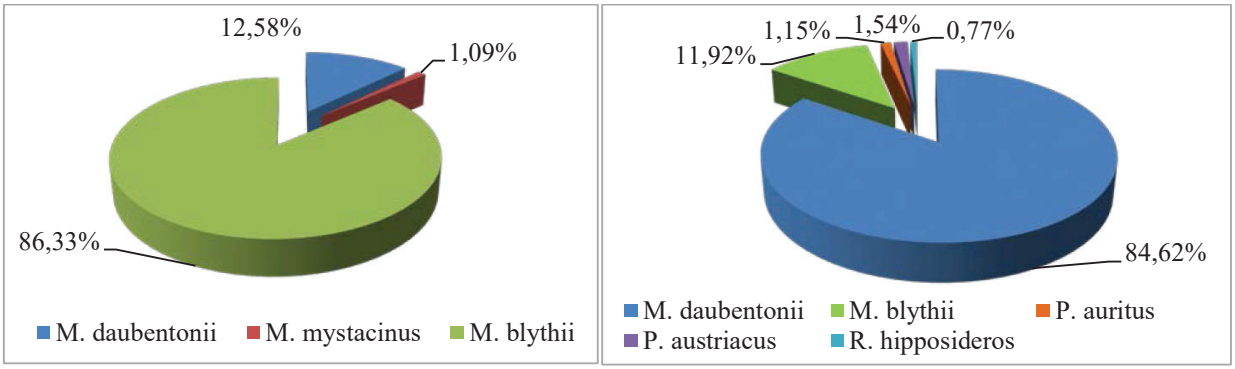

Fig. 2: Community structure of bats hibernating in Cupcini (A) and Hordinești (B) underground roosts

According to the zoogeographic origin all registered bat species belong to different areas of Palearctic zone (tab. 1). After the criteria of rarity all the species found in both locations are included in Annex II of Bern Convention, in EUROBATS agreement, in the Red Book of Moldova, 3rd edition, and in the Red Book of Vertebrates from Romania with various category of rarity – vulnerable, endangered or critically endangered (tab. 1).

Table 1: Zoogeographic origin and rarity status of registered bat species

Species	Zoogeographic origin	Red Book of Moldova	Red Book of Vertebrates from Romania	Bern Convention	EUROBATS
Rhinolophus hipposideros	West-Palearctic	En	Vu	Annex II	+
Myotis blythii	South-Palearctic	Vu	En	Annex II	+
M. daubentonii	North-Palearctic	Vu	Cr	Annex II	+
M. mystacinus	Palearctic	Vu	En	Annex II	+
Plecotus austriacus	South-Palearctic	Vu	En	Annex II	+
P. auritus	North-Palearctic	En	Vu	Annex II	+

During the study in several places of Hordinești mines, in passages situated not far from the entrances, up to 50–70 m, large accumulation of guano was recorded (fig. 3). Significant portion of the walls and ceiling in this area had yellowish-brown color, remained after being sprinkled with urine of many individuals. It was concluded that these are remains of activity from maternal colonies during reproduction period. Therefore, Hordinești stone quarry is also an important breeding site for certain bat species.

Fig. 3: Accumulations of guano and urine traces of maternal colonies in Hordinești mines

In 60–70 of the past century, near the studies locations in Brînzeni village, in several grots of natural origin hibernating individuals of *M. blythii* have been registered [3, 4]. In the Atlas of vertebrate species [5] in the studied area of Edinet district is mentioned the presence of *M. mystacinus* and *P. austriacus*. Other species found in our study are not indicated for this area.

Cupcini and Hordinești stone quarries represent important sites of bat hibernation in the northern zone of Moldova. Hundreds of individuals from at least 6 species spent the winter in these roosts; all the registered species are rare. The monitoring of these sites will continue and measures for their protection will be proposed.

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DATE PRELIMINARE PRIVIND LILIECII CARE HIBERNEAZĂ ÎN CARIERELE CUPCINI ȘI HORDINEȘTI DIN ZONA DE NORD A REPUBLICII MOLDOVA

(Rezumat)

Cercetările au fost efectuate în carierele de piatră Cupcini şi Hordineşti din zona de nord a Republicii Moldova, la sfârşitul lunii ianuarie 2015. În total au fost parcurşi circa 6 km de treceri subterane. Liliecii au fost studiaţi vizual, toţi indivizii au fost identificaţi. În total au fost semnalaţi 461 indivizi din 3 specii la Cupcini (*Myotis blythii, M. daubentonii, M. mystacinus*) şi 265 indivizi din 5 specii la Hordineşti (*Rhinolophus hipposideros, M. blythii, M. daubentonii, M. mystacinus, Plecotus austriacus, P. auritus*). Structura comunităţilor hibernante este diferită în cele două mine. La Cupcini, dominantă a fost specia *M. blythii* (86.33%), în Hordineşti – *M. daubentoni* (84.62%). Toate speciile semnalate aparţin diferitor zone ale regiunii Palearctice. Speciile din ambele mine au diverse categorii de raritate.

THE DIVERSITY OF LEAF-BEETLES (INSECTA, COLEOPTERA: CHRYSOMELIDAE) IN THE NATURE RESERVE "PĂDUREA DOMNEASCĂ"

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Abstract: The paper includes the study of 17 *Chrysomelidae* species from diverse habitats of the Nature Reserve "Pădurea Domnească". The material was collected in 2010–2015 by methods specific for entomological research, including: mowing with entomological net, shaking insects on cloth and manual collection. Among *Chrysomelidae* species the Euro-Siberian (7) and Transpalearctical (6) species are prevailing, followed by two European species, and by one Mediterranean and one Palearctic species. List of species, trophic spectrum, ecology and distribution are included.

Keywords: *Chrysomelidae,* leaf – beetles species, ecology, distribution.

Introduction

The Chrysomelidae (Coleoptera, Chrysomelidae) is one of the largest families of the order Coleoptera. According to some bibliographical sources, there are known 35 to 50 thousand species in the world. The *Chrysomelidae* are exclusively phytophagous.

The insect biodiversity in forest ecosystems is determined both by climatic and natural factors and allows to highlight the degree of stability of the ecosystem. In Moldova one can not speak of intact forest areas: even areas protected by the state suffer some changes due to anthropogenic interventions that directly affect the normal development of insects.

The territory occupied by forest vegetation in the Nature Reserve, "Pădurea Domnească" (Royal Forest) belongs to the Moldovan Northwest Plateau and is located in the middle course of the river Prut and its tributary Kamenka from the village Branişte at the North to Pruteni at the South. To the West it is bounded by the river Prut and to the East by the reef area of Butesti – Cobani, and at the South by the terraces of the river Prut near the Eastern part of the villages Viişoara and Pruteni. The total area of the Reserve is 5736 ha, of which 4952 hectares are covered with forests.

Materials and methods

The materials consist of collections and observations conducted in the "Pădurea Domnească" Reserve in 2010–2015. The material was collected by methods specific for entomological research, including: mowing with entomological net, shaking insects on cloth, and manual collection. Identification of Chrysomelidae species was made according to fundamental works [2]. The processed material is presented in table 1, and arranged in systematic order according to Bouchard et. al. (2011) [1].

Results and discussions

The composition of fauna of beetles in Moldova is due to its geographical position in a region of interference of several biogeographic regions (Central European, Eurasian and Mediterranean) and to the variety of food plants and insects, which are closely linked to the intensive economic development of the territory.

The biotopes near the river Prut are specific mesofite and hydrophilic ecosystems, in which a rich insect fauna is developing. As a result of performed investigations there were recorded 17 species of 10 genera and 5 subfamilies. Most species of leaf-beetles are assigned to the Cryptocephalinae subfamily – 7 species, followed by Chrysomelidae – 4 species, Cassidinae – 3 species, Criocerinae – 2 species, and Galerucinae – only one species.

The list of leaf – beetles species of the Nature Reserve "Pădurea Domnească" including trophic spectrum, ecology and distribution have been included in the Table 1.

Table 1: Leaf – beetles (Coleoptera: Chrysomelidae) in the Nature Reserve "Pădurea Domnească"

No.	Taxon	Trophic spectrum	Ecology	Distribution
	Subfamily *Criocerinae*			
	Genus *Oulema* Gozis, 1886			
1.	*Oulema melanopus* (Linnaeus, 1758)	oligophagous	eurybionte	Transpalearctical
2.	*Oulema gallaeciana* (Heyden, 1870)	oligophagous	xerophile	Euro-Siberian
	Subfamily *Cassidinae*			
	Genus *Hypocassida* Weise, 1893			
3.	*H. subferruginea* (Schrank, 1776)	oligophagous	xerophile	Transpalearctical
	Genus *Cassida* Linnaeus, 1758			
4.	*C. vibex* Linnaeus, 1767	oligophagous	mesophile	Euro-Siberian
5.	*C. rubiginosa* Müller, 1776	oligophagous	xerophile	Transpalearctical
	Subfamily *Chrysomelinae*			
	Genus *Chrysolina* Motschulsky, 1860			
6.	*Ch. fastuosa* (Scopoli, 1763)	oligophagous	mezophile	Euro-Siberian
7.	*Ch. graminis* (Linnaeus, 1758)	oligophagous	mezophile	Transpalearctical
	Genus *Chrysomela* Linnaeus, 1758			
8.	*Ch. vigintipunctata* (Scopoli, 1763)	oligophagous	higrophile	Euro-Siberian
	Genus *Gastrophysa* Chevrolat, 1837			
9.	*G. viridula* (Degeer, 1775)	oligophagous	higropfile	Transpalearctical
	Subfamily *Galerucinae*			
	Genus *Phyllobrotica* Chevrolat, 1837			
10.	*Ph. adusta* (Creutzer, 1799)	monophagous	xerophile	Mediterranean
	Subfamily *Cryptocephalinae*			
	Genus *Smaragdina* Chevrolat, 1837			
11.	S. *affinis* (illiger, 1794)	polyphagous	mezophile	European
12.	S. *salicina* (Scopoli, 1775)	polyphagous	mezophile	European
	Genus *Cryptocephalus* Geoffroy, 1762			
13.	*C. sericeus* (Linnaeus, 1758)	polyphagous	xerophile	Transpalearctical
14.	*C. hypochoeridis* (Linnaeus, 1758)	polyphagous	mezophile	Euro-Siberian
15.	*C. moraei* (Linnaeus, 1758)	polyphagous	higrophile	Euro-Siberian
16.	*C. octacosmus* Bedel, 1891	polyphagous	mezophile	Palearctic
	Genus *Pachybrachis* Chevrolat, 1836			
17.	*P. hieroglyphicus* (Laicharting, 1781)	oligophagous	mezophile	Transpalearctical

In "Pădurea Domnească" Reserve there were identified *Chrysomelidae* species belonging to five zoogeographical groups. Among them the Euro-Siberian (7) and Transpalearctical (6) species are prevailing, followed by two European species, and by one Mediterranean and one Palearctic species (fig.1). The presence of species with a narrow spread area (European and Mediterranean) indicates the importance of the region chosen for the study in terms of biodiversity conservation.

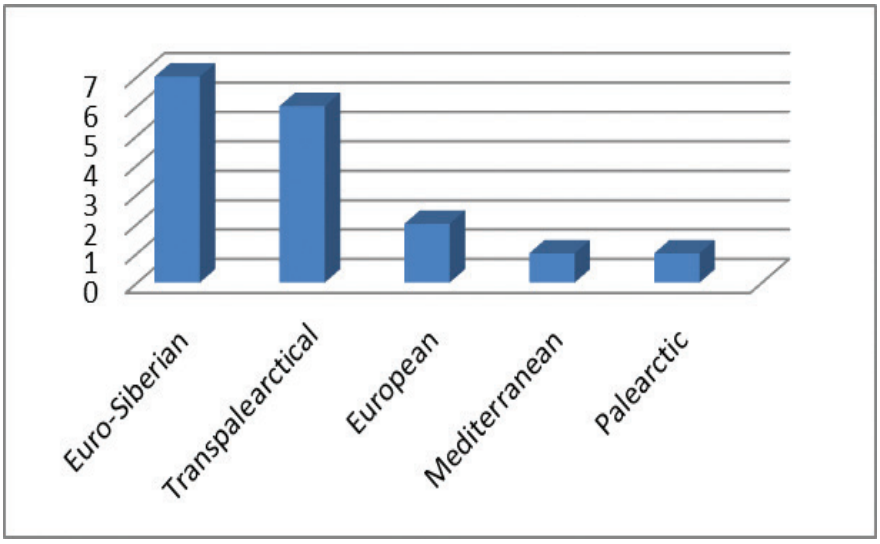

Fig. 1: Zoogeographical distribution of *Chrysomelidae* species from "Pădurea Domnească" Reserve

Some *Chrysomelidae* species are forestry pests. Their economic importance is often underestimated, since the caused injuries rarely lead to the total destruction of the plant. Feeding with green parts of the plant leads often to worsening the physiological state of the plant attacked. Commonly, *Chrysomelidae* feeding is more intensive in the larval stage, therefore the larvae harms more than the adult insect. A particular feature of *Chrysomelidae* is the relatively narrow trophic spectrum. Usually, each harmful species is trophically closely related to the injured species.

However, leaf beetles, as well as the enthomofauna as a whole are an important component of biodiversity that should be taken into account, given their multi-faceted value that has not yet been sufficiently disclosed, although some species became rare or even disappeared.

Conclusions

As a result of investigations conducted during 2010–2015 in the Nature Reserve "Pădurea Domnească", 17 species of *Chrysomelidae* in 10 genera and 5 subfamilies were recorded.

Republic of Moldova is located at the intersection of three biogeographical regions that explains the presence of Euro-Siberian, Transpalearctical, European, Mediterranean and Palearctic elements.

Most of *Chrysomelidae* species included in the study are found in adjacent areas of the studied region. The *Chrysomelidae* fauna includes both forestry and grassland species.

Acknowledgement

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DIVERSITATEA CRIZOMELIDELOR (INSECTA, COLEOPTERA: CHRYSOMELIDAE) DIN REZERVAŢIA „PĂDUREA DOMNEASCĂ”

(Rezumat)

Lucrarea include studiul a 17 specii de crizomelide din diverse habitate ale Rezervației „Pădurea Domnească”. Materialul a fost colectat în perioada 2010–2015, prin metode specifice cercetărilor entomologice (care includ: cosirea cu fileul entomologic, scuturarea insectelor pe pânză și colectarea manuală). Dintre speciile de *Chrysomelidae* predomină cele Euro-siberiene (7 specii) și transpalearctice (6 specii), apoi urmează cele europene (2 specii), și mediteraneene și palearctice cu câte o specie fiecare. Lucrarea include lista speciilor, distribuția și spectrul lor trofic.

FAUNA AND ECOLOGY OF SCARABEOIDEA COLEOPTERANS (COLEOPTERA: SCARABAEOIDEA) FROM THE SCIENTIFIC RESERVE "CODRII"

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Abstract: The paper represents a study of fauna and ecology of coleopterans from the suprafamily Scarabaeoidea from the forest ecosystems of the scientific reserve "Codrii". As result of the investigations during 2004–2014 in 7 forest types of the scientific reserve "Codrii" 79 species were identified from 29 genera and 3 families, of which 4 rare and endangered species included in the 3rd edition of the Red Book of Republic of Moldova. After trophic regime the fauna of scarabeoid coleopterans from the forest ecosystems of scientific reserve "Codrii" was composed of three trophic groups: 55% are coprophagous species, followed by phytophagous 41% and only 3% were xilophagous. The zoogeographical analysis was found that scarabeoid coleopterans fauna belongs to 8 zoogeographical elements: Trans-Palearctic, European, Euro-Siberian, cosmopolite, Holarctic, Euro-Caucasian, Euro-Mediterranean and Mediterranean, with the predominance of species with European area type (20%), Trans-Palearctic (19%) and Mediterranean – 17%.

Keywords: Coleoptera, ecology, fauna, zoogeography, trophic spectrum

Introduction

The problem of biodiversity conservation and especially in state protected areas is considered a problem at global level, as well as in the Republic of Moldova.

The Scientific reserve "Codrii" was created in 1971, total area of the reserve is of 5177 ha. The main purpose of the reserve is to preserve the most representative central European deciduous forests and the conservation of rare plant and animal species and communities, restoring the biodiversity of the most particular phytocenosis [22].

Superfamily Scarabaeoidea is one of the largest groups of beetles (approximately 31,000 species) spread over Terra with great diversity and morphological features that, from ecological point of view, are important links in food chains of ecosystems, contributing to the maintainance of ecological balance in natural and anthropic ecosystems [8]. In the fauna of Moldova, currently about 150 species are known, which constitutes about 75% of the country's fauna.

The first studies of insect fauna in the study area were made by Miller and Zubovski at the beginning of XX century [16], who in the work Bessarabia Catalog listed 84 species of scarabeid beetles. In 30's–40'sof the XX century new data on fauna of some scaraboid coleopterans in this area are presented in the works of Ienistea [14] W. Knektel, S. Panin [15] etc.

In the second half of the XX century different taxonomic and faunistic works appeared, completed with new data on ecology and biology by local and foreign specialists [12, 17, 18].

A separate investigation constituted the study of rare and disappearing species of coleopterans from the investigated territory [3, 4, 7, 20].

Also in recent years a series of papers have been published regarding the coleopterans from natural areas protected by state. Here can be mentioned the papers of: Andreev et al. [1]; Neculiseanu Z., E. Baban [19] E. Baban [2, 3], Abstract of biological diversity [10]. In these papers are presented faunistic, ecological, zoogeographical data of some scarabeoid coleopteran species in this area. Up to present there was no work of synthesis of performed researches on scarabeoid coleopteran from forest ecosystems identified in the scientific reserve "Codrii".

Materials and methods

As base for this paper served the collections and studies performed during 2004–2014 in the forest ecosystems of the scientific reserve "Codrii". Also, the materials from the entomological collection of the Institute of Zoology of the ASM were used. Faunal material was collected in seven forest types that represent different characters in terms of vegetation: oak forest mixed with beech; forest of oak mixed with hornbeam; mixed forest of oak and lime-ash; forest oak with hornbeam and ash mixture; mixed forest of hornbeam and oak; oak forest with a mixture of ash and lime; ash forest mixed with hornbeam.

Scarabeoid coleopterans were collected in forest ecosystems by use of soil traps of Barber type, using vessels with a volume of 700 ml. As the preservative-fixer liquid served the concentrated solution of sodium chloride (NaCl) and acetic acid (CH_3COOH), as well as collection using entomological net, manual collection from various plants, shrubs, ground surface etc. In total during 10 years they were collected and analyzed about 9,000 individuals.

Identification of collected scarabeoids was done based on the work of the authors Panin [21] Medvedev [18] Gîdei, Popescu [13].

Results and discussions

After the analysis of data obtained by the authors and those from the literature, it was emphasized the presence in the scientific reserve "Codrii" of a rich fauna of scabaeoid coleopterans, which includes a large number of taxa. To prepare the list of scarabeoid fauna there were used works: Chimișliu [8], Cilipic [9], Bacal et al. [5]. It was established that scarabeoid beetle fauna of the forest ecosystems is represented by 3 families, 29 genera and 79 species (tab. 1), of which 4 species are rare and endangered in Moldova and are included in the III edition of the Red Book of the Republic Moldova: *Protaetia aeruginosa* Dr., 1770; *Oryctes nasicornis* (L., 1761), *Gnorimus octopunctatus* L., 1758; *Lucanus cervus* (L., 1758) [7].

Table 1: Ecological – faunistic characteristic of scarabeoid beetles (Coleoptera: Scarabeoidea) from the scientific reserve "Codrii"

No	Taxon	Feeding type	Type of area
1.	2	3	4
Suprafamily *SCARABAEOIDEA*			
Family *LUCANIDAE*			
	Genus *Lucanus* Scopoli, 1763		
1.	*L. cervus* (Linnaeus, 1758) **	Xylophagous	Euro-Mediterranean
	Genus *Dorcus* MacLeay, 1819		
2.	*D. paralellipipedus* Linnaeus, 1758 **	Xylophagous	Euro-Caucasian

No	Taxon	Feeding type	Type of area
	Genus *Platycerus* Geoffroy, 1762		
3.	*P. caraboides* (Linnaeus, 1758)	Xylophagous	European
	Family *GEOTRUPIDAE*		
	Genus *Geotrupes* Latreille, 1807		
4.	*G. stercorarius* (Linnaeus, 1758)	Coprophagous	Euro-Siberian
5.	*G. stercorosus* Scriba, 1791	Coprophagous	Euro-Siberian
6.	*G. vernalis* (Linnaeus, 1758)	Coprophagous	European
	Genus *Lethrus* Scopoli, 1768		
7.	*L. apterus* Laxamnn, 1770	Phytophagous	Mediterranean
	Family *SCARABAEIDAE*		
	Genus *Aphodius* Illiger, 1798		
8.	*A. arenarius* Olivier, 1789	Coprophagous	Euro-Mediterranean
9.	*A. caspius* (Menetries, 1842)	Coprophagous	Euro-Mediterranean
10.	*A. depressus* (Kugelan, 1792)	Coprophagous	Trans-Palearctic
11.	*A. distinctus* (Müller, 1776)	Coprophagous	Holarctic
12.	*A. erraticus* (Linnaeus, 1758)	Coprophagous	Holarctic
13.	*A. fimetarius* (Linnaeus, 1758)	Coprophagous	Trans-Palearctic
14.	*A. fossor* (Linnaeus, 1758)	Coprophagous	Holarctic
15.	*A. granarius* (Linnaeus, 1767)	Coprophagous	Cosmopolite
16.	*A. lividus* (Olivier, 1789)	Coprophagous	Cosmopolite
17.	*A. lugens* Creutzer, 1799	Coprophagous	Euro-Caucasian
18.	*A. luridus* Fabricius, 1775	Coprophagous	Trans-Palearctic
19.	*A. melanostictus* Schmidt, 1840	Coprophagous	Euro-Mediterranean
20.	*A. merdarius* (Fabricius, 1775)	Coprophagous	Trans-Palearctic
21.	*A. prodromus* (Brahm, 1790)	Coprophagous	Holarctic
22.	*A. pusillus* Herbst, 1789	Coprophagous	Euro-Siberian
23.	*A. quadriguttatus* (Herbst, 1783)	Coprophagous	Euro-Caucasian
24.	*A. quadrimaculatus* (Linnaeus, 1761)	Coprophagous	European
25.	*A. rufipes* (Linnaeus, 1758)	Coprophagous	Trans-Palearctic
26.	*A. sticticus* Panzer, 1798	Coprophagous	Euro-Siberian
27.	*A. tristis* Zenker, 1801	Coprophagous	Euro-Caucasian
28.	*A. varians* (Duftschmid, 1812)	Coprophagous	Trans-Palearctic
	Genus *Pleurophorus* Mulsant, 1842		
29.	*P. caesius* Creutzer, 1796	Coprophagous	Holarctic
	Genus *Oxyomus* Escholtz, 1839		
30.	*O. silvestris* Scopoli, 1763	Coprophagous	Holarctic
	Genus *Ryssemus* Mulsant, 1842		
31.	*R. germanus* (Linnaeus, 1767)	Coprophagous	Trans-Palearctic
	Genus *Sisyphus* Latreille, 1807		
32.	*S. schaefferi* (Linnaeus, 1758)	Coprophagous	Mediterranean
	Genus *Caccobius* Thomson, 1859		
33.	*C. schreberi* (Linnaeus, 1761)	Coprophagous	Trans-Palearctic
	Genus *Onthophagus* Latreille, 1807		
34.	*O. coenobita* (Herbst, 1783)	Coprophagous	Trans-Palearctic
35.	*O. fracticornis* Preyssler, 1790	Coprophagous	Trans-Palearctic
36.	*O. furcatus* Fabricius, 1781	Coprophagous	Mediterranean
37.	*O. illyricus* Scopoli, 1763	Coprophagous	Mediterranean
38.	*O. lemur* Fabricius, 1781	Coprophagous	Mediterranean
39.	*O. lucidus* Sturm, 1800	Coprophagous	Mediterranean
40.	*O. ovatus* (Linnaeus, 1758)	Coprophagous	Trans-Palearctic
41.	*O. ruficapillus* Brulle, 1832	Coprophagous	Mediterranean

No	Taxon	Feeding type	Type of area
42.	*O. taurus* Schreber, 1759	Coprophagous	Trans-Palearctic
43.	*O. vacca* (Linnaeus, 1767)	Coprophagous	Trans-Palearctic
44.	*O. verticicornis* Leicharting, 1781	Coprophagous	Euro-Caucasian
45.	*O. amyntas* (Olivier, 1789)	Coprophagous	Euro-Caucasian
46.	*O. vitulus* Fabricius, 1776	Coprophagous	Euro-Siberian
	Genus *Oniticellus* Serville, 1825		
47.	*O. pallipes* Fabricius, 1781	Coprophagous	Trans-Palearctic
48.	*O. fulvus* Goeze, 1777	Coprophagous	Holarctic
	Genus *Oryctes* Illiger, 1798		
49.	*O. nasicornis* Linnaeus, 17581**	Phytophagous	Trans-Palearctic
	Genus *Pentodon* Hope, 1837		
50.	*P. idiota* Herbst, 1789	Phytophagous	Mediterranean
	Genus *Anomala* Samouelle, 1819		
51.	*A. dubia* (Scopoli, 1763)	Phytophagous	Euro-Mediterranean
52.	*A. vitis* Fabricius, 1775	Phytophagous	Mediterranean
	Genus *Anisoplia* Serville, 1825		
53.	*A. agricola* (Poda, 1761)	Phytophagous	Euro-Caucasian
54.	*A. aprica* (Erichson, 1847)	Phytophagous	European
55.	*A. austriaca* (Herbst, 1783)	Phytophagous	European
56.	*A. lata* (Erichson, 1847)	Phytophagous	Mediterranean
57.	*A. segetum* Herbst, 1783	Phytophagous	European
58.	*A. villosa* (Goëze, 1777)	Phytophagous	European
	Genus *Melolontha* Fabricius, 1775		
59.	*M. melolontha* Linnaeus, 1758	Phytophagous	European
60.	*M. hippocastani* Fabricius, 1775	Phytophagous	European
	Genus *Polyphylla* Harris, 1842		
61.	*P. fullo* Linnaeus, 1758	Phytophagous	European
	Genus *Rhizotrogus* Berthold, 1827		
62.	*Rh. aestivus* (Olivier, 1789)	Phytophagous	Mediterranean
63.	*Rh. pilicollis* Gyllenhal, 1817	Phytophagous	Mediterranean
64.	*Rh. vernus* (Germar, 1823)	Phytophagous	Mediterranean
	Genus *Hoplia* Illiger, 1803		
65.	*H. praticola* Duftschmid, 1812	Phytophagous	European
66.	*H. philanthus* Fuesly, 1775	Phytophagous	European
	Genus *Gnorimus* Serville, 1825		
67.	*G. octopunctatus* Fabricius, 1775**	Phytophagous	Euro-Mediterranean
68.	*G. nobilis* Linnaeus, 1758	Phytophagous	Euro-Mediterranean
	Genus *Valgus* Scriba, 1857		
69.	*V. hemipterus* (Linnaeus, 1758)	Phytophagous	Euro-Siberian
	Genus *Epicometis* Burmeister, 1843		
70.	*E. hirta* (Poda, 1761)	Phytophagous	Trans-Palearctic
	Genus *Oxythyrea* Mulsant, 1842		
71.	*O. funesta* (Poda, 1761)	Phytophagous	European
	Genus *Cetonia* Fabricius, 1775		
72.	*C. aurata* (Linnaeus, 1758)	Phytophagous	Trans-Palearctic
	Genus *Liocola* Thomson, 1859		
73.	*L. lugubris* Herbst, 1786	Phytophagous	Euro-Siberian
	Genus *Protaetia* Reitter, 1898		
74.	*P. aeruginosa* Drury, 1770**	Phytophagous	European
	Genus *Potosia* Reitter, 1898	Phytophagous	
75.	*P. affinis* Andresch, 1798	Phytophagous	Euro-Siberian

No	Taxon	Feeding type	Type of area
76.	*P. fieberi* Kraatz, 1880	Phytophagous	Euro-Siberian
77.	*P. hungarica* Herbst, 1790	Phytophagous	European
78.	*P. metallica* Herbst, 1782		Euro-Mediterranean
79.	*P. lugubris* Herbst, 1790**	Phytophagous	European

Note: ** – *rare and endangered species*

The most representative were the genera: *Aphodius* (21 species) and *Onthophagus* (13 species). Other genera have a smaller number of species. Most of these beetles are mesophilic, more or less related to tree vegetation (genera *Melolonthus*, *Rutelus*, *Valgus*, *Cetonia*). There are also steppe groups (representatives of subfamily Coprinae), more or less xerophilous, sometimes even deserticolous, but there are no hygrophilous forms [21].

In terms of taxonomic diversity the investigated families of beetles differ from one another. The largest was the family Scarabaeidae, including 72 species, representing 91% of the total number of species identified on the territory. Geotrupidae family was represented by 4 species (5%), and family Lucanidae – only by 3 species (4%). (fig. 1).

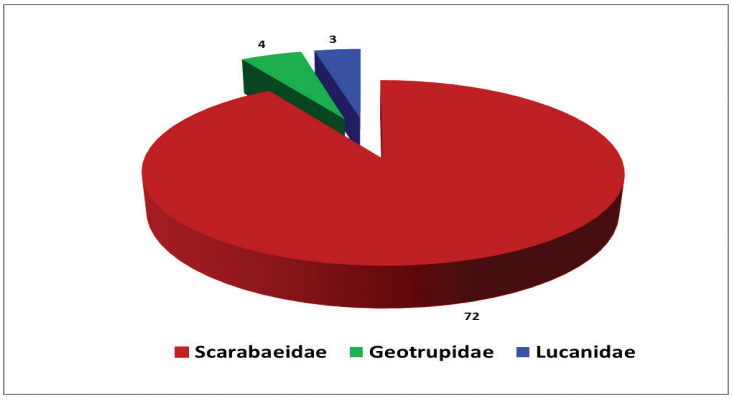

Fig. 1: Taxonomic structure of registered scarabeoid coleopterans

After food preferential regime the fauna of scarabeoid coleopterans from the forest ecosystems of scientific reserve "Codrii" was composed of three trophic groups: 55% are coprophagous species, followed by phytophagous 41% and only 3% were xilophagous (fig. 2).

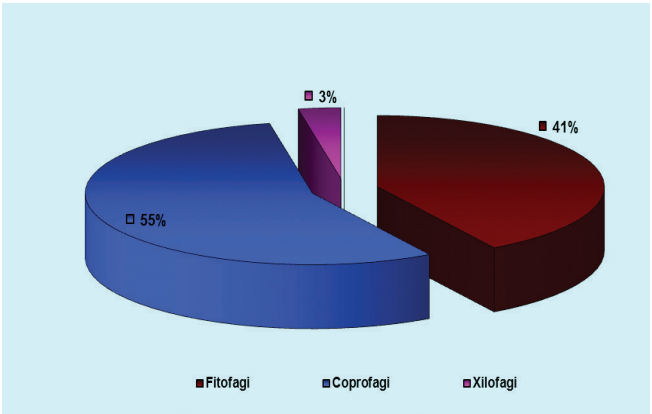

Fig. 2: Trophic spectrum of scarabeoid coleopterans from scientific reserve "Codrii"

Analysis of the geographical spread of scarabeoids from the forest ecosystems of the scientific reserve "Codri" was based on assumptions of renowned entomologists, which allowed us to observe that coleopteran fauna in this area is composed of elements of very different faunal origins and period, and on fauna formation in investigated area definitive influence had the glacial refuges, the centers of arboreal and eremial spreading [6, 11].

The zoogeographical analysis was found that scarabeoid coleopterans fauna identified in the scientific reserve "Codrii" belongs to 8 zoogeographical elements: Trans-Palearctic, European, Euro-Siberian, cosmopolite, Holarctic, Euro-Caucasian, Euro-Mediterranean and Mediterranean, with the predominance of species with European area type (20%), Trans-Palearctic (19%) and Mediterranean – 17% (fig. 3).

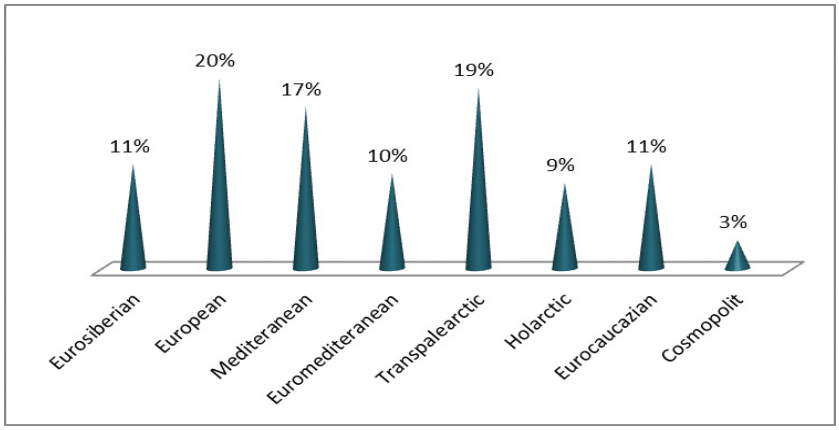

Fig. 3. Geographic spreading of identified scarabeoid coleopterans

Scarabeoid coleopterans fauna from the forest ecosystems of the scientific reserve "Codrii" qualitatively resembles to that of Central Europe. This is of great interest due to the position of given territory at the interference of biogeographic zones Central-European, Eurasian and Mediterranean. The works published in the course of about a hundred years and personal investigations reveal the importance of these coleopterans in maintenance of forest ecosystems stability.

Conclusions

Scarabeoid fauna from the forest ecosystems is represented by 3 families, 29 genera and 79 species. In investigated ecosystems there were recorded 4 rare and endangered species: *Protaetia aeruginosa* Dr., 1770; *Oryctes nasicornis* (L., 1761), *Gnorimus octopunctatus* L., 1758; *Lucanus cervus* (L., 1758), included in the 3rd edition of the Red Book of Republic of Moldova. After trophic regime the fauna of scarabeoid coleopterans from the forest ecosystems of scientific reserve "Codrii" was composed of three trophic groups: 55% are coprophagous species, followed by phytophagous 41% and only 3% were xilophagous. The zoogeographical analysis was found that scarabeoid coleopterans fauna belongs to 8 zoogeographical elements: Trans-Palearctic, European, Euro-Siberian, cosmopolite, Holarctic, Euro-Caucasian, Euro-Mediterranean and Mediterranean, with the predominance of species with European area type (20%), Trans-Palearctic (19%) and Mediterranean – 17%.

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FAUNA ŞI ECOLOGIA COLEOPTERELOR SCARABEOIDEE (COLEOPTERA: SCARABAEOIDEA) DIN REZERVAŢIA ŞTIINŢIFICĂ „CODRII"

(Rezumat)

Lucrarea de faţă prezintă un studiu asupra faunei şi ecologiei coleopterelor suprafamiliei Scarabaeoidea, din ecosistemele forestiere ale rezervaţiei ştiinţifice „Codrii". Pe baza investigaţiilor din perioada anilor 2004–2014, în 7 tipuri de pădure ale rezervaţiei ştiinţifice „Codrii" au fost identificate 79 specii de scarabeoidee ce aparţin la 29 genuri şi 3 familii, dintre care 4 specii sunt rare şi ameninţate cu dispariţia în Republica Moldova, fiind incluse în ediţia III a Cărţii Roşii a Republicii Moldova. După regimul trofic preferenţial, s-a stabilit că fauna de coleoptere scarabeoidee din ecosistemele forestiere ale rezervaţiei ştiinţifice „Codrii" a fost compusă din 3 grupe trofice: 55% o constituie speciile coprofage, urmate de cele fitofage 41% şi doar 3% xilofagii. Analiza zoogeografică relevă faptul că, fauna coleopterelor scarabeoidee identificate aparţine la 8 elemente zoogeografice: transpalearctice, europene, eurosiberiene, cosmopolite, holarctice, eurocaucaziene, euromediteraneene şi mediteraneene, cu predominarea speciilor cu areale de tip european (20%), transpalearctic (19%) şi mediteranean – 17%.

THE SPECIES *PLATYCIS COSNARDI* (CHEVROLAT, 1839) (COLEOPTERA: LYCIDAE), THE SECOND MENTION IN THE REPUBLIC OF MOLDOVA

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Abstract: The paper presents general information about the collection site, phenology and morphological characteristics of the species *Platycis cosnardi* (Chevrolat, 1839). This being the second record of the species in the Republic of Moldova, *Platycis cosnardi* is regarded as a rare saproxylic species.

Keywords: Coleoptera, *Platycis cosnardi*, Republic of Moldova.

Introduction

The species *Platycis cosnardi* (Chevrolat, 1829), belongs to family Lycidae Laporte, 1836. This family is comprised of about 160 genera and over 4000 described species, with the highest diversity in tropical rainforest [3; 5]. For European Lycidae fauna 12 species from 7 genera were described [10].

The adults in lengths vary from 6 to 20 mm. Body shape is usually elongated with triangular head, the antennae are long, thick and serrated. Body color is usually brick-red. Lycidae beetles are associated with forest habitats, they likely to prefer larger girth beech trunks as these provide a greater volume of larval habitat, and decay over a longer period, therefore providing more habitat for longer. The larvae grow under bark or in leaf litter with a high content of organic substances. It is considered that larvae feed on fermented substances from inhabited substrate. Adults prefer shady places, they have a short life and does not feed at all, except few nectarivorous species. The adults are protected from predators by being toxic. In most of the Lycidae taxa wings are present for both males and females, but there are some genera with apterous females [3].

Materials and methods

Material examined: the species *Platycis cosnardi* (Chevrolat, 1839) was collected in the Scientific Reservation "Codrii" near Lozova (47 7' 58" North, 28 23' 9" East, Altitude: 112 m) on 17.05.2015. Only one exemplar was found from dead decaying oak, by manual collection. Forest vegetation of the "Codrii" is represented by leafy forests of the type of Central European forests. The edifice of the forest is the beech (*Fagus sylvatica*), durmast (*Quercus petraea*) and the oak tree (*Quercus robur*), the last being the most often met in the depression. Voucher specimens are deposited in the Collection of the Museum of Entomology, Institute of Zoology, Academy

of Sciences of Moldova. The taxonomy of the species is based on the works of Bei-Bienko (1965) [2], [8].

Results and discussions

This is the second record of the species *Platycis cosnardi* (Chevrolat, 1839) in the Republic of Moldova. First mention of the species dates from 1933 by A. Ruscinsky [6], the author describes the coleopteran fauna of some localities from Basarabia (Bularda, Harjauca, Leordoaia and Palanca belonging to Calarasi district). The species was assigned to Cantharidae family as *Dictyopterus cosnardi* Chevrolat, 1829. Only one exemplar was found on 21.05.1928, from wood, near Leordoaia locality (47 20' 44" North, 28 9' 12" East). Two more synonyms are known for *Platycis cosnardi* (Chevrolat, 1839) (= *Erotides cosnardi* (Chevrolat, 1829) and *Dictyopterus cosnardi* (Chevrolat, 1839).

The body size of collected specimen varies between 7–8 mm. Body color is black with brick-red elytra and black pronotum with brick-red sides. The head is short, but with elongated rostrum, that is not visible from above being hidden by pronotum. The filiform antennae are placed on the forehead between eyes and entirely black colored, consisting of eleven segments. The shape of pronotum is almost square, longitudinal carinae on pronotum not converging anteriorly, meeting front edge well separated, not enclosing a discoidal areola. The pits between the four main elytral costae arranged irregularly (Fig. 1 and 2).

The species is widespread in central Europe (France, Belgium and Denmark), the Balkan Peninsula in southern Sweden and Poland [10]. The ecology of species is poorly known. The larvae develop in dead wood of deciduous species. Adults emerge from May to late June.

According to specialized sources the species *Platycis cosnardi* has been found on dead wood in hornbeam and oak forests in Russia [1] and beech forests in the UK [12]. In Poland, the adults were collected on grass, flowers and also on rotten wood of beech, birch and oak [9].

Platycis cosnardi is regarded as a saproxylic species, in Sweden the species is treated as vulnerable [4]. Shirt (1987) was the first to assign a conservation status to *Platycis cosnardi* in Britain [11]. It was given endangered status as it was only known from three reliably identified British individuals from two localities.

Conclusions

Platycis cosnardi is incontestably a rare and difficult beetle to find with, only a single individual found by the current survey. By promoting a better awareness of the species, of its habitats, identification characters and its phenology, would provide valuable contribution for conservation of species.

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SPECIA *PLATYCIS COSNARDI* (CHEVROLAT, 1839) (COLEOPTERA: LYCIDAE), A DOUA MENȚIUNE ÎN REPUBLICA MOLDOVA

(Rezumat)

Lucrarea de față prezintă informații generale despre locul de colectare, perioada de activitate și caracteristica morfologică a speciei *Platycis cosnardi.* Specia este la a doua mențiune în Republica Moldova. Ambele semnalări sau făcut în zona de centru. Prima colectare datează din luna mai a anului 1928, și a fost realizată din pădurea de lângă localitatea Leordoaia, cea de a doua înregistrare a speciei a fost în 2015, de asemenea în luna mai, în Rezevația Codrii.

Fig. 1: ***Platycis cosnardi***

Fig. 2: ***Platycis cosnardi*** **(pronotum)**

ROLE OF ECOTONE ZONE IN SURVIVAL OF THE SPECIES *MUS SPICILEGUS* PETENYI 1882 (MURIDAE, RODENTIA)

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Abstract: One of the most widespread rodent species in Moldova is the mound-building mouse *Mus spicilegus* Petenyi, 1882. The studies have been performed during 2010–2015 in autumn-spring period in various types of agrocenoses, fallow ground, abandoned land and ecotone zone from the central part of R. Moldova. In the cold period of the year *M. spicilegus* lives in mounds with food reserves. The mound construction begin in mid-July – early September. In autumn the most numerous mounds were registered on fallow ground (20.18%), in unharvested maize and in sunflower (14.91%), at ecotone fallow ground – wheat (14.04%) and fallow ground – maize (12.27%), and the lowest number (7.02%) of mounds– in alfalfa and wheat stubble. At the ecotone fallow-agrocoenoses the mounds are the largest, because only in this area there are many seed of both crops and spontaneous plants. In spring the largest mounds were at the ecotone between agrocoenoses, on corn stubble, on fallow ground and at the ecotone fallow-corn stubble, while the smallest mounds were on alfalfa field. The longest period the mounds preserve on fallow, on strip between agrocenoses, on lands with perennial plants and in the area of ecotone, because these lands are not subject so often to agro-technical activities. Abandoned land, fallow ground and ecotone zone plays an important role in the survival of the species. In these biotopes the highest number of mounds was found, they were the largest and the period of preservation was the longest.

Keywords: *Mus spicilegus*, mound, size, preservation, agrocoenosis, ecotone

Introduction

One of the most widespread rodent species in Moldova is the mound-building mouse *Mus spicilegus* Petenyi, 1882. The species has a patchy distribution on the republic territory, populating only open type habitat, especially the agrocenoses. The varied composition of trophic base allows mice to populate the lands cultivated with various agricultural and fodder plants, as well as abandoned land, fallow ground etc., switching easily from one type of food to another. The highest density is recorded on cultivated land, mostly in the cereals, maize, sunflower, fodder plants and fallow ground. Species density in various types of agrocoenoses reaches at the end of reproductive period 150–200 individuals per hectare and the ecological significance of the species varies between 15% and 25% [5, 6]. The mound-building mouse can be also found in ecotone zone (forest shelter belt – agrocoenoses, fallow ground – abandoned orchard, fallow ground – vineyard, fallow ground – agrocenoses, strips grown with spontaneous vegetation between cultivated land), on roadsides.

This species has several adaptive peculiarities (building of mounds with food reserves for winter period, a complex network of underground galleries, location of common nests at

relatively high depths, high reproductive potential, intense migration activity, varied composition of trophic resources), enabling it to survive in conditions of intensive agriculture [1, 4, 7, 9, 10]. For the mound-building mouse it is very important not only the possibility of building mounds, but also their preservation, which depends primarily on agro-technical measures (harrowing, plowing) applied to these lands. In general, the presence of the species is conditioned by the availability of trophic resources, represented by seeds of crop and spontaneous plants. In the trophic spectrum of mound-building mouse there were identified 53 species of wild and cultivated plants from 14 families [2]. Terms of ripeness, abundance and availability of certain plant species are the main factors that determine their collection as food reserves in mounds.

The aim of the work is to emphasize the role of ecotone zone in survival of mound-building mouse during the cold period in the conditions of agricultural ecosystems.

Materials and methods

The studies have been performed during 2010–2015 in autumn-spring period in various types of agrocoenoses (wheat, maize, sunflower, alfalfa), fallow ground, abandoned land and ecotone zone from the central part of R. Moldova. The mounds have been monitored since the early days of construction up to their finishing. In total 179 mounds were investigated and the following parameters were recorded: large diameter, small diameter and height of the mound. The peculiarities of trophic base were highlighted depending on the biotope. The mound-building mouse individuals were caught with live traps placed on and around the mound (20 traps per mound). All captured individuals were weighed, marked, their external aspect, sex, age and reproductive activity have been considered. The ecological analysis of mound-building mouse populations included the following parameters: the density of individuals in various biotopes, its seasonal dynamics, sex ratio, age groups, reproductive intensity. In mound investigations the following parameters were considered: minimum, maximum and mean values of large diameter, of small diameter, of mound height, mean number of individuals per mound, time period of mound preservation.

Results and discussions

The annual life cycle of the species *M. spicilegus* comprises two periods: I – spring – summer – the individuals begin to reproduce and pass in simple summer galleries with 1–2 exits and a nest without food reserves where they remain until August-September; II – Autumn – Winter – individuals live in mounds with complicated system of galleries, with a large nest, food reserves and don't reproduce [1, 4, 8].

In the cold period of the year *M. spicilegus* lives in mounds with food reserves and are represented by young individuals from the last generations, forming the basis of population and have much higher survival rate in comparison with those born in first generations. An important feature of individuals from wintering generations is the low mortality during autumn – winter.

The mound construction begins in mid-July – early September, after the ripening of fodder plants seeds and toward the end of reproductive process. *M. spicilegus* gather in groups of 6–14 individuals born in late summer and early autumn and represent the main of mound-building mouse population (about 80%) and forms the last cohort, the role of which in the population functioning is to provide shelter and trophic resources for the survival in winter conditions [3]. Most individuals that participate in mound construction are juveniles with body weight of 6–8 g, in which body growth has stopped till the end of winter. The high density of population can be observed in autumn period, after finishing mound construction (Fig. 1).

Fig. 1: Distribution of mounds on wheat stubble in autumn period

Mound location is conditioned by two main factors: the terms of seeds' ripening and food abundance. The first mounds appear on wheat, barley and other gramineae fields during the harvest. Their construction begins in mid-July and is related to the agro-technical measures carried out on these fields (harvest, plowing etc.). On perennial plants' lands the first mounds appear in late August. The latest mound building was reported on land with maize and sunflower crops. Mass construction in cereal fields begin in the first half of August, on lands with perennial plants – in the second half of September and in maize and sunflower crops – in October-November. Several individuals (4–14) participate at the construction of mounds with food reserves that are used by the inhabitants in late autumn, in winter and early spring.

In autumn period from 114 studied mounds the most numerous were registered on fallow ground (20.18%), in unharvested maize and in sunflower (14.91%), at ecotone fallow ground – wheat (14.04%) and fallow ground – maize (12.27%), and the lowest number (7.02%) of mounds – in alfalfa and wheat stubble (Fig. 2).

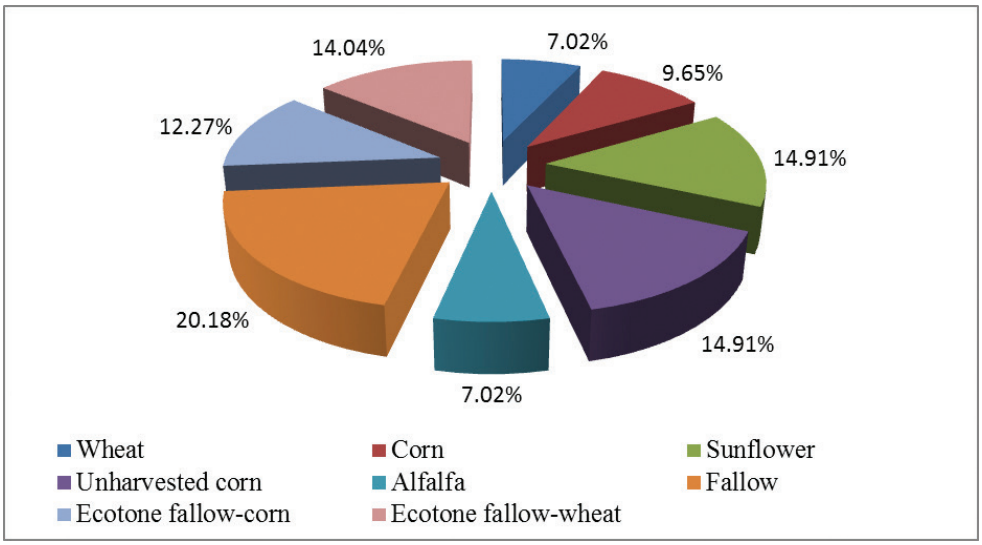

Fig. 2: Distribution of mounds in various types of biotopes in autumn

The duration of mound construction varies depending on the biotope and climatic conditions. Despite the fact that mound construction process is similar, they differ in form, size, weight of food reserves and the number of individuals they inhabit it [5]. After the form of its base the mound resembles most often with irregular ellipse (65%), rarely it is round (35%). On wheat and maize stubbles and on fallow ground double mounds were found (4%). The biggest mounds have been identified in the area of ecotone fallow – wheat stubble and fallow – corn stubble, while the lowest – on the fields of alfalfa (Tab. 1). On fallow and on a strip of weedy not harvested corn particularly large mounds have been found. The length of this strip was about 1.4 km and width of 7 m. It has investigated only a portion of 0,07ha (100x7m), where 11 mounds were observed and investigated. The distance between the mounds varied between 8 and 25 m. Some of them were very high – 45–49 cm and nears om at about 0,5–1 m food reserves non-covered ground were found, in spite of the fact that it was already late October. Thus, the climatic conditions were favorable, food was plentiful and it has allowed longer duration of mound construction.

At the ecotone fallow-agrocoenoses the mounds are the largest, because only in this area there are many seed of both crops and spontaneous plants. Mound size depend not only on the seed abundance, but also on the number of individuals participating in construction (r = 0.99). The number of individuals in mounds with smaller diameter, up to 100 cm, is of 5–6 individuals, with a diameter of 150–200 cm – is of 9–10 individuals and with diameter of higher than 200 cm – is of 12- 14 individuals. As it can be observed, the number of individuals in mounds is the largest at ecotone and in fallow.

Table 1: Dimensions of mounds depending on biotope and number of individuals in autumn

Biotope	Large diameter, m			Small diameter, m			Height, m			Ni.ind./mound
	min.	max.	mean	min.	max.	mean	min.	max.	mean	mean
Maize stubble	0.8	2.57	1.28±0.15	0.8	1.33	1.04±0.06	0.20	0.35	0.25±0.02	8.9±0.62
Unharvested maize	0.8	2.2	1.40±0.10	0.8	1.6	1.19±0.07	0.18	0.49	0.35±0.03	9.8±0.58
Wheat stubble	0.8	1.55	1.21±0.09	0.7	1.55	1.13±0.09	0.2	0.37	0.28±0.02	8.3±0.07
Sunflower stubble	1.0	1.98	1.34±0.06	0.8	1.57	1.23±0.06	0.2	0.54	0.36±0.02	8.9±0.42
Alfalfa	0.74	1.2	0.99±0.05	0.74	1.2	0.97±0.05	0.16	0.32	0.22±0.02	6.5±0.27
Fallow	0.9	2.3	1.50±0.07	0.8	1.76	1.28±0.05	0.18	0.56	0.36±0.02	10.1±0.47
Ecotone fallow-wheat	1.2	2.4	1.68±0.1	0.95	1.5	1.29±0.06	0.3	0.45	0.38±0.02	11.1±0.46
Econote fallow-maize	1.15	1.99	1.67±0.08	1.15	1.8	1.45±0.06	0.24	0.52	0.35±0.02	10.2±0.35

In wheat crops the highest density was recorded up to the harvest, followed by number decrease of population. In maize crops the number of individuals increases along with crop growth until the harvest, followed by a sharp decrease of density and the complete renewal of the population. In alfalfa crops the maximum density was recorded during the growing season (May-June), then, depending on agro-technical works, the number of individuals varies significantly and the population is renewing 2–3 times per year. On fallow and at ecotone zones the reproductive activity is also high in other months, because there are no agricultural works and the trophic base is always abundant. On cereal fields in the first half of the summer the reproduction is the most intense (73.1% of reproductive females) compared to the land with perennial plants

(51.9%) and fallow ground (56.4%), while in late July after harvest, the activity individuals in wheat and perennials decreases sharply (0 and 3.4%), due to their dispersal adjacent uncultivated lands, where breeding activity reaches about 60% (in fallow).

In August the proportion of breeding females in lands with perennials grow again and constitute about 60%. Namely the individuals of the last generation born in August – September participates intensively at the construction of mounds and ensures the survival of the population during the cold season.

After analyzing the mound-building population in autumn in various biotypes, the highest density was recorded in some agrocoenoses and in the area of ecotone (shelter belts – agrocoenoses, strip between agrocoenoses). The abundance in corn stubble varied from 7.2% to – 59.2%, on wheat stubble – from 8.6% to 34.38%, on sunflower stubble – 1.1%–19.6% on alfalfa field – 0.7%–9.9%, on fallow – 2.3%–25%, at ecotone shelter belt – cornfield – 45.5%–66.7%, on strip between agrocoenoses – 16.7%–36.4%. In these biotopes the mound-building mouse is a constant or characteristic species with ecological significance (W) 7.9%–44.4%.

Rapid recovery of population is also assured by periodic dispersion particular for this species. Rich assortment of seeds of crop and spontaneous plants used for food permit to individuals to populate various types of agricultural biotypes, to survive in the conditions of common agro-technical works (rolling, plowing, harvesting) and then to migrate to adjacent biotypes. In general, the presence of the species is conditioned by the availability of trophic resources. At first they populate the edges of fields where their density is 2.1 times higher than in the center. Here the formation of new groups occurs where individuals of spring – summer generations prevails. In the first decade of July, before the harvest, an intense migration of individuals from gramineae lands on the corn can be observed and in early September the density of individuals on the outskirts of filed is 1.3 times higher than in the center.

For mound-building mouse is very important not only the possibility of building mounds, but also their preservation, which depends primarily on agro-technical measures applied to the inhabited lands. The longest period the mounds preserve on fallow, on strip between agrocenoses, on lands with perennial plants and in the area of ecotone, because these lands are not subject so often to agro-technical activities (Tab. 2). In maize and sunflower crops the mounds are preserved from 2–3 up to 6–7 months depending on the agro-technical measures applied to these lands. The shortest period of 1–2 months the mounds remain intact on gramineae fields, because in most cases, these lands are plowed in autumn.

Table 2: Period of mound preservation in various biotopes

Biotope	Mound construction	Period of preservation
Perennial plants	II-nd half of September	6 – 7 months (till spring)
Gramineae	I-st half of August	2 – 3 months (till autumn plowing)
Maize, sunflower	II-nd half of October – I-st half of November	6 – 7 months (till spring plowing)
Fallow	I-st half of August	6 – 7 months (till spring)
Ecotone	I-st half of August	6 – 7 months (till spring)

Despite the fact that the mounds stay 6–7 months, in spring, the seeds from the food supply germinate and the mounds turns into green "islands", which can be seen very well and serve as a food source for hares, wild boar, deer etc. (Fig. 5).

Fig. 5: Mounds with germinated seeds on wheat field in spring

In order to establish the distribution and period of mound preservation in spring 65 mounds were investigated in different biotypes: corn stubble, alfalfa, fallow, at ecotone orchard – fallow, fallow-corn and strip between agrocenoses (Fig. 6).

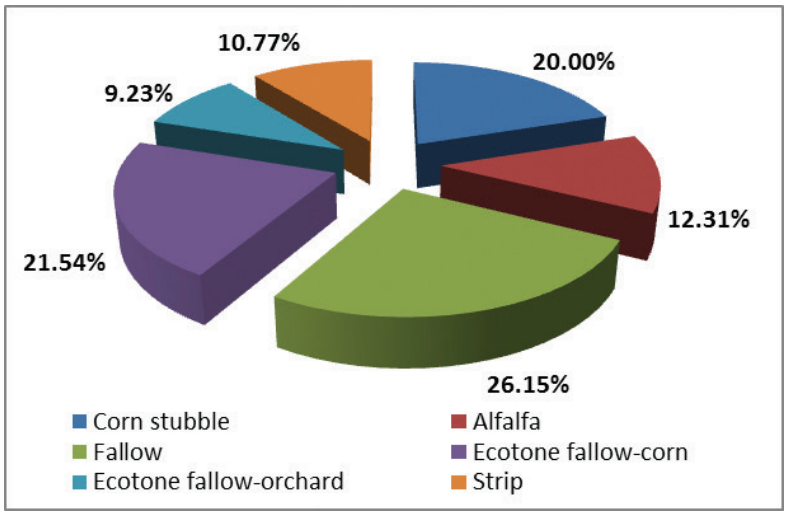

Fig. 6: Distribution of mounds in various biotopes in spring

Most of the mounds were found on fallow (26.15%), at the ecotone fallow-corn (21.54%) and corn stubble (20%) and the least – at ecotone fallow-orchard (9, 2. 3%). On wheat stubble mounds were not found, because in autumn these fields have been plowed. On some land in the places of mounds built in autumn some rather large patches have been found with diameter of 1–2 m, where the wheat was taller and has a darker color. Around these patches holes were found, probably, the soil was plowed not to deep and after wheat sowing the mice were able to reconstruct the galleries and restore some of the food supply (Fig. 7).

The possibility of rebuilding the destroyed mounds is an adaptation of mound-building mouse to the conditions of agrocoenoses. If climatic conditions are favorable, the duration of mound rebuilding is low (3–4 days), but if it is cold and/or raining, then the duration of the rebuild is longer.

Fig. 7: Distribution of mounds on wheat field in spring

Table 3: Dimensions of mounds depending on biotope and number of individuals in spring

Biotope	Large diameter, m			Small diameter, m			Height, m			Ni.ind./mound
	min.	max.	mean	min.	max.	mean	min.	max.	mean	mean
Corn stubble	0,8	2,4	1,42±0,12	0,8	2,0	1,27±0,08	0,20	0,4	0,29±0,02	8,0±0,82
Alfalfa	0,8	2,0	1,34±0,13	0,8	1,5	1,19±0,08	0,15	0,3	0,2±0,02	6,4±0,8
Fallow	0,5	1,5	1,06±0,07	0,5	1,5	1,0±0,06	0,15	0,25	0,19±0,01	5,0±0,45
Ecotone fallow-corn	0,8	2,0	1,25±0,08	0,8	1,5	1,14±0,05	0,1	0,4	0,2±0,02	6,3±0,55
Ecotone fallow-orchard	0,6	1,5	1,15±0,14	0,6	1,5	1,05±0,14	0,2	0,4	0,3±0,03	6,3±0,49
Strip	1,3	1,8	1,5±0,06	1,0	1,4	1,2±0,05	0,3	0,5	0,36±0,03	8,3±1,36

In spring the number of individuals that inhabit the mound may not correspond to its size because the survival rate of mound-building mouse in the cold season is 35–67% and varies from year to year depending on climatic conditions. Even spring mound dimensions are smaller. From the moment of mound construction finishing until spring the mounds suffer some changes: in size, especially height, they become smaller under the action of autumn rains, of snow; the seeds from the food supply are less, some rot, others germinate. After analyzing mound sizes various biotopes in spring we found that the largest mounds were at the ecotone between agrocoenoses, on corn stubble, on fallow ground and at the ecotone fallow- corn stubble, while the smallest mounds were on alfalfa field (Tab. 3). By comparing the mound size with the number of individuals it was observed that the highest number of individuals was on maize stubble and at ecotone area of agrocoenoses (strip between agrocenoses).

Thus, at present the mound-building mouse is one of the dominant species in agricultural ecosystems of R. Moldova. Abandoned land, fallow ground and ecotone area between fallows and agrocoenoses plays an important role in the survival of the species. In these biotopes the highest number of mounds was found, they were the largest and the period of preservation was the longest since the agricultural activities are missing.

Conclusions

The highest density of mound-building mouse was recorded on fallow ground in some agrocoenoses and in the area of ecotone. In these biotopes the mound-building mouse is a constant or characteristic species with ecological significance (W) 7.9% – 44.4%.

In autumn the most numerous mounds were registered on fallow ground, in unharvested maize and in sunflower, at ecotone fallow ground – wheat and fallow ground – maize, and the lowest number of mounds – in alfalfa and wheat stubble. At the ecotone fallow-agrocoenoses the mounds are the largest, because only in this area there are many seed of both crops and spontaneous plants.

In spring the largest mounds were at the ecotone between agrocoenoses, on corn stubble, on fallow ground and at the ecotone fallow- corn stubble, while the smallest mounds were on alfalfa field. The longest period the mounds preserve on fallow, on strip between agrocenoses, on lands with perennial plants and in the area of ecotone, because these lands are not subject so often to agro-technical activities.

Abandoned land, fallow ground and ecotone zone plays an important role in the survival of the species. In these biotopes the highest number of mounds was found, they were the largest and the period of preservation was the longest.

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ROLUL ZONEI DE ECOTON ÎN SUPRAVIEȚUIREA SPECIEI *MUS SPICILEGUS* PETENYI 1882 (MURIDAE, RODENTIA)

(Rezumat)

Una dintre cele mai răspândite specii de rozătoare în Moldova este șoarecele de mișună *Mus spicilegus* Petenyi. Cercetările au fost efectuate în perioada 2010–2015, în diverse tipuri de ecosisteme agricole și la ecoton, din zona centrală a Republicii Moldova. În perioada rece a anului, *M. spicilegus* trăiesc în mișuni cu rezerve de hrană. Construcția mișunilor începe pe la mijlocul lunii iulie – începutul lunii septembrie. Toamna, cele mai multe mișuni au fost întâlnite pe pârloagă (20,18%), porumb nesecerat și floarea soarelui (14,91%), la ecoton pârloagă-grâu (14,04%) și pârloaga-porumb (12,27%), iar cele mai puține – în lucernă și pe miriștea de grâu (7,02%). În zona de ecoton pârloagă-agrocenoză mișunile sunt cele mai mari, anume în această zonă pot fi colectate multe semințe, atât ale plantelor de cultură, cât și spontane. Primăvara, cele mai mari mișuni erau pe hat – o zonă de ecoton între agrocenoze, pe miriștea de porumb, pârloagă și la ecoton pârloagă-miriște de porumb, iar cele mai mici mișuni erau în lucernă. Cel mai mult se păstrează mișuna pe pârloagă și în zona de ecoton, deoarece aceste terenuri nu sunt supuse lucrărilor agrotehnice. Terenurile neprelucrate, pârloaga și zona de ecoton joacă un rol foarte important în supraviețuirea șoarecelui de mișună. În aceste biotopuri mișunile sunt cele mai multe, cele mai mari și se păstrează cel mai mult timp.

PRELIMINARY STUDY REGARDING THE DISTRIBUTION, BIOLOGY AND ECOLOGY OF *NATRIX TESSELATA* (LAURENTI 1768) IN THE REPUBLIC OF MOLDOVA

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Abstract: The actual distribution of the species *Natrix tessellata* in Republic of Moldova was studied. The favorite sites of species and wintering dens' location were analyzed. It was estimated the density of snakes in different populations and it was analyzed the biometric and morphological peculiarities. The basic trophic objects and the main factors of disturbance were highlighted.

Keywords: *Natrix tessellata*, distribution, biology, ecology.

Introduction

Dice snake (*Natrix tessellata*) is a rheophilous species of medium size, which spreads to West of South- Western of France and Eastern of North Africa, through Central and South Europe, at South reaching up to the Persian Gulf, at East until Afghanistan, West Pakistan, North-West of India and Western of China. The northern limit of the area of dice snake is framed between 49–53° parallels north latitude.

In Republic of Moldova, the spread area of the species coincides with the meadows of Dniester and Prut Rivers and their tributaries, water snake being also reported in the Cahul River floodplain. The rocks, clay and sandy-clay slopes, sometimes covered with rare vegetation, near water basins are favorite for *Natrix tessellata*. It can be met also around standing water basins located in the floodplain of rivers.

Materials and methods

A number of 98 specimens, of which 54 males and 5 juveniles were captured and examined. The classical research methods were used. Determining the species was carried out using the identification keys according to Banikov, Darevskii and Fuhn [1, 2]. In population nuclei it was studied the density of specimens at 1 km of route using transects method. The captured specimens were studied and biometric parameters such as body and tail length, body mass have been taken. For the analysis of folidozis the abdominal shield number, rows number of dorsal and subcaudal scales, head scales were counted. In populations from Trebujeni and Gura Bicului the sex ratio was also studied. In some specimens the stomach content was extracted by palpation method and caused vomiting, then the food bowl was analyzed. At capture places of specimens the biotope conditions were described. During the investigations no specimen was killed [3, 4].

Results and discussions

During the study *Natrix tessellata* has been recorded in 39 stations: 8 stations in the meadow of the Prut River: Criva, Costesti, Cobani, Balatina, Ungheni, Valea Mare Slobozia Mare, Giurgiulesti; 14 stations in the meadow of Dniester River: Naslavcea, Calaraseuca, Unguri, Holosnita, Cosauti, Racovat Cerlina, Saharna, Tipova, Viscauti, Molovata, Holercani, Copanca Palanca; 10 stations in the meadow of Raut River: Ghindesti, Rogojeni, Stefanesti, Brinzenii Vechi, Brinzenii Noi, Furceni, Ivancea, Branesti, Trebujeni, Mascauti; 3 stations in the Cahul River floodplain: Gavan, Vulcanesti, Etulia; by one station in the meadows of Rivers Ikel (Goian), Draghiste (Brinzeni), Bic (Gura Bicului), Isnovat (Milestii Mici).

The density of snakes at 1 km of route varies depending on site, trophic resources and season and oscillates between 12 specimens (Unguri) and 150 specimens (Gura Bicului) (Fig. 1), but on average is estimated at 20–40 specimens.

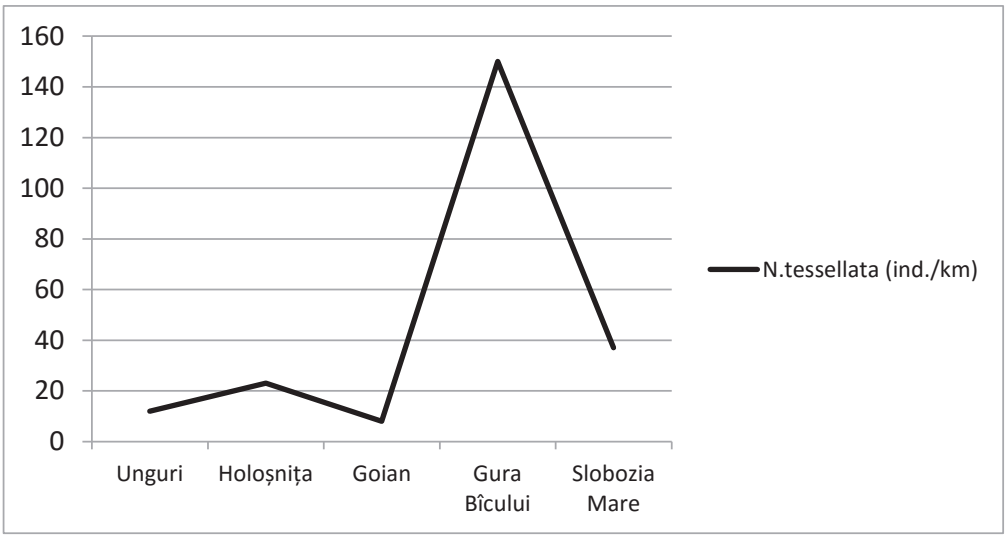

Fig. 1: The density of dice snake in different sites estimated at 1 km of route

Sizes of mature snakes, which were measured, vary between 43.2 (male captured at Trebujeni) and 103.3 cm (female captured at Gura Bicului). Males, usually, have smaller dimensions than females, ranged between 43.2–84.5 cm, while the size of females was from 72.2 to 103.3 cm. Male tail length varies between 10.5–18.2 cm and of females between 13.4–18.8 cm. Weight of snakes varies between 25.75 and 240.8 g, females usually being thicker. Dorsal scales are arranged in 19 rows. They have between 153–180 abdominal shields and between 51–73 pairs of subcaudal shields (Tab. 1).

Table 1: Characteristic of main biometric and morphological parameters of species *Natrix tessellata* in the Republic of Moldova

Sex	Values	L.tot. (mm)	L.head+L.body. (mm)	L.cd. (mm)	w (g)	S.v.	S.cd.	Sq
♂	Max.	84.5	66.3	18.2	104.16	179	73	19
	Min.	43.2	43.2	10.5	25.75	165	59	19
	Med.	70.5±5.7	55.6±4.5	14.8±1.3	58.5±17.6	172	67	19

Sex	Values	L.tot. (mm)	L.head+L.body. (mm)	L.cd. (mm)	w (g)	S.v.	S.cd.	Sq
♀	Max.	103.3	84.5	18.8	240.8	180	64	19
	Min.	72.2	57.7	13.4	61.54	153	51	19
	Med.	87.2±7.8	71.1±6.6	16.1±1.2	145.5±52.7	168	60	19
Whole sample	Max.	**103.3**	**54.5**	**18.8**	240.8	180	73	19
	Min.	**43.2**	**43.2**	**10.5**	25.75	153	51	19
	Average.	76.6±8.7	**61.3±7.7**	**15.3±1.3**	98.2±46.8	170	65	19

Preocular shields are ranged from 2 to 4, superior labial ones – from 7 to 9, while inferior labial from 7 to 11 shields.

The coloration of snakes is quite varied. On the back dice snake from researched area can have a greyish green background with black spots or black or white, rarely these spots generally are lacking (Photo 1). On the abdomen white spots are alternated with black or pink, red, orange and black (Photo 2).

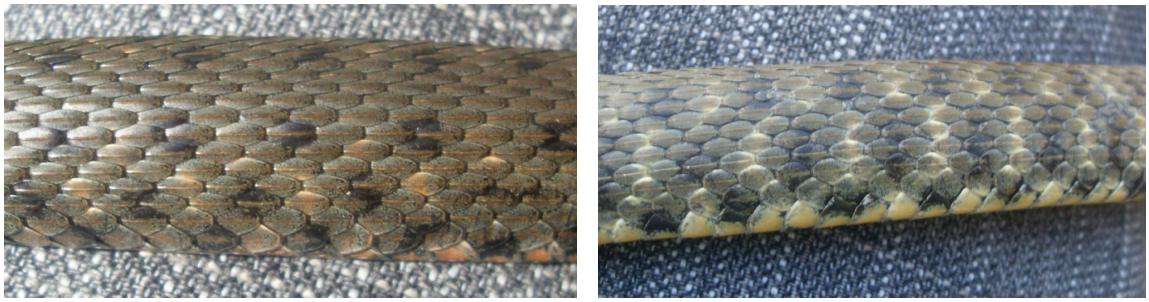

Photo 1: Variations of back coloration in the species *Natrix tessellata*.

Photo 2: Variations of abdomen coloration in the species *Natrix tessellata*.

In habitats of dice snake in the central and northern part of republic rocky slopes are present, and in the southern part of republic – clay and sandy-clay slopes.

As hibernation burrows snakes use the cracks naturally formed between the blocks of stones, or between layers of clay and rarely the gaps formed at trees root rot (Photo 3).

Photo 3: Hibernation dens of dice snake near Gura Bicului

The slopes with hibernation dens in the most cases are exposed to the south, southeast or southwest (Fig. 2). In hibernation dens from several up to hundreds of specimens can overwinter, depending on their ability. Hibernation groups are made up of females, males and juveniles. According to our observations males are the first that leave the hibernation dens.

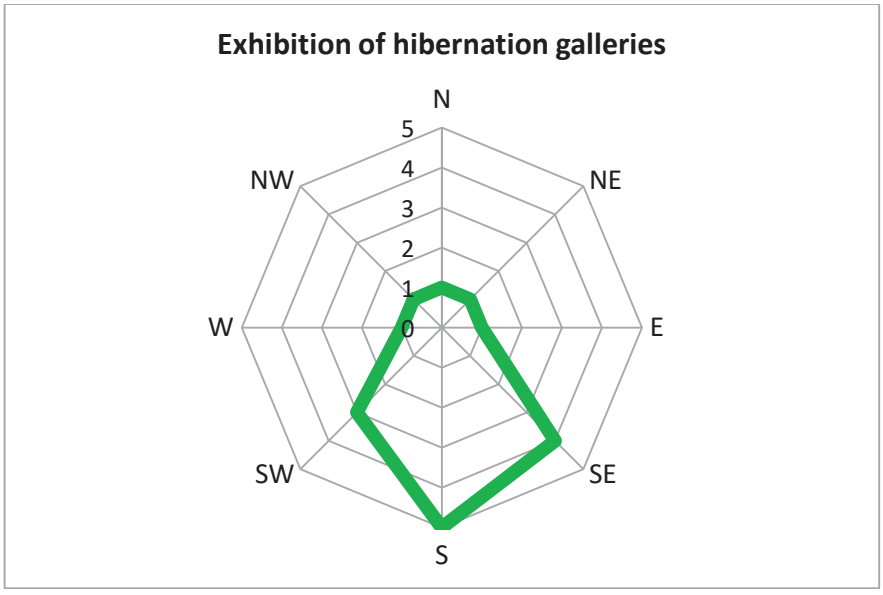

Fig. 2: The distribution of wintering gallery in dependence of the biotope exposure

The earliest appearance of the dice snake after hibernation was registered on 5 April 2005 (Gura Bicului) and the last registration before hibernation – 25 September of the same year (Giurgiulesti). In the first days after hibernating the snakes are less active, stay longer beside den and do sunbath, when being disturbed they hide back into burrows. In the first weeks of activity snakes still do not feed. After the first or second week after hibernating, snakes began to

moult. Snakes moult, usually, in the morning, when humidity is higher – a factor that favors the moulting proccess. Snakes moult fully, and the process starts from the head (Photo 4).

Photo 4: The moulting of dice snake.

The time of moulting depends on the size and speed of movement of the animal, but usually is no more than 4–5 minutes. During a season of activity the healthy snakes moult up to 4 times.

The mating period of the dice snake starts in the second half of April, depending on weather conditions and takes 2–3 weeks. In the mating period snakes form "tangles", reaching up to tens of specimens, but in the most cases "tangles" consist of a female, rarely two females and 7–9 males of different ages. Sex ratio tends towards 1: 1, as demonstrated on populations from Trebujeni and Gura Bicului (Fig. 3).

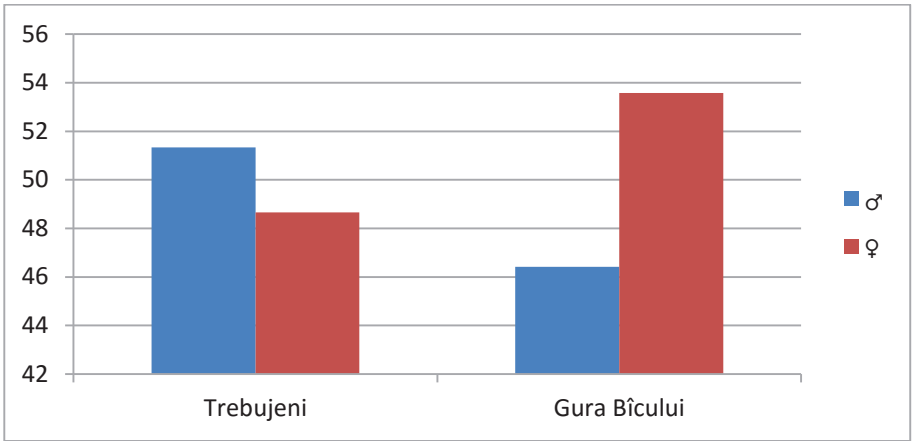

Fig. 3: Relationship between the sexes of the species *Natrix tessellata* in populations of Trebujeni and Gura Bicului, 2016 (%).

After the mating period snakes disperse towards trophic sectors and in late April and early May (depending on environmental conditions) they begin to feed. The study of stomach contents extractions showed that the main subject of food of dice snake in populations from

meadow of Dniester River is the fish, the ratio of which reach up to 90% in the studied populations, being represented by two species – *Neogobius fluviatilis* and *N. gimnotrachelus* (Fig. 4). Also, in samples there were detected caudata and ecaudata amphibians in various stages of development (*Triturus cristatus, Rana ridibunda, Rana esculenta*).

In fish ponds for industrial growth the trophic spectrum of water snake is more varied, in stomach contents there were found *Cyprinus carpio*, *Carassius gibelio*, *Brama abramis*, *Rutilus rutilus*, *Scardinius erytrophthalmus, Hypophthalmichthys molitrix*.

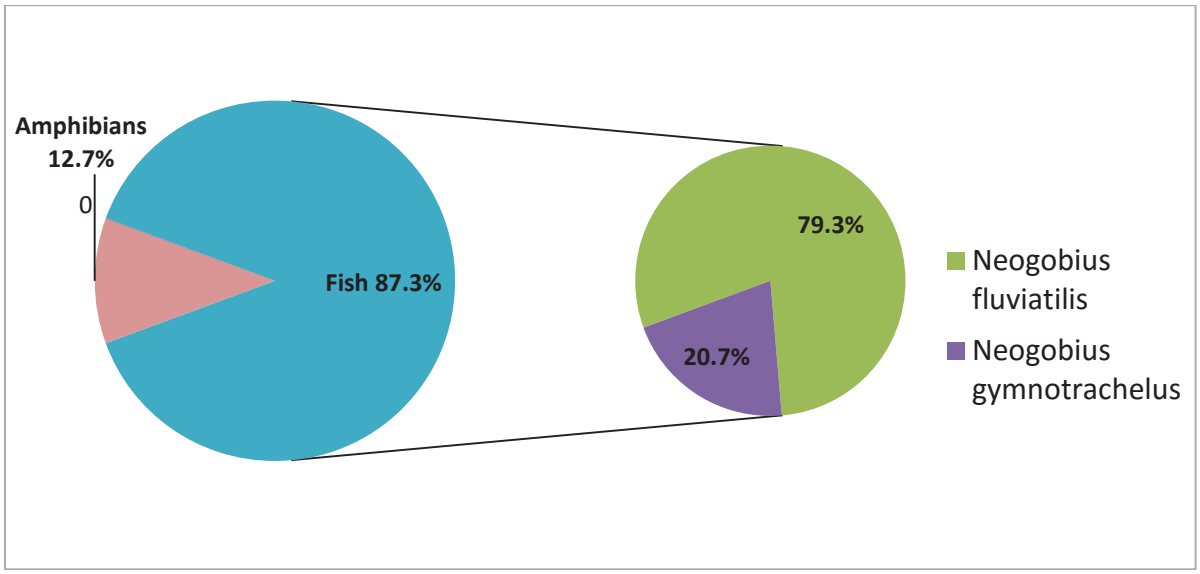

Fig. 4: Trophic spectrum of dice snake in populations of meadow of Dniester River.

The females are hatching from 5 to 22 eggs in late June – early July, in the mellow substrate, sandy or rich in plant debris, near water basin, in humid and sunny sites (Table 2).

Table 2: Peculiarities of biological-ecological activity of the species *Natrix tessellata* in the Republic of Moldova

	January	February	March	April	May	June	July	August	September	Octomber	November	December
Active period												
Nutrition												
Moulting												
Mating												
Hatching of eggs												
Anabiozis												

Hatching of eggs takes place in late July and in the first and second decade of August (Photo 5). The snakes hatchings have 14–16 cm in length.

Photo 5: Eggs hatched by *Natrix tessellata*.

Towards the end of active period and before the hibernation, snakes stop feeding and gather in wintering sites. As temperatures allow, snakes can be seen near the hibernation dens doing sunbathing. No activity was recorded for *Nartix tessellata* species in February, even if temperatures can get up to 25 °C.

Snakes are eaten by herons, but the biggest threat to their populations are the human and his activity. Due to superstition well hardened by centuries among natives, snakes are mostly destroyed directly by humans or die on the roads in their migration path towards watersheds, being run over by transport (Photo 6).

Even if the species *Natrix tessellata* today is not in danger, for the species protection already at present it is necessary to take some measures.

Photo 6: Snakes destroyed by humans.

Conclusions

In the Republic of Moldova dice snake is spread mainly in the meadow of Dniester and Prut Rivers, favorite sites being rocky, clay and sandy-clay slopes near water basins. Hibernation dens, in the most cases, are located on the slopes exposed to the south, southeast or southwest. Snakes can be also met around standing water basins located in the floodplain of rivers.

Maximum density of the species *Natrix tessellata* is 150 specimens at 1 km route, but on average it is estimated in limits of 20–40 specimens.

Dimensions of mature snakes in studied populations are between 43.2 and 103.3 cm. Females, usually, are larger than males.

Snakes have very varied coloration due to the presence or lack of pigmentation, of white and black on back and pink, orange on abdomen.

The active period of the species on the territory of Republic of Moldova is between 5 April and 25 September.

The trophic basic object of the dice snake is the fish, whose proportion reaches up to 90% and in natural pools consist of species *Neogobius fluviatilis* and *N. gimnotrachelus*.

The greatest danger for the populations of the species *Natrix tessellata* presents the human and his activity.

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DATE PRELIMINARE PRIVITOARE LA DISTRIBUŢIA, BIOLOGIA ŞI ECOLOGIA ŞARPELUI DE APĂ (*NATRIX TESSELLATA*, LAURENTI 1768) ÎN REPUBLICA MOLDOVA

(Rezumat)

În lucrarea de faţă a fost studiată distribuţia actuală a speciei *Natrix tessellata* pe teritoriul Republicii Moldova. Au fost analizate staţiunile preferate ale speciei şi amplasarea vizuinilor de iernare. A fost estimată densitatea şerpilor în diferite populaţii şi analizate unele particularităţi biometrice şi morfologice. Au fost evidenţiate obiectele trofice de bază şi principalii factori de deranj.

NEW FAUNAL DATA ON SAPROXYLIC BEETLES (INSECTA: COLEOPTERA) FROM THE NATURA 2000 SITE "SIGHIŞOARA-TÂRNAVA MARE"

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Abstract: The objective of this writing is to make known the results of the study of the inventory of the Saproxylic Beetles fauna from the Natura 2000 Site,"Sighişoara-Târnava Mare", a project that was developed between 2011 and 2013. The insects collecting took place in a large area that include the extremities of the counties Mureş, Sibiu and Braşov, characterized by hills with forests of beech and oak. Due to the relative isolation in eastern Transylvania, the deficient transport network and the Saxon villages where traditional agriculture is still practiced, meadows with oaks and ancient forest were preserved in this area. This landscape represent a favorable habitat for developing of a diverse fauna. In the introduction, there are presented some ecological considerations linked to the Saproxylic Beetles and their role in keeping the forest as healthy as possible and ways to protect it as well. There is a characterization of the main habitats in which the forest vegetation is growing. The list of the Saproxylic Beetles species contains 138 species, belonging to 19 families and representing 80% of the total coleopteran species collected. They are a part of the big number of the collected species by the author in the study area. Some rare species are being included on the red list of some countries in Europe, including Romania, or on the lists of some nongovernmental organizations that fights to protect the natural habitat.

Keywords: saproxylic, beetles, old trees, cerambycidae, lucanidae, Natura 2000

Introduction

The beetles (Coleoptera), with more than 350,000 known species and with new species frequently discovered, rank as the largest order in the animal kingdom according to Liebherr. J.K. and McHugh, J.V. [7]. In Europe, beetles comprise several ten-thousand of species, exhibiting a rich variety of form as well as varied life-cycle strategies. [5].

The definition of the beetles we used for this list is one that was proposed by Alexander, K. [1] and shows their preference for the wood that had been attacked by the fungus and it doesn't require old or dead trees. Saproxylic species which are involved in or dependent on wood decay caused by fungus or aging are associated with both living and dead trees. Conventionally two groups are being included in the definition: a) the ones that are associated with the sap running down the bark of trees, the species that are dependent on the flow of sap and b) other than fungal organisms that feed directly with wood.

The Saproxylic Beetles are insects that are dependent in their larval development of the rotten wood and and therefore play an important role in decomposition processes and thus for recycling nutrients in natural ecosystems. It was found that the trees are being attacked by the

beetles in different life stages. Usually, debilitated, old trees are victims of the first attack, realized by the cerambycidae, so later on, other groups of beetles (buprestidae, scarabaeidae, etc.) to develop in the rotten wood. So every tree's stage of life has its own beetle fauna. The increasing number of beetles depends of the amount and the quality of the available dead wood found in the forest, the size of the wood, the management and fragmentation of it [8].

The beetles from de study area are often related to the surface with rare, old trees, and less to old forests that can be found in a few places due of the forest management. The Saxon's grasslands that shelter a special type of oak, are wealthy in this type of fauna. However, in the higher areas, in the forests of the Natura 2000 Site "Sighişoara-Târnava Mare", can be found a lot of old trees. They are difficult to clean up because of limited access.

Saproxylic Beetles interact with a lot of organisms, like different fungus that produce rot and red timber (Fig 2), but a group of bacteria fungus, nematodes and arachnids are transported from tree to tree by the Saproxylic Beetles, thus favorize their spread in the habitat. The ones that feed with pollen have a role in pollination.

Saproxylic Beetles represent an ecological group and not a taxonomic one. Generally, we found more indicator species of coleopterans in wet areas and in the areas with a big amount of dead wood. It's considered that forest's anthropogenic disturbance produced by the man results in an artificial structure, such as even-aged forests and a big fragmentation of the beech forests. [9]. *Fagus silvatica* is a dominant tree in the temperate forests of the Central Europe, but today it only occupies a small area of its original area. Generally, it is considered that the Saproxylic Beetles species can be found in warmer areas, and in the cold ones they only can be found combined with a big amount of dead wood. The importance of maintaining continuity of dead wood and old trees for the conservation of species listed on the red list is recognized for a long time, and Buse, J. [3] showed that saproxylic relict species are correlated with the continuity of forest cover. To preserve the habitat should therefore also be considered when evaluating forest reserves.

The decline of these species exists, in spite of the increase of the area covered with forest in Europe, the increasing of the average age of trees and the foresters effort to grow forests with species of natural composition, namely species that are native to the area, Zanchi, G. et al. [12]. The decline is usually attributed to the low level of dead wood in forests. From this reason it's helpful to increase the amount of dead wood. European forests located in the plains become more dense during the last 150 years, thanks to the growing politics of the wood, competing with the traditional management techniques such as coppicing and wooded pastures [13]

Previous studies on saproxylic beetle fauna in the investigated area were made by Petri, K. [10] who identifies about 60 species of beetles around Sighişoara. More recently, Bucşa, C. and Tăuşan, I. [2] published a study on the role of the old oaks of Breite Plateau in maintaining the biodiversity of xylophagous beetles.

Materials and methods (objectives and methods)

The inventory of the fauna of insects beetles was conducted during the years 2011–2013 within the POS project: "For nature and local communities – the bases for a Natura 2000 integrated management in Hârtibaciu – Târnava Mare area" (Fig. 3). The studied area of the beetles includes a hilly area belonging to the Târnavelor plateau and Transylvanian Subcarpathians. Here hills reaching up to 800 m in the east, the highest point of beetles collection is 820 m, Pietrişului hill, in the east of Mureni village. Forests here occupy a large part of the area and are represented mostly by beech-oak forests and in the rivers valley, floodplain forests occur. Because of the high relief and the depression landform climate, there are few crops and most people grow animals.

The collection of material in the field of Natura 2000 site Sighişoara-Târnava Mare was conducted over a period of three years, in followed date ranges:

24.07–2011–31.07.2011, 5.08.2011–9.08.2011, 1.06.2012–30.06.2012, 1.07.2012–30.07.2012, 21.08.2012–31.08.2012, 8.04.2013–30.04.2013, 1.05. 2013–19.05.2013, 1.06.2013–4.06.2013, 4.07.2013–23.07.2013.

Independent observations of the author also have occurred in the summers of 2008 and 2009.

We followed in our study to cover as many places collecting and gathering to take place over a longer period of time.

In 2011, the first year, the collection was realized only in the middle of the summer because of some objective causes which have kept the project start date. In 2011 we started collecting at the beginning of June, and in 2013 we started collecting in the first part of April. We tend to mention that the collecting took place until the end of the July, when most of the insects finished their stage of flying, and in 2011 and 2012 our project took place until August when we the species could be found under the bark.

The collecting of the coleopterans has been done in the most important habitats containing woody vegetation:

• Forest of *Quercus robur* pedunculate oak, sessile oak *Quercus petraea* and pubescent oak *Quercus pubescens*.

• *Fagus sylvatica* beech forests.

• Wood-pastures with *Quercus robur* and *Quercus pedunculiflora* .

• Coniferous plantation: *Pinus sylvestris* scots pine, *Pinus nigra* black pine and *Picea abies* spruce.

• Shrubbs in the edge of forests.

• alluvial forest of willows and poplar which can be found near rivers.

The most important sites in which coleopterans have been collected, which are characterised by a high biodiversity can be found in the localities belonging to the Mureş, Braşov and Sibiu counties, as follows: Apold, Archita, Beia, Biertan, Bunești, Copșa Mare, Cloașterf, Criș, Criț, Daia, Daneș, Fișer, Mihai Viteazu, Noul Săsesc, Roadeș, Roandola, Rora, Saschiz, Șaeș, Sighișoara, Stejerenii, Țeline, Valchid, Viscri.

The collecting of saproxylic coleopterans has been done through the appropriate methods. The collecting places were chosen after an examination of the elderly trees frequency, including numerous drying phenomena, at the end of which a high presence of snags, fallen rotten tree trunks and hollows had been noticed. Generally speaking, the places where the quantity of rotten wood is high are excellent habitats for numerous rare species.

Once the extraction site has been settled, the adults that could be found on branches, snags or tree trunks were collected, as a result of direct observation. It's important to know that many groups are made up of coleopterans, such as cerambycidae, which are thermophile insects; because of this, the tree trunks or the branches need to be at least partially placed into sunlight. Also, the best results can be obtained if the branches that have holes are inspected with sawdust freshly taken out. The stored wooden stacks by foresters at the borders of the forests represent the ideal place for collecting multiple cerambycidae species, which can be found on wood. Large trees, oaks that are found in the meadows near the Saxon villages are often attacked by *Cerambyx cerdo* or other species. The emergence galleries of the adults of these species are large in size and they are easy to identify. A special method of extraction is finding larvae that live in the rotten wood of the old oaks' roots. This is how the *Lucanus cervus* larvae have been found.

Inspecting the flowers near forests has permitted the extraction of cerambycidae trees adults, buprestidae, scrabaeidae with the help of entomological nets. Many insects hide under the bark of trees during the day, while others spend the winter as adults; this is why the extraction of dry bark and the rotten wood under it with a knife has resulted in the discovery of larvae and adults in the pupal rooms.

Insects that live in the crowns of trees, especially cetoniidae, are more difficult to notice and to directly collect. For this purpose, a 1–2 l bottle was turned into a trap, filled with bait that consisted of fermented fruits and wine. These were hanged in the trees at a certain height, so as to not be taken down with ease. The coleopterans are attracted by these baits because they feed off fermented juices that drip down the trees bark. As a result of constant checking of the traps, the adults were collected.

The gps coordinates were noted for all the species that were important and the coordinates of the areas with the richest biodiversity. The material that was entirely collected by the author was identified on the field and the insects that were too difficult to identify were killed and conserved in ethyl alcohol 70%, so as to be identified later in the laboratory, using newest scientific literature. Some individuals have been prepared and kept in the author's personal collection. Where this was possible, the insects were photographed in their natural habitat, obtaining larger images as well. These images were used for a book concerning the coleopteras living in that particular area.

Results and discussions

There have been identified sites with a high level of biodiversity, as follows:

• The pubescent oaks *Quercus pubescens* forests on the left side of the Iacobeni Valley

Locality of reference – Criș, MS.

Coordinates of the site in a central point: 46°07.721 and 024° 40.993 for the site on the Zăpodii hill and 46°07. 290, and 024° 41. 397 for the site on the Gotca Mare hill.

The site is characterized by the presence of certain well preserved pubescent oak forests (Fig. 4), with grasslands stretching at the base of the hill. The slope is very steep towards south. Trees are rare, with numerous shrub species and a rich herbaceous vegetation including a remarkable number of orchids. Among the rare coleopteran species identified in this area, we can note: *Cerambyx scopoli*, *Prionus coriarius*, *Rosalia alpina*, and *Xylotrechus rusticus* (found on the fallen trees of the Iacobeni Valley).

Also, two nocturnal rodents populations have been identified – *Glis glis* and *Muscardinus avellanarius*, which make their nests in old tree hollows. The access towards this location is granted on the left side of Criș, DJ 143 towards Iacobeni.

• The Bircheni Forest, the Colibari Pasture with secular *Quercus robur* oaks and the woods on the Frumos – Ghergheleu Peak.

Locality of reference – Fișier, BV.

The coordinates of the site in a central point: N 46.05.567, E 025.07.855.

The forest is remarkable through its homogenous woody composition, consisting of mature, tall oaks. It is located near the Colibari Pasture. There can be found numerous secular oaks, *Quercus robur*, which has a trunk larger than the ones at the Breite Plateau near Sighișoara. There are numerous specimens where the drying phenomenon is highly visible, as they have rotten trunks, as well as wild, secular pear-tree. The pastures widens up to north-west, toward the

Platan-Fișer Forest, made up of oaks and sessile. This forest consists of numerous species, such as maple and platinum. Also, on the east side of the site, the Burih Forest can be found, as well as on old *Pinus sylvestris* pine plantation, with specific types of trees. Among the rare coleopteran species, the following are particularly worth mentioning: *Lucanus cervus*, *Osmoderma barnabita*, *Aesalus scarabaeoides*, *Cerambyx cerdo, Cetonischema speciossissima, Gnorimus octopunctatus*.

Access can be granted in DN 43, beyond Bunești, towards Fișer. At the top of the hill, paths which lead to oak pastures can be found near the forest.

• The oak pasture on the Capra Hill

Locality of reference – Bunești, BV.

Coordinates in a central point: 46° 05.2011 și 025°05.162.

It is an important pasture with oaks, among which a few specimens are of secular age and have hollows. Most of them have been taken down, so only the remaining rotten stumps can be observed, as their diameter is of 2 meters. At the peak of the hill there can be found a large number of old beeches; unfortunately, many of them have been cut. Rare species of coleopterans that have been identified are: *Osmoderma barnabita*, *Cerambyx cerdo, Rosalia alpina, Lucanus cervus.*

The preservation of the current state and the protection of old oaks is important.

Access can be granted beyond the Bunești Village, on DN 43 towards Fișer, following paths that start on the right side of the road.

• La Tufe pasture and forest

Locality of reference – Roadeș, BV.

Coordinates in a central point: 46°07.768 și 025°05.085

The area is situated near the Lența Forest (Fig. 5), where numerous old oaks have grown – approximately 30, in total. The oak population is extended in the forest, as well as the nearing pasture. Next to the oaks, there can be seen secular beeches and hornbeam. The burning and cutting of oaks represent threats. The site of secular oaks is in great danger, as a lot of specimens are dry. Rare identified species: *Osmoderma barnabita*, *Lucanus cervus, Cerambyx cerdo, Gnorimus octopunctatus*.

Access is granted from the road leading to Roadeș, or before it, the left side of the road leads to the site as well.

• The Punțile de Piatră Pasture

Locality of reference – Saschiz, MS.

Coordinates in a central point: 46°12.369 and 024° 56. 368.

On a high plateau there can be found numerous secular and young oaks. The moderate attackers of secular oaks are *Cerambyx cerdo*. The *Lucanus cervus* larvae were identified, as well as *Osmoderma barnabita*.

As of now, there are no great threats and the presence of young oaks will take the place of the secular ones.

Acccess is possible from Vânători, on a road down south.

• The beech forests on the Pietriș Hill

Locality of reference – Archita, MS.

The beeches are massive and have been recently cut. The forest is situated on the Taghirt Hill. The dried beeches represent an excellent habitat for *Rosalia alpina* and other mountain

species, such as *Stenurella melanura*. The site is part of the Transylvanian Sub Carpathians. At the peak of the hill where the altitude goes beyond 800 meters, there are secular beeches and dry sessile oaks.

These forests are accessible by using the path that starts from the road with connect the Mureni Village and Archita.

• The forest on the Crepe Hill

Locality of reference – Mihai Viteazu, MS.

Coordinates in a central point – N 46 11 771, E 025 01 613.

This is a forest that has both beeches and oaks. At the border of the forest there are massive beech specimens. In the forest there are secular hollow hornbeams, which has a trunk of 1.2 meters in diameter, and dry oaks. Beyond the peak, at the Făget Hill, there is a wood-pasture with oaks. It represents the perfect habitat for species such as *Lucanus cervus* and *Cerambyx cerdo*. The spruce forest goes downhill, towards the Archita River. In the forest, dry stumps and tree trunks of pre-existent oaks can be found. Among the rare species, *Prostomis mandibularis* is frequent.

• The Apold Pasture, În Găuri area

Locality of reference – Apold, MS.

Coordinates in a central point: N 46 08 192, E 024 48 368.

The path is margined by oaks. In the pasture, near the relay, there are a few secular oaks with a diameter of 1.2–1.5 meters, with bark in which entries for different species of insects, such as *Cerambyx cerdo*, have been carved. The oak have hollows too, which make them perfect for *Osmoderma barnabita*. There are also old, hollow hornbeam, with a diameter of 1,2 meters, burned on the inside, which makes it a proper habitat for saproxylic coleopterans. Rare identified coleopterans: *Cerambyx cerdo, Osmoderma barnabita.*

• The pasture near the Fața Deasă Forest

City of reference – Viscri, BV.

Coordinates in a central point: N 46 03 602, E 025 04 230.

On the left side of the path that leads to the Fața Deasă Forest, there can be found a pasture with a number of 12–15 *Quercus robur* secular oaks with an important population of *Cerambyx cerdo*, which is a priority species. Here, an oak with a diameter of 2 meters has been discovered – N 46 03 585, E 024 04 138, probably one of the thickest oaks that can be found in the Târnave Plateau. Also, it is worth noting the fact that the oaks are rather tall.

At Viscri, there is an old plantation of pines situated west of the village, with old specimens, some dry, where *Strictoleptura rubra, Rhagium inquisitor*, which evolve into coniferous were identified.

Coordinates for both male and female specimens in a central point: N 46 02 989, E 025 04 394. Under the bark of old pines an individual of *Cucujus cinnaberinus,* a rare species in the fauna of our country was found. . Among important species, the ones worth mentioning are: *Lucanus cervus, Cerambyx cerdo*.

• La Pitar Pasture

Locality of reference – Cloașterf, MS.

Situated west from the village, along the Cimaș River, the pasture shelters a rare population of secular oaks. From the original population, the vast majority of the oaks have been

cut down between 2010–2013 and stored for a while near the forest road. Here, there have been identified priority species, such as: *Osmoderma barnabita, Lucanus cervus, Cerambyx cerdo*, and the *Eurythirea quercus* golden bug.

• The slope with pubescent oaks on the Cuțuman Hill
Locality of reference – Stejerenii, MS.
Coordinates in central point: N 46 08 839, E 024 43 724.
At the border of the forest, the area of the Cuțuman Hill situated south of the village, on a sunny slope, there is an old forest of pubescent oaks, characterized by trees of exceptional size. Here were found numerous specimens of *Hoplia praticola* on hawthorn flowers, and on a freshly cut trunk of willow, multiple specimens of *Trachypteris picta decostigma*, a shiny bug.

• The forest on the Bisericii Hill
Locality of reference – Sighișoara, MS.
Coordinates in a central point: N 46 13 804, E 024 47 678.
At the border of the forest, the Villa Franka area, there are numerous old oaks, some specimens being hundreds of years old. The forest is rare, a suitable habitat for priority species. Also, coleopterans have been collected from under the bark.

Other places of interest in relation to the study of saproxilic coleopteran are:
Pârâul Daia Valley and the forest near the Criț Village, the Apold-Halmer Forest, The oak pasture on the Doala Hill near Florești, the old oak pasture near Roadeș, the secular oaks Breite Plateau near Sighișoara, and the forest in the Gura de Apă area, between Saschiz and Daia.

LIST OF SPECIES

Family **Cerambycidae**

Aegomorphus clavipes (Schrank, 1781): Criţ, 04.07.2013, flying a large female;
Fişer, 07/05/2013; near a stack of wood (Fig. 6); Sighişoara, Breite Plateau, 03.06.2013, on a stack of wood; Ţeline, Faţa Frumoasă 10.06.2012, on the aspen's stumps.
Alosterna tabacicolor (De Geer, 1775): Apold, V. Raspberry, 18. 05.2013; Archita, Gravel Hill, 12.5.2013.
Anaesthetis testacea (Fabricius, 1781): Forest Fişer Bircheni, 10.05.2013; Buneşti- Fişer, 09.06.2016, forest evening flight.
Anaglyptus mysticus (Linnaeus, 1758): Daneş-Stejerenii, 17.05.2013; Criţ, 16.06.2009.
Anastrangalia dubia (Scopoli, 1763): Criţ, Gravel Hill, 07.01.2012.
Anastrangalia sanguinolenta (Linnaeus, 1761): Copşa Mare, 06.01.2013; Sighişoara, Breite, 06.2012.
Anoplodera rufipes (Schaller, 1783): Roadeş, 12.05.2013, hawthorn flowers on the edge of the forest.
Anisorus quercus (Goeze, 1783): Buneşti, forest Bircheni, 02.06.2012; Fişer,
03.06.2012.
Anoplodera sexguttata (Fabricius, 1775): Daneş-Stejerenii, 05.17.2013; Criţ Zaifan Valley, 2.06.2012, numerous; Criţ, Daia Valley, 03.06.2012; Ţeline, Faţa Frumoasă, 10.06.2012.
Asemum striatum (Linnaeus, 1758): Plateau Fişer, 07.26.2013.
Callimellum angulatum (Schrank 1789): Criş, pubescent oak forests 06.2009.
Cerambyx cerdo (Linnaeus, 1758): Buneşti, right pasture, 10.07.2012, a female;
Cloaşterf,Cimaş Valley, 29.06.2012; Criş, pubescent oak forests, 07.03.2012; Fişer, grassland Colibari Pasture, 26.07.2011, 28.07.2012; Roadeş, forest La Tufa, 28.06.2012; Roadeş, forest Bircheni,

22.07.2013, a dead female under a secular oak; Roadeş-Fişer, Colibari Pasture 07.04.2012; Sighişoara, Breite, 07.02.2012; Sighişoara, Villa Franka, 04.07.2013.
Cerambyx scopolii (Fuesslins, 1775): Apold, pasture "În Găuri", 05.18.2013, Apold, Valley Raspberry, Fişer end of the valley, 22.07.2013, under the bark of an oak stump; Cloaşterf, The Small Meadow, on the flowers of thistles, 07.07.2013, Criţ, 14.06.2009; Floreşti, Doala Hill, 28.07.2011; Sighişoara, Breite, 07.02.2012; Ţeline, Faţa Frumoasă, 06.07.2013.
Chlorophorus figuratus (Scopoli, 1763): Criţ, 16.06.2009; Ţeline, Faţa Frumoasă
10.06.2012.
Chlorophorus herbstii (Brahm, 1790): Daneş, Dracula Inn, 05.07.2012; Rora, Valley Stejerenii, 07.04.2013.
Chlorophorus sartor (Müller, 1766): Daneş, V. Stejerenii, 07. 2012.
Chlorophorus varius (Müller, 1766): Criţ, Zaifan Valley, 26.07.2012.
Clytus arietis (Linnaeus 1758): Criţ, Zaifan Valley, 02.06.2012; Criţ, V.Daia,
05.11.2013; Stejerenii, 19.05.2013; Valchid, 01.06.2013.
Cortodera humeralis (Schaller, 1783): Roadeş, 12.05.2013, on hawthorn flowers; Sighişoara, Villa Franka, 05.18.2013).
Dinoptera collaris (Linnaeus, 1758): Criţ, V.Daia 04.06.2012; Daneş Criş, 18.05.2013.
Exocentrus adspersus (Mulsant, 1846): Criţ, V. Zaifan, 2 and 03.06.2012; Fişer,
pasture oaks, 09.06.2012; Roadeş 07, 2012, collected from bright screen.
Exocentrus lusitanicus (Linnaeus, 1767): Biertan, 06.01.2013.
Grammoptera ruficornis (Fabricius, 1781): Apold, Valley Raspberry, 18.05.2013.
Grammoptera abdominalis (Stephens, 1831), rare species: Criş, 08.06.2010; Fişer, Forest Bircheni, 11.05. 2013 on hawthorn flowers.
Hylotrupes bajulus (Linnaeus, 1758): Roadeş-Archita, 07.20.2013.
Leptura annularis (Fabricius, 1801): Apold, Valley Raspberry, 5.18.2013; Archita, 05.12.2013; Criţ Daia Valley, 14.06.2009; Daneş-Stejerenii, 05.17.2013; Fişer,
06.03.2012, 24.06.2012; Roadeş, the forest edge, 11–12.05.2013; Ţeline, Faţa
Frumoasă, 10.06.2012, 26.06.2012.
Leptura quadrifasciata (Linnaeus, 1758): Stejerenii, Stejereni Creek, 27.06.2012.
Leptura aurulenta (Fabricius, 1792): Buneşti-Fişer, 08.05.2012; Criş, 08.2010; Criţ, 29.07.2011; Cloaşterf, Cimaş Valley, 30.06.2012; Fişer, Colibari Pasture, 26.07.2011; Roadeş, forest La Tufa, 07.05.2009, 28.06.2012, 27.07.2011; Ţeline, Faţa Frumoasă, 26.06.2012.
Leiopus nebulosus (Linnaeus, 1758): Criţ, V. Daia, 10.06.2012, 06.07.2013, on freshly cut hornbeam, Criţ, 03.11.2013, in the village, on the stack of firewood stored in a
storage timber; Fişer, 05.07.2013, dry wood, Fişer, forest edge, oak, 07.22.2013;
Meşendorf, 03.06.2013; Roadeş-Fişer, 09.06.2012; Sighişoara, Breite, 06.03.2013;
Ţeline, Faţa Frumoasă 10.06.2012.
Mesosa curculionides (Linnaeus, 1761): Criţ Daia Valley, 26.06.2012.
Mesosa nebulosa (Fabricius, 1781): Fişer, Colibari Pasture, 06.09.2012, oak twigs.
Molorchus minor (Linnaeus, 1758): Stejerenii: 19.05.2013.
Musaria affinis (Harrer, 1784): Criţ Daia Valley, 26 and 29.06.2012; Cloaşterf, Cimaş Valley, 30.06.2012; Daneş-Stejerenii, 05.17.2013; Rora,Valley Stejerenii, 07.04.2013; Sighişoara, 05.18.2013.
Necydalis major (Linnaeus, 1758): Apold, Forest Halmer, 3–4. 07.2009; Apold, forest Halmer, 1.06.2012, individuals found in a hornbeam trunk on the forest's edge; Sighişoara, Breite, 02.07.2012, specimen found dead in the trunk of a hornbeam.
Opsilia caerulescens (Scopoli, 1763): Roadeş, 2–4.VII. 2009.
Oberea linearis (Linnaeus, 1761): Apold, Valley Raspberry, 5.18.2013; Stejerenii, 17- 19.05.2013.
Pachytodes cerambyciformis (Schrank, 1781): Cloaşterf, Cimaş Valley, 30.06.2012; Cloaşterf, Lunca Mică, 07.07.2013; Roadeş, forest La Tufa, 28.06.2012, Ţeline, Faţa Frumoasă, 06.07.2013.

Pachytodes erraticus (Dalmane, 1817): Buneşti, grassland on Goat Hill; Criţ, Daia Valley, 16.06.2009, 06.03.2012, 29.06.2012, 07.06.2013; Cloaşterf, Cimaş Valley,
30.06.2012; Cloaşterf, Lunca MicăLunca Mică, 7.07.201310.07.2012; Daneş, Dracula Inn,
5–07.2012; Fişer, peak, 07.05.2013; Mihai Viteazul, Crepelor Hill, 7.24.2013;
Roadeş, Bircheni forest and adjacent pasture Roadeş, 15.06.2009, 07.07.2013,
22.07.2013, on *Achillea millefolium* flowers; Roadeş, pasture, 06.07.2013; Rora,
Valley Stejerenii, 07.04.2013; Sighişoara, Villa Franka, 04.07.2013; Ţeline, Faţa
Frumoasă.
Paracorymbia fulva (De Geer, 1775): Criţ, Zaifan Valley, 29.06.2012
Phymatodes testaceus (Linnaeus, 1758): Apold, V.Zmeurei, 05.18.2013; Criş. 08.2010; Criţ, Valley Daia, 16.06.2009, 10.06.2012, 10–11.05.2013 on wooden logs; Sighişoara, Breite, 06.03.2013; Fişer, 06.02.2013, Bircheni forest.
Pyrrhidium sanguineum (Linnaeus, 1758): Sighişoara, Breite, 02.06.2012.
Pidonia lurida (Fabricius, 1792): Apold, The Raspberry V., 05.18.2013.
Plagionotus detritus (Linnaeus, 1758): Cloaşterf, 10.07.2012; Fişer, pasture,
28.07.2012, fallen branches on the ground; Fişer, Colibari pasture, 27.06.2012,
07.04.2012; Cloaşterf, Cimaş Valley, 29.06.2012; Sighişoara, Breite, 07.02.2012.
Plagionotus arcuatus (Linnaeus, 1758): Apold, forest, 5.18.2013; Buneşti, forest hill Chindra, 26.05.2012; Criţ, V. Daia, 16.06.2009, 05.02.2013; 07.04.2012; Cloaşterf,
10.07.2012, logs fresh cut; Fişer, Colibari Pasture, 27.06.2012; Fişer, forest, stack
wood, 07.05.2013; Roadeş-Fişer, Colibari Pasture, Ţeline, Faţa Frumoasă 10.06.2012.
Poecilium alni (Linnaeus, 1767): Criţ, Daia Valley, 05.02.2013.
Poecilium rufipes (Fabricius, 1776): Fişer, Bircheni Forest, 10–11.05. 2013.
Prionus coriarius (Linnaeus, 1758): Apold, Valley Raspberry, larva found in rotting logs cut and partially rotten 05.18.2013; Buneşti, pasture Goat Hill, 10.07.2012, two larvae; Criţ, Daia Valley, 27.07.2012, a female; Cloaşterf, 07.2012 evening at the screen;
Fişer, Platan Forest, 07.22.2013.
Rosalia alpina (Linnaeus, 1758): Archita, Gravel Hill, 7.1.2012; Copşa Mare,
7.19.2013; Cloaşterf, 10.07.2012, on beechs' fresh cut logs; Cloaşterf, Cimaş Valley,
29.06.2012; Criş, forests of pubescent oaks, 07.03.2012; Criţ, Zaifan Valley, 20.07.2011,
29.07.2011, 29.06.2012; Floreşti, Doala Hill, 28.07.2011; Noul Săsesc, 12.07.2013, on beech, in the cuttings.
Rhagium sycophanta (Schrank, 1781): Roadeş, forest La Tufa, 05/02/2013; Criţ, Daia Valley, 05/02/2013.
Rhagium inquisitor (Linnaeus, 1758): Viscri, 1.05. 2013 larvae and adults under the bark of pine.
Rhagium mordax (De Geer, 1775): Fişer, Forest Bircheni, 5.2.2013, 02.06.2013.
Ropalopus macropus (Germar, 1824): Apold, Zmeurei Valley, 18.05.2013, Daneş- Stejerenii, 17.05.2013, Meşendorf, Faţa Frumoasă, 03.06.2013, 10.06.2012; Ţeline, Faţa Frumoasă 10.06.2012.
Rutpela maculata (Poda, 1761): Cloaşterf, Gura de Apă, 7.7.2013; Criş, pubescent oak forests, 07.03.2012; Criţ, Zaifan Valley, 02.06.2012; Criţ, Daia Valley, 26.06.2012, 06.07.2013; Daneş, Dracula Inn, 05.07.2012; Roadeş, Colibari Pasture, 07.07.2013; Rora, Valley Stejerenii, 07.04.2013; Ţeline, Faţa Frumoasă, 06.07.2013.
Saperda scalaris (Linnaeus, 1758): Criţ Daia Valley, 03.06.2012 (Fig. 7); Daneş, V. Stejerenii, 05.17.2013.
Spondylis buprestoides (Linnaeus, 1758): Roadeş, forest "La Tufa", 05.03.2013, under old pine stumps.
Stenopterus rufus (Linnaeus 1767): Apold, 04.03.2000; Criţ, Daia Valley, 17.06.2009.
Stenostola dubia (Laicharting, 1784): Stejerenii, 05.17.2013.
Stenostola ferrea (Schrank, 1776): Apold, Zmeurei Valley, 18.05.2013.
Stenurella bifasciata (Müller 1776): Ţeline, Faţa Frumoasă, 07.06.2013.
Stenurella melanura (Linnaeus, 1758): Cloaşterf, Lunca Lunca Mică, 07.07.2013; Cloaşterf, Gura de Apă, 7.7.2013; Criţ, on Boldi, 07.06.2013; Fişer, forest Bircheni 9.06. 2012, Fişer hillside 07.05.2013; Roadeş, pasture, 07.07.2013; Rora, Stejerenii Valley, 07.04.2013.

Stenurella nigra (Linnaeus, 1758): Copşa Mare, 06.02.2013; Criş, pubescent oak forests, 03.07.2013; Criţ, 16.06.2009; Roadeş, forest La Tufa, 28.06.2012.
Stenurella septempunctata (Fabricius, 1792): Apold, La Movile, 07.02.2009; Criţ, 14.06.2009.
Strangalia attenuata (Linnaeus, 1758): Buneşti, forest Bircheni, 02.06.2012; Cloaşterf, Cimaş Valley, 30.06.2012; Viscri, 08.21.2013.
Strictoleptura erythroptera (Hagenbach, 1822): Archita, Pietriş Hill, 07.01.2012.
Strictoleptura rubra (Linnaeus, 1758): Viscri, 07.21.2013.
Strictoleptura scutellata (Fabricius, 1781): Archita, Pietriş Hill, 07.01.2012, numerous; Cloaşterf, Lunca Lunca Mică, 30.06.2012, 07.07.2013; Criş, pubescent oak forests, 07.03.2012; Criţ, Daia Valley, 06.07.2013; Daneş, Dracula Inn, 05.07.2012; Fişer, 06.02.2013; Ţeline, Faţa Frumoasă, 06.07.2013.
Tetrops praeustus (Linnaeus, 1758): Apold, Zmeurei Valley, 05.15.2013, hazel leaves; Rora, 05.19.2013.
Vadonia unipunctata (Fabricius, 1787): Apold, La Movile, 07.02.2009; Criţ 06, 2009, 14.06.2009.
Xylotrechus antilope (Schrönherr, 1817): Buneşti, forest hill Chindra, 26.05.2012; Criţ, 16.06.2009; Fişer, Colibari Pasture, 07. 2011, 27.06.2012, 07.04.2012, 28.07.2012, fallen branches on the ground; Fişer, stack wood, 06.02.2013, 07.05.2013; Floreşti Doala Hill, 07.03.2012; Roadeş, 07.2011; Ţeline, Faţa Frumoasă, 26.06.2012, on blackberry flowers.
Xylotrechus rusticus (Linnaeus, 1758): Archita, Pietriş Hill, 5.18.2013; Buneşti-Criţ V. Dăii, 24.06.2012; Criş, Valley Iacobeni, 04.02.2009, 01.07.2009; Criţ, 2.5.2013, 11.5.2013; Daneş-V.Stejerenii, 19.05.2013.

Family **Lucanidae**

Aesalus scarabaeoides (Panzer, 1794): Criţ, Zaifan Valley, 06.02.2012, larvae and adults in the rotten stocks, (Fig. 8); Fişer, forest Platan, 07/22/2013, the forest edge, adults and larvae found in two wild apple tree stumps or maple; Roadeş, 05.02.2013, larvae and adults at forest edge.
Dorcus parallelipipedus (Linnaeus, 1758): Buneşti, forest hill Chindra, 26.05.2012; Cloaşterf, Gura de Apă, 7.7.2013; Cloaşterf, Lunca Lunca Mică, 07.07.2013; Criţ, Valley Daia, 25.07.2012.
Lucanus cervus (Linnaeus, 1758): Buneşti, forest Bircheni, 02.06.2012, 2 females; Buneşti, forest on the Chindra Hill, 26.05.2012,2.06.2013, found a female in the pupal room, 07.22.2013, forest, dead male; Criţ, Dăii Valley, 25.07.2012; Criţ, Zaifan Valley; Fişer, forest Bircheni, 22.07.2013; Fişer, Colibari Pasture, 28.07.2012; Fişer, forest, 06.02.2013; Floreşti, Doala Hill, 28.07.2011; Mureni, forest Braniştii, 30.07.2011; Roadeş, forest La Tufa, 28.06.2012; Roadeş, forest Bircheni; 29.07.2011; Sighişoara, villa Franka, 06.04.2013.
Platycerus caraboides (Linnaeus, 1758): Fişer, Bircheni forest edge, 05.02.2013; Criş, downy oak forest, 29.04.2010.
Sinodendron cylindricum (Linnaeus, 1758): Daneş, forest on the Hill Rustig, 07.05.2012, found larvae and adults in a rotten beech trunk.

Family **Scarabaeidae**

Cetonia aurata (Linnaeus, 1761): Cloaşterf, Lunca Mică, 07.07.2013; Cloaşterf, 10.07.2012; Fişer, Colibari Pasture, 28.07.2012, Oak Forest, bottle traps baited with wine; Roadeş, forest Bircheni on thistle flower; Roadeş, pasture, 07.07.2013; Sighişoara, Villa Franka, 04.07.2013; Stejerenii, Forest Cutuman, 08.09.2011.
Cetonischema speciosissima (Drury, 1770): Cloaşterf, 10.07.2012, the oaks come from pasture; Fişer, pasture, 28.07.2012, Oak Forest, bottle traps baited with wine; Floreşti Doala Hill, 07.03.2012.
Epicometis hirta (Poda, 1761): Archita, Gravel Hill, 7.1.012; Criş Valley Gotca Mare, 15–20.04.2013; Roadeş, forest La Tufa, 28.06.2012; Rora, Valley Stejerenii, 07.04.2013.

Eupotosia fieberi (Kraatz, 1880), Fişer, Colibari Pasture, 28.07.2012, oak forest,
bottle traps baited with wine.
Gnorimus nobilis (Linnaeus, 1758): Cloaşterf, Lunca Mică, 07.07.2013; Cloaşterf, Gura de Apă, 7.7.2013; Criţ, Daia Valley, 03.06.2012, on elder white inflorescences; Criţ, Daia Valley, 06/07/2013, on *Viburnum lantana* flowers; Roadeş, 7.07. 2013.
Gnorimus variabilis (Linnaeus, 1758): Buneşti-Fişer, forest Bircheni, 04.07.2012, many specimens in a hollow oak; Roadeş, La Tufa forest edge, 12.07.2012, trapping collected, 02.05.2013, sheath and larvae; Sighişoara, Breite, 07.02.2012; Viscri, Faţa Deasă forest, 08.07.2012; Fişer, Colibari Pasture, 28.07.2012, traps; Criţ, Daia Valley, 06.07.2013.
Hoplia praticola (Duftschmidt, 1805): Apold, Valley Raspberry, 5.18.2013; Stejerenii, on hawthorn flowers, 19.05.2013.
Liocola lugubris (Herbst, 1786): Apold, forest, 5.18.2013; Cloaşterf, 10.05.2012, hollow shambles; Fişer, Colibari Pasture, 28.07.2012, Oak Forest, bottle traps baited with wine; Stejerenii, Forest Cutuman, 08.09.2011.
Potosia cuprea metallica (Fabricius, 1775): Apold, forest edge, 05.18.2013; Cloaşterf, Răzoare-Sembeş, 30.06.2012; Cloaşterf, forest, 10.07.2012, hollow logs on, Fişer, Colibari Pasture, 28.07.2012, 05.11.2013, oak forest, bottle traps baited with wine; Stejerenii, Forest Cutuman, 08/09/2011; Criţ, forest, 30.06.2012.
Osmoderma barnabita (Motchulsky, 1845) (Fig. 9): Buneşti, Goat Hill, 27.07.2011, specimen found in a trunk cut; Cloaşterf, 10.07.2012, exoskeleton fragments in hollows; Roadeş, 08.07.2012, 12.07.2012, 07.22.2013, trapping the hollow; Saschiz,
30.07.2012, trapping, the stone bridges.
Oxythyrea funesta (Poda, 1761): Apold, Movile, 05.18.2013; Criţ Zaifan Valley, 27.07.2012; Fişer on chamomile flowers, 07.05.2013; Ţeline, Faţa Frumoasă, 06.07.2013; Viscri, meadow, 23.08.2012.
Trichius sexualis (Bedel, 1906): Apold, V.Zmeurei, 10.07.2013; Criş. Gotca Mare Valley, 15–20.04. 2013; Criţ-Cloaşterf, 24.06.2012; Sighişoara city, 17.05.2013, on the daisy flowers; Ţeline, Faţa Frumoasă 26.06.2012.
Hemipterus valgus (Linnaeus, 1758): Criţ, Daia Valley, 04.27.2013.

Family **Buprestidae**

Agrilus angustulus sulcicollis (Lacordaire, 1835): Archita, Gravel Hill, 5.12.2013; Criţ, Daia Valley, 16.06.2009, 11.05.2013; Biertan, 06.01.2013; Stejerenii, 06.10.2013; Meşendorf, Faţa Frumoasă, 10.06.2012, stack hornbeam; Roadeş-Fişer, 07.04.2012, pasture on dry twigs.
Agrilus biguttatus (Fabricius, 1776): Cloaşterf, V.Cimaş, 30.06.2012; Sighişoara,
Breite, 07.02.2012; Fişer, 06.02.2013.
Anthaxia fulgurans (Schrank, 1789): Apold, 2–4.07.2009; Fişer, on *Rosa canina* flowers, 06.02.2013; Criţ, 16.06.2009.
Anthaxia manca (Linnaeus, 1767): Archita, Gravel Hill, 05.12.2013, on a stack of freshly cut wood.
Anthaxia signaticollis (Kryniki, 1832): Criţ, 16.06.2009; Fişer, on *Rosa canina* flowers, 02.06.2013.
Buprestis haemorrhoidalis (Herbst, 1780): Viscri, Fişer, galleries and sheath emergence.
Chrysobothris affinis (Fabricius, 1784): Apold, 05.18.2013; Cloaşterf, Faţa Frumoasă, 10.06.2012; Criţ, 16.06.2009; Roadeş-Fişer, 27.06.2012, 07.04.2012, pasture on oak twigs; Fişer, 30.06.2012, 05.11.2013, 05.07.2013, dry wood; Mihai Viteazul, Hill Crepelor, 07.24.2013, beech trunk in the sun; Balaur Forest, 05.17.2013; Rora, Valley Stejerenii, 07.04.2013; Sighişoara, Breite, 07.02.2012.
Coraebus undatus (Fabricius 1787): Biertan, 01.06.2013, on a blackberry bush.
Dicerca berolinensis (Herbst, 1789): Noul Săsesc, 12.07.2013, on the trunk of a broken beech.
Eurythyrea quercus (Herbst, 1780): Cloaşterf, Cimaş Valley, 30.06.2012, a secular oak stump (Fig. 10).
Ptosima flavoguttata (Illiger, 1783): Criţ, in the village, near the firewood, 06.01.2013; Criţ, V. Zaifan, 03.06.2012.

Trachypteris picta decostigma (Fabricius, 1787): Daneş, Copşa Mare and Stejerenii Valley.

Family **Anthiribidae**

Platyrrhinus resinosus (Scopoli, 1763): Cloaşterf, Gura de Apă, 7.7.2013; Stejerenii, 11.07.2013.
Tropideres albirostris (Schaller, 1783): Criş 07.2008 on old poplar logs; Roadeş-Criţ, 24.06.2012.

Family **Bostricidae**

Bostrichus cappucinus (Linnaeus, 1758): Criţ, V. Daia, 05.02.2013; Meşendorf, Frumoasa Valley, 10.06.2012.
Lichenophanes varius (Illiger, 1801): Apold, "La găuri" area, 07.10.2013; Roadeş, 02.05.2013.

Family **Cleridae**

Clerus mutillarius (Fabricius, 1775): Criţ, 16.06.2009, on tree bark; Fişer, Colibari Pasture, 07.22.2013, twigs and trunks of oaks.
Tillus elongatus (Linnaeus, 1758): Fişer-Roadeş, 09.06.2012; Sighişoara, 08. 2008.
Tilloidea unifasciata (Fabricius, 1787): Roadeş, 26.06.2009.
Trichodes apiarius (Linnaeus, 1758): Sighişoara, Villa Franka, 07.04.2013.

Family **Colydiidae**

Bitoma crenata (Fabricius, 1775): Buneşti, under tree bark, 07.2011.

Family **Cucujidae**

Cucujus cinnaberinus (Scopoli, 1763): Daneş, Valley Stejerenii, 05.10.2013, under the bark of an old poplar.

Family **Elateridae**

Ampedus elegantulus (Schonherr, 1817): Criţ, Zaifan Valley, 04.09.2013.
Ampedus praeustus (Fabricius, 1792): Criţ, V.Daia, 02.06.2013; Fişer, 02.06.2012.
Ampedus sanguineus (Linnaeus, 1758): Archita, Gravel Hill, 2.6.2013; Buneşti, 07.2011; Criţ, Daia Valley, 06.2012; Viscri, 01.05.2013, pine forest, under the bark of trees.
Ampedus sanguinolentus (Schrank, 1776): Criţ, Zaifan Valley, 09.04.2013; Roadeş, 11.05.2013; Viscri, 05.01.2013, pine forest.

Family **Erotylidae**

Triplax aenea (Schaller, 1793): Stejerenii, 10.05.2013, on hornbeam.

Family **Endomychidae**

Mycetina cruciata (Schaller, 1783): Roadeş, 08.07.2013, under the bark of beech.

Family **Histeridae**

Hololepta plana (Sulzer, 1776): Roadeş, 16.06.2009, under the bark poplar.

Platysoma compressum (Herbst, 1783): Daneş, V. Stejerenii, 10.05.2013; Fişer, 22.07.2013, pasture and forest adjacent under the bark oak; Roadeş, 20.07.2013; Sighişoara, Breite, 02.07.2012, under the bark; Viscri, 08.07.2012, under the oak bark.
Platysoma parallelum (Say 1825)?: Roadeş, 03.06.2013.

Family **Lymexylidae**
Lymexylon navale (Linnaeus, 1758): Cloaşterf, Lunca Mică, 07.07.2013, a huge hub; Sighişoara, Breite, 2–07.2012, flying around the trunks of pine forest deposited on the roadside.

Family **Mycetophagidae**

Mycetophagus atomarius (Fabricius, 1787): Roadeş, 2009.
Mycetophagus quadripustulatus (Linnaeus, 1761): Archita, 20.07.2013.

Family **Nitidulidae**

Glischrochilus quadripunctatus (Linnaeus 1758): Criţ, 07.2010.

Family **Pyrochroidae**

Phyrochroa coccinea (Linnaeus, 1762): Archita, 18.05.2013; Daneş, Valea Stejerenii, 17.05.2013; Viscri, 1.05.2013, pine forest.
Schizotus pectinicornis (Linnaeus, 1758): Stejerenii, 19.05.2013; Criţ, V. Daia, 2.05.2013; Viscri, 1.05.2013.

Family **Prostomidae**

Prostomis mandibularis (Fabricius, 1801): Criţ, Valea Daia, 2.05.2013; Fişer, 2.06.2012; Mihai Viteazul, Dealul Crepelor, 24.07.2013, fir forest.

Family **Silvanidae**

Uleiota planata (Linnaeus, 1761): Buneşti, 07, 2011, under oak bark; Cloaşterf, Lunca Mică, 7.07.2013; Criţ, under oak bark, 16.06.2011; Fişer, 22.07.2013; Roadeş, forest Bircheni, 22.07.2013, under old oak bark, pasture of the village; Viscri, 21.07.2013.

Family **Tenebrionidae**

Bolitophagus reticulatus (Linnaeus, 1767): Floreşti, Doala Hill, Laslea area, 28.07.2011, under the bark of on old beech.
Corticeus unicolor (Piller&Mitterpacher, 1783): Daneş, V. Stejerenii, 10.05.2013; Roadeş, 20.07.2013; Cloaşterf, 11.05.2013.
Diaperis boleti (Linnaeus, 1758): Copşa Mare, 19.07.2013; Roadeş, 06, 2009, inside the log of an old oak.
Scaphidium quadrimaculatum (Olivier, 1790): Criţ, 16.06.2009; Stejerenii, 10.05.2013.
Menephilus cylindricus (Herbst, 1787): Buneşti, 28.07.2011; Fişer, oak pasture, 26.07.2011; Roadeş-Archita, 2.07.2013; Sighişoara, Breite, 11.07.2013.
Stenomax aeneus (Scopoli, 1763): Meşendorf, 3.06. 2013, on logs.
Tenebrio opacus (Duftschmid, 1812): Criţ, 4.07.2013, at evening, during fly; Cloaşterf, Gura de Apă, 7.07.2013.

Tenebroides fuscus (Goeze, 1777): Buneşti, BV, 07, 2011.
Uloma culinaris (Linnaeus, 1758): Roadeş, 26.07.2011; Sighişoara, Breite, 11.07.2013.
Uloma rufa (Piller&Mitterpacher, 1783): Cloaşterf, Lunca Mică, 7.07.2013; Cloaşterf, Gura de Apă, 7.07.2013; Stejerenii, 11.05.2013.
Tritoma bipustulata (Fabricius, 1775): Mihai Viteazul, 2.07.2009, under the bark of beech.

Conclusions

We appreciate that from the work of systematic collection of saproxylic coleopteras carried out during three years (2011–2013) and supplemented in 2008–2009, we collected a considerable material, which managed to identify about 138 species, belonging to 19 families. Of these, most species belong to the families Cerambycidae, Scarabaeidae, Tenebrionidae and Buprestidae, the remaining families being represented by fewer species.

All these species of beetles are saproxylic / xylophagous and their larval development is related to the presence of woody vegetation. As a result, their collection was performed using specific methods, in habitats with woody vegetation consisting of old trees or in the adjoining: the edge of forests, meadows.

The total number of species identified by the author represents about 80% of all species collected, the rest being small insects, a few milimeters body length and which require closer observation of morphological characters.

Also, some species require different methods of collection, therefore saproxylic beetles fauna data from the researched area is not complete. We also remember the insufficient knowledge of the ecology of some species, that needs to be clarified in future to be included or not in the category of saproxylic.

Among the species identified in the Natura 2000 Site "Sighişoara-Târnava Mare": *Cerambyx cerdo, Osmoderma barnabita, Cucujus cinnaberinus, Rosalia alpina* and *Lucanus cervus* are listed in Annex. 2 of the Berne Convention on protected species.

These species have been identified in several locations on the area of Natura 2000 Site "Sighişoara – Târnava Mare", which shows that the investigated forest habitats are valuable. Also, in all the investigated sites were identified indicator species of valuable natural habitats for wildlife conservation.

During the field activity there were taken numerous photos of natural habitats or slightly modified by man habitats. Also, images of the species in their natural environment can form the basis for further work. Using data related to the frequency and dispersion of the species introduced into the database project, we improved the knowledge of insect fauna of Romania.

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NOI DATE FAUNISTICE REFERITOARE LA COLEOPTERELE SAPROXILICE (INSECTA: COLEOPTERA) DIN SITUL NATURA 2000 „SIGHIŞOARA-TÂRNAVA MARE"

(Rezumat)

Obiectivul acestei lucrări este de a face cunoscute rezultatele sudiului de inventariere a faunei de coleoptere saproxilice din Situl Natura 2000 „Sighișoara-Târnava Mare", proiect desfășurat între anii 2011–2013. Colectările de insecte au avut loc într-o arie largă, care cuprinde extremitățile județelor: Mureș, Sibiu și Brașov, caracterizată printr-un relief de dealuri medii și înalte, bogat împădurite cu fag și stejar. Relativa izolare datorată amplasării în estul Transilvaniei, rețeaua de căi de transport deficitară și satele săsești în care se practică agricultura tradițională, a permis păstrarea pajiștilor cu stejari seculari și a pădurilor cu arbori vechi, habitatul propice dezvoltării unei faune diverse. În partea introductivă sunt prezentate câteva considerații ecologice legate de coleopterele saproxilice și de rolul lor în păstrarea unei păduri sănătoase, ca și mijloacele prin care putem să le protejăm. Se face o caracterizare a principalele habitate în care se dezvoltă vegetația forestieră, precum și considerentele în alegerea siturilor în care s-au făcut colectări de insecte, cu prezentarea celor mai importante dintre acestea.

Lista speciilor de coleoptere saproxilice determinate cuprinde în total un număr de circa 138 de specii, aparținând la 19 familii și reprezintă circa 80% din totalul speciilor de coleoptere saproxilice colectate. Ele constituie doar o parte din numărul mare de specii de insecte colectate de autor din aria aflată în studiu. Câteva specii rare sunt incluse în listele roșii de faună ale unor țări din Europa, inclusiv România, sau în cele ale unor instituții și organizații nonguvernamentale care luptă pentru protejarea mediului natural, fiind buni indicatori ai habitatelor naturale.

Fig. 1: Oak in the meadow in Viscri. The bark presents holes of *Cerambyx cerdo*

Fig. 2: Bunești, Goat Hill, rotten wood in the trunk of a red oak

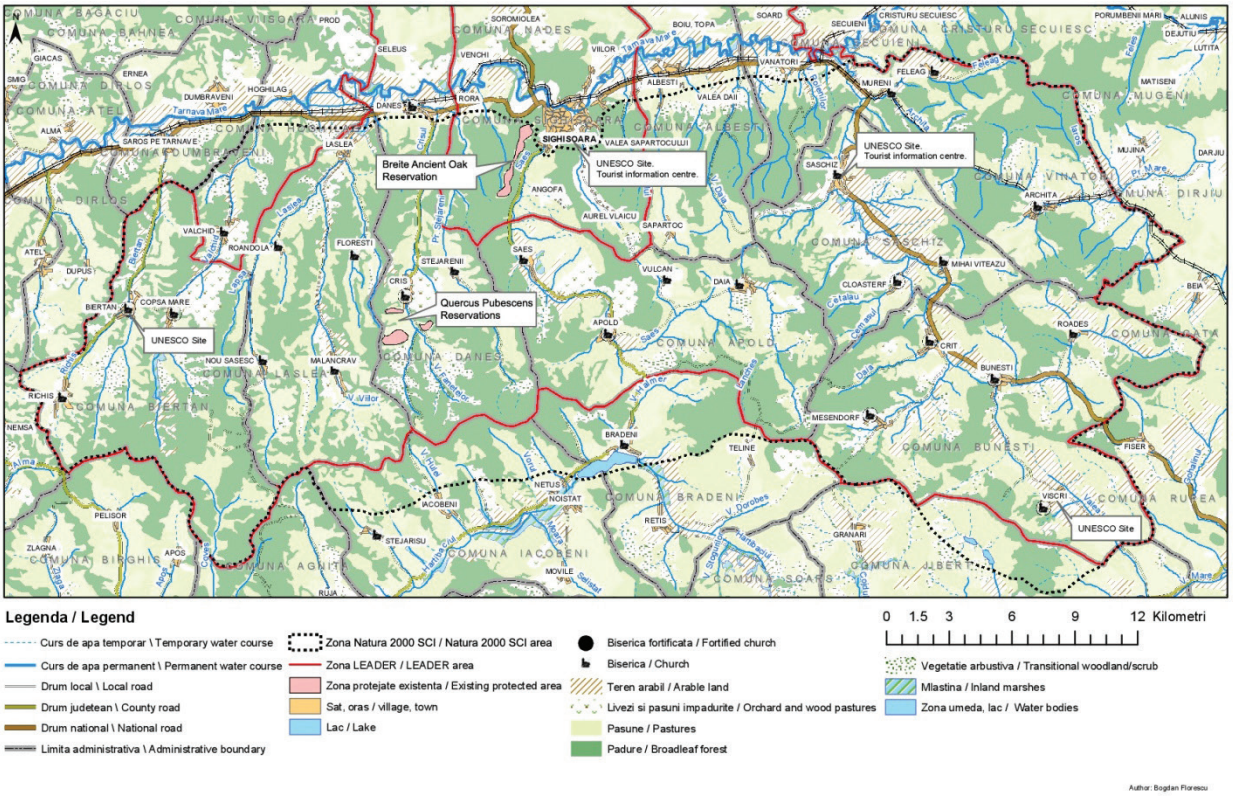

Fig. 3: Natura 2000 Site Sighișoara-Târnava Mare

Fig. 4: Criș, rare downy oak forest

Fig. 5: Roadeș, forest Lenţa

Fig. 6: *Aegomorphus clavipes*, Ţeline, Faţa Frumoasă, 10.06.2012

Fig. 7: *Saperda scalaris*, Criţ, Daia Valley, 03.06.2012

Fig. 8: *Aesalus scarabaeoides*, Criţ, Zaifan Valley, 02.06.2012

Fig. 9: ***Osmoderma barnabita*****, Roadeş, 08.07.2012**

Fig. 10: ***Eurythyrea quercus*****, Cloaşterf, Cimaş Valley, 30.06.2012**

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