

**MUZEUL OLTENIEI CRAIOVA**

**OLTENIA**  
**STUDII ȘI COMUNICĂRI**  
**ȘTIINȚELE NATURII**

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# CORRELATIONS BETWEEN THE INDUCTION OF CYCLOBUTYL-PYRIMIDINE-DIMERS AND THE CYTOGENETIC EFFECTS OF UV RADIATIONS AT BEAN (*PHASEOLUS VULGARIS* L.)

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**Abstract.** The study was focused on estimating the early effects of UV-B at molecular and chromosomal level and the specific responses of four bean cultivars from Romania. The molecular damage was estimated by analysing the cyclobutane - pyrimidine dimers (CPDs) formation and their photorepair, and the cytogenetic effects by the occurrence and frequency of chromosomal aberrations, which may appear during cell division in root apex. The study proves that for Ardeleana, Avans, Star, and Diva cultivars, UV-B had little influence on the amount of CPDs formation in hypocotyls hook, and the cytogenetic effect is also very similar, the DNA lesions leading to the same types of chromosomal aberrations, with aberrations frequency correlated with the mitotic index, presenting a low sensitivity to increases of UV-B radiation. The choice of *Phaseolus vulgaris* (LINNAEUS 1753) as biological material for investigations can be explained by the importance of seeds and legumes in humans' nutrition, because of the increased level of high quality proteins, and the high energetically level, and due to the importance in soil amelioration.

**Keywords:** dimmers, aberrations, bean, UV-B.

**Rezumat.** Corelații între inducerea formării dimerilor ciclobutil pirimidinici și efectele citogenetice ale radiațiilor UV la fasole (*Phaseolus vulgaris* L.). Studiul s-a axat pe estimarea efectelor radiațiilor UV-B la nivel molecular și cromosomal și a răspunsurilor specifice a patru soiuri românești de fasole. Leziunile apărute la nivel molecular au fost evaluate în urma analizei formării și respectiv fotoreparării prin clivare a dimerilor ciclobutan pirimidinici (CPDs), iar efectele citogenetice au fost estimate în urma analizei frecvenței de apariție a aberațiilor cromosomiale, la nivelul apexului radicular. Studiul dovedește că în cazul soiurilor: Ardeleana, Avans, Star și Diva, radiația UV-B are o eficiență scăzută în inducerea formării dimerilor de timină la nivelul cărjei hipocotilare, leziunile apărute la nivel ADN determinând apariția aceluiași tipuri de aberații cromosomiale indiferent de soi, având frecvența corelată cu indicele mitotic, dovedind o sensibilitate redusă la intensificarea iradierii cu UV-B. Alegerea fasolei *Phaseolus vulgaris* (LINNAEUS 1753), drept material biologic folosit în investigații, poate fi explicată prin importanța folosirii semințelor și păștilor în nutriția omului, datorită conținutului ridicat în proteine de calitate, a nivelului energetic ridicat cât și a importanței folosirii speciei, drept plantă precursoră în ameliorarea solului.

**Cuvinte cheie:** dimeri, aberații, fasole, UV-B.

## INTRODUCTION

In the last decades, the scientific world research focused, because of stratospheric ozone layer depletion, on the effects of UV irradiations (particularly UV-B) on organisms' survival, on the induction of changes at the level of biochemical and genetic processes, and on the variability of characters.

The most important consequence of the stratospheric ozone depletion is an increase in the amount of UV-B (280-315nm) radiation reaching the earth's surface, because ozone selectively filters out the shorter UV wavelengths, (BJÖRN et al., 1999a). The shift of spectral UV composition towards shorter wavelengths has on higher plants damaging effects, including DNA damage, commonly represented by formation of cytotoxic cyclobutane pyrimidine dimers (CPDs), which can be reversed by splitting of CPDs by subsequent exposure to UV-A – blue light radiation (360-420nm), phenomenon termed photoreactivation (photorepair), via DNA photolyase (PRE) (BUCHHOLZ et al., 1995). DNA damage and repair, illustrated by kinetics of CPDs formation and repair as well as chromosomal aberrations occurred during cell division as response to mutagenic agents has been investigated in several plant species, but information of behavior shown by different cultivars of the same species can be important for the study of individual variability in a population. In the present study, we examined the formation and photorepair of DNA damage and the chromosomal aberrations induced by UV-B radiation in four Romanian cultivars of *Phaseolus vulgaris* L. (LINNAEUS 1753).

## MATERIAL AND METHODS

### Plant Material and Light Treatments

Biological material: *Phaseolus vulgaris* L. seeds of 4 Romanian cultivars (Diva, Ardeleana, Avans, Star), obtained from S.C.D.A. Podu-Iloaiei Iași Romania.

Mutagenic agent: UV-B radiations.

Light Sources for induction of cytotoxic cyclobutane pyrimidine dimers (CPDs):

Short-wavelength UV radiation was obtained from a Philips TL 40-W/12 fluorescent tube ( $\lambda_{\max}$  310 nm, fluence rate  $4.81 \text{ W m}^{-2}$  for 20 cm irradiation height). This light source was used unfiltered (covered with quartz) or filtered through 3mm Schott cutoff filters WG 360 (8,  $3 \text{ W m}^{-2}$ ). The filters cut UV-B radiation with certain wavelength (50% transmission for the given wavelength).

Light Sources for photorepair, via DNA photolyase:

UV-A was obtained from Osram L36-W/73 tubes ( $3.3 \text{ Wm}^{-2}$ ), fluence rate  $19.6 \text{ Wm}^{-2}$  for 20 cm irradiation height. Irradiation time: 30 minutes for UV-B and 60 minutes for UV-A.

Light sources used for cytogenetic studies designated UV/white light, is a mixture of:

2 L 40 W/73 (UV-A), Osram

2 TL 40 W/18 (Blue Light), Philips

1 TL 40 W/12 (UV-B), Philips.

Fluence rate of UV-B lamp is  $3 \text{ Wm}^{-2}$  total fluence rate is  $8 \text{ Wm}^{-2}$ .

The lamps were positioned in the next order: 1, 2, 3, 2, 1.

The Osram L 40 W/73 (UV-A source) includes sufficient UV-B radiation to activate UV-B photoreceptors (BEGGS & WELLMANN, 1985).

Relevant WG type cutoff filters (Schott and gen, Mainz, Germany) were used for the experiment: WG 305 with  $11, 9 \text{ Wm}^{-2}$  fluence rate, WG 320 ( $11 \text{ Wm}^{-2}$ ) and WG 360 ( $8, 3 \text{ Wm}^{-2}$ ). The last one was used for UV-B control. The filters cut UV-B radiation with certain wavelength (50% transmission for the given wavelength).

#### Working steps:

For each experimental variant, 20 seeds of four bean (*Phaseolus vulgaris* L.) cultivars were selected and sown in 300ml humid Vermiculite (Deutsche vermiculite Dämmstoff GmbH Sprockhövel), in 9/9 cm plastic box. Seedlings were germinated and grown at  $25^\circ\text{C}$  for 4 days with controlled conditions of humidity and light/darkness alternation, in a phytochamber.

For testing UV irradiation effects, including DNA damage, represented by formation of cyclobutane pyrimidine dimers (CPDs), the hypocotyls were cut longitudinally in halves, placed with the cut face on wet filter paper, and covered with a 3 mm quartz plate penetrated by UV or transmission WG360 cutoff filter (50% transmission at the given wavelengths, cutting completely UV-B, representing Control variant for each cultivar).

The hypocotyls halves were then, depending on the experimental variant, frozen in liquid nitrogen for estimating CPDs formation, or subsequent irradiated with UV-A for photorepair.

Six hypocotyls halves for each cultivar were ground for 3 minutes using sand 0.5 ml of CTAB buffer. DNA extraction was carried out essentially as described by TAKEUCHI et al. (1996) using a CTAB-based procedure. DNA damage was assayed by determination of cyclobutane pyrimidine dimers (CPDs) using a method adapted from MORI et al., 1991. DNA samples were denaturized, immobilized on an ELISA (Enzyme Linked Immunosorbent Assay) plate, and CPDs detected using the primary TDM-2 monoclonal antibody and the secondary HRP antibody. The method is based on the detection of the primary bound antibody by the secondary antibody (Sigma, St. Louis) and measuring the absorbance at 490 nm. CPD photorepair was assayed measuring the rate of disappearance of CPDs from DNA by activation of the DNA photolyase after exposing the samples to UV-A.

The rates of the CPDs photorepair in hypocotyls, were calculated as follows:

$$\% \text{ Rep.} = \frac{\sum Q - \sum R}{\sum Q - \sum K} \times 100 \quad \text{where } \% \text{ Rep represent the percent of restored dimmers, Q-the UV-B treatment}$$

variant, R-the UV-B+UV-A treatment variant and K the Control variant.

For cytogenetic studies: for each cultivar, there were 6 experimental variants (5 treatment variants and 1 control). For treatment variants, 72h old seedlings (15 for each variant) were irradiated in boxes covered with cutoff filters (WG360, WG320, WG305, WG275, Q) for 0,5h; 1,5h; or 3h with the light source described above. For control variant, 15 seedlings (72h old) were kept in dark at  $25^\circ\text{C}$ . After irradiation, roots were coloured by Feulgen method and microscope slides were prepared using root tips of 0.5-1 cm, following Squash techniques for cytogenetic studies (CÎMPEANU et al. 2002).

## RESULTS AND DISCUSSIONS

After extraction, the DNA containing samples were read at the spectrophotometer at  $\lambda 260\text{nm}$  respectively  $\lambda 280\text{nm}$ , to check out if the proportion between the two obtained values are in the range of 1.8-2.0, which is an essential condition before following the next steps. Results were very similar for all the four cultivars, for all experimental variants, as shown in the Table 1.

Table 1. Ratio between readings at  $\lambda 260\text{nm}$   $\lambda 280\text{nm}$ .  
Tabel 1. Raportul între absorbțiile la  $\lambda 260\text{nm}$  și  $\lambda 280\text{nm}$ .

Cultivar	Variants		
	Samples irradiated through WG 360 filter (C)	Sample irradiated through Q filter (Q)	Samples irradiated with UV-B followed by UV-A irradiation (R)
Diva	1,93	1,96	1,94
Ardeleana	1,91	1,95	1,95
Avans	1,96	1,95	1,86
Star	1,91	1,95	1,92

Regarding the action of the UV-B irradiation on the induction of CPDs, the results showed that the level of UV-B had little influence on the amount of CPDs formed in hypocotyls in the case of the four Romanian bean cultivars. The unexpected identification of dimmers also in Control samples, can be explained by the unspecific binding of thymine monomers or other azotate base to DNA, or the induction by UV-A in the case of a high energetic flux (Fig.1). UV-B radiation was probably effectively filtered by the UV-B absorbing compounds or CPDs were effectively photorepaired by the action of the DNA photolyase. Estimations of the rate of the CPDs photorepair in hypocotyls, indicate that, after 1h under photorepair conditions (UV-A irradiation) depending on cultivar, between 7.2-16.85 % of the CPDs disappeared (Table 2). This experiment indicate that the investigated bean cultivars presents a low sensitivity to increases of UV-B radiation, the photorepair, even if not effective enough to remove all CPDs, helps in avoiding the increase of DNA damage by this radiation.

It was also observed that for each cultivar, DNA quantity increased due to UV-B irradiation compared with the Control.

For each tested cultivar, on the ELISA plate, there were placed 200ng DNA per cell, in three repetitions: one negative control variant (represented by TE buffer), the Control variant (C) represented by the WG360 filtered UV irradiated samples, the DNA lesion (Q) variant represented by UV-B irradiated samples, and the photoreparation (R) variant, represented by samples irradiated with UV-B followed by UV-A irradiation.

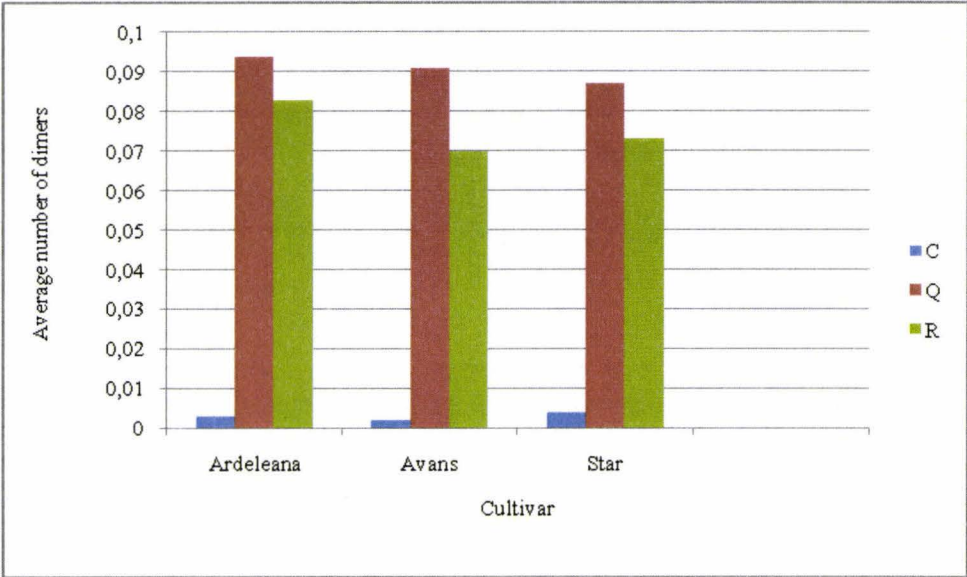


Figure 1. Average number of CPDs induced by UV irradiation at *Phaseolus vulgaris* L.  
Figura 1. Numărul mediu de dimeri formați în urma iradierii cu UV la *Phaseolus vulgaris* L.

After reading the ELISA plate at DYNEX.MRX at  $\lambda 490\text{nm}$ , for all investigated cultivars it could be noticed an increase of dimmers number following UV-B irradiation and a decrease after subsequent UV-A irradiation, because of photoreparation, as shown in Fig.1. It can be observed that the percent of restored dimmers is 6.95% for *Diva*, 11.71% for *Ardeleana*, 23.08% for *Avans* and 16.10% for *Star* (Table 2).

Table 2. The percent of restored dimmers for each investigated cultivar.  
Tabel 2. Procentul dimerilor clivați în urma fotoreparării, pentru fiecare dintre soiurile investigate.

Cultivar			
Diva	Ardeleana	Avans	Star
6.95%	11.71%	23.08%	16.10%

Knowing the average number of dimmers formed in the case of DNA lesions variant (Q: UV-B irradiated samples), and the average number of dimmers which were not cleaved during photoreparation R, it was calculated the average number of dimmers which were cleaved during photoreparation (Table 3).

Table 3. Average number of dimmers which were cleaved for each investigated cultivar.  
Tabel 3. Numărul mediu de dimeri clivați, pentru fiecare soi investigat.

Cultivar			
Diva	Ardeleana	Avans	Star
0.01	0.011	0.021	0.014



Comparing the photoreparation efficiency for the 4 bean cultivars, it can be observed that from this point of view, the most resistant to the damaging UV-B action is Avans, followed by Star, Ardeleana, Diva (Fig. 2). Diva is the most sensitive, because both: highest number of formed dimmers and lowest percent of restored dimmers.

A possible way of explanation can be the distribution of dimmers leading to differences in photolias accessibility (which is the cleavage enzyme).

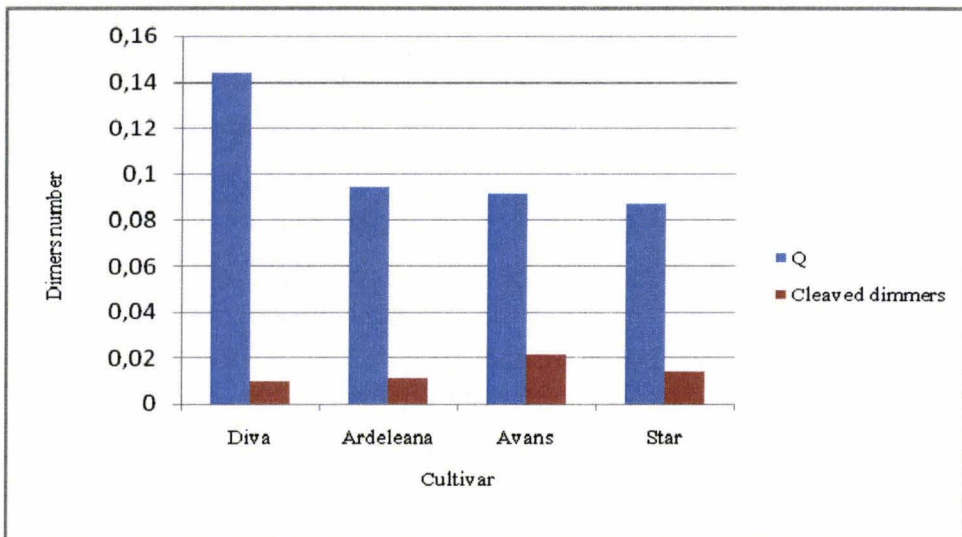


Figure 2. The photoreparation efficiency for the 4 bean cultivars.  
Figura 2. Eficiența fotoreparației în cazul celor 4 soiuri de fasole.

#### The frequency of cells with chromosomal aberrations

If we consider the values induced by different wavelength UV (for 0.5h irradiation time) in ana-telophase (A-T) of the 4 bean cultivars (Ardeleana, Avans, Star, Diva), it could be noticed that the frequency of cells with chromosomal aberrations increase with the decrease of radiation wavelength (meaning UV-A, to UV-B and finally UV-C kind of radiation). The maximal number and types of aberrations were found in the case of full spectrum UV (filter Q), especially for Diva cultivar, following Star, Ardeleana and Avans.

For 1.5h irradiation time, results were similar regarding aberrations frequency connected with cultivar type: the frequency of cells with chromosomal aberrations increase with the decrease of radiation wavelength, the maximal number and types of aberrations were found in the case of full spectrum UV.

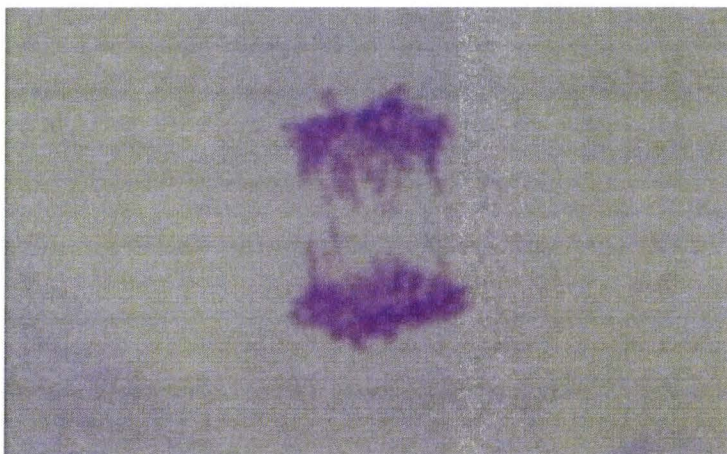


Figure 3. A-T with broken bridges, expelled, retarded chromosome, Star, WG320, 1.5h.  
Figura 3. A-T cu punți rupte, retardatari și un expulzat, Star, WG320, 1,5h.

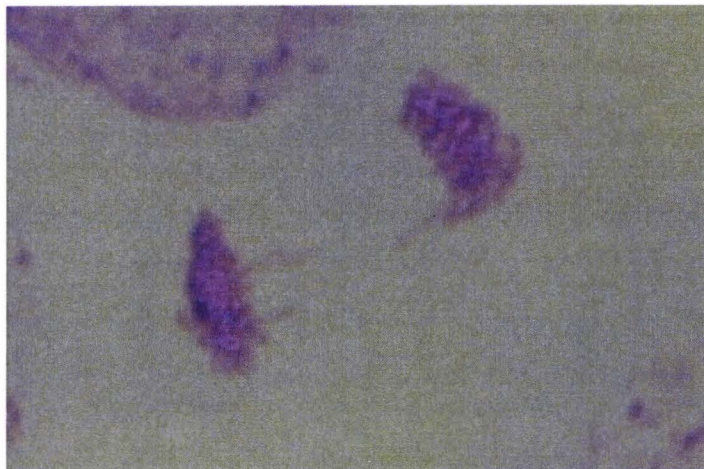


Figure 4. A-T with broken bridge, retardate chromosome Avans, WG275, 1,5h.

Figura 4. A-T cu punte ruptă și retardatari, Avans, WG275, 1,5h.

For 3h irradiation time, it could be observed the increase of aberration frequency for all irradiations variants (WG 360, WG 320, WG 305, WG 275, Q), meaning UV-A, UV-B, UV-C and full spectrum of UV, proving the importance of treatment period next to UV harmfulness (increasing with the decrease of wavelength) in disturbing cell division.

The Ardeleana, Star, Avans and Diva cultivars reacted very similar. Aberrations types were in order of their occurring frequency: simple or multiple bridges, retardate chromosomes, expelled chromosomes, simple or multiple bridges combined with chromosomes or chromosomal fragments (Figs. 3-5) and in a very low percent some other aberrations types as more than one retarded chromosomes, expelled genetic material, and multiple division poles.

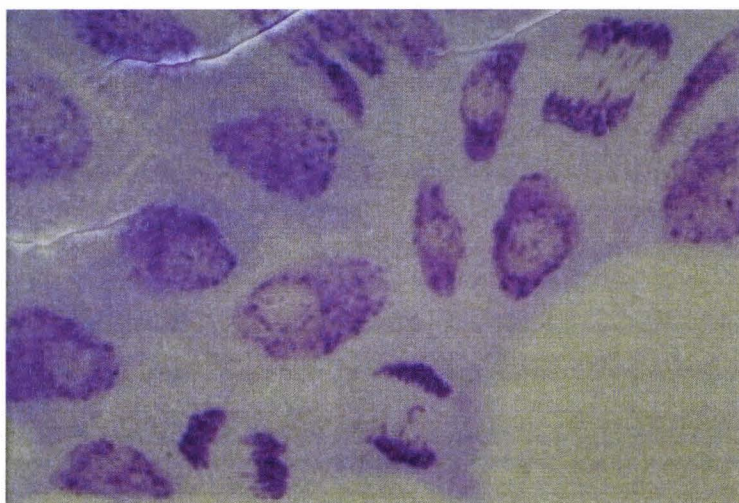


Figure 5. A-T with multiple broken bridges, retardate chromosome Diva, Q 3h.

Figura 5. A-T cu punți rupte, retardatari Diva, Q 3h.

The most frequent aberration types induced by UV, are multiple broken bridges, but could be observed also combinations between bridges and retardate or expelled chromosomes, one or more retardate chromosomes, unequal and also tripolar ana-telophase (Figs. 4-5).



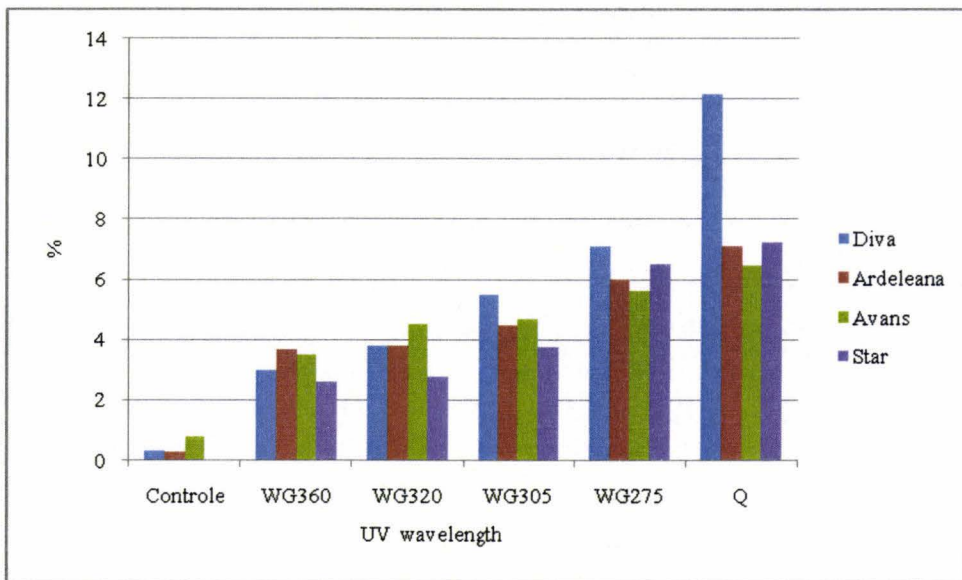


Figure 6. Frequency of aberrant A-T different cultivars of bean, depending on UV wavelength, 0.5h irradiation time.

Figura 6. Frecvența A-T aberante, pentru diferitele soiuri de fasole, în funcție de lungimea de undă a radiației UV, durata iradierii 0,5h.

After analyzing aberrations type, it can be noticed that in the case of all investigated cultivars, UV irradiation induced lesions at DNA level but also affected division spindle. The induction of lesions at DNA level was proven also by the increase of CPD dimmers number following UV-B irradiation.

For all the 4 cultivars, the results regarding the aberrations frequency can be correlated with the mitotic index. The aberrations frequency value increases and the mitotic index decrease (as a plant protection mechanism) correlated with the decrease of UV wavelength and increase of irradiation time (BĂRA & GRAMA-ȚIGĂNAȘ, 2005). The mitotic index decrease, proves an inhibition of cells division, shown that a supra UV-B dose could cause reduction in plant growth and in biomass production, similar to some other studies (SULLIVAN & TERRAMURA, 1989, TOSSERAMS et al., 2001).

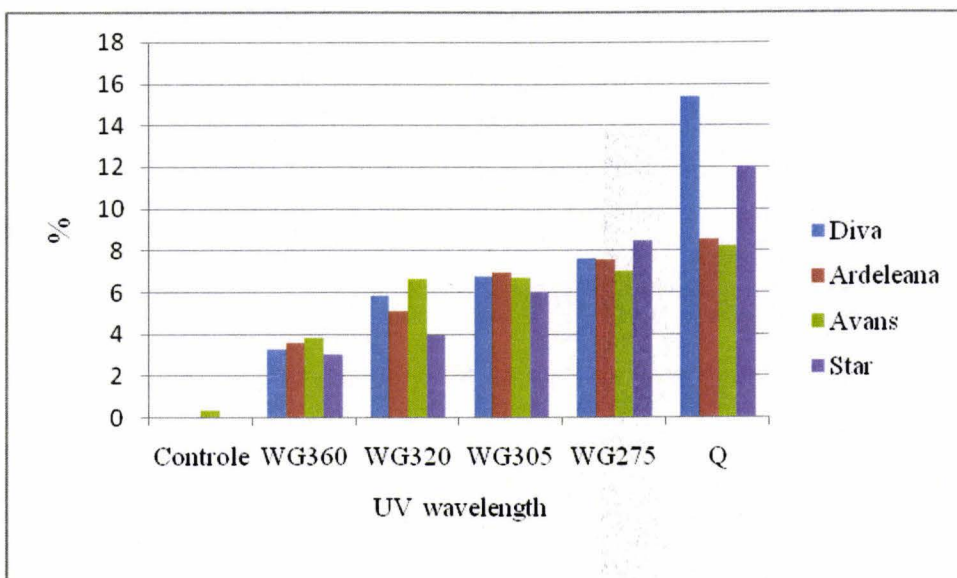


Figure 7. Frequency of aberrant A-T for different cultivars of bean depending on UV wavelength, for 1.5h irradiation time.

Figura 7. Frecvența A-T aberante, pentru diferitele soiuri de fasole, în funcție de lungimea de undă a radiației UV, durata iradierii 1,5h.



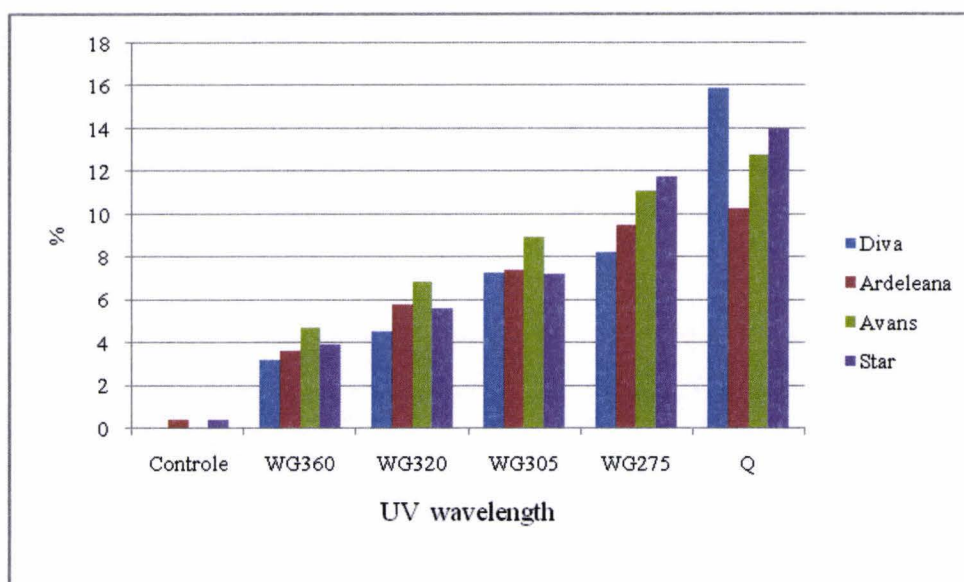


Figure 8. Frequency of aberrant A-T for different cultivars of bean, depending on UV wavelength, for 3h irradiation time.  
 Figura 8. Frecvența A-T aberante, pentru diferitele soiuri de fasole, în funcție de lungimea de undă a radiației UV, durata iradierii 3h.

It can be observed (Figs. 6-8) that for all irradiation time variants, the frequency of aberrant A-T, reaches the highest values for Diva cultivar, in the case of full spectrum UV (filter Q), in concordance with the DNA level damage, proved by the highest number of induced dimmers and lowest percent of restored dimmers. Persisting lesions occurred due to the dimmers which were not cleaved after photoreparation, led to chromosomal aberrations, the frequency and types of which, were, as expected increased for Diva cultivar comparing with the other 3 cultivars (Avans, Star and Ardeleana, which reacted quite similar).

## CONCLUSIONS

1. UV-B had little influence on the amount of CPDs formed in hypocotyls hook, on aberrations type or aberrations frequency, for the Romanian *Phaseolus vulgaris* L. investigated cultivars, all showing a low sensitivity.
2. The frequency of aberrant A-T reaches the highest values for Diva cultivar, in the case of full spectrum UV, in concordance with the DNA level damage, proved by the highest number of induced dimmers and lowest percent of restored dimmers.
3. For all investigated cultivars it could be noticed an increase of dimmers number following UV-B irradiation and a decrease after subsequent UV-A irradiation, because of photoreparation.
4. The photorepair, even if not effective enough to remove all CPDs, helps in avoiding the increase of DNA damage by this radiation.
5. Regarding kinetics of CPDs formation and cleavage at DNA level, for the investigated four bean cultivars, the most resistant is *Avans*, than *Star*, *Ardeleana* and *Diva*.
6. For all 4 investigated cultivars, the frequency of aberrations induced by UV increases with the decrease of wavelength and with the increase of irradiation time, but the percent of mutations occurrence is similar to the natural induced ones, proving the low mutagenic effect of UV.
7. After analyzing aberrations type, it can be noticed that in the case of all investigated cultivars, UV irradiation induced lesions at DNA level but also affected division spindle, occurring multipolar ana-telophase, retardate chromosomes.
8. The maximal number and types of aberrations were found in the case of full spectrum UV, correlated with the mitotic index decrease.

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## EPIPHYTIC AND TERRICOLOUS LICHENS DIVERSITY IN COZIA NATIONAL PARK (ROMANIA)

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**Abstract.** *A list of 76 lichens taxa, including mainly epiphytic and many terricolous lichenized fungi, is reported from Cozia National Park-Romania. Nine taxa are newly recorded for Romania. 54 taxa are new for Cozia.*

**Keywords:** *lichenized fungi, diversity, epiphytic, terricolous, Cozia.*

**Rezumat.** *Diversitatea lichenilor tereștri și epifitici din Parcul Național Cozia (România). O listă cu 76 de taxoni, incluzând în special lichenii epifitici și tericoli, este raportată din Parcul Național Cozia (Romania). 9 taxoni sunt amintiți în premieră pentru România, iar 54 taxoni pentru Cozia.*

**Cuvinte cheie:** *licheni, diversitate, epifitic, tericol, Cozia.*

### INTRODUCTION

Lichens as unique symbiotic organisms have important ecological roles. Epiphytic lichens, especially being highly sensitive to pollution, are well-known bioindicators. The present study focusing on mainly epiphytic and terricolous lichen diversity in Cozia Mount is one of the most detailed lichenological surveys aimed to contribute for Romanian lichen mycota.

The lichen flora of Romania has been studied for more than 150 years and the results are found in over 300 publications (BARTÓK, 1993, 1994; BURLACU, 1967; BURLACU et al., 1969; CIURCHEA, 1969, 1970; CIURCHEA & CODOREANU, 1967; CODOREANU, 1966; CODOREANU et al., 1960; HORIA, 1965; MORUZI & TOMAN, 1967, 1969, 1970-71; SAVA, 1972, 1973; MORUZI et al., 1967) presented a survey (in Romanian) of all available floristic information. Following practice of that time, these authors included many infraspecific entities, listing a total of 2,575 taxa (CIURCHEA, 2007b). Effectuated research about lichens from Cozia Mount: CODOREANU & CIURCHEA (1965) mentions 35 species of lichens on gneiss, at altitudes between 1,000-1,200 m; BARTÓK (1990) mentions 36 species of lichens; some of them had been reconsidered by nomenclature and included in "Catalogue of lichens in Romania" (CIURCHEA, 1998, 2007a).

#### Study Area

Cozia Mount, placed east of the Olt Defile, is part of the Mountains Fagaras group, being the south-west subdivision of those. The Fagaras Mountains are located in the central zone of Romania, in the central-southern part of the Southern Carpathians and are crossed, from North to South, by the Olt River. Administratively, it belongs to Valcea County (Fig. 1).

According to our pre-research on Cozia Mount, the eligible area for lichen collecting is about 117.6 km<sup>2</sup> that is a part of Cozia National Park. This possible study area is a large rectangle with sides of 6' x 8' length. The coordinates of the corners are; from North to South: 45°22'N-24°25'E, 45°16'N-24°25'E and from East to West 45°22'N-24°17'E, 45°16'N-24°17'E. There are 6 squares from East to West and 8 squares from North to South. Each square has 1 x 1 (km) dimensions and will be called 'Grid'. This grid system will make our work easier and well organized. Data about the plan of research can be found on the Website about Lichens of Cozia. <http://cozialichens.googlepages.com>

**Geology and geomorphology.** Geologically it prevails gneiss, which is known as „gneiss of Cozia“, like crystals of orthoclase and granite. The southern unit is formed by reef limestone, conglomerates with elements of gneiss and grit stones (all from Cretaceous), packets of rocks that sink into new sedimentary systems. The relief of the National Park Cozia, with an altitude difference of about 1,360 m (between the Olt Valley and Cozia Peak, 1,668 m), it is characterized by a dynamic aspect: big differences of level on small areas, steep slopes and ruiniform landforms.

There are mainly three types of soil (cambisols, spodosols, hydromorphic soils) with a lot of sub-types. Cambisols contain eumezobasic brown soils formed on rocks rich in minerals and iron-magnesium – limestone rocks, dolomites, conglomerates, calcareous sandstones formed on mountainsides with different expositions and slopes. These soils support the growing of beech stands, mixed with maple and ash trees, on shadowed mountainsides; oaks are mixed with linden trees and field maples on sunny slopes; brown acid soils are formed on acid rocks rich in iron-magnesium, on slopes with different expositions and inclinations and they encourage the growing of spruce woods. Spodosols are represented by feriilluvial brown soils, which formed under cold and very humid climatic conditions, on acid rocks and podzol soils, which formed in cold and rainy climate, on acid substratum. Due to the presence of waterproof substrata in connection to an excessive humid regime, there are also hydromorphic soils situated on the banks of some brooks.

**Hydrology.** All the rivers that drain Cozia National Park are tributaries to the Olt, either directly (the Baiasu, the Lotrisor, the Pausa, the Călineștiul etc.), or indirectly, through the gathering of those of the Lotru (the Vasilatu etc.).

**Climate.** The annual average temperature at Cozia station (1,573 m alt.) is of 3.3 °C, and the average quantity of precipitation is of 1,015 mm/year. With the decrease of the altitudes, the annual average temperature grows, reaching 10°C in the Olt Valley, while precipitation decreases to 700 mm/year. The southern slopes are submitted to the influence of warmer air that advances northwards along the Olt, which influences the local vegetation.

**Flora and vegetation.** The Park flora is extremely luxuriant, having approximately 932 taxa. Endemics are: *Centaurea stoebe* var. *coziensis* and *Stipa pulcherrima crassiculmis* (*S. crassiculmis*). There are also numerous rare species. A peculiarity of Cozia Massif is an unusual stratification of vegetation. The wood vegetation characterized by *Quercus dalechampii*, *Q. petraea* can be found up to 1,026 m, while fir and beech are found at 300-400 m (COSTACHE et al., 2007).

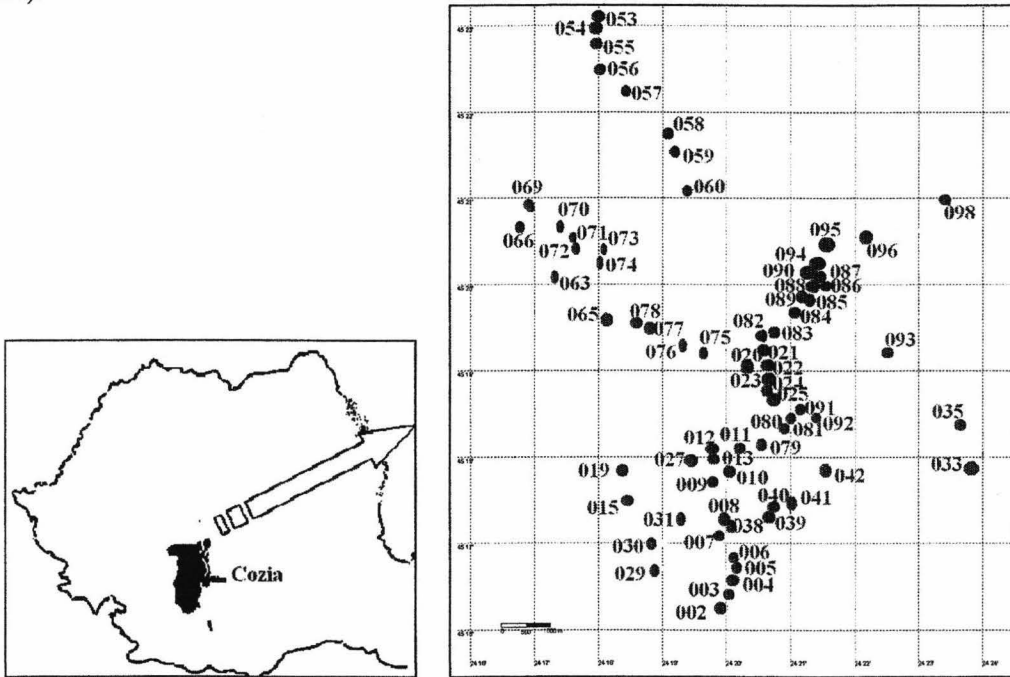


Figure 1. Study area (Cozia) with numbers of the collecting sites.  
Figura 1. Zona studiată (Cozia) cu numerele punctelor de colectare.

## MATERIALS AND METHODS

The lichen material was collected from 70 sites in Cozia National Park. Epiphytic samples were collected on tree substrata including certain species such as *Fagus sylvatica*, *Quercus robur*, *Q. dalechampii*, *Betula pendula*, *Carpinus betulus*, *Tilia argentea*, *Acer pseudoplatanus*, *Cerasus avium*, *Fraxinus ornus*, *F. excelsior*, *Alnus incana*, *Populus tremula*, *P. canescens*, *Pinus sylvestris*, *Picea abies*, *Abies alba*, *Larix decidua*, *Juniperus communis*. Terricolous lichen samples were also collected on soil substrate, some being together with the mosses. The geographic coordinates and elevations were recorded on the paper bags as well as the substrate types in the field. The collected samples were let air dried and put in herbarium envelopes after identification.

The collected lichen material was investigated microscopically (Olympus SZx40) and chemically by using spot tests. The taxa were identified with the aid of flora books and identification keys (BRODO et al., 2001; DOBSON, 1992; JAHNS, 1987; PURVIS et al., 1992; WIRTH, 1995). The lichen specimens are preserved in the Herbarium of the Faculty of Science and Arts, Marmara University, Istanbul (MUFE) with numbers given by GÜLŞAH ÇOBANOĞLU, (G.Ç. ROM01 – G.Ç.ROM76).

### List of Collecting Sites:

**CZ002:** 336 m; 45° 16' 14.75855"N-24° 19' 56.81929"E; 08.VII.2007, **CZ003:** 423 m; 45° 16' 26.15182"N-24° 20' 03.69418"E; 08.VII.2007, **CZ004:** 372 m; 45° 16' 35.12960"N-24° 20' 07.38703"E; 08.VII.2007, **CZ005:** 417 m; 45° 16' 45.01805"N-24° 20' 09.42033"E; 08.VII.2007, **CZ006:** 426 m; 45° 16' 49.01007"N-24° 20' 07.29264"E; 08.VII.2007, **CZ007:** 463 m; 45° 17' 04.74401"N-24° 19' 53.99781"E; 08.VII.2007, **CZ008:** 451 m; 45° 17' 15.08972"N-24° 19' 59.34647"E; 08.VII.2007, **CZ009:** 531 m; 45° 17' 42.39680"N-24° 19' 48.62121"E; 09.VII.2007, **CZ010:** 581 m; 45° 17' 52.58793"N-24° 20' 01.44658"E; 09.VII.2007, **CZ011:** 687 m; 45° 18' 07.04824"N-24° 20' 11.31990"E; 09.VII.2007, **CZ012:** 676 m; 45° 18' 03.69624"N-24° 19' 47.60486"E; 09.VII.2007, **CZ013:** 708 m; 45° 17' 59.83013"N-24° 19' 46.93192"E; 09.VII.2007, **CZ015:** 420 m; 45° 17' 30.77821"N-24° 18' 27.07645"E; 10.VII.2007, **CZ019:** 672 m; 45° 17' 49.51465"N-24° 18' 25.62827"E; 10.VII.2007, **CZ020:** 1591 m; 45° 19' 03.22187"N-24° 20' 18.13823"E; 11.VII.2007, **CZ021:** 1611 m; 45° 19' 02.84782"N-24° 20' 29.39471"E; 11.VII.2007, **CZ022:** 1606 m; 45° 19' 01.72114"N-24° 20' 30.26952"E; 11.VII.2007, **CZ023:** 1595 m; 45° 18' 57.43050"N-24° 20' 37.87606"E; 11.VII.2007, **CZ024:** 1428 m; 45° 18' 52.53857"N-24° 20' 40.13700"E;



11.VII.2007, **CZ025**: 1416 m; 45° 18' 51.01236"N-24° 20' 42.58132"E; 11.VII.2007, **CZ027**: 766 m; 45° 17' 56.46753"N-24° 19' 30.26521"E; 12.VII.2007, **CZ029**: 385 m; 45° 16' 42.43135"N-24° 18' 55.46694"E; 17.VII.2007, **CZ030**: 476 m; 45° 16' 59.53345"N-24° 18' 51.58902"E; 17.VII.2007, **CZ031**: 648 m; 45° 17' 16.73723"N-24° 19' 19.00023"E; 17.VII.2007, **CZ033**: 771 m; 45° 17' 40.78499"N-24° 24' 30.79593"E; 18.VII.2007, **CZ035**: 822 m; 45° 18' 23.10527"N-24° 23' 39.03611"E; 18.VII.2007, **CZ038**: 483 m; 45° 17' 12.10929"N-24° 20' 03.97233"E; 19.VII.2007, **CZ039**: 571 m; 45° 17' 19.01823"N-24° 20' 42.58660"E; 19.VII.2007, **CZ040**: 600 m; 45° 17' 21.19259"N-24° 20' 47.07178"E; 19.VII.2007, **CZ041**: 613 m; 45° 17' 25.36506"N-24° 21' 01.56418"E; 19.VII.2007, **CZ042**: 939 m; 45° 17' 51.06793"N-24° 21' 35.22049"E; 19.VII.2007, **CZ053**: 353 m; 45° 23' 03.97723"N-24° 18' 02.89572"E; 27.VII.2007, **CZ054**: 372 m; 45° 22' 59.86269"N-24° 18' 00.14214"E; 27.VII.2007, **CZ055**: 383 m; 45° 22' 47.46528"N-24° 17' 59.63888"E; 27.VII.2007, **CZ056**: 366 m; 45° 22' 28.31854"N-24° 18' 03.17495"E; 27.VII.2007, **CZ057**: 344 m; 45° 22' 15.83181"N-24° 18' 26.10615"E; 27.VII.2007, **CZ058**: 429 m; 45° 21' 44.68114"N-24° 19' 07.88679"E; 27.VII.2007, **CZ059**: 470 m; 45° 21' 32.39559"N-24° 19' 16.72491"E; 27.VII.2007, **CZ060**: 530 m; 45° 21' 05.54550"N-24° 19' 21.28016"E; 27.VII.2007, **CZ063**: 412 m; 45° 20' 05.26488"N-24° 17' 18.03854"E; 29.VII.2007, **CZ065**: 1040 m; 45° 19' 37.02296"N-24° 18' 06.46777"E; 29.VII.2007, **CZ066**: 279 m; 45° 20' 39.96160"N-24° 16' 47.86334"E; 29.VII.2007, **CZ069**: 403 m; 45° 20' 55.65288"N-24° 16' 53.15769"E; 08.VIII.2007, **CZ070**: 537 m; 45° 20' 40.02741"N-24° 17' 23.31740"E; 08.VIII.2007, **CZ071**: 640 m; 45° 20' 31.62968"N-24° 17' 37.01498"E; 08.VIII.2007, **CZ072**: 665 m; 45° 20' 27.79604"N-24° 17' 38.54510"E; 08.VIII.2007, **CZ073**: 617 m; 45° 20' 23.65716"N-24° 18' 06.08352"E; 08.VIII.2007, **CZ074**: 571 m; 45° 20' 16.09765"N-24° 18' 01.52305"E; 08.VIII.2007, **CZ075**: 1524m; 45° 19' 12.43961"N-24° 19' 39.40065"E; 09.VIII.2007, **CZ076**: 1405 m; 45° 19' 18.68811"N-24° 19' 18.43168"E; 09.VIII.2007, **CZ077**: 1303 m; 45° 19' 29.28500"N-24° 18' 55.67337"E; 09.VIII.2007, **CZ078**: 1278 m; 45° 19' 30.60948"N-24° 18' 48.20019"E; 09.VIII.2007, **CZ079**: 797 m; 45° 18' 09.01431"N-24° 20' 33.46553"E; 11.VIII.2007, **CZ080**: 925 m; 45° 18' 20.53389"N-24° 20' 51.36649"E; 11.VIII.2007, **CZ081**: 1008 m; 45° 18' 24.18784"N-24° 21' 00.26130"E; 11.VIII.2007, **CZ082**: 1548 m; 45° 19' 26.35763"N-24° 20' 33.51149"E; 12.VIII.2007, **CZ083**: 1523 m; 45° 19' 27.24702"N-24° 20' 42.80963"E; 12.VIII.2007, **CZ084**: 1486 m; 45° 19' 38.11519"N-24° 21' 05.78989"E; 12.VIII.2007, **CZ085**: 1465 m; 45° 19' 47.94637"N-24° 21' 19.02205"E; 12.VIII.2007, **CZ086**: 1469 m; 45° 20' 00.63567"N-24° 21' 30.59456"E; 12.VIII.2007, **CZ087**: 1506 m; 45° 20' 04.99844"N-24° 21' 27.70730"E; 12.VIII.2007, **CZ088**: 1410 m; 45° 19' 58.64828"N-24° 21' 18.17549"E; 13.VIII.2007, **CZ089**: 1391 m; 45° 19' 59.51569"N-24° 21' 13.93852"E; 13.VIII.2007, **CZ091**: 1151 m; 45° 18' 32.80938"N-24° 21' 08.44666"E; 14.VIII.2007, **CZ092**: 1076 m; 45° 18' 28.49374"N-24° 21' 22.95395"E; 14.VIII.2007, **CZ093**: 1176 m; 45° 19' 13.83042"N-24° 22' 31.51604"E; 22.VIII.2007, **CZ094**: 1518 m; 45° 20' 13.29210"N-24° 21' 25.69096"E; 22.VIII.2007, **CZ095**: 1527 m; 45° 20' 26.67983"N-24° 21' 40.24043"E; 22.VIII.2007, **CZ096**: 1517 m; 45° 20' 30.85268"N-24° 22' 07.95117"E; 22.VIII.2007, **CZ098**: 796 m; 45° 20' 55.71095"N-24° 23' 28.03726"E; 22.VIII.2007.

## RESULTS

Each identified lichen taxa is listed below in an alphabetical order; including 76 taxa belong to 39 genera (75 species, 4 varieties, 4 subspecies, 2 forms), following by the numbers of the collecting sites, types of substrata (abbreviated as shown under the list) and the G. Ç. Herbarium numbers.

The nomenclature mainly follows the Index Fungorum ([www.indexfungorum.com](http://www.indexfungorum.com)) and the recent literature (AHTI & HAWKSWORTH, 2005; BLANCO et al., 2004). The names of authors are abbreviated according to BRUMMITT & POWELL (1992).

An asterisk (\*) indicates a new record for Romania; 9 taxa are new to Romanian lichen mycota. 54 taxa were newly recorded in Cozia; each of them was indicated with a plus sign (+) in the list.

### List of Taxa

1. +*Amandinea punctata* (HOFFM.) COPPINS & SCHEID 5(*Ro-p*), 30(*Q*), 57(*Fr*) (G.Ç. ROM-001)
2. +*Anaptychia ciliaris* (L.) KÖRB 41(*Fr*), 42(*Fr*), 81(*P*), 85(*Fa*) (G.Ç.ROM-002)
3. +*Bryoria capillaris* (ACH.) BRODO & D. HAWKSW. 89(*P*), 94(*P*) (G.Ç. ROM-003)
4. +*Bryoria fuscescens* var. *fuscescens* (GYELN.) BRODO & D. HAWKSW. 78(*Be*) (G.Ç. ROM-004)
5. +*Bryoria implexa* (HOFFM.) BRODO & D. HAWKSW. 89(*P*), 94(*P*) (G.Ç. ROM-005)
6. +*Candelaria concolor* (DICKS.) STEIN 29(*Ca*), 30(*Q*), 53(*Q,Fa-s*), 54(*Be*), 57(*Fr*), 69(*Q*), 78(*Be*), 93(*Q*) (G.Ç. ROM-006)
7. +*Candelariella reflexa* (NYL.) LETTAU 5(*Ro-p*), 30(*Q*), 33(*Fa*), 53(*Fa, Fa-s*), 54(*Q-r*) (G.Ç. ROM-007)
8. *Cetraria islandica* subsp. *islandica* (L.) ACH. 12(*S*), 79(*Be*), 80(*S*), 84(*S*), 96(*S*) (G.Ç. ROM-008)
9. +*Cladonia chlorophaea* (FLÖRKE ex SOMMERF.) SPRENG. 31(*S*), 53(*S*), 58(*B*), 60(*S*) (G.Ç. ROM-009)
10. +*Cladonia coccifera* (L.) WILLD. 22(*S*), 91(*S*), 92(*S*), 96(*Fa,S*) (G.Ç.ROM-010)
11. +*Cladonia coniocraea* (FLÖRKE) SPRENG 4(*S*), 13(*Pi-s*), 21(*S*), 30(*S*), 31(*S*), 54(*Q-d*), 56(*S*), 74(*S*), 82(*S*), 85(*Fa*), 86(*S*), 94(*P*) (G.Ç.ROM-011)
12. +*Cladonia fimbriata* (L.) FR. 11(*S-M*), 22(*S*), 56(*S*), 82(*S*), 88(*S*), 91(*S*), 92(*S*), 96(*Fa*) (G.Ç.ROM-012)
13. \**Cladonia floerkeana* (FR.) FLÖRKE 88(*S*) (G.Ç.ROM-071)

14. +*Cladonia furcata* subsp. *furcata* (HUDS) SCHRAD. 22(S), 30(S), 31(S), 53(Q-d), 56(S), 60(S), 65(Fa), 71(S), 74(S), 79(S), 80(S), 84(S), 88(S), 89(P) (G.Ç.ROM-013)
15. +*Cladonia macilenta* var. *macilenta* HOFFM. 12(S) (G.Ç.ROM-014)
16. +*Cladonia pyxidata* (L.) HOFFM. 3(S), 22(S), 30(S), 56(S), 71(S), 74(S.), 84(S), 85(Fa), 88(S) (G.Ç.ROM-015)
17. +*Cladonia ramulosa* (WITH.) J. R. LAUNDON 22(S) (G.Ç. ROM-072)
18. *Cladonia rangiferina* (L.) WEBER ex F. H. WIGG. 12(S), 31(S), 96(S) (G.Ç.ROM-016)
19. +*Cladonia rangiformis* HOFFM. 70(S) (G.Ç.ROM-073)
20. +*Cladonia scabriuscula* (DELISE) LEIGHT. 96(S) (G.Ç.ROM-017)
21. +*Cladonia subulata* (L.) WEBER ex F.H. WIGG. 54(Q-r) (G.Ç.ROM-018)
22. +*Evernia divaricata* (L.) ACH. 85(Fa), 89(P) (G.Ç. ROM-019)
23. *Evernia prunastri* (L.) ACH. 11(Ab), 41(Fr), 42(Fr), 57(Al), 59(Pi), 65(Fa), 66(W), 69(Q), 70(Q), 72(Q), 73(Q), 78(Be), 79(Be), 85(Fa), 93(Q), 98(Ce) (G.Ç. ROM-020)
24. +*Flavoparmelia caperata* (L.) HALE 3(Q), 4(Al), 5(Ro-p), 8(Pi), 9(Q), 12(Q), 13(Pi), 15(Fa), 19(Q), 30(Pi,Q), 31(Fa), 33(Fa), 38(Pi-s, Fa, Al), 39(Ac), 40(Q,Pi-s,Pr-aAc), 41(Q,Fr), 42(Fr), 53(Ca-b,Q,Fa-s), 54(Ca,Q-r), 55(Pi-is), 57(Al-I,Fr), 63(Fa), 66(W), 69(Fa,Q), 70(Q), 72(Q), 73(Q), 79(Be), 91(Pi-s), 93(Q), 98(Ce,Fa) (G.Ç.ROM-021)
25. +*Hypocenomyce scalaris* (ACH. ex LILJ.) M. CHOISY 13(Pi-s) (G.Ç.ROM-022)
26. +*Hypogymnia farinacea* ZOPF 6(Q), 11(Ab,P), 15(Fa), 23(Ab), 55(Ca-b), 57(Fr), 76(P), 77(Be), 82(P), 84(P), 86(P) (G.Ç.ROM-023)
27. *Hypogymnia physodes* (L.) NYL. 2(Pi), 6(Fa), 11(P), 12(J), 13(Be), 29(T), 30(Pi,Q), 35(P), 38(Pi,Fa,Al), 40(Pr-a,Ac,Pi-s), 41(Q), 54(Q-r), 55(Pi-s), 57(Al-i), 59(Al), 63(Fa), 66(W), 72(Q), 77(Be), 78(Be), 79(Be), 82(P), 83(L), 84(P), 85(Fa), 86(P), 88(P), 89(P), 92(Pi), 93(Q), 94(P), 98(Fa) (G.Ç.ROM-024)
28. +*Hypogymnia tubulosa* (SCHAER.) HAV. 29(T), 30(Pi), 41(Q), 63(Fa), 70(Q), 75(P), 79(Be), 83(L), 88(P) (G.Ç.ROM-025)
29. +*Lecanora argentata* (ACH.) MALME 27(Q), 31(Fa), 33(Fa), 54(Be), 55(Pi-s), 57(Ca, Al, Fr), 70(Q), 85(Fa), (G.Ç.ROM-026)
30. +*Lecanora campestris* subsp. *campestris* (SCHAER) HUE 83(L) (G.Ç.ROM-027)
31. +*Lecanora chlarotera* NYL. 12(J), 23(Ab), 33(Fa), 35(Ab), 53(Fa-s), 57(Ca), 65(Fa), 77(Be), 82(P), 85(Fa), 87(Fa), 96(Fa) (G.Ç.ROM-028)
32. \**Lecanora conizaeoides* f. *conizaeoides* NYL. ex CROMBIE 74(Fa), 82(P) (G.Ç.ROM-029)
33. *Lecidella elaeochroma* f. *elaeochroma* (ACH.) M. CHOISY 5(Ro-p), 7(Fa), 30(Pi), 31(Fa), 57(Al,Fr), 65(Fa) (G.Ç.ROM-030)
34. +*Leptogium cyanescens* (PERS.) KÖRB. 33(Fa), 74(Fa,S), 79(Be) (G.Ç.ROM-031)
35. +*Lobaria pulmonaria* (L.) HOFFM. 10(Q), 60(S), 74(Fa), 87(Fa) (G.Ç.ROM-032)
36. +*Melanelia subaurifera* NYL. ESSL. 11(Fa), 41(Q) (G.Ç.ROM-033)
37. +*Melanelixia fuliginosa* subsp. *glabratula* (LAMY) 3(Po), 6(Fa), 7(Fa), 9(Q), 12(J), 27(Q), 29(T), 30(Q), 31(Fa), 33(Fa), 38(Pi), 40(Q,Ac), 42(Fr), 53(Ca-b), 54(Q-r), 55(Pi-s), 57(Al-I,Fr), 65(Fa), 66(W), 69(Q,Fa), 70(Q), 72(Q), 74(Fa), 79(Be), 87(Fa), 92(Pi), 98(Ce), (G.Ç.ROM-034)
38. +*Nephroma parile* (ACH.) ACH. 71(S), 74(S,Fa) (G.Ç.ROM-035)
39. +*Opegrapha herbarum* MONT 9(Q), 24(Be), 54(Q-r) (G.Ç. ROM-036)
40. \**Opegrapha prosodea* ACH. 27(Q), 29(T), 31(Fa), 33(Fa), 53(Fa,Fa-s), 57(Al), (G.Ç. ROM-037)
41. +*Parmelia saxatilis* (L.) ACH. 11(Fa), 12(S), 12(S,S-R), 13(Be), 29(T), 33(Fa), 55(Pi-s), 65(Fa), 66(W), 78(Be), 93(Q), 94(P), 95(P), 96(Fa), 98(Fa,Ce) (G.Ç. ROM-038)
42. \**Parmelia submontana* NÁDV. ex HALE 13(Be) (G.Ç. ROM-039)
43. *Parmelia sulcata* TAYLOR 29(T), 31(Fa), 39(Ac), 40(Pi-s,Ac), 41(Q,Fr), 42(Fr), 57(Al), 59(Pi), 63(Fa), 65(Fa), 66(W), 69(Q,Fa), 70(Q), 73(Q), 79(Be), 87(Fa), 98(Ce,Fa) (G.Ç. ROM-040)
44. *Parmelina carporrhizans* TAYLOR 15(Fa), 42(Fr), 79(Be) (G.Ç.ROM-041)
45. \**Parmelina pastillifera* (HARM.) HALE 31(Fa) (G.Ç.ROM-042)
46. *Parmelina tiliacea* (HOFFM.) ACH. 3(Q), 5(Q), 6(Fa), 41(Fr), 81(Q), 85(Fa), 98(Fa) (G.Ç.ROM-043)
47. +*Parmeliopsis ambigua* (WULFEN) NYL. 78(Be), 82(P), 83(L), 84(P), 88(P), 94(P), 95(P), 96(Fa) (G.Ç.ROM-044)
48. +*Parmotrema perlatum* (HUDS.) M.CHOISY 12(S), 30(Q,Pi), 57(Fr,Al-i), 87(Fa) (G.Ç.ROM-045)
49. +*Peltigera horizontalis* (HUDS.) BAUMG. 3(Q), 11(S-M), 60(S), 70(S), 74(S,Fa), 80(S) (G.Ç.ROM-046)
50. +*Peltigera praetextata* (FLÖRKE ex SOMMERF.) VAIN. 38(S), 60(S), 70(S,Q), 79(Be) (G.Ç.ROM-047)
51. +*Pertusaria lactea* (L.) ARNOLD 31(Fa), 53(Ca), 57(Fr), 74(Fa) (G.Ç.ROM-048)
52. +*Pertusaria pustulata* (ACH.) DUBY 54(Q-r), 57(Fr,Ca) (G.Ç.ROM-049)
53. +*Phaeophyscia orbicularis* (NECK.) MOBERG 29(Ca), 33(Fa), 53(Ca-b), 81(Q), 85(Fa) (G.Ç.ROM-050)
54. \**Phaeophyscia rubropulchra* (DEGEL.) MOBERG 27(Q), 53(Fa-s,Fa), 63(Fa), 98(Fa), (G.Ç. ROM-051)
55. +*Physcia adscendens* (TH.FR.) H. OLIVIER 98(Fa) (G.Ç. ROM-052)
56. +*Physcia aipolia* (EHRH. ex HUMB.) FÜRNR. 42(Fr) (G.Ç.ROM-053)
57. +*Physcia leptalea* (ACH.) DC. 33(Fa), 42(Fr), 53(Fa) (G.Ç. ROM-054)



58. +*Physcia stellaris* (L.) NYL. 98(Fa) (G.Ç. ROM-055)
59. +*Physconia distorta* (WITH.) J. R. LAUNDON 41(Fr), 54(Ca), 57(Al,Fr), 63(Fa), 81(Q), 98(Fa) (G.Ç. ROM-056)
60. +*Platismatia glauca* (L.) W.L. CULB. & C.F. CULB. 4(Al), 6(Q), 11(P), 12(J), 13(Be), 20(P,Be), 23(Ab), 72(Q), 76(P), 77(Be), 78(Be), 79(Be), 82(P), 83(L), 84(P), 86(P), 88(P), 89(P), 91(Pi-s), 92(Pi), 94(P), 95(P), 96(Fa) (G.Ç.ROM-057)
61. *Pseudevernia furfuracea* var. *ceratea* (ACH.) D.HAWKSW. 40(Pr-a), 75(P), 80(Be), 81(Q), 89(P), 94(P), 95(P) (G.Ç.ROM-058)
62. *Pseudevernia furfuracea* var. *furfuracea* (L.) ZOPF 2(Pi), 3(Q), 6(Fa,Q), 11(P), 12(J,S-R), 13(Be), 19(Q), 20(Be,P), 23(Ab), 25(P), 35(P), 59(Pi), 65(Fa), 66(W), 73(Q), 75(P), 76(P), 77(Be), 79(Be), 82(P), 83(L), 84(P), 85(Fa), 86(P), 88(P), 91(Pi-s), 92(Pi), 93(Q), 94(P), 96(Fa) (G.Ç.ROM-059)
63. +*Punctelia subrudecta* NYL. KROG 30(Q,Pi), 31(Fa), 33(Fa), 57(Fr), 69(Fa,Q) (G.Ç.ROM-060)
64. \**Ramalina canariensis* J. STEINER 31(Fa), 33(Fa), 53(Ca-b), 54(Q-r), 63(Fa), 69(Fa), 70(Q), 77(Be) (G.Ç.ROM-061)
65. +*Ramalina farinacea* (L.) ACH. 40(Ac), 41(Fr,Q), 57(Al-i), 85(Fa) (G.Ç.ROM-062)
66. *Ramalina fraxinea* (L.) ACH. 41(Fr), 42(Fr), 57(Ac), 70(Q), 81(Q), 87(Fa), 98(Fa) (G.Ç.ROM-063)
67. +*Ramalina pollinaria* (WESTR.) ACH. 30(Q), 53(Ca-b,Q-d), 54(Q-r), 65(Fa), 69(Q), 85(Fa) (G.Ç.ROM-064)
68. \**Rimularia furvella* NYL. ex MUDD 82(S) (G.Ç. ROM-074)
69. +*Solorina saccata* (L.) ACH. 60(S) (G.Ç.ROM-075)
70. *Tuckermanopsis chlorophylla* (WILLD.) HALE 86(P), 92(Pi), 95(P) (G.Ç.ROM-065)
71. +*Usnea subfloridana* STIRT. 13(Be), 59(Pi), 82(P), 85(Fa), 94(P), 96(Fa) (G.Ç.ROM-066)
72. \**Usnea subscabrosa* NYL. ex MOTYKA 11(P), 73(Q), 78(Be), 83(L), 89(P), 94(P) (G.Ç.ROM-067)
73. +*Vulpicida pinastri* (SCOP.) J. E. MATSSON 11(P), 78(Be), 82(P), 83(L), 86(P), 95(P) (G.Ç.ROM-068)
74. *Xanthoparmelia conspersa* (EHRH. ex ACH.) HALE 12(S,S-R), 22(S), 91(Pi-s), 92(Pi) (G.Ç. ROM-076)
75. +*Xanthoparmelia somloensis* GYELN. HALE 13(Pi-s), 82(P) (G.Ç.ROM-069)
76. +*Xanthoria parietina* (L.) TH. FR. 41(Fr), 42(Fr), 54(Q-r), 57(Al), 63(Fa), 69(Fa,Q), 74(Fa), 98(Fa) (G.Ç.ROM-070)

*Abies* sp. = Ab, *Acer* sp. = Ac, *Alnus* sp. = Al, *Alnus incana* = Al-i, Bark = B, *Betula* sp. = Be, *Carpinus* sp. = Ca, *Carpinus betulus* = Ca-b, *Cerasus* sp. = Ce, *Fagus* sp. = Fa, *Fagus sylvatica* = Fa-s, *Fraxinus* sp. = Fr, *Juniperus* sp. = J, *Larix* sp. = L, *Picea* sp. = P, *Pinus* sp. = Pi, *Pinus sylvestris* = Pi-s, *Populus* sp. = Po, *Prunus avium* = Pr-a, *Robinia pseudacacia* = Ro-p, *Quercus* sp. = Q, *Quercus robur* = Q-r, *Quercus dalechampii* = Q-d, Soil = S, Soil & Moss = S-M, Soil & Rock = S-R, *Tilia* sp. = T, Wood = W

New record for Romania = \*, New record for Cozia = +

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## MAPLES DISTRIBUTION IN ROMANIA

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**Abstract.** Maples of the genus *Acer* are distributed in the Northern Hemisphere, in North America, Europe and Asia. The species cross the equator in the Southern Hemisphere, only in Java and the surrounding islands. Although the area covered by maples is large, the species represent a small percentage of the total tree species. Research has shown the presence of maples in the Miocene. There was preserved fossil leaves, fruits and sometimes wood, pollen and even flowers. In our country there is information about *Acer* fossils from upper Oligocene. It became very frequent, with leaves and flowers in the Neogene deposits. In Romania there are five native species of the genus *Acer*, *Acer pseudoplatanus* (Sycamore maple), *A. platanoides* (Norway maple), *A. campestre* (Hedge maple), *A. tataricum* (Tatarian maple) and *A. monspessulanum* (Montpellier maple). Sycamore maple and Norway maple are main species that are found in upper story of the stands. Species appear in nearly all altitudinal plant belts from sub alpine forest field to the plain land. Two are the altitudinal plant belt more common for these maples, Mountain mixed stand belt for Sycamore maple and the hilly altitudinal plant belt with sessile oak, European beech stand and European beech-sessile oak stand for Norway maple. In relation to the maples regeneration, the study shows that in most stands with Sycamore and Norway maple in their composition, regeneration by seeds is common. The natural and artificial regeneration is being undertaken in close, but yet different proportions depending on the stands age.

**Keywords:** Sycamore maple, Norway maple, distribution, regeneration.

**Rezumat. Răspândirea paltinilor în România.** Speciile genului *Acer* sunt răspândite în emisfera nordică, în America de Nord, Europa și Asia. În emisfera sudică, speciile se întâlnesc doar în Java și insulele înconjurătoare. Deși se întâlnesc pe o suprafață destul de mare, acerinele ocupă un procent mic din totalul speciilor. Cercetările au arătat că specii ale genului *Acer* au existat încă din Miocen. Genul *Acer* este cunoscut în stare fosilă sub formă de frunze, fructe iar uneori s-a conservat și lemn, polen sau chiar flori. În țara noastră genul *Acer* este descris din oligocenul superior devenind foarte frecvent, prin frunze și flori în depozitele neogene. În România sunt cinci specii indigene din genul *Acer*, *Acer pseudoplatanus* (paltinul de munte), *A. platanoides* (paltinul de câmp), *A. campestre* (jugastrul), *A. monspessulanum* (jugastrul de Banat) și *A. tataricum* (arșarul tătareșc). Paltinul de munte și paltinul de câmp sunt specii principale de amestec care se regăsesc în etajul superior al arboretelor. Speciile apar în aproape toate etajele fitoclimatice din silvostepa până în etajul subalpin așa cum era de așteptat în etajul premontan de amestec în cazul paltinului de munte respectiv în etajul deluros de gorunete, fâgete și goruneto-fâgete în cazul paltinului de câmp. În ceea ce privește modul de regenerare al acerineelor studiul arată că în majoritatea arboretelor care au paltini în compoziție regenerarea acestora s-a produs pe cale generativă, în cadrul acesteia regenerarea naturală și artificială fiind realizată în proporții apropiate dar diferențiată în funcție de vârsta arboretelor.

**Cuvinte cheie:** paltin de munte, paltin de câmp, răspândire, mod de regenerare.

## INTRODUCTION

Species of the genus *Acer* are distributed in the northern hemisphere, North America, Europe and Asia, crossing the equator in the southern hemisphere, only in Java and the surrounding islands. The area occupied by maples is large but the percentage of the total woody species is small. Research has shown the presence of maples in the Miocene. Information assemble of maples date of apparition are not known (GELDEREN et al., 1994). Maples are known in the fossil state in particular in the form of leaves and fruits. There also was preserved wood, pollen and even flowers. In Romania there is information about *Acer* fossils from upper Oligocene (the Jiu Valley, the Almas Valley). It became very common with leaves and fruits in Neogene deposits (Salaj, Valcea, north-west of Oltenia, Sibiu, Maramures) (PETRESCU & DRAGASTAN, 1981). In Romania, there are five native species of the genus *Acer* (NETOIU et al., 2008), but there are also other species of *Acer* genus, non-native species like *Acer saccharinum* and *A. negundo* (Annex). Sycamore maple and Norway maple are main species found in the upper story of the stands. Hedge maple, Montpellier maple and Tatarian maple are species with an important role in the growth and pruning of the stands main species and in soil amelioration. These species are distributed in all altitudinal belts (DONITĂ et al., 1980).

## MATERIAL AND METHODS

In order to study the spreading of native maples in Romania the database of national forest fund has been used. We are talking about effective areas determined by multiplying the compartment area, the percentage of species participation in stand composition and crown density of the stand. The class production and the way of regeneration were also studied.

To put in evidence the maples regeneration on the forests from the Timiș county over the years, the way of regeneration in relation to age was studied.

## RESULTS AND DISCUCTIONS

Like we said before, there are five native species of *Acer* species in Romania, Sycamore maple, Norway maple, Hedge maple, Montpellier maple and Tatarian maple. Sycamore maple and Norway maple are main species that are found in the upper story of the stands. Sycamore and Norway maple distribution in our country are shown in Fig. 1.

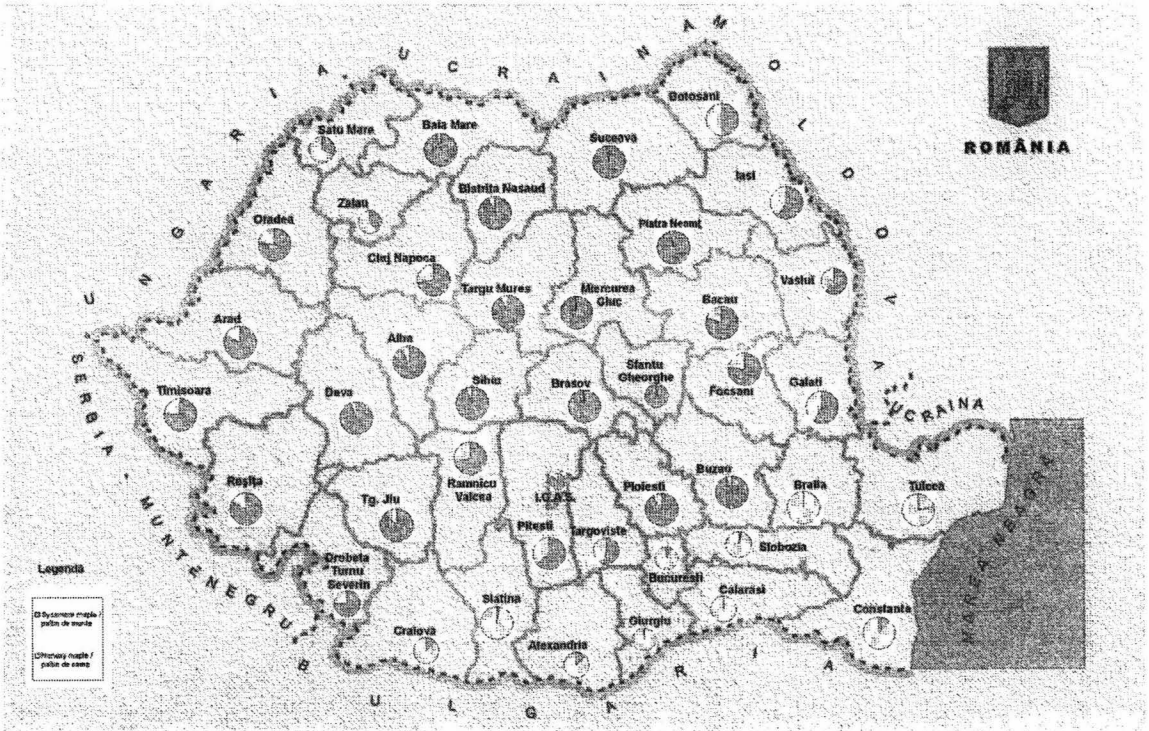


Figure 1. Sycamore and Norway maple distribution on Forest Administrations  
 Figura 1. Distribuția paltinilor pe direcții silvice.

The spreading on the altitudinal plant belt was study for these species and also the regeneration of maples (Fig. 2).

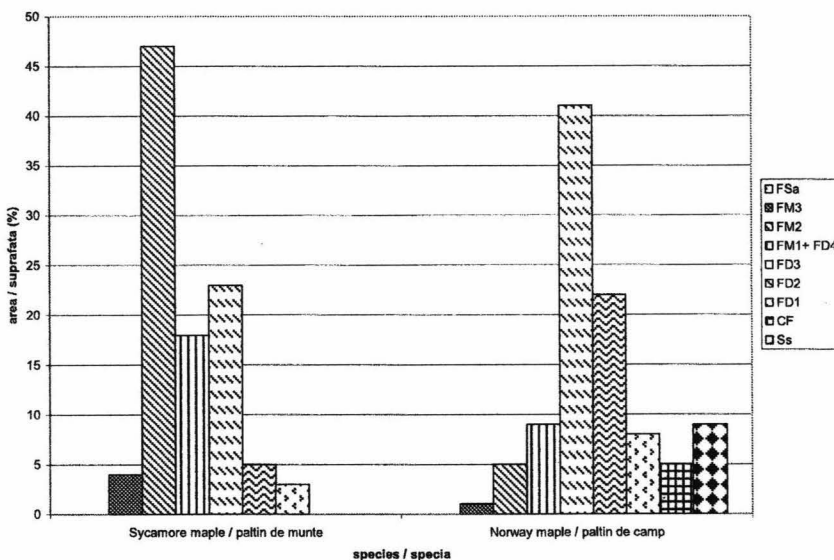


Figure 2. Distribution of maples in terms of altitudinal plant belts.  
 Figura 2. Distribuția paltinilor pe etaje fitoclimatice.

We find Sycamore maple from the subalpine belt to the plain forests. The species is spread mainly in the Mountain mixed stand, where it represented 47% of total area occupied by this species. Sycamore maple occupied also a considerable area in the premountain European beech stands (18%) and hilly stand with sessile oak stand, European beech stand, European beech-sessile oak mixed stand (23%).

Norway maple is spread especially in the Hilly stand with sessile oak stand, European beech stand, European beech-sessile oak mixed stand (41%) followed by altitudinal belt-hilly stand with *Quercus* sp. (sessile oak, Turkey oak, Hungarian oak and mixed stands) and hilly mixed hardwood forest (22%). There is no a large area occupied by this species in the hilly stand with common oak (and Turkey oak, Hungarian oak, sessile oak and mixed stand of them) and plain forest. An explanation could be the small area occupied by the forest in this altitudinal belt.

A study was made about maples regeneration. The generative way is most common for Sycamore and Norway maples. The proportion of natural and artificial regeneration is similar (Table 1).

Table 1. Distribution of maples in terms of regeneration ways.  
Tabel 1. Distribuția paltinilor în funcție de modul de regenerare.

No.	Way of regeneration	Sycamore maple		Norway maple	
		area			
		Ha	%	ha	%
1	Natural insemination	13,199.8	47	1,286.3	23
2	Artificial insemination	38.3	0	13.6	0
3	Seedlings	14,439.4	52	3,877.6	71
4	Stool-shoot	316.3	1	303.0	6
5	Root-shoot	0,7	0	1.5	0
Total		27,994.5	100	5,482.0	100
Natural regeneration					
Artificial regeneration		14,477.7	52	3,891.2	71
Total		27,994.5	100	5,482.0	100
Generative regeneration		27,677.5	99	5,177.5	94
Vegetative regeneration		317.0	1	304.5	6
Total		27,994.5	100	5,482.0	100

The maples regeneration over the years is interesting and the fact is highlighted by the analysis of the regeneration and the age classes (Figs. 3 and 4).

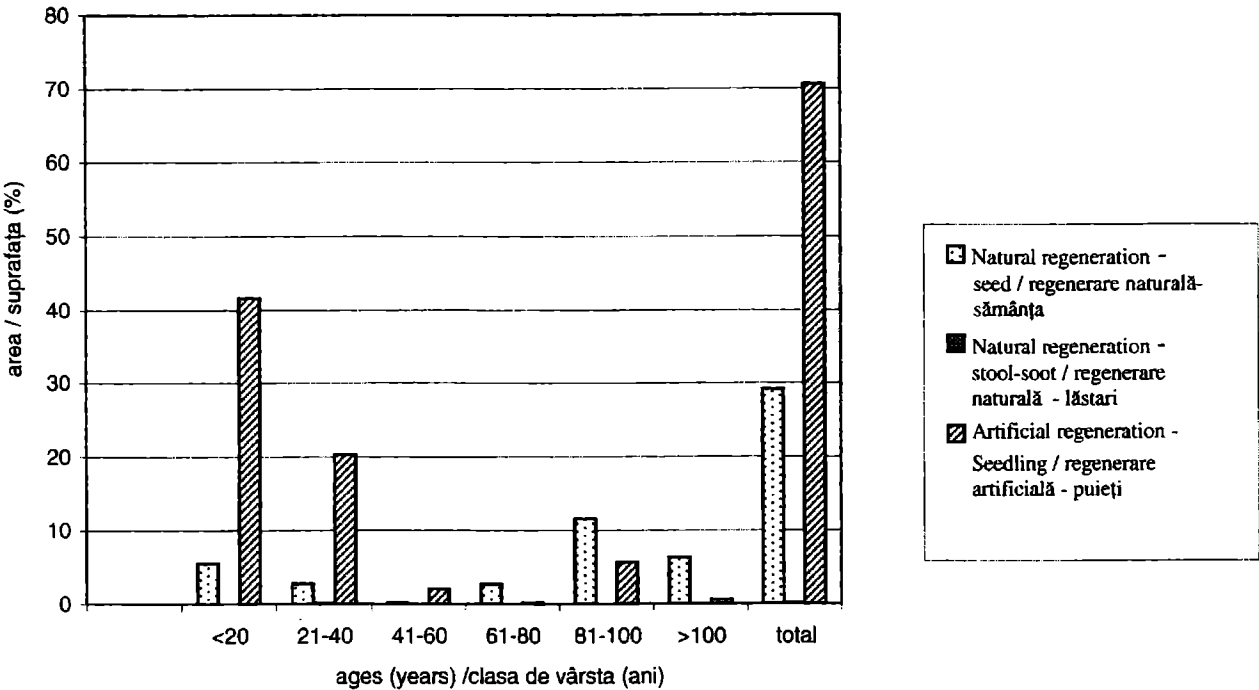


Figure 3. Percent distribution of the areas covered by Sycamore maple on age classes in terms of regeneration way.  
Figura 3. Distribuția procentuală a suprafeței ocupate de paltinul de munte pe clase de vârstă.

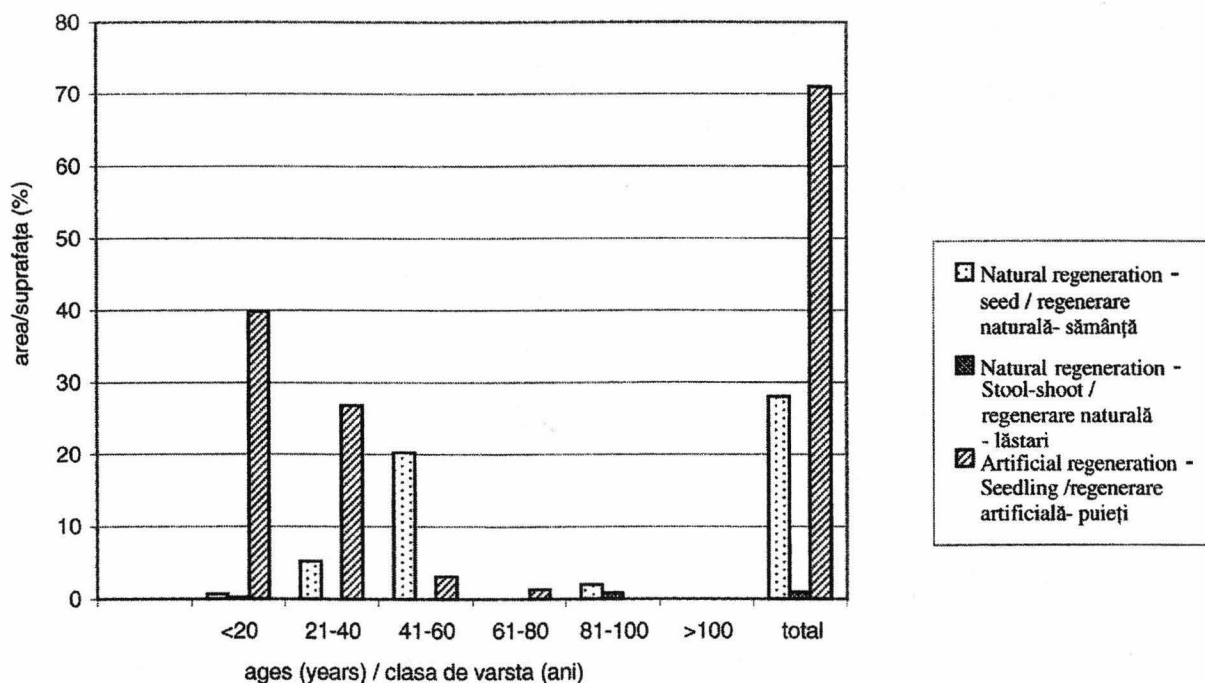


Figure 4. Percent distribution of the areas covered by Norway maple on age classes in terms of regeneration way.

Figura 4. Distribuția procentuală a suprafeței ocupate de paltinul de câmp pe clase de vârstă.

In order to study the maples distribution on site class, three groups was establish:

- superior - I and II site classes;
- middle - III site class;
- inferior - IV and V site classes.

Research shows that both Sycamore and Norway maples are found in the first two groups, that means superior and inferior site classes (Fig. 5).

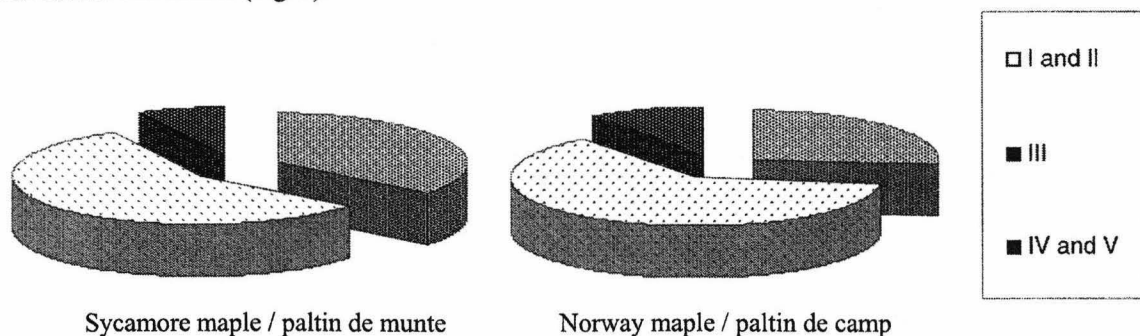


Figure 5. Distribution of maples from the national forest resources in terms of site classes.

Figura 5. Distribuția paltinilor din fondul forestier național pe clase de producție.

## CONCLUSIONS

Sycamore and Norway maple are mixture species that may appear disseminated or in small clumps without forming pure stands.

In our country the total area occupied by these species is 35,476.5 ha, 29,994.5 ha with Sycamore maple and 5,482.0 with Norway maple.

Both, Sycamore and Norway maple are species with large ecological amplitude. These species are found up in the mountain regions where they may reach the constraints of woody vegetation and down to the plains and forest steppe.

These species are important for their silvicultural value and also for the economic value of timber.

The study shows that in most stands with maples in their composition, regeneration occurred in the generation way, both natural and artificial regeneration undertaken in close proportion.



The way of regeneration in relation to age showed a higher percentage of natural regeneration in higher age classes compared to smaller age classes, classes in which the large share is the artificial regeneration of seedlings.

With regard to the maples distribution on site class, the study showed that the classes of production for maples are higher or medium in most stands.

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a. *Acer campestre*-bark, leaves / ritidom, frunze



b. *Acer monspessulanum*-bark, leaves, fruits / ritidom, frunze, fructe



c. *Acer platanoides*-bark, leaves, fruits / ritidom, frunze, fructe



d. *Acer pseudoplatanus* bark, leaves / ritidom, frunze



e. *Acer saccharinum*-bark, leaves, / ritidom, frunze



f. *Acer negundo*-bark, leaves / ritidom, frunze

Maples species in Romania.  
Specii din genul *Acer* în Romania.



## THE ANALYSIS OF THE FLORA FROM THE LOWER BASIN OF THE MOTRU RIVER

IULIAN COSTACHE

**Abstract.** *The work presents the analysis of the flora from the Lower Basin of the Motru River, being emphasized the character and the particularities of the flora that cooperates at the phytogeographic framing of the studied zone and implicitly at the making of the vegetal groups specific to the zone.*

**Keywords:** *analysis, Basin, flora, the Motru, Romania.*

**Rezumat.** *Analiza florei din Bazinul inferior al Motrului. Lucrarea prezintă analiza florei din Bazinul Inferior al râului Motru, evidențiindu-se caracterul și particularitățile florei care concurează la încadrarea fitogeografică a zonei studiate și implicit la constituirea grupărilor vegetale specifice zonei.*

**Cuvinte cheie:** *analiză, Bazin, flora, Motru, România.*

## INTRODUCTION

From the geographical point of view, the Lower Basin of the Motru River lies in the western part of the Getic Piedmont, with the coordinates: 44° 55' North latitude and 23° 45' East longitudes. The studied area is 691 Km<sup>2</sup>. From the administrative-territorial point of view, the territory under research is located at the borderline between the counties of Gorj and Mehedinti-the borderline starts in the eastern part of the Negoiesti Hills (Comanesti-Mehedinti, altitude 388 m) and reaches the Jiu Valley near Gura Motrului (altitude 110 m). Being situated in the south-western part of the country and of the Getic Piedmont, the studied area has a Central-European climate with sub-Mediterranean influences. The valleys are not so deep, and the summits more matured; nevertheless, the slope processes are active, with a maximum intensity on deforested slopes. The slope processes developed due to the rock nature, favourable to denudation, quick withdrawal of the gradients to the axis of the interfluvies. This fact contributed to wider valleys and extended river meadows. Between the eastern limit of the Mehedinti Plateau, the western passage of the Jiu River and especially to the long valley of the Husnita River (in South), stands out the Motru Piedmont (with a surface of about 1,837 km<sup>2</sup>), within its territory being separated, west of the Motru, the lower region of the Cosustei Hills (MIHAILESCU, 1966).

In the territory under research, there have been made floristic and phytosociological studies between 1997 and 2005, within the PhD. thesis (COSTACHE, 2005).

## MATERIAL AND METHODS

The description of the taxa was performed by using specialty literature: The Illustrated Flora of Romania (BELDIE, 1977, 1979; CIOCĂRLAN, 2000; ROTHMALER, 2002 etc.) and others. The graphic representation of the specters has been made using Microsoft Office Excel 2003.

Abbreviations and conventional signs used in our paper:

Bioforms (biological forms, life forms): T.-terrophytes (annual plants which go over unfavourable conditions during winter or summer under the form of seeds); H.-hemicriptophytes (perennial plants whose regeneration organs are located at the soil level and are protected, during winter, by vegetal remains or snow).

Ecologic characterization: significance of the indexes U T R used in the paper in order to simplify the carrying out of the spectra when studying vegetation (according to POPESCU & SANDA, 1998, with some modifications COSTACHE, 2005).

Soil humidity level (U<sub>1-6</sub>): U<sub>1</sub>-xerophyte (they grow in dry soils and they can stand the prolonged dryness of the soil); U<sub>2</sub>-xeromesophyte; U<sub>3</sub>-mesophytes (in soils with average humidity, they cannot stand prolonged dryness); U<sub>4</sub>-mesohygrophyte; U<sub>5</sub>-hygrophyte (they grow in wet soils, and their roots are under water or in swampy areas); U<sub>6</sub>-hydrophyte (according to the author-ultrahydrophyte), (plants which grow in water, the regeneration organs are found under water); U<sub>3(5)</sub>-alternately hygrophyte (with oscillations of the humidity level during the plants' vegetation period); U<sub>1-5</sub>, ( includes U<sub>1-3</sub>, U<sub>2-5</sub> etc.) - euri. = euriphyte (with large amplitude against the soil humidity).

Heat level (T): T<sub>1</sub>-hechistothermic; T<sub>2</sub>-microthermic; T<sub>3</sub>-mesothermic; T<sub>4</sub>-subthermophytes (moderately thermophytes); T<sub>5</sub>-thermophytes; T<sub>1-5</sub> (include T<sub>1-4</sub>, T<sub>2-4</sub>, T<sub>2-5</sub>, T<sub>3-5</sub>)-euriterm. = euriterms.

Acidity level (R): R<sub>1</sub>-high acidophilus species; R<sub>2</sub>-acidophilus; R<sub>3</sub>-acido-neutrophile; R<sub>4</sub>-low acid-neutrophile; R<sub>5</sub>-neutral-basophile; R<sub>1-5</sub>-(includes R<sub>1-4</sub>, R<sub>1-3</sub>, R<sub>2-5</sub> etc.) - euriionic.

Geoelement (phytogeographical elements, origin of the species): Adv.-adventive (species which appeared because of man's inconstant activity); Am.-America; As.-Asia; Atl.-Atlantic; Balc.-Balkan; Circ.-Circumpolar (spread in the northern part of Eurasia and North America); Cosm.-Cosmopolite (large spreading all over the world); Euras.-Eurasian; Euras. cont.-Eurasian continental; Eur.-European; Eur. centr.-Central European; Eur. cont.-European

continental; Medit.-Mediterranean; Pont.-Pontic (North of the Black Sea); Pan.-Pannonic (In the Pannonic Plain); Submedit.-SubMediterranean; Subatl.-SubAtlantic. Others: No. crt.-Number characteristic.

## RESULTS AND DISCUSSIONS

The conspectus of the flora in the Lower Basin of the Motru River includes about 1,231 taxa (COSTACHE, 2005). The presentation order of the analysis is the one followed in the characterization of the vegetal associations, like below.

### The taxonomic analysis

The floristic list contains 1,231 taxa (1,018 species, 89 subspecies, 68 varieties, 21 forms, 11 hybrids and 24 cultivated species), distributed as it follows: Chlorophyta with 2 taxa-(1 species with 1 variety); Lichenophyta with 7 taxa (7 species) assigned at 3 families; Bryophyta with 65 taxa (60 species, 4 varieties and 1 form) assigned at 22 families; Pteridophyta with 22 taxa (20 species and 2 varieties) assigned at 9 families; Spermatophyta with 1,135 taxa, from which: Pinophytina with 4 taxa (3 species and 1 variety) assigned at 2 families; Magnoliophytina with 1,131 taxa (927 species, 89 subspecies, 60 varieties, 20 forms, 11 hybrids and 24 cultivated species-from which 16 have become sub-spontaneous), assigned at 93 families. From the Spermatophytes, the Asteraceae detain the biggest percent, followed by the Poaceae (Table 1).

Table 1. The families' balance sheet according to the number of the belonging taxa.

Tabel 1. Bilanșul familiilor în funcție de numărul de taxoni aparținători.

No.	Family	No. taxa	No.	Family	No. taxa
1.	ASTERACEAE	126	49.	GENTIANACEAE	3
2.	POACEAE	105	50.	CONVOLVULACEAE	3
3.	FABACEAE	73	51.	ALISMATACEAE	3
4.	LAMIACEAE	54	52.	URTICACEAE	3
5.	ROSACEAE	51	53.	CORYLACEAE	3
6.	BRASSICACEAE	46	54.	IRIDACEAE	3
7.	SCROPHULARIACEAE	42	55.	ARACEAE	2
8.	CARYOPHYLLACEAE	39	56.	AMARYLLIDACEAE	2
9.	CYPERACEAE	39	57.	CORNACEAE	2
10.	APIACEAE	34	58.	VALERIANACEAE	2
11.	RANUNCULACEAE	27	59.	RHAMNACEAE	2
12.	LILIACEAE	22	60.	POLYGALACEAE	2
13.	POLYGONACEAE	22	61.	CUCURBITACEAE	2
14.	BORAGINACEAE	21	62.	ARISTOLOCHIACEAE	2
15.	ORCHIDACEAE	19	63.	CANNABACEAE	2
16.	CHENOPODIACEAE	18	64.	JUGLANDACEAE	1
17.	RUBIACEAE	17	65.	BETULACEAE	1
18.	EUPHORBIACEAE	15	66.	PHYTOLACCACEAE	1
19.	VIOLACEAE	15	67.	PORTULACACEAE	1
20.	SALICACEAE	11	68.	SAXIFRAGACEAE	1
21.	JUNCACEAE	10	69.	CAESALPINIACEAE	1
22.	FAGACEAE	10	70.	HALORAGACEAE	1
23.	MALVACEAE	9	71.	HIPPURIDACEAE	1
24.	CAMPANULACEAE	9	72.	LORANTHACEAE	1
25.	ONAGRACEAE	8	73.	CELASTRACEAE	1
26.	GERANIACEAE	7	74.	VERBENACEAE	1
27.	PLANTAGINACEAE	7	75.	CALLITRICHACEAE	1
28.	DIPSACACEAE	7	76.	ACANTHACEAE	1
29.	ALLIACEAE	6	77.	LENTIBULARIACEAE	1
30.	PRIMULACEAE	6	78.	OROBANCHACEAE	1
31.	OLEACEAE	6	79.	ADOXACEAE	1
32.	SOLANACEAE	6	80.	BUTOMACEAE	1
33.	POTAMOGETONACEAE	5	81.	DIOSCOREACEAE	1
34.	AMARANTHACEAE	5	82.	HYDROCHARITACEAE	1
35.	TYPHACEAE	4	83.	VITACEAE	1
36.	LEMNACEAE	4	84.	STAPHYLEACEAE	1
37.	CRASSULACEAE	4	85.	ZYGOPHYLLACEAE	1
38.	LYTHRACEAE	4	86.	BALSAMINACEAE	1
39.	CUSCUTACEAE	4	87.	LINACEAE	1
40.	CAPRIFOLIACEAE	4	88.	ARALIACEAE	1
41.	ACERACEAE	4	89.	CISTACEAE	1
42.	FUMARIACEAE	4	90.	RESEDACEAE	1
43.	ULMACEAE	3	91.	APOCYNACEAE	1
44.	PAPAVERACEAE	3	92.	ASCLEPIADACEAE	1
45.	PINACEAE	3	93.	MORACEAE	1
46.	OXALIDACEAE	3	94.	CERATOPHYLLACEAE	1
47.	HYPERICACEAE	3	95.	CUPRESSACEAE	1
48.	TILIACEAE	3			

Further, the analysis will be effectuated only on spontaneous and sub-spontaneous taxa from Phylum Spermatophyta.

**The Life expectancy analysis**

Just like it was expected, from the graphic shown below it results the domination of the perennials (Table 2, Fig. 1) followed by annual species, being in correlation with the explications from the bioforms.

Table 2. The Life expectancy analysis.  
Tabel 2. Analiza duratei de viață.

No	Life expectancy	No. taxa	No	Life expectancy	No. taxa
1.	Perennial	653		Annual by winter	3
	Perennial (Biennial)	1		Annual by winter-Biennial	2
	Total	654		Total	293
2.	Annual	223	3.	Biennial	39
	Annual-biennial	35		Biennial-perennial	20
	Annual-by winter	20		Biennial (annual-perennial)	1
	Annual-perennial	10		Total	60

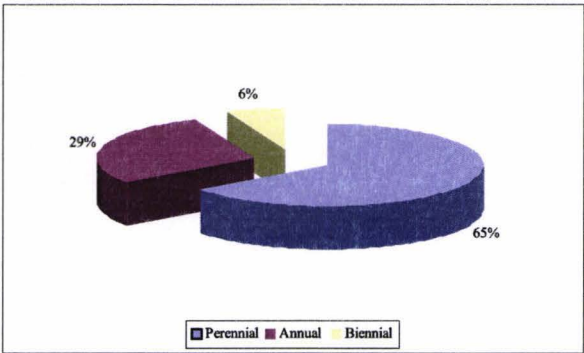


Figure 1. The Life expectancy spectrum.  
Figura 1. Spectrul duratei de viață.

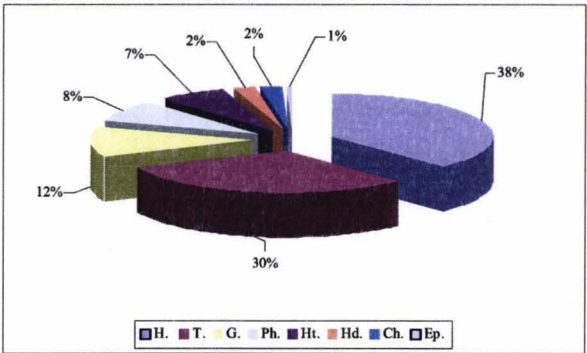


Figure 2. The bioforms spectrum.  
Figura 2. Spectrul bioformelor.

**The bioforms analysis**

The domination of the hemicriptophytes shows a moderate climate, with the abundance of the herbaceous formations edified by the perennial Poaceae. The fact that these are followed by the terrophytes shows the degree of aridization of the zone and the effects of the anthropization on the vegetation and flora, and the geophytes reveal the short periods of vegetation because of the alternation between the drought and rainy seasons, registered in the last years. The increasing of the importance of these compared to the percent of 8% that the phanerophytes register, clearly indicates the installation of the secondary vegetal groups, consequence of the clearing of the forests (Table 3, Fig. 2).

Table 3. The bioforms analysis.  
Tabel 3. Analiza bioformelor.

No.	Bioform	No. taxa	No.	Bioform	No. taxa	No.	Bioform	No. taxa
1.	H.	365		T-Ht., H	1	5.	Ht.	42
	H.(HH.)	10		Total	314		Ht.-H.	23
	H.(Ch.)	8		G.	101		Ht.-Ch.	1
	H.(G.)	8		G. (HH.)	16		Ht.(T.-H.)	1
	Total	392		G. (H.)	4		Total	67
2.	T.	216	4.	Ph.	54	6.	Hd.	15
	T.-Ht.	52		MPh. (tree)	19		HH.	8
	T.-H.	5		mPh. arbust	6		Higr.-Hidr.	1
	T. (HH.)	4		mMPh. (shrub-tree)	5		Total	24
	T.- Ht.-H.	3		MPh. creeper	3	7.	Ch.	19
	T.-H. (HH.)	2		Total	87		Ch.-H.	2
	T.-Ch.	1	8.	Ep.	7		Total	21

**The analysis of the ecological parameters**

The analysis of the ecological parameters leads us to the emphasizing of the ecological particularities of all the plant species from the studied field, allowing us in this way to establish the reports regarding the complex of local pedological-climatic factors.

The analysis of the soil humidity spectrum (Table 4, Fig. 3) reveals the fact that on the apparent mesophilous nature of the zone emphasizes the domination of the xeromesophilous-mesophilous elements, main characteristic that defines the intermediary position of the studied field, with southern influences emphasized by the presence of the



xerophile-xeromesophilous on the one hand, on the other the influences from the north-west, wetter, emphasized by the mesophilous-mesohygrophilous elements. The rate of 3% of the registered hygrophyle species emphasizes the secondary place that is occupied by the vegetation from the valleys. The aquatic vegetation is weakly represented in this context.

Table 4. The analysis of the soil humidity spectrum.

Tabel 4. Analiza umidității solului.

No.	Soil humidity level	No. taxa	No.	Soil humidity level	No. taxa	No.	Soil humidity level	No. taxa
1.	U <sub>2</sub>	137	3.	U <sub>4</sub>	51	6.	U <sub>6</sub>	30
	U <sub>2-3</sub>	264		U <sub>4-5</sub>	81		Total	30
	U <sub>2-3</sub> (4)	8	4.	U <sub>1</sub>	1	7.	U <sub>2-4</sub>	6
	U <sub>2(3)</sub>	1		U <sub>1-2</sub>	60		U <sub>2-5</sub>	3
2.	Total	410	5.	Total	61		U <sub>1-4</sub>	3
	U <sub>3</sub>	177		U <sub>5</sub>	33		U <sub>1-5</sub>	2
	U <sub>3-4</sub>	129	Total	U <sub>5-6</sub>	8		U <sub>3-5</sub>	2
	U <sub>3-4</sub> (5)	1		Total	41		U <sub>1-3</sub>	1
Total		307	Total		41	Total (U <sub>1-5</sub> )		17

The spectrum of the temperature (Table 5, Fig. 4) emphasizes the domination of the mesotherme, followed closely by the subthermophile, fact that proves the mesothermophilous-subthermophilous character of the studied field, in concordance with the climate and the physic-geographic position of the basin. The eurithermes have a considerable importance. The thermophile influences are weakly represented but are felt in the general context of the climate.

Table 5. The analysis of the temperature.

Tabel 5. Analiza temperaturii.

No.	Temperature	No. taxa	No.	Temperature	No. taxa	No.	Temperature	No. taxa
1.	T <sub>3</sub>	445	3.	T <sub>2-5</sub>	51	4.	Total	102
	T <sub>3-4</sub>	98		T <sub>3-5</sub>	35		T <sub>2</sub>	14
	Total	543		T <sub>2-4</sub>	6		T <sub>2-3</sub>	21
2.	T <sub>4</sub>	275		T <sub>1-4</sub>	4	5.	Total	35
	T <sub>4-5</sub>	32		T <sub>1-5</sub>	4		T <sub>5</sub>	11
	Total	307		T <sub>1-3</sub>	2	Total		11

The reaction of the soil (Table 6, Fig. 5) emphasizes the presence of weak acid-neutrophilous species in large number, fact that proves the stability of some groups of coenoses regarding the characteristics of the eu-mesobasic soils, although it exists a big percent of unstable species (the euriionic). The presence of the acid-neutrophilous and weak alkaline species is explicated by the local particularities of the substratum and relief.

Table 6. The reaction of the soil analysis.

Tabel 6. Analiza reacției solului.

No.	Acidity level	No. taxa	No.	Acidity level	No. taxa	No.	Acidity level	No. taxa
1.	R <sub>4</sub>	416	3.	R <sub>2-5</sub>	107	4.	R <sub>5</sub>	21
	R <sub>4-5</sub>	85		R <sub>3-5</sub>	49		Total	21
	Total	501		R <sub>2-4</sub>	10		R <sub>2</sub>	1
2.	R <sub>3</sub>	145		R <sub>1-5</sub>	9	5.	R <sub>2-3</sub>	10
	R <sub>3-4</sub>	140		R <sub>1-4</sub>	2		R <sub>2-3</sub> (4)	1
	Total	285		R <sub>1-3</sub>	1		R <sub>1-2</sub>	1
			Total (R <sub>1-5</sub> )		178	Total		13

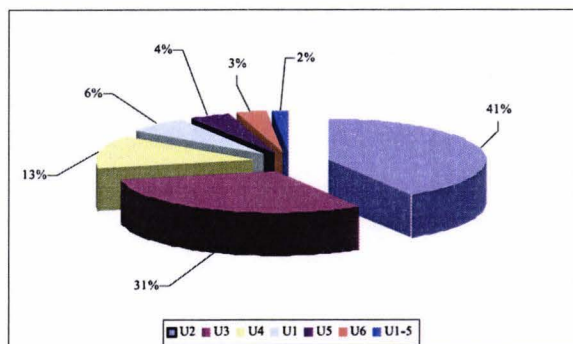


Figure 3. The soil humidity spectrum.

Figura 3. Spectrul umidității solului.

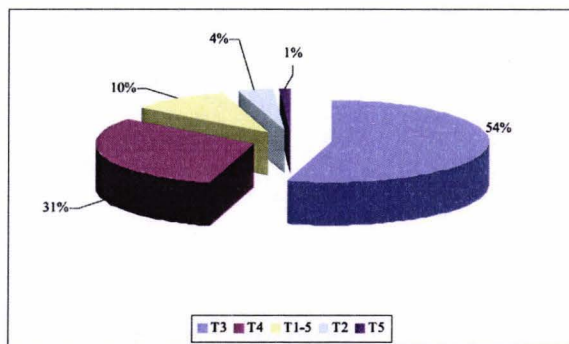


Figure 4. The heat level spectrum.

Figura 4. Spectrul temperaturii.

The analysis of the geoelements

The analysis of the geoelements (Table 7, Fig. 6) emphasizes the big importance of the European species (26%) in the context of the domination of the Eurasian (38%), group characteristic to the general phytogeographic context. Relevant are the central Europeans that, through their participation percent (14%), sustain the location of the studied field in the central European region.

It seems that all the other elements have a balanced participation rating, from these being emphasized the Circumpolars, their existence probably being connected with the different postglacial phases, when they migrated from the alpine; Submediterraneans and Mediterranean's have found here softer conditions, being helped by the valleys of the Motru's tributaries that have a south-western and north-western orientation. The Submediterranean-Mediterranean, Balkan and autochthon elements are weakly represented from the percentage point of view, but as populations are well represented, some of them forming associations. The presence of the Pontic elements, more abundant in the Balacita Plain, is connected with the intensity of the influences from north-east, south-east. The other elements are weaker represented, as it is emphasized in the table below (Table 7). The large number of Meridional elements (Fig. 7), identified on the researched territory, imprint a specific, hard to interpret, character to the phytocoenoses.

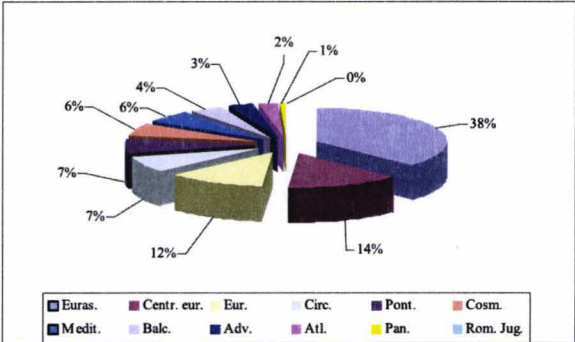


Figure 6. The geoelements spectrum.  
Figura 6. Spectrul geoelementelor.

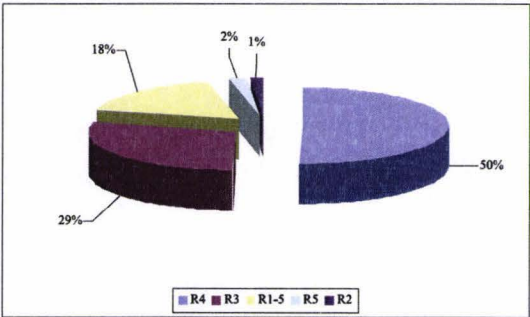


Figure 5. The reaction of the soil spectrum.  
Figura 5. Spectrul reacției solului.

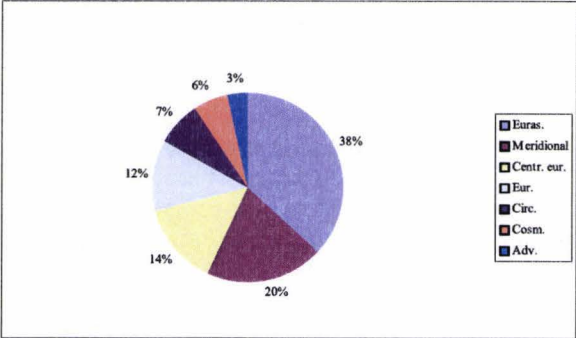


Figure 7. The Meridional elements balance sheet.  
Figura 7. Bilanțul elementelor meridionale.

Table 7. The reaction of the soil analysis.  
Tabel 7. Analiza reacției solului.

No.	Geoelement	No. taxa	No.	Geoelement	No. taxa
1.	Euras.	268	6.	Pont.-pan.-balc.	16
	Euras. cont.	64		Pont.-centr. eur.-medit.	5
	Euras. (submedit.)	18		Pont.-pan.	4
	Euras. de S	3		Pont.-balc.	3
	Euras. medit.	3		Pont.-medit.-pan.	1
	Euras. (mont.)	2		Pont.-pan.-medit.	1
	Euras. submedit.	2		Total	66
	Euras. (Am. de N)	2	7.	Cosm.	61
	Euras. (presently cosm.)	1		Medit.	41
	Euras. (cosm.)	1	8.	Submedit.	14
	Euras. (medit.)	1		Medit. (cosm.)	2
	Euras. centr.	1		Medit. -carp.-balc.	1
	Euras. de N.	1		Medit. -submedit.	1
	Euras. (Tertiary relict)	1		Submedit.-medit.	1
	Euras. (subatl.-submedit.)	1		Total	60
	Total	369		Balc.	17
2.	Centr. eur.	57		Balc.- pan.	8
	Eur. centr.-medit.	23		Carp.-balc.	6
	Eur. centr. și de S	11		Carp. -balc.-cauc.	2
	Eur. centr. și de SE	11		Dacic.	2
	Eur. centr.-submedit.	9		Daco.-balc.	2
	Eur. centr. și de V	7		Daco.-balc.-pan.	1
	Eur. centr. și de SV	6		Balc.-danub.-pont.	1
	Eur. centr.-submedit.-atl.	4		Alp.-carp.-balc.	1
	Eur. centr. (submedit.)	3		Carp.-balc.-pan.	1
	Eur. centr. și de E	3		Total	40



	Eur. centr.-atl.-medit.	2	9.	Adv. (Am. de N)	19
	Eur. centr.-subatl.	2		Adv. (Am. de S)	2
	Centr. eur.-balc.-cauc.	1		Am. de N.	2
	Eur. centr. și de S, As. de SV	1		Adv. (Am. de N) presently Cosm.	1
	Eur. centr.-atl.	1		Adv. (Am. de N și S)	1
	Eur. centr. și N.	1		Adv. (Am. de S) presently Cosm.	1
	Eur. centr.-subatl.-submedit.	1		Adv. (Am. de S și Peru) presently Cosm.	1
	Eur. centr.-pont.	1		Adv. (Am. trop.)	1
	Eur. centr.-pont.-medit.	1		Adv. (As. de SV)	1
	Centr. Eur.-balc.	1		Adv. (As. NE, Am de N?)	1
	V, Centr. Eur.-medit.	1		Adv. (Medit. de E.)	1
	<b>Total</b>	<b>144</b>		As. de V. (Cosm.)	1
3.	<b>Eur.</b>	<b>95</b>		As. de SV	1
	Eur. cont.	8	<b>Total</b>		<b>33</b>
	Eur. de S.	5	10.	Atl.-medit.	17
	Eur. (submedit.)	3		Atl.-submedit.	1
	Eur. (mont.)	2		Atl.-centr.-eur.-medit.	1
	Eur. de SE.	2		Subatl.-submedit.	1
	Eur. (excepție N)	2		Subatl.-submedit.-centr. eur.	1
	Eur. de S. (mont.)	1	<b>Total</b>		<b>21</b>
	Eur. de S. (Africa de N.)	1	11.	Pan.	6
	Eur. SE., As. Centr.	1		Pan.-balc.	1
	Eur. medit.	1	<b>Total</b>		<b>7</b>
	<b>Total</b>	<b>121</b>	12.	Rom. Jug.	1
4.	<b>Circ.</b>	<b>74</b>			
5.	<b>Pont.</b>	<b>8</b>			
	Pont.-medit.	28			

### The phytogeographic situation of the studied field

According to the last classification (CIOCĂRLAN, 2000), based on the geographic position of Romania and on the criteria: floristic, pedological-geographic, climatic, geo-morphological and physico-geographic and ecological, the studied field is situated at the border between two provinces and districts (Fig. 8) thus:

### Central European Region

**Carpathian Province (Fig. 8-4)**

### SubCarpathian Subprovince (Fig. 8-4.2)

**District of Getic Subcarpathians-between Negoesti and Motru (Fig. 8-4.2.3)**

### The Danubian-Getic Province (Fig. 8-5)

**The district of the Getic Plateau-between Motru and Gura Motrului (Fig. 8-5.1)**

All these elements are in correlation with the types and the division into zones of the vegetal groups identified in the studied zone. So, the division into zones of the vegetation on vertical brings up numerous problems in the studied field, situation emphasized in the Upper Basin of the Motru River too (MALOŞ, 1977).

Nevertheless, it can be told that the studied field mostly belongs to the nemoral zone (Oak forest's zone) - between 110-300 m height, between Motru and Gura Motrului.

In this zone, the main woody vegetal formations are the Turkish oak and Hungarian oak forests (*Quercetum frainetto-cerris*), characteristic to the *Quercetea pubescentis* class, in whose area there are settled secondary (after the clearing of the forests) dry meadows characteristic to the *Festuco-Brometea* class, edified by the steppe hairgrass (*Festuca valesiaca*) and the furrowed hairgrass (*F. rupicola*), fragmented by blackthorn and hawthorn boscajes (*Pruno spinosae-Crataegetum*).

The mesophilous everglade vegetations characteristic to the *Quercus-Fagetea* class is weakly represented, with a fragmentary character, the more representative woody vegetal formations being found in the high everglade of the Motru River and his principal tributaries (the Hușnița and the Coșuștea). These are represented by pedunculate oak forests (*Quercus robur*), in which it has been identified as principal association *Convallario majalis-Quercetum roboris*, and on small areas, in floodable places, temporary sloppy, based on the clearing of the pedunculate oak, there are settled the phytocoenosis edified by *Fraxinus excelsior*, *F. angustifolia* subsp. *oxycarpa* and fewer *F. pallisiae*, situated in the *Quercus robori-Fraxinetum* association.

Between the altitudes 300-380 m, they frame at the lower limit of the common oak sublevel, from the nemoral level (of the deciduous forests), being continued in the Upper Basin of the Motru River to 1.000 m height (MALOȘ, 1977).

In the studied field, between Motru and Negoiești, we can not talk strictly about a sublevel characteristic to the Subcarpathian hills, because the woody vegetal formations that form the forests from this transition zone have a mixed character, in their composition being met all the three oak species (*Quercus dalechampii*, *Q. polycarpa*, *Q. petraea*), in which *Fraxinus ornus*, *Tilia tomentosa* participate, as well as the infiltration of *Quercus cerris*, *Q. frainetto*, which gives the transition character of these forests. The association that is identified within these forests is *Potentillo micranthae-Quercetum dalechampii* HORVÁT 1981 (COSTACHE, 2005, 2007), being an association of transition between

the downy oak (*Quercus pubescens*), characteristic to the forest steppe zone, and the mesophilous one characteristic to acid oak forests met in the Subcarpathian hills.

These difficult combinations are also pointed by ROMAN, 1974, in the south of the Mehedinti Piedmont; therefore he did not described associations from these forests.

The grassy layer of these forests is generally poor, composed of: *Melica uniflora*, *Poa nemoralis*, *Lathyrus niger*, *Galium schultesii*, as well as the central European-Mediterranean recognition species *Potentilla micrantha*.

The durmasts' clearing has led to the extension of the juniper boscsages, *Juniperus communis*, and on the very extended surfaces there are acacia plantations.

In the area of these forests, the principal meadows are the ones edified by the grass of the field (*Agrostis capillaris*). Because of the presence of the red fescue (*Festuca rubra*) in this zone, we have considered adequate the differentiation of the association *Festuco rubrae-Agrostetum capillaris* HORVAT, 1951.

In this sublevel, as mesophilous wooden vegetal formations, during the short valley with temporary stream, on northern expositions, are met moesic beech forests, framing them provisionally in the association *Helleboro odori-Fagetum moesiaca* SOÓ & BORHIDI in SOÓ 1960 (COSTACHE, 2005, 2006; COSTACHE & NICOLAE, 2009), on the basis of the nucleus of Balkan elements, which prove the origin connections with the old forests that were populating the Balkan-Crimean-Dobroudja hills and the ones from Oltenia, in this way differentiating them of the mountainous beech forests (BORZA, 1957). Eliminating the beech from these phytocoenoses settles down secondary the association *Carici pilosae-Carpinetum* NEUHÄUSL & NEUHÄUSLOVÁ-NOVOTNÁ 1964 em. BORHIDI 1996. These come in contact with small phytocoenosis of *Populus tremula* and *Corylus avellana*. The *Castanea sativa* and *Corylus colurna* species are seldom met here.

In the intrazonal vegetation, the acacia and poplar riverside coppices are representatives. Within the framework of these it had been described the *Salicetum albae* ISSLER sensu lato association, beside which, in the rivers' gravel, there are willow groves of red osier (*Salicetum purpureae*).

The riverside coppices of common alder, located during the narrow valleys of the Motru's tributaries and sporadically in the Motru's meadow, are weakly represented. From their framework it has been described the *Aegopodio-Alnetum glutinosae* association, in whose structure it has been identified only one relevé with *Matteuccia struthiopteris*, at the superior limit of the researched territory, on the Pestrita valley.

In the high meadows and on the first terraces of the hills there are mesophilous-mesohygrophilous associations, some of them forming lawns on extended surfaces (*Festucetum pratensis*, *Agrostetum stoloniferae*), and others are located on smaller surfaces, *Poëtum pratensis*, *Agrostetum caninae*; with Submediterranean character it is met the *Poëtum sylvicolae* association, well known and studied in Oltenia. On the temporary marshy fields, a special peculiarity is represented by the presence of the Mediterranean species *Cirsium creticum*, which, in the Motru's Basin is more abundant in the phytocoenosis edified by *Carex hirta*, giving them an apart specific character, therefore we propose as regional subassociation *Cirsietosum creticae* COSTACHE 2005 (COSTACHE, 2005, 2008) in the framework of the *Caricetum hirtae* association.

The aquatic and swamp vegetation is weakly represented, being met especially in the Motru's meadow between Motru and Gura Motrului.



Figure 8. The floristic Provinces of Romania (by CIOCARLAN, 2000).

Figura 8. Provinciile floristice ale României (după CIOCARLAN, 2000).

The high meadows of the rivers as well as the hills' low and middle terraces have a fragmentary aspect because of the agriculture, fact that influences the composition and the dynamics of the phytocoenosis of herbaceous species associations too, in the sense of the penetration of numerous species of segetal and ruderal weeds, giving them a pronounced character of ruderalization.

## CONCLUSIONS

In conclusion, the floristic diversity and implicit the complexity of the vegetal groups existing in the researched area is due to physical-geographical, pedological-climatic and phytogeographical peculiarities, situation pointed out by ROMAN, 1974, in the south of the Mehedinți Plateau, and also by MALOȘ, 1977, in the Upper Basin of the Motru, of course with certain apart peculiarities.

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## DATA ABOUT THE SEGETAL FLORA FROM CALAFAT-BECHET AREA

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**Abstract.** In this paper there are presented the results of the research made in a period of 4 years. As compared to the years 1970-1990 when the agricultural crops from the researched area covered large surfaces and the species of weeds were hard to control, presently these surfaces reduced but the weed encroachment grade is still high due to the poor treatment of the crops and of the fallow lands near them.

**Keywords:** segetal flora, weeds.

**Rezumat.** Date despre flora segetală dintre Calafat și Bechet. În această lucrare se prezintă rezultatele cercetărilor efectuate în decursul a 4 ani de zile. Spre deosebire de anii 1970-1990 când culturile agricole din teritoriul cercetat ocupau suprafețe mari iar speciile de buruieni erau greu de combătut, în prezent suprafețele s-au redus însă gradul de îmburuienare se menține ridicat datorită slabei tratări a culturilor și prezenței locurilor pârlogite în apropierea acestora.

**Cuvinte cheie:** flora segetală, buruieni.

## INTRODUCTION

On the agricultural fields, there also grow spontaneous plants together with the cultivated plants (CIOCĂRLAN & CHIRILĂ, 1982). Their extension has always generated problems the complexity grade of which has been influenced by anthropogenous, climatic, geographical and technological factors.

Although the technology in agriculture has reached high levels, still, weeds are a menace for the agricultural crops (PĂUN, 1966).

The floristic structure of the weeds from the cultivated lands, as well as the number of the individuals and of the seeds from the soil reflect the level of the agriculture from a certain area and especially the efficiency of man's intervention upon the weed encroachment.

According to the general aspect of the relief, with altitudes of 60-70 m, the researched territory belongs to the Oltenia Plain. Chernozems represent the zonal soils and they cover the first three terraces of the Danube.

Although studies upon the weeds from Oltenia are found in several papers ((BUJOREAN 1956, 1960), (PĂUN & POP, 1970), (PĂUN et al., 1975), (CHIRILĂ, 2001), (CIOCĂRLAN, 2004)), we still consider this paper useful, since it brings information upon the current state of the cultures' weed encroachment.

There have been studied the weeds from the following groups of crops: haulms (wheat, barley, oat), plants that are hoed up (corn, sunflower), grape vine and vegetable gardens.

## MATERIAL AND METHOD

The work method consisted of observations and comparisons in the field. Among the methods used for weeds study, I used the general visual evaluation method on the field.

At the species chorology it have been put down the localities only at those taxa that have a more restricted area, the ones present almost on the entire area are called frequency.

It is a method based on the principles of Zürich-Montpellier school and offers the advantage that it is fast, but its data have a relative value, hard to use in fighting the weeds through agro-technical or chemical means.

With all their subjectiveness, the results obtained through this method offer a relatively exact image of the weed encroachment situation.

## RESULTS AND DISCUSSIONS

From the research made in the above mentioned period, there have been identified a number of species. In order to find easier the taxon, the species presentation is being made alphabetically: *Abutilon theophrasti* MEDIK. – T., Euras. (frequent), *Adonis aestivalis* L. – T., Euras. Cont. (Ciupercenii Noi, Tunari), *Agrostemma githago* L. – T., Cosm. (Desa, Rast), *Ajuga chamaeptytis* (L.) SCHEBER subsp. *ciliata* (BRIQ.) SMEJKAL. – T., Pont. Medit. (Rast), *Amaranthus albus* L. – T., Adv. (Am. de N.) (frequent), *A. retroflexus* L. – T., Adv. (Am. de N.) (frequent), *Ambrosia artemisiifolia* L. – T., Adv. (Am. de N.) (frequent), *Anagallis arvensis* L. – T-HT., Circ. (frequent), *Anthemis arvensis* L. – T., Eur. (frequent), *A. austriaca* JACQ. – T., Centr. Eur. Pont. (frequent), *Apera spica venti* (L.) BEAUV. – T., Euras. (frequent), *Arenaria serpyllifolia* L. – T., Circ. (Rast, Bistret), *Aristolochia clematidis* L. – G., Medit. (Tunari, Rast, Negoii), *Atriplex patula* L. – T., Circ. (frequent), *Avena fatua* L. – T., HT., Euras. (frequent), *Bifora radins* L. – T., Medit. (Rast), *Calamagrostis epigeios* (L.) ROTH. – G., Euras. (frequent), *Capsella bursa-pastoris* (L.) MEDIK. – T-HT., Cosm. (frequent), *Cardaria draba* L. – H., Euras. Medit. (frequent), *Caucalis platycarpus* L. – T., Pont. Pan. (Calafat,

Piscu Vechi, Ghidici), *Centaurea apiculata* LEDEB., subsp. *spinulosa* (ROCHEL) DOSTÁL – H., Centr. and SE Eur. (frequent), *C. cyanus* L. – T.-HT., Cosm. (frequent), *Cephalaria transylvanica* (L.) ROEMER & SCHULTES – HT., Pont. Medit. (frequent), *Chenopodium album* L. – T., Cosm. (frequent), *Chondrilla juncea* L. – HT.-H., Cont. Euras. (frequent), *Chorispora tenella* (PALLAS) DC. – T., HT., Euras. Cont. (Rast), *Cichorium intybus* L. – H., Euras. (frequent), *Cirsium arvense* (L.) SCOP. – G., Euras. (frequent), *Conium maculatum* L. – Ht., Euras. (frequent), *Consolida regalis* S. F. GRAY – T., Eur. (frequent), *Convolvulus arvensis* L. – (G) H., Cosm. (frequent), *Conyza canadensis* (L.) CRONQ. – T., Adv. (Am. de N.) (frequent), *Cuscuta campestris* YUNCKER – T., Adv. (Am. de N.) (frequent), *Cynodon dactylon* (L.) PERS. – G., Cosm. (frequent), *Datura stramonium* L. – T., Cosm. (frequent), *Daucus carota* L. subsp. *carota* – HT., Euras. (frequent), *Descurainia sophia* (L.) WEBB ex PRANTL – T.-HT., Euras. (frequent), *Digitaria sanguinalis* (L.) SCOP. – T., Cosm. (frequent), *Diplotaxis muralis* (L.) DC. – T.-HT., Centr. Eur. Medit. (frequent), *Echinochloa crus-galli* (L.) BEAUV. – T., Cosm. (frequent), *Eragrostis minor* HOST. – T., Centr. Eur. Medit. (frequent), *Erodium cicutarium* (L.) L'HÉRIT. – T., Cosm. (frequent), *Euphorbia helioscopia* L. – T., Euras. (frequent), *E. virgata* WALDST. & KIT. – H., Euras. Cont. (frequent), *Falcaria vulgaris* BERNH. – HT. (T., H.), Euras. (Submedit.) (Rast, Negoii, Catane, Bechet), *Fallopia convolvulus* (L.) A. Löve T., Circ. (frequent), *Fumaria schleicheri* SOY.-WILLEM – T., Euras. (frequent), *Galium aparine* L. – T., Circ. (frequent), *Galinsoga quadriradiata* RUIZ & PAVON – T., Adv. (Am. de S) (Rast), *Geranium dissectum* L. – T., Euras. (frequent), *Gypsophila muralis* L. – T., Euras. (frequent), *Heliotropium europaeum* L. – T., Submedit. (Rast), *Hibiscus trionum* L. – T., Euras. (frequent), *Holosteum umbellatum* L. – T., Euras. (Calafat, Piscu Vechi, Catane, Negoii), *Hyoscyamus niger* L. – HT., Euras. (Rast, Ciupercenii Noi, Desa), *Kickxia elatine* (L.) DUMORT. – T., Centr. Eur. Medit. (frequent), *Lactuca serriola* L. – Ht., Euras. (frequent), *Lamium amplexicaule* L. – T., Euras. (frequent), *L. purpureum* L. – T., Euras. (frequent), *Lapsana communis* L. – T.-H., Euras. (frequent), *Lathyrus aphaca* L. – T., Medit. (frequent), *L. tuberosus* L. – H., Euras. (frequent), *Linaria vulgaris* MILL. – H., Euras. (frequent), *Lithospermum arvense* L. – T., Euras. (frequent), *Matricaria perforata* MÉRAT – T.-HT., Euras. (frequent), *Neslia paniculata* (L.) DESV. – T., Eur. Centr. and SE (Calafat, Rast, Bechet), *Nigella arvensis* L. – T., Pont. Medit. (Tunari), *Panicum miliaceum* L. – T., China, As. Centr. (frequent), *Papaver dubium* L. subsp. *dubium* T., Eur. and subsp. *albiflorum* (BESS.) DOSTÁL – T., Pont. Medit. (frequent), *P. rhoeas* L. – T., Cosm. (frequent), *Phragmites australis* (CAV.) STEUDEL – G. (HH.), Cosm. (frequency), *Portulaca oleracea* L. – T., Cosm. (frequency), *Ranunculus arvensis* L. – T., Euras. (frequency), *R. sardous* CR. – T., Eur. (frequency), *Raphanus raphanistrum* L. – T., Medit. (Cosm.) (Rast, Catane, Dunăreni), *Rorippa austriaca* (CR.) BESS. – H., Pont. (frequency), *Rubus caesius* L. var. *arvalis* RCHB. – Ph., Eur. (Rast, Negoii), *Rumex crispus* L. – H., Euras. (frequent), *Salsola kali* L. subsp. *ruthenica* (ILJIN) SOÓ – T., Euras. (Calafat, Bechet), *Sambucus ebulus* L. – H., Euras. (frequent), *Senecio vernalis* WALDST. & KIT. – T., Euras. Cont. (frequent), *S. vulgaris* L. – T., Euras. (frequent), *Setaria pumila* (POIRET) ROEM & SCHULT. – T., Cosm. (frequency), *Setaria viridis* (L.) BEAUV. – T., Cosm. (frequent), *Sinapis arvensis* L. – T., Euras. (frequent), *Sisymbrium orientale* L. – T., Pont. Medit. (frequent), *Solanum nigrum* L. – T., Cosm. (frequency), *Sonchus arvensis* L. G., Euras. (frequent), *Sorghum halepense* (L.) PERS. – G., Medit. (frequent), *Stachys annua* L. – T., Eur. (submedit) (frequent), *Stellaria media* (L.) VILL. – T.-HT. Cosm. (frequent), *Taraxacum officinalis* WEBER ex WIGGERS – H., Euras. (frequent), *Thlaspi arvense* L. – T.-Ht., Euras. (frequent), *Torilis arvensis* (HUDS.) LINK – T., Eur. Centr. (frequent), *Tribulus terrestris* L. – T., Centr. Eur. Medit. (frequent), *Trifolium arvense* L. – T., Euras. (frequency), *Vaccaria hispanica* (MILL.) RAUSCHERT – T., Euras. (Ciupercenii Noi, Desa, Rast), *Veronica arvensis* L. – T., Euras. (frequency), *V. hederifolia* L. – T., Euras. (frequency), *V. persica* POIRET – T., Adv. (As. de SV) (frequent), *V. polita* FRIES – T., Euras. (frequent), *V. triphyllus* L. – T., Eur. (frequent), *Vicia tetrasperma* (L.) SCHREB. – T., Euras. (frequent), *V. villosa* ROTH – T.-HT., Eur. (frequent), *Viola arvensis* MURRAY – T., Cosm. (frequent), *Xanthium italicum* MORETTI – T., Eur. de S. (frequent), *X. spinosum* L. – T., Cosm. (frequent).

From the presented species there has been noticed that one of them has a better representation in the cultivated crops (*Sorghum halepense*, *Sonchus arvensis*, *Hibiscus trionum* ș.a.) and others in the cereal crops (*Setaria pumila*, *Sorghum halepense*, *Vaccaria hispanica*, *Centaurea cyanus*, *Cirsium arvense*, *Papaver rhoeas* and so on). In the vineyards, it has been observed that the hardest species to fight were *Cynodon dactylon* and *Convolvulus arvensis*. To the luxuriant development of these species contributed the very well developed rhizome system (to *Cynodon dactylon*) or the buds from the races (*Convolvulus arvensis*).

Analysing the bioforms spectrum (Fig. 1), it has been found that the terophytes possess the pre-eminence with 66%, followed at big distance by annual-biannual, hemipterophytes, geophytes and the biennial species. The rest have an insignificant weight.

Of the geoelements, the biggest weight is registered by Eurasian species with 41%, which are followed, at some distance, by the cosmopolites. The other geoelements categories are present in a much smaller percent (Fig. 2).

From the floristic list presented above it can be noticed that on the researched territory the southern elements are relatively well represented. Some of these have a large number of individuals and form even associations with large area: ex. *Cardaria draba* L., *Sisymbrium orientale* L. and other.

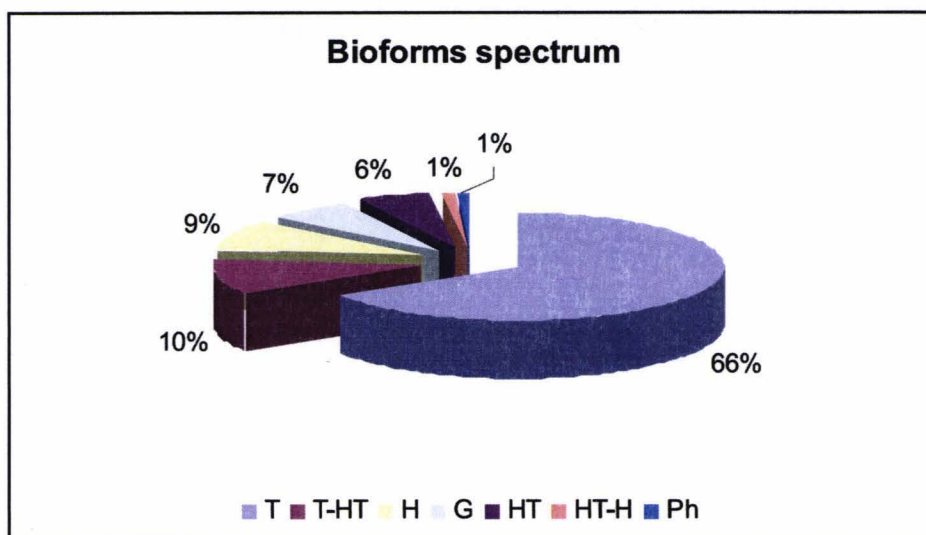


Figura 1. Spectrul bioformelor.

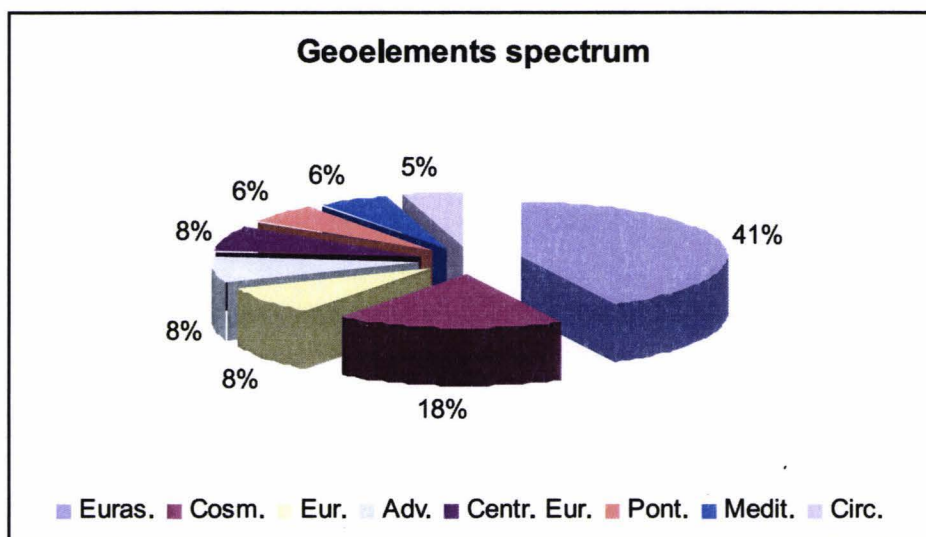


Figura 2. Spectrul geoelementelor.

### CONCLUSIONS

The present study has lead to the conclusion that, the corn crops have more weeds than the haulms ones, especially annual and perennial liliates, as well as magnoliates, which are more numerous as species, but with a lower density than of the previous ones.

The sun-flower crops are well weed encroached in the incipient stage, after which the plant inhibits weeds growing.

The destruction of the irrigation systems from the researched area increased the development of the weeds from the crops, due to the fact that they have a high resistance and an ecological plasticity.

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# CONTRIBUTIONS TO THE ANALYSIS OF VERTICAL DISTRIBUTION OF CILIATES (PROTOZOA: CILIOPHORA) IN THE PARAMARINES AND MARINES SEDIMENTS IN THE CENTRAL AREA OF THE ROMANIAN SEASHORE

RALUCA KERKMANN, NICOLAE PAPADOPOL, ANGELICA CURLIȘCĂ

**Abstract.** *The hereby research paper presents the analysis results of the vertical distribution of ciliates from marine sediments, as well as lacustrine areas, seaside lakes from the south of Cap Midia. The methodology used took into consideration the issues proposed by Fenchel (FENCHEL, 1966). According to detailed research papers of Mrs. PhD. Adriana Petran (PETRAN, 1977), developed between the 70s, I focused on presenting a range of investigations in the seaside of Modern beach, from Constanta, as well as sediments of the lacustrine complex Siutghiol-Tăbăcărie. The vertical distribution has been analysed on 63 species from the seaside field, Modern beach and 37 species from Siutghiol, respectively 28 species from Tăbăcărie. The results that were obtained highlight the fact that most of species are airfield species, with a high concentration in the first three centimetres of the sediments.*

**Keywords:** *ciliates, ecological features, basins within Constanța Museum Complex, vertical distribution.*

**Rezumat.** *Contribuții la cunoașterea distribuției pe verticală a ciliatelor (Protozoa-Ciliophora) din sedimentele paramarine și marine din zona centrală a litoralului românesc. Actuala lucrare cuprinde date referitoare la comunitățile de ciliate care populează domeniul sedimentar și perifitonul anexei lacului Tăbăcărie din incinta CMSN Constanța; aspectele calitative sunt însoțite de informații referitoare la ecologia fiecăreia din cele 34 de specii identificate. În compoziția calitativă a epibiozei bazinelor cu apă sărată în care este adăpostit patrimoniul viu al secției Delfinariu, a fost identificată o selecție interesantă de ciliate aparținând la 74 de specii, rezistența la variații semnificative ale salinității și concentrației de hipoclorit de sodium, substanță introdusă zilnic în bazine în scopul limitării proliferării faunei bacteriene.*

**Cuvinte cheie:** *ciliate, caracteristici ecologice, bazine incinta Complex Muzeal Constanța, distribuție pe verticală.*

## INTRODUCTION

The interstitial environment represents a special biotope for a large variety of invertebrates among which the protozoa ciliates dominates the other groups by means of the diversity of species and their density.

The study of ciliates distribution in the depth of sandy sediments was initiated by Fenchel (FENCHEL, 1967) who also created the corresponding method. The ciliates fauna in the sediments of low depth areas of nearshore lakes have been studied by us over a long period of time (1997-2004) (DUMITRACHE, 2004; DUMITRACHE, 2006).

Until the date of our study dedicated to this aspect, we have not found in the Romanian specialised literature information on this subject for the lakes Siutghiol and Tăbăcărie. The vertical distribution of ciliates in the mediolittoral of different points on the Romanian Black Sea seashore has been studied by Petran (PETRAN, 1976), therefore we have limited ourselves only to the study of the vertical distribution of the ciliates on the "Modern" beach; the reasons for choosing this sampling unit are based on the diverse aggregate grading of the sediments and the large quality spectrum of species in August: 63.

## MATERIAL AND METHODS

The results of the sampling process and the study of the samples collected in the months of August of 2004-2008 are focused on establishing the vertical distribution of ciliates in the sandy and muddy sediments of lake and marine areas. For the paramarine lakes Siutghiol and Tăbăcărie, the samples have been collected from the sediments of the low depth areas; the number of the sampling units was 4 and the weekly rhythm consisted in 5 samples per sampling unit (map). For the study of the vertical distribution of the ciliates on Constanta "Modern" beach, there were created two units in sheltered areas of the main bays, the weekly rhythm being 7 samples per sampling unit. The average values of the abiotic factors such as temperature and salinity for the points "Casino - Modern" Constanta are mentioned in Table 1; the salinity in the samples collected from the Tăbăcărie lake varied between 1.2-1.5 PSU.

Table 1. Average values of temperature and salinity for the sampling unit Constanta Casino-Modern (Constanta NIMRD analysis).

Tabel 1. Valorile medii ale temperaturii și salinității pentru stația Cazino Constanța-Modern (determinari INCDM Constanța).

Year	Temperature (average values) (0°C)	Salinity (average values) (PSU)
2004	22.2	14.60
2005	24.3	13.56
2006	23.4	15.68
2007	23.7	15.74
2008	24.5	12.83

The technique applied was the one recommended by Fenchel (FENCHEL, 1968). After separating the sediments into Petri dishes, there followed a general examination with the binocular eyeglasses. The separation of the ciliates from the sandy and muddy sediments was carried out by means of Uhlig method (DRAGESCO & DRAGESCO-KERNÉIS, 1986) and then this step was followed by that of diagnosis. Certain species were identified "in vivo", others required green colours such as acetic methyl; other species imposed the application of the techniques Bodian and Chatton-Lwoff, Wilbert variant (DRAGESCO & DRAGESCO-KERNÉIS, 1986).

## RESULTS AND DISCUSSIONS

The diversity of the ciliates in the analysed samples was significant including 37 (from the total amount of 45 species) in the sediments of Siutghiol Lake, 28 (from the total amount of 34 species) in Tăbăcărie Lake and 63 in the mediolittoral of Constanța "Modern" beach.

The large qualitative spectrum of marine and freshwater ciliates is doubled by a taxonomic diversity as they belong to 22 families and 33 genera. The ciliates identified have euryhaline affinities with x number of genera being represented both in the marine ecosystem and in the lake ecosystems.

The analysis of the samples collected highlighted a maximum concentration in the first 3-4 centimetres from the top of the sediment, the qualitative and quantitative spectrum decreasing while the depth increases (Table 1, 2 and 3). The results are rendered in percentages expressing the species frequency in the samples.

Table 1. Vertical distribution in the sediment depth of certain ciliates on Modern beach (frequency in samples-percentages).  
Tabel 1. Distribuția verticală în adâncimea sedimentului a unor populații de ciliade de la plaja Modern (frecvența în probe-valori procentuale).

No.	SPECIES	LAYER (cm)							
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
1	<i>Holophrya oblonga</i> (SCHEWIAKOFF 1895)	2	1	1	-	-	-	-	-
2	<i>Holophrya</i> sp. 1	1	0.5	0.5	-	-	-	-	-
3	<i>Prorodon marinus</i> (CLAPAREDE & LACHMANN 1858)	2	1	1	0.5	-	-	-	-
4	<i>Prorodon</i> sp.	2	1	0.5	0.5	-	-	-	-
5	<i>Dinophrya</i> sp.	3	2.5	2	0.5	-	-	-	-
6	<i>Coleps pulcher</i> (SPIEGEL 1926)	1	1	0.5	-	-	-	-	-
7	<i>Coleps</i> sp.	1	1	0.6	-	-	-	-	-
8	<i>Lacrymaria coronata</i> (CLAPAREDE & LACHMANN 1858)	3	2.5	0.5	0.5	-	-	-	-
9	<i>Lacrymaria delamarei</i> (DRAGESCO 1960)	2.5	2	1	1	-	-	-	-
10	<i>Lacrymaria lagenula</i> (CLAPAREDE & LACHMANN 1858)	2.5	1	0.5	0.5	-	-	-	-
11	<i>Lacrymaria</i> sp. 1	3	2	1	1.5	-	-	-	-
12	<i>Didinium nasutum</i> (MULLER 1786)	2.5	1	0.5	0.5	0.5	-	-	-
13	<i>Didinium</i> sp.	1.5	1	1	0.5	0.5	-	-	-
14	<i>Mesodinium pulex</i> (CLAPAREDE & LACHMANN 1858)	4	2.5	2	-	-	-	-	-
15	<i>Mesodinium rubrum</i> (LOHMANN 1908)	2	2	0.5	-	-	-	-	-
16	<i>Lionotus lamella</i> (EHRENBERG 1838)	3	2.5	1	1	0.5	0.5	-	-
17	<i>Loxophyllum helus</i> (STOKES 1884)	2	1	0.5	0.5	0.5	-	-	-
18	<i>Loxophyllum setigerum</i> (QUENNERSTEDT 1867)	3	1.5	2	0.5	0.5	-	-	-
19	<i>Hemionotus caudatus</i> (KAHL 1933)	2	2.5	1.5	1	1	0.5	0.5	-
20	<i>Trachelocercida</i> sp. 1	1	1	0.5	-	-	-	-	-
21	<i>Trachelocercida</i> sp. 2	1	1	0.5	-	-	-	-	-
22	<i>Trachelocercida</i> sp. 3	1	1	0.5	-	-	-	-	-
23	<i>Trachelocercida</i> sp. 4	1	1	0.5	-	-	-	-	-
24	<i>Trachelocercida</i> sp. 5	1	1	0.5	-	-	-	-	-
25	<i>Trachelocercida</i> sp. 8	1	1	0.5	-	-	-	-	-
26	<i>Trachelocercida</i> sp. 9	1	1	0.5	-	-	-	-	-
27	<i>Trachelocercida</i> sp. 12	1	1	0.5	-	-	-	-	-
28	<i>Remanella multinucleate</i> (KAHL 1933)	2	1.5	1	0.5	-	-	-	-
29	<i>Remanella rugosa</i> (KAHL 1933)	1	1	0.5	0.5	-	-	-	-
30	<i>Remanella margaritifera</i> (KAHL 1933)	1.5	1	1	0.5	-	-	-	-

31	<i>Remanella granulose</i> (KAHL 1933)	2	2	0.5	0.5	-	-	-	-
32	<i>Remanella minuta</i> (DRAGESCO 1960)	1	1.5	0.5	0.5	-	-	-	-
33	<i>Remanella swedmarki</i> (DRAGESCO 1960)	2	1.5	1	1	-	-	-	-
34	<i>Remanella</i> sp.	1	0.5	0.5	0.5	-	-	-	-
35	<i>Kentrophoros gracilis</i> (RAIKOV 1963)	2	2	0.5	0.5	1	1.5	1	0.5
36	<i>Ciliofaurea</i> sp.	1	1	0.5	-	-	-	-	-
37	<i>Geleia</i> sp.	1.5	0.5	0.5	-	-	-	-	-
38	<i>Plagiopyla nasuta</i> (STEIN 1860)	1	1	0.5	2.5	2	2	1	1.5
39	<i>Plagiopyla</i> sp.	0.5	1	1	0.5	2	2.5	2	0.5
40	<i>Coelosomides teissieri</i> (DRAGESCO 1960)	1	1	0.5	0.5	-	-	-	-
41	<i>Paraspathidium fuscum</i> (KAHL 1928)	1.5	2	2	1.5	0.5	0.5	-	-
42	<i>Paraspathidium</i> sp.	1.5	2	2	1.5	0.5	0.5	-	-
43	<i>Cryptopharinix setigerum</i> (KAHL 1928)	0.5	0.5	1	0.5	-	-	-	-
44	<i>Frontonia marina</i> (FABRE -DOMERGUE 1891)	1.5	0.5	1	0.5	-	-	-	-
45	<i>Uronema marinum</i> (DUJARDIN 1841)	0.5	0.5	1	1	1.5	1	0.5	0.5
46	<i>Vorticella</i> sp.	0.5	0.5	-	-	-	-	-	-
47	<i>Blepharisma steini</i> (KAHL 1932)	1.5	1	0.5	0.5	-	-	-	-
48	<i>Metopus contortus</i> (KAHL 1931)	2	1	1	0.5	1.5	0.5	0.5	0.5
49	<i>Condylostoma arenarium</i> (SPIEGEL 1926)	3	1.5	1	0.5	1.5	1	1	0.5
50	<i>Strombidium arenicola</i> (DRAGESCO 1960)	3.5	1.5	1	1	0.5	0.5	0.5	0.5
51	<i>Strombidium faurei</i> (DRAGESCO 1960)	2	1	1	1	0.5	0.5	0.5	0.5
52	<i>Strombidium sauerbrayae</i> (KAHL 1930)	2	1.5	1	1	0.5	0.5	0.5	0.5
53	<i>Strongylidium arenicolus</i> (DRAGESCO 1960)	1.5	0.5	-	-	-	-	-	-
54	<i>Epiclintes ambiguous</i> (MULLER 1786) BUTSCHLI 1889	1	0.5	-	-	-	-	-	-
55	<i>Trachelostyla caudate</i> (KAHL 1932)	2	1	0.5	-	-	-	-	-
56	<i>Trachelostyla dubia</i> (DRAGESCO 1960)	2	1	0.5	-	-	-	-	-
57	<i>Uroleptus rattulus</i> (STEIN 1859)	0.5	0.5	1	0.5	-	-	-	-
58	<i>Oxytricha gibba</i> (MULLER 1786)	0.5	0.5	-	-	-	-	-	-
59	<i>Euplotes</i> sp. 1	0.5	1.5	0.5	-	-	-	-	-
60	<i>Euplotes</i> sp. 3	0.5	1	1.5	0.5	-	-	-	-
61	<i>Euplotes</i> sp. 4	0.5	0.5	-	-	-	-	-	-
62	<i>Diophrys scutum</i> (DUJARDIN 1841)	1	0.5	-	-	-	-	-	-
63	<i>Uronychia transfuga</i> (MULLER 1786)	1	0.5	-	-	-	-	-	-

Table 2. Vertical distribution of ciliates in the sediments of Siutghiol Lake (frequency in samples-percentages).  
Tabel 2. Distribuția verticală a ciliatelor în sedimentele lacului Siutghiol (frecvența în probe, valori procentuale).

No.	SPECIES	LAYER (cm)							
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	
1	<i>Holophrya atra</i> (SCHEWIAKOFF 1893)	1	0.5	-	0.5	-	-	-	
2	<i>Holophrya ovum</i> (SCHEWIAKOFF 1893)	0.5	-	-	-	-	-	-	
3	<i>Holophrya nigricans</i> (LAUTRBORN 1894)	0.5	-	-	-	-	-	-	
4	<i>Holophrya</i> sp.2	0.5	-	-	-	-	-	-	
5	<i>Urotricha globosa</i> (CLAPAREDE & LACHMANN 1857)	10	10	10	15	10	2	0.5	
6	<i>Plagiocampa rouxi</i> (KAHL 1930)	0.5	0.5	0.5	-	-	-	-	
7	<i>Lagynophria rostrata</i> (KAHL 1930)	0.5	-	-	0.5	-	-	-	
8	<i>Lagynophria acuminata</i> (KAHL 1930)	0.5	0.5	-	-	-	-	-	
9	<i>Lacrymaria olor</i> (MULLER 1788)	2	3	1	1	-	-	-	
10	<i>Trachelophyllum sigmoides</i> (KAHL 1931)	2	0.5	0.5	-	-	-	-	
11	<i>Spathidium</i> sp.	1	0.5	-	1	-	-	-	
12	<i>Lionotus lamella</i> (SCHEWIAKOFF 1896)	3	3	1	2	1	0.5	-	
13	<i>Loxodes striatus</i> (ENGELMANN 1862)	1	0.5	-	0.5	-	-	-	
14	<i>Plagyopila nasuta</i> (STEIN 1860)	1	1	0.5	1	5	5	2	

15	<i>Bresslaua</i> sp.	0.5	-	-	-	-	-	-
16	<i>Colpoda cucullus</i> (MULLER 1786)	1	1	0.5	-	-	-	-
17	<i>Colpoda steini</i> (KAHL 1935)	1	-	-	0.5	-	-	-
18	<i>Nassula picta</i> (EHRENBERG 1933)	1	1	0.5	-	-	-	-
19	<i>Tetrahymena</i> cf. <i>pyriformis</i> (EHRENBERG 1830); LWOFF 1947	10	15	15	10	6	3	1
20	<i>Ophryoglena atra</i> (EHRENBERG 1831)	1	0.5	0.5	1	2	-	-
21	<i>Dexiostoma campylum</i> (FÖCKE 1836)	2	1	1	0.5	-	-	-
22	<i>Paramecium caudatum</i> (EHRENBERG 1838)	5	3	1	2	-	-	-
23	<i>Paramecium</i> cf. <i>aurelia</i> (EHRENBERG 1838)	1	1	-	0.5	-	-	-
24	<i>Paramecium putrinum</i> (HILL 1752)	1	1	2	2	3	1	-
25	<i>Paramecium trichium</i> (HILL 1752)	1	-	-	-	-	-	-
26	<i>Paramecium</i> sp.	0.5	-	-	-	-	-	-
27	<i>Lembadion bullinum</i> (PERTY 1852)	5	6	4	2	1	1	0.5
28	<i>Uronema nigricans</i> (MULLER 1786)	10	10	15	15	-	0.5	-
29	<i>Cyclidium glaucoma</i> (MULLER 1786)	20	20	15	10	10	5	0.5
30	<i>Spirostomum teres</i> (CLAPAREDE & LACHMANN 1858-1859)	3	3	2	2	0.5	-	-
31	<i>Metopus</i> sp. 2	1	1	4	5	7	5	2
32	<i>Strombidium sauerbrayae</i> (KAHL 1930)	2	2	6	2	3	2	0.5
33	<i>Strombidium viride</i> (FOISSNER 1986)	2	2	4	2	1	-	0.5
34	<i>Saprodinium</i> sp.	1	1	3	2	3	1	2
35	<i>Uroleptus</i> sp.	6	5	5	7	10	15	10
36	<i>Oxytricha</i> sp.1	0.5	1	-	0.5	-	-	-
37	<i>Euplotes patella</i> (MULLER 1786) EHRENBERG 1838	0.5	0.5	-	0.5	-	-	-

Table 3. Vertical distribution of ciliates in the sediments of Tăbăcărie Lake (frequency in samples-percentages).  
 Tabel 3. Distribuția verticală a ciliatelor în sedimentele lacului Tăbăcărie (frecvența în probe, valori procentuale).

No.	SPECIES	LAYER (cm)							
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
1	<i>Holophrya ovum</i> (SCHEWIAKOFF 1893)	3	1	-	-	-	-	-	-
2	<i>Urotricha globosa</i> (CLAPAREDE & LACHMANN 1857)	5	7	7	-	3	0.5	2	1
3	<i>Plagiocampa rowxi</i> (KAHL 1930)	7	3	0.5	-	-	-	-	-
4	<i>Lagynophria rostrata</i> (KAHL 1930)	3	1	0.5	-	-	-	-	-
5	<i>Phithothorax processus</i> (KAHL 1931)	1	-	-	-	-	-	-	-
6	<i>Trachelophyllum sigmoides</i> (KAHL 1931)	1	-	0.5	-	-	-	-	-
7	<i>Spathidium</i> sp.	5	2	0.5	-	-	-	-	-
8	<i>Litonotus lamella</i> (SCHEWIAKOFF 1896)	5	3	1	0.5	-	-	-	-
9	<i>Loxodes striatus</i> (ENGELMANN 1862)	2	-	0.5	-	-	-	-	-
10	<i>Plagyopila nasuta</i> (STEIN 1860)	1	-	2	4	7	2	0.5	0.5
11	<i>Colpoda steini</i> (KAHL 1935)	1	1	0.5	-	-	-	-	-
12	<i>Nassula picta</i> (EHRENBERG 1933)	3	1	-	-	-	-	-	-
13	<i>Tetrahymena</i> cf. <i>pyriformis</i> (EHRENBERG 1830); LWOFF 1947	10	10	7	5	3	1	1	1
14	<i>Ophryoglena arta</i> (EHRENBERG 1831)	3	1	0.5	0.5	-	-	-	-
15	<i>Paramecium</i> cf. <i>aurelia</i> (EHRENBERG 1838)	1	2	2	-	-	-	0.5	-
16	<i>Paramecium caudatum</i> (EHRENBERG 1838)	5	3	-	0.5	-	-	-	-
17	<i>Paramecium putrinum</i> (HILL 1752)	3	7	2	7	3	1	0.5	-
18	<i>Paramecium trichium</i> (HILL 1752)	1	-	-	1	-	-	-	-
19	<i>Lembadion bullinum</i> (PERTY 1852)	6	8	2	0.5	2	0.5	0.5	-
20	<i>Uronema nigricans</i> (MULLER 1786)	15	10	7	1	-	-	2	-
21	<i>Metopus</i> sp. 2	1	2	5	7	7	3	2	0.5
22	<i>Saprodinium</i> sp.	1	5	7	5	3	1	1	-
23	<i>Strombidium sauerbrayae</i> (KAHL 1930)	3	6	10	10	5	2	2	1
24	<i>Uroleptus</i> sp.	3	5	15	10	15	15	10	10

25	<i>Paruroleptus</i> sp.	2	4	-	0.5	-	-	-	-
26	<i>Oxytricha</i> sp.1	5	5	-	1	-	-	-	-
27	<i>Euplotes patella</i> (MULLER 1786); EHRENBURG 1838	1	0.5	-	0.5	-	-	0.5	-
28	<i>Aspidisca</i> sp.	1	1	0.5	1	-	-	-	-

a. The number of the identified species in the first 3 centimetres of the “Modern” beach was around 60 (Figs. 1-3), whereas in the 3-4 cm layer the number decreases beyond 35; the ciliates identified at a depth of 7-8 cm, tolerant to the decrease of oxygen concentration, belong only to 10 species.

In the mediolittoral of “Modern” beach there were identified a series of species with strictly aerobic affinities, their existence being limited by this abiotic parameter to the top 1-3 cm: species of *Holophrya*, *Coleps*, *Geleia*, *Strongylidium*, *Trachelocerca* etc.

Other ciliates are tolerant to the decrease of oxygen concentration and are to be found in the 3-5 cm layer; this is the case for species from the genera *Didinium*, *Loxophyllum*, *Paraspathidium*.

Finally, other species present a special resistance to certain microaerophile and even anaerobe conditions, their representatives being identified at the top layer until 7-8 cm limit in the sandy sediment: *Kentrophoros gracilis* (RAIKOV 1963), *Plagiopyla nasuta* (STEIN, 1860), *Uronema marinum* (DUJARDIN, 1841), *Metopus contortus* (KAHL, 1931), *Strombidium* species.

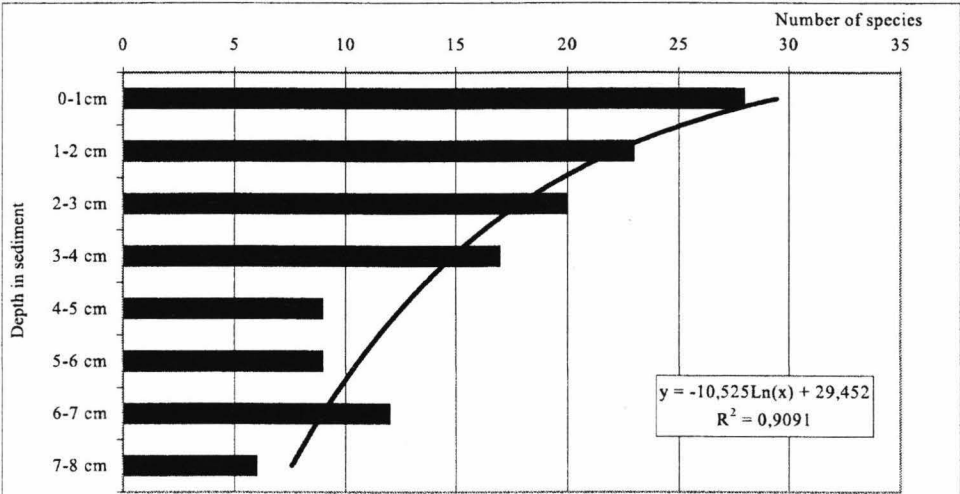


Fig.1- Diversitatea populațiilor de ciliatelor din lacul Siutghiol în adâncimea sedimentului  
Fig. 1- Diversity of ciliates in Siutghiol Lake in the depth of the sediment

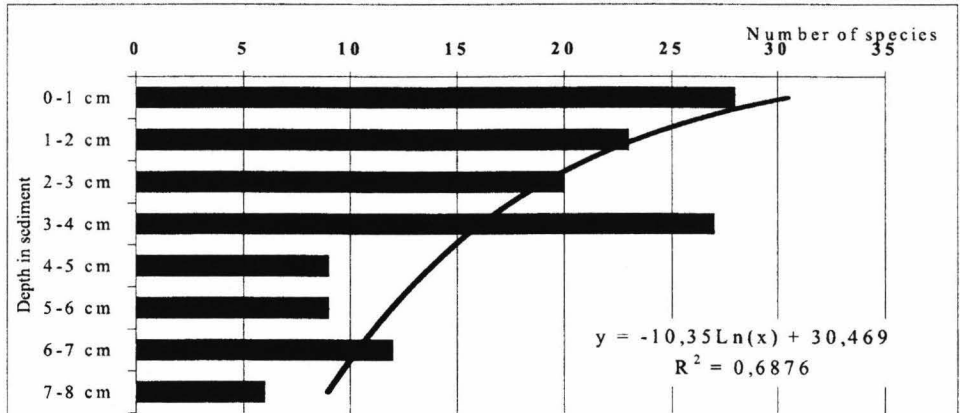
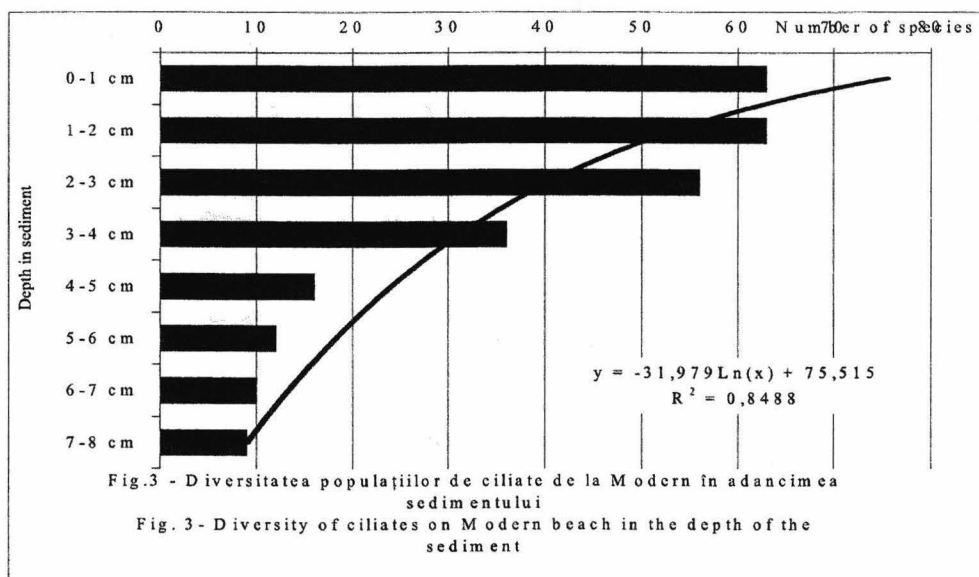


Fig.2 - Diversitatea populațiilor de ciliatelor din lacul Tabăcărie în adâncimea sedimentului  
Fig. 2- Diversity of ciliates in Tabăcărie Lake in the depth of the sediment





The tolerance of the species to the oxygen concentration variation in the sediments is also completed by euritherme characteristics, almost half of the species identified in the summer months being also identified in the other periods of the year.

b. The analysis of the samples collected from the sediments of the low depth areas of the lakes Siutghiol and Tăbăcărie (with the annex building of CMSN Constanta) highlighted the fact that the ciliates fauna is also concentrated in the first top 3 centimetres (Figs. 1-3).

While in the first top centimetre of the sediments of Siutghiol Lake there were identified 37 species, respectively 28 species in Tăbăcărie Lake, in the 2-3 cm layer there were identified around 20 species for both ecosystems and in the 7-8 cm layer there were identified about 5 species. Among the oxyphile there can be quoted: *Lagynophra acuminata* (KAHL, 1830), *Nassula picta* (EHRENBERG, 1833), *Bresslaia* sp., *Phyothorax processus* (KAHL, 1931). A series of examples belonging to the species: *Lionotus lamella* (EHRENBERG, 1838), *Lembadion bullinum* (PERTY, 1852), species of *Strombidium*, *Uroleptus* etc., are tolerant to progressive decrease of oxygen concentration along with depth increase in the sediment.

In conclusion, the oxygen represents an abiotic factor limitative to ciliates distribution in sediments, the results acquired being encouraging for continuing the research in this direction.

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## DATA ON CILIATES (PROTOZOA: CILIOPHORA) FROM THE AQUATIC ENCLOSURE OF CONSTANȚA NATURAL SCIENCES MUSEUM COMPLEX

RALUCA KERKMANN, NICOLAE PAPADOPOL, ANGELICA CURLIȘCĂ

**Abstract.** *The hereby research paper contains data referring to the ciliates communities which populate the sedimentary field from the aquatic field of the section Micro-reservation/CMSN, resulted out of the embankment of a part of Tabacarie Lake. The data related to the structure of the species are accompanied by corresponding information related to the ecology of each of the 34 species that were identified. In the quality composition of the epibiosis of the basins with salt water from Delfinariu, basins that discharge part of their water in the aquatic field to which this paper refers to, there has been identified an interesting diversity of ciliates belonging to 74 species, with high resistance to significant variations of salinity and sodium hypochlorite concentration. This research paper also discusses the range of species identified in the field of sweet water, comparatively with the structure of ciliate list from marine water.*

**Keywords:** *ciliates, ecological features, basins within Constanța Museum Complex.*

**Rezumat.** *Date privind ciliatele (Protozoa: Ciliophora) din incinta acvatică de la Complexul Muzeal de Științe ale Naturii Constanța. Actuala lucrare cuprinde date referitoare la comunitățile de ciliate care populează domeniul sedimentar și perifitonul din incinta acvatică a secției Microrezervație/CMSN, rezultată prin îndiguirea unei secțiuni a lacului Tăbăcărie. Datele privind structura în specii sunt însoțite de informații referitoare la ecologia fiecăreia din cele 34 de specii identificate. În compoziția calitativă a epibiozei bazinelor cu apă sărată de la Delfinariu, bazine care își deversează o parte a apelor în incinta acvatică la care se face referință, a fost identificată o diversitate interesantă de ciliate aparținând la 74 de specii, rezistentă la variații semnificative ale salinității și concentrației de hipoclorit de sodiu. Lucrarea ia în discuție gama de specii întâlnite în condiții de apă dulce, comparativ cu structura listei de ciliate din apa marină.*

**Cuvinte cheie:** *ciliate, caracteristici ecologice, bazine în incinta Complexului Muzeal Constanța.*

### INTRODUCTION

The ciliates are protozoa which populate the majority of freshwater aquatic and marine environments characterized by a great ecological plasticity.

The Romanian specialised literature is poor in information regarding the ciliofauna of the paramarine lakes, except for Techirghiol Lake (TUCULESCU, 1965).

The poor information regarding the ciliofauna characteristic to the above mentioned ecosystems would be the result of the difficulty to analyse the samples due to low dimensions (rendered in micrometers) of the ciliates, as well as their difficult handling manoeuvres taking into account the imminent cytolysis at the fragile species.

### MATERIAL AND METHODS

Our researches carried out between 1997 and 2004 established a list of species attached to information regarding their ecological characteristics (DUMITRACHE, 2004; DUMITRACHE, 2006). There were analysed samples from low depth areas of the lakes, from the mud accumulated at its inferior part; there were also analysed zooplankton samples, as well as fragments from the paludal vegetation.

These researches were continued between 2004 and 2008 with other aspects regarding the ecology of the above mentioned species; the focus was set on the samples collected from the plankton and the benthos of Tabacarie Lake, as well as from the analysis of certain fragments belonging to the paludal vegetation; the total number of the collected samples was 217.

To these there can be added 72 samples collected from the covered pools with sea water from Dolphinarium enclosure which shelter the live patrimony (two sea lions and one dolphin).

The daily pouring of sodium hypochlorite to water in view of impeding the microorganism proliferation constitutes a rigorous selection factor of certain types of ciliates resistant to a high concentration, taking into account the fact that immediately after the pouring into the pools the concentration may reach 1 mg/l so that in 6-7 hours it could reach 0.1 mg/l and then 0 due to the recirculation system of the pool water. The values of the abiotic factors from the enclosure of the covered pools are kept relatively constant; the salinity varied between 13.8 and 18.3 PSU and the temperature of the water ranged between 19-24 C degrees due to acclimatizer system (CMSN data, determination by PhD student Angelica Curlisca). The pH values were higher than 7.

The samples collected from the pools consisted in the epibiosis from their side walls, but also in fragments of algae macrophytic fauna collected from the bottom of the pools at the periodical cleaning carried out by the diver.

After the sample collection, the ciliates were separated from the sediment by means of different methods (Uhlig, Webb, Dragesco) (DRAGESCO & DRAGESCO-KERNEÉIS, 1986; WEBB, 1956), others were collected by means of direct use of the pipette and transfer to the Petri dishes.

The next step consisted in the general examination of the ciliates from the Petri dishes with the binocular eyeglasses. For analysis there were collected drops with the pipette and transferred on a lamella, the decrease of the speed was done by adding a few drops of MS-222 Merck solution prepared for this scope by means of adding water from the same ecosystem.

Certain species were determined "in vivo", for others there were used colours of the nuclear device such as green acetic methyl; in the case of other species there was necessary the use of the techniques for the highlight of infraciliature and other taxonomic details by use of the techniques Chatton-Lwoff and Bodain (Wilbert variant) (DRAGESCO & DRAGESCO-KERNÉIS, 1986).

## RESULTS AND DISCUSSIONS

The qualitative spectrum of the ciliates from the samples analysed is composed of 72 forms among which 14 were identified only to the genus (Table 1).

From the total amount of 72 species, 25 were identified in the covered pools of the Dolphinarium enclosure, the rest being part of the benthos and periphyton of Tabacarie Lake and its appendix from CMSN Constanta, 5 forms being common to both ecosystems.

The sediments of the low depth areas of Tabacarie Lake, as well as the muddy accumulations are very populated by ciliates; thus, as far as the preferred habitat of freshwater species is concerned, 27% of the species were identified in benthos, plankton and periphyton, 22% are strictly benthonic; 17% are strictly planktonic, whereas the other variants represent combinations and they are less represented.

As for the tolerance to salinity of the freshwater species, 46% of the species have euryhaline valence; 10% are oligoeuryhaline and oligomesoeuryhaline, the other categories being low represented.

The ciliates trophic spectrum is mostly bacterivore – 60% of the species, the rest to 100% is represented by predator and omnivorous species.

In accordance with the information provided by FOISSNER (1986), 19% of the species are indicating areas with alpha-polymesosaprobic and alpha-betamesosaprobic, whereas 17% are strictly metasaprobic, the other categories being represented by lower percentages (Table 1).

The 25 species identified in the epibiosis of the pools of the Dolphinarium enclosure are mostly marine; preserving the populations of these species selections in the conditions of sudden chlorinity variations (by adding daily sodium hypochlorite) and salinity (the values of this abiotic factor are artificially preserved in constant parameters by adding NaCl) is due to the euryhaline properties of the majority of species (45%); 30% are oligo/euryhaline, whereas the rest have oligo-stenohaline values.

The success of preserving them in this artificial biotope is provided by the bacteria feeding strategy of the majority of species.

In conclusion, from a systematic point of view, more than half of the species belong to the ciliate superior classes, with differentiated ciliature, improved mouth structure, as a result with acquisitions in the phylogenetic evolution which allow the adjustment to a complex and selective artificial environment such as the one from the Dolphinarium's covered pools.

The study of the ciliate fauna characteristic to the epibiosis of the pools should be deepened with other biometry aspects and observation of the tolerance limits to extreme variations of the abiotic factors, as a future task.

In brief, the ciliates are organisms with special ecological plasticity capable to adapt to environments characterized by special variations of the abiotic factors, their study creating new interesting perspectives.

Table 1. Qualitative composition of ciliates in the analysed samples.

Tabel 1. Compoziția calitativă a ciliatelor din probele analizate.

No.	TAXA	T.S.	H.P.	G.S.	Tabacarie sediments	Tabacarie periphyton	Dolphinarium pools - epibiosis
1	<i>Holophrya binucleata</i> (KAHL, 1930)	oms	Ba,Cy,Al	a-p	+	+	-
2	<i>Holophrya gargamelae</i> (FAURE-FREMIET, 1924)	oms	Ba,Cy,Al	a-p	+	+	-
3	<i>Holophrya ovum</i> (SCHEWIAKOFF, 1893)	oms	Ba,Cy,Al	a-p	+	+	+
4	<i>Holophrya oblonga</i> (FAURE-FREMIET, 1924)	?	Ba,Cy Al,Cil	-	-	-	+
5	<i>Prorodon marinus</i> (CLAPAREDE & LACHMANN, 1858)	he?	Cil	-	-	-	+
6	<i>Prorodon ovum</i> (EHRENBERG, 1838)	he	Cil	-	-	-	+
7	<i>Urotricha globosa</i> (CLAPAREDE & LACHMANN, 1857)	he?	Ba, Al	b	+	-	-
8	<i>Plagyocampa rouxi</i> (KAHL, 1930)	he	Ba, Al	-	+	-	-
9	<i>Pseudoprorodon sulcatus</i> (?) (KAHL, 1930)	?	Al, Fl	-	-	+	-
10	<i>Coleps hirtus</i> (NITZSCH, 1817)	he?	O	a-b	+	-	-
11	<i>Coleps spetai</i> (KAHL, 1930)	os	Al, Cy	b	+	+	-
12	<i>Lagynophrya rostrata</i> (KAHL, 1930)	os	Al	o	+	-	-
13	<i>Lagynophrya acuminata</i> (KAHL, 1930)	os	Al	o	-	+	-
14	<i>Pleuronema coronatum</i> (KENT, 1881)	he?	O	b	+	+	-

15	<i>Phithothorax processus</i> (KAHL, 1931)	?	Al	?	+	-	-
16	<i>Lacrymaria coronata</i> (CLAPAREDE & LACHMANN 1858)	he	Cil	b	+	-	+
17	<i>Lacrymaria acuta</i> (KAHL, 1930)	he	Cil	b	+	-	-
18	<i>Lacrymaria olor</i> (MÜLLER, 1788)	he	Cil	b	+	+	-
19	<i>Stentor polymorphus</i> (MÜLLER, 1773) EHRENBURG 1830	oms	O	a-b	+	+	-
20	<i>Trachelophyllum sigmoides</i> (KAHL, 1931)	he?	Ba, Fl, Cil	b-a	+	-	-
21	<i>Trachelophyllum apiculatum</i> (PERTY, 1936)	he?	Ba, Fl, Cil	b-a	+	+	-
22	<i>Didinium nasutum</i> (MÜLLER, 1786)	oe?	Cil	a-b	+	+	+
23	<i>Mesodinium pulex</i> (KAHL, 1933)	oe?	Ba, Al, Fl	-	-	-	+
24	<i>Mesodinium rubrum</i> (LOHMANN, 1908)	oe?	Ba, Al, Fl	-	-	-	+
25	<i>Spathidium</i> sp.	he	Cil	-	+	-	-
26	<i>Lionotus (Lithonotus) lamella</i> (EHRENBURG, 1838)	he	Cil	a	+	-	+
27	<i>Loxophyllum helus</i> (STOKES, 1884)	he?	Cil	b	+	+	+
28	<i>Loxodes striatus</i> (ENGELMANN, 1862)	os?	Ba, Fl, Al	p	+	-	-
29	<i>Loxophyllum laevigatum</i> (SAUERBREY, 1928)	oe	Cil	b	-	-	+
30	<i>Remanella multinucleata</i> (KAHL, 1933)	he?	Al, Fl	-	-	-	+
31	<i>Remanella rugosa</i> (KAHL, 1933)	he?	Al, Fl	-	-	-	+
32	<i>Trithigmostoma cucullulus</i> (KAHL, 1931)	he	Ki, Al, Cy, Ba	a-p	+	+	-
33	<i>Plagiopyla nasuta</i> (STEIN, 1860)	oe?	Ba, Sb, Al, Fl	p-i	+	-	-
34	<i>Uronema marinum</i> (DUJARDIN, 1841)	he	Ba	a	-	-	+
35	<i>Pleuronema marinum</i> (DUJARDIN, 1841)	hc	Ba, Fl, Al	b	-	-	+
36	<i>Vorticella</i> sp.	oe?	Ba, Al	b?	-	-	+
37	<i>Stentor polymorphus</i> (KAHL, 1930)	oms	O	b-a	+	+	-
38	<i>Bresslaui</i> sp.	?	?	?	+	-	-
39	<i>Colpoda ecaudata</i> (LIEBMAN, 1836)	ome	Ba	p-i	+	-	-
40	<i>Colpoda inflata</i> (KAHL, 1931)	ome	Ba, Fl	a-p	+	-	-
41	<i>Colpoda steinii</i> (KAHL, 1935)	ome	Ba	a-p	+	-	-
42	<i>Bursaria</i> sp.	?	?	?	+	-	-
43	<i>Nassula picta</i> (EHRENBURG, 1833)	oe?	Cy	b	+	-	-
44	<i>Tetrahymena pyriformis-complex</i> (EHRENBURG, 1830)	oms?	Ba	p-i	+	-	-
45	<i>Ophryoglena atra</i> (EHRENBURG, 1831)	-	histofag	-	+	+	-
46	<i>Paramecium aurelia-complex</i> (EHRENBURG, 1838)	ome	Ba	a-b	+	+	-
47	<i>Paramecium caudatum</i> (EHRENBURG, 1838)	ome	Ba, Al	p-a	+	-	-
48	<i>Paramecium putrinum</i> (HILL, 1752)	ome	Ba, Sb, Cy, Al	p-a	+	-	-
49	<i>Paramecium trichium</i> (HILL, 1752)	ome	Ba, Cy, Al	p	+	-	-
50	<i>Lembadion bullinum</i> (PERTY, 1852)	oe?	Ba, Al, Fl	b	+	-	-
51	<i>Uronema nigricans</i> (MÜLLER, 1786)	he	Ba, Fl	a-p	+	-	-
52	<i>Vorticella campanula</i> (KAHL, 1930)	he?	Ba, Al	a-b	+	+	-
53	<i>Spirostomum teres</i> (CLAPAREDE & LACHMANN 1859)	oe?h e?	Sb, Ba, Al, Cy	p	+	-	-
54	<i>Metopus</i> sp.	he	Ba, Fl, Al	p-m	-	-	-
55	<i>Saprodinium</i> spp.	os	Ba, Sb	p-m	+	-	-
56	<i>Strombidium viride</i> (FOISSNER, 1986)	oe	Ki, Al, Ba	b	+	-	-
57	<i>Uroleptus</i> sp.	oe?	Ba, Al	a-p	+	-	-
58	<i>Paruroleptus</i> sp.	he	Ba, Al	b-a	+	-	-
59	<i>Oxytricha</i> sp.	he?	Ba, Fl, Ki	a	+	-	-
60	<i>Stylonichia mytilus-complex</i> (MÜLLER, 1773)	ome	O	a	+	+	-
61	<i>Condyllostoma arenarium</i> (SPIEGEL, 1926)	he	Fl, Cil	-	-	-	+
62	<i>Trachelostyla caudate</i> (KAHL, 1932)	oe?	Cil	a	-	-	+
63	<i>Trachelostyla dubia</i> (DRAGESCO, 1960)	oe?	Cil	a	-	-	+
64	<i>Oxytricha gibba</i> (MÜLLER, 1786)	he	Ba, Fl, Ki	-	-	-	+
65	<i>Euplotes patella</i> (MÜLLER, 1786)	he	Ba, Fl, Al	b	+	-	-
66	<i>Euplotes</i> sp. 1	he?	Ba, Al, Ki, Fl	-	-	-	+
67	<i>Euplotes</i> sp. 2	he?	Ba, Al, Ki, Fl	-	-	-	+
68	<i>Euplotes</i> sp. 3	he	Ba, Fl	a	+	+	-
69	<i>Diophrys scutum</i> (DUJARDIN, 1841)	os?	Al, Fl	-	-	-	+
70	<i>Uronychia transfuga</i> (MÜLLER, 1786)	os?	Ba, Al, Fl	-	-	-	+
71	<i>Aspidisca steini</i> (BUDDENBROCK, 1920)	he?	Ba	?	-	-	+
72	<i>Aspidisca</i> sp.	he?	Ba	a-b	+	-	-

## Abbreviations used in table 1:

a = alphamesosaprobic  
 a-b = alphamesosaprobic-polysaprobic  
 a-p = alphamesosaprobic-polysaprobic  
 b = betamesosaprobic  
 b-a = betamesosaprobic-alphamesosaprobic  
 Ba = Cil bacteria = ciliates  
 Cy = cyanobacteria  
 Fl = heterotrophic flagellates  
 Fs = anaerobic mud and anaerobic zones in the pelagial  
 GS = saprobity level  
 he = halo-euryhaline  
 HP = preferred food  
 histophagus = type of feeding where the trophic base is represented by tissues  
 i = isosaprobic  
 m = metasaprobic  
 MH = type of feeding  
 NBE = normal activated sludge  
 O = omnivorous  
 o = oligosaprobic  
 oe = oligo-euryhaline (0-10 psu)  
 ome = oligo or meso-euryhaline (0-30 psu)  
 oms = oligo to meso-stenohaline (0-4 psu)  
 os = oligo-stenohaline (0-1 psu)  
 p = polysaprobic  
 p-i = polysaprobic-isosaprobic  
 p-a = polysaprobic-alphamesosaprobic  
 p-m = polysaprobic-metasaprobic  
 Sb = sulphur bacteria  
 TS = tolerance to salinity  
 ? = incertitude regarding the feeding method, tolerance to salinity, saprobity level or community of the species concerned (FOISSNER, 1986)  
 + = present species  
 - = absent species

## Abrevieri utilizate în tabel 1:

a = alfamezosaprobă  
 a-b = alfamezosaprobă-polisaprobă  
 a-p = alfamezosaprobă-polisaprobă  
 b = betamezosaprobă  
 b-a = betamezosaprobă-alfamezosaprobă  
 Ba = bacterii Cil = ciliate  
 Cy = cianobacterii  
 Fl = flagelate heterotrofe  
 Fs = mături anaerobe și zone anaerobe în pelagial  
 GS = grad de saprobitate  
 he = holoeurihaline (între 0 și mai mult de 30 psu)  
 HP = hrană preferată  
 histofag = modalitate de hrănire în care baza trofică o reprezintă țesuturile  
 i = izosaprobă  
 m = metasaprobă  
 MH = modalitate de hrănire  
 NBE = mături activate normale  
 O = omnivore  
 o = oligosaprobă  
 oe = oligo-eurihalin (0-10 psu)  
 ome = oligo sau mezo-eurihalin (0-30 psu)  
 oms = oligo-mezo-stenohaline (0-4 psu)  
 os = oligostenohaline (0-1 psu)  
 p = polisaprobă  
 p-i = polisaprobă-izosaprobă  
 p-a = polisaprobă-alfamezosaprobă  
 p-m = polisaprobă-mezosaprobă  
 Sb = bacterii sulfuroase  
 TS = toleranța la salinitate  
 ? = reprezintă incertitudinea referitoare la modalitatea de hrănire, toleranță la salinitate, grad de saprobitate sau comunitatea căreia îi aparține respectiva specie (FOISSNER, 1986)  
 + = specie prezentă  
 - = specie absentă

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## SPECIES DIVERSITY OF FRESHWATER AND SOIL NEMATODES OF SOME LOCALITIES ALONG THE DNIESTER RIVER

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**Abstract.** Species and trophic diversity of freshwater and soil nematodes of some localities along the Dniester River have been studied during the last few years. At present, 63 species of nematodes from 43 genera, 27 families and 9 orders were revealed in the sediment and river bank of the Dniester River. The largest number of nematode species belongs to the orders Dorylaimida-14 species (22.22% from total number of species), Rhabditida-12 (19%), Tylenchida-11 (17.46%) followed by Triplonchida-9 species (14.28%), Plectida-9 (14.28%), Monhysterida-5 (7.93%), Mononchida-2 (3.17%), Aphelenchida-1 (1.58%) and Chromadorida-1 (1.58%). Most of the nematode species are bacterial feeders-28 species (44.44%), followed by plant feeders-11 (17.46%), omnivores-11 (17.46%), predators-6 (9.52%), microalgae feeders-4 (6.35%) and hyphal feeders-3 (4.76%). In the littoral zone of the Dniester River the microalgae feeders (Tobrilidae), bacterial feeders (Monhysteridae, Plectidae, Cephalobidae, Panagrolaimidae and Rhabditidae) dominated both on the species diversity and their abundance. In the river bank the nematode plant parasites are mainly composed of ectoparasites, some populations of endoparasites were revealed.

**Keywords:** freshwater and soil nematodes, species and trophic diversity, the Dniester River.

**Rezumat.** Diversitatea speciilor de nematode acvatice și edafice în câteva localități de-a lungul fluviului Nistru. A fost studiată diversitatea specifică și structura trofică a comunităților (cenozelor) de nematode acvatice și edafice colectate din diverse zone ale fluviului Nistru. Până în prezent (2009) au fost identificate 63 specii de nematode aparținând la 43 genuri, 27 familii și 9 ordine. Cel mai mare număr de specii s-a găsit pentru ordinul Dorylaimida-14 specii (22.22% from total number of species), Rhabditida-12 (19%), Tylenchida-11 (17.46%) followed by Triplonchida-9 species (14.28%), Plectida-9 (14.28%), Monhysterida-5 (7.93%), Mononchida-2 (3.17%), Aphelenchida-1 (1.58%) și Chromadorida-1 (1.58%). Cea mai multe specii de nematode aparțin grupei trofice bacteriofage-28 specii (44.44%), urmate de fitoparazite-11 specii (17.46%), omnivore-11 (17.46%), prădătoare-6 (9.52%), consumatoare de microalge-4 (6.35%) și micofage-3 (4.76%). În zona litorală a fluviului Nistru, nematoadele consumatoare de microalge (Tobrilidae), bacteriofagele (Monhysteridae, Plectidae, Cephalobidae, Panagrolaimidae și Rhabditidae) domină comunitățile atât prin abundență cât și prin diversitatea specifică. Dintre nematoadele edafice fitofage predomină ectoparazițele, dar uneori sunt întâlnite, de asemenea, specii de nematode endoparazite.

**Cuvinte cheie:** nematode acvatice și edafice, specii și diversitatea trofică, fluviul Nistru.

### INTRODUCTION

Nematodes are the most diverse, abundant and widely distributed group of invertebrate animals. Nematodes often occur in environmental conditions on water, sediment and soil; they occupy positions at the base of the food chains that ultimately sustain other animals. They are the main catalyst of some water, sediment and soil processes, especially mineralization and humification of dead organic matter, responsible for cycling of sediment and soil nutrients and self-purification of water due to their interaction with bacteria, algae and fungi (WASILEWSKA, 1997; BONGER, FERRIS, 1999 etc.).

In the last few years we have been studying the biodiversity of freshwater and soil nematodes from different localities and habitats along the Dniester River.

### MATERIAL AND METHODS

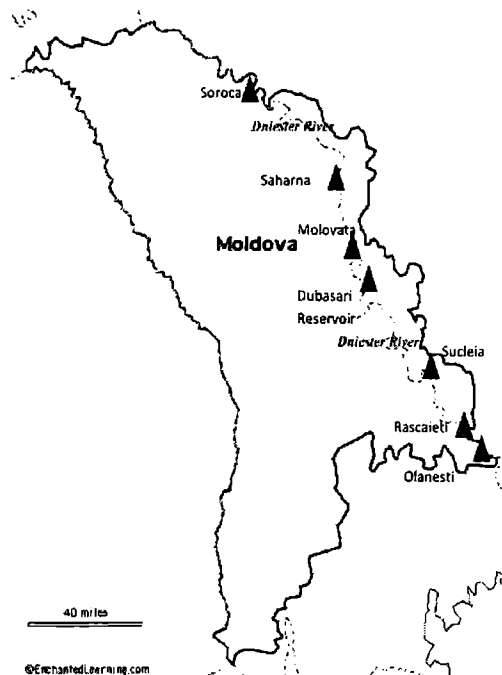
#### Site description

The Dniester drains a long, narrow basin that is about 72,000 square km but nowhere is more than 100–110 km wide. The Dniester River flows through the territories of densely populated counties of Ukraine and Moldova. The river's basin is bounded on the north by the Volyn-Podilsk Upland and on the south of the river's upper course by the Carpathian Mountains. Farther to the south there are hilly plains and the Bassarabia Upland, and at the south eastern most end of the basin is the Black Sea Lowland. The climate of the river basin is humid, with warm summers. A large proportion of the land of the basin is under cultivation. The Dniester frequently floods, causing extensive damage to settled areas ("Ecosystems of Dniester River", 1990). Towards the Dniester's mouth, the composition of the bottom gradually alters from calcareous, shingly sand to sand, silt sand and silt with different textures. The river-bed is curved and stream velocity is slow especially in the lower stretch forming a large spectrum of habitats. According to the hydrological and physical characters, the Dniester River is divided in three stretches: the upper one – Carpathian (from source to the village of Cosauti, Soroca district), the middle one – Podolian (down to the town Dubasari) and the lower one (down to the mouth). The long-term research of the chemical composition of water and sediment of the Dniester River in the Laboratory of Hidrobiology and Ecotoxicology, Institute of Zoology ASM has shown that the levels of ammonium nitrogen, nitrite nitrogen, and phosphor mineral were comparable nowadays with those from the 1980s. However, the levels of organic nitrogen and organic matter were twice greater (ZUBCOV, 1988, ZUBCOV & SCHLENK, 2004). The water of the Dniester River was characterized as moderately polluted. The twice-increase of the ammonium

nitrogen and nitrite nitrogen is often observed in the water below the city Soroca. The channel of the river and water area of the Dubasari Reservoir intensively grows now with the higher water plants. Reception of cold water in the reservoir in summer time strengthens the processes of half-decay macrophytes that finally conduct to secondary pollution of water by organic substances and reduction of the dissolved oxygen (ZUBCOV, 1998; ZUBCOV & SCHLENK, 2004).

### Sampling localities

The samples of sediment and soil of the river bank were collected in the localities along the Dniester River for different habitats and periods of time (2004–2008). In the upper stretch of the Dniester River the sampling localities were below the city Soroca (sediment samples); in the middle one - Dubasari Reservoir, near the towns of Rezina, Saharna and Malovata (soil samples of the river bank) and in the lower one - near villages Sucleia (sediment samples of littoral zone), Rascaeti (grassland) and town Olanesti (floodplain grassland, willow plantation) (Fig. 1).



### Sampling and extraction

Samples were collected for the last five years from different habitats. Soil samples were taken from a 25 square cm surface area and 10 cm depth. The aquatic nematodes were collected with a hand-held Perspex core tube in the littoral zone. Nematodes were extracted alive by sieving and decanting using standard methods of brass screens (40, 60, 100, 325 and 500 mesh) and Baermann funnels and fixed in hot 4% formaldehyde. Then the specimens of nematodes were accounted and some of them were picked out, and processed to glycerine, mounted on permanent slides, labelled with sampling data and reference numbers, identified and deposited in a managed collection ("Methods for the examination of organism diversity in soils and sediments", 1996). The nematode specimens were identified on mass-slides to species using the keys and species description by NESTEROV (1979), NICKLE (1991), JAIRAJPURI (1992), GAGARIN (1993, 2001), LOOF (1999), SIDDIQI (2000), ZULLINI (2005), ANDRASSY (2005), EYUALEM-ABEBE et al. (2006). Classification of Phylum Nematoda accepted in the "Fauna Europaea" database ([www.faunaeur.org](http://www.faunaeur.org)) is used in this paper. The nematode trophic groups were given according to YEATS et al. (1993).

Figure 1. Sampling localities along the Dniester River (The Republic of Moldavia).

Figura 1. Localitățile de unde s-au prelevat probe de-a lungul Fluviului Nistru (Republica Moldova).

## RESULTS AND DISCUSSIONS

At present (2009), 63 species of freshwater and terrestrial nematodes from 43 genera, 27 families and 9 orders were revealed in the sediment and river bank of some localities along the Dniester River. The identified species of nematodes belong to the following orders and families, such as order **Chromadorida**: Chromadoridae - *Punctodora* sp.; **Dorylaimida**: Aporcelaimidae - *Aporcelaimellus amplexor* (NESTEROV & LISETSKAJA, 1965), *A. krygeri* (DITLEVSEN, 1928), Dorylaimidae - *Dorylaimus montanus* STEFANSKI, 1923, *D. stagnalis* DUJARDIN, 1845, *Mesodorylaimus bastiani* (BÜTSCHLI, 1873), *M. mesonyctius* (KREIS, 1930), *M. potus* HEYNS, 1963, *M. pseudobastiani* LOOF, 1969, *Mesodorylaimus* sp., Leptonchidae - *Tylencholaimellus coronatus* THORNE, 1939, Qudsinematidae - *Eudorylaimus acuticauda* (DE MAN, 1880), *Thonus ettersbergensis* (DE MAN, 1885), Xiphinematidae - *Xiphinema pachtaicum* (TULAGANOV, 1938), Tylencholaimidae - *Tylencholaimus stecki* STEINER, 1914; **Mononchida**: Mononchidae - *Mononchus aquaticus* COETZEE, 1968, Mylonchulidae - *Mylonchulus sigmaturus* (COBB, 1917); **Monhysterida**: Monhysteridae - *Eumonhystera dispar* (BASTIAN, 1865), *E. filiformis* (BASTIAN, 1865), *Monhystera paludicola* DE MAN, 1881, *M. stagnalis* BASTIAN, 1865, Xyalidae - *Daptonema dubium* (BÜTSCHLI, 1873); **Plectida**: Rhabdolaimidae - *Udonchus tenuicaudatus* COBB, 1913, *Udonchus* sp., Chronogastridae - *Chronogaster typica* (DE MAN, 1921), Plectidae - *Anaplectus granulosus* (BASTIAN, 1865), *Plectus acuminatus* BASTIAN, 1865, *P. aquatilis* ANDRÁSSY, 1985, *P. parietinus* BASTIAN, 1865, *P. parvus* BASTIAN, 1865, *P. rhizophilus* DE MAN, 1880; **Triplonchida**: Prismatolaimidae - *Prismatolaimus dolichurus* DE MAN, 1880, *P. intermedius* (BÜTSCHLI, 1873), Tobrilidae - *Brevitobrilus stefanskii* (MICOLETZKY, 1925), *Neotobrilus diversipapillatus orientalis* (DADAY, 1905), *N. longus* (LEIDY, 1852), *Tobrilus gracilis* (BASTIAN, 1865), Tripylidae - *Tripyla affinis* DE MAN, 1880, *T. filicaudata* DE MAN, 1880, *Trischistoma monohystera* (DE MAN, 1880); **Aphelenchida**: Aphelenchidae - *Aphelenchus* sp.; **Rhabditida**: Cephalobidae - *Acrobeles complexus* THORNE, 1925, *Cephalobus parvus* THORN, 1937, *C. persegnis* BASTIAN, 1865, *Eucephalobus paracornutus* DE CONINCK, 1943, *Heterocephalobus elongatus* (DE MAN, 1880),

Diplogastridae - *Diplogaster rivalis* (LEYDIG, 1854), Panagrolaimidae - *Panagrolaimus hygrophilus* BASSEN, 1940, *P. rigidus* (A. SCHNEIDER, 1866), *Panagrolaimus* sp., Rhabditidae - *Poikilolaimus oxycerca* (DE MAN, 1895), *Caenorhabditis* sp., *Mesorhabditis* sp.; **Tylenchida:** Tylenchidae - *Aglenchus agricola* (DE MAN, 1884), *Filenchus filiformis* (BÜTSCHLI, 1873), *Tylenchus davainei* BASTIAN, 1865, Ecphyadophoridae - *Lelenchus leptosoma* (DE MAN, 1880), Hoplolaimidae - *Helicotylenchus erythrinae* (ZIMMERMANN, 1904), *Rotylenchus robustus* (DE MAN, 1876), Pratylenchidae - *Hirschmanniella* sp., *Pratylenchus pratensis* (DE MAN, 1880), Tylotylenchidae - *Merlinius brevidens* (ALLEN, 1955), *Merlinius* sp. and *Bitylenchus dubius* (BÜTSCHLI, 1873).

The largest number of species were noted from the orders Dorylaimida (14 species), Rhabditida (12), Tylenchida (11) followed (in descending order) by Triplonchida (9 species), Plectida (9), Monhysterida (5), Mononchida (2), Aphelenchida (1) and Chromadorida (1). According to the feeding types (trophic groups by Yeats et al., 1993) among the revealed nematode species prevailed the bacterial feeders (28 species), followed by the plant feeders (11, mainly ectoparasites and epidermal cell feeders), omnivores (11), predators (6), microalgae feeders (4) and hyphal feeders (3).

In the sampling locality situated below the wastewater treatment station of the city Soroca (sediment samples) the following species were revealed: *Tobrilus gracilis*, *Neotobrilus diversipapillatus orientalis*, *Neotobrilus longus*, *Brevitobrilus stefanskii*, *Monhystera paludicola*, *Plectus* cf. *rhizophilus*, *Chronogaster typica*, *Panagrolaimus* sp., *Panagrolaimus hygrophilus*, *Heterocephalobus elongatus*, *Caenorhabditis* sp., *Aphelenchus* sp., *Poikilolaimus oxycerca*, *Dorylaimus stagnalis* and *Mesodorylaimus* sp.. The species belonging to the family Tobrilidae were diverse and numerous, their populations consisting in mature females, males and juveniles (sampled in June 2007). Between tobrilids the species of the genus *Neotobrilus* were dominant. Among the trophic groups the microalgae feeders (Tobrilidae) and bacterial feeders (Monhysteridae, Plectidae, Cephalobidae, Panagrolaimidae and Rhabditidae) were dominant. The common species *Dorylaimus stagnalis* prefers the standing polluted water.

In the sampling locality along the Dubasari Reservoir where the river bank was covered with herbaceous plants the species of plant feeders were numerous and diverse, such as *Filenchus filiformis*, *Lelenchus leptosoma*, *Helicotylenchus erythrinae*, *Rotylenchus robustus*, *Pratylenchus pratensis*, *Merlinius brevidens*, *Xiphinema pachtaicum* and between the bacterial feeders, the following species *Poikilolaimus oxycerca*, *Acrobeles complexus*, *Cephalobus parvus*, *Trischistoma arenicola*, *Aporcelaimellus amplexor*, *Tylencholaimus stecki* and *Tylencholaimellus coronatus* were predominant. In the littoral zone of the Dubasari Reservoir, with sandy bottom, the species *Tobrilus gracilis*, *Diplogaster rivalis*, *Tripyla affinis*, *Dorylaimus stagnalis*, *D. montanus* and *Mesodorylaimus potus* were found. The first four species were numerous.

In the flooded tree plantations along the lower stretches of the Dniester River (near the village Olanesti), which include willow, mixed forests and floodplain grassland, the following species have been noted, such as: *Aglenchus agricola*, *Tylenchus davainei*, *Filenchus filiformis*, *Bitylenchus dubius*, *Merlinius* sp., *Rotylenchus robustus*, *Mesorhabditis* sp., *Eucephalobus paracornutus*, *Cephalobus persegnis*, *Monhystera dispar*, *Anaplectus granulosus*, *Plectus aquatilis*, *P. parietinus*, *Prismatolaimus intermedius*, *Mylonchulus sigmaturus*, *Eudorylaimus acuticauda*, *Mesodorylaimus bastiani*, *M. mesonyctius*, *Aporcelaimellus krygeri* and *Thonus ettersbergensis*.

In the littoral zone with silt sand (the Dniester River near the village Olanesti) two species *Dorylaimus stagnalis* and *Tobrilus gracilis* were predominant among other species, such as: *Mesodorylaimus mesonyctius*, *M. potus*, *Plectus aquatilis*, *Trischistoma monohystera*, *Tripyla filicaudata*, *Diplogaster rivalis* and *Panagrolaimus* sp.

In the littoral zone of the lower stretches of the Dniester River (near the village Sucleia) the species *Punctodora* sp., *Chronogaster* sp., *Tobrilus gracilis*, *Brevitobrilus stefanskii*, *Neotobrilus diversipapillatus orientalis*, *Hirshmaniella* sp., *Mononchus aquaticus*, *Dorylaimus stagnalis*, *Monhystera stagnalis*, *Eumonhystera filiformis*, *Daptonema dubium*, *Prismatolaimus dolichurus*, *Ironus tenuicaudatus*, *Eumonhystera dispar*, *Plectus acuminatus*, *Ironus* cf. *gagarini*, *Panagrolaimus hygrophilus*, *Udonchus* sp. were found.

The analysis of the nematode species from the littoral zone of some sampling localities along the Dniester River has been carried out using the ecological groups suggested by GAGARIN (2001). The first ecological group includes the hydrobionts formed by three subgroups, such as the true hydrobionts (oxygen consumers) are the species from the family Tobrilidae and the genera *Tripyla*, *Ironus*, *Mononchus* (*M. aquaticus*), some *Monhystera*, *Eumonhystera* (*E. dispar* and *E. filiformis*), *Daptonema*, *Chronogaster* etc.; the freshwater saprobionts (adapted for the deficiency of oxygen) are the species *Panagrolaimus hygrophilus* and *Diplogaster rivalis* and the phytoparasitic nematodes of freshwater macrophytes are the species of the genus *Hirschmanniella*. The second ecological group - amphibionts include the majority of species from the genera *Eumonhystera*, *Plectus*, *Anaplectus*, *Mylonchulus*, *Mesodorylaimus*, *Eudorylaimus*, species *Panagrolaimus rigidus*, *Poikilolaimus oxycerca* and few species of the genus *Aphelenchoides* living in the freshwater, moss and humidified soil. The third ecological group - edaphobionts adapted to the terrestrial conditions appearing in the freshwater casually. These species are not adapted for the dwelling in the aquatic environment for a long time though they suffer easily from the deficiency of oxygen. This group includes practically the majority of terrestrial species from the orders Rhabditida, Tylenchida, Aphelenchida and Dorylaimida.

## CONCLUSIONS

A large spectrum of aquatic and terrestrial habitats along the Dniester River formed the favourable living conditions for the different species of Phylum *Nematoda*. At present (2009), 63 species of freshwater and terrestrial nematodes from 43 genera, 27 families and 9 orders were revealed in the sediment and river bank of some localities along the Dniester River. In the littoral zone of the studied localities, the microalgae feeders (Tobrilidae), bacterial feeders (Monhysteridae, Plectidae, Cephalobidae, Panagrolaimidae and Rhabditidae) are dominant concerning the species diversity and their abundances. The species *Dorylaimus stagnalis* was common in all freshwater samples. In the river bank the plant feeders are mainly composed of the non-obligatory plant parasites as ectoparasites and root hair feeders especially the genera *Filenchus*, *Lelenchus*, *Malenchus* and *Tylenchus*. Only the numerous populations of endoparasitic species *Pratylenchus pratensis* and ectoparasitic species *Helicotylenchus erythrinae*, *Rotylenchus robustus*, *Merlinius brevidens* and *Xiphinema* spp. could cause some depressions or diseases of herbaceous or tree plants.

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## ENDEMISM OF LAND AND FRESHWATER GASTROPODS IN THE LAKES REGION (TURKEY)

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**Abstract.** *In this study, zoogeography and endemism of land and freshwater snails of Lakes Region, the richest inland water reservoir in Turkey, were evaluated. 40 species and subspecies from 21 genera and 10 families of the subclass Prosobranchia have been recorded in the Lakes Region (27 being endemic to Anatolia), also 24 species belonging to 14 genera and 4 families of the subclass Pulmonata have been recorded (2 out of 4 Anatolian endemics also present). Of 705 land snail taxa recorded so far in Turkey, 122 taxa, 53 being endemics, are also found to occur in Lakes Region. Zoogeographic characteristics of the area were discussed depending on the distribution of the gastropod species in the lakes.*

**Keywords:** *Lakes region, endemism, Mollusca, Zoogeography, Turkey.*

**Rezumat.** *Gasteropode endemice de uscat și apă dulce din Regiunea Lacurilor (Turcia). În cadrul acestui studiu, a fost analizată zoogeografia și speciile endemice de gasteropode de uscat și apă dulce din Regiunea Lacurilor, cea mai reprezentativă zonă lacustră din Turcia. În Regiunea Lacurilor, au fost înregistrate 40 de specii și subspecii din 21 de genuri și 10 familii din subclasa Prosobranchia (27 fiind endemisme din Anatolia) și alte 24 de specii aparținând la 14 genuri și 4 familii din subclasa Pulmonata (2 din cele 4 endemisme din Anatolia fiind de asemenea prezente). Din cele 705 specii de gasteropode de uscat înregistrate până în prezent în Turcia, 122 specii se regăsesc în această regiune, 53 dintre acestea fiind endemisme. Caracteristicile zoogeografice ale zonei au fost de asemenea discutate deoarece distribuția speciilor de gasteropode depinde de acestea.*

**Cuvinte cheie:** *Regiunea Lacurilor, endemism, moluște, zoogeografie, Turcia.*

### INTRODUCTION

Both qualitatively and quantitatively, Lakes Region has the richest inland aquatic reservoir in Turkey. Being among the most important karstic areas, the area attained a relatively rich aquatic fauna through active paleogeographic history of Turkey. The geographical and biological structure and development process of the area, however, have been affected negatively by the eremial periods and recently by human impact. Therefore the area becomes more important with regard to the level of threat to the organisms (esp. birds) found in the area (ERTAN et al., 1996).

The Lakes District is situated within the western Toros Mountains in southwestern Turkey. The change in direction of the Toros Mountains to the north of Antalya Bay has resulted in the formation of narrow and long mountain belts surrounding depressions in some of which numerous lakes were formed. Lakes region and close areas fully became terrestrial by late Miocene. Tectonic character of the lakes like Beyşehir and Eğirdir relates to depressions formed during or after Miocene, which were filled by Neogene lakes. Recent activities and heavy use affected the lakes greatly resulting in drying of the lakes and extinction of local species. The three freshwater lakes, Söğüt, Kestel (Burdur) and Avlan (Antalya) have been systematically dried for agricultural needs so far (İNANDIK, 1965; ATALAY, 1997).

Although the area is a relatively well known area still the inventory of mollusks is far from complete. Researchers having intensive studies on gastropod fauna of the area are: SCHÜTT (1964; 1965; 1983; 1990; 1991; 1992; 1994), RADOMAN (1973; 1976; 1983), BILGIN (1967; 1980) and YILDIRIM (1999a, b).

### MATERIAL AND METHODS

Study is based on the excursions performed between 1993 and 2009 and literature data. In excursions, aquatic habitats possessing permanent waters and terrestrial habitats representative of the faunas were chosen for sampling. Literature works mainly followed for identification are ZHADIN (1952); SCHÜTT (1964, 1965, 2005) and GLÖER et al. (2001).

### RESULTS AND DISCUSSIONS

#### Freshwater Prosobranchia species

A total of 40 prosobranch species and subspecies from 21 genera and 10 families of the subclass Prosobranchia have been recorded in the Lakes Region. Of these, 27 are endemic to Anatolia (as compared to 46 in total), 25 endemics are strictly restricted to the region. Local endemism is thus 68% (57% for all species). In addition, 22 species and 6 subspecies of fossil prosobranchs have been described in sediments of different geological periods from various parts of Anatolia (YILDIRIM, 1999b). Present findings show that many species await description, as remote unvisited springs often present new species. The endemics can be listed as:



1. *Theodoxus heldreichi heldreichi* (MARTENS, 1879): Nominal subspecies is found only in Beyşehir and Eğirdir lakes. Fossils are found in Acıgöl, Konya Lake (Çumra) and Hotamış area Quaternary sediments (SCHÜTT & ŞEŞEN, 1989; SCHÜTT, 1991; YILDIRIM, 1999b).
2. *Theodoxus heldreichi fluviocola* SCHÜTT & ŞEŞEN, 1992: Much commoner than nominal subspecies. Widely distributed in many undisturbed aquatic systems in southern Aegean region (İzmir, Manisa, Aydın, Denizli, Isparta etc.) (BILGIN, 1980; SCHÜTT & ŞEŞEN, 1989; SCHÜTT, 1991; YILDIRIM, 1999b).
3. *Theodoxus altenai* SCHÜTT, 1965: It is found only in Kırkgöz Kaynağı (Döşemealtı, Antalya) (YILDIRIM, 1999b).
4. *Hydrobia anatolica* SCHÜTT, 1965: The taxonomic status of this species described from Düdenbaşı (Antalya) (SCHÜTT, 1965) is uncertain and it is possibly a *Graceoanatolica* RADOMAN species.
5. *Pseudamnicola geldiyana* SCHÜTT & BILGIN, 1970: It is an endemic distributed in springs around Dinar, and Çivril (SCHÜTT & BILGIN, 1970; BILGIN, 1980; YILDIRIM, 1999b).
6. *Pyrgorientalia zilchi* (SCHÜTT, 1964): It is found only in Kırkgöz spring (SCHÜTT, 1964; BILGIN, 1980; RADOMAN, 1983; YILDIRIM, 1999b).
7. *Kirelia carinata* RADOMAN, 1973: It is found only in Lake Beyşehir (RADOMAN, 1973; YILDIRIM, 1999b).
8. *Falsipyrgula pfeiferi* (WEBER, 1927): It is endemic to Lake Eğirdir (SCHÜTT, 1965, 1990; RADOMAN, 1983).
9. *Falsipyrgula beysehirana* (SCHÜTT, 1965): It is found only in Lake Beyşehir (SCHÜTT, 1965, 1990; RADOMAN, 1983).
10. *Falsipyrgula schuetti* SCHÜTT & YILDIRIM, 1999: It is found only in Lake Beyşehir (SCHÜTT & YILDIRIM, 1999b).
11. *Horatia parvula* (NAEGELE, 1894): It has been reported at Isparta, Tokat (terra typica), Mardin, and Diyarbakır (SCHÜTT, 1965; BILGIN, 1967, 1980), but validity of these records are doubtful.
12. *Pseudorientalia natolica smyrnensis* SCHÜTT, 1970: It is distributed in İzmir, Aydın, Denizli, and Isparta (SCHÜTT, 1965; SCHÜTT & BILGIN, 1970; BILGIN, 1967, 1980; YILDIRIM, 1999b).
13. *Tefennia tefennica* SCHÜTT & YILDIRIM: It is endemic to Başpınar spring in Tefenni, Burdur (SCHÜTT & YILDIRIM, 2003).
14. *Turkorientalia anatolica* RADOMAN, 1973: It is restricted to Yercey spring (Burdur) (YILDIRIM, 1999b).
15. *Graecoanatolica lacustriturca* RADOMAN, 1973: It is widespread in Pleistocene sediments in Isparta and Burdur (SCHÜTT, 1990; YILDIRIM, 1999b), but now it can be found only in Eğirdir and Beyşehir Lakes and a few springs in Burdur (RADOMAN, 1973, YILDIRIM, 1999b).
16. *Graecoanatolica tenuis* RADOMAN, 1973: It was described from Gemiş spring (Denizli) (YILDIRIM, 1999b).
17. *Graecoanatolica conica* RADOMAN, 1973: This extinct species was described from springs connected to Acıgöl lake (YILDIRIM, 1999b).
18. *Graecoanatolica brevis* RADOMAN, 1973: It is another extinct species once occurred in İncirlişpınar, a spring located in SW corner of lake Burdur (YILDIRIM, 1999b).
19. *Graecoanatolica kocapınarica* RADOMAN, 1973: It is endemic to Kocapınar spring in Yukarı Gökdere village, (Eğirdir, Isparta) (RADOMAN, 1973; YILDIRIM, 1999b).
20. *Graecoanatolica pamphylica* (SCHÜTT, 1964): This species, conchologically distinct from all congeners, can be found in Kırkgöz springs (terra typica), as well as in several other springs in Antalya (SCHÜTT, 1964, 1990; RADOMAN, 1973; YILDIRIM, 1999b; YILDIRIM & KARASAHIN, 2000).
21. *Sadleriana byzanthina demirsoyii* YILDIRIM & MORKOYUNLU, 1997: It is restricted to localities in Burdur and Antalya, while nominal subspecies is found in İzmir, Manisa, and Kütahya (SCHÜTT, 1965; SOYLU, 1990; YILDIRIM & MORKOYUNLU, 1997).
22. *Sadleriana minuta* (NAEGELE, 1903): It was described from Ereğli (Konya) (YILDIRIM, 1999b).
23. *Islamia pseudorientalica* RADOMAN, 1973: Like the other two congeners it is endemic to Kırkgöz springs.
24. *Islamia anatolica* RADOMAN, 1973.
25. *Islamia bunarbasa* (SCHÜTT, 1964).
26. *Bythinella turca* RADOMAN, 1976: It is an endemic of Isparta (RADOMAN, 1983; YILDIRIM, 1999b).
27. *Bithynia pseudemmericia* SCHÜTT, 1964: It is the most widespread endemic *Bithynia* species and found in localities of Afyon, Isparta, Antalya, Konya, Burdur. It is also common and widespread in Quaternary fossil strata: Hazar Lake, Gemiş vil. pond (SCHÜTT, 1965, BILGIN, 1980); Çumra, Çatalhöyük and Konya Quaternary sediments; Yarışlı, Burdur Lake Quaternary sediments (SCHÜTT, 1990; YILDIRIM, 1999a).

Endemic freshwater prosobranch taxa distributions can be used for the analysis of driving factors for the development of Anatolian malacofauna. Only three endemic species, *Th. heldreichi*, *G. lacustriturca* and *B. pseudemmericia*, can be accepted as widespread although they are only to be found in few parts of SW Anatolia outside the region. Most endemics show great impact of isolated position of Anatolia through geological history, also climatic and hyrogeographical conditions. For instance, Quaternary fossils of *B. pseudemmericia* are distributed in parts of Anatolia. Almost all the sites were once connected by an ancient lake system enabling faunal exchanges with Asia and Sarmatian Sea from Oligocene onwards (Figure 1). Present range, particularly formed by split of the lake into two basins and extensions towards SW Anatolia in Pliocene, represent only a small fraction of the former range. WILKE et al. (2007) demonstrated molecular evidence for the Sarmatian origin of Lakes region Pyrgulids (*Falsipyrgula* spp.) and notably a recent relative divergence time from the Sarmatian stock which may indicate consistency of faunal exchanges via river systems.

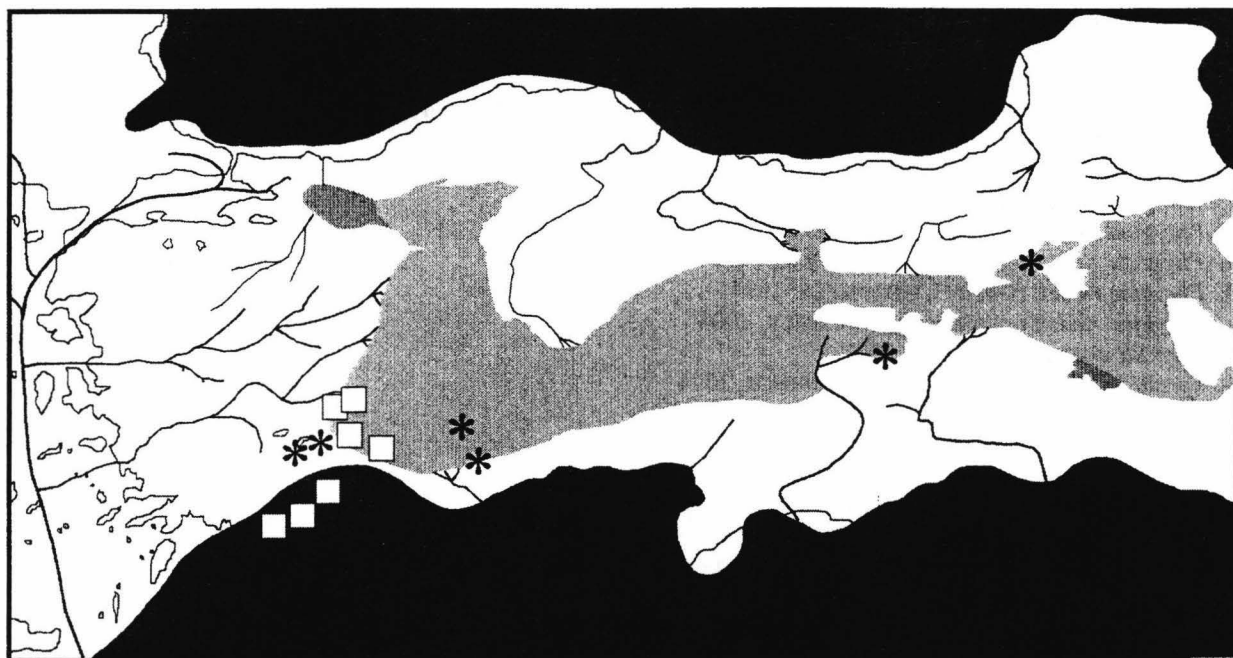


Figure 1. Ancient lake system (grey coloured) of Anatolia in its greatest extend (during Miocene) and distribution of present (empty squares) and fossil (asterisks) occurrences of *B. pseudemmericia* (Source: DEMIRSOY, 1999).

Figura 1. Sistem vechi de lacuri (colorat gri) în Anatolia în perioada de maximă extensiune (Miocene) și distribuția aparițiilor de *B. pseudemmericia* din prezent (pătrate goale) și a celor fosile (\*) (sursa: DEMIRSOY, 1999).

#### Freshwater Pulmonates (Basommatophora)

Of 33 species to be found in Turkey, only 4 are endemics. 24 species (72%) and among them, 2 strictly endemic taxa can be encountered in the freshwaters of the region. The endemics can be listed as:

Although not endemics, several exemplified by *Bathyomphalus contortus* (L., 1758) and *Hippeutis complanatus* (L., 1758) found in single spots in the region mark the refugial character of the region.

1. *Stagnicola tekecus* GLÖER & YILDIRIM, 2006: It is an interesting species conchologically similar to widespread *S. palustris* and can only be found in Kırkgöz and Konne springs (Antalya and Isparta);
2. *Gyraulus pamphylicus* GLÖER & RÄHLE, 2009: It is also a long unnoticed species from Kırkgöz spring (Antalya) having a distinctly angular body whorl.

#### Land Pulmonates (Stylommatophora)

Of 705 taxa occurring in Turkey, 112 can be found in the region (SCHÜTT, 2005). 53 of these (47%) are endemics. The endemics can be listed as:

1. *Euxinolauria superba zilchi* (SUBAI, 1993)
2. *Schileykula nordsiecki* HAUSDORF, 1996
3. *Schileykula scypus lycaonica* HAUSDORF, 1996
4. *Pilorcula trifilaris anatolica* HAUSDORF, 1996
5. *Pagodulina pisidica* SCHÜTT, 1993
6. *Pagodulina subdola orientalis* HAUSDORF, 1996
7. *Buliminus carneus* (L. PFEIFFER, 1846)
8. *Buliminus lycicus* (L. PFEIFFER, 1846)
9. *Paramastus spratti* (L. PFEIFFER, 1846)
10. *Turanena albrechti* RÄHLE, 1988
11. *Turanena tuccari* GITTENBERGER, 1986
12. *Jaminia loewii loewii* (PHILIPPI, 1844)
13. *Multidentula squalina eudoxinus* (NAEGELE, 1894)
14. *Chondrula lycaonica* (STURANY, 1904)
15. *Chondrula microtragus tricuspidata* (KÜSTER, 1843)
16. *Borlumastus yildirimi* (SCHÜTT, 1995)
17. *Vitrea ernesti* RIEDEL & SUBAI, 2004
18. *Lindbergia karainensis* RÄHLE & RIEDEL, 1987
19. *Zonites beydaglariensis* RIEDEL, 1982
20. *Zonites osmanicus* RIEDEL, 1987

21. *Turcozonites megistus* (ROLLE, 1894)
22. *Turcozonites wandae* (RIEDEL, 1982)
23. *Mesolimax escherichi* SIMROTH, 1899
24. *Strumosa strumosa meridiana* SCHUTT, 2001
25. *Phrygica euxinaeformis* H. NORDSIECK, 1994
26. *Phrygica ilegiensis* H. NORDSIECK, 2004
27. *Phrygica raehlei raehlei* H. NORDSIECK, 1994
28. *Phrygica raehlei pygmaea* H. NORDSIECK, 2004
29. *Phrygica riedeli jansseni* H. NORDSIECK, 1994
30. *Phrygica riedeli riedeli* H. NORDSIECK, 1994
31. *Phrygica riedeli orientalis* H. NORDSIECK, 2004
32. *Sprattia aksoylari* YILDIRIM, 1997
33. *Sprattia aksuensis aksuensis* H. NORDSIECK, 2004
34. *Sprattia aksuensis barlaensis* H. NORDSIECK, 2004
35. *Sprattia beycola beycola* H. NORDSIECK, 1994
36. *Sprattia beycola medoroides* H. NORDSIECK, 2004
37. *Sprattia blissi blissi* (O. BOETTGER, 1899)
38. *Sprattia blissi yalvacensis* H. NORDSIECK, 2004
39. *Sprattia pseudophrygica* H. NORDSIECK, 2004
40. *Sprattia sillyonensis candirensis* H. NORDSIECK, 2004
41. *Sprattia sowerbyana princeps* H. NORDSIECK, 2004
42. *Monacha pamphylica* HAUSDORF, 2000
43. *Monacha subaii* HAUSDORF, 2000
44. *Xeropicta smyrnoretica* (GERMAIN, 1933)
45. *Metafruticicola schuberti* (ROTH, 1839)
46. *Metafruticicola dedegoelensis* HAUSDORF, GÜMÜŞ, YILDIRIM 2004
47. *Metafruticicola oerstani* HAUSDORF, GÜMÜŞ, YILDIRIM 2004
48. *Isaurica callirhoe* (ROLLE, 1894)
49. *Isaurica lycia* (E. MARTENS, 1889)
50. *Isaurica pamphylica* SUBAI, 1994
51. *Isaurica riedeli* SUBAI, 1994
52. *Isaurica schuetti* SUBAI, 1994
53. *Helix dickhauti* (KOBELT, 1903)

Three endemic genera - *Sprattia* NORDSIECK, *Phrygica* NORDSIECK (Clausiliidae), and *Isaurica* KOBELT (Helicidae) - show spectacular diversity in the region, while remaining genera possess either narrow endemic members (like *Turanena tuccari*, *T. albrechti*) or widely distributed endemics centered in the region, like *Mesolimax escherichi* and *Helix dickhauti*. *Euxinolauria superba zilchi*, *Pagodulina subdola orientalis*, *Lindbergia karainensis*, *Strumosa strumosa meridiana* are quite disjunct from their nearest relatives. Probably *Borlumastus yildirimi*, *Chondrula lycaonica*, *Paramastus spratti*, *Metafruticicola dedegoelensis* and *M. oerstani*, which are almost all endemic solely to the region, represent quite distinct lineages. Of widespread endemics there are two discernible groups: the first one (*Pilorcula trifilaris anatolica*, *Pagadulina pisidica*, *Buliminus carneus*, *Jaminia loewii loewii*, *Chondrula lycaonica*, and *Mesolimax escherichi*) comprises endemics widespread on Taurus mountains, the other (*Multidentula squalina eudoxinus*, *Chondrula microtragus tricuspidata*, *Xeropicta smyrnoretica*, and *Helix dickhauti*) comprising species having W Anatolian extensions in distribution.

Land snail faunas may also have been shaped by immigrations, geological and hydrological events affecting Taurus refugial area till Pliocene and perhaps early Pleistocene. Land snail assemblages in Pliocene deposits of Afyon-Burdur area (SCHÜTT, 1992; 1994), show a general resemblance with modern faunas except for the presence of several genera like *Caucasotachea* and *Cepaea*. Furthermore, Pleistocene glaciations locally without permafrost conditions would probably have acted in speciation via climatic vicariance.

## CONCLUSIONS

As a conclusion SW Anatolia and Lakes Region is an important center for speciation and distribution of Gastropoda species. Due to isolated position of the faunas, supportive studies in molecular systematics and palaeontology would provide better understanding and explanation of the gastropod fauna of the Lakes Region.

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## LAND SNAIL FAUNA OF AEGEAN REGION (TURKEY): ENDEMISM PATTERNS AND VULNERABILITY

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**Abstract.** *In this study, it is aimed to evaluate the endemism patterns and vulnerability in land snail fauna of Aegean region, among the most populated regions in Turkey. According to field studies and available literature 145 species, of which 29 are endemics, were determined in the area. 15 of the endemic taxa are strictly endemic to the region. This figure changes when the regional endemics, taxa shared by Eastern Aegean islands (Greece), are included. Unlike other centres of endemism in Anatolia, in Aegean region many taxa have extensions along grabens thanks to glacial sea level changes and peculiar geology. Anthropogenic pressure and destruction of habitats particularly caused by tourism activities and housing, are the most important threats.*

**Keywords:** *Aegean region, land snails, endemism, vulnerability, anthropogenic pressure.*

**Rezumat.** *Fauna de melci tereștri din Regiunea Egeană (Turcia): caracteristici endemice și vulnerabilitate. Prezentul studiu urmărește să evalueze caracteristicile endemice și vulnerabilitatea faunei de melci tereștri din Regiunea Egeană, una dintre cele mai populate regiuni din Turcia. Conform studiilor din teren și a literaturii de specialitate, în zonă au fost determinate 145 de specii, 29 dintre acestea fiind endemice. 15 dintre taxonii endemici sunt caracteristici numai acestei regiuni. Această valoare se schimbă dacă sunt luate în calcul și endemismele regionale, taxonii comuni cu cei din Insulele Mării Egee de est (Grecia). Spre deosebire de alte centre endemice din Anatolia, în Regiunea Egeană, mulți taxoni se extind de-a lungul grabenelor ca urmare a schimbărilor nivelului mării din perioada glaciară și a particularităților geologice. Presiunea antropică și distrugerea habitatelor cauzată, în special, de activitățile turistice și domestice reprezintă cele mai importante amenințări.*

**Cuvinte cheie:** *Regiunea Egeană, melci de uscat, endemism, vulnerabilitate, presiune antropică.*

### INTRODUCTION

The Aegean region is one of the geographical regions of Turkey (Fig. 1). Located in the western half of the country and surrounded by Aegean Sea it covers 85,000 km<sup>2</sup> (about 10% of total area). The region is a remarkably deforming part of the Alpine-Himalayan orogenic belt, which has the highest seismic activity in Europe (KOMUT, 1998). This is reflected as parallel depressions (grabens or rift valleys), extending inwards from the sea and a long coastline of 2,805 km, nearly 35% the Turkish coastline.

In the area, as compared to montane areas of Turkey, topography is relatively even and the elevated habitats are separated by broad depressions. Thus, the aquatic gastropod fauna has relatively been studied (BILGIN, 1967 and 1980; YILDIRIM, 1999), as compared to the land snail fauna which has been subject of few surveys only.

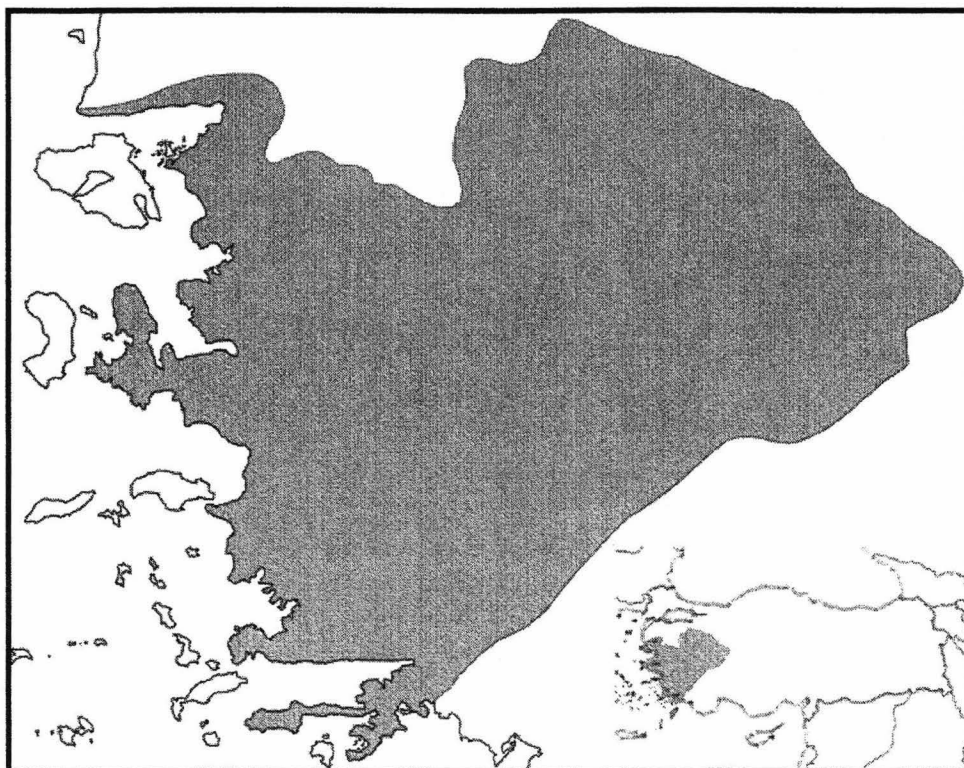


Figure1. Map of Aegean region.  
Figura 1. Harta regiunii Egeene



# MATERIAL AND METHODS

The study is based on excursions performed between 2003 and 2008 and literature data. During the excursions, the southern half of the region was surveyed. For the analysis of the results and literature data, a GIS application (DIVA GIS version 5.4) and Shannon index for diversity analysis has been used.

Table 1. Distribution of land gastropod taxa in 7 geographical regions of Turkey: endemics (of regional /national scale) in thick borders, also shared species between regions.

Tabel 1. Distribuția gasteropodelor de uscat în cele 7 regiuni ale Turciei: endemisme (la scară regională/națională) în careurile îngroșate, de asemenea speciile comune regiunilor.

	MAR	AEG	MED	C ANA	W BLA	C & E BLA	E ANA	SE ANA
MARMARA	153 19/33 E							
AEGEAN	79	145 15/29 E						
MEDITERRANEAN	60	74	274 141/155 E					
CENTRAL ANATOLIA	29	32	37	74 11/37 E				
WESTERN BLACK SEA	62	48	43	35	120 30/47 E			
CENTRAL AND EASTERN BLACK SEA	38	26	27	26	45	229 91/115 E		
EASTERN ANATOLIA	12	11	18	19	16	36	91 21/39 E	
SOUTHEASTERN ANATOLIA	9	12	20	8	10	10	16	43 9/13 E

# RESULTS AND DISCUSSIONS

145 species and 29 endemics (15 being narrow endemics of the region) have been determined to occur in the region (Table 1) (DEMIRSOY, 1999, SCHÜTT, 2005).

When the biodiversity of land snails (according to Shannon index) is mapped (Fig. 2), four regions (having values above 2) appear with higher diversity. It can also be seen that northwestern and interior parts are relatively unknown and relatively poor in diversity according to current knowledge. Of these, two eastern areas can be accepted as extensions of endemism centres Uludağ and Lakes Region. However, remaining two as exemplified by the distribution of Zonitidae in Turkey, show a distinct faunal composition among other regions of Turkey and a higher affiliation with eastern Aegean islands. The area extending from Muğla northwards along Aegean coast towards Izmir (Fig. 2, left circle) have the highest overall diversity values in southwestern Anatolia and it is somewhat split into two. These two areas are also characterized by marked presence of the genus *Zonites* MONFORT, 1810, endemic to Greece and Turkey, replaced by *Turcozonites* RIEDEL, 1987 in further east. As of *Zonites* spp., few other mesophilic species having similar feature (like *Lindbergia karainensis* RÄHLE & RIEDEL, 1987) can be found extending along western Taurus ranges bordering Aegean region.

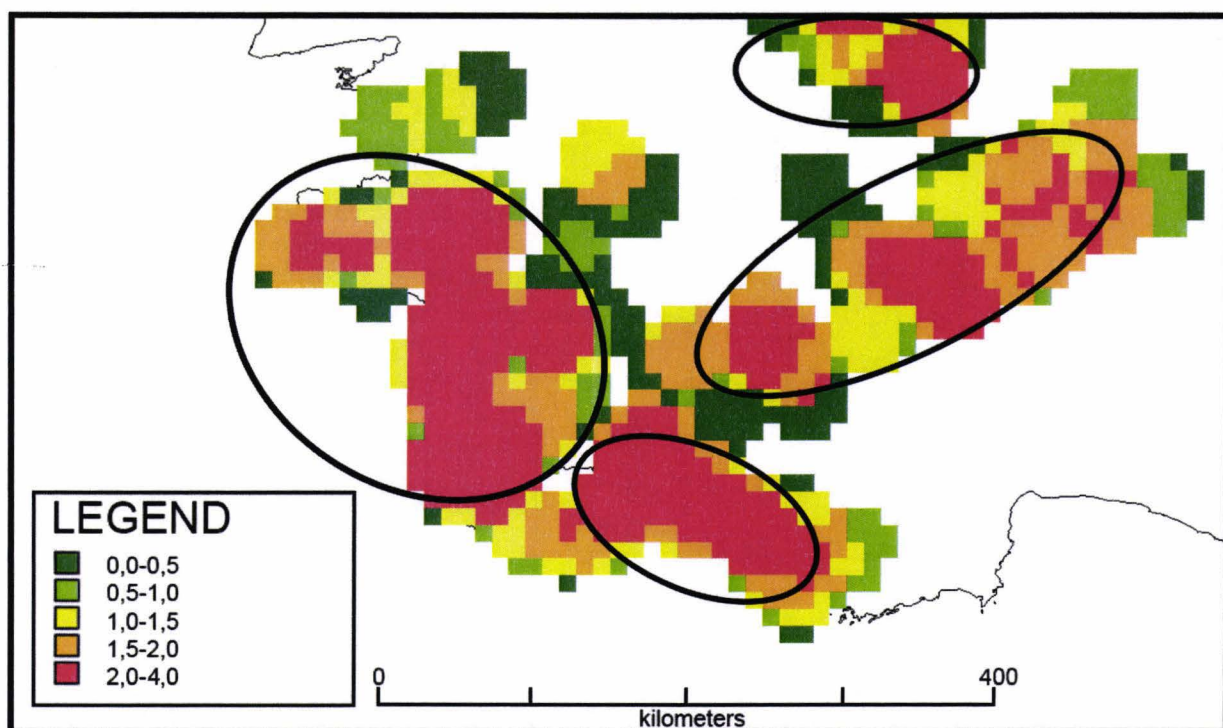


Figure 2. Biodiversity of land snails (according to Shannon index) in Aegean region.  
 Figura 2. Biodiversitatea melcilor de uscat (conform indicelui Shannon) în regiunea Egeană.

As for endemic taxa in strict sense (Fig. 3, upper map) of the two mentioned areas, only two distant spots with high biodiversity - e.g. distinctness in endemic taxa - are discernible (circled in Fig. 3) with a gap in between (Bodrum-Milas area, shown with square in Fig. 3) possessing few endemics in narrow sense despite having high overall biodiversity (Fig. 2).

When the regional endemics (e.g. species shared with off-shore Greek islands) are included (Fig 3, lower map), it can be seen that the figure changes greatly. This denotes the importance of Aegean endemics among the fauna of coastal parts of southwestern Anatolia. In Fig. 3, inclusion of Aegeanin 'endemics has no effect on 'northern' part, unlike eastern part in which Aegean elements are present.

Despite presence of certain endemism centres on mainland, since faunal exchanges between mainland and islands (even with Rhodes separated from mainland 1.8 mya) were re-established several times since Messinian crisis, homogenization to some degree can be mentioned for the faunas. This is in particular enabled by the corridor like depressions transferring humidity and uninterrupted mountains (horsts) extending into the sea as islets. Several instances of inland records of the 'Aegean' endemics, like *Milax altenai* FORCART, 1972 (YILDIRIM & KEBAPÇI, 2004), also prove this phenomenon. Another characteristic of the unique fauna is the distinctness and limited exchange with fauna of the Taurus Mountains. Presence of genera *Rhabdoena* KOBELT & MOELLENDORFF, *Zonites* MONTFORT and marked absence of *Buliminus* BECK, *Paramastus* HESSE, *Sprattia* BOETTGER and *Turcozonites* RIEDEL indicate isolation of two speciation centres.

During the marine transgressions lower elevations are invaded by the sea. This can be a reason for lower biodiversity of endemics in interior parts and corridor-like depression areas. These isolation phases should certainly have been effective in emergence of different faunas.

As in Greek islands, heavy use of the coastal land and recently more interior parts threatens sustainability of habitats. Several centres like Bodrum and Izmir become more populated as centres of tourism and economy. These tourism centres possess high endemic land snail biodiversity when regional endemism considered, but low endemism in narrow sense due to homogenization via connections took place. For such cases, naturally also in other groups, usage of national level endemism as a tool can be confusing in the determination of rarity and conservational status.

## CONCLUSIONS

Unfortunately, as in the case of Antalya and Bursa-Istanbul areas, the highest snail diversity of Aegean region is found around coastal cities like Izmir, the most populated city of the region. It is worth to keep in mind, however, that all above mentioned figures are still results of poor surveys and incomplete taxonomical works. For understanding the conservational consequences, taxonomical and distributional relations, future studies are needed.



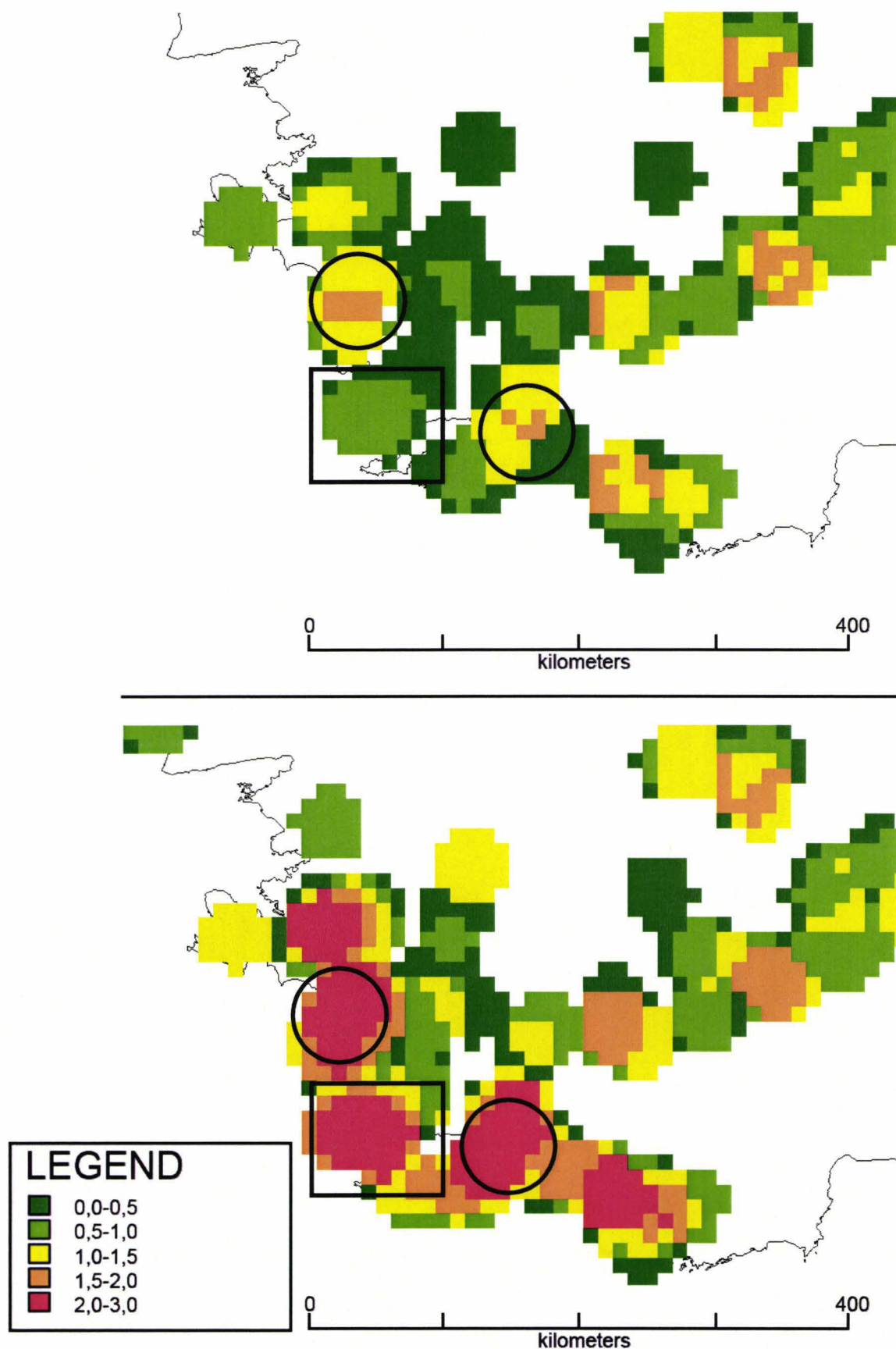


Figure 3. Biodiversity of endemic land snails (according to Shannon index) in Aegean region: only Anatolian endemics (upper map), endemics shared with East Aegean islands included (lower map).

Figura 3. Biodiversitatea melcilor de uscat endemici (conform indicelui Shannon) în regiunea Egeană: sunt incluse numai endemismele din Anatolia (harta de sus) și endemismele comune cu cele ale insulelor din Marea Egee de Est (harta de jos).

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## THYSANOPTERA SPECIES BIOINDICATORS OF THE ENVIRONMENT POLLUTION WITH HEAVY METALS (INSECTA: THYSANOPTERA)

LILIANA VASILIU-OROMULU, DANIELA BĂRBUCEANU, ELISABETA BIANU

**Abstract.** *The LIFE 02ENV/RO/000461 project had as main purpose the identification and use of bioindicators for air quality monitoring in the urban area, represented by three parks, situated in down town Bucharest, Romania, polluted by intense car traffic. Thysanoptera insects presented an increase of the biodiversity from the limits of the parks to their central parts, which is less exposed to the air pollution. Frankliniella intonsa proved to be very resistant to pollution according to the very high values of the numerical density even at the parks' limits. Only these species presented antennal anomalies. The analysis of heavy metals in Frankliniella intonsa confirmed that this species is a very important bioindicator of urban pollution in the herbaceous layer of the parks.*

**Keywords:** *Thysanoptera, bioindicator, pollution, heavy metals.*

**Rezumat.** *Specii de Thysanoptere biondicatori ai poluării mediului cu metale grele (Insecta: Thysanoptera). Proiectul LIFE 02ENV/RO/000461 a avut ca principal scop identificarea și utilizarea bioindicatorilor pentru monitoringul calității aerului în zona urbană, reprezentată de trei parcuri, situate în centrul Bucureștiului, România, poluate de traficul intens de mașini. Insectele thysanoptere au prezentat o creștere a biodiversității dinspre marginea parcurilor spre centru, mai puțin expus poluării. Frankliniella intonsa este considerată a fi foarte rezistentă la poluare datorită densității numerice foarte mari chiar la marginea parcurilor. Numai această specie a prezentat anomalii ale antenelor. Analiza metalelor grele la Frankliniella intonsa a confirmat că aceasta specie este un important bioindicator al poluării urbane din stratul ierbos al parcurilor.*

**Cuvinte cheie:** *Thysanoptera, bioindicator, poluare, metale grele.*

### INTRODUCTION

The combination of natural stress factors intensified in the city and intensification of pollution causes the decrease of thrips species richness and their density populations. Thysanoptera have been used as indicators to describe changes in agroecosystems (LEWIS, 1973), indicators of the climatic changes (VASILIU-OROMULU, 1995, 2002) and of the air pollution (VASILIU in IONESCU et al. 1973, VASILIU-OROMULU et al., 2008).

The Order Thysanoptera comprises about 5,500 described species and possibly there are three times more. Adults have typically four slender wings, with a long fringe of margin cilia. Thrips are found in all kinds of vegetation: flowers, foliage, under bark of live and dead trees, litter, in stored bulbs and a few forms galls or distort leaves. Almost all of them are phytophagous, only a few being predatory. Some species are serious pests, some are considered beneficial, as they may facilitate pollination and decomposition. Thrips are cosmopolitan, with most species found in tropical regions, many in the temperate zone, but only few in the arctic regions (LEWIS, 1973).

The present study is the first research in the world on the heavy metals accumulation in Thysanoptera insects.

### MATERIAL AND METHODS

The pilot area is represented by three public parks, Cișmigiu, Izvor and Unirea, located in downtown Bucharest, an area with intense car traffic accounting for up to 70% of the local air pollution. Also, the elements of local industrial pollution exceed standard levels. The pollutants are a mixture of NO<sub>x</sub>, SO<sub>2</sub>, H<sup>+</sup>, heavy metals and suspensions. The sites—GPS coordinates were for Cișmigiu Park: 44° 26' 09" N, 26° 05' 28" E, 73m altitude; for Izvor Park : 44° 25' 53" N, 26° 05' 19" E, 68m altitude and for Unirea Park: 44° 21' 41" N, 26° 06' 56" E, 71m altitude.

The investigations were carried out in 2006-2007, from April to September, on a transect from the park limits, more exposed to air pollution, to the centre, less exposed, on both native and ornamental plant species. The thrips fauna was collected from the herbaceous layer, by entomological sweep-net (30 Ø cm), 5 samples/site (one sample = 50 sweeps). Also, soil samples were taken simultaneously. In 2006, in Unirea Park, the scant herbaceous layer caused a small number of thrips samples to be collected. Immature thrips were not used in the count.

Heavy metals (Pb, Cu, Zn, Cd) from soil, plants, thrips samples have been analysed with Perkin Elmer Analyst 800 Atomic Absorption Spectrophotometer incorporating all spectrometer and atomizer components using graphite furnace or flame techniques.

**Abbreviations:** m<sup>2</sup> - sq m.

### RESULTS AND DISCUSSIONS

Thrips may represent a useful tool to differentiate between polluted and unpolluted areas; those species growing in polluted areas may be long-term biomonitors. The pollutants are taken up by plants from the soil, and transferred to the next links of the trophic chain (ONETE, 2008).

The influence of the pollutants on the Thysanoptera insects was visible at the following levels: the specific diversity; ecological indicators; morphological changes; chemical analysis.



### The specific diversity.

In the two years of research, 38 species were identified. The “basic nucleus” of thrips was represented by 7 species common to the parks: *Aeolothrips intermedius* BAGNALL, 1934, *Anaphothrips obscurus* (MÜLLER, 1776), *Frankliniella intonsa* (TRYBOM, 1895), *Thrips tabaci* LINDEMAN, 1889 (S. Ord. Terebrantia), *Haplothrips aculeatus* (FABRICIUS, 1803), *Haplothrips leucanthemi* (SCHRANK, 1781) and *H. niger* (OSBORN, 1883) (S. Ord. Tubulifera) (Figs. 1-3). *Frankliniella intonsa* was the most representative species in all three parks, during the two years of study. *Haplothrips niger* was very numerous on *Trifolium pratense* especially in 2006 and *Bagnaliella yuccae* was characteristic for *Yucca filamentosa*.

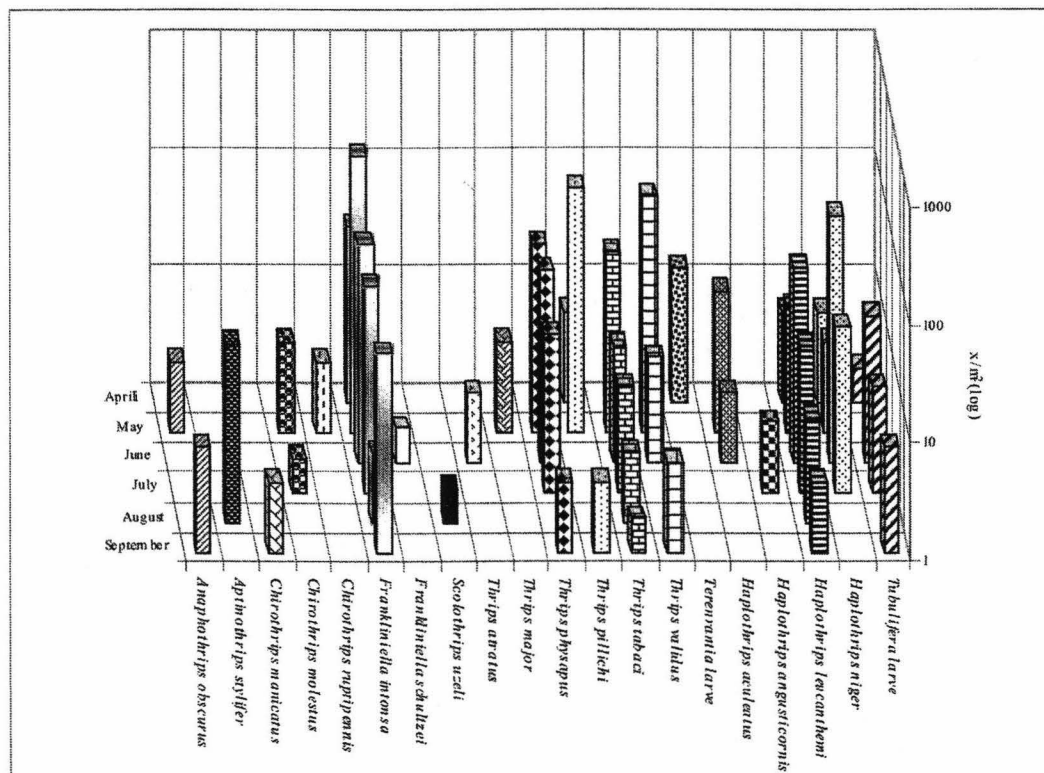


Figure 1. Thysanoptera species in Cișmigiu Park-2007 / Figura 1. Specii de Thysanoptere în Parcul Cișmigiu-2007.

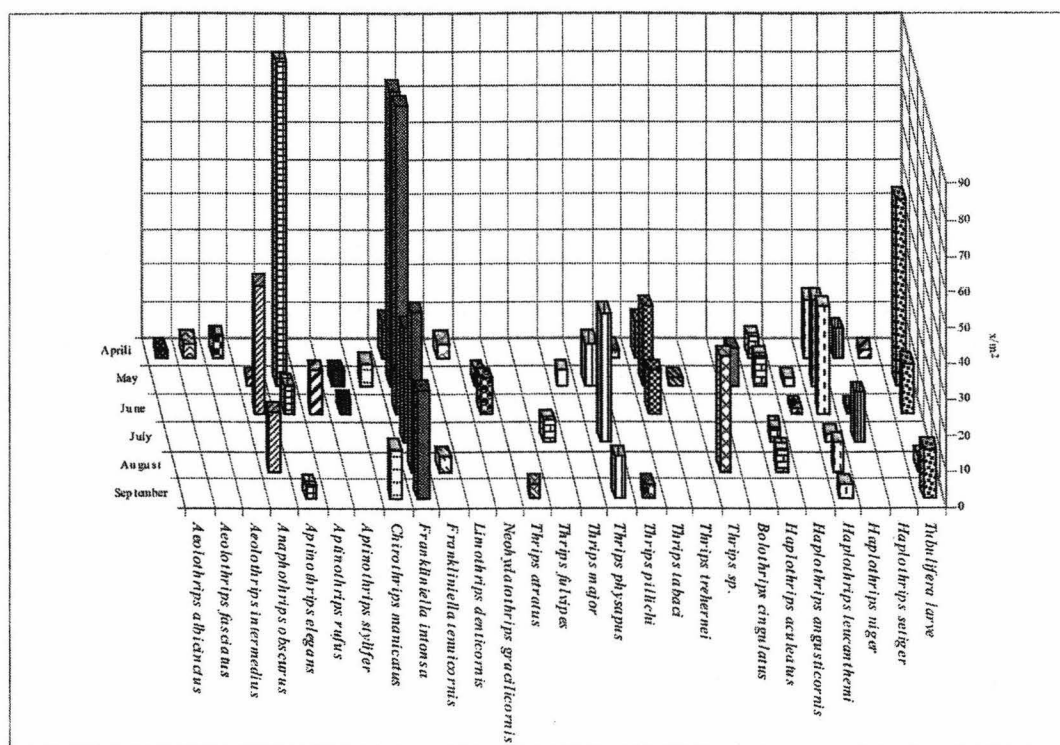


Figure 2. Thysanoptera species in Izvor Park-2007 / Figura 2. Specii de Thysanoptere în Parcul Izvor-2007.

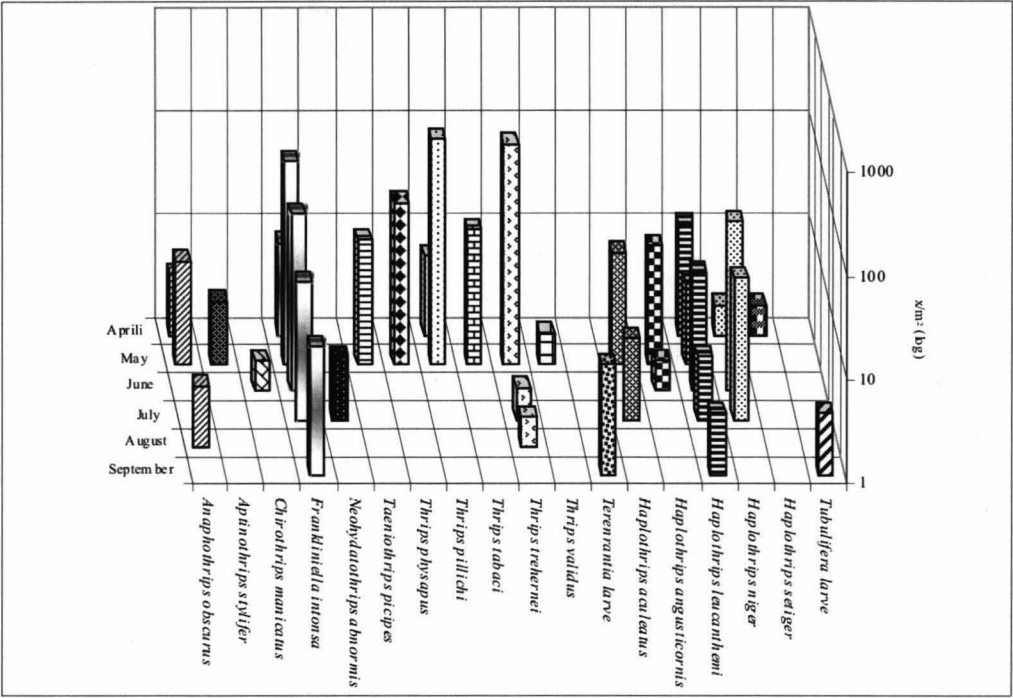


Figure 3. Thysanoptera species in Unirea Park-2007.  
Figura 3. Specii de Thysanoptere în Parcul Unirea-2007.

Ecological indicators

A large number of individuals, namely 5,920 individuals/sq m belonging to 38 species were collected from the three sites during the two consecutive years. However, their quantitative and qualitative representation was different, generating distinct coenosis (Figs. 1-3).

The highest values of the numerical density were obtained in Cișmigiu Park where the environmental conditions are more favourable to thrips populations.

The temporal dynamics shows lower values of the numerical density in 2007 compared with the values obtained in 2006 because the summer 2007 was characterised by extremely high temperatures which together with the pollutants affected the normal development of the thrips. Maximal values of the monthly numerical density in the studied parks were observed for 2006 during the month of June, and for 2007 during May, before the hot summer.

*Frankliniella intonsa* was a dominant species, presenting the highest values of the relative abundance, 24-81%, for the two years. This species had a maximal frequency of 100% in Cișmigiu and Izvor Parks and 40% in Unirea Park.

In Cișmigiu Park the pick of numerical density of *Frankliniella intonsa* had values of 970 ind/sq m in July 2006, while in May 2007 it reached as maximum only 228 ind/sq m due to the unusually hot summer (Figs. 4-5).

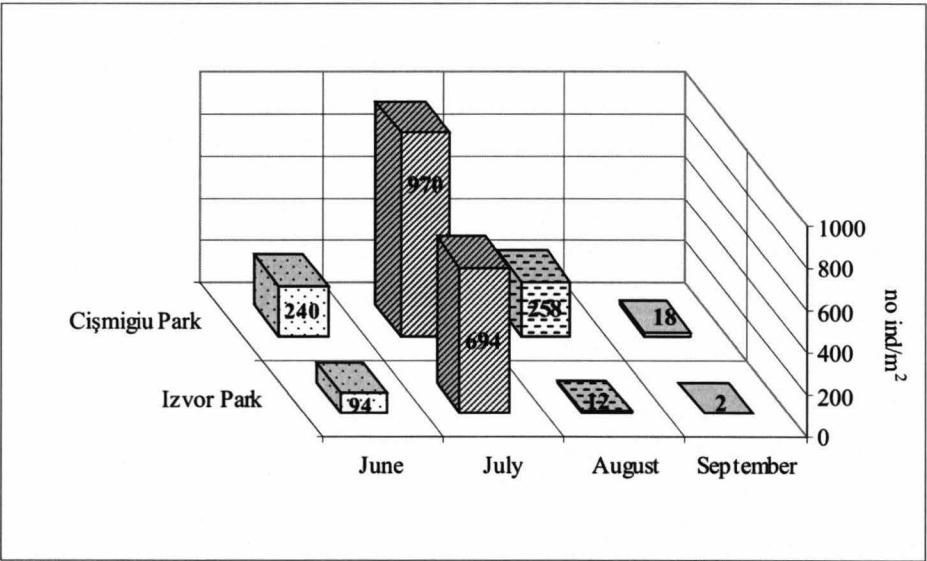
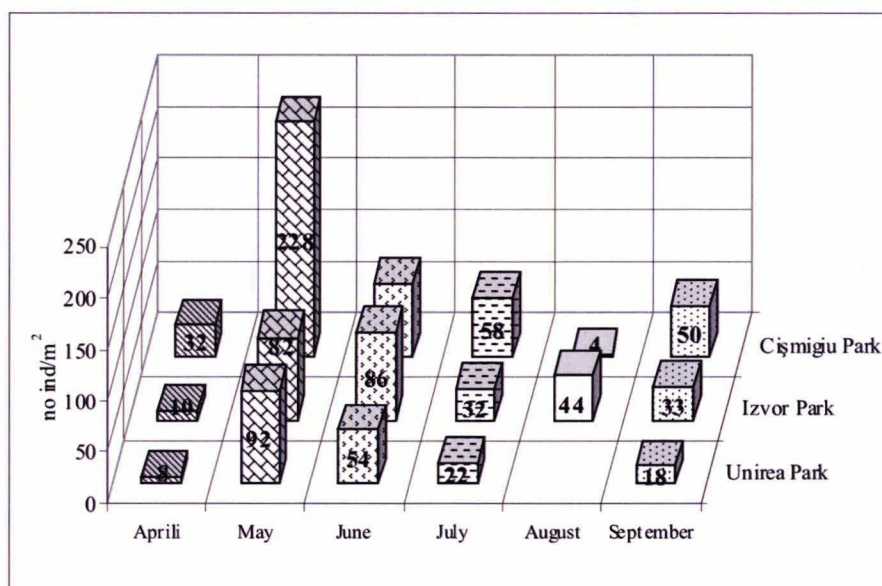


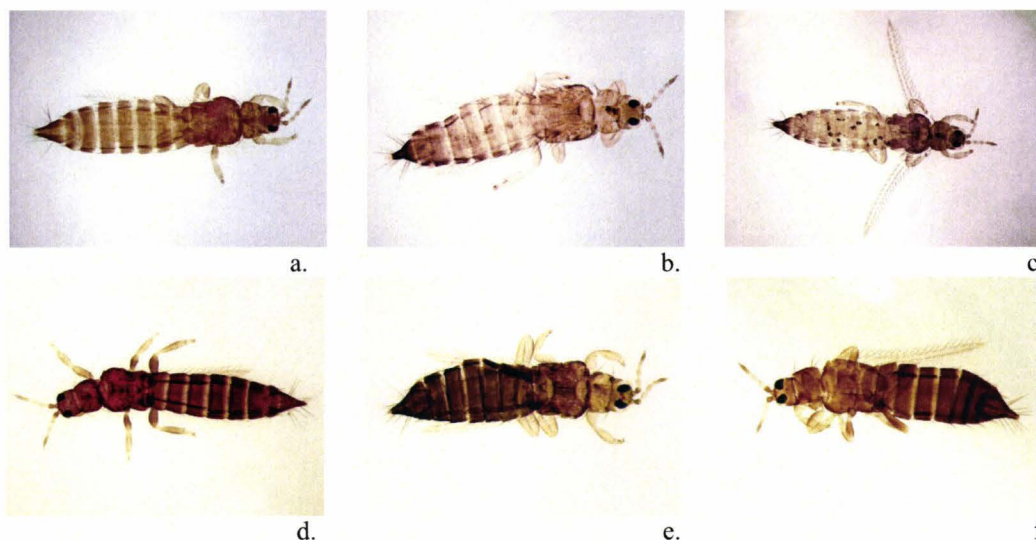
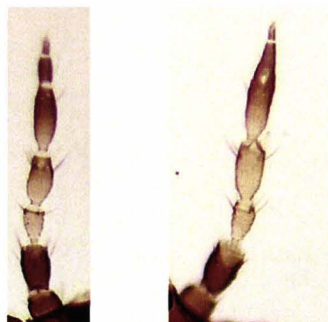
Figure 4. Numerical density/sq m of *Frankliniella intonsa* populations, 2006.  
Figura 4. Densitatea numerică/m² a populațiilor de *F. intonsa*, 2006.

Figure 5. Numerical density / sq m of *Frankliniella intonsa* populations, 2007.Figura 5. Densitatea numerică / m<sup>2</sup> a populațiilor de *F. intonsa*, 2007.

The thrips community in Cișmigiu Park is more equilibrated, due to the presence of two trophodynamics modules, with both primary consumers (93.33%) and secondary ones (6.67%). Thysanoptera insects showed a very fast reaction to pollutants, which can be explained by their intense metabolic activity.

### Morphological changes

The following biological effects of pollutants were found on *Frankliniella intonsa*: discoloration of various body parts; large variations in body size (Fig. 6a-f); individuals (10%) with anomalies of the antennae (a smaller number of antenna articles, and modifications of the latter as compared to the typical antenna) (Fig. 7) phenomenon which had not been encountered in our earlier studies on mountainous, non-polluted grasslands (VASILIU-OROMULU, 2002). The other species, collected on the same sites displayed no antennal abnormalities.

Figure 6. *Frankliniella intonsa*: a - typical species; b - f - females with different colours and sizes of the body type.Figura 6. *Frankliniella intonsa*: a - specia-tip; b - f - femele cu diferite culori și mărimi ale corpului.Figure 7. *Frankliniella intonsa* - antennal anomalies.Figura 7. *Frankliniella intonsa* - anomalii antenale.

### The chemical analysis

Air pollution data provided by Bucharest Environmental Protection Agency emphasises the mean annual Pb concentration ( $\mu\text{g}/\text{m}^3$ ) in the air decreasing along 2004-2008 in different sites from Bucharest and rural area. According to the Council Directive 1999/30/EC and Romanian Government Order 592 from June 25 2002 regarding the air quality, the annual limit value of Pb released in the atmosphere is  $0.5 \mu\text{g}/\text{m}^3$  in order to insure the protection of human health. The values of heavy metal content in the soil of the three central parks (Table 1) reveals that the Pb and Cu concentrations in Cișmigiu Park are four times higher than MAC (maximum acceptable concentrations) and in Izvor and Unirii Parks are almost twice as high as MAC. Zn concentration is two times MAC in Cișmigiu Park (Table 1).

Table 1. Mean value and range of heavy metals (mg/kg = ppm dw) in the soil of central Bucharest parks (ONETE, 2008).

Tabel 1. Valoarea medie și variația metalelor grele (mg/kg = ppm s.u.) în solul parcurilor centrale din București.

Element	Cișmigiu		Unirii		Izvor	
	average	range	average	range	average	range
Cd	0.79	0.47 – 1.21	0.48	0.36 – 0.8	0.59	0.44 – 0.78
Cu	77.59	24.6 – 168.5	43.02	19.16 – 105	35.88	12.32 – 89.74
Pb	82.16	32.3 – 199.8	44.93	27.68 – 104.6	40.27	15.02 – 92.87
Zn	193.60	104.6 – 330.3	107.96	64.81 – 214.5	106.84	63.94 – 194

Calculating the soil accumulation factor (SAF) in plants, based on the heavy metal analysis of plants and soil from every park, could show that the metal uptake from soil is different with different plants species. For Pb, in the Cișmigiu Park, the highest SAF values are for *Geum urbanum* LINNAEUS (0.101 mg/kg) and all of these species localized in sites close to the major traffic roads. The highest Cu accumulation is in the herbaceous species in the Cișmigiu Park : *Lamium amplexicaule* LINNAEUS (0.940) and *Geum urbanum* L. (0.303). Zn accumulation is higher in the following species: *Ailanthus altissima* (MILLER) SWINGLE (0.108); *Achillea millefolium* LINNAEUS (0.179); *Medicago sativa* LINNAEUS (0.102); *Phragmites australis* (CAV.) STEUEL. (0.112); *Polygonum aviculare* LINNAEUS (0.154). All the species have the highest Cd accumulation in the three parks. *Populus nigra* LINNAEUS, *Quercus robur* LINNAEUS are heavy metal resistant and bio-accumulator species, showing the particular conditions of pollution in Bucharest's central parks (ONETE, 2008).

Plant species are the trophic niche for Thysanoptera. These insects accumulate higher values of heavy metals than the host species, due to the transfer by food and by respiration.

Table 2. The content of the heavy metals on *Frankliniella intonsa* (mg/kg = ppm dw).

Tabel 2. Conținutul în metale grele la *F. intonsa*.

S/Ord, Terebrantia <i>Frankliniella intonsa</i>	Pb (ppm)	Cu (ppm)	Zn (ppm)
Date	Cișmigiu Park		
06.2006	8.40	42.68	1.39
07.2006	0.60	7.53	2.98
08.2006	2.01	42.49	1.45
06.2007	2.31	37.41	6.26
	Unirea Park		
07.2006	1.22	22.52	1.28
06.2007	1.77	19.22	1.83
	Izvor Park		
07.2006	3.08	23.33	1.83
06.2007	2.35	39.90	3.44

The chemical analysis of heavy metals content in the body of the bioindicators shows that *Frankliniella intonsa*, which can be found at the limit of the street with maximum pollution level, have the highest value of Pb and Cu in Cișmigiu Park during June 2006, and of Zn in June 2007 (Table 2).

In Unirea Park the maximal values are in June 2007 for Pb, and Zn, and for Cu in July 2006. The same results are in Izvor Park for Pb in July 2006 and Cu and Zn in June 2007.

The content of the three heavy metals, Pb, Cu and Zn in this species is the highest in Cișmigiu Park.

Cd is under the detection limit in the body of this thrips.

### CONCLUSIONS

The study of the influence of the air pollution on Thysanoptera communities was conducted during the years 2006 and 2007 in three public parks (Cișmigiu, Izvor, Unirea Parks) in downtown Bucharest, Romania, a city area heavily polluted by intense car traffic.

The specific diversity is lower than in non-polluted grasslands. The number of 35 species in 2007 revealed an increase of xero-termophilous thrips and a replacement of the mesophilous ones, probably due to the very hot and long summer as well as to the interaction with pollutants.

The analysis of the spatial dynamics of the thrips populations emphasises the richest communities in the Cișmigiu Park, in both years of study.

The impact of environmental changes is reflected by the taxonomical diversity, the values of structural and functional indices, as well as by the incidence of abnormal morphological aspects on *Frankliniella intonsa*.

*Frankliniella intonsa* is the species most resistant to air pollution; its sensitivity manifested in morphological changes makes it probably the most accurate bioindicator among the invertebrate fauna from the herbaceous layer.

The chemical analysis of heavy metals content in the body of the bioindicators shows that *Frankliniella intonsa* which can be found at the limit of the street with maximum pollution level, have the highest value of Pb and Cu in Cișmigiu Park during June 2006, as well as the highest value of Zn in June 2007.

The chemical analysis of the heavy metals concentrated in the thrips body certifies that *Frankliniella intonsa* is a good bioindicator of the air and soil heavy metals pollution.

The study is the first complex research in the world on the effects of air pollution on the biodiversity and ecology of Thysanoptera, and answers numerous calls in the field literature for such an endeavour.

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## SPECIES OF THE GENUS *ORCHESELLA* (COLLEMBOLA: ENTOMOBRYIDAE) FROM THE REPUBLIC OF MOLDOVA

GALINA BUȘMACHIU, VIORICA CEBAN

**Abstract.** The species from the genus *Orchesella* are wonderful and beautiful Collembola with distinctive colour patterns, usually present in the litter and moss of the forest, herbs along the streams, shores of lakes and meadows. The species are common and widely distributed, common also in orchards and vineyards. Among those ten registered species, seven species have European and Central-European distributions; two are known from Europe and USA and one species *O. pontica* has a restricted area of distribution.

**Keywords:** *Collembola*, *Orchesella*, Republic of Moldova.

**Rezumat.** Speciile genului *Orchesella* (Collembola: Entomobryidae) din Republica Moldova. Speciile genului *Orchesella* sunt unele din cele mai superbe și frumoase colorate colembole, fiind un component stabil al literei și mușchilor pădurilor, abundente pe plantele erbacee de pe malurile râurilor, lacurilor și ale luncilor umede. Speciile, ecologic mai plastice, sunt prezente și în plantațiile pomicole și cele viticole. Printre cele zece specii semnalate în Republica Moldova, șapte sunt cunoscute în Europa sau în Europa Centrală; două sunt răspândite în Europa și SUA, iar specia *O. pontica* se întâlnește numai în Republica Moldova și România.

**Cuvinte cheie:** *Collembola*, *Orchesella*, Republica Moldova.

### INTRODUCTION

*Orchesella* TEMPLETON, 1835 is a genus of Collembola belonging to the family Entomobryidae. According to the updated list, there are 107 species of this genus in the world (JANSSENS, 2009). The species of the genus *Orchesella* are easily recognisable among other Collembola specimens by their clear pattern of the body. They are wonderful and beautiful Collembola up to 4 mm long when full grown, have very variable colour and look very pretty. The ground colour of the insect is generally yellow with a dark pattern formed by black-blue or black-brown pigment. In some species, the correct determination is difficult because of the very variable intensity of pigmentation or lack of distinct, easily discerned details of the dorsal side of the body.

### MATERIAL AND METHODS

Samples of soil and litter were collected from the different types of forests, steppes, orchards, vineyards and also wetlands of the Prut and the Dniester Rivers during 1998-2009 years. Additionally, the specimens of *Orchesella* from the tree trunks, herbs and aquatic plants were collected by exhaustor and fixed. Specimens from the soil, litter and moss were extracted by means of Berlese-Tullgren funnels and then fixed in 80% ethyl alcohol. Collembola were identified according to key of Stach, 1960. Several specimens of each species were stored in an alcohol collection.

#### List of biotopes and localities:

1. Apple orchards and vineyards;
2. "Bugeac", South steppe region;
3. Chisinau city, parks;
4. Wetland of the Lower Prut;
5. "Codri Tigheci" Forest Reserve;
6. Natural forest in Central Moldova;
7. Petrophyte forest near the Dniester River;
8. Natural forest in the South of Moldova;
9. Meadows near the Dniester River;
10. "Plaiul Fagului" State Nature Reserve;
11. Shores of Manta Lake;
12. Wetland of the Lower Dniester.

### RESULTS AND DISCUSSIONS

As a result of investigations ten species of the genus *Orchesella* were found in the Republic of Moldova. Most of them were collected from different types of biotopes including forest, steppe, wetlands, orchards and vineyards. For some species such as *O. cincta*, *O. flavescens* and *O. pseudobifasciata* there were found variable forms of pigmentation of the body according to STACH, 1960.

1. *Orchesella albofasciata* STACH, 1960.  
Occurrence: Europe.  
Ecology: steppe and wetland.  
Material: numerous specimens (ssp.), collected in locality (loc.) 2, 4, 9, 11, 12.
2. *Orchesella cincta* (LINNAEUS, 1758).  
Occurrence: Europe and USA.  
Ecology: litter of forest, meadows and wetland.  
Material: numerous ssp. collected in loc.1, 3, 10-12.
3. *Orchesella disjuncta* STACH, 1960.  
Occurrence: Republic of Moldova, Poland, Romania, Russia and Ukraine.  
Ecology: litter of forest.  
Material: loc. 3 and 9.
4. *Orchesella flavescens* (BOURLET, 1839).  
Occurrence: Europe and USA.  
Ecology: litter of forest.  
Material: loc. 3, 5 and 10.
5. *Orchesella multifasciata* SCHERBAKOW, 1898.  
Occurrence: Central Europe.  
Ecology: widely distributed.  
Material: loc. 1-12.
6. *Orchesella orientalis* STACH, 1960.  
Occurrence: Republic of Moldova, Romania, Russia and Ukraine.  
Ecology: banks of river, shores of lake.  
Material: loc. 6, 11 and 12.
7. *Orchesella pontica* (IONESCU, 1915).  
Occurrence: Moldova and Romania.  
Ecology: banks of rivers, shores of lakes.  
Material: loc. 5 and 10.
8. *Orchesella pseudobifasciata* STACH, 1960.  
Occurrence: Central Europe.  
Ecology: banks of rivers, shores of lakes.  
Material: numerous ssp. collected in loc 6, 11 and 12.
9. *Orchesella spectabilis* TULLBERG, 1871.  
Occurrence: Central and South Europe.  
Ecology: banks of rivers, shores of lakes.  
Material: loc.7 and 10.
10. *Orchesella xerothermica* STACH, 1960.  
Occurrence: Central Europe.  
Ecology: litter of forest and moss.  
Material: numerous ssp. collected in loc.2, 3, 6 and 10.

*Orchesella xerothermica* is a common species during all the season in the litter of "Plaiul Fagului" State Nature Reserve (BUȘMACHIU, 2008). However, in the moss of this reserve, the dominant species are: *O. pseudobifasciata* f. *obscura*, *O. albofasciata* and *O. orientalis*. These species were collected from vegetations along the streams, shores of lakes and meadows (BUȘMACHIU, 2004; 2006). *O. cincta* and *O. multifasciata* are widely distributed and prefer mostly open habitats, such as meadows (KAPRUS et al., 2004), but it can be also found in orchards and vineyards. *Orchesella disjuncta*, *O. pontica* and *O. spectabilis* are rare or with a few specimens in the studied habitats.

*Orchesella* species from the Republic of Moldova have European and Central-European distributions and only two species have been found in Europe and USA. *O. pontica* has a limited area of geographical distribution including only two countries - Republic of Moldova and Romania (FIERA, 2007).

## CONCLUSIONS

The species from the genus *Orchesella* are typical for all natural biotopes. They prefer litter of forest, moss and herbs near the banks of rivers, shores of lakes and meadows. Widely distributed species are common also in open habitats such as meadows, orchards and vineyards.

*Orchesella* species have European and Central-European geographical distributions. Two species have a large area of distributions including Europe and USA. One species - *O. pontica* is present only in the Republic of Moldova and Romania.

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HETEROPTERIAN DIVERSITY (INSECTA: HETEROPTERA) IN THE  
“PRUTUL-DE-JOS” SCIENTIFIC RESERVE

VALERIU DERJANSCHI

**Abstract.** *In the scientific reserve „Prutul-de-Jos”, 77 species of bugs belonging to 14 families. The most numerous groups are represented by Heteroptera, which live on the steppe and meadow vegetation.*

**Keywords:** *“Prutul-de-Jos” Reserve, heteropterian diversity, biotopical distribution.*

**Rezumat.** *Diversitatea heteropterelor (Insecta: Heteroptera) în Rezervația Științifică „Prutul-de-Jos”. În rezervația științifică „Prutul-de-Jos” au fost semnalate 77 specii de heteroptere din 14 familii. Cele mai numeroase grupuri sunt heteropterele care trăiesc pe vegetația stepicolă și de luncă.*

**Cuvinte cheie:** *Rezervația „Prutul-de-Jos”, diversitatea heteropterelor, distribuția biotopică.*

INTRODUCTION

The scientific reserve “Prutul-de-Jos” was created in 1991 with the purpose of preserving the flora and fauna of lake Beleu and the most representative associations around it. The reserve has an area of 1,691 hectares and it is located along the lower course of the Prut, between the villages of Valeni and Slobozia-Mare of Kahul area.

The largest part of the reserve (1,000 hectares) is covered by the lake, a flooded wood and water meadows. On the slopes adjoining to the reserve, the steppe vegetation typical for the south of the republic was preserved.

270 species of vascular plants, basically from the families Asteraceae and Poaceae have been identified in the flora of the reserve. The inundated wood is formed of two kinds of willows - *Salix alba* and *S. fragilis* (POSTOLACHE & CHETROI, 1997).

Till now, in the reserve there were not made special entomological researches, therefore the present paper represents a scientific interest.

MATERIAL AND METHODS

As material for the present paper we have used the entomological gathering of the author made between 2002 and 2007 within the territory of the reserve and adjoining sites (a transitive zone). Water species of bugs were caught by means of special entomological net and ground Heteroptera were collected also by means of the exhaustor.

RESULTS AND DISCUSSIONS

As a result of our researches 77 species of bugs from 14 families have been registered on the territory of the reserve. The most numerous species were found on meadow and steppe vegetation (Table 1).

Table 1. Biotopical distribution of heteropterian species within the “Prutul-de-Jos” reserve.  
Tabel 1. Distribuția biotopică a speciilor de heteroptere în rezervația „Prutul-de-Jos”.

	Families and Species	Biotope			
		Water area of lake	Trees and bushes	Wet meadow	Steppe vegetation
I	Fam. CORIXIDAE				
1	<i>Hesperocorixa linnaei</i> (FIEBER 1848)	+	-	-	-
2	<i>Sigara falleni</i> (FIEBER 1848)	+	-	-	-
3	<i>S. lateralis</i> (LEACH 1817)	+	-	-	-
4	<i>S. striata</i> (LINNAEUS 1758)	+	-	-	-
II	Fam. GERRIDAE				
1	<i>Gerris argentatus</i> SCHUMMEL 1832	+	-	-	-
2	<i>G. lacustris</i> (LINNAEUS 1758)	+	-	-	-
3	<i>G. odontogaster</i> (ZETTERSTEDT 1828)	+	-	-	-
III	Fam. SALDIDAE				
1	<i>Saldula opacula</i> (ZETTERSTEDT 1838)	-	-	+	-
2	<i>S. pilosella</i> (THOMSON 1871)	-	-	+	-

IV	<b>Fam. NABIDAE</b>				
1	<i>Nabis pseudoferus</i> REMANE 1949	-	-	+	-
2	<i>N. punctatus</i> A. COSTA 1847	-	-	+	+
V	<b>Fam. ANTHOCORIDAE</b>				
1	<i>Orius niger</i> (WOLFF 1804)	-	-	+	+
VI	<b>Fam. MIRIDAE</b>				
1	<i>Deraeocoris serenus</i> (DOUGLAS & SCOTT 1868)	-	-	+	-
2	<i>Adelphocoris lineolatus</i> (GOEZE 1778)	-	-	+	+
3	<i>A. ticinensis</i> (MEYER-DÜR 1843)	-	-	+	-
4	<i>Agnocoris reclairei</i> WAGNER 1949	-	+	-	-
5	<i>A. rubicundus</i> (FALLEN 1807)	-	+	-	-
6	<i>Phytocoris insignis</i> REUTER 1876	-	-	-	+
7	<i>Lygus gemellatus</i> (HERRICH-SCHAEFFER 1836)	-	-	-	+
8	<i>L. pratensis</i> (LINNAEUS 1758)	-	-	-	+
9	<i>L. rugulipennis</i> POPPIUS 1912	-	-	+	+
10	<i>Orthops campestris</i> (LINNAEUS 1758)	-	-	+	-
11	<i>Polymerus vulneratus</i> (PANZER 1806)	-	-	+	-
12	<i>Stenodema calcarata</i> (FALLEN 1807)	-	-	+	-
13	<i>Teratocoris antennatus</i> (BOHEMAN 1852)	-	-	+	-
14	<i>Trigonotylus caelestialium</i> (KIRKALDY 1902)	-	-	+	-
15	<i>T. ruficornis</i> (GEOFFROY 1785)	-	-	-	+
16	<i>Halticus apterus</i> (LINNAEUS 1758)	-	-	+	-
17	<i>Globiceps sphegiformis</i> (ROSSI 1790)	-	-	+	-
18	<i>Ortотylus flavosparsus</i> (C. SAHLBERG 1842)	-	-	+	-
19	<i>Systellonotus triguttatus</i> (LINNAEUS 1767)	-	-	+	-
20	<i>Megalocoleus molliculus</i> (FALLEN 1807)	-	-	+	-
21	<i>M. naso</i> (REUTER 1879)	-	-	+	-
22	<i>Oncotylus setulosus</i> (HERRICH-SCHAEFFER 1837)	-	-	-	+
23	<i>Europiella artemisiae</i> (BECKER 1864)	-	-	-	+
24	<i>E. alpina</i> (REUTER 1875)	-	-	+	-
25	<i>Campylomma annulicorne</i> (SIGNORET 1865)	-	+	-	-
26	<i>Chlamydatus pullus</i> (REUTER 1870)	-	-	+	-
27	<i>Plagiognathus bipunctatus</i> REUTER 1883	-	-	+	-
28	<i>P. chrysanthemi</i> (WOLFF 1804)	-	-	+	-
29	<i>Salicarus roseri</i> (HERRICH-SCHAEFFER 1838)	-	+	-	-
VII	<b>Fam. TINGIDAE</b>				
1	<i>Agramma atricapillum</i> (SPINOLA 1837)	-	-	+	-
2	<i>A. confusum</i> (PUTON 1879)	-	-	+	-
3	<i>Copium clavicorne</i> (LINNAEUS 1758)	-	-	-	+
4	<i>Lasiacantha capucina piligera</i> (GARBIGLIETTI 1869)	-	-	-	+
5	<i>Oncochila scapularis</i> (FIEBER 1844)	-	-	-	+
6	<i>Tingis ampliata</i> (HERRICH-SCHAEFFER 1838)	-	-	+	-
7	<i>T. auriculata</i> (A. COSTA 1847)	-	-	+	-
8	<i>T. pilosa</i> HUMMEL 1825	-	-	+	-
VIII	<b>Fam. PIESMATIDAE</b>				
1	<i>Parapiesma kochiae</i> (BECKER 1867)	-	-	-	+
IX	<b>Fam. BERYTIDAE</b>				
1	<i>Berytinus montivagus</i> (MEYER-DÜR 1841)	-	-	-	+
X	<b>Fam. LYGAEIDAE</b>				
1	<i>Nysius helveticus</i> (HERRICH-SCHAEFFER 1850)	-	-	-	+
2	<i>N. cymoides</i> (SPINOLA 1837)	-	-	-	+
3	<i>N. senecionis</i> (SCHILLING 1829)	-	-	+	+
4	<i>Ortholomus punctipennis</i> (HERRICH-SCHAEFFER 1838)	-	-	-	+
5	<i>Cymus claviculus</i> (FALLEN 1807)	-	-	+	-
6	<i>C. melanocephalus</i> FIEBER 1861	-	-	+	-



7	<i>Geocoris erythrocephalus</i> (LEPELETIER & SERVILE 1825)	-	-	-	+
8	<i>Chilacis typhae</i> (PERRIS 1857)	-	-	+	-
9	<i>Holcocranum satirejae</i> (KOLENATI 1845)	-	-	+	-
10	<i>Heterogaster artemisiae</i> SCHILLING 1829	-	-	-	+
11	<i>Microplax interrupta</i> (FIEBER 1837)	-	-	+	-
12	<i>Oxycarenus pallens</i> (HERRICH-SCHAEFFER 1850)	-	-	+	+
13	<i>Beosus quadripunctatus</i> (MÜLLER 1766)	-	-	+	+
14	<i>Peritrechus geniculatus</i> (HAHN 1832)	-	-	+	-
15	<i>P. gracilicornis</i> PUTON 1877	-	-	+	-
16	<i>Raglius alboacuminatus</i> (GOEZE 1778)	-	-	+	-
XI	<b>Fam. RHOPALIDAE</b>				
1	<i>Brachycarenus tigrinus</i> (SCHILLING 1829)	-	-	-	+
XII	<b>Fam. PLATASPIDAE</b>				
1	<i>Coptosoma scutellatum</i> (GEOFFROY 1785)	-	-	+	+
XIII	<b>Fam. SCUTELLERIDAE</b>				
1	<i>Eurygaster testudinaria</i> (GEOFFROY 1785)	-	-	+	-
XIV	<b>Fam. PENTATOMIDAE</b>				
1	<i>Graphosoma lineatum</i> (LINNAEUS 1758)	-	-	+	+
2	<i>Aelia acuminata</i> (LINNAEUS 1758)	-	-	+	+
3	<i>Anthemina lunulata</i> (GOEZE 1778)	-	-	+	-
4	<i>Dolycoris baccarum</i> (LINNAEUS 1758)	-	-	+	-
5	<i>Carpocoris pudicus</i> (PODA 1761)	-	-	-	+
6	<i>Eurydema oleracea</i> (LINNAEUS 1758)	-	-	+	+
6	<i>E. ornata</i> (LINNAEUS 1758)	-	-	+	+
7	<i>Ventocoris trigonus</i> (KRYNICKI 1871)	-	-	-	+
	<b>Number of species</b>	<b>7</b>	<b>4</b>	<b>48</b>	<b>31</b>

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## THE DIVERSITY OF THE COREOIDS (INSECTA: HETEROPTERA: COREOIDEA) FAUNA OF THE GÂRBOAVELE FOREST RESERVATION (GALAȚI COUNTY)

CECILIA ȘERBAN

**Abstract.** The entomological material was collected in July 2005 and May and August 2007 from Garboavele forest reservation area, located at approximately 20 km from the city of Galați. Garboavele Forest (400 hectares) is located in the Covurlui High Plain at 47-120 m altitude, on black earth, being composed of fluffy oak (41%), acacia (29%), hoarfrosty oak (27%), ash (2%), other species (1%) and the vegetation of this forest is a typical forest steppe. In the studied area we identified 13 species coreoids belonging to 11 genera included into 3 families. Most species of coreoids identified belong to Rhopalidae family (8 species), Coreidae and Alydidae families having a small number of representatives (3, respectively one species). The highest values of number and relative abundance were recorded by *Coreus marginatus* (LINNE, 1758), being the characteristic species and edifying for this type of habitat. From the zoogeographic point of view, in this habitat the palearctic elements (30.77%) and holarctic elements (23.07%) are predominant, the remaining elements, represented by one species (7.7%), being: Euro Asian, Euro Siberian, cosmopolitan, Holomediterranean and Asian. All species identified in the area have a wide spread on the territory of Romania. The species identified for the first time in this type of habitat are *Rhopalus maculatus* (FIEBER, 1837) and *Chorosoma schillingi* (SCHILLING, 1829), belonging to the Rhopalidae family.

**Keywords:** fauna, ecology, zoogeography, Coreoidea, Garboavele Forest.

**Rezumat.** Diversitatea faunei de coreoide (Insecta: Heteroptera: Coreoidea) din rezervația Pădurea Gârboavele (județul Galați). Materialul entomologic a fost colectat în lunile iulie 2005 și mai și august 2007 din arealul rezervației forestiere Pădurea Gârboavele aflată la aproximativ 20 km de orașul Galați. Pădurea Gârboavele (400 hectare) situată în Câmpia Înalță a Covurluiului, pe teritoriul administrativ al comunei. Este situată la 47-120 m altitudine, pe cernoziom cambic, fiind alcătuită din stejar pufos (41%), salcâm (29%), stejar brumăriu (27%), frasin (2%), alte specii (1%), iar vegetația acestei păduri fiind tipic de silvostepă. În zona studiată am identificat 13 specii de coreoide ce aparțin la 11 genuri încadrate în 3 familii. Cele mai multe specii de coreoide identificate aparțin familiei Rhopalidae (8 specii), familiile Coreidae și Alydidae având un număr redus de reprezentanți (3, respectiv o specie). Cele mai mari valori ale abundenței numerice și relative au fost înregistrate de *Coreus marginatus* (LINNE, 1758), ea fiind specia caracteristică și edificatoare pentru acest tip de habitat. Din punct de vedere zoogeografic, în acest habitat predomină elementele palearctice (30,77%) și holarctice (23,07%), restul elementelor, reprezentate prin câte o specie (7,7%), fiind: eurasiatice, eurosiberiene, cosmopolite, holomediterraneene și asiatic. Toate speciile identificate în zona cercetată au o largă răspândire pe teritoriul României. Speciile identificate pentru prima dată în acest tip de habitat sunt *Rhopalus maculatus* (FIEBER, 1837) și *Chorosoma schillingi* (SCHILLING, 1829), aparținând familiei Rhopalidae.

**Cuvinte cheie:** faună, ecologie, zoogeografie, Coreoidea, Pădurea Gârboavele.

### INTRODUCTION

Gârboavele forest, with an area of approximately 400 hectares, is located in the Covurlui High Plain at 1.5 kilometres West of Tulucești, on the administrative territory of this commune. The forest is crossed by two valleys oriented north-south, cut into Levantine clays: Great Valley and Gârboavele Valley; the relief is feebly corrugated, with average heights ranging between 50 and 75 m, with exhibition predominantly south-east and slope between 2°-10°. The underground waters are approximately 15-20 m deep.

The forest is located in the sub district of Covurlui Plain with temperate continental climate, with clear sky days (annual) = 94; days with fog = 53; relative air humidity (annual) = 74.9; predominating winds from the NE, N and SV (frequency = 65%), the maximum average temperature = 10.5° C, the minimum average temperature = - 3.1° C (in January), the minimum absolute temperature = - 28.6° C, the maximum average temperature = 20.3° C (in June), the maximum absolute temperature = 39° C, days without frost = 208; days of snow covering the ground = 41, average rainfall per year = approximately 400 mm (at Gârboavele, compared to 426 mm and 380 mm at Galați and at Pechea); the change in the quantity of rainfall annually = between 256-753 mm (extreme quantities); days without rainfall = 80-100 per year. The general character of the local climate is excessive continental.

The predominantly soil is feebly tacked black earth with clay texture and normal structure, formed on loess, sandy deposits (garden ones) or clays (on valleys); sporadically there can be found steppe light brown soil formed on sandy loess.

The vegetation of this forest is a typical forest steppe, consisting of several associations (types) of forest, mostly degraded (cut) with weak consistency trees, abundant flora invading the surrounding steppe, with a reduced power of regeneration (from sprouts) and being obviously modified by the introduction of many species of trees and planted acacias. The flora of this forest has been investigated sporadically; floristic statements regarding this forest are made by ENCULESCU (1924), PAȘOVȘCHI DONIȚA (1968) and especially BORZA (1958) citing from here 140 species of angiosperms. Research carried out on the forest flora of Gârboavele by MITITELU et al., 1968 and SÂRBUTU et al., 1997, have highlighted that on this restricted area grow over 470 species of angiosperms from which approximately 40 are very rare in the flora of Moldova.

From the very rare species or from the endemic ones, some deserve special protection in this forest park, attended mostly as a place of recreation; *Paeonia peregrina* var *romanica*, *Iris brandzae*, *Asparagus pseudoscaberr*, *Cytisus heuffelii*, *Pirus babadagensis*, *Ulmus ambigua* and *Asperula scutellaris* (cited from the surroundings of this forest – at the Tuluc Valley, in the only place in the country).

Research on terrestrial heteropters in Covurlui Plain were made sporadically by MARCU in 1982, for the reservation forest area Gârboavele Forest being cited 12 species of coreoids. MARCU publishes a list of the south-eastern Moldova heteropters belonging to the estate of the Natural Sciences Museum from Galati, most collection data belonging to Hanu Conachi reservation and to Gârboavele forest reservation, both situated in the county of Galati. Our research completes the heteropters species distribution map in the forest reservation area of Gârboavele forest, and brings data on the ecology of coreoids population in this area.

## MATERIAL AND METHODS

The study of coreoids heteropters fauna of the Gârboavele forest reservation area was realized as a result of the entomological material collection in July 2005 and May and August 2007. Collections were made with entomological fillet through manual mowing method directly from the plants and by shaking the cornice of trees and shrubs in umbrella bag. The collected material was separated on samples, killed with ethyl ether and preserved dry by stinging with entomological needles and stored in insectariums boxes.

Determinations were performed in the laboratory using stereomicroscope with the help of different bibliographic sources (KIS 1984, 2001; WAGNER, 1966).

The material was classified on families and subfamilies and species according to the present taxonomic system (DAVIDOVA-VILIMOVA & MCPHERSON 1994 (1995), KIS (1984, 2001).

For each species it is given the number of individuals, numerical abundance and relative abundance in determining the trophic spectrum and zoogeographical being determined by consulting various sources of literature (KIS, 1984, 2001, ROȘCA, 1984).

## RESULTS AND DISCUSSIONS

For this type of habitat there were collected 81 individuals belonging to 13 species of coreoids included in 3 families. The largest number of species belongs to Rhopalidae family (8 species), Coreidae family being represented by 4 species and Alydidae family by a single species (Table 1). Compared to the previous studies from this area, *Rhopalus conspersus* (FIEBER, 1837) (Rhopalidae family) is not in my samples, and the *Rhopalus maculatus* (FIEBER, 1837) species and *Chorosoma schillingi* (SCHILLING, 1829) are new for this type of habitat.

Table 1. The ecological and fauna characterization of the coreoids communities from the wet lawns located in the fluffy oak forest and in the acacia forest from Gârboavele.

Tabel 1. Caracterizarea faunistică și ecologică a comunităților de coreoidee din pajiștile mezofile aflate în pădurea de stejar pufos și salcâm de la Gârboavele.

Nr. crt	Taxon	Zoogeographical area	Gârboavele forest			
			♂	♀	N	X
Coreidae Family						
1	<i>Gonocerus acuteangulatus</i> GOEZE 1778	Hm-AsMj	1		1	0.05
2	<i>Syromastus rhombeus</i> LINNAEUS 1767	P	3	2	5	0.23
3	<i>Coreus marginatus</i> LINNAEUS 1758	Hp	21	23	44	2.09
4	<i>Coriomeris denticulatus</i> SCOPOLI 1763	Hp	1		1	0.05
Alydidae Family						
5	<i>Alydus calcaratus</i> LINNAEUS 1758	H	1		1	0.05
Rhopalidae Family						
6	<i>Corizus hyoscyami</i> LINNAEUS 1758	Hp	1		1	0.05
7	<i>Rhopalus subrufus</i> GMELIN 1790	C	4	3	7	0.33
8	<i>Rhopalus maculatus</i> FIEBER 1837	Eusb		1	1	0.05
9	<i>Brachycarenum tigrinus</i> SCHILLING 1829	P	4	2	6	0.28
10	<i>Stictopleurus punctatonevus</i> GOEZE 1778	P	1	2	3	0.14
11	<i>Stictopleurus abutilon</i> ROSSI 1790	P	1	1	2	0.09
12	<i>Myrmus miriformis</i> FALLEN 1807	EuAs	2	1	3	0.14
13	<i>Chorosoma schillingi</i> SCHILLING 1829	Eu-AsMc-AsC	1	5	6	0.28
	Total				81	

**Legend 1:** N-total number of collected samples, X-numerical abundance; Hm-Holomediterranean; Hp-Holopaleartic; AsMc-Asia Minor; ASC-Central Asia; AsMj-Middle Asia, Sp-South Palearctic; C-cosmopolite; P-Paleartic; EuAs-Eurasian; Eusb-Euro Siberia.

**Legenda 1:** N-număr total de exemplare colectate, X-abundența numerică; Hm-Holomediterranean; Hp-Holopaleartic; AsMc-Asia Mică; AsC-Asia Centrală; AsMj-Asia Mijlocie; Sp-Sud paleartic; C-Cosmopolit; P-Paleartic; EuAs-Eurasiatic; Eusb-Eurosiberian.



From the zoogeographic point of view, in this habitat predominant are the Palearctic elements (4 species) and Holopaeartic elements (3 species), the remaining elements, represented by one species, being: Euro Asian, Euro Siberian, Cosmopolitan, Holomediterranean and Asian.

The species with the highest numerical abundance is *Coreus marginatus* ( $X = 2.09$ ). It is followed at a big distance by *Rhopalus subrufus* species ( $X = 0.33$ ), *Brachycarenum tigrinus* ( $X = 0.28$ ) and *Chorosoma schillingi* ( $X = 0.28$ ). The species with the smallest populations are *Gonocerus acuteangulatus*, *Coriomeris denticulatus*, *Alydus calcaratus*, *Corizus hyoscyami* and *Rhopalus maculatus* ( $X = 0.05$ ).

The community of terrestrial heteropters belonging to Coreoidea super families, from the forest reservation of Gârboavele, is characterized by very high abundance relative values for *Coreus marginatus* ( $A = 54.32\%$ ), being the single subdominant species. High values of relative abundance for this type of habitat are recorded by the *Syromastus rhombeus* ( $A = 6.17\%$ ), *Rhopalus subrufus* ( $A = 8.64\%$ ), *Brachycarenum tigrinus* ( $A = 7.40\%$ ) and *Chorosoma schillingi* ( $A = 7.40\%$ ) species, all being dominant.

Table 2. Ecological indices of the coreoids communities from the wet lawns located in the fluffy oak forest and in the acacia forest from Gârboavele.

Tabel 2. Indicii ecologici ai comunităților de coreoidee din pajiștile mezofile aflate în pădurea de stejar pufos și salcâm de la Gârboavele.

Current number	Taxon	Gârboavele forest					
		A		F		W	
Coreidae Family							
1	<i>Gonocerus acuteangulatus</i> GOEZE 1778	1,23	D <sub>2</sub>	4,76	C <sub>1</sub>	0,05	W <sub>1</sub>
2	<i>Syromastus rhombeus</i> LINNAEUS 1767	6,17	D <sub>4</sub>	23,80	C <sub>1</sub>	1,47	W <sub>3</sub>
3	<i>Coreus marginatus</i> LINNAEUS 1758	54,32	D <sub>5</sub>	100	C <sub>4</sub>	54,32	W <sub>5</sub>
4	<i>Coriomeris denticulatus</i> SCOPOLI 1763	1,23	D <sub>2</sub>	4,76	C <sub>1</sub>	0,05	W <sub>1</sub>
Alydidae Family							
5	<i>Alydus calcaratus</i> LINNAEUS 1758	1,23	D <sub>2</sub>	4,76	C <sub>1</sub>	0,05	W <sub>1</sub>
Rhopalidae Family							
6	<i>Corizus hyoscyami</i> LINNAEUS 1758	1,23	D <sub>2</sub>	4,76	C <sub>1</sub>	0,05	W <sub>1</sub>
7	<i>Rhopalus subrufus</i> GMELIN 1790	8,64	D <sub>4</sub>	19,04	C <sub>1</sub>	1,64	W <sub>3</sub>
8	<i>Rhopalus maculatus</i> FIEBER 1837	1,23	D <sub>2</sub>	4,76	C <sub>1</sub>	0,05	W <sub>1</sub>
9	<i>Brachycarenum tigrinus</i> SCHILLING 1829	7,40	D <sub>4</sub>	23,80	C <sub>1</sub>	1,76	W <sub>3</sub>
10	<i>Stictopleurus punctatonervosus</i> GOEZE 1778	3,70	D <sub>3</sub>	14,28	C <sub>1</sub>	0,52	W <sub>2</sub>
11	<i>Stictopleurus abutilon</i> ROSSI 1790	2,47	D <sub>3</sub>	9,52	C <sub>1</sub>	0,23	W <sub>2</sub>
12	<i>Myrmus miriformis</i> FALLEN 1807	3,70	D <sub>3</sub>	14,28	C <sub>1</sub>	0,52	W <sub>2</sub>
13	<i>Chorosoma schillingi</i> SCHILLING 1829	7,40	D <sub>4</sub>	19,04	C <sub>1</sub>	1,40	W <sub>3</sub>

Legend 2: A-relative abundance (%); F-frequency (%); W-ecological significance index (%); D-dominance (%); C-Constancy (%)  
Legenda 2: A-abundența relativă (%); F-frecvența (%); W-indicele de semnificație ecologică (%); D-dominanța (%); C-constanța (%)

All other coreoids species identified in Gârboavele Forest Reservation are, by the relative abundance values, subdominant (Table 2, Fig. 1).

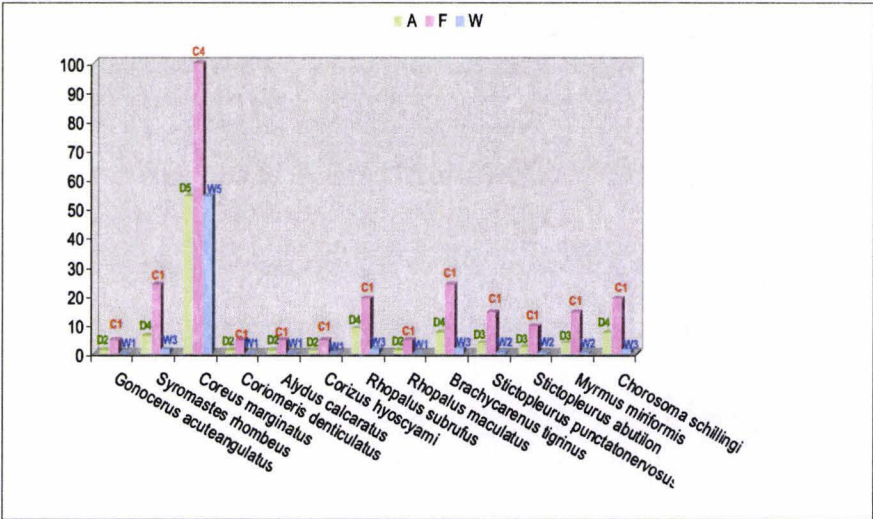


Figure 1. Graphical representation of the ecological indices for the communities from the wet lawns located in the fluffy oak forest and in the acacia forest from Gârboavele (W-ecological significance index, D-dominance, C-constancy).  
Figura 1. Reprezentarea grafică a indicilor ecologici pentru comunitățile de coreoidee din pajiștile mezofile aflate în pădurea de stejar pufos și salcâm de la Gârboavele.

## CONCLUSIONS

In the studied area we identified 13 species of coreoids belonging to 11 genera included into 3 families.

Most species of coreoids identified belong to Rhopalidae family (8 species), Coreidae and Alydidae families having a small number of representatives (3, one species).

The highest values of number and relative abundance were recorded by *Coreus marginatus*, being the characteristic species and edifying for this type of habitat.

From the zoogeographic point of view, in this habitat predominant are the Palearctic elements (30.77%) and Holarctic elements (23.07%), the remaining elements, represented by one species (7.7%), being: Euro Asian, Euro Siberian, Cosmopolitan, Holomediterranean and Asian.

All species identified in the area have a wide spread in the territory of Romania.

The species identified for the first time in this type of habitat are *Rhopalus maculatus* and *Chorosoma schillingi*, belonging to the Rhopalidae family.

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## NEW PTEROMALIDAE (HYMENOPTERA: CHALCIDOIDEA) TO THE REPUBLIC OF MOLDOVA

**GHEORGHE MANIC**

**Abstract.** The genera *Nasonia* ASHMEAD, 1904 and *Lamprotatus* WESTWOOD, 1833, and the species *Lamprotatus crassipes* THOMSON (Miscogasterinae), *Nasonia vitripennis* WALKER, *Trichomalus inscitus* WALKER, *Mesopolobus subfumatus* RATZEBURG, *M. jucundus* WALKER, *M. mesostenus* GRAHAM, *M. aspilus* WALKER, *Pteromalus cionobius* ERDOS, *P. cardui* ERDOS (Pteromalinae) are recorded for the first time in the Republic of Moldova.

**Keywords:** Hymenoptera, Pteromalidae, new genera and species to the Republic of Moldova.

**Rezumat.** Pteromalidae (Hymenoptera: Chalcidoidea) noi pentru Republica Moldova. Genurile *Nasonia* ASHMEAD, 1904 și *Lamprotatus* WESTWOOD, 1833, precum și speciile *Lamprotatus crassipes* THOMSON (Miscogasterinae), *Nasonia vitripennis* WALKER, *Trichomalus inscitus* WALKER, *Mesopolobus subfumatus* RATZEBURG, *M. jucundus* WALKER, *M. mesostenus* GRAHAM, *M. aspilus* WALKER, *Pteromalus cionobius* ERDOS, *P. cardui* ERDOS (Pteromalinae) sunt citate pentru prima dată în fauna Republicii Moldova.

**Cuvinte cheie:** Hymenoptera, Pteromalidae, genuri și specii noi pentru Republica Moldova.

### INTRODUCTION

The pteromalids are small parasitic wasps feeding, as larvae, on the immature stages of other species of insects, many of them phytophagous. Thus, they play an important role in most of the ecosystems, mainly as secondary or tertiary consumers.

In this note nine species of pteromalids (Hymenoptera: Pteromalidae) are listed, new to the Republic of Moldova. The examined material, as well as general remarks regarding the geographical distribution and the hosts of the species, are presented.

### MATERIAL AND METHODS

All the individuals were collected using an entomological net, between 2001 and 2008, mostly by the author. The material was collected from several Nature Reserves (Codrii, Plaiul Fagului, Pădurea Domnească, Prutul de Jos), as well as from some other locations.

### RESULTS

#### Family Pteromalidae

##### Subfamily Miscogasterinae

*Lamprotatus crassipes* THOMSON

**Identified material:** Codrii Nature Reserve: 1♀ August 14, 2003; 1♂ October 13, 2008 (Gh. Manic).

**Geographical distribution:** Czech Republic, Great Britain, Slovakia, Sweden.

**Biology:** hosts unknown.

##### Subfamily Pteromalinae

*Nasonia vitripennis* WALKER

**Identified material:** Codrii Nature Reserve: 3♀♀ August 7, 2008 (Gh. Manic).

**Geographical distribution:** *N. vitripennis* is found worldwide.

**Biology:** Calliphoridae and Muscidae (Diptera).

*Trichomalus inscitus* WALKER

**Identified material:** Cneazevca: 1♀ July 11, 2008 (Gh. Manic).

**Geographical distribution:** West Europe.

**Biology:** reared from *Rhynchaenus alni* (L.), *R. fagi* (L.), *R. quercus* (L.) and *R. testaceus* (MULL.).

*Mesopolobus subfumatus* RATZEBURG

**Identified material:** Hâncești: 2♀♀ August 14, 2005 (Gh. Manic).

**Geographical distribution:** Russia (Moscow, Kostroma region), Western Europe.

**Biology:** reared from *Diprion* (Diprionidae).

*Mesopolobus jucundus* WALKER

**Identified material:** Pănășesti: 1♀ July 16, 2003, Prutul de jos Nature Reserve: 1♀ July 11, 2007, Codrii Nature Reserve: 2♀♀ September 10, 2008 (Gh. Manic).

**Geographical distribution:** Crimea, Western Europe.

**Biology:** gall wasps (*Hymenoptera*, *Cynipidae*).

*Mesopolobus mesostenus* GRAHAM

**Identified material:** Prutul de jos Nature Reserve: 1♀ July 11, 2007, Codrii Nature Reserve: 1♀ August 7, 2008 (Gh. Manic).

**Geographical distribution:** Great Britain.

**Biology:** unknown.

*Mesopolobus aspilus* WALKER

**Identified material:** Codrii Nature Reserve: 2♀♀ July 14, 2003, Prutul de jos Nature Reserve: 1♀ July 11, 2007, Traian: 1♀ July 12, 2008 (Gh. Manic).

**Geographical distribution:** Sweden, Great Britain.

**Biology:** reared from *Euura amerinae* L. (*Tenthredinidae*), *Oligotrophus juniperinus* L., *Taxomyia taxi* INCHB. (*Cecidomyiidae*).

*Pteromalus cionobius* ERDOS

**Identified material:** Vulcănești: 1♀ July 12, 2008 (Gh. Manic).

**Geographical distribution:** Hungary.

**Biology:** reared from *Cionus thapsi* F. (*Curculionidae*).

*Pteromalus cardui* ERDOS

**Identified material:** Codrii Nature Reserve: 1♀ July 12, 2004, 3♀♀ August 7, 2008; Prutul de jos Nature Reserve: 1♀ July 11, 2007, Giurgiulești: 1♀ July 2, 2007, Traian: 2♀♀ July 12, 2008, Hâncești: 1♀ July 11, 2007, Leova: 2♀♀ July 11, 2007 (Gh. Manic).

**Geographical distribution:** Kazakhstan, Czech Republic, Great Britain, Hungary, Slovakia.

**Biology:** the pteromalid obtained from flower heads *Carduus acanthoides* (L.).

## CONCLUSIONS

Two genera (*Nasonia* and *Lamprotatus*) and nine species are recorded for the first time in the Republic of Moldova: *Lamprotatus crassipes* THOMSON (*Miscogasterinae*), *Nasonia vitripennis* WALKER, *Trichomalus inscitus* WALKER, *Mesopolobus subfumatus* RATZBURG, *M. jucundus* WALKER, *M. mesostenus* GRAHAM, *M. aspilus* WALKER, *Pteromalus cionobius* ERDOS, *P. cardui* ERDOS (*Pteromalinae*).

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## CHANGES OF SECONDARY PRODUCTIVITY OF CARABID COMMUNITIES (INSECTA: COLEOPTERA) IN NATURAL FOREST ECOSYSTEMS IN RELATION TO GEOLOGICAL SUBSTRATE AND VERTICAL ZONALITY

ZBYŠEK ŠUSTEK

**Abstract.** *The secondary productivity of 48 carabid communities from natural forests on different geologic substrates and at different altitudes is compared. In spite of a great variability, it shows a decreasing trend from communities from habitats on alkaline or nitrophilous substrates to the acidic substrates and from low altitudes to the high altitudes. In communities on more fertile substrates, a considerable part of biomass is bound by large species occurring in a lower number of individuals, whereas on the less fertile substrates the existing biomass tends to be split among a large number of little species. In some cases, the direct influence of the habitat trophicity or climatic factors is combined with indirect influence of litter structure or its continuous covering by mosses.*

**Keywords:** *Carabidae, secondary productivity, geological substrate, vertical zonality.*

**Rezumat.** *Schimbările productivității secundare ale cenzelor de carabide (Insecta: Coleoptera) din ecosisteme forestiere naturale în relație cu substratul geologic și zonalitatea verticală. Compararea productivității secundare a 48 de cenoze de carabide din păduri naturale de pe substrat geologic și altitudine diferită a arătat că, în ciuda variabilității mari, există un trend descrescător de la cenozele din biotopii de pe substratele alcaline sau nitrofile până la cele acidofile, precum și din altitudinile mici până la cele înalte. În cenozele de pe substrat mai bogate, o mare parte a biomasei este legată de specii mari care se întâlnesc în număr relativ mic. Spre deosebire, pe substratele mai sărace, biomasa tinde să fie împărțită între un număr mare de specii mici. În unele cazuri, influența directă a substratului sau a factorilor climatici este combinată cu influență indirectă a structurii de litieră sau acoperirea ei continuă de mușchi.*

**Cuvinte cheie:** *carabide, productivitate secundară, substrat geologic, zonalitate verticală.*

### INTRODUCTION

Geological substrate and vertical zonality of climate belong to the most important abiotic factors responsible of productivity of ecosystems. The geological substrate indirectly influences the hydrological regime in ecosystems and directly influences the soil fertility, which increases from the acid soils to the nitrophilous or alkaline soils. The production of plant communities determines the food basis for herbivores and, secondarily, of carnivores and destructors. The aim of this contribution is to show, how the productivity of carabids communities changes along the geologic and climatic gradients in the natural forest stands in Central Europe.

### MATERIAL AND METHODS

The material was pitfall trapped in 48 habitats in 16 localities (ŠUSTEK 1972, 1976, 1982, 1983, 1984, 1986, 1988, 2006, Tab. 1) in Bohemia, Moravia and Slovakia in 1970-2006: Malá Pleš 49°59'4"N, 13°49'32"E; Kohoutov 49°59'43"N, 13°50'29"E; Hřebínek 50°50'54"N, 15°16'2"E; Žákova hora 49°41'1"N, 16°1'15"E; Františkova Myslivna 50°3'27"N, 17°12'28"E; Pavlovské kopce 48°52'40"N, 16°39'33"E; Boleradice 48°58'23"N, 16°47'39"E; Buchlovce 49°5'57"N, 17°17'50"E; Křačianska Magura 49°9'14"N, 18°57'40"E; Šrámková 49°11'13"N, 19°7'11"E; Zadná Javorová dolina 49°12'40"N, 20°9'19"E.; Kolová dolina 49°10'14"N, 20°10'30"E, Zadné Meďodoly 49°14'10"N, 20°10'44"E. More detailed characteristics of the localities are given in the papers cited above. In these papers the complete surveys of species are also given.

The ecological conditions in these habitats are characterized according to the Zlatník's system of phytocoenological classification of natural forests in the Central Europe (ZLATNÍK & RAUŠER 1966, ZLATNÍK 1976), which in relation to the geological substrate distinguishes four trophic series (A-acidophilous, B-neutral, C-nitrophilous, D-alkaline) and three transition series (AB, BC and BD), while in rapport to sequence of altitudinal and expositional changes of climate defines nine vegetation tiers named according to dominant edificatory trees (oak, beech-oak, oak-beech, beech, beech-fire, beech-fire-spruce, spruce, dwarf pine, alpine meadows).

The habitats belonging purely to the alkaline trophic series D were omitted in this study, because the available material originates from the steppe-like formations with an extremely low occurrence of carabids. Also the floodplain ecosystems were intentionally omitted in this study, because the possible direct influence of the geologic substrate is here masked by a rich input of sediments, converging to the conditions in the nitrophilous series C. At the same time, the secondary production of Carabids in them is strongly subjected to natural fluctuations of hydrological regime and its profound anthropogenic changes.

The number of traps (glass or plastic jars with diameter of 75 mm, filled with 4% formalin) installed in each habitat varied according to purposes in the respective investigations. In the earlier studies (ŠUSTEK 1972, 1976, 1983), 10 traps were installed in homogenous habitats in accordance with the experimental study of OBRTEL (1971), while in



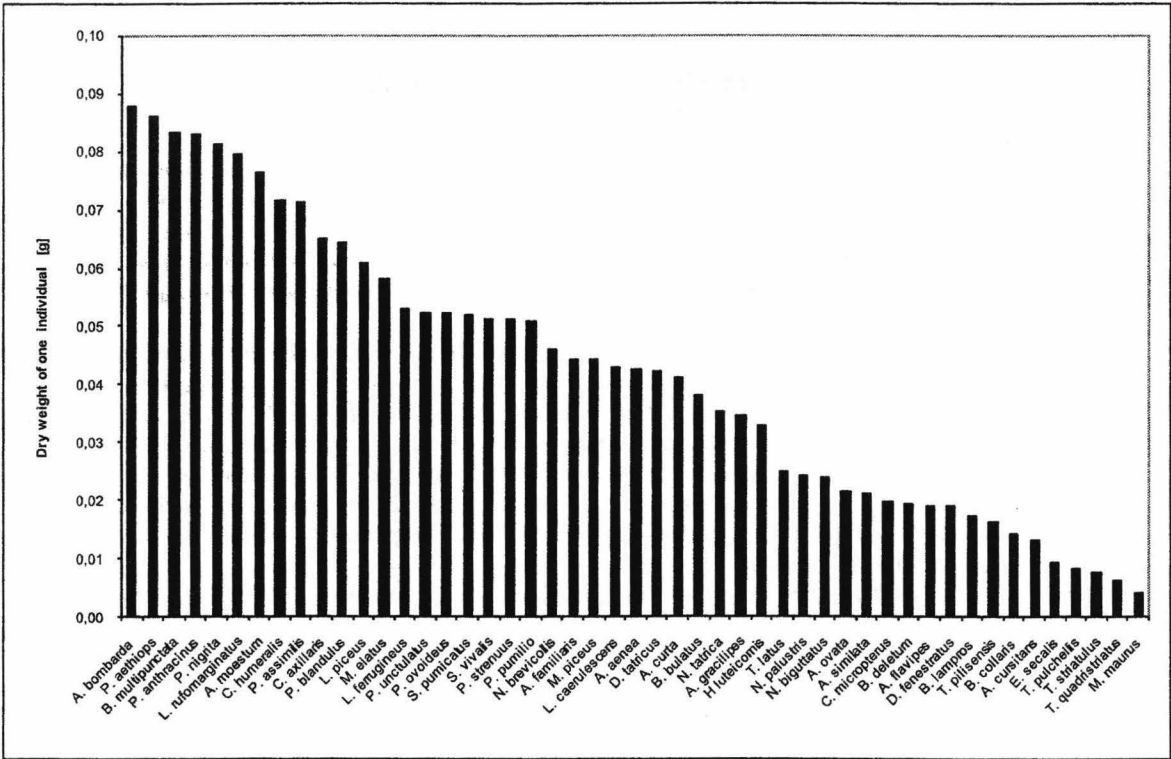


Figure 2. Average weight of Carabids species with the weight bellow 0.1 g.  
Figura 2. Greutatea medie a speciilor de carabide sub 0,1 g.

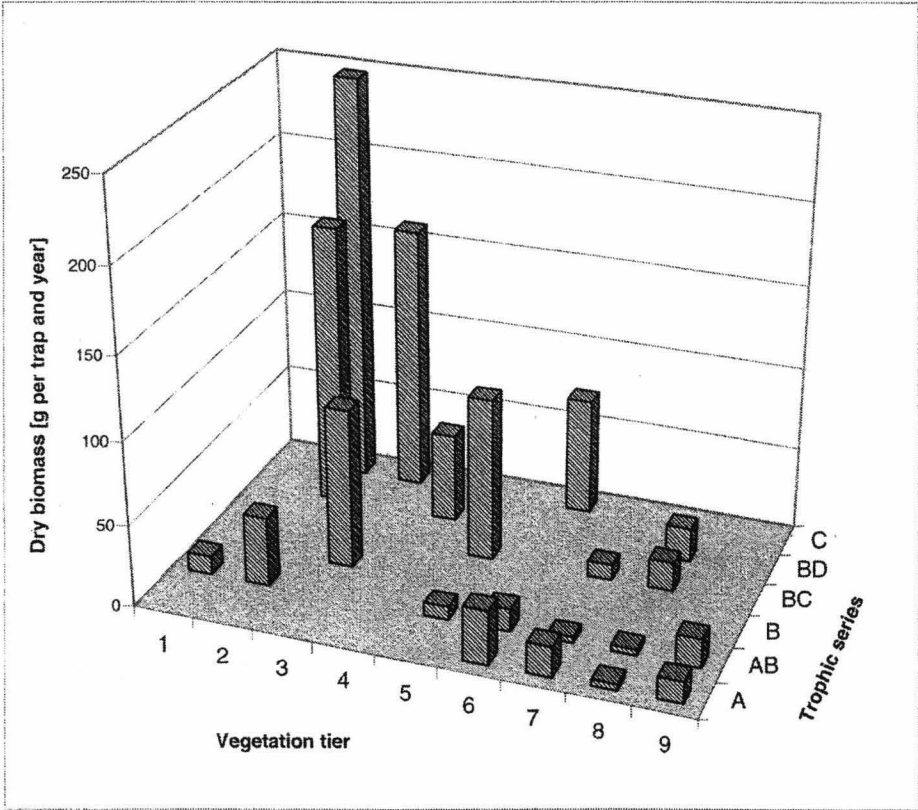


Figure 3. Average weight of dry biomass of carabid communities in different vegetation tiers and trophic series (1-9: oak vegetation tier-veg. tier of alpine meadows; A- acidophilous trophic series, B-neutral trophic series, C-nitrophilous trophic series, D-alkaline trophic series, AB, BD and BD-transitory trophic series).  
Figura 3. Greutatea medie a biomasei uscate in cenozele de carabide în diferite zone de vegetație și serii trofice (1-9: zona de vegetație a stejarului - zona de vegetație a pășiiștilor alpine; A-serie trofică acidofilă, B-serie trofică neutrală, C-serie trofică nitrofilă, D-serie trofică alcalică, AB, BC și BD-serii trofice de tranziție).



The productivity of carabid communities in the individual trophic series and vegetation tiers is obviously very variable, as between these two categories (Fig. 3), as within them (Fig. 5). The extreme values are 300 g per trap and season (Pavlovské kopce, beech-oak vegetation tier, neutral-alkaline trophic series, *Querci Fageta*) and 0.9 g per trap and season (High Tatra, spruce vegetation tier, acid-alkaline series, *Sorbi abieti piceeta*). However, there are evident two clear tendencies: A decrease two directions—from the average values of almost 220–250 g per trap and year in the nitrophilous trophic series and in the beech-oak or oak-beech vegetation tier to average values of about 5–30 g per trap and year in the acidophilous trophic series and in the vegetation tiers of dwarf pines and alpine meadow. There exists a relatively high correlation between trophic series and cumulative dry biomass of the community ( $r = 0.68$ ), while correlation between trophic series and number of individuals is lower ( $r = 0.55$ ). The dry biomass of some communities, especially of those in higher altitudes is, however, in a contradiction ( $r = 0.47$ ) with cumulative number of individuals (Fig. 4).

It is due to huge amounts of small species, especially *Pterostichus pumilio*, *Pterostichus unctulatus* and species of the genus *Trechus* in acidophilous spruce forests and a low quantitative representation or even absence of large species. In such cases, the low secondary production does not result only from little fertile substrate and, as a consequence, low food offer, but also from character of the litter or covering the ground surface or from a continuous growth of mosses, which make difficult movement or burying activity of large Carabids. On the contrary, in the most productive communities in low vegetation tiers and in the trophic series BD, BC and C, the high productivity and a relatively reduced number of individuals (Fig. 4) is caused by the predominance of *Carabus coriaceus* and/or of the species with average weight of one individual of 1.5–2.0 g (Table 1).

Especially in the habitats on the limestone or dolomitic limestone substrates (they do not mostly belong to the alkaline trophic series D, but in dependence of the terrain relief they belong to the nitrophilous series C or to the transitory series BD), the high productivity often results from high levels of carbonates in the soil making favourable conditions for mollusks. Their high abundance represents a rich food offer for large *Carabus* species. Within the material examined in this study it is particularly the case of all habitats in the Pavlovské kopce hills. On the contrary, the mollusks are almost absent on the acidophilous substrates, especially in the mountain forests of High Tatras of Malá Fatra.

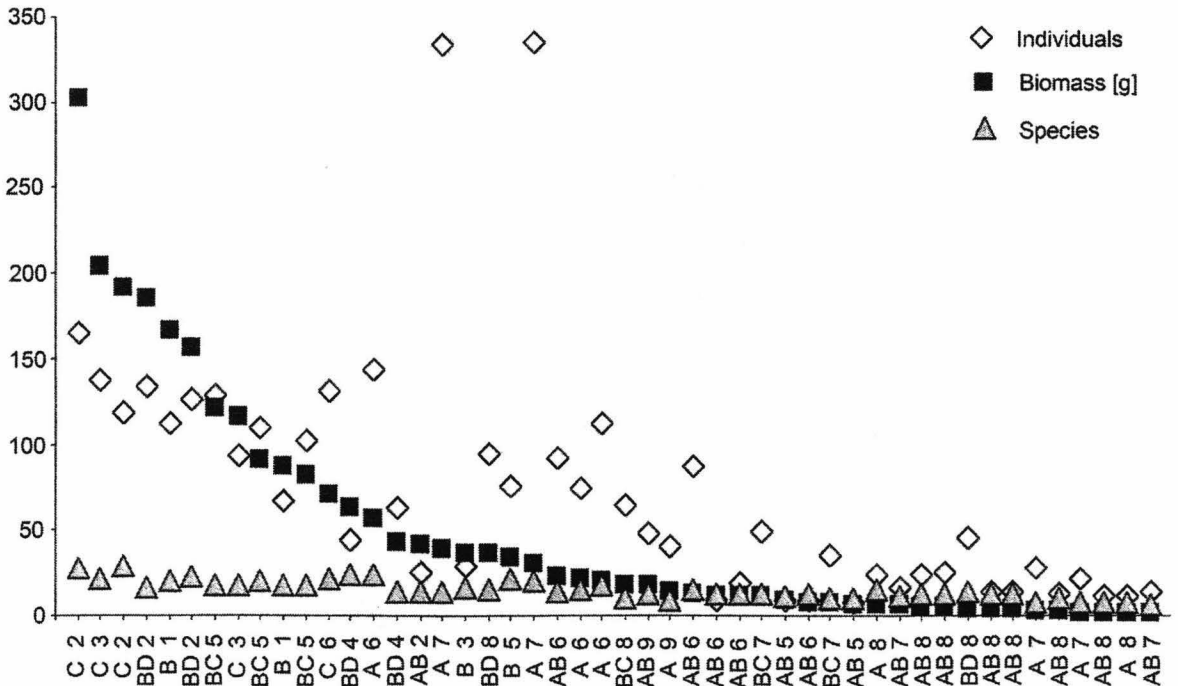


Figure 4. Dry biomass in grams, number of individuals and number of species of carabid communities in different vegetation tiers and trophic series, (abbreviations as in Fig. 3).

Figura 4. Greutatea medie a biomasei uscate în grame, numărul indivizilor și a speciilor în cenozele de Carabidae în diferite zone de vegetație și serii trofice (abrevieri ca în figura 3).

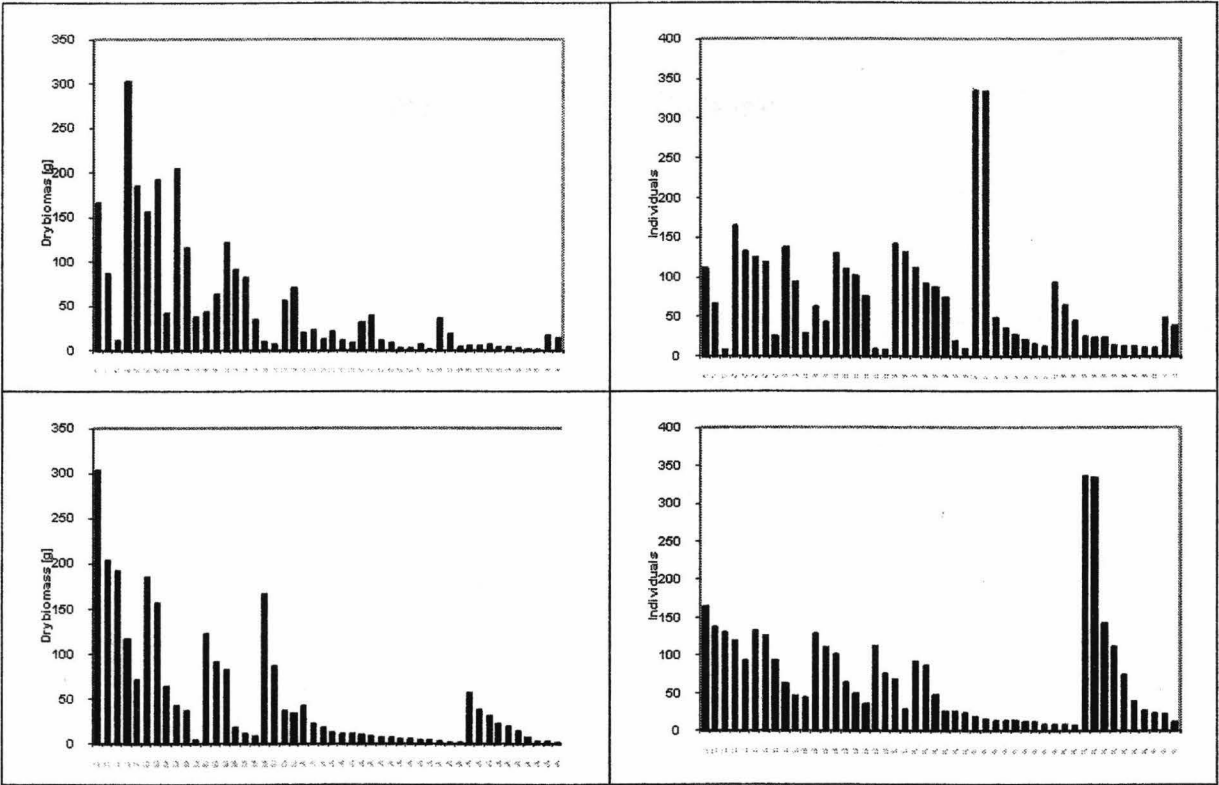


Figure 5. Variability of dry biomass and number of individuals with each trophic series and vegetation tier (abbreviations as in Fig. 3).

Figura 5. Variabilitatea biomasei uscate și a numărului de indivizii în cadrul fiecărei serii trofice și a zonei de vegetație (abrevieri ca în figura 3).

Table 1. Survey of localities.  
Tabel 1. Lista localităților.

Locality	Part of transection	Year of sampling	Group of geobiocoens	Vegetation tier	Trophical series	Number of traps
Pavlovské vrchy		1981	CaQ	1	B	10
Pavlovské vrchy		1971	CaQ	1	B	10
Pavlovské vrchy		1981	TAc inferiora	2	C	10
Pavlovské vrchy		1971	TAc inferiora	2	C	10
Pavlovské vrchy		1981	FQ	2	B	10
Pavlovské vrchy		1971	FQ	2	B	10
Boleradice		1971	FQ	2	B	6
Pavlovské vrchy		1981	TAc superiora	3	C	10
Pavlovské vrchy		1971	TAc superiora	3	C	10
Buchlovice		1971	QF	3	B	6
Malá Pleš		1980	QF	4	BD	5
Kohoutov		1980	Fp	4	BD	10
Šrámková	32 - 40	1982	FAc	5	BC	8
Šrámková	L 10 - 13	1982	FAc	5	C	4
Šrámková	41 - 47	1982	FAc	5	BC	7
Šrámková	1 - 12	1982	FA	5	B	12
Žákova hora		1970	FA	5	AB	
Žákova hora		1971	FA	5	AB	10
Šrámková	24 - 32	1982	FAc	6	C	9
Šrámková	13 - 19	1982	PiAb	6	A	7
Křačianska Magura	1 - 3	1984	FA	6	AB	3
Hřebíněk	1 - 6	1980	SPi	6	AB	6
Křačianska Magura	27 - 32	1984	FA	6	AB	5
Křačianska Magura	20 - 26	1984	FAc	6	BC	8
Františkova Myslivna		1970	FA	6	AB	
Františkova Myslivna		1971	FA	6	AB	10
Křačianska Magura	4 - 10	1984	AcPi	7	A	7
Křačianska Magura	11- 19	1984	Spi	7	A	8
Kolové pleso		2006	Spi	7	BC	6
Kolové pleso		2006	Spi	7	BC	6
Zadné Meďodoly		2005	SPi	7	AB	6
Zadné Meďodoly		2005	SPi	7	A	12

Zadná javorová dolina	2005	Spi	7	AB	6
Zadné Meďodoly	2004 - 2006	Pm	8	BD	18
Kraková hoľa	2006	Pm	8	BC	6
Zadné Meďodoly	2005	Pm	8	BD	6
Zadné Meďodoly	2003 - 2006	Pm	8	A	18
Zadná javorová dolina	2005	Pm	8	AB	6
Kolové pleso	2005	Pm	8	AB	6
Kráľova hoľa	2006	Pm	8	AB	6
Zadná javorová dolina	2005	Pm	8	A	6
Zadná javorová dolina	2005	Ljt	9	AB	6
Zadná javorová dolina	2005	Ljt	9	A	6
Kráľova hoľa	2005	Ljt	9	AB	6
Ďumbier	2006	Ljt	9	AB	6
Ďumbier	2006	Pm	9	AB	6

Explanations:

Groups of geobiocoens: AcPi – *Aceri Pineta*, CaQ – *Carpini Querceta*, FAc – *Fagi Acereta*, FQ – *Fagi Querceta*, QF – *Querci Fageta*, PiAb – *Pini abiettea*, Pm *Pineta mugho*, Spi – *Sorbi Pineta*, TAc – *Tiliae Acereta*,

Vegetation tiers: 1 – oak veg. tier, 2 – beech-oak veg. tier, 3 – oak-beech veg. tier, 4 – beech veg. tier., 5 – beech-fire veg. tier, 6 – spruce-beech-fire veg. tier, 7 – spruce veg. tier, 8 – dwarf pine veg. tier, 9 – alpine meadows.

Table 2. Average dry weight of one individual of Carabid species (arranged alphabetically).  
Tabel 2. Greutatea uscată medie a unui individ de carabidele (specii aranjate alfabetic).

Species	Weight [g]	Species	Weight [g]
<i>Abax ovalis</i> (DUFTSCHMIDT, 1812)	0.6283	<i>Harpalus luteicornis</i> (DUFTSCHMIDT, 1812)	0.0329
<i>Abax paralelopipedus</i> (PILLER ET MITTERPACHER, 1783)	1.1521	<i>Harpalus punctulatus</i> (DUFTSCHMIDT, 1812)	0.1390
<i>Abax parallelus</i> (DUFTSCHMIDT, 1812)	0.5140	<i>Harpalus quadripunctatus</i> DEJEAN, 1829	0.1012
<i>Agonum moestum</i> DUFTSCHMIDT, 1812	0.0764	<i>Harpalus rufipalpis</i> STURM, 1818	0.1128
<i>Agonum gracilipes</i> (DUFTSCHMIDT, 1812)	0.0346	<i>Harpalus tardus</i> (PANZER, 1797)	0.1693
<i>Amara aenea</i> (DE GEER, 1774)	0.0424	<i>Chlaenius tristis</i> (SCHALLER, 1783)	0.4236
<i>Amara curta</i> DEJEAN, 1828	0.0413	<i>Leistus ferrugineus</i> (LINNAEUS, 1758)	0.0501
<i>Amara cursitans</i> ZIMMERMANN, 1832	0.0206	<i>Leistus piceus</i> FROELICH, 1799	0.0610
<i>Amara eurynota</i> (PANZER, 1797)	0.0457	<i>Leistus rufomarginatus</i> (DUFTSCHMIDT, 1812)	0.0795
<i>Amara familiaris</i> DUFTSCHMIDT, 1812	0.0444	<i>Licinus hoffmannsegi</i> (PANZER, 1803)	0.1458
<i>Amara ovata</i> (FABRICIUS, 1792)	0.0213	<i>Loricera caerulea</i> (LINNAEUS, 1758)	0.0428
<i>Amara similata</i> (GYLLENHALL, 1810)	0.0211	<i>Microlestes maurus</i> (STURM, 1827)	0.0041
<i>Aptinus bombarda</i> (ILLIGER, 1800)	0.0879	<i>Molops elatus</i> (FABRICIUS, 1801)	0.0582
<i>Asaphidion flavipes</i> (LINNAEUS, 1764)	0.0192	<i>Molops piceus</i> (PANZER, 1793)	0.0443
<i>Badister bulatus</i> (SCHRANK, 1798)	0.0381	<i>Nebria brevicollis</i> (FABRICIUS, 1792)	0.0459
<i>Bembidion lampros</i> (HERBST, 1784)	0.0172	<i>Nebria tetrica</i> I. MILLER, 1859	0.0354
<i>Bembidion deletum</i> AUDINET-SERVILLE, 1821	0.0195	<i>Notiophilus biguttatus</i> (FABRICIUS, 1779)	0.0240
<i>Blethisa multipunctata</i> (LINNAEUS, 1758)	0.0834	<i>Notiophilus palustris</i> (DUFTSCHMIDT, 1812)	0.0241
<i>Bradytelus collaris</i> (PAYKULL, 1798)	0.0142	<i>Ophonus azureus</i> (FABRICIUS, 1775)	0.1002
<i>Calathus metallicus</i> DEJEAN, 1828	0.1403	<i>Ophonus rufibarbis</i> (FABRICIUS, 1792)	0.1001
<i>Calathus micropterus</i> (DUFTSCHMIDT, 1812)	0.0196	<i>Platynus assimilis</i> (PAYKULL, 1790)	0.0713
<i>Calosoma inquisitor</i> (LINNAEUS, 1758)	1.6412	<i>Poecilus cupreus</i> (LINNAEUS, 1758)	0.2710
<i>Carabus arvensis</i> HERBST, 1784	1.0965	<i>Poecilus lepidus</i> (LESKE, 1787)	0.1827
<i>Carabus auronitens</i> FABRICIUS, 1792	1.3251	<i>Pseudophonus rufipes</i> (DE GEER, 1774)	0.4126
<i>Carabus cancelatus</i> ILLIGER, 1758	1.3600	<i>Pterostichus aethiops</i> (PANZER, 1797)	0.0862
<i>Carabus convexus</i> FABRICIUS, 1775	1.1212	<i>Pterostichus anthracinus</i> (ILLIGER, 1798)	0.0831
<i>Carabus coriaceus</i> LINNAEUS, 1758	6.5950	<i>Pterostichus blandulus</i> I. MILLER, 1859	0.0643
<i>Carabus fabricii</i> PANZER, 1813	1.1013	<i>Pterostichus burmeisteri</i> (HEER, 1801)	0.1546
<i>Carabus glabratus</i> PAYKULL, 1790	1.7215	<i>Pterostichus cordatus</i> LETZNER, 1847	0.0953
<i>Carabus hortensis</i> LINNAEUS, 1758	1.7800	<i>Pterostichus foveolatus</i> (DUFTSCHMIDT, 1812)	0.2152
<i>Carabus irregularis</i> FABRICIUS, 1792	1.1241	<i>Pterostichus melanarius</i> (ILLIGER, 1798)	0.5336
<i>Carabus linnei</i> PANZER, 1813	1.0568	<i>Pterostichus melas</i> (CREUTZER, 1799)	0.6421
<i>Carabus nemoralis</i> MÜLLER, 1764	1.7370	<i>Pterostichus morio</i> DUFTSCHMIDT, 1812	0.2322
<i>Carabus obsoletus</i> STURM, 1815	1.9821	<i>Pterostichus niger</i> (SCHALLER, 1783)	1.0600
		<i>Pterostichus nigrita</i> (PAYKULL, 1790)	0.0812

<i>Carabus scheidleri</i> PANZER, 1799	2.1885	<i>Pterostichus oblongopunctatus</i> (FABRICIUS, 1787)	0.1941
<i>Carabus sylvestris</i> PANZER, 1793	1.1216	<i>Pterostichus ovoideus</i> (STURM, 1824)	0.0521
<i>Carabus ullrichi</i> GERMAR, 1824	1.5132	<i>Pterostichus pilosus</i> (HOST, 1789)	0.6352
<i>Carabus violaceus</i> LINNAEUS, 1758	1.7457	<i>Pterostichus pumilio</i> (DEJEAN, 1828)	0.0410
<i>Cychrus attenuatus</i> (FABRICIUS, 1792)	0.9125	<i>Pterostichus strenuus</i> (PANZER, 1797)	0.0511
<i>Cychrus caraboides</i> (LINNAEUS, 1758)	0.9256	<i>Pterostichus unctulatus</i> (DUFTSCHMIDT, 1812)	0.0523
<i>Cymindis axillaris</i> (FABRICIUS, 1794)	0.0652	<i>Stomis pumicatus</i> (PANZER, 1796)	0.0520
<i>Cymindis humeralis</i> (FOURCROY 1785)	0.0715	<i>Synuchus vivalis</i> (OLLIGER, 1798)	0.0512
<i>Deltomerus tatricus</i> (I. MILLER, 1859)	0.0421	<i>Trechus latus</i> PUTZEYS, 1846	0.0248
<i>Dromius fenestratus</i> (FABRICIUS, 1794)	0.0192	<i>Trechus pilisensis</i> CSIKI, 1918	0.0163
<i>Epaphius secalis</i> (PAYKULL, 1790)	0.0092	<i>Trechus pulchellus</i> Putzeis, 1846	0.0082
<i>Harpalus atratus</i> LATREILLE, 1804	0.1561	<i>Trechus quadristriatus</i> (SCHRANK, 1781)	0.0062
<i>Harpalus distinguendus</i> (DUFTSCHMIDT, 1812)	0.1873	<i>Trechus striatulus</i> PUTZEYS, 1847	0.0076
<i>Harpalus latus</i> (LINNAEUS, 1758)	0.1773	<i>Trichotichnus laevicollis</i> (DUFTSCHMIDT, 1812)	0.1431

Influence of the geological substrate of the secondary productivity and species composition of Carabids is not evident only from comparison of samples from remote localities, but can be directly observed in some parts of the West Carpathians, where a mosaic of acid or alkaline substrates exists on a small territory and their boundaries can be observed in the terrain ŠUSTEK (2006), ŠUSTEK & ŽUFFA (1986, 1988).

## CONCLUSIONS

The maximum productivity of Carabid communities reaches 300 g per trap and vegetation season, while the minimum productivity drops to 1.6 g per trap and vegetation season. It is very variable, as within individual trophic series and vegetation tiers, as between them. The variation ranges within individual trophic series or vegetation tiers overlap mutually. But there is a general tendency of decreasing of productivity from the average values of 220-280 g per trap and vegetation season in the nitrophilous or transitory neutral – alkaline trophic series and lower vegetation tiers to 5-30 g per trap and vegetation season in the acid trophic series and mountain vegetation tiers. The average values of productivity in a richer trophic series are mostly visibly higher than those in the next poorer series. The secondary productivity expressed by the dry biomass is freely correlated with the productivity expressed by the cumulative number of individuals. In the more productive communities, a lower number of individuals of large species bind the major part of biomass, whereas in the less productive communities the existing biomass is split among a large number of individuals of small species. This relation is, however, strongly biased by character of litter and covering of soil surface by mosses, which create conditions for movement of individual species through the litter and hiding in it. Number of individuals can be generally used as an indicator of secondary productivity of Carabid communities, but it is to be always interpreted in regard with body size structure of the communities. Otherwise it can lead to misinterpretations.

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## THE GENUS *CARABUS* (COLEOPTERA: CARABIDAE) IN THE WHEAT CROPS OF MOLDAVIA (ROMANIA)

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**Abstract.** *The content of the paper is a synthesis of the data of collecting of the species of the genus Carabus that act in the wheat crops of Moldavia, 1977-2002.*

**Keywords:** *Moldavia, wheat crop, Carabus, species, ecological requirements.*

**Rezumat.** *Genul Carabus (Coleoptera: Carabidae în culturile de grâu din Moldova (România). Lucrarea de față este o sinteză a colectării speciilor genului Carabus din culturile de grâu din opt județe și 15 localități ale Moldovei în condițiile meteorologice ale celor 10 ani (1977-2002). Pentru colectarea materialului entomologic epigeic s-a folosit metoda clasică de colectare, 12 capcane Barber în fiecare localitate (staționar). Capcanele au funcționat permanent între 51 și 137 zile în staționare. În total, s-au colectat 290 indivizi, aparținând la 7 specii ale genului Carabus. Din totalul indivizilor colectați se evidențiază speciile: Carabus cancellatus ILLIGER, 1798 (37,93%), C. scabriusculus OLIVIER, 1795 (29,31%), C. besseri FISCHER VON WALDHEIM, 1822 (25,86%). În ce privește principalele cerințe ecologice ale speciilor găsite, ele s-au caracterizat prin predominarea speciilor cu reproducere în primăvară (57,14%), mezofile (71,43%) cu preferințe pentru biotopul de pădure (42,86%), culturi, stepă (28,57%), euritopice (28,57%), zoofage (100%), distribuite geografic în Europa (28,57%), Palearctic (42,86) etc.*

**Cuvinte cheie:** *Moldova, cultura de grâu, Carabus, specii, cerințe ecologice.*

### INTRODUCTION

Movement and organization characterizes the living world and the nonliving world. Biosphere and Ecosphere are structured in the organization levels. Hierarchical levels of organization of the Biosphere are: the individual level, the population level (or of the species) and the biocoenotic level.

The functional unit of the Biosphere is the ecosystem, concretized in the unity and interaction between biotope and biocoenosis. The biotope with its natural attributes has a priority status and determines the characters of the biocoenosis.

Our research took place in wheat crops of Moldavia. Moldavia, by its geographical location in eastern Romania, is a zoogeographical region (KJSS, 1970). The climate of Moldavia is temperate continental, with average annual temperatures between 7 (in the north) and 9 C degrees (in the south) and annual average precipitations between 450 and 650 mm, depending on altitude, lower at lower altitude and higher at higher altitude.

In the past, the hilly region of Moldavia was covered by deciduous forests, from south to north: oak, common oak and beech, then replaced by meadows and cultivated land. This fact helps us to understand the evolution and adaptation of the fauna to the new conditions (VARVARA & BRUDEA, 1983).

In Moldavia, as in the rest of Romania, the wheat crop is a main crop for the food needs of the population.

The wheat crop ecosystem gets a microclimate in the form of pedoclimate in connection with the characters of the soil (slope, exposure etc.) and a phytoclimate determined by the crop plant (density and size of plants, phases of vegetation), both characterized by more reduced particular values of temperature, luminosity, compared with the outside and a higher humidity of the soil and air.

At the level of the soil a fauna of epigeic arthropods is structured in which the following taxa predominate: Insecta, Arachnida, Coleoptera, Carabidae, Staphylinidae.

In the concrete conditions of the wheat crop ecosystems from Moldavia, for knowing the diversity and structure of the epigeic arthropods: classes, orders, families, species, the relative abundance of the species of Carabidae, the Shannon-Wiener diversity index of the coenosis of Carabidae, the following authors published certain papers: VARVARA et al., (1991), VARVARA & BULIMAR (2003), VARVARA & MOGLAN (1993), CÂRLAN & VARVARA (1999), VARVARA (1991, 2001, 2005).

The authors CHIRECEANU et al. (2009) in the paper "The Invertebrate Fauna Associated with the Wheat Agrocoenosis in Amzacea, Constanța County" mention the papers in the rest of Romania which have content related to the fauna in the wheat crop ecosystem.

In Banat, BICĂ realized a doctorate thesis (2005) related to the epigeic coleopterans (Carabidae) from the wheat, barley and maize crops.

In the Republic of Moldavia, dr. habilitat NECULISEANU in his thesis to obtain the title of doctor habilitat (2003) synthesized the data from all his papers referring to the study of the Carabidae family in the space of the Republic of Moldavia, among which the carabids from the wheat crops in the vegetation periods of the years (1979-2003) from over 170 localities of collecting from natural and agricultural ecosystems.

In Europe, researching directions on carabids living in different crops are very well synthetized in the paper "Long-termed changes in ground beetle (Coleoptera: Carabidae) assemblages in a field treated by organic fertilizers" (2008).

Our paper may be included in the first direction " (1) study of population and community structure in different crops (SKUHRÁVÝ & NOVÁK 1957; SKUHRÁVÝ et al., 1959; ŠTEPANOVIČOVÁ & BELÁKOVÁ, 1960; ŠTUSÁK 1962; PETRUŠKA 1966, 1971, 1986, 1987, 1988; OBRTEL 1969; NOVÁK 1972; ANDERSEN 1999A; BASEDOW et al., 1976; SEKULIĆ et al., 1973; ERICSON 1978; SHAROVA 1983; HONĚK 1997; PETŘVALSKÝ & PORHAJAŠOVÁ 2002, PORHAJAŠOVÁ 2002 (cited according to paper, 2008).

The purpose of our paper is to achieve a synthesis of personal data on the presence of species of the genus *Carabus* in the wheat crops of Moldavia.

## MATERIAL AND METHODS

The rigorous, appropriate, objective, relevant collecting of the zoological material is important for knowledge of the taxonomic structure, the relative abundance and dynamics of constant, abundant and dominant taxa.

Methodologically, the presentation of the working method must detail answers at three questions: **where, when and how.**

The most used, classical and standard method in collecting the ground beetles is the use of soil pitfalls with preserving liquid (Barber) and protected from rainfalls. This method permits the collecting of qualitative and quantitative material in a given period of time established by the researcher in order to obtain data on a series of parameters, such as: the taxonomic diversity of the populations of carabids, the relative abundance of the species, their constancy and dominance, the dynamics of a population of a species in connection with the natural characteristics of the biotope, comparisons among sites of collecting and the discussions of results.

The material was collected from Moldavia, from eight counties, beginning from south to north of Moldavia (Brăila, Galați, Vaslui, Vrancea, Iași, Bacău, Botoșani, Suceava) from 16 localities (sites with wheat crops) in the interval of the years, 1977-2002 (May, June, July) (Table 1). For the collecting of the individuals of carabids, 12 pitfalls were used, as an optimum number, with an exception in the wheat crop, Chirița, Iași (Iași County) where seven sites were chosen with five pitfalls in each site. Each soil pitfall had a volume of 800 cubic centimetres, 7 centimetres in diameter and 11 centimetres in height, being protected from rainfalls.

The pitfalls were set in the ecosystem of wheat crops at the dates shown in Table no.1, on three rows with four pitfalls on each row. The distance between rows and pitfalls was of three meters. The pitfalls functioned continuously a number of days between 51 (May, June, July, August) and 137. As preserving liquid a solution of 3-4 % formol was used.

### Collecting of the material

In the temperate area, climate influences the activity of the ectothermic invertebrates. We collected the material twice a month to follow the seasonal variation of the specific composition, the variation of diversity and the number of the individuals belonging to each species, the characteristic of the dynamics.

The first collecting was made around the middle of each month, (May-July) and the second one at the end of each month, mentioned above in the Table no.1. The last collecting was made at the end of the first half of July, with some exceptions. The material was collected from each pitfall, recording the main data of the site, number of the pitfall, collecting date. In the whole period of the years 1977-2002, 112 collections were made, and 1,488 samples were examined (Table 1).

Identification of species, their nomenclature were made according to FREUDE et al. (1976).

For the characterization of the species of the genus *Carabus* we used the following parameters: relative abundance, ecological requirements (time of reproduction, preference for moisture, biotope, food, and geographical distribution). Nomenclature of the species was used according to FREUDE et al. (1976).

To characterize the species of the genus *Carabus* from the ecosystem crop of autumn wheat, referring to reproduction, preferences for humidity, biotope, food regime, geographical distribution, we used some personal observation in the field and information from the literature (PETRUSENKO, 1970; PETRUSENKO & PETRUSENKO, 1972; TURIN et al., 1991; NECULISEANU, 1991, 2003; ŠUSTEK, 2000, VARVARA, 2005).

Table 1. General data on the collecting of the material.  
Tabel 1. Datele generale asupra colectării materialului.

1	2	3	4	5	6	7
1	Brăila, Terasă, 1985 (Brăila)	April 10 – July 10, 1985	91	12	7	84
2	Corod, 1983 (Galați)	April 25 – July 10, 1983	77	12	7	84
3	Vaslui, 1977 (Vaslui)	May 1 – July 20, 1977	81	12	7	84
4	Perieni, 1989 (Vaslui)	April 24 – July 28, 1989	95	12	8	96
5	Căbești, 1983 (Bacău)	April 25 – June 25, 1983	62	12	6	78
6	Pogonești, 1983 (Vaslui)	April 15 – August 30, 1983	137	12	12	144
7	Lețcani, 1981 (Iași)	May 10 – July 17, 1981	69	12	7	84
8	Lețcani, 1982 (Iași)	May 10 – July 16, 1982	68	12	7	84
9	Miroslava, 1981 (Iași)	May 20 – July 15, 1981	97	12	8	96

# BEETLES (INSECTA: COLEOPTERA) IN NESTS OF FIVE SPECIES OF PASSERIFORM BIRDS (*CARDUELIS CHLORIS*, *TROGLODYTES TROGLODYTES*, *TURDUS MERULA*, *TURDUS PHILOMELOS*, *TURDUS PILAS*) IN CENTRAL EUROPE

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**Abstract.** Beetles in nests of five passeriform birds (*Carduelis chloris*, *Troglodytes troglodytes*, *Turdus merula*, *Turdus philomelos*, *Turdus pilaris*) were represented altogether by 65 species. In the nest of the respective birds, the number of beetle species ranged from 8 to 25. Just a minor part of them were typical nidicolous, especially *Haploglossa nidicola* and *Gnathoncus* spp. They, however, they occurred in the nests in a lower number of individuals than in nests of most other birds and their occurrence tended to be concentrated in few nests. The major part of beetles was ubiquitous penetrating in the nests occasionally or searching there temporal cover. Their composition strongly reflected the environment, in which the nests were placed, in this case, the floodplain forests or suburban orchards. Only the fungivorous beetles were represented in the nests of the five birds species studied at the same level as in nests of other birds studied until present more in details.

**Keywords:** beetles, bird nests, passeriform birds, Central Europe.

**Rezumat.** Gândaci din cuiburile a cinci specii de passeriforme (*Carduelis chloris*, *Troglodytes troglodytes*, *Turdus merula*, *T. philomelos*, *T. pilaris*) în Europa Centrală. Gândaci din cuiburile a cinci specii de păsări passeriforme (*Carduelis chloris*, *Troglodytes troglodytes*, *Turdus merula*, *T. philomelos*, *T. pilaris*) au fost identificate un total de 65 de specii, iar în cuiburile păsărilor respective, numărul speciilor de gândaci a fluctuat între 8 și 25. Numai o mică parte din ele, mai ales *Haploglossa nidicola* și *Gnathoncus* spp. au fost specii nidicole tipice. Spre deosebire de cuiburile celorlalte păsări, aceste specii au fost înregistrate în număr mai scăzut de indivizii care, uneori, tindeau la o concentrare în puține cuiburi. Partea cea mai mare a gândacilor a fost formată din specii ubiquiste care intrau în cuiburi ocazional sau se ascundeau acolo. Compoziția lor a oglindit puternic mediul înconjurător în cuiburile respective, mai ales păduri de luncă sau grădini suburbane. Numai speciile fungivore au fost reprezentate în cuiburile studiate, pe nivel observat, în cuiburile celorlalte specii de păsări studiate.

**Cuvinte cheie:** gândaci, cuiburi de păsări, păsări passeriforme, Europa Centrală.

## INTRODUCTION

Beetle fauna of bird nests is in focus of attention since mid 1930-ies. Since that time a lot of data on the occurrence of individual beetles in birds' nests (HICKS 1959, 1962, 1971) or on structure and dynamics of beetle fauna in nests of some bird species (NORDBERG, 1936; JURÍK & ŠUSTEK, 1978; KRIŠTOFÍK et al., 1993, 1994, 1995, 1996, 2001, 2002, 2003, 2005, 2007; MERKL & BAGYURA, 2004; ŠUSTEK & HORNÝCHOVÁ, 1983; ŠUSTEK & JURÍK, 1980, ŠUSTEK & KRIŠTOFÍK, 2002, 2003, TRYJANOWSKI et al. 2001) have been obtained. These data show, that there are considerable differences in beetle fauna structure depending on the type of bird nests, their placement in the nature and structure of the material they are build from, as well as in dependence of the predominant food of the birds. In spite of the existing data of beetle fauna in nests, most bird species are unknown or its knowledge is insufficient. The aim of this contribution is to describe the fauna in nests of five passeriform birds (*Carduelis chloris* (LINNAEUS, 1758), *Troglodytes troglodytes* (LINNAEUS, 1758), *Turdus merula* (LINNAEUS, 1758), *T. philomelos* BREHM, 1831, *T. pilaris* (LINNAEUS, 1758)). These birds build their nests on vegetation. The nests of the four species are open, only the nest of *T. troglodytes* represents a cavity constructed from plant material on low vegetation, with a side entry. The interior of nests of *Turdus* species is lined by a mixture of loam and salivaries. All these birds are omnivorous, *Carduelis chloris* is previously phytophagous, whereas other four species are previously zoophagous, eating insects, rain worms or small molluscs. The knowledge of beetle fauna in their nests is reduced just to records of occurrence of three species in nests of *T. merula*, *T. philomelos* and *T. pilaris* cited by HICKS (1959).

The aim of this study is to describe the structure of beetle fauna in the nests of all five species and to compare it with the fauna in nests of other beetles studied in more details by the authors cited above.

## MATERIAL AND METHODS

The material was collected by the second author in the years 1991-1994 in 13 localities in West and central Slovakia (Komárno-National nature reserve Apáli 47°48'23"N, 18°5'33"E; Bodíky 47°55'14"N, 17°27'3"E; Bratislava-Lištiny 48°9'49"N, 17°3'59"E; Bratislava-Železná Studnička 48°10'52"N, 17°4'35"E; Devínska Nová Ves 48°11'58"N, 16°58'31"E; Dolná Riečka 48°35'48"N, 19°29'39"E; Dobrohošť 47°59'24"N, 17°20'52"E; Gabčíkovo 47°53'50"N, 17°33'45"E; Horná Riečka 48°36'17"N, 19°31'8"E; Hriňová-Pivnička 48°34'49"N, 19°31'14"E; Jahodná 48°2'22"N, 17°42'57"E; Svätý Jur-National nature reserve Šúr 48°13'46"N, 17°12'58"E; Komárno 47°45'22"N, 18°6'31"E; Krivec 48°35'11"N, 19°29'8"E; Malé Leváre 48°29'58"N, 16°57'32"E; Predná Pol'ana? 48°39'29"N, 19°19'14"E; Veľké Blahovo 48°2'51"N, 17°35'39"E; Vojka pri Dunaji 47°58'27"N, 17°22'28"E; Vysoká pri Morave 48°19'3"N, 16°54'32"E) and in two localities in the adjacent parts of South Moravia (Klentnica 48°51'13"N, 16°38'28"E; Pavlov

48°52'12"N, 16°39'59"E). Most localities lay in lowlands, at altitudes of 220-300 m, only the localities of *T. pilaris* are at higher altitudes (400-500 m).

The nests were collected immediately after fledging of the chicks. The arthropods were extracted by the Tulgrenn's funnels for 48 hours and then conserved in alcohol. The material is deposited in the Institute of Zoology of Slovak Academy of Sciences in Bratislava.

The beetles were identified mostly by the keys of FREUDE et al. (1964b, 1967, 1974), SMRECZYŃSKI, (1972, 1974), RÜCKER (1983). Nomenclature of beetles is adopted according to JELÍNEK (1993).

The bionomical data on beetles were taken from the above works and from BOHÁČ & MATEJÍČEK (2003), FREUDE et al. (1964a), ROUBAL (1930, 1936, 1939), while those on birds were taken from FERIANC (1965) and HUDEC (1983). Because of a low number of beetles in most nests the material from nests of each bird species was pooled. Occurrence of beetles in the nests is characterized by their abundance, presence and average number of individuals per nests (= index of occurrence according to JURÍK & ŠUSTEK (1978) or mean intensity according to MARGOLIS et al. (1982). Structure of the fauna is characterized by Shannon-Weaver diversity index and equitability (PIELOU, 1975). The average linkage clustering using the Whiteker's similarity index served for comparison of fauna from the studied nests.

## RESULTS AND DISCUSSIONS

Altogether 65 beetle species were found in nests of the five passeriform species (Table 1). The number of beetle species in nests of individual birds moved from 8 (*Turdus pilaris*) to 25 (*T. merula*) and the number of individuals moved from 14 (*T. pilaris*) to 141 (*T. troglodytes*). Both values were positively correlated with increasing number of nests of birds ( $r = 0.71$  and  $0.72$  respectively). Most species were represented in the whole material by a very low number of individuals (32 species by 1 individual, 13 species by 2 individuals, 9 species by 3 individuals, 3 species by 4 individuals and 1 species by 5 individuals). Most of these species occurred only in a single nest and showed a low value of presence and occurrence intensity (Table 1). In contrast, only eight species were represented by more than 10 individuals. This structure of beetle fauna is illustrated by a high value of equitability (Table 1).

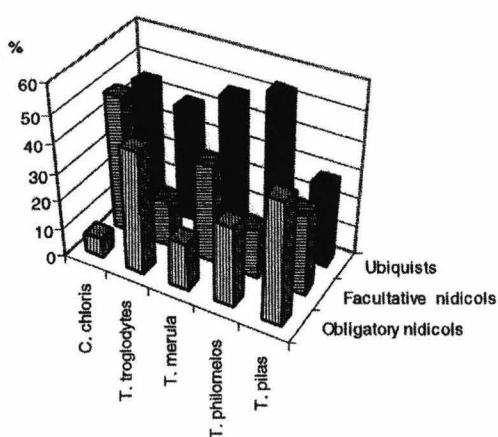


Figure 1. Relative abundance of beetles according to their relation to the nests of five species of passeriform birds.  
Figura 1. Abundența relativă a gândacilor în funcție de relația lor față de cuiburile a cinci specii de păsări paseriforme.

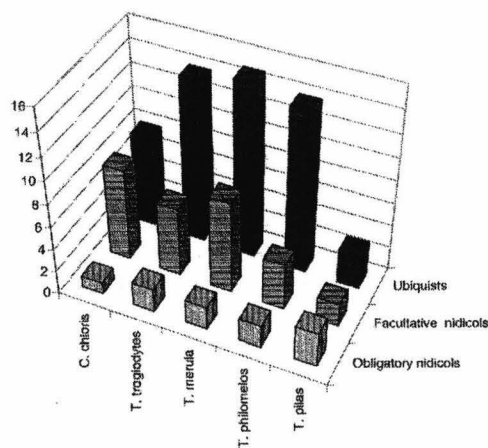


Figure 2. Number of species of beetles according to their relation to the nests of five species of passeriform birds.  
Figura 2. Numărul speciilor de gândaci în funcție de relația lor față de cuiburile a cinci specii de păsări paseriforme.

Among all 65 species, three species, *G. buyssoni*, *G. communis* and *H. puncticollis* are typical nidicolous occurring exclusively in the nests of many other birds, while two other species, the algivorous *A. vaga* and carnivorous *Ph. subiliformis*, show an increased affinity to the bird's nests (Table 1, Figs. 1 and 2). They are predominant, qualitatively and quantitatively, in the nests of *T. troglodytes* and *T. pilaris*. In the nests of other three birds, especially in *C. chloris*, their representation was lower. Only *H. puncticollis* was found in the nests of all five birds, but its occurrence was low (0.15-0.88 individuals per nest), except the nests of *T. troglodytes* (3.32 individuals per nests). However, in its nests 56 individuals of 58 were concentrated in a single nest. A similar concentration of *H. puncticollis* was also observed in nest of other four species.

All other species had a free relation to the nests. They can be divided into two groups. The first group is represented by facultative nidicolous and includes the necrophagous (*Trox perrisi*, *T. scaber*, *S. watsoni*, *G. quadriguttatus*), fungivorous (representatives of Lathridiidae, Cryptophagidae, Corylophidae) and detritophagous species (representatives of Anobiidae, Phalacriidae). They frequently occur in nests of many birds being attracted by the rests of food of animal origin or by bodies of dead chicks as well as by moulded or decaying construction material of the nests. They predominate especially in the nests of *Carduelis chloris* and reached a considerable representation in nests of *Turdus merula* and *T. pilaris* (Figs. 1 and 2). The second group represents ubiquists and includes a wide

spectrum of species frequently occurring in the nests surrounding and penetrating there occasionally or searching there a temporal cover. Composition of this group (especially the species *P. assimilis*, *O. obscurus*, *E. micans*, *C. rivularis*, *O. rugosus*, *S. juno*, *C. scutellata*, *C. variabilis*) reveals placement of a parts of the nests of *T. troglodytes*, *T. merula* and *T. philomelos* in humid places, near a brook (Bratislava-Železná studienka) or in floodplain forests, near adjacent reed stands (Bodíky, Dobrohošť, Vojka pri Dunaji, Jahodná, National nature reserves Apáči and Šúr). Most species of this group were the species living at the moment of the nests sampling on the twigs of tress or shrubs (all Curculionidae and Chrysomelidae, among the carabids *L. cyanocephala*). Also the high presence of *D. longimanus*, a weevil living on poplars, is characteristic for the nests from the above floodplain localities, while the species of the *Anthonomus* genus are characteristic for the nests collected in the orchards in Bratislava-Lištiny. All these species represented a highly dominant component of the nests fauna in all nests, except those of *T. pilaris* (Figs. 1 and 2).

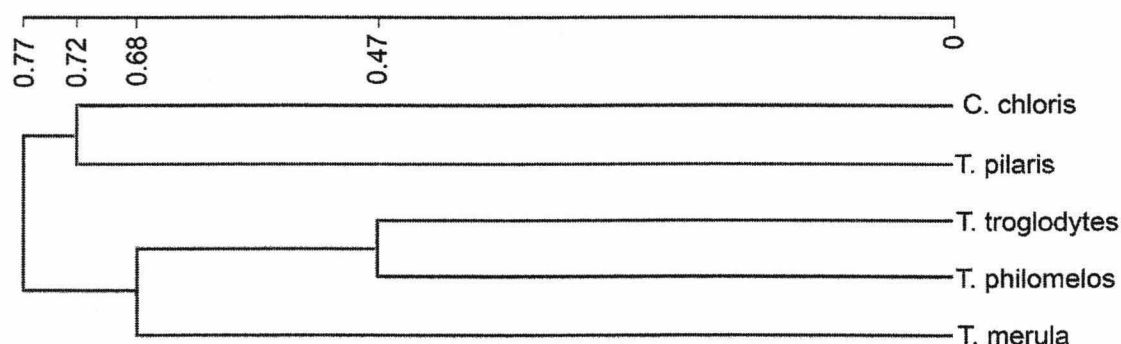


Figure 3. Classification of beetle fauna in nests of five passeriform beetles.  
Figura 3. Clasificarea faunei de gândaci din cuiburile a cinci specii paseriforme.

When compared mutually, the beetle fauna in the nests of each bird species forms two clusters at the dissimilarity level 0.77 (Fig. 1). The first includes fauna of nests of *Carduelis chloris* and *T. pilaris*. Their common features is a low number of species and individuals resulting from a reduced number of nests studied and absence of the hygrophilous species penetrating into the nest from the surroundings. The second cluster includes the nests of *T. troglodytes*, *T. philomelos* and *T. merula*. Structure of this cluster results especially from higher number of *P. assimilis*, *A. vaga*, *H. puncticollis* and *D. longimanus* and reflects collecting on a considerable part of the nests in floodplain localities. This pattern of clustering is however strongly biased by the environment in which the nests were collected.

The relation of a large number of species is more clearly illustrated by representation of trophic groups of species (Fig. 2). In nests of all five bird species, the carnivorous species predominate (20.7 to 64.3%), being followed by phytophags (14.3 to 32.7%) and fungivores (6.4-27.6%). They were present in the nest of all five species. Algivores were absent in the nests of *T. pilaris*, but in the nests of other species were represented by 3.8-9.4%. Detritophags and necrophags were found only in nests of *T. merula*, *T. troglodytes* and *C. chloris*. Their representation ranged from 0.7% in nests of *T. troglodytes* to 10.3% in *Carduelis chloris*.

Already NORDBERG (1936) showed that composition of beetle fauna depends on nest type. In general, a richer fauna was found in the birds nesting in tree or soil cavities and boxes and the birds of prey or insectivorous birds. The later studies (JURÍK & ŠUSTEK, 1978; KRIŠTOFÍK et al., 1993, 1994, 1995, 1996, 2001, 2002, 2005, 2007; MERKL & BAGYURA, 2004; ŠUSTEK & HORNYCHOVÁ, 1983; ŠUSTEK & JURÍK, 1980; ŠUSTEK & KRIŠTOFÍK, 2002, 2003) confirmed this relationship. They also found that there is a relatively small number of nidicolous species forming the nest fauna, while the major part of fauna always consisted of ubiquists using nests as one of food resources or cover. Their number is almost linearly correlated with increasing number of nests examined (KRIŠTOFÍK & ŠUSTEK 2002, 2003). The poorest beetle fauna in bird nests was found in nest of *Remiz pendulinus* (KRIŠTOFÍK et al. 1993, 1995), whose firm walls consisting of dense and fine plant fibbers did allow only the existence of the minute fungivorous Lathiidae. At the same time fixing of its nest on the top of thin twigs inhibited penetration of other beetle species. A beetle fauna most influenced by the surroundings was found in nests of *Acrocephalus arundinaceus*, *A. scirpaceus* and *A. palustris* (KRIŠTOFÍK et al. 2001, 2005). In the nests of the first two species it consisted of enormous numbers of *C. scutellata*, a lady bird eating the aphids living on reed, while in the nests of *A. palustris* it included also many

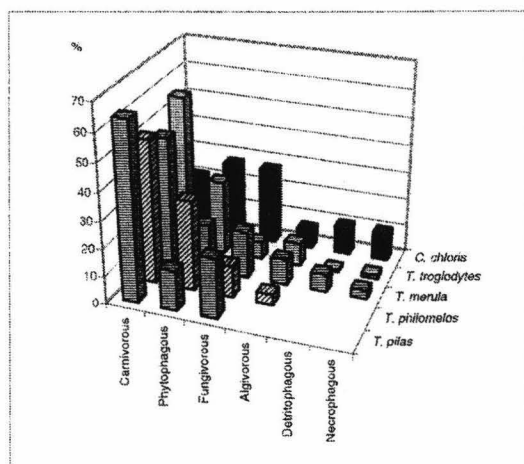


Figure 4. Relative abundance of six trophic groups of beetles in nests of five passeriform birds.  
Figura 4. Abundența relativă a șase grupe trofice ale gândacilor din cuiburile a cinci specii paseriforme.



representatives of soil fauna escaping on the reed stalks during floods. The most specific beetle fauna occurs in the nest of *Riparia riparia* (ŠUSTEK & JURÍK, 1980; KRIŠTOFÍK et al. 1994) where a single specified obligatory nidicol, *Haploglossa nidicola* (FAIRMAIR, 1852) highly predominates. The most similar beetle fauna with the nests of the five birds *T. merula*, *T. philomelos*, *T. pilaris*, *T. troglodytes* and *Carduelis chloris* was found in the nests of *Lanius collurio* and *Lanius minor* (KRIŠTOFÍK et al. 2002). They were also characteristic with by a low proportion of typically nidicolous species and by a large diversity of phytophagous beetles living on trees on which the nests were situated. The similarity of beetle fauna of these birds' species reflects the nest type.

As to representation of trophic groups of beetles, the predominance of carnivores is characteristic of nests of most birds. However, in a clear correlation between quantity of carnivorous beetles, especially of the typical nidicols, and presence of other arthropods (mites, flea larvae) in the nests has not been found (KRIŠTOFÍK et al. 2001, 2005, 2007). In the nest of all studied birds so far in more details, they tend to be concentrated in a small number of nests. However, most carnivorous beetles in the nests of the five birds in this study used the nests just as temporal cover. The fungivorous beetles always occur in the nest in relatively low numbers, but, at the same time, they represent the most constant component of beetle fauna in bird nests, even in those with a very poor beetle fauna, like in *Remiz pendulinus* (KRIŠTOFÍK et al. 1993, 1995). The phytophags are always present in the nests as ubiquists and mostly are little abundant. A similarly high abundance and diversity of them was observed only in nests *Lanius collurio* and *L. minor* (KRIŠTOFÍK et al. 2002, TRYJANOWSKI et al. 2001). Unlike the nests of other birds, there was a low representation of phytophags, detritophags and necrophags. Especially, the necrophags occur in the nest of most birds accidentally, being attracted there by bodies of dead chicks. More regularly the necrophags occur in the nests with accumulated keratinous particles (nests of *Passer* spp.) or in nests owls, birds of prey and of *Merops apiaster* where food rests are accumulated in large quantities, especially at the end of breeding period (KRIŠTOFÍK et al. 1996, 2003, 2005; MERLK & BAGYURA 2004).

## CONCLUSIONS

The beetle fauna of five passeriform birds *T. merula*, *T. philomelos*, *T. pilaris*, *T. troglodytes* and *Carduelis chloris* is relatively poor in comparison with nests of many other birds. It consisted of 2 or 3 obligatory nidicolous species, which predominated quantitatively in nests of *T. troglodytes* and *T. pilaris*, while in nests of the other three species their representation was lower or much lower than that of the facultative nidicolous or ubiquist species. In all studied nests, their representation was considerably lower than in nests of the cavity nesting birds. It was obviously due to lower humidity in the nests built up on trees or shrubs. Among the facultatively nidicolous species, only the fungivores reached a comparable representation within nest of other birds. The nest fauna in all nests studied was strongly influenced by the character of localities, where the nests were collected. It was and penetrated by many ubiquist species, mostly Carabids and Staphylinids from the ground surface or Curculionids living on trees or shrubs, on which the nests had been constructed. These beetle represented the predominating component of the nest fauna, except nests of *T. pilaris*, where their representation was approximately balanced with other two ecological groups of beetles. The present knowledge of the nests fauna of all five bird species, however, remains incomplete and needs further investigations.

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Table 1. Survey of beetles, their relations to bird nests (R) and trophic relation (T), number of individuals (N), average number of individuals per nest (A) and presence (P %) in nests of five passeroform beetles (Relation to nests: U – ubiquists, F – facultative nidicols, O – obligatory nidicols; trophic relations: A – algivors, C – carnivores, D – detritophags, F – fungivors, N – necrophagus, P – phytophagus).

Tabel 1. Specii de gândaci, relațiile lor față de cuiburi (R) și relațiile lor trofice, numărul indiviziiilor (N), numărul mediu al indiviziilor pe un cuib (A) și prezența (P %) lor în cuiburile de cinci specii de păsări paseriforme (Relația față de cuiburi: U – ubiquiști, F – nidicoli facultativi nidicoli, O – nidicoli obligatorii; relații trofice: A – algivori, C – carnivori, D – detritofagi, F – fungivori, N – necrofagi, P – fitofagi).

Family and species of beetles	R.	T	Species of birds														
			<i>C. chloris</i>			<i>T. troglodytes</i>			<i>T. merula</i>			<i>T. philomelos</i>			<i>T. pilas</i>		
			N	A	P %	N	A	P	N	A	P %	N	A	P	N	A	P %
<b>Carabidae</b>																	
<i>Dromius longiceps</i> (DEJEAN, 1826)	U	C	3	0.23	15.38												
<i>Europhilus micans</i> (NICOLAI, 1826)	U	C										2	0.13	6.25			
<i>Lebia cyanocephala</i> (LINNAEUS, 1758)	U	C													2	0.40	40.00
<i>Oxypselaphus obscurus</i> (HERBST, 1784)	U	C							1	0.08	8.33						
<i>Platynus assimilis</i> (PAYKULL, 1790)	U	C				11	0.61	27.78				5	0.31	6.25			
<i>Trechus quadristriatus</i> (SCHRANK, 1781)	U	C				1	0.06	5.56									
<b>Hydrophilidae</b>																	
<i>Coelostoma orbicularis</i> (FABRICIUS, 1775)	U	D				1	0.06	5.56									
<b>Histeridae</b>																	
<i>Gnathoncus buyssoni</i> AUZAT, 1917	O	C				3	0.17	11.11	4	0.33	8.33	1	0.06	6.25	3	0.60	20.00
<i>Gnathoncus communis</i> (MARSEUL, 1862)	O	C													1	0.20	20.00
<i>Paralister carbonarius</i> (HOFFMANN, 1903)	O	C				1	0.06	5.56									
<b>Ptiliidae</b>																	
<i>Acrotrichis intermedia</i> (GILLMEISTER, 1845)	F	D	1	0.08	7.69												
<b>Leiodidae</b>																	
<i>Sciodrepoides watsoni</i> (SPENCE, 1815)	F	N				2	0.11	5.56									
<b>Staphylinidae</b>																	
<i>Aleochara brevipennis</i> (GRAVENHORST, 1806)	F	C										1	0.06	6.25			
<i>Atheta divisa</i> (MÄRKEL, 1845)	F	A							2	0.17	8.33						
<i>Atheta vaga</i> (HEER, 1839)	F	A	1	0.08	7.69	12	0.67	5.56	4	0.33	16.67	2	0.13	6.25			
<i>Haploglossa puncticolis</i> (KIRBY, 1832)	N	C	2	0.15	15.38	58	3.22	11.11	7	0.58	16.67	14	0.88	18.75	2	0.40	20.00
<i>Omalium caesum</i> GRAVENHORST, 1806	U	C							3	0.25	8.33						
<i>Omalium rivulare</i> (PAYKULL, 1789)	U	C							1	0.08	8.33						
<i>Othius punctulatus</i> (GOEZE, 1777)	U	C				1	0.06	5.56	1	0.08	8.33						
<i>Oxytelus rugosus</i> (FABRICIUS, 1775)	U	C							1	0.08	8.33						
<i>Oxytelus tetracariniatus</i> (BLOCK, 1799)	U	C							3	0.25	8.33	1	0.06	6.25			
<i>Philonthus fimetarius</i> (GRAVENHORST, 1802)	U	C				2	0.11	5.56									

<i>Philonthus subuliformis</i> (GRAVENHORST, 1802)	F	C													1	0.20	20.00
<i>Philonthus quisquiliarius</i> (GYLLENHAL, 1810)	U	C						4	0.33	8.33							
<i>Quedius fuliginosus</i> (GRAVENHORST, 1802)	U	C						3	0.25	16.67							
<i>Quedius ochripennis</i> (MÉNÉTRIÉS, 1832)	U	C						1	0.08	8.33							
<i>Brachygluta haematica</i> (REICHENBACH, 1816)	U	C						1	0.08	8.33							
<i>Stenus juno</i> FABRICIUS, 1801	U	C									1	0.06	6.25				
<i>Tachyporus chrysomelinus</i> (LINNAEUS, 1758)	U	C				1	0.06	5.56			1	0.06	6.25				
<i>Carpelinus rivularis</i> (MOTSCHULSKI, 1860)	U	C									1	0.06	6.25				
<b>Helodidae</b>																	
<i>Cyphon variabilis</i> (THUNBERG, 1787)	U	P	1	0.08	7.69												
<b>Trogidae</b>																	
<i>Trox perrisi</i> FAIRMAIRE, 1868	F	N						2	0.17	8.33							
<i>Trox scaber</i> (LINNAEUS, 1767)	F	N	2	0.15	7.69												
<b>Scarabaeidae</b>																	
<i>Oxyomus silvestris</i> (SCOPOLI, 1763)	F	D						1	0.08	8.33							
<b>Anobiidae</b>																	
<i>Stegobium paniceum</i> (LINNAEUS, 1758)	F	D						2	0.17	8.33							
<b>Nitidulidae</b>																	
<i>Glyschrochilus quadriguttatus</i> (FABRICIUS, 1776)	U	N	1	0.08	7.69												
<b>Phalacridae</b>																	
<i>Olibrus affinis</i> (STURM, 1807)	F	D	1	0.08	7.69												
<i>Olibrus fracticornis</i> (STURM, 1807)	F	D	1	0.08	7.69												
<b>Cryptophagidae</b>																	
<i>Atomaria gravidula</i> ERICHSON, 1846	F	F						2	0.17	8.33							
<i>Cryptophagus dentatus</i> (HERBST, 1793)	F	F				1	0.06	5.56									
<b>Coccinelidae</b>																	
<i>Coccidula scutellata</i> (HERBST, 1783)	F	C	1	0.08	7.69												
<i>Propylea quatuordecimpunctata</i> (LINNAEUS, 1758)	U	C				1	0.06	5.56									
<b>Corylophidae</b>																	
<i>Sericoderus lateralis</i> (GYLLENHAL, 1827)	F	F				1	0.06	5.56			4	0.25	12.50				
<b>Lathridiidae</b>																	
<i>Corticaria rubripes</i> MANNERHEIM, 1844	F	F	4	0.31	23.08	4	0.22	16.67	5	0.42	25.00	2	0.13	12.50			
<i>Corticaria gibbosa</i> (HERBST, 1793)	F	F	3	0.23	15.38												
<i>Enicmus transversus</i> (OLIVIER, 1790)	F	F				3	0.17	16.67									
<i>Thes bergrothi</i> (REITTER, 1890)	F	F							4	0.33	8.33						
<i>Cartodere constricta</i> (GYLLENHAL, 1827)	F	F	1	0.08	7.69												

<b>Lagriidae</b>																	
<i>Lagrius hirtus</i> (LINNAEUS, 1758)	U	P										1	0.06	6.25			
<b>Tenebrionidae</b>																	
<i>Scaphidema metallicum</i> (LINNAEUS, 1758)	U	D							1	0.08	8.33						
<b>Chrysomelidae</b>																	
<i>Dibolia femoralis</i> REDTENBACHER, 1849)	U	P				2	0.11	5.56									
<i>Dibolia occultans</i> (KOCH, 1803)	U	P				1	0.06	5.56									
<i>Phylotreta nemorum</i> (LINNAEUS, 1758)	U	P	1	0.08	7.69												
<i>Phylotreta vittula</i> REDTENBACHER, 1849	U	P										2	0.13	6.25			
<i>Lema melanopus</i> (LINNAEUS, 1758)	U	P	1	0,08	7,69	1	0,06	5,56				1	0.06	6.25			
<b>Curculionidae</b>																	
<i>Anthonomus pomorum</i> (LINNAEUS, 1758)	U	P	2	0.15	7.69										1	0.20	20.00
<i>Anthonomus pinivorax</i> SILFVERBERGER, 1977	U	P							1	0.08	8.33						
<i>Anthonomus spilotus</i> REDTENBACHER, 1849	U	P													1	0.20	20.00
<i>Anthonomus phyllocola</i> (HERBST, 1795)	U	P										1	0.06	6.25			
<i>Neogloeianus maculalba</i> (HERBST, 1795)	U	P				24	1.33	33.33									
<i>Dorytomus longimanus</i> (FORSTER, 1777)	U	P	3	0.23	23.08	8	0.44	27.78	8	0.67	16.67	8	0.50	25.00			
<i>Hypera arator</i> (LINNAEUS, 1758)	U	P							1	0.08	8.33	2	0.13	6.25			
<i>Phytonomus dauci</i> (OLIVIER, 1807)	U	P							1	0.08	8.33						
<i>Sitona hispidulus</i> (FABRICIUS, 1776)	U	P				2	0.11	11.11				1	0.06	6.25			
<i>Trachyphloeus spinimanus</i> GERMAR, 1824)	U	P										1	0.06	6.25			
Number of nests			13			18			12			16			5		
Number of individuals			29			141			64			52			14		
Number of species			17			22			25			20			8		
H'			3.62			3.02			4.29			3.64			2.84		
Equitability			0.88			0.68			0.92			0.84			0.95		



## THE ECOLOGICAL AND ZOOGEOGRAPHICAL STRUCTURE OF THE ROVE BEETLE ASSEMBLAGES (COLEOPTERA: STAPHYLINIDAE) IN THE FLOODPLAINS OF THE LARGE PLAIN RIVERS (BY THE EXAMPLE OF BELARUS)

ALEXANDER DERUNKOV

**Abstract.** *The ecological group spectrum and zoogeographical structure of the rove beetle assemblages has been studied in the floodplain wetlands in Belarus. Results of the long-term studies are presented in the paper. The staphylinid assemblages in the forest and open floodplain ecosystems were selected. The dominant species composition was found out in wetlands of different types. The conception of forming of staphylinid assemblage species diversity in the river wetlands of Belarus was developed. It implies that staphylinid assemblage composition is defined, on the one hand, by the very labile and diverse group of the riparian species and open habitat species, among which the eurytopic hygrophilous and stenoecic wetland species prevail, and on the other hand by the relatively stable in its composition group of the floodplain forest species the core of which are eurytopic forest species. The species composition of the staphylinid assemblages in Byelorussian wetlands is historically relatively young and process of its forming is continuing intensively by means of penetration of the new species, which did not inhabited this territory.*

**Keywords:** *rove beetles, Belarus, floodplains, ecological groups, zoogeographical structure.*

**Rezumat.** *Structura ecologică și zoogeografică a cenzelor de stafilinide (Coleoptera: Staphylinidae) în luncile râurilor mari (prin exemplul din Belarus). Lucrarea prezintă spectrul ecologic și structura zoogeografică a cenzelor de stafilinide din luncile umede din Belarus, pe baza rezultatelor pe termen lung. S-au ales ecosistemele de pădure și de loc deschis. Studiul a început în 1996. Marea majoritate a speciilor s-a colectat prin metoda capcanelor Barber, cu lichid fixator. Speciile dominante se găsesc în habitate umede de diferite tipuri. Structura cenozei de stafilinide este definită de speciile ripariene și de locuri deschise, predominând speciile higrofile euritope și stenece și de speciile de pădure euritope. Procesul de formare a structurilor și compoziției cenzelor de stafilinide este istoric, relativ tânăr, prin pătrunderea de noi specii.*

**Cuvinte cheie:** *stafilinide, Belarus, lunci, grupuri ecologice, structură zoogeografică.*

### INTRODUCTION

Byelorussian territory is very rich in the water resources. More than 1 million 300 thousands hectares of bogs and fens (or 6.4% of the territory), 10 thousands of lakes and 20,800 rivers remains here in their natural state. The total length of rivers is 90.6 thousand kilometres (Fig. 1). The Byelorussian rivers belong to basins of two seas - The Baltic Sea and The Black Sea. The sources of the Neman, the large Baltic river basin, and the sources of the most of the left Pripyat tributaries, the Berezina River in particular, are situated on the Byelorussian territory. Almost the entire section of the Middle Pripyat runs in the center of the Polesye lowland in the south of Belarus. Therefore, river floodplains are a considerable part of Byelorussian landscapes.

Floodplain ecosystems are formed of a shifting mosaic of the aquatic, semiaquatic and terrestrial landscape elements. While these elements change their location, size and configuration over time, their entire abundance often remains constant. This phenomenon is referred to as "the shifting habitat mosaic" (STANFORD et al., 2005). In the conditions of such shifting habitat mosaic the exchange and transfer of matter exists what determines all matter and energy flow in the natural ecosystems. The flood regime control and river-bed canalization led to the loss of habitat mosaic, deceleration of the organic matter decomposition in some locations and to accumulation of organic matter in other locations. As a result, the natural process of biogenic elements exchange and its flow down to the stream is broken. The key to the quality assessment of the impact of habitat heterogeneity on the ecosystem processes is to understand the relationships between the heterogeneity and function of the river-floodplain system (LANGHANS et al., 2006). The important component for this understanding is the animal community, especially insects, in river landscape.

### MATERIAL AND METHODS

The author's studies of Staphylinids in the river floodplains began in 1996. Main attention was focused on the floodplains of the large rivers of Belarus like the Pripyat, the Berezina and the Neman (Fig. 1). The most of the material was collected by pitfall trapping. Plastic cups with an opening diameter of 72 mm and a volume of 250 ml were used as pitfall traps. A formalin mixture (4 %) was used as a fixing agent. Separation of the species into the ecological groups was made using the data of Middle Europe (KOCH, 1989) and author's personal observations. The Gorodkov's classification and nomenclature was used for zoogeographical analysis (GORODKOV, 1984). Analysis of species distribution was carried out according to the Catalogue of Palaearctic Coleoptera (LÖBL & SMETANA, 2004).

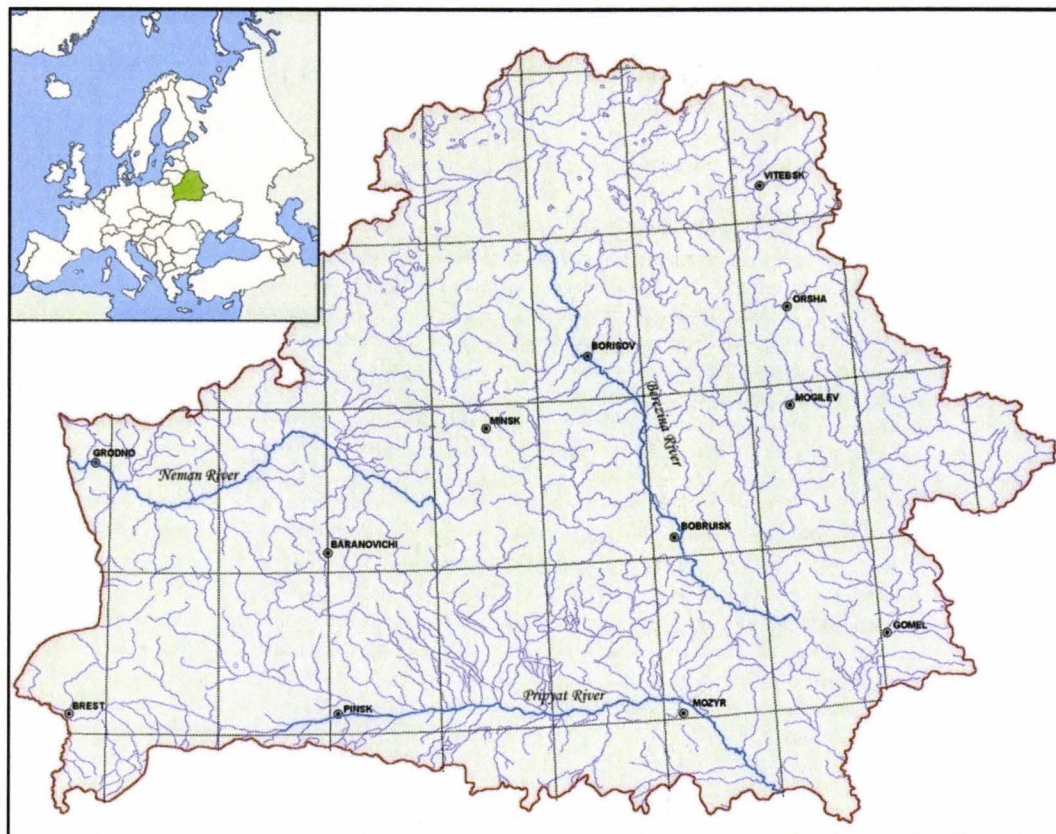


Figure 1. The map of the river system in Belarus. Studied rivers are marked with thick lines.  
 Figura 1. Harta rețelei cu râuri din Belarus. Râurile studiate sunt marcate cu linii groase.

## RESULTS AND DISCUSSIONS

Based on the results, it is possible to assert that river floodplains are distinguished by the greatest staphylinid diversity among all other ecosystems. At the moment, the staphylinid species richness in the studied river floodplains is more than 350 species or about 45% of species of the family known from the Byelorussian territory. That staphylinid species richness is defined by the large habitat diversity in the floodplains. It is possible to distinguish staphylinid assemblages of open and forested ecosystems, also ephemeral habitats, for example, mushrooms and dung of wild and domestic animals.

The black alder forests and oak forests are dominant in the floodplains of the large rivers of Belarus. Also, hornbeam forests are widespread and ash forests occur in some sites. More than 100 staphylinid species are found in the floodplain forests. 15-20 staphylinid species form the core of staphylinid assemblages: *Acrotona fungi* (GRAVENHORST, 1806), *Philonthus decorus* (GRAVENHORST, 1802), *Staphylinus erythropterus* LINNAEUS, 1758, *Olophrum assimile* (PAYKULL, 1800), *O. fuscum* (GRAVENHORST, 1806), *Omalium caesum* GRAVENHORST, 1806, *Tachinus rufipes* (LINNAEUS, 1758), *Atheta sodalis* (ERICHSON, 1837), *Geostiba circellaris* (GRAVENHORST, 1806), *Drusilla canaliculata* (FABRICIUS, 1787), *Stenus humilis* ERICHSON, 1839, *Rugilus rufipes* GERMAR, 1836, *Othius punctulatus* (GOEZE, 1777), *Anthobium atrocephalum* (GYLLENHAL, 1827), *Gabrius osseticus* (KOLENATI, 1846), *Ischnosoma splendidum* (GRAVENHORST, 1806), *Quedius fuliginosus* (GRAVENHORST, 1802), *Myllaena minuta* (GRAVENHORST, 1806), *Anotylus rugosus* (FABRICIUS, 1775), *Zyras collaris* (PAYKULL, 1800), *Tachyporus transversalis* GRAVENHORST, 1806, *Ocypus nitens* (SCHRANK, 1781) and *Xantholinus tricolor* (FABRICIUS, 1787). Most of them are dominants and subdominants.

The highest staphylinid diversity was observed in the floodplain black alder forests. More than 60 species were found here. The species richness is lower in the hornbeam and ash forests. The list of species includes from 35 to 41 species. 24-31 species were found in the studied oak forests. Staphylinid species richness may be very high (60-70 species) in the floodplain broad-leaved forests like oak and hornbeam forests, in the cases, when the high habitat mosaic is observed. Floodplain oak forests occur frequently as raised islands among the open flat areas subjected to flooding. In such cases they are not only habitats of forest species but also refugia for species of open habitats for the period of flood. Therefore, staphylinid species diversity substantially increases in such oak forests during the spring and autumn.

The staphylinid species composition in the open habitats is more diverse in comparison with forests. Totally, more than 150 species were found in the open habitats. Every studied site was distinguished by particular species composition. Therefore, it is difficult to pick out any core of species as a basis of staphylinid assemblage. In the open habitats alternated with forest plots the following species were frequent: *Acrotona fungi*, *Philonthus micans* (GRAVENHORST, 1802), *Philonthus quisquiliarius* (GYLLENHAL, 1810), *Lathrobium geminum* KRAATZ, 1857,



*Tetartopeus quadratus* (PAYKULL, 1789), *Lathrobium fovulum* STEPHENS, 1833, *Stenus europaeus* PUTHZ, 1966, *S. exspectatus* PUTHZ, 1965. On the floodplain meadows and fens the following species are common: *Ochtheophilum fracticorne* (PAYKULL, 1800), *Euaesthetus bipunctatus* (LJUNGH, 1804), *Platystethus nodifrons* MANNERHEIM, 1830, *Aleochara brevipennis* GRAVENHORST, 1806, *Atheta elongatula* (GRAVENHORST, 1802), *Amischa analis* (GRAVENHORST, 1802). It is possible to explain these considerable differences in the species composition by the high heterogeneity of open habitats, where microclimatic conditions in every site are much more variable in comparison with different forest habitats. Most of staphylinid species prefers a particular microhabitat and this preference is greater in comparison for example with carabids. Staphylinids are quite sensitive to the environment changes and so assemblage structure may be used for purposes of bioindication (BOHÁČ & FUCHS, 1991).

The core of ecological groups of the staphylinid assemblages in the forest habitats was composed by the eurytopic forest species, proportion of which was more than 40 % almost at all studied sites (Fig. 2). The dominant species like *Philonthus decorus*, *Staphylinus erythropterus*, *Othius punctulatus* were members of this group. In black alder forest, the dominants were stenoecic hygrophilous species inhabiting various wet forests types and other wetland habitats-*Olophrum assimile* and other species of the genus, for example, *O. fuscum*.

The proportion of eurytopic hygrophilous species inhabiting a wide variety of moist, but not wet habitats was high. The proportion of species of two other groups widely presented in all habitats, ubiquitous sensu lato and ubiquitous saprophiles, was from 8 to 14%. The first group included species inhabiting various forest and open habitats. For example, *Acrotona fungi*, was dominant in almost all studied sites. The second group included species occurring anywhere because they live in the decayed organic remains or animal dung. Those included, for example, *Omalium caesum* GRAVENHORST, 1806 and *Omalium rivulare* (PAYKULL, 1789) that are found almost in all sites.

The characteristic feature of the staphylinid assemblages in forest habitats is the presence of those of the stenoecic forest species, which may be found almost exceptionally in forests. This group includes species living under tree bark (*Xylodromus testaceus* (ERICHSON, 1840)), and *Mycetoporus eppelsheimianus* FAGEL, 1968 inhabiting the forest litter. Eurytopic xerophilous and mesoxerophilous forest species were found even in swamped floodplain forests. These species-*Bryophacis crassicornis* (MÄKLIN, 1847), *Mycetoporus lepidus* (GRAVENHORST, 1806), *Stenus clavicornis* (SCOPOLI, 1763) and *Stenus geniculatus* GRAVENHORST, 1806 are typical for the dry coniferous forests and only single specimens were collected in floodplain sites.

In open habitats, the staphylinid ecological group composition differed substantially from that of forest habitats (Fig. 3). First of all, the number of ecological groups was higher here. The stenoecic wetland species dominated. Their proportion in many sites was higher than 30 %. As in the forest habitats, the substantial proportion of species in the staphylinid assemblages were eurytopic hygrophilous species, ubiquitous and ubiquitous saprophiles.

Eurytopic wetland species were found out in all open habitats. Their proportion, as a rule, was a few times higher in comparison with forest habitats. In the open habitats, only eurytopic meadow species were found, for example, *Micropeplus porcatus* (PAYKULL, 1789) and *Philonthus cognatus* STEPHENS, 1832, also stenoecic ripicolous species like *Stenus intermedius* REY, 1884 or *Bisnius nitidulus* (GRAVENHORST, 1802), found primarily on the banks.

In some floodplain meadows the proportion of the eurytopic xerophilous species (*Acrotona orbata* (ERICHSON, 1837), *Stenus circularis* GRAVENHORST, 1802, *Stenus clavicornis* (SCOPOLI, 1763)) was very high. It may be caused by hydrological regime peculiarities when meadows on sandy alluvial soil may dry up considerably in the summer. Thus, the staphylinid ecological group spectrum clearly reflects the forest and meadow habitat peculiarities and the habitat conditions for species in individual site.

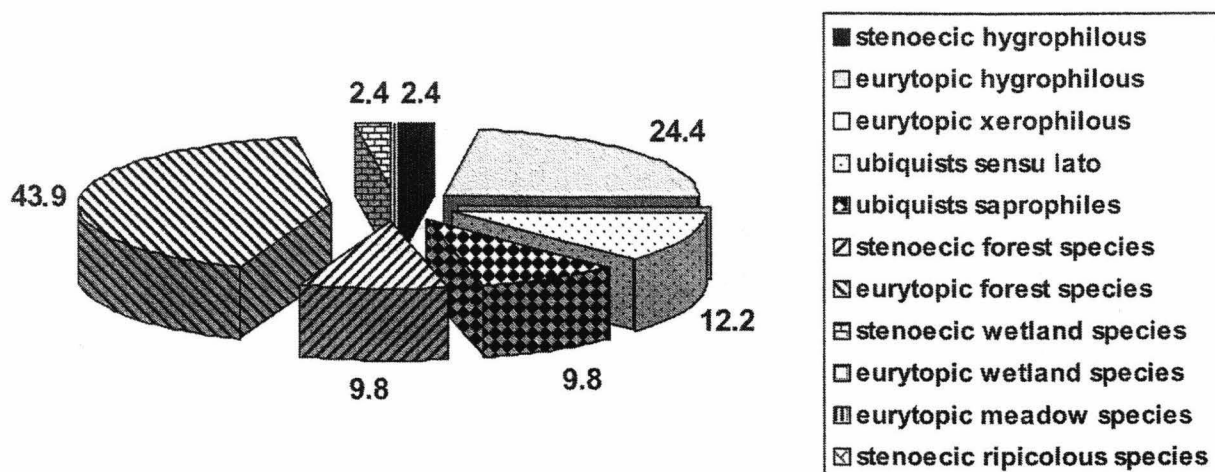


Figure 2. The proportion of the staphylinid beetles of different ecological groups in the forest ecosystems in the Pripiat river floodplain.

Figura 2. Proporția diferitelor grupe ecologice de stafilinide în ecosistemele de pădure din lunca râului Pripiat.

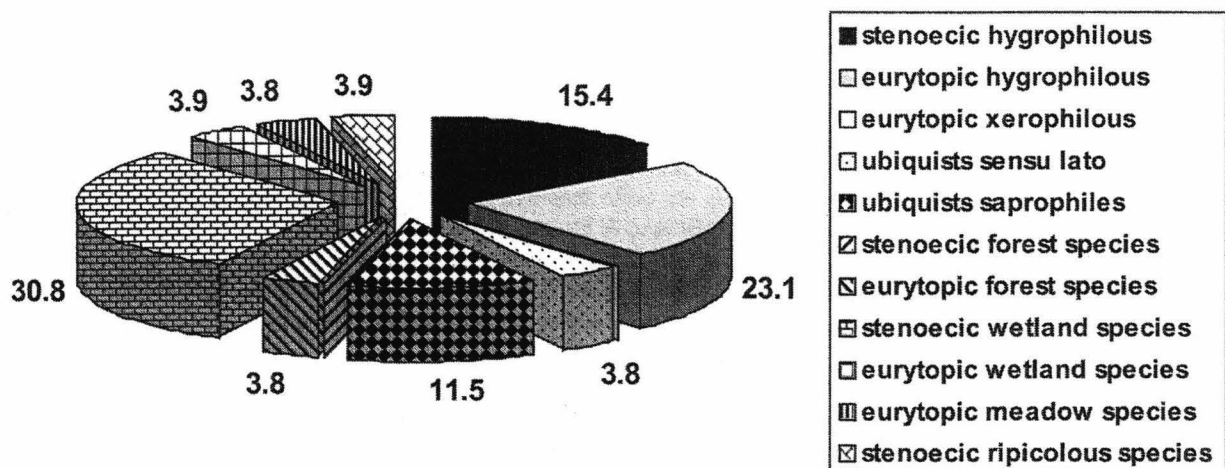


Figure 3. The proportion of the staphylinid beetles of different ecological groups in the open ecosystems in the Pripjat river floodplain.

Figura 3. Proporția diferitelor grupe ecologice de stafilinide în ecosistemele deschise din lunca râului Pripiat.

Based on the zoogeographical analysis of the rove beetle fauna in the wetlands in Belarus it was found that more than 80% of the species are distributed in the Palearctic only (Fig. 4). Cosmopolitan species are 3.8%. This group is formed first of all from the species inhabiting the animal dung and decaying organic matter and which are independent of the concrete type of biocoenosis. These species may be found most often in the floodplains, in the meadows used like pastures.

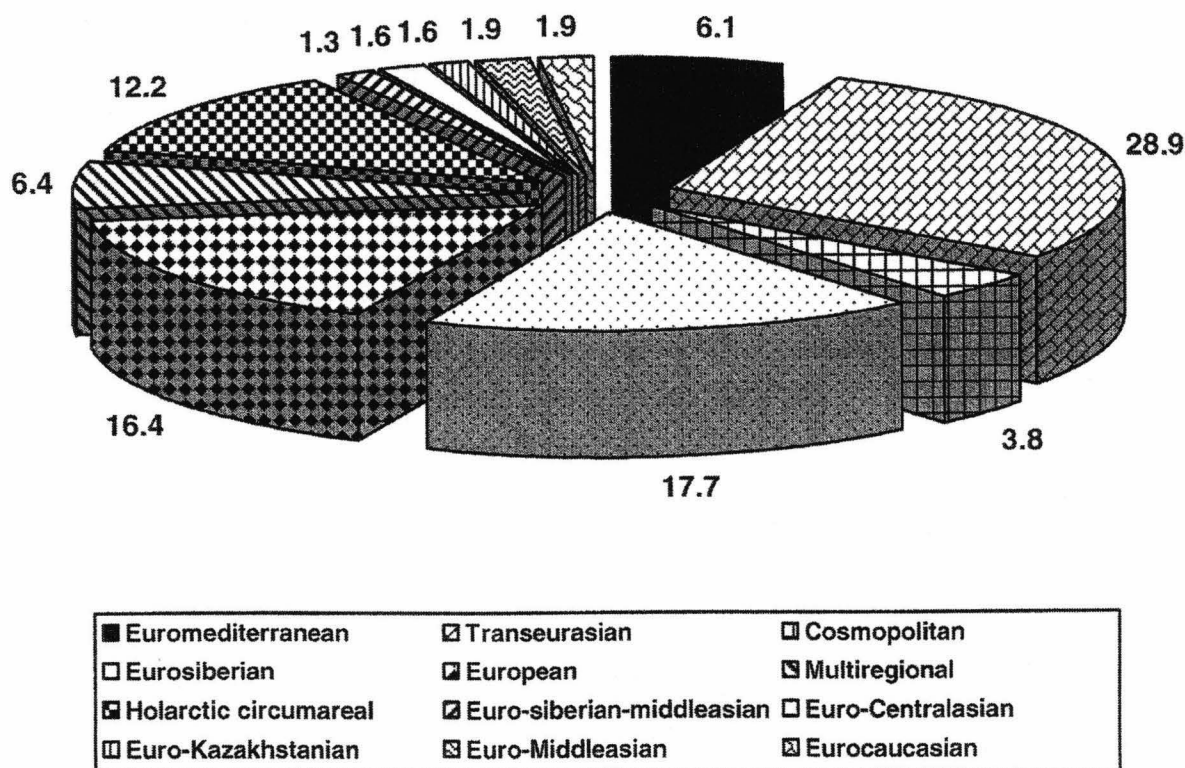


Figure 4. The zoogeographical structure of the rove beetle assemblages in the river floodplains on the Byelorussian territory.

Figura 4. Structura zoogeografică a cenzelor de stafilinide în luncile de pe teritoriul Belarus.

The portion of the circumholarctic species distributed in the Eurasia and North America is more than 12%. Many of them were unpremeditatedly introduced in the North America from Eurasia and expanded their area in that way. Almost two times less (6.4%) species with multiregional distribution were found. These species were distributed at least in 2 or more zoogeographical regions. Most of the studied multiregional species occur except the Palearctic in the Oriental and Afrotropical regions. Some species are distributed in Neotropic and Australian regions, too. Many species

of this group like cosmopolitan species may be found in the decaying materials, for example, *Philonthus parvicornis* (GRAVENHORST, 1802) and *Anotylus rugosus*. At the same time, many species of this group were distributed in the river valleys, namely in the riverine ecosystems and illustrate the role of the river valleys as intrazonal corridors along which species penetrate to other regions. Such species are *Neobisnius procerulus* (GRAVENHORST, 1806), *Paederus fuscipes* CURTIS, 1826, some species of the genus *Carpelimus*. Ubiquist species *Ischnosoma splendidum* belong to that group too and they it may be found in the different types of ecosystems, in forests, in open biotopes.

Staphylinid assemblages in the river floodplains in Belarus originated from the species that survived the last glaciation and inhabit floodplains from refugiums. The main ways of staphylinid fauna forming maybe the same as for carabid beetles that are studied quite well on the Byelorussian territory (ALEXANDROVICH, 1995). The dispersion of the Westpalaearctic and European-Central-Asian riparian and fen species went along river floodplains from the Mediterranean, South-European and Middle-Asian refugiums. As a result the wetland staphylinid assemblages are very mixed by the zoogeographical composition and they include Euro-Mediterranean, Euro-Siberian-Middle-Asian, Euro-Central-Asian, Euro-Kazakhstanian, Euro-Middle-Asian and Eurocaucasian species.

The Euro-Mediterranean species complex comes to 6.1% and includes mostly riparian species, but also mycetophilous species like *Gyrophana lucidula* ERICHSON, 1837. The high proportion of species from that group is evidenced by the importance of Mediterranean Holocene refugiums in the forming of recent staphylinid fauna on the territory of Belarus.

The proportion of Euro-Central-Asian, Euro-Kazakhstanian, Euro-Middle-Asian, Euro-Siberian-Middle-Asian and Eurocaucasian species is very small. In general, it is a little more than 8%. Most species from that group belongs to subfamily Aleocharinae; their distribution requires accurate definition due to the incomplete data. Maybe some species from those groups are transpalaearctic or even multiregional. But, now, the known distribution data may be evidenced by the small role of Middle-Asian refugiums in the forming of recent staphylinid fauna on the territory of Belarus.

River floodplains turned out to be the corridors for penetration of the Central-European and Caucasian species. For example, the species *Paederus limnophilus* ERICHSON, 1840 known only from the Central Europe was found in the Neman river floodplain. In the same place, it was found *Tachinus schneideri* LUZE, 1900 that was previously known as Caucasian endemic (ULLRICH, 1975). Now, this species is widely distributed in the Central Russia (NIKITSKY et al., 1998).

The base of staphylinid species assemblages in the wetlands are Trans-Eurasian, Euro-Siberian and European species. Their proportion was 28.9%, 17.7% and 16.4% accordingly. Some Trans-Eurasian species have Circum-Holarctic distribution, now, as a result of unpremeditated introduction to the American continent with agricultural production, planting material, soil etc. Some Euro-Siberian species inhabit bogs and fens that illustrate azonal character of their habitats.

## CONCLUSIONS

The floodplains play the role of intrazonal corridors in the landscape along which it takes place the species migration and species penetration out of the zonal ecosystems. In the floodplain ecosystems an original complex of herpetobiontic insects is formed, among which we mention beetles, in particular rove beetles, which have an important place. In the floodplain ecosystems the diversity of rove beetles is higher than in zonal communities. Floodplain ecosystems in general, especially floodplain forests are key habitats for many rare species, including postglacial relicts.

On the basis of received results the conception of forming the species diversity of staphylinid assemblage in the river wetlands of Belarus was developed. It implies that staphylinid assemblage composition is defined, on the one hand, by the very labile and diverse group of the riparian species and open habitat species, among which the eurytopic hygrophilous and stenoecic wetland species prevail, and on the other hand, by the relatively stable in its composition group of the floodplain forest species, the core of which are eurytopic forest species. Species composition of the staphylinid assemblages in Byelorussian wetlands is historically relatively young and the process of its forming continues intensively by means of penetration of the new species which did not inhabited this territory.

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ROVE BEETLES (COLEOPTERA: STAPHYLINIDAE) FROM THE DEAD WOOD  
IN THE FORESTS OF THE LOWER DNIESTER, REPUBLIC OF MOLDAVA

SVETLANA BACAL, ALEXANDER DERUNKOV

**Abstract.** *The paper completes the faunistic data on the rove beetles of the Lower Dniester based on the material collected in November 2008-March 2009 (19 species) and on the verification in the list of staphylinids from Republic of Moldova.*

**Keywords:** *rove beetles, Republic of Moldova, fauna.*

**Rezumat.** *Coleoptere stafilinide (Coleoptera: Staphylinidae) din lemnul descompus al pădurilor Nistrului Inferior, Republica Moldova. Lucrarea completează lista faunistică a stafilinidelor Nistrului Inferior, conform materialului colectat în noiembrie 2008-Martie 2009 (19 specii) și în baza verificării listelor de stafilinide existente în Republica Moldova.*

**Cuvinte cheie:** *stafilinide, Republica Moldova, faună.*

INTRODUCTION

In the Republic of Moldova, the information about the fauna of Staphylinidae appeared for the first time in 1912, in the work of ІАТЕНТОВСЬКІЙ (ЯЦЕНТКОВСКИЙ, 1912), in which the author presented a list of dates and places of collection of 70 species. In 1917, the authors MILLER and ZUBOVSKI (МИЛЕР & ЗУБОВСКИ, 1917) included this list in the general list of beetles from Basarabia. In 1957, the researchers Medvedev and Sapiro (МЕДВЕДЕВ & ШАПИРО, 1957) mentioned in their paper 4 new records of staphylinid species from Basarabia.

Rove beetles enumerated in the authors' works above, were collected by chance from different biocoenoses. Later, there were made complex researches in some agrocoenoses. As a result of the research carried out by ADASCHEVICI (АДАШКЕВИЧ, 1972) in 1972, 117 species of staphylinids were published. NECULISEANU (НЕКУЛИСЯНУ, 1984) mentioned 23 species in 1984, but some of them were identified as genera. Since 2003 till 2008 after a study of epigeal beetles from Landscape Reserve "Codrii Tigheci" 11 new species were added (STAN & BACAL, 2006). Thus, the rove beetles fauna from the Republic of Moldova numbers more than 230 species, about 30% of the expected number of Staphylinidae from the region.

MATERIAL AND METHODS

The materials discussed in this paper were extracted from the rotten wood of deciduous forests of the Lower Dniester by means of the separation method in the period of November 2008-March 2009. The subarid forest was selected for study. It is located in the proximity of locality Gradinita (46 39' N 29 35'E), where a Mediterranean vegetation prevails, the main tree vegetation is represented by oaks *Quercus petrea* and *Quercus pubescens*. This paper presents preliminary results concerning a peculiar diversity of the coleopteran group the study of which was only fragmentary in the region of the Lower Dniester. As a result of direct study, a rich material was found in this area, and the paper comprises meaningful issues. By means of the method of separation from the soil and the wooden material in the process of decomposition 19 staphylinids species were extracted, eleven of them are mentioned for the first time in the republic's fauna.

RESULTS AND DISCUSSIONS

According to the analysis of the literature in the field we may mention that the zone of the Lower Dniester was quoted in the previous works. Thus, 18 species of staphylinids were found in this region only. The flotation method was not used in the Republic of Moldova till present for the extraction of staphylinids. Therefore, practically all collected material is new for this region. Only one common species was tracked down from those 18 quoted. And about 1/3 from the discussed material is new for the republic's fauna.

Table 1. List of the identified staphylinids from the Lower Dniester.  
Tabel 1. Lista faunistică a stafilinidelor identificate în pădurile Nistrului Inferior.

Nr.	Taxon	Synonym	Mentioning		Distribution
			before	actual	
	Subfamily Oxytelinae				
1.	<i>Carpelimus biliniatus</i> STEPHENS, 1834	<i>Trogophloeus bilineatus</i> (STEPHENS, 1834)	+		Cosmopolitan

2.	<i>Anotylus nitidulus</i> (GRAVENHORST, 1802)	<i>Oxytelus nitidulus</i> GRAVENHORST, 1802	+		Cosmopolitan
3.	<i>Anotylus rugosus</i> (FABRICIUS, 1775)	<i>Oxytelus rugosus</i> (FABRICIUS, 1775)	+		Holarctic
4.	<i>Anotylus tetracarinatus</i> (BLOK, 1799)	<i>Oxytelus tetracarinatus</i> (BLOK, 1799)	+		Holarctic
5.	<i>Bledius tricornis</i> (HERBST, 1784)		+		Transpalearctic
6.	<i>Bledius gallicus</i> (GRAVENHORST, 1806)	<i>Bledius fracticornis</i> (PAYKULL, 1790)	+		Transpalearctic
<b>Subfamily Oxyporinae</b>					
7.	<i>Oxyporus rufus</i> (LINNAEUS, 1758)		+		Transpalearctic
<b>Subfamily Habrocerinae</b>					
8.	<i>Habrocerus capillaricornis</i> (GRAVENHORST, 1806)			+	Cosmopolitan
<b>Subfamily Tachyporinae</b>					
9.	<i>Mycetoporus forticornis</i> FAUVEL, 1875*			+	European
10.	<i>M. eppelsheimianus</i> FAGEL, 1968*	<i>M. brucki</i> auct. nec PANDELLÉ, 1869		+	European
11.	<i>Sepedophilus immaculatus</i> (STEPHENS, 1832)*			+	Transpalearctic
12.	<i>Sepedophilus marshami</i> (STEPHENS, 1832)*			+	Transpalearctic
13.	<i>Sepedophilus obtusus</i> LUZE, 1902*			+	Euromediterranean
14.	<i>Tachyporus hypnorum</i> (FABRICIUS, 1775)			+	Transpalearctic
15.	<i>Tachyporus nitidulus</i> (FABRICIUS, 1781)			+	Cosmopolitan
16.	<i>Tachyporus solutus</i> ERICHSON, 1839		+	+	Eurosiberian
17.	<i>Tachinus corticinus</i> GRAVENHORST, 1802	<i>Tachinus collaris</i> GRAVENHORST, 1802		+	Transpalearctic
<b>Subfamily Aleocharinae</b>					
18.	<i>Gyrophaena joyi</i> WENDELER, 1924*	<i>Gyrophaena convexicollis</i> JOY, 1912		+	European
19.	<i>Oxypoda abdominalis</i> (MANNERHEIM, 1830)*			+	Transpalearctic
20.	<i>Acrotona fungi</i> (GRAVENHORST, 1806)*			+	Holarctic
21.	<i>Zyras haworthi</i> STEPHENS, 1832			+	Euromediterranean
<b>Subfamily Paederinae</b>					
22.	<i>Sunius fallax</i> (LOKAY, 1919)*			+	Euromediterranean
23.	<i>Paederus riparius</i> (LINNAEUS, 1758)		+		Holarctic
24.	<i>Rugilus similis</i> (ERICHSON, 1839)	<i>Stiliculus similis</i> ERICHSON, 1839	+		Eurocaucasian
25.	<i>Lithocharis ochracea</i> (GRAVENHORST, 1802)		+		Cosmopolitan
26.	<i>Achenium depressum</i> (GRAVENHORST, 1802)		+		European
<b>Subfamily Staphylininae</b>					
27.	<i>Othius punctulatus</i> (GOEZE, 1777)			+	Euromediterranean
28.	<i>Philonthus carbonarius</i> (GRAVENHORST, 1802)	<i>Philonthus varius</i> (GYLLENHAL, 1810)		+	Holarctic
29.	<i>Philonthus salinus</i> KIESENWETTER, 1844		+		Westpalearctic
30.	<i>Philonthus punctus</i> (GRAVENHORST, 1802)		+		Transpalearctic
31.	<i>Staphylinus caesareus</i> CEDERHJELM, 1798		+		Westpalearctic
32.	<i>Ocypus brunnipes</i> (FABRICIUS, 1781)	<i>Staphylinus brunnipes</i> (FABRICIUS, 1781)	+		European
33.	<i>Ontholestes murinus</i> (LINNAEUS, 1758)	<i>Ontholestes dieckmanni</i> SMETANA, 1958	+		Transpalearctic
34.	<i>Quedius fulgidus</i> (FABRICIUS, 1793)	<i>Quedius assimilis</i> (NORDMANN, 1837)	+		Cosmopolitan
35.	<i>Quedius limbatus</i> (HEER, 1839)*	<i>Quedius limbatoideus</i> COIFFAIT, 1963		+	Eurocaucasian
36.	<i>Quedius suturalis</i> KIESENWETTER, 1845*			+	European

**Legend:** The species with (\*) are mentioned for the first time in the Republic of Moldova.

**Legendă:** Speciile marcate cu asterisc (\*) - sunt menționate pentru prima dată în fauna Republicii Moldova.

As a result of the species distribution analysis (LÖBL & SMETANA, 2004, ГРЕБЕННИКОВ, 2002) we ascertained that coleopteran's fauna from the zone of the Lower Dniester belongs to 8 zoogeographical elements: Transpalearctic, Westpalearctic, European, Eurosiberian, Euromediterranean, Eurocaucasian, Holarctic, Cosmopolitan. The most interesting faunistic findings are *Sunius fallax* and *Zyras haworthi*. The first species had mostly south-European

distribution. According to the Catalogue of Palaearctic Coleoptera (LÖBL & SMETANA, 2004) *S. fallax* was found in Bosnia and Herzegovina, Bulgaria, Greece, Hungary, Macedonia and Slovakia. The species is rare and prefers more or less dry plots in beech (*Fagus*) forests and riverine habitats. The species *Z. haworthi* is distributed wide all over the middle and South Europe, but it is rare everywhere. The species is myrmecophilous (connected with *Lasius* and *Formica* species) and occurs previously in the mountain regions.

Most collected rove beetle species use dead wood only as refuges. Some species (like *Gyrophana* and *Oxyporus*) are real fungicolous species. Others most likely feed on the saprophytic and mold fungi (like *Habrocerus* and some *Sepedophilus* species) grown in the wood.

## CONCLUSIONS

The fauna of staphylinids discussed in this paper belongs to 7 subfamilies, 24 genera and 36 species. The faunistic list of this family in the Republic of Moldova was completed with eleven new species. In the examined zone Transpalearctic, Cosmopolitan and European staphylinid species prevails.

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## TAXONOMICAL DIVERSITY OF TERRESTRIAL COLEOPTERANS (INSECTA: COLEOPTERA) COLLECTED FROM EIGHT DANUBE ISLETS (CĂLĂRAȘI COUNTY)

MELANIA STAN

**Abstract.** *Faunistic data on the terrestrial beetles of eight Danube islets-Călărași county are presented here for the first time. 106 beetle species which belong to 17 families were identified. The habitat/microhabitat of each species is mentioned. The coleopteran material was collected during the project "Environmental Conservation and Integrate Management of Danube islets, Romania" in 2007 and 2008.*

**Keywords:** *Coleoptera, diversity, Danube islets, Călărași, Romania.*

**Rezumat.** *Diversitatea taxonomică a coleopterelor terestre (Insecta: Coleoptera) de pe opt ostroave dunărene (județul Călărași). Lucrarea prezintă date asupra diversității coleopterofaunei de pe opt ostroave dunărene, județul Călărași pentru prima dată. Au fost identificate 106 specii care aparțin la 17 familii. Cel mai bine reprezentate sunt familiile Staphylinidae și Carabidae (45, respectiv 32 specii). Familia Carabidae este bine reprezentată și prin numărul mare de exemplare colectate. Pentru fiecare din cele opt ostroave se menționează speciile identificate, precum și habitatele și microhabitatele de unde exemplarele au fost colectate. Materialul a fost colectat în cadrul proiectului „Conservarea și managementul integrat al ostroavelor de pe Dunăre, România”, în perioada 2007-2008.*

**Cuvinte cheie:** *Coleoptera, diversitate, ostroave dunărene, Călărași, România.*

### INTRODUCTION

The Danube islets are dynamic formations which change their size and shape all the time depending on the hydrological dynamics of the river, the erosion and sedimentation processes, the regime of periodic flooding, the navigation and the management of floodplain forests.

The project "Environmental Conservation and Integrate Management of Danube islets, Romania" - LIFE/NAT/RO/000177 allowed the achievement of hydrologic, petrological and biodiversity studies on eight pilot islets: Albina (km 410), Haralambie (km 400), Ciocănești (km 395), Pisica (km 365), Șoimu (km 353), Turcescu (km 344-342), Cianu Nou (km 342) and Fermecatu (km 324-322).

The floodplain ecosystems (natural floodplain forests, swamps, sand belts and channels) characterise these islets. On Haralambie, Ciocănești, Șoimu and Cianu Nou islets there is natural vegetation consisting of willow forests (*Salix alba*, *S. fragilis*), black poplar forests (*Populus nigra*) and white poplar forests (*P. alba*). The number of ruderal species is reduced, meaning that the anthropogenic impact is insignificant. On Albina and Fermecatu islets, besides the natural vegetation, there are plantations of Euroamerican poplar (*Populus canadensis* x *P. tremula*) as well as a lot of ruderal plants, which means significant human impact. The same situation was observed on Pisica and Turcescu islets.

The eight Danube islets are within two Natura 2000 sites, one of them being declared as Site of Community Interest (SCI) and the other as Special Protected Areas (SPA). Three of the islets (Haralambie, Ciocănești, Șoimu) were declared reserves since November 2004.

For the evaluation of faunistic diversity of these islets the Order Coleoptera is very important being the group with the most described species up to now, its representatives live in different terrestrial and aquatic habitats, and they have an important role in the trophic pattern of area through different categories: predatory species, phytophagous, decompositions (detritophagous, coprophagous, necrophagous).

There are no previous studies regarding the qualitative composition of beetle fauna from Danube islets-Călărași county. In 2005 a few data about rove beetles from four Danube islets: Cama, Dinu, Slobozia and Mocanu-Giurgiu county were published (STAN, 2005).

### MATERIAL AND METHODS

The qualitative studies of terrestrial beetles were made on the eight islets: Albina (N: 44° 07. 543'; E 026° 52. 426'), Haralambie (N: 44° 08. 431'; E 026° 59. 627'), Ciocănești (N: 44° 08. 745'; E 027° 04. 105'), Pisica (N: 44° 07. 769'; E 027° 22. 209'), Șoimu (N: 44° 09. 730'; E 027° 30. 822'), Turcescu (N: 44° 11. 714'; E 027° 34. 770'), Cianu Nou (km 342) and Fermecatu (N: 44° 14. 810'; E 027° 52. 079').

In 2007 beetle specimens were collected using the following collecting methods:

- pitfall traps (5 for each islet) which were placed in right line parallel with the bank of the Danube and close to it in the thin layer of poplar and willow leaf litter on Haralambie, Ciocănești, Șoimu, Fermecatu islets (the 26<sup>th</sup> of June - the 28<sup>th</sup> of August);



- exhauster on the sandy wet bank of the Danube river (Fermecatu, Turcescu, Pisica islets, on the 28<sup>th</sup> of August and Albina, Ciocănești islets, on the 29<sup>th</sup> of August), on the clay bank with short vegetation (Haralambie islet, on the 29<sup>th</sup> of August) and horse dung (Fermecatu, Turcescu islet, on the 28<sup>th</sup> of August);

- sweep netting (Haralambie and Pisica islets, on the 26<sup>th</sup> of June);

- hand capture (Albina, Ciocănești, Șoimu, Fermecatu islets, on the 27<sup>th</sup> of June).

In 2008 were used as collecting methods:

- pitfall traps (4 for each islet) installed in the same way on Albina, Haralambie, Ciocanesti, Soimu, Cianu Nou islets (the 26<sup>th</sup> of March - the 27<sup>th</sup> of May);

- exhauster on the sandy wet bank of the Danube river (Soimu, Fermecatu islets on the 26<sup>th</sup> of May), on the edge of temporary and permanent pools, in willow forest what presented the traces of the previously floods (Haralambie, Pisica, Fermecatu islets on the 26<sup>th</sup> of May), on the rotten poplar stump (Turcescu islet on the 26<sup>th</sup> of May);

- sifting poplar and willow leaf litter (Turcescu, Cianu Nou islets, on the 26<sup>th</sup> of May and Albina, Haralambie islets, on the 27<sup>th</sup> of May);

- flotation method (fungi grown on the willow stumps, Fermecatu islet, on the 26<sup>th</sup> of May);

- shaking the bushes (Turcescu islet, on the 26<sup>th</sup> of May).

Identified beetle species are presented in Table 1, in alphabetical order, grouped according to families. For each species the islet and the specific habitat or microhabitat are mentioned, where it was collected using abbreviations. Nomenclature of species and families have been updated according to the taxonomic system and nomenclature used in Fauna Europaea ([www.faunaeur.org](http://www.faunaeur.org)).

## RESULTS AND DISCUSSIONS

The specimens of 106 terrestrial beetle species which belong to 17 families were collected from eight Danube islets-Călărași county in 2007 and 2008. Family Carabidae is very well represented by the number of specimens, while Family Staphylinidae is very well represented by the number of species (45), followed by Family Carabidae (32).

Table 1. The taxonomic pattern of the terrestrial beetle fauna on the eight Danube islets (Călărași county).  
Tabel 1. Structura taxonomică a faunei de coleoptere terestre de pe opt ostroave dunărene (județul Călărași).

	Taxons	Al	Ha	Ci	Pi	Șo	Tu	CN	Fe
<b>Suborder Adephaga</b>									
<b>Family Carabidae</b>									
1	<i>Agonum scitulum</i> (DEJEAN, 1828)					a			
2	<i>Amara aenea</i> (DE GEER, 1774)		c					c	
3	<i>Amara familiaris</i> DUFTSCHMID, 1812			c					
4	<i>Anisodactylus binotatus</i> FABRICIUS, 1787	c							
5	<i>Asaphidion flavipes</i> (LINNAEUS, 1761)	c		c, d				d	a
6	<i>Badister bullatus</i> (SCHRANK, 1798)				b				
7	<i>Bembidion lampros</i> (HERBST, 1784)			c					
8	<i>Bembidion laticolle</i> (DUFTSCHMID, 1812)								a1
9	<i>Bembidion quadrimaculatum</i> (LINNAEUS, 1761)		a1						
10	<i>Bembidion semipunctatum</i> (DONOVAN, 1806)	B		a1		a1			
11	<i>Bembidion striatum</i> (FABRICIUS, 1792)		a1						a1
12	<i>Bembidion subcostatum</i> vau NETOLITZKY, 1913			c					
13	<i>Brachinus psophia</i> SERVILLE, 1821							c	
14	<i>Calathus fuscipes</i> (GOEZE, 1777)			C					
15	<i>Carabus cancellatus graniger</i> PALLIARDI, 1825	c	C, c	C, c		C, c			C
16	<i>Chlaeniellus nitidulus</i> (SCHRANK, 1781)	c	C, c	c				d	C
17	<i>Chlaenius festinus</i> (PANZER, 1796)			C					C
18	<i>Chlaenius spoliatus</i> (P. ROSSI, 1792)		C	C, c		C			C
19	<i>Clivina fossor</i> (LINNAEUS, 1758)	c							
20	<i>Dolichus halensis</i> (SCHALLER, 1783)			C		C			C
21	<i>Dyschiriodes aeneus</i> (DEJEAN, 1825)		c	c	b				
22	<i>Elaphrus riparius</i> (LINNAEUS, 1758)		c						
23	<i>Licinus depressus</i> (PAYKULL, 1790)							c	
24	<i>Limodromus assimilis</i> (PAYKULL, 1790)	c	c, d	C, c		a, c		c	
25	<i>Nebria brevicollis</i> (FABRICIUS, 1792)			c					
26	<i>Poecilus cupreus</i> (LINNAEUS, 1758)	c	C, c	C, c	b			c	C, c
27	<i>Pterostichus niger</i> (SCHALLER, 1783)			C					
28	<i>Pterostichus anthracinus</i> (ILLIGER, 1798)	c		C					
29	<i>Pterostichus ovoideus</i> STRUM, 1824	c	c	c		c			
30	<i>Pseudoophonus rufipes</i> (DE GEER, 1774)	c	C, c	C					C
31	<i>Stenolophus discophorus</i> (FISCHER, 1823)			d	b				
32	<i>Stomis pumicatus</i> (PANZER, 1796)	c	C, c	C, c					
<b>Suborder Polyphaga</b>									
<b>Family Hydrophilidae</b>									
33	<i>Sphaeridium scarabaeoides</i> (LINNAEUS, 1758)						h		

<b>Family Silphidae</b>									
34	<i>Necrophorus vespillo</i> (LINNAEUS, 1758)			C		C			C
35	<i>Silpha carinata</i> HERBST, 1783	c							
36	<i>Silpha obscura</i> LINNAEUS, 1758	c						c	
37	<i>Phosphuga atrata</i> (LINNAEUS, 1758)		d	C, c					
<b>Family Staphylinidae</b>									
38	<i>Acrotoma muscorum</i> (BRISOUT DE BARNEVILLE, 1860)					a1	h		
39	<i>Alaobia scapularis</i> (SAHLBERG, 1831)	c					h		
40	<i>Aleochara haematoptera</i> KRAATZ, 1858			C		a1, a	a1		C, a1
41	<i>Aleochara intricata</i> MANNERHEIM, 1830								h
42	<i>Aloconota gregaria</i> (ERICHSON, 1839)		b						
43	<i>Atheta elongatula</i> (GRAVENHORST, 1802)		C						
44	<i>Atheta orbata</i> (ERICHSON, 1837)		c	c					
45	<i>Bledius dissimilis</i> ERICHSON, 1840		A						
46	<i>Dinaraea angustula</i> (GYLLENHALL, 1810)			C					
47	<i>Carpelimus exiguus</i> (ERICHSON, 1839)		A		a1		a1		
48	<i>Carpelimus obesius</i> (KIESENWETTER, 1844)								a1
49	<i>Gabrieus nigrifolius</i> (GRAVENHORST, 1802)		c						C
50	<i>Gyrophaena joyioides</i> WÜSTHOFF, 1937								e
51	<i>Gyrophaena lucidula</i> ERICHSON, 1837								e
52	<i>Ischnopoda umbratica</i> (GRAVENHORST, 1806)				b	a			b
53	<i>Ischnosoma splendidum</i> (GRAVENHORST, 1806)					C			
54	<i>Lathrobium taxi</i> BERNHAUER, 1902				b				b
55	<i>Leptacinus batychnus</i> (GYLLENHALL, 1827)								h
56	<i>Liogluta longiuscula</i> (GRAVENHORST, 1802)	c							
57	<i>Neobisnius procerulus</i> (GRAVENHORST, 1806)				b				
58	<i>Ocyptus nitens</i> (SCHRANK, 1781)		c						
59	<i>Paederus fuscipes</i> CURTIS, 1826	B	A, b		b, i	a1, a	d		a1, a
60	<i>Platystethus cornutus</i> (GRAVENHORST, 1802)								h
61	<i>Platystethus nitens</i> (SAHLBERG, 1832)			c					
62	<i>Philonthus diversiceps</i> BERNHAUER, 1901		b						
63	<i>Philonthus micans</i> (GRAVENHORST, 1802)		b		b			d	b
64	<i>Philonthus punctus</i> (GRAVENHORST, 1802)								C
65	<i>Philonthus succicola</i> THOMSON, 1860			C					
66	<i>Pseudomedon obsoletus</i> (NORDMANN, 1837)				b				
67	<i>Sepedophilus immaculatus</i> (STEPHENS, 1832)	c							
68	<i>Sepedophilus testaceus</i> (FABRICIUS, 1793)			C					
69	<i>Stenus biguttatus</i> (LINNAEUS, 1758)	B	A			a1	a1		a1
70	<i>Stenus boops</i> LJUNGH, 1810	B	A						
71	<i>Stenus comma</i> LE CONTE, 1863		b						
72	<i>Stenus circularis</i> GRAVENHORST, 1802	c							
73	<i>Stenus fuscipes</i> GRAVENHORST, 1802	B	b	a1					b
74	<i>Stenus humilis</i> ERICHSON, 1839			c					
75	<i>Stenus incrassatus</i> ERICHSON, 1839		b						
76	<i>Stenus morio</i> GRAVENHORST, 1806	B	A, b				a1		a1, b
77	<i>Stenus stigmula</i> ERICHSON, 1840	B	A		a1, b				b
78	<i>Stenus providus</i> ERICHSON, 1839				b				
79	<i>Sunius melanocephalus</i> (FABRICIUS, 1792)							d	
80	<i>Tachyporus hypnorum</i> (FABRICIUS, 1775)	c	A	C		C			
81	<i>Tachyusa coarctata</i> ERICHSON, 1837	B							a1
82	<i>Tasgius melanarius melanarius</i> (HEER, 1839)					c		c	
<b>Family Cetoniidae</b>									
83	<i>Cetonia aurata</i> LINNAEUS, 1761	F							
84	<i>Valgus hemipterus</i> (LINNAEUS, 1758)	F					f		
<b>Family Coccinellidae</b>									
85	<i>Adalia bipunctata</i> (LINNAEUS, 1758)	f					f	f	f
86	<i>Coccinella septempunctata</i> LINNAEUS, 1758	F		F					F
87	<i>Oenopia conglobata</i> (LINNAEUS, 1758)		F						
88	<i>Psyllobora vigintiduopunctata</i> (LINNAEUS, 1758)		F	F	F				
<b>Family Dermestidae</b>									
89	<i>Dermestes gyllenhali</i> LAPORTE DE CASTELNAU, 1840		c	C					C
<b>Family Cleridae</b>									
90	<i>Trichodes apiarius</i> LINNAEUS, 1758	F							
<b>Family Malachidae</b>									
91	<i>Malachius bipustulatus</i> (LINNAEUS, 1758)	f					f		
<b>Family Mycetophagidae</b>									
92	<i>Mycetophagus quadrimaculatus</i> (LINNAEUS, 1761)			C					
<b>Family Zopheridae</b>									
<b>Subfam. Colydiinae</b>									
93	<i>Bitoma crenata</i> (FABRICIUS, 1775)						g		
<b>Family Anthicidae</b>									
94	<i>Anthelephila pedestris</i> (ROSSI, 1790)	c	c, d		b	C, a	c	c	
95	<i>Hirticomus hispidus</i> (ROSSI, 1792)				i	C			C

Family Mordellidae									
96	<i>Variimorda villosa</i> (SCHRANK, 1781)			F					F
Family Pyrochroidae									
97	<i>Pyrochroa serraticornis</i> (SCOPOLI, 1763)	F							
Family Tenebrionidae									
Subfamily Lagriinae									
98	<i>Lagria hirta</i> LINNAEUS, 1758	f				F			
Family Cerambycidae									
99	<i>Agapanthia villosoviridescens</i> (DE GEER, 1775)	f							
100	<i>Aromia moschata</i> LINNAEUS, 1758			F					
Family Chrysomelidae									
101	<i>Chrysomela vigintipunctata</i> (SCOPOLI, 1763)								f
102	<i>Chrysomela populi</i> LINNAEUS, 1758	F							
103	<i>Crepidodera pluta</i> (LATREILLE, 1804)		f					f	
104	<i>Galerucella lineola</i> (FABRICIUS, 1781)		F						
105	<i>Podagrica fuscipes</i> (FABRICIUS, 1775)				F				
106	<i>Phyllotreta ochripes</i> (CURTIS, 1837)		F						
The number of beetle species which were collected on the each Danube islet		30	35	33	17	18	13	12	35

**Abbreviations:**

Al. Albina islet; Ha. Haralambie islet; Ci. Ciocănești islet; Pi. Pisica islet; Șo. Șoimu islet; Tu. Turcescu islet; C N. Cianu Nou islet; Fe. Fermecatu islet.

A. Danube clay bank with very rare vegetation (2007); a1. Danube sandy wet bank (2007); a. Danube sandy wet bank (2008); B. high Danube bank with willow trees, without litter; b. edge of temporary pool, willow forest (2008); C. thin layer of poplar, willow leaf litter (pitfall traps 2007); c. thin layer of poplar and willow leaf litter (pitfall traps 2008); d. thin layer of poplar litter, close to the bank of the Danube River (sifting litter, 2008); e. fungi grown on willow stumps (2008); F. bushes and herbaceous plants (2007); f. bushes and herbaceous plants (2008); g. rotten poplar stump (2008); h. under dry horse dung (2007); i. hand capture from the soil (2007).

**Abrevieri:**

Al. Ostrov Albina; Ha. Ostrov Haralambie; Ci. Ostrov Ciocănești; Pi. Ostrov Pisica; Șo. Ostrov Șoimu; Tu. Ostrov Turcescu; C N. Ostrov Cianu Nou; Fe. Ostrov Fermecatu.

A. mal argilos al Dunării cu vegetație scundă (2007); a1. mal nisipos umed al Dunării (2007); a. mal nisipos umed al Dunării (2008); B. mal înalt al Dunării cu salcie; b. mal zonă inundată temporar în pădure de salcie (2008); C. litieră subțire de plop și salcie (capcane de sol, 2007); c. litieră subțire de plop și salcie (capcane de sol 2008); d. litieră subțire de plop în apropierea malului Dunării (cernere litieră, 2008); e. fungi crescuți pe trunchiuri căzute de salcie (2008); F. arbuști și plante ierboase (2007); f. arbuști și plante ierboase (2008); g. trunchi de plop putred (2008); h. sub balegă uscată de cabaline (2007); i. colectare directă de pe sol (2007).

A great number of the ground beetles specimens were found in pitfall traps: *Carabus cancellatus graniger* (59 specimens (sps.) Ciocănești islet, 28 sps. Fermecatu islet), *Poecilus cupreus* (142 sps. Fermecatu islet, 7 sps. Ciocănești islet), *Chlaenius spoliatus* (63 sps. Ciocănești islet, 19 sps. Fermecatu islet) and *Pseudoophonus rufipes* (51 sps. Ciocănești islet, 19 sps. Fermecatu islet). In 2008 the pitfall traps were put earlier than in 2007 (at the end of March) and only two ground beetle species were collected in a large number: *Carabus cancellatus graniger* (22 sps. Albina islet, 17 sps. Ciocănești and Șoimu islets, 10 sps. Haralambie islet) and *Limodromus assimilis* (44 sps. Ciocănești islet, 30 sps. Albina islet, 10 sps. Șoimu islet and 9 sps. Haralambie islet). On Pisica and Turcescu islets it was not possible to install the pitfall traps, explaining the absence of ground beetles here. Many areas on the islets were not explored because of their very dense thicket vegetation (for example, Ciocănești islet was explored only close to the Danube bank). The natural communities of Carabidae and Staphylinidae are not so rich in species.

Based on our field observations the edaphic beetles (ground beetles, rove beetles, carrion beetles, dermestid beetles and ant-like beetles) are more frequently on these islets than floricolous and arboricolous species. The most species of ground beetles and rove beetles collected from these islets are humicolous. The species of *Bembidion* genus and rove beetle species *Ischnopoda umbratica*, *Tachyusa coarctata*, *Bledius dissimilis*, *Aleochara haematoptera*, *Carpelimus exiguus*, *Stenus biguttatus* are ripicolous. *Philonthus diversiceps*, *P. micans* are paludicolous species.

*Bembidion subcostatum* is represented in Romanian fauna only by the subspecies *B. subcostatum vau*, the northern limit of its areal does not overcome 50°lat. N. (NIȚU, 2006). *Lathrobium taxi* a rare rove beetle species was found on two islets (Pisica and Fermecatu) on the edge of temporary pools.

The ground beetles and most of the rove beetles collected from these islets are predatory species. Floricolous and arboricolous species like *Trichodes apiarius*, *Malachius bipustulatus*, *Pyrochroa serraticornis*, *coccinelids* are predators, too. The necrophilous species are represented by four species of Silphidae (one of them *Necrophorus vespillo* being collected in a big number from Șoimu islet-14 sps) and *Dermestes gyllenhalii*. *Coprophilous species*, *Sphaeridium scarabaeoides*, *Aleochara intricata*, *Platystethus cornutus* were found under the dry horse dung. *Mycetophilous species*: *Gyrophana joyioides*, *G. lucidula* were found only on Fermecatu islet. *Bitoma crenata* is a saproxylic beetle being collected from the rotten poplar stump. *Phytophagous* species are represented by the species of leaf beetles, cetonids and longhorn beetles.

## CONCLUSIONS

We can appreciate that the diversity of beetle fauna on the eight islets is rather similar, the difference regarding the number of species is given by the collecting methods, the choice (and availability) of the collecting sites and the collecting period. This project permitted us to make the first step for the estimation of the taxonomical diversity of terrestrial coleopterans from eight Danube islets-Călărași county.

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# THE SYNECOLOGICAL ANALYSIS OF SOME POPULATIONS OF SCARABEOID DUNG BEETLES (INSECTA: COLEOPTERA: SCARABAEOIDEA) FROM THE FLOODPLAIN OF THE SIRET RIVER AREA (HOLT VILLAGE, LETEA VECHE COMMUNE)

MIHAELA ARINTON

**Abstract.** Holt Village (Letea Veche Commune) is situated within the floodplain of the Siret River (Bacău County). The climate of this region is influenced by the Azoric anticyclone, Siberian anticyclone, Iceland cyclone and Mediterranean cyclones. The vegetation of this area is determined by the relief and climate. The diversity of scarabeoid dung beetles from the floodplain of the Siret River area were studied between 2004 and 2006. The material collected during these three years was represented by 11,588 specimens, which systematically belong to two families: Geotrupidae and Scarabaeidae, eighteen genera and twenty-eight species. Twenty-two species were collected in each year of study (they are euconstant species). *Onthophagus taurus* (SCHREBER, 1759), *Euoniticellus fulvus* (GOEZE, 1777), *Aphodius fimetarius* (LINNAEUS, 1758) and *Caccobius schreberi* (LINNAEUS, 1767) are eudominant species. *Euoniticellus fulvus* GOEZE, *Aphodius fimetarius* L., *Caccobius schreberi* L., *Colobopteris erraticus* (LINNAEUS, 1758), *Onthophagus taurus* SCHR., *O. illyricus* (SCOPOLI, 1763), *O. ruficapillus* (BRULLÉ, 1832) and *Acanthobodilus immundus* (CREUTZER, 1799) were identified as the characteristic species for the floodplain of the Siret River area. The highest coenotic affinity is between two species: *Onthophagus nuchicornis* (LINNAEUS, 1758) and *O. ovatus* (LINNAEUS, 1767) - 90.8%. Another group of species is represented by *Aphodius fimetarius* L. and *Caccobius schreberi* L. (90.7%).

**Keywords:** dung beetles, synecological analyse, coenotic affinities.

**Rezumat.** Analiza sinecologică a unor populații de scarabeoidee coprofage (Insecta: Coleoptera: Scarabaeoidea) din zona de luncă a Siretului (Satul Holt, comuna Letea Veche). Satul Holt (comuna Letea Veche) este situat în zona de luncă a Siretului. Clima acestei zone este influențată de anticiclonele Azorice, anticiclonele siberiene, ciclonele islandeze și ciclonele mediteraneene. Vegetația este determinată de relieful și de climă. Diversitatea scarabeoideelor coprofage din zona de luncă a Siretului a fost studiată în perioada 2004-2006. Materialul colectat în cei trei ani de studiu a fost reprezentat prin 11.588 de indivizi, care din punct de vedere sistematic aparțin la două familii (Geotrupidae și Scarabaeidae), 18 genuri și 28 de specii. 22 de specii au fost colectate în fiecare an (aceste specii sunt euconstante). *Onthophagus taurus* (SCHREBER, 1759), *Euoniticellus fulvus* (GOEZE, 1777), *Aphodius fimetarius* (LINNAEUS, 1758) și *Caccobius schreberi* (LINNAEUS, 1767), sunt specii eudominante. Speciile: *Onthophagus taurus* SCHR., *Euoniticellus fulvus* GOEZE, *Aphodius fimetarius* L., *Caccobius schreberi* L., *Colobopteris erraticus* (LINNAEUS, 1758), *Onthophagus illyricus* (SCOPOLI, 1763), *O. ruficapillus* (BRULLÉ, 1832) și *Acanthobodilus immundus* (CREUTZER, 1799) au fost identificate ca fiind caracteristice pentru zona de luncă a râului Siret. Cea mai mare afinitate cenotică există între speciile: *Onthophagus nuchicornis* (LINNAEUS, 1758) și *O. ovatus* (LINNAEUS, 1767) - 90,8%. O altă grupă de specii este reprezentată de *Aphodius fimetarius* L. și *Caccobius schreberi* L. (90,7%).

**Cuvinte cheie:** coprofage, analiza sinecologică, afinități cenotice.

## INTRODUCTION

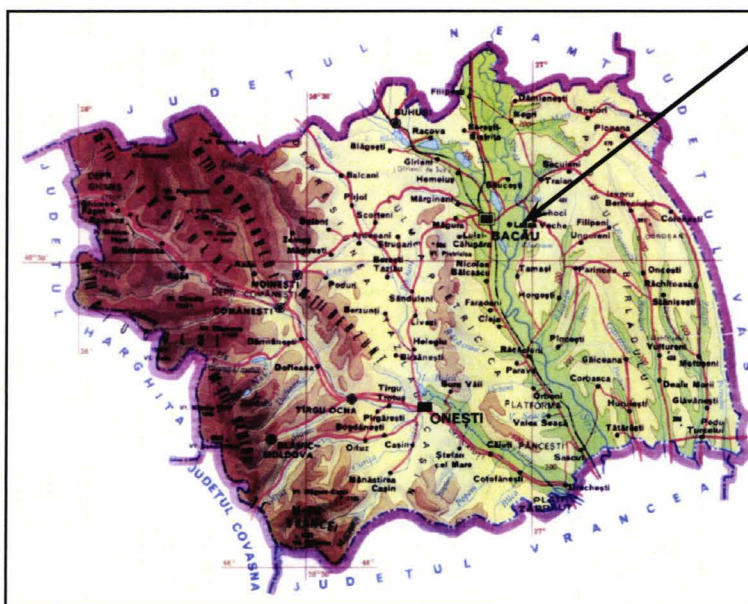


Figure 1. The physical-geographical map of Bacău County (FILIP et. al., 1996).

Figura 1. Harta fizico-geografică a județului Bacău (FILIP et. al., 1996).



Holt Village (Letea Veche Commune) is situated in Bacău County, within the floodplain of the Siret River (Fig. 1).

The climate of this region (the climate of the floodplain of the Siret River) is influenced by the Azoric anticyclone, Siberian anticyclone, Iceland cyclone and Mediterranean cyclones, all of them with a semi-permanent character. Thus, the temperature here reaches +20.3° C in July and -3.5° C in January. The main characteristic of the precipitation is their variation in time – the annual average rainfall is 554 mm.

The vegetation of this area is determined by the relief and climate. Hereby, the vegetation is represented by different types of vegetal associations, such as: *Phragmitetum vulgaris* (SOÓ, 1927), *Typhaetum latifoliae* (LANG, 1973), *Glycerietum maximae* (HUECK, 1931), *Scirpetum sylvatici* (RALSKI, 1931), *Caricetum acutiformis* (EGGLER, 1933), *Trifolio-Lolietum perennis* (KRIPPELOVA, 1967), *Salci-Populetum* (MEIJER-DREES, 1936), *Stellario nemorum-Alnetum glutinosae* (LOHMEYER, 1957), *Hippophaë-Berberidetum* (MOOR, 1958), *Pruno spinosae-Crataegietum* (HUECK, 1931) (MARĂ et al., 2004).

## MATERIAL AND METHODS

The diversity of scarabeoid dung beetles from the floodplain of the Siret River area was studied between 2004 and 2006. During each year, the material was collected weekly, from May to September. Hereby, there were 16 samples for each year of study. Each sample was represented by ten dung pads (proximate sizes) – the quantity of the faeces was approximately the same. There have been studied only faeces populated by insects (dung with crust). In the field, the author also dug for the insects burrowed in the soil, under the faeces. The scarabeoid beetles were collected by investigating the dung on a transparent plastic foil.

The coprophagous beetles collected from the dung have been preserved in alcohol. The material was identified using the specialty literature (DELLACASA, 1983, IENIȘTEA, 1975, 1982, MEDVEDEV, 1965). The taxonomy and nomenclature used in this paper is in accordance with Fauna Europaea.

In order to make a synecological analysis, some ecological indexes were calculated: abundance, frequency, constancy, dominance, the ecological significance index (W) and the similarity index (VARVARA et al., 2001).

## RESULTS AND DISCUSSIONS

During the forty-eight weeks of study (2004-2006), 11,588 specimens of scarabeoid dung beetles were collected from the floodplain of the Siret River area: 3,652 insects in 2004, 4,893 in 2005 and 3,043 in 2006. Systematically, these coleopterans are included into two families: Geotrupidae (one subfamily – Geotrupinae) and Scarabaeidae (with two subfamilies – Aphodiinae and Scarabaeinae), eighteen genera and twenty-eight species.

In Table 1 it is presented the synecological analysis for the twenty-eight species collected from the Siret River area (Holt Village, Letea Veche Commune) during 2004-2006.

Table 1. The synecological analysis for the Scarabaeoidea species, collected from the floodplain of the Siret River area (2004-2006).  
Tabel 1. Analiza sinecologică pentru speciile de Scarabaeoidea, colectate din zona de luncă a râului Siret (2004-2006).

No.	Specie	2004	2005	2006	A	C	D	W			
1.	<i>Onthophagus taurus</i> SCHR.	590	926	567	2083	100	C4	17.97	D5	17.97	W5
2.	<i>Euoniticellus fulvus</i> GOEZE	787	472	379	1638	100	C4	14.13	D5	14.13	W5
3.	<i>Aphodius fimetarius</i> L.	300	609	455	1364	100	C4	11.77	D5	11.77	W5
4.	<i>Caccobius schreberi</i> L.	348	578	294	1220	100	C4	10.53	D5	10.53	W5
5.	<i>Colobopterus erraticus</i> L.	191	551	270	1012	100	C4	8.73	D4	8.73	W4
6.	<i>Onthophagus illyricus</i> SCOP.	214	320	291	825	100	C4	7.12	D4	7.12	W4
7.	<i>Onthophagus ruficapillus</i> BRULLÉ	148	367	144	659	100	C4	5.69	D4	5.69	W4
8.	<i>Acanthobodilus immundus</i> CREUTZ.	326	141	134	601	100	C4	5.18	D4	5.18	W4
9.	<i>Onthophagus furcatus</i> FABR.	119	182	75	376	100	C4	3.24	D3	3.24	W3
10.	<i>Eupleurus subterraneus</i> L.	131	119	65	315	100	C4	2.72	D3	2.72	W3
11.	<i>Onthophagus ovatus</i> L.	69	164	71	304	100	C4	2.62	D3	2.62	W3
12.	<i>Onthophagus nuchicornis</i> L.	53	150	50	253	100	C4	2.18	D3	2.18	W3
13.	<i>Bodilus lugens</i> CREUTZER	104	80	65	249	100	C4	2.15	D3	2.15	W3
14.	<i>Copris lunaris</i> L.	74	42	63	179	100	C4	1.55	D2	1.55	W3
15.	<i>Otophorus haemorrhoidalis</i> L.	106	43	17	166	100	C4	1.43	D2	1.43	W3
16.	<i>Onthophagus vacca</i> L.	21	62	29	112	100	C4	0.97	D1	0.97	W2
17.	<i>Aphodius foetens</i> FABR.	38	15	28	81	100	C4	0.7	D1	0.7	W2
18.	<i>Coprimorphus scrutator</i> HERBST	19	22	22	63	100	C4	0.54	D1	0.54	W2
19.	<i>Geotrupes puncticollis</i> MALIN.	3	15	8	26	100	C4	0.23	D1	0.23	W2
20.	<i>Teuchestes fossor</i> L.	2	11	11	24	100	C4	0.21	D1	0.21	W2
21.	<i>Anoplotrupes stercorosus</i> SCRIBA	4	2	2	8	100	C4	0.07	D1	0.07	W1
22.	<i>Onthophagus vitulus</i> FABR.	1	1	2	4	100	C4	0.04	D1	0.04	W1

No.	Specie	2004	2005	2006	A	C		D		W	
23.	<i>Onthophagus fracticornis</i> PREYSS.	1	1		2	66.66	C3	0.02	D1	0.01	W1
24.	<i>Oxyomus sylvestris</i> SCOP.		11		11	33.33	C2	0.09	D1	0.03	W1
25.	<i>Calamosternus granarius</i> L.		9		9	33.33	C2	0.08	D1	0.02	W1
26.	<i>Agrilinus rufus</i> MOLLER	2			2	33.33	C2	0.02	D1	0.006	W1
27.	<i>Trichonotulus scrofa</i> FABR.			1	1	33.33	C2	0.01	D1	0.003	W1
28.	<i>Bodilus ictericus</i> LAICH.	1			1	33.33	C2	0.01	D1	0.003	W1
		3652	4893	3043	11588	-	-	100	-	-	-

The synecological analysis shows that *Onthophagus taurus* (SCHREBER, 1759) (Fig. 2a), *Euoniticellus fulvus* (GOEZE, 1777) (Fig. 2b), *Aphodius fimetarius* (LINNAEUS, 1758) (Fig. 2c) and *Caccobius schreberi* (LINNAEUS, 1767) (Fig. 2d) are eudominant species. Other four specie – *Colobopterius erraticus* (LINNAEUS, 1758), *Onthophagus illyricus* (SCOPOLI, 1763), *O. ruficapillus* (BRULLÉ, 1832) and *Acanthobodilus immundus* (CREUTZER, 1799) – are included in the dominant class. According to the same index, *Eupleurus subterraneus* (LINNAEUS, 1758), *Onthophagus furcatus* (FABRICIUS, 1781), *O. ovatus* (LINNAEUS, 1767), *O. nuchicornis* (LINNAEUS, 1758) and *Bodilus lugens* (CREUTZER, 1799) are subdominant species. Only two species are recedent – *Copris lunaris* (LINNAEUS, 1758) and *Otophorus haemorrhoidalis* (LINNAEUS, 1758); the last thirteen species are subrecedent.

The values of the ecological significance index (W) indicate that the twenty-eight species of dung beetles belong to three groups. Thus, for the floodplain of the Siret River area there were identified eight characteristic species: *Euoniticellus fulvus* GOEZE, *Aphodius fimetarius* L., *Caccobius schreberi* L., *Colobopterius erraticus* L., *Onthophagus taurus* SCHR., *O. illyricus* SCOP., *O. ruficapillus* BRULLÉ and *Acanthobodilus immundus* CREUTZ.; twelve species are accessory and other eight species are accidental.



Figure 2. The eudominant coprophagous species identified for the floodplain of the Siret River area (2004-2006).  
Figura 2. Speciile coprofage eudominante identificate pentru zona de luncă a Siretului (2004-2006).  
a) *Onthophagus taurus* SCHR.; b) *Euoniticellus fulvus* GOEZE; c) *Aphodius fimetarius* L.; d) *Caccobius schreberi* L.

For revealing the coenotic affinities between the twenty-eight coprophagous species, it was necessary to calculate the similarity index (Table 2). Based on the values of this index it was easy to represent graphically the coenotic relationships between the species of Scarabaeoidea collected from the floodplain of the Siret River area during 2004-2006. The dendrogram is presented in Fig. 3.

Analyzing the dendrogram (Fig. 3) it is easy to notice that the highest coenotic affinity is between two species: *Onthophagus nuchicornis* L. and *O. ovatus* L.-90.8% (in every year of study, their abundance had close values). *Aphodius fimetarius* L. and *Caccobius schreberi* L. were also well represented in all three years of study; the coenotic affinity between these two species is 90.7%. *Calamosternus granarius* (LINNAEUS, 1767) and *Oxyomus sylvestris* (SCOPOLI, 1763) were collected only in 2005, but they were represented by a different number of individuals (nine, respectively eleven insects). The affinity between these two species is 90%.

The dendrogram also indicates other groups of species: *Bodilus lugens* CREUTZER and *Eupleurus subterraneus* L.-88.3%; *Teuchestes fossor* (LINNAEUS, 1758) and *Geotrupes puncticollis* (MALINOWSKY, 1811)-84%; *Coprimorphus scrutator* (HERBST, 1789) and *Aphodius foetens* (FABRICIUS, 1787)-77.8%. The species included in these groups were collected each year, but their abundance index had different values. Another group is constituted by *Agrilinus rufus* (MOLLER, 1782), *Bodilus ictericus* (LAICHTING, 1781) *Onthophagus fracticornis* (PREYSSLER, 1790), *O. vitulus* (FABRICIUS, 1776) and *Anoplotrupes stercorosus* (SCRIBA, 1791). The coenotic affinity between these five species is 66.6%.

Table 2. The values of the similarity index calculated for the coprophagous species collected from the floodplain of the Siret River area (2004-2006).

Tabel 2. Valorile indicelui de similaritate calculat pentru speciile coprofage colectate în zona de luncă a Siretului (2004-2006).

1 - *Onthophagus taurus* SCHR., 2 - *Euoniticellus fulvus* GOEZE, 3 - *Aphodius fimetarius* L., 4 - *Caccobius schreberi* L., 5 - *Colobopterus erraticus* L., 6 - *Onthophagus illyricus* SCOP., 7 - *Onthophagus ruficapillus* BRULLÉ, 8 - *Acanthobodilus immundus* CREUTZ., 9 - *Onthophagus furcatus* FABR., 10 - *Eupleurus subterraneus* L., 11 - *Onthophagus ovatus* L., 12 - *Onthophagus nuchicornis* L., 13 - *Bodilus lugens* CREUTZER, 14 - *Copris lunaris* L., 15 - *Otrophorus haemorrhoidalis* L., 16 - *Onthophagus vacca* L., 17 - *Aphodius foetens* FABR., 18 - *Coprimorphus scrutator* HERBST, 19 - *Geotrupes puncticollis* MALIN., 20 - *Teuchestes fossor* L., 21 - *Anoplotrupes stercorosus* SCRIBA, 22 - *Onthophagus vitulus* FABR., 23 - *Onthophagus fracticornis* PREYSS., 24 - *Oxyomus sylvestris* SCOP., 25 - *Calamosternus granarius* L., 26 - *Agrilinus rufus* MOLLER, 27 - *Trichonotulus scrofa* FABR., 28 - *Bodilus ictericus* LAICH.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1																											
2	77.4																										
3	79.1	76.7																									
4	73.9	77.9	90.7																								
5	65.4	70.4	85.2	90.7																							
6	56.7	67.0	75.4	80.7	85.0																						
7	48.0	57.4	65.1	70.1	78.9	82.5																					
8	44.8	53.7	58.5	66.0	57.8	68.6	67.1																				
9	30.6	37.3	43.2	47.1	54.2	62.6	72.6	68.6																			
10	26.3	32.2	37.5	41.0	47.5	55.2	64.7	68.8	87.7																		
11	25.5	31.3	36.4	39.9	46.2	53.8	63.1	62.1	89.4	81.7																	
12	21.6	26.5	31.3	34.3	40.0	46.9	55.5	57.1	80.4	78.1	90.8																
13	21.3	26.4	30.9	33.9	39.5	46.3	54.8	58.6	79.7	88.3	77.4	72.9															
14	15.8	19.7	23.2	25.6	30.0	35.6	42.7	45.9	64.5	72.4	72.0	67.1	83.6														
15	14.7	18.4	21.7	23.9	28.2	33.5	40.2	43.3	61.2	69.0	54.9	53.9	79.0	77.1													
16	10.2	12.8	15.2	16.8	19.9	23.9	29.0	31.4	45.9	52.4	53.8	61.3	62.0	63.2	58.3												
17	7.5	9.4	11.2	12.4	14.8	17.9	21.9	23.7	35.4	40.9	42.0	48.5	49.1	62.3	56.7	66.3											
18	5.9	7.4	8.8	9.8	11.7	14.2	17.4	19.0	28.7	33.3	34.3	39.9	40.4	52.0	50.6	72.0	77.8										
19	2.4	3.1	3.7	4.2	5.0	6.1	7.5	8.3	12.9	15.2	15.7	18.6	18.9	25.3	27.1	37.7	48.6	58.4									
20	2.3	2.9	3.4	3.8	4.6	5.6	7.0	7.7	12.0	14.1	14.6	17.3	17.6	23.6	25.2	35.3	45.7	55.2	84.0								
21	0.7	1.0	1.1	1.3	1.6	1.9	2.4	2.6	4.1	4.9	5.1	6.1	6.2	8.5	9.2	13.3	18.0	22.5	41.8	37.5							
22	0.4	0.5	0.6	0.6	0.8	0.9	1.2	1.3	2.1	2.5	2.6	3.1	3.1	4.4	4.7	6.9	9.4	11.9	26.6	28.6	66.6						
23	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.6	1.0	1.2	1.3	1.6	1.6	2.2	2.4	3.5	4.8	6.1	14.3	15.4	40.0	66.6					
24	1.0	1.3	1.6	1.8	2.1	2.6	3.3	3.6	5.7	6.7	7.0	8.3	8.4	11.6	12.4	17.9	23.9	29.7	59.4	62.8	21.0	13.3	15.4				
25	0.8	1.1	1.3	1.4	1.7	2.1	2.7	2.9	4.7	5.5	5.7	6.9	7.0	9.6	10.3	14.9	20.0	25.0	51.4	54.5	23.5	15.4	18.2	90.0			
26	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.6	1.0	1.2	1.3	1.6	1.6	2.2	2.4	3.5	4.8	6.1	14.3	15.4	40.0	33.3	50.0	0.0	0.0		
27	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.6	0.6	0.8	0.8	1.1	1.2	1.8	2.4	3.1	7.4	8.0	22.2	40.0	0.0	0.0	0.0	0.0	
28	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.6	0.6	0.8	0.8	1.1	1.2	1.8	2.4	3.1	7.4	8.0	22.2	40.0	66.6	0.0	0.0	66.6	0.0

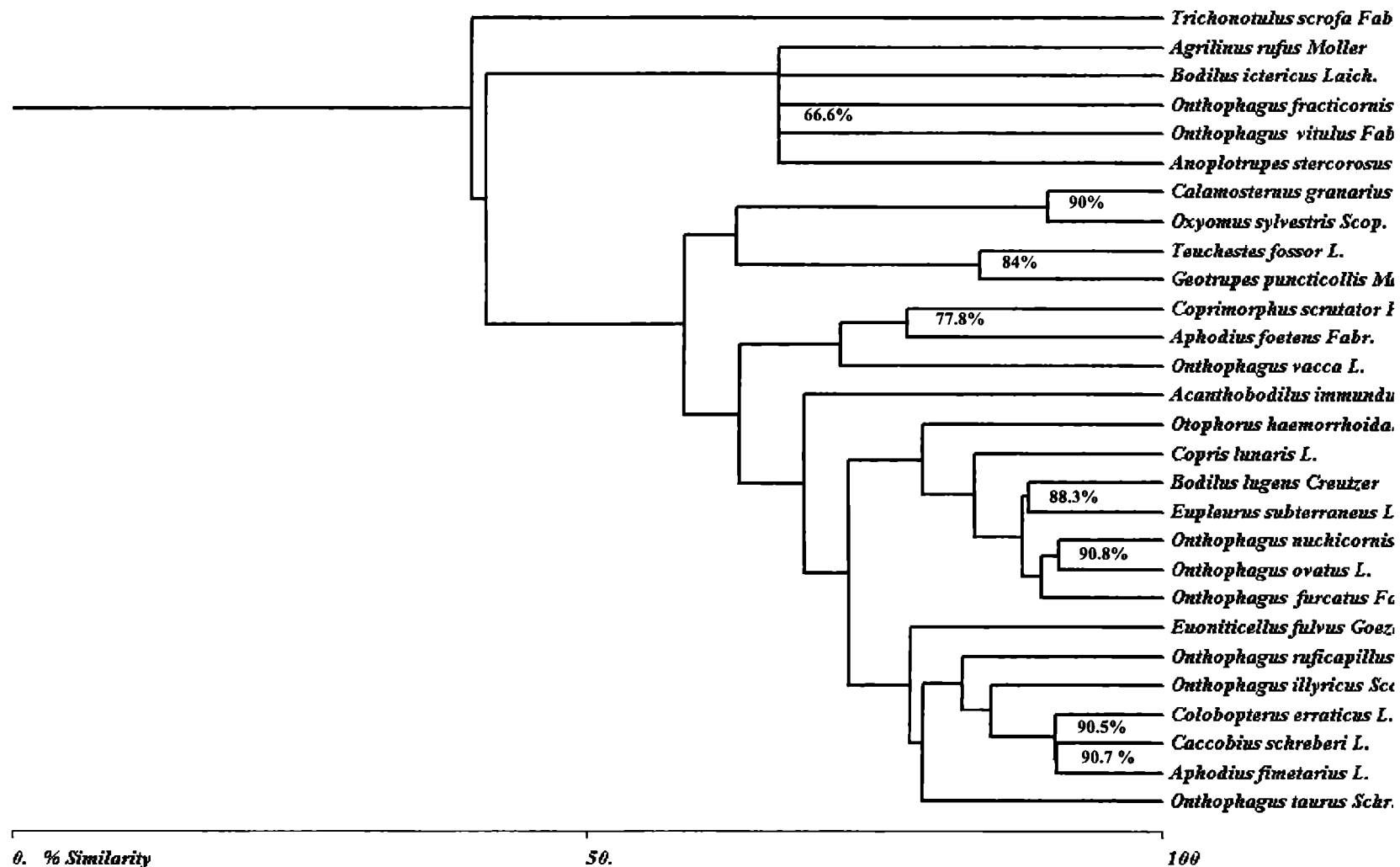


Figure 3. The coenotic affinities between the coprophagous species collected from the floodplain of the Siret River area (2004-2006).

Figura 3. Afinitățile cenotice dintre speciile de coprofage colectate în zona de luncă a Siretului (2004-2006).

## CONCLUSIONS

1. The research concerning the diversity of scarabeoid dung beetles from the floodplain of the Siret River area were made between 2004 and 2006. Systematically, the 11,588 individuals collected in this area belong to two families (Geotrupidae and Scarabaeidae), three subfamilies (Geotrupinae, Aphodiinae and Scarabaeinae), eighteen genera and twenty-eight species.

2. Twenty-two species were collected during each year of study (they are euconstant species). *Onthophagus fracticornis* PREYSSLER is the only constant specie. *Oxyomus sylvestris* SCOP., *Calamosternus granarius* L., *Agrilinus rufus* MOLLER, *Trichonotulus scropha* FABR., *Bodilus ictericus* LAICH. are accessory species.

3. According to the synecological analysis, *Onthophagus taurus* SCHR., *Euoniticellus fulvus* GOEZE, *Aphodius fimetarius* L. and *Caccobius schreberi* L. are eudominant species. *Colobopterus erraticus* L., *Onthophagus illyricus* SCOP., *O. ruficapillus* BRULLÉ and *Acanthobodilus immundus* CREUTZ. – are included in the dominant class.

4. The characteristic coprophagous species for the floodplain of the Siret River area are: *Euoniticellus fulvus* GOEZE, *Aphodius fimetarius* L., *Caccobius schreberi* L., *Colobopterus erraticus* L., *Onthophagus taurus* SCHR., *O. illyricus* SCOP., *O. ruficapillus* BRULLÉ and *Acanthobodilus immundus* CREUTZ.; twelve species are accessory and other eight species are accidental.

5. The highest coenotic affinity is between two species: *Onthophagus nuchicornis* L. and *O. ovatus* L.-90.8% (every year of study, their abundance had proximate values). *Aphodius fimetarius* L. and *Caccobius schreberi* L. were also well represented in each number; the coenotic affinity between these two species is 90.7%.

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# CONSIDERATIONS ON THE DYNASTIDAE FAMILY (INSECTA: COLEOPTERA: SCARABAEOIDEA), FROM THE FAUNA OF OLTENIA, ROMANIA

CORNELIA CHIMIȘLIU, GIMA MOGOȘEANU

**Abstract.** This paper introduces in the scientific informational circuit new data regarding the presence of the Dynastidae in the fauna of Oltenia. We analyzed 111 specimens collected during the years 1995–2009 by the specialists of the Natural Science Section from 22 sites mostly from Dolj County. We identified the two species known in Romania *Pentodon idiota idiota* (HERBST 1789) and *Oryctes (Oryctes) nasicornis* (LINNAEUS 1758), the last one being a saproxylic species, a bioindicator of the forests of European importance.

**Keywords:** considerations, Dynastidae family, Oltenia's fauna, Romania.

**Rezumat. Considerații asupra familiei Dynastidae (Insecta: Coleoptera: Scarabaeoidea) din fauna Olteniei, România.** Lucrarea introduce în circuitul științific informațional, noi date privind prezența dinastidelor în fauna Olteniei. Sunt analizate 111 exemplare colectate în perioada anilor 1995–2009 de către specialiștii Secției de Științele Naturii, din Oltenia, din 22 de situri, majoritatea din județul Dolj. Au fost identificate cele două specii cunoscute din România *Pentodon idiota idiota* (HERBST 1789) și *Oryctes (Oryctes) nasicornis* (LINNAEUS 1758), ultima fiind specie saproxilică, bioindicator al pădurilor de importanță europeană.

**Cuvinte cheie:** considerații, familia Dynastidae, fauna Olteniei, România.

## INTRODUCTION

The Dynastinae Family KOLBE 1897 is represented in Romanian fauna by 4 species and subspecies included in two genera and two tribes. Data regarding the geographical distribution, the morphology, the economic importance, and the presence of this group of coleopterans in the fauna of Oltenia are found in the synthesis paper published by CHIMIȘLIU (2005). In this paper, the author has scientifically processed data of 359 specimens collected during the years 1951 – 2003 by the specialists of the Natural Science Section from 47 sites from the five counties of Oltenia. The author had also centralized data on the Dynastidae fauna from Oltenia since 1928. The present paper intends to introduce in the scientific informational circuit new data regarding the presence of the Dynastidae in Oltenia's fauna.

## MATERIAL AND METHODS

The analyzed material is represented by 111 specimens preserved in the entomological collections of the museum and collected during 1995–2009 by the specialists of the Natural Science Section, from the natural and anthropogenic ecosystems of Oltenia (Fig. 1).

In order to determine the collected material we used the papers of PANIN (1957) and MEDVEDEV (1960) as bibliographical material.

The taxonomic system and the species nomenclature are those used in Fauna Europaea.

The paper includes the list of specialists who have collected the material with the abbreviations used in text and a list of the collection sites (with the indication of the counties). For every species, there were given:

- previous reports from the Oltenia Museum patrimony (BOBÎRNAC et al., 1999a; BOBÎRNAC et al., 1999b; CHIMIȘLIU, 2000, 2005) and the patrimony of the Iron Gates Region Museum from Drobeta Turnu-Severin (CHIMIȘLIU & BOTU, 2000).

- collection data for each species are presented in the alphabetical order of the collection sites and within these, data are expressed in chronological order.

### Abbreviations:

County names: DJ – Dolj; GJ – Gorj; MH – Mehedinți; OT – Olt; VL – Vâlcea.

Collectors' names (legit): B.L. - Bălă Lavinia; C.C. - Chimișliu Cornelia; F.G. - Filcu Gheorghita; N.A. - Năstase Adrian; V.A. - Vișan Aneta.

Collecting sites (Fig. 1):

- |                           |                           |                           |
|---------------------------|---------------------------|---------------------------|
| 1. Bratovoști (DJ)        | 8. Ciineni (VL)           | 16. Negoii (DJ)           |
| 2. Brezoi (VL)            | 9. Craiova (DJ)           | 17. Ocnița (VL)           |
| 3. Bucovăț (DJ)           | 10. Craiova- Parc (DJ)    | 18. Pădurea Sarului (OT)  |
| 4. Calafat (DJ)           | 11. Craiova (Teatru) (DJ) | 19. Pădurea Stârmina (MH) |
| 5. Cheile Galbenului (GJ) | 12. Dăbuleni (DJ)         | 20. Răcari (DJ)           |
| 6. Cheile Sohodol (GJ)    | 13. Dr. Tr. Severin (MH)  | 21. Secui (DJ)            |
| 7. Ciocadia (GJ)          | 14. Leamna (DJ)           | 22. Straja (GJ)           |
|                           | 15. Leu (DJ)              |                           |

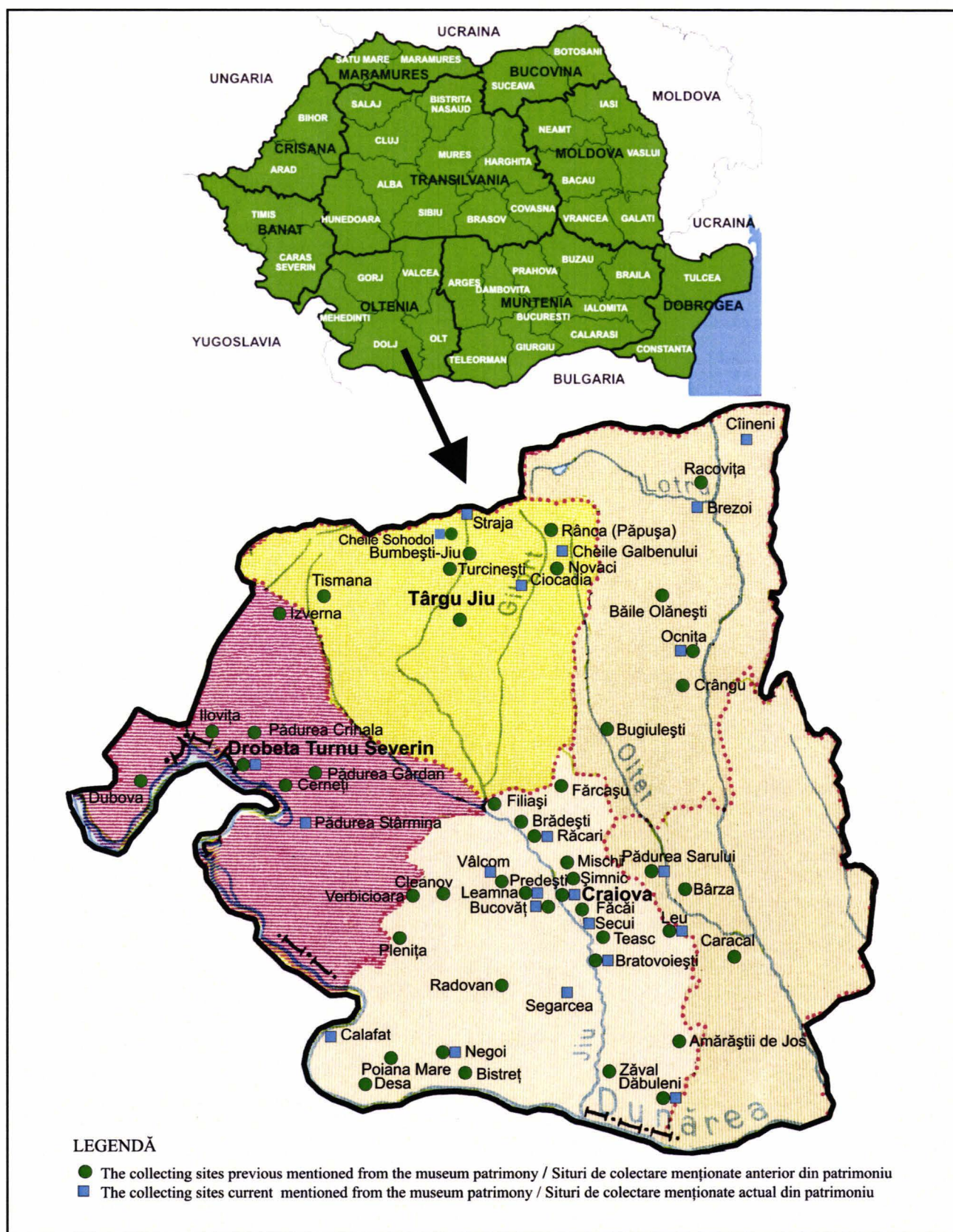


Figure 1. Romania map with Oltenia location and the collecting sites.  
 Figura 1. Harta Romaniei cu localizarea Olteniei și siturile de colectare.

## RESULTS AND DISCUSSIONS

As a result of processing the material, the species *Oryctes (Oryctes) nasicornis* and *Pentodon idiota idiota* were identified.

The two species were collected from 22 sites from the five counties of Oltenia. Most collections were made in Dolj County (12), followed by the counties Gorj (4), Vâlcea (3), Mehedinți (2) and Olt (1). The results obtained by analyzing the material, come to reconfirm the presence of the two species in the fauna of Oltenia. Thus, of those 22 sites, 10 are mentioned now for the first time.

We shall further present the list of the identified species:

***Oryctes (Oryctes) nasicornis* (LINNAEUS 1758)**

**Previous reports from the museum patrimony:** BOBÎRNAC et al. (1999b): Bugiulești; CHIMIȘLIU & BOTU (2000): Cerneți, Drobeta Turnu-Severin; CHIMIȘLIU (2000): Craiova, Plenița, Tismana, Verbicioara; CHIMIȘLIU (2005): Amărăștii de Jos, Bratovoști, Bucovăț, Bugiulești, Bumbesti, Cerneți, Cheile Sohodol, Craiova, Craiova-Gr. Botanică, Craiova-Obedeanu, Crângu, Desa, Drobeta Turnu-Severin, Făcăi, Fărcașu, Filiași, Izverna, Ilovița, Leamna, Leu, Mischii, Ocnîța, Olănești, Rânca (Păpușa), Plenița, Predești, Pădurea Sarului, Poiana Mare, Racovița, Răcari, Șimnic, Târgu Jiu, Teasc, Turcinești, Vâlcom, Verbicioara.

**Examined material:** 67 specs.: Balș – July 12, 2000; Bratovoști – 1 ♂ June 9, 2004 leg. C. C.; 1 ♀ July 25, 2004 leg. N. A.; Brezoi – 1 ♂ July 1, 1998 leg. N. A.; Bucovăț – 1 ♂ and 1 ♀ June 10, 2000 leg. C. C.; 1 ♀ May 5, 2000 leg. V. A.; 1 ♂ and 1 ♀ June 31, 2001 leg. V. A.; 1 ♂ and 1 ♀ June 19, 2001 leg. B. L.; 1 ♂ July 5, 2005 leg. B. L.; 1 ♀ May 27, 2007 leg. V. A.; Calafat – 1 ♂ June 7, 2008 leg. C. C.; Cheile Sohodol – 1 ♀ July 27, 1995 leg. C. C.; 1 ♂ August 17, 2002 leg. C. C.; Ciocadia – 1 ♂ July 5, 2008 leg. B. L.; Cîineni – 1 ♀ July 18, 2003 leg. N. A.; Craiova – 1 ♀ June 26, 2002 B. L.; ♂ June 10, 2003 leg. B. L.; 1 ♀ June 8, 2004 leg. B. L.; 1 ♂ July 6, 2005; 1 ♂ June 27, 2006; 3 specs. June 14, 2007 B. L.; 2 ♂♂ May 17, 2008 leg. B. L.; 1 ♂ June 11, 2008 leg. B. L.; 2 ♂♂ and 2 ♀♀ July 3, 2008 leg. C. C. and B. L.; 1 ♂ June 16, 2009 leg. R. M.; Craiova-Park – 1 ♂ June 24, 2003 leg. F.G.; Dăbuleni – 2 ♀♀ July 23, 2004 leg. C. C.; Gogoșu – 1 ♂ August 10, 2001 leg. N.A.; Leamna – 1 ♂ and 2 ♀♀ July 31, 2001. leg. B. L.; Leu – 1 ♂ June 15, 1999 leg. C. C.; Negoii – 3 ♀♀ July 12, 2004 leg. V. A.; 1 ♀ June 5, 2007 leg. V. A.; 2 ♂♂ and 3 ♀♀ June 21, 2008 leg. V. A.; Ocnîța – 2 ♂♂ August 17, 1999 leg. C. C.; Orșova – 1 ♀ June 20, 2007; Pădurea Sarului – 2 ♂♂ July 14, 2000 leg. C. C.; 1 ♂ July 25, 2001 leg. N.A.; Pădurea Stârmina – 1 ♂ July 23, 2001 leg. N. A.; Răcari – 1 ♂ July 17, 2001 leg. C. C.; Secui – 1 ♂ DJ May 24, 2008 leg. C. C.; 1 ♂ and 1 ♀ July 22, 2009; Straja – 1 ♂ August 3, 2000 leg. V. A.; Șimnic – 1 ♀ July 15, 2004 leg. F.G.; 1 ♂ April 1, 2007; 1 ♂ June 10, 2008; 1 ♂ and 2 ♀♀ June 6, 2008 leg. F.G.;

***Pentodon idiota idiota* (HERBST 1789)**

**Previous reports from the museum patrimony:** BOBÎRNAC et al. (1999a): Valea Sohodol; BOBÎRNAC et al. (1999b): Novaci; CHIMIȘLIU & BOTU (2000): Dubova, Pădurea Crihală (Breznița); CHIMIȘLIU (2000): Craiova; CHIMIȘLIU (2005): Bârza, Bistreț, Brădești, Bucovăț, Caracal, Cheile Sohodol, Cleanov, Craiova, Craiova-Botanical Garden, Dăbuleni, Desa, Drobeta Turnu-Severin, Dubova, Leamna, Leu, Negoii, Novaci, Pădurea Gârdan, Radovan, Segarcea, Șimnic, Verbicioara, Zăval.

**Examined material:** 44 specs.: Bucovăț – 5 specs. July 5, 1999 leg. C. C.; June 9, 1999 leg. C. C.; July 5, 2005 leg. B. L.; Cheile Galbenului – August 13, 2005 leg. C. C.; Cheile Sohodol – July 27, 1995 leg. C. C.; 2 specs. August 28, 1999 leg. C. C.; August 17, 2002 leg. C. C.; Craiova – July 7, 2001 leg. F. G.; August 3, 2002 leg. V. A.; June 2, 2005 leg. F. G.; June 25, 2005 leg. B. L.; Craiova (Theatre) August 1, 2001 leg. C. C.; Dr. Turnu-Severin – June 6, 2009 leg. C. C.; Negoii – May 18, 2002; June 5, 2004 leg. V. A.; Secui – April 14, 2008 leg. C. C.; Șimnic – June 9, 2000 leg. F.G.; 2 specs. March 23, 2000 leg. F.G.; 2 specs. May 10, 2004 leg. F.G.; May 13, 2004 leg. F.G.; June 13, 2004 leg. F.G.; June 17, 2004 leg. F.G.; June 20, 2004 leg. F.G.; 2 specs. June 23, 2004 leg. F.G.; July 7, 2004 leg. F.G.; March 29, 2005 leg. F.G.; April 22, 2005 leg. F.G.; June 2, 2005 leg. F.G.; June 15, 2005 leg. F.G.; June 19, 2005 leg. F.G.; June 20, 2005 leg. F.G.; June 5, 2006 leg. F.G.; June 1, 2007 leg. F.G.; June 10, 2007 leg. F.G.; March 20, 2008 leg. F.G.; April 12, 2008 leg. F.G.; June 15, 2008 leg. F.G.; June 12, 2008 leg. F.G.;

This paper joins the efforts of specialists who contribute to the knowledge of the entomofauna diversity, being known the fact that, though the insects have the biggest role as number of species and individuals in the animal kingdom and contribute to maintaining the biological balance of ecosystems, they are often underestimated, many groups of insects and large areas being unstudied and unknown for experts.

Of the two species of dynastids identified in the analyzed material, *Oryctes nasicornis* belongs to the category of saproxylic coleopterans, indicators of the forests of European importance (BACAL, 2006, BABAN, 2008) together with other scarabeoids (*Lucanus cervus* LINNAEUS, 1758, *Cetonischema aeruginosa* (DRURY 1770), *Gnorimus octopunctatus* (FABRICIUS 1775), *Liocola lugubris* (HERBST 1786), *Osmoderma eremita* (SCOPOLI 1763)). The knowledge of its distribution in Oltenia may constitute a database for the studies made for identifying the different types of forests of European importance.

The saproxylic species are recognized in the European legislation as being a fundamental part of the European natural heritage due to their scientific importance, educational, cultural, recreational, aesthetic and intrinsic value. In Europe, a large number of saproxylic organisms have disappeared and others have become very rare due to the deterioration or extinction of habitats. Taking into account that saproxylic species are excellent bioindicators of the forests

of European importance and many species are in decline, many experts have approached the study of ecology of the saproxylic species. Many species and their habitats are protected by EU and national legislation.

Recognizing the saproxylic insects as components of the World Natural Heritage, Council of Europe has recommended a series of measures relating to nature conservation, management of natural forests and of protected natural areas, intended to lead to the knowledge and protection of saproxylic coleopterans and of their habitats.

### CONCLUSIONS

Two species *Oryctes (Oryctes) nasicornis* (LINNAEUS 1758) and *Pentodon idiota idiota* (HERBST 1789) collected from 22 sites were identified. The first one is a saproxylic species, a bioindicator of the forests of European importance.

The Natural Science Section patrimony preserves all the representatives Dynastidae family mentioned so far in the fauna of Romania, constituting an important database for the knowledge of the diversity of Oltenia's entomofauna.

The addition of those 10 new sites expands the family area within Oltenia's territory.

Thanks to the established and preserved collections, the museums of natural sciences contribute to the knowledge of species and their importance in nature, which are essential in the efforts made by specialists for nature conservation and protection of wild fauna species.

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# NEW DATA REGARDING THE CERAMBYCIDAE SPECIES (INSECTA: COLEOPTERA: CERAMBYCOIDEA) PRESERVED IN THE PATRIMONY OF THE OLTENIA MUSEUM CRAIOVA (ROMANIA)

RODICA SERAFIM, CORNELIA CHIMIȘLIU

**Abstract.** *The paper includes new data concerning the Cerambycidae species recently entered in the patrimony of the Museum of Oltenia, Craiova, Department of Natural Sciences, collected during the years 1967 - 2009 from 29 sites, most of them from Oltenia. 58 species were identified. 12 species are new for the collection, one of them not previously reported in Oltenia (Exocentrus punctipennis MULSANT & BUILEBEU 1856).*

**Keywords:** *new data, Cerambycidae, the Oltenia Museum patrimony, Craiova.*

**Rezumat.** *Noi date privind speciile familiei Cerambycidae (Insecta: Coleoptera: Cerambycoidea) conservate în patrimoniul Muzeului Olteniei Craiova (România). Lucrarea cuprinde date noi referitoare la speciile de Cerambycidae intrate recent în patrimoniul Muzeului Olteniei din Craiova, Secția de Științele Naturii, colectate în perioada 1967 - 2009, din 29 de situri, majoritatea din Oltenia. Au fost identificate 58 specii, dintre acestea 12 sunt noi pentru colecție, una dintre acestea nu a mai fost semnalată în Oltenia (Exocentrus punctipennis MULSANT & BUILEBEU 1856).*

**Cuvinte cheie:** *date noi, Cerambycidae, patrimoniul Muzeului Olteniei, Craiova.*

## INTRODUCTION

In 2004, SERAFIM et al. published the catalog of Cerambycidae species preserved in the patrimony of the Oltenia Museum, Craiova. According to the published data, the collection of the Museum of Natural Sciences included 1,077 specimens belonging to 94 species (which represent about 40% of all known species of Romania's fauna). The material comes from the collecting trips, made between 1951 and 2004, from 103 sites located in 10 counties (mostly in the south of Romania). The best-represented subfamilies were: Cerambycinae (34 species), Lamiinae (30 species) and Lepturinae (27 species). The Prioninae subfamily was represented by 2 species and Spondyliinae subfamily by a single species.

The data provided by the species of the collection were published in several papers (BOBÂRNAC et. al., 1999, CHIMIȘLIU 2006, 2007, 2007a, 2008, 2008a; SERAFIM & SIDERE 2006; SERAFIM 2007).

## MATERIAL AND METHODS

The material presented in the paper was collected by the specialists of the Natural Sciences Section of the Museum of Oltenia, Craiova, during the years 1968 – 2009, from 29 sites (Fig. 1)<sup>1</sup>. The species identification was made by Rodica Serafim.

The nomenclature and the used systematics are according to SAMA (2005), DANILEVSKY (2007) and HOSKOVEC & REJZEK (2009). The families, genera and species are arranged in alphabetical order.

### List of collection sites:

Băile Herculane (CS)	Cheile Sohodol, Vâlcan Mts. (GJ)	Olănești (VL)
Bociu (CJ)	Craiova (DJ)	Răcari (DJ)
Boișoara (VL)	Craiova (Botanic Garden) (DJ)	Secui (DJ)
Bratovoiești (DJ)	Craiova (Hanul Doctorului) (DJ)	Segarcea (DJ)
Bucovăț (DJ)	Craiova (Park) (DJ)	Straja (GJ)
Bugiușești (VL)	Drobeta-Turnu Severin (MH)	Șimnic (DJ)
Canaraua Feti (CT)	Huși (VS)	Tărtășești (DB)
Cetate (DJ)	Mischii (DJ)	Turcinești (GJ)
Cheile Bistriței (GJ)	Iezer Mountains (AG)	Valea Cheii (VL)
Ciocadia (GJ)	Negoi (DJ)	

### Abbreviations:

County names: AG – Argeș; CS – Caraș Severin; CJ – Cluj; CT – Constanța; DB – Dâmbovița; DJ – Dolj; GJ – Gorj; MH – Mehedinți; VS – Vaslui; VL – Vâlcea.

Collector's name: A.N. – Adrian Năstase; A.V. – Aneta Vișan; C.C. – Cornelia Chimișliu; C.G. – Claudia Goga; G.F. – Gheorghița Filcu; L.B. – Lavinia Bălă; N.G.L. – Narcisa Gima Lila; N.S. – Nicolae Săvulescu.

Mt./Mts – Mountain/s; spec./s – specimen/s; \* - species recently introduced in the collection.

<sup>1</sup> Oltenia entirely includes the counties: Gorj, Dolj and parts of the counties: Mehedinți (mainly in Oltenia, but the western part belongs to Banat), Vâlcea (mainly in Oltenia, but the eastern part belongs to Muntenia), Olt (the western half, the former Romanat County), Teleorman (only the village Islaz) (Fig. 1).





Figure 1. The administrative map of Romania and the collection sites.  
 Figura 1. Harta administrativă a României și punctele de colectare.

Below, we present the identified species, in alphabetical order, and date of collection (Table 1):

Table 1. Species of Cerambycidae from the collections of the Oltenia Museum.  
Tabel 1. Specii de Cerambycidae din colecțiile Muzeului Olteniei.

No. species	Taxa (subfamilies, tribes, species)	New data
	<b>Family CERAMBYCIDAE</b>	
	<b>Subfamily CERAMBYCINAE</b>	
	<b>Tribe Callichromatini</b>	
1.	<i>Aromia moschata moschata</i> (LINNAEUS, 1758)	Material examined: 1 spec. Cheile Sohodolului, Vâlcăni Mts August 8, 2004 C.C.
	<b>Tribe Callidiini</b>	
2.	<i>Callidium violaceum</i> (LINNAEUS, 1758)	Material examined: 1 spec. Boișoara May 25, 2001 A.N.; 1 spec. Cetate June 18, 2001 A.N.; 4 specs. Negoii May 3, 2005 A.V.; 1 spec. Craiova (Botanical Garden) May 20, 2008 G.F.; 2 specs. Șimnic May 4-18, 2009 G.F.
3.	<i>Phymatodes testaceus</i> (LINNAEUS, 1758)	Material examined: 2 specs. Cetate June 18, 2001 A.N.; 4 specs. Șimnic June 5, 2006 G.F.
4.	<i>Pyrrhidium sanguineum</i> (LINNAEUS, 1758)	Material examined: 1 spec. Șimnic April 12, 2008 G.F.
5.	<i>Ropalopus macropus</i> (GERMAR, 1824)	Material examined: 1 spec. Tărtășești May 17, 2006 G.F.
	<b>Tribe Clytini</b>	
6.	<i>Chlorophorus figuratus</i> (SCOPOLI, 1763)	Material examined: 2 specs. Bucovăț July 5, 2005 G.F., A.V.; 1 spec. Drobeta-Turnu Severin June 6, 2005 C.C.; 1 spec. Cheile Bistriței August 9, 2005 C.C.
7.	<i>Chlorophorus sartor</i> (MULLER, 1766)	Material examined: 1 spec. Bucovăț July 19, 2001 C.C.
8.	<i>Chlorophorus varius</i> (MÜLLER, 1766)	Material examined: 1 spec. Șimnic July 15, 2004 G.F.; 2 specs. Secui May 26, 2007 C.C., July 12, 2008 C.C.; 2 specs. Iezer Mts. June 27, 2008 N.G.L., C.C.
9.	<i>*Clytus arietis</i> (LINNAEUS, 1758)	Material examined: 2 specs. Secui May 1, 2007 C.C.
10.	<i>*Clytus lama</i> MULSANT, 1847	Material examined: 1 spec. Secui June 6, 2008 C.C.
11.	<i>Clytus rhamni</i> GERMAR, 1817	Material examined: 3 specs. Canarua Fetii June 6, 2008 C.C.
12.	<i>Plagionotus arcuatus</i> (LINNAEUS, 1758)	Material examined: 1 spec. Bugiulești July 25, 2004 A.N.
13.	<i>Plagionotus floralis</i> (PALLAS, 1733)	Material examined: 3 specs. Craiova (Park) June 8, 2004 L.B., G.F., A.V.; 3 specs. Negoii, June 28, 2005 A.V.; 2 specs. Bucovăț July 5, 2005 L.B., G.F.
14.	<i>Xylotrechus antilope</i> (SCHÖNHERR, 1817)	Material examined: 1 spec. Mischii (DJ) June 10, 2004 G.F.
15.	<i>Xylotrechus rusticus</i> LINNAEUS, 1758	Material examined: 1 spec. Secui May 26, 2007 C.C.
	<b>Tribe Hesperophanini</b>	
16.	<i>*Trichoferus fasciculatus</i> (FALDERMANN, 1837)	Material examined: 1 spec. Șimnic June 23, 2007 G.F.; 1 spec. Ciocadia July 5, 2008 L.B.
	<b>Tribe Purpuricerini</b>	
17.	<i>Purpuricenius budensis budensis</i> (GÖTZ, 1783)	Material examined: 1 spec. Răcari August 10, 1999 C.C.; 1 spec. Olănești July 5, 2002 A.N.; 1 spec. Șimnic July 7, 2004 G.F.; 1 spec. Secui June 21, 2009 C.C.
	<b>Tribe Stenopterini</b>	
18.	<i>Stenopterus flavicornis</i> KÜSTER, 1846	Material examined: 2 specs. Turcinești June 10, 1968; 1 spec. Craiova (Botanical Garden) June 19, 1997 G.F.; 1 spec. Craiova July 14, 2001 L.B.; 7 specs. Bucovăț July 19, 2001 C.C., July 5, 2005 G.F., L.B.; 1 spec. Segarcea June 10, 2002 C.C.
19.	<i>Stenopterus rufus</i> (LINNAEUS, 1767)	Material examined: 2 specs. Cheile Sohodolului August 8, 2004 C.C.
	<b>Subfamily LAMIINAE</b>	
	<b>Tribe Acanthocinini</b>	
20.	<i>*Exocentrus punctipennis</i> MULSANT & BUILEBEU, 1856	Material examined: 1 spec. Cheile Sohodolului August 5, 2004 C.C.
21.	<i>Leiopis nebulosus</i> (LINNAEUS, 1758)	Material examined: 1 spec. Craiova May 17, 2008 L.B.
	<b>Tribe Agapanthiini</b>	
22.	<i>*Agapanthia cardui</i> (LINNAEUS, 1767)	Material examined: 3 specs. Craiova (Botanical Garden) May 20, 2008 L.B., May 5, 2009 G.F.; 2 specs. Șimnic May 25, 2009 G.F.
23.	<i>Agapanthia dahli</i> (RICHTER, 1821)	Material examined: 2 specs. Negoii May 27, 1996 A.V., May 22, 2009 A.V.; 12 specs. Craiova (Park) June 24, 2003 G.F., June 8, 2004 A.V., G.F., L.B., 1 spec. May 2, 2008 A.V.
24.	<i>Agapanthia violacea</i> (FABRICIUS, 1775)	Material examined: 1 spec. Bucovăț May 7, 2000 A.V., May 15, 2004; 1 spec. Craiova April 3, 2001 L.B.; 1 spec. Craiova (Botanical Garden) May 5, 2009 G.F.; 2 specs. Secui May 1, 2007 C.C.
25.	<i>Agapanthia villosiviridescens</i> (DEGEER, 1775)	Material examined: 5 specs. Valea Cheii May 30, 2008 C.C.
26.	<i>Calamobius filum</i> (ROSSI, 1790)	Material examined: 2 specs. Bucovăț June 9, 1999 C.C., May 7, 2000 A.V.; 4 specs. Craiova (Park) May 17, 2001 G.F., June 8, 2004 G.F.; 1 spec. Craiova (Botanical Garden) April 29, 2009 L.B.
	<b>Tribe Dorcadiini</b>	
27.	<i>Carinatodorcadion fulvum canaliculatum</i> FISCHER VON WALDHEIM, 1823	Material examined: 11 specs. Huși April 24, 2006 A.V.
28.	<i>Neodorcadion bilineatum</i> (GERMAR, 1824)	Material examined: 4 specs. Craiova (Park) June 8, 2004 A.V., L.B., G.F.; 1 spec. Craiova (Botanical Garden) June 20, 2005 L.B.; 2 specs. Bucovăț July 5, 2005 L.B.; 3 specs. Secui May 20-June 10, 2009 C.C.
29.	<i>Pedestredorcadion murrayi</i> KÜSTER, 1847	Material examined: 1 spec. Huși April 24, 2006 A.V.
30.	<i>Pedestredorcadion pedestre</i> (PODA, 1761)	Material examined: 3 specs. Bucovăț June 13, 2004 A.V.

	<b>Tribe Mesosini</b>	
31.	<i>*Mesosa curculionoides</i> (LINNAEUS, 1761)	<b>Material examined:</b> 1 spec. Bratovoiești August 9, 2008 C.C.
	<b>Tribe Monochamini</b>	
32.	<i>Monochamus sartor</i> (FABRICIUS, 1787)	<b>Material examined:</b> 4 specs. Cheile Sohodolului August 3-4, 2004 C.C.
	<b>Tribe Phytoeciini</b>	
33.	<i>Oberea erythrocephala</i> (SCHRANK, 1776)	<b>Material examined:</b> 3 specs. Răcari June 7, 1998 C.C.
34.	<i>Phytoecia coerulea</i> (SCOPOLI, 1772)	<b>Material examined:</b> 1 spec. Craiova (Botanic Garden) May 4, 2004 A.V.
	<b>Tribe Saperdini</b>	
35.	<i>Saperda carcharias</i> (LINNAEUS, 1758)	<b>Material examined:</b> 1 spec. Cheile Bistriței August 8, 2005 C.C.
36.	<i>*Stenostola ferrea</i> (SCHRANK, 1776)	<b>Material examined:</b> 1 spec. Băile Herculane May 21, 1967 N.S.
	<b>Subfamily LEPTURINAE</b>	
	<b>Tribe Lepturini</b>	
37.	<i>*Leptura aurulenta</i> FABRICIUS, 1792	<b>Material examined:</b> 4 specs. Cheile Sohodolului August 5, 2004 C.C., August 10, 2005 C.C.; 1 spec. Cheile Galbenului August 13, 2005 C.C.
38.	<i>Leptura quadrifasciata</i> LINNAEUS, 1758	<b>Material examined:</b> 1 spec. Cheile Galbenului August 13, 2005 C.C.
39.	<i>Pachytodes cerambyciformis</i> (SCHRANK, 1781)	<b>Material examined:</b> 1 spec. Bociu July 15, 2002 C.G.; 5 specs. Cheile Sohodolului August 3-9, 2004 C.C.; 1 spec. Cheile Galbenului August 13, 2005 C.C.
40.	<i>Pachytodes erraticus</i> (DALMAN, 1817)	<b>Material examined:</b> 23 specs. Bucovăț June 13, 2004, July 5, 2005 A.V., L.B., G.F.
41.	<i>*Paracorymbia maculicornis</i> (DE GEER, 1775)	<b>Material examined:</b> 1 spec. Bociu July 15, 2002 C.G.
42.	<i>Pseudovadonia livida</i> (FABRICIUS, 1776)	<b>Material examined:</b> 6 specs. Segarcea May 16, 2000 L.B., June 10, 2002 C.C.; 6 specs. Craiova (Park) May 17, 2001 L.B., June 8, 2004 L.B., A.V.; 5 specs. Bucovăț July 29, 2001 A.V., June 13, 2004 A.V., July 5, 2005 L.B.; 4 specs. Cheile Sohodolului August 2-7, 2004 N.G.L.; 1 spec. Șimnic June 27, 2005 G.F.; 1 spec. Cheile Bistriței August 8, 2005 C.C.
43.	<i>Rutpela maculata</i> PODA, 1761	<b>Material examined:</b> 13 specs. Cheile Sohodolului August 2-11, 2004, August 10, 2005 C.C., N.G.L.; 7 specs. Cheile Bistriței August 8, 2005 C.C.; 4 specs. Cheile Galbenului August 13, 2003 C.C.
44.	<i>Stenurella bifasciata</i> (MÜLLER, 1776)	<b>Material examined:</b> 1 spec. Craiova (Hanul Doctorului) June 6, 2001 L.B.; 1 spec. Segarcea June 10, 2002 C.C.; 1 spec. Bucovăț June 13, 2004 A.V.; 1 spec. Șimnic June 27, 2005 G.F.
45.	<i>Stenurella melanura</i> (LINNAEUS, 1758)	<b>Material examined:</b> 4 specs. Bociu July 15, 2002 C.G.; 12 specs. Cheile Galbenului August 14, 2003 C.C., August 13-14, 2005 C.C.; 43 specs. Cheile Sohodolului August 7-11, 2004 C.C., August 10-12, 2005 C.C., N.G.L.; 11 specs. Cheile Bistriței August 8, 2005 C.C.
46.	<i>Stenurella septempunctata</i> (FABRICIUS, 1792)	<b>Material examined:</b> 1 spec. Cheile Sohodolului August 11, 2004 C.C.; 1 spec. Cheile Bistriței August 8, 2005 C.C.
47.	<i>*Stictoleptura cordigera</i> (FUESSLY, 1775)	<b>Material examined:</b> 2 specs. Bucovăț July 5, 2005 C.C., A.V.
48.	<i>Stictoleptura rubra</i> (LINNAEUS, 1758)	<b>Material examined:</b> 2 specs. Cheile Galbenului August 14, 2003, August 13, 2005 C.C.; 19 specs. Cheile Sohodolului August 4-10, 2004, August 12, 2005 C.C.; 2 specs. Cheile Bistriței August 8, 2005 C.C.
49.	<i>Stictoleptura scutellata</i> (FABRICIUS, 1781)	<b>Material examined:</b> 18 specs. Cheile Sohodolului August 2-11, 2004 C.C., N.G.L.; 3 specs. Cheile Bistriței August 8, 2005 C.C.
50.	<i>Strangalia attenuata</i> (LINNAEUS, 1758)	<b>Material examined:</b> 1 spec. Șimnic June 27, 2005 G.F.; 2 specs. Bucovăț June 5, 2005 A.V., L.B.
	<b>Tribe Rhagilini</b>	
51.	<i>Cortodera femorata</i> (FABRICIUS, 1787)	<b>Material examined:</b> 3 specs. Segarcea May 16, 2000 A.V.
52.	<i>Dinoptera collaris</i> (LINNAEUS, 1758)	<b>Material examined:</b> 5 specs. Bucovăț May 7, 2000 A.V.
53.	<i>Gaurotes (Carilia) virginea</i> (LINNAEUS, 1758)	<b>Material examined:</b> 1 spec. Bociu July 15, 2002
54.	<i>Pidonia lurida</i> (FABRICIUS, 1792)	<b>Material examined:</b> 2 specs. Segarcea May 16, 2000 L.B.; 1 spec. Bucovăț May 17, 2000 C.C.
	<b>Subfamily PRIONINAE</b>	
	<b>Tribe Prionini</b>	
55.	<i>Prionus coriarius</i> (LINNAEUS, 1758)	<b>Material examined:</b> 2 specs. Straja June 4, 2004 A.V.; 1 spec. Cheile Sohodolului August 9, 2004 C.C.
	<b>Subfamily SPONDYLIDINAE</b>	
	<b>Tribe Asemini</b>	
56.	<i>Arhopalus rusticus</i> (LINNAEUS, 1758)	<b>Material examined:</b> 1 spec. Șimnic June 23, 2007 G.F.
57.	<i>*Tetropium castaneum</i> (LINNAEUS, 1758)	<b>Material examined:</b> 1 spec. Tărtășești June 20, 2005 G.F.
	<b>Tribe Saphanini</b>	
58.	<i>*Saphanus piceus piceus</i> (LAICHTARTING, 1784)	<b>Material examined:</b> 1 spec. Craiova May 23, 2006 L.B.; 3 spec. Șimnic June 23, 2004 G.F., June 1, 2007 G.F., June 15, 2008 G.F.

## RESULTS AND DISSCUSIONS

We had 370 specimens at our disposal for study. A number of 58 species were identified. From the 94 species cited above, only 46 of them were found. (SERAFIM et al., 2004).

The collection has been enriched with 12 species: *Clytus arietis*, *C. lama*, *Trichoferus fasciculatus* (Cerambycinae), *Exocentrus punctipennis*, *Agapanthia cardui*, *Mesosa curculionoides*, *Stenostola ferrea* (Lamiinae), *Leptura aurulenta*, *Paracorymbia maculicornis*, *Stictoleptura cordigera* (Lepturinae), *Tetropium castaneum* and *Saphanus piceus* (Spondylidinae).

*Agapanthia cardui* is reported at Comana (MONTANDON 1906), Pojoga (PANIN & SĂVULESCU 1961), Dorohoi and Vorona (ANDRIESCU 1972), Turceni (BOBÎRNAC et al., 1999). Now, it is reported in Craiova (Botanical Garden) and Șimnic.

For Oltenia, *Mesosa curculionoides* is reported at Gura Văii (Drobeta-Turnu Severin) (TOGĂNEL 2004). In the museum's collection, there is a material from Bratovoiești.

*Stictoleptura cordigera* is reported in Dobroudja (Măcin, Oltina, Băneasa – Canaraua Fetii, Iortmac, Niculițel - Cocoș monastery), from Ilfov County (Ileana, Pasărea fores), Giurgiu County (Comana Forest) (PANIN & SĂVULESCU 1961; SERAFIM 2006) and Mehedinți County (the Iron Gates, the Danube and the Oglânic Valley) (RUICĂNESCU 1992a, b). The species is collected at Bucovăț.

In Romania, *Saphanus piceus piceus* was reported especially in the mountain areas. From Oltenia, it was reported only at Cloșani (MARCU 1928; BOBÎRNAC et al., 1999). In the museum's collection, there is a material from Craiova and Șimnic (Dolj County).

*Calamobius filum* is a rare species in the Romanian fauna, known only in Dobroudja region: Eforie Sud (PANIN & SĂVULESCU 1961) and Agigea (SERAFIM & MAICAN 2004), Oltenia region: Ișalnița and Craiova (SERAFIM et al., 2004), Buzău area: Dealul Balauru, Izvorul Dulce, Beceni (UNGUREANU et al., 2008). The material recently entered in the collection, was collected in Bucovăț and Craiova (in the Park and the Botanical Garden).

The species *Exocentrus punctipennis* has not been reported from Oltenia, until now.

*Exocentrus punctipennis* is a species less known in Romania (PANIN & SĂVULESCU 1961; SERAFIM 1985). It is collected from Cheile Sohodol (Gorj County).

## CONCLUSIONS

The Cerambycidae collection of the Oltenia Museum includes now 1,447 specimens, belonging to 107 species included in 5 subfamilies (Table 2).

Table 2. The distribution of the species of the Museum of Oltenia in subfamilies.  
Tabel 2. Repartizarea speciilor din Muzeul Olteniei pe subfamilii.

Subfamilies	No. of species	%
Cerambycinae	37	34.58
Lamiinae	34	31.78
Lepturinae	31	28.97
Prioninae	2	1.87
Spondylidinae	3	2.80
Total	107	100.00

We consider that new systematic studies in this area are necessary for additional information on the specific fauna and diversity of Cerambycidae of Oltenia.

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## SPECIES OF CERAMBYCIDS (COLEOPTERA: CERAMBYCIDAE), FROM CHEILE BICAZULUI – HĂȘMAȘ NATURAL PARK

GABRIELA GURĂU

**Abstract.** *The paper presents the results of the research concerning the cerambycids fauna from Cheile Bicazului-Hășmaș Natural Park (July 2005). Thus, it has been identified a number of seventeen species (155 specimens), eleven genera, and respectively three subfamilies of Cerambycidae: Lepturinae, Cerambycinae and Lamiinae. This study presents new data about the species of cerambycids from the studied area, the host plants-the data from literature were compared with the field observations. The nomenclature and systematic used in this paper are those published by DANILEVSKY (2003).*

**Keywords:** *Cerambycidae, host plant, biodiversity.*

**Rezumat.** *Specii de cerambycide (Coleoptera: Cerambycidae), din Parcul Natural Cheile Bicazului-Hășmaș. Lucrarea prezintă rezultatele studiilor efectuate în teren, în Parcul Natural Cheile Bicazului-Hășmaș (iulie 2005), cu privire la fauna de cerambycide. Astfel, au fost identificate 17 specii (155 de exemplare), 11 genuri și respectiv trei subfamilii de Cerambycidae: Lepturinae, Cerambycinae și Lamiinae. Sunt prezentate date noi cu privire la speciile de cerambycide din zona studiată, plantele lor gazdă - datele din literatură fiind comparate cu observațiile făcute pe teren. Nomenclatura și sistematica utilizată în lucrare sunt cele publicate de DANILEVSKY (2003).*

**Cuvinte cheie:** *Cerambycidae, plantă gazdă, biodiversitate.*

### INTRODUCTION

The beauty and elegance of their forms, and their biodiversity have made from cerambycids an interesting object of study for scientists since the 18<sup>th</sup> century. In Romania, few scientists choose to study this beautiful group of coleopterans. The majority of papers dedicated to cerambycids present the fauna of the western part of Romania.

Even if in the collection "Romanian Fauna" is published a volume dedicated to cerambycids fauna, the data presented there are until 1965. Therefore, the author considered opportune to study the diversity of cerambycids from Cheile Bicazului-Hășmaș Natural Park.

The paper brings new data about the species of cerambycids from the studied area, their host plants (SANDA et. al., 1997) and their vegetal associations (POPESCU et. al., 1998).

Cheile Bicazului-Hășmaș Natural Park is a protected area, relatively new (instituted by law in 2000), with a surface of 6,575 ha. Cheile Bicazului-Hășmaș Natural Park is situated in the Oriental Carpathians. The Park area reaches over two counties: Harghita and Neamț (Fig. 1). This protected area comprises two areas: special conservation area (78%), and the safety area (22%).

### MATERIAL AND METHODS

The material analysed in this paper was collected directly from the plants. The author considered it the best method for analysing the biodiversity of cerambycids and their host plants.

The nomenclature and systematic used in this paper are those published by DANILEVSKY (2003). The material was identified using *Natura Revista di Scienze Naturali Insetti della Fauna Europea Coleotteri Cerambycidi* (PESARINI & SABBADINI, 1994), and PANIN & SĂVULESCU (1965). In order to study the host plants, the author collected them from the field and identified them with the help of professor PhD. NECULAI BARABAȘ.

### RESULTS AND DISCUSSIONS

The research concerning the diversity of cerambycids from Cheile Bicazului-Hășmaș Natural Park was made in July 2005. The insects were collected from three different locations (representative parts of Cheile Bicazului-Hășmaș Natural Park): Cheile Șugăului, Suhardul Mic and Ucigașul Peak (Fig. 2).

From those locations, there were collected 155 specimens of cerambycids. Analysing the collected individuals in the Laboratory of Entomology from the Natural History Museum "Ion Borcea" Bacău, the author found that, taxonomically, the 155 specimens belong to 17 species included into 11 genera, respectively, from 3 subfamilies of Cerambycidae Family: Lepturinae, Cerambycinae and Lamiinae (Table 1).

In order to observe the diversity of cerambycids from Cheile Bicazului-Hășmaș Natural Park, it was necessary to collect cerambycids from different species of plants. Thus, it was easy to identify the host plants for different species of Cerambycidae.

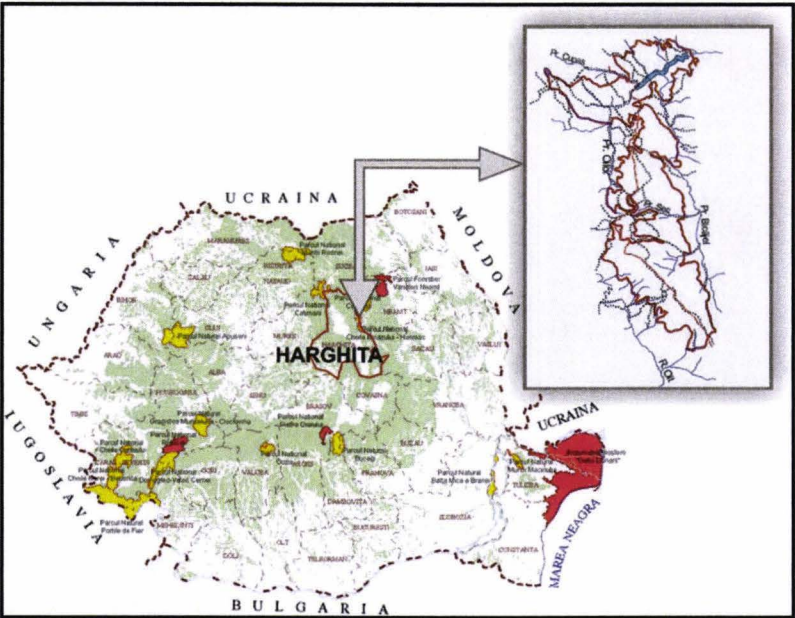


Figure 1. Cheile Bicazului-Hășmaș Natural Park-the geographical location (www.cheilebicazului-hasmas.ro).  
Figura 1. Parcul Natural Cheile Bicazului-Hășmaș-localizarea geografică (www.cheilebicazului-hasmas.ro).



Figure 2. Ucișul Peak-one of the collection sites-images from the field.  
Figura 2. Unul dintre punctele de colectare-Vârful Ucișul-aspecte din teren.

Table 1. Species of cerambycids collected from Cheile Bicazului-Hășmaș Natural Park (July, 2005).  
Tabel 1. Specii de cerambycide colectate din Parcul Natural Cheile Bicazului-Hășmaș (iulie, 2005).

No.	Subfamily	Species	Cheile Șugăului	Suhardul Mic	Ucișul	Total no. specimens
1.	Lepturinae	<i>Rhagium mordax</i> (DEGEER 1775)	1	-	-	1
2.		<i>Pachyta quadrimaculata</i> (LINNAEUS 1758)	1	-	3	4
3.		<i>Carilia virginea</i> (LINNAEUS 1758)	3	23	61	87
4.		<i>Leptura quadrifasciata</i> (LINNAEUS 1758)	-	2	1	3
5.		<i>Leptura maculata</i> (PODA 1761)	3	5	21	29
6.		<i>Pidonia lurida</i> (FABRICIUS 1792)	5	-	-	5
7.		<i>Paracorymbia maculicornis</i> (DEGEER 1775)	1	-	-	1
8.		<i>Corymbia rubra</i> (LINNAEUS 1758)	2	1	-	3
9.		<i>Corymbia scutellata</i> (FABRICIUS 1781)	1	1	-	2
10.		<i>Anastrangalia sanguinolenta</i> (LINNAEUS 1761)	3	3	-	6
11.		<i>Anastrangalia dubia</i> (SCOPOLI 1763)	-	-	1	1
12.		<i>Judolia sexmaculata</i> (LINNAEUS 1758)	-	1	-	1
13.		<i>Stenurella melanura</i> (LINNAEUS 1758)	1	4	2	7
14.		<i>Stenurella nigra</i> (LINNAEUS 1758)	2	-	-	2

15.	Cerambycinae	<i>Callidium violaceum</i> (LINNAEUS 1758)	1	-	-	1
16.	Lamiinae	<i>Agapanthia villosiviridescens</i> (DEGEER 1775)	1	-	-	1
17.		<i>Agapanthia violacea</i> (FABRICIUS 1775)	1	-	-	1
	3	Total	26	40	89	155
		%	16.7	25.8	57.5	100%

In the field the author observed that several species of cerambycids prefer the pollen and reproductive elements of the flowers (such as: *Filipendula vulgaris* MOENCH. and *Leucanthemum vulgare* LAM.) as food sources.

The observations from the field were completed with the data presented in literature. In Table 2, for each species collected from Cheile Bicazului-Hășmaș Natural Park there are mentioned the host plant species-the data from literature and the data from the field-different host plants species.

Table 2. Preferences of cerambycids species collected from Cheile Bicazului-Hășmaș Natural Park for certain host plants.  
Tabel 2. Preferințele speciilor de cerambycide colectate din Parcul Natural Cheile Bicazului-Hășmaș, pentru anumite plante gazdă.

No.	Species	Host plants	
		(Literature)	(Cheile Bicazului-Hășmaș Natural Park)
1.	<i>Rhagium mordax</i> DEGEER	deciduous trees (oak, beech, birch) The bark of the conifers	<i>Quercus petraea</i> LIEBL.
2.	<i>Pachyta quadrimaculata</i> L.	Coniferous, beech flowers of Umbeliferae	<i>Filipendula vulgaris</i> MOENCH.
3.	<i>Carilia virginea</i> L.	Conifers, beech Umbeliferae, composites	<i>Trollius europaeum</i> LINNAEUS 1753, <i>Leucanthemum vulgare</i> LAM.
4.	<i>Leptura quadrifasciata</i> L.	firs from sub mountainous and mountainous regions, beech, coniferous	<i>Leucanthemum vulgare</i> LAM., <i>Filipendula vulgaris</i> MOENCH.
5.	<i>Leptura maculata</i> PODA	Under the bark of sawow, beech, birch, lime and poplar; imago on flowers	<i>Filipendula vulgaris</i> MOENCH.
6.	<i>Pidonia lurida</i> FABR.	deciduous trees (willow, birch, beech, elm, poplar), conifers	<i>Filipendula vulgaris</i> MOENCH., <i>Leucanthemum vulgare</i> LAM., <i>Urtica dioica</i> L., <i>Telekia speciosa</i> BAUMG.
7.	<i>Paracorymbia maculicornis</i> DEGEER	beech, oak, sawow, probably conifers; imago on flowers (especially on the flowers of Umbeliferae)	<i>Leucanthemum vulgare</i> LAM., <i>Filipendula vulgaris</i> MOENCH.
8.	<i>Corymbia rubra</i> L.	Conifers; imago on trunks, on flowers	<i>Filipendula vulgaris</i> MOENCH.
9.	<i>Corymbia scutellata</i> FABR.	oak, beech, chestnut, birch Conifers; imago on trunks, on flowers	<i>Filipendula vulgaris</i> MOENCH. <i>Verbascum</i> sp. L., <i>Urtica</i> sp. L.
10.	<i>Anastrangalia sanguinolenta</i> L.	Conifers, beech; imago on flowers	<i>Leucanthemum vulgare</i> LAM.
11.	<i>Anastrangalia dubia</i> SCOP.	Conifers, beech; imago on flowers	<i>Leucanthemum vulgare</i> LAM.
12.	<i>Judolia sexmaculata</i> L.	in conifers wood, beech; imago on flowers	<i>Filipendula vulgaris</i> MOENCH.
13.	<i>Stenurella melanura</i> L.	deciduous trees, conifers; imago on flowers	<i>Leucanthemum vulgare</i> LAM. <i>Achillea millefolium</i> L. <i>Filipendula vulgaris</i> MOENCH.
14.	<i>Stenurella nigra</i> L.	deciduous trees (oak, beech) Imago on flowers	<i>Filipendula vulgaris</i> MOENCH., <i>Achillea millefolium</i> L.
15.	<i>Callidium violaceum</i> L.	Imago on flowers	<i>Leucanthemum vulgare</i> LAM.
16.	<i>Agapanthia villosiviridescens</i> DEGEER	<i>Angelica sylvestris</i> L., <i>Aconitum</i> L., <i>Cirsium palustre</i> L., <i>C. arvense</i> SCOP., <i>Eupatorium cannabinum</i> L., <i>Heracleum sphondylium</i> L., <i>Senecio aquaticus</i> HUDS., <i>Carduus</i> L., <i>Urtica</i> L.)	<i>Filipendula vulgaris</i> MOENCH.
17.	<i>Agapanthia violacea</i> FABR.	<i>Carduus</i> L., imago on the flowers of <i>Scabiosa</i> L., etc.	<i>Filipendula vulgaris</i> MOENCH.

Analysing the data presented in Table 2, it can be noticed that species like *Stenurella melanura* (LINNAEUS 1758), *Carilia virginea* (LINNAEUS, 1758), *Anastrangalia dubia* (SCOPOLI, 1763) can be found on the same host plants. Also, on the same flowers of *Filipendula vulgaris* MOENCH., the author have found individuals from different species like *Corymbia rubra* (LINNAEUS, 1758) and *Leptura maculata* (PODA, 1761), *Corymbia scutellata* (FABRICIUS, 1781) and *Rhagium mordax* (DE GEER, 1775). For the first time, it is mentioned *Trollius europaeus* L. as host plant species for *Carilia virginea* L. (Fig. 3).

## CONCLUSIONS

1. The seventeen species identified in the researched area are mentioned for the first time for Cheile Bicazului-Hășmaș Natural Park. Thus, the paper brings new data about the diversity of cerambycids from this area.

2. Taxonomically, the cerambycids collected from Cheile Bicazului-Hășmaș Natural Park are included into three subfamilies of Cerambycidae Family (Lepturinae, Cerambycinae, Lamiinae), eleven genera and seventeen species.



3. The paper presents also new data concerning the preferences of cerambicids for certain host plants-the observations from the field were completed with the data from literature. For the first time it is mentioned *Trollius europaeus* L. as a preferred plant for *Carilia virginea* L.



Figure 3. *Carilia virginea* L. on *Trollius europaeus* L.  
Figura 3. *Carilia virginea* L. pe *Trollius europaeus* L.

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## FAUNISTIC DATA ON LEAF BEETLES (COLEOPTERA: CHRYSOMELIDAE) FROM THE PRAHOVA AND THE DOFTANA VALLEYS, ROMANIA

SANDA MAICAN

**Abstract.** This paper presents data regarding the occurrence of leaf-beetles species in some forests phytocoenosis and shrub lands situated on the middle courses of the Prahova and the Doftana rivers, on the basis of the material collected between 2007 and 2008. Until now there were recorded in the researched sites 41 chrysomelid species, belonging to 24 genera and 7 subfamilies: Criocerinae (one species), Clythrinae (4 species), Cryptocephalinae (9 species), Chrysomelinae (15 species), Galerucinae (one species), Alticinae (9 species) and Cassidinae (2 species). In addition, for every species cited in the taxa list, information about the present distribution range and the biology of these species are mentioned. All the identified leaf beetle species are mentioned for the first time in the investigated areas.

**Keywords:** Coleoptera, Chrysomelidae, the Prahova, the Doftana, Romania.

**Rezumat.** Date faunistice asupra crisomelidelor (Coleoptera: Chrysomelidae) de pe Văile Prahovei și Doftanei, România. Lucrarea prezintă date referitoare la prezența crisomelidelor în câteva fitocenoze lemnoase și de tufărișuri situate pe cursurile mijlocii ale râurilor Prahova și Doftana, pe baza unui material colectat în perioada 2007-2008. Până în prezent, în siturile cercetate au fost identificate 41 specii, încadrate în 24 genuri și 7 subfamii: Criocerinae (1 specie), Clythrinae (4 specii), Cryptocephalinae (9 specii), Chrysomelinae (15 specii), Galerucinae (1 specie), Alticinae (9 specii) și Cassidinae (2 specii). Pentru fiecare specie citată în lista taxonomică, sunt prezentate informații referitoare la arealul actual de răspândire și la biologia acestor specii. Toate speciile de crisomelide identificate sunt menționate pentru prima dată în zonele cercetate.

**Cuvinte cheie:** Coleoptera, Chrysomelidae, Prahova, Doftana, România.

### INTRODUCTION

Romania has a remarkable entomofaunistic diversity, due to its considerable territorial area, geomorphologic characteristics and biotopes variety. The taxonomic and faunistic studies are the basis for both the biodiversity evaluation and the management of natural resources.

The Chrysomelidae, commonly known as leaf beetles, is one of the most numerous family of Coleoptera Order (also with Curculionidae and Staphylinidae families), including about 40,000 species in the world fauna. The leaf beetles species have a great adaptive capacity, being found from the oceans coasts to the alpine areas (JOLIVET, 1997).

Chrysomelids are phytophagous coleopterans, strictly specialized on certain species, genera or families of plants. The adults are commonly found on flowers and leaves and the larvae feed on leaves and roots. Many species are important from an economical point of view, being serious pests for forests and agricultural crops.

An updated check-list of the Chrysomelidae from Romania, including 571 species from 82 genera belonging to 13 subfamilies, was published by MAICAN (2005).

### MATERIAL AND METHODS

The present contribution is based on the study of chrysomelid material collected between 2007 and 2008, from 11 sites situated on the middle reaches of the Prahova and the Doftana rivers. Until now, in the Romanian coleopterological literature there is no published information regarding the leaf-beetles fauna from these areas.

Studies were made within the research programs from the Ecology, Taxonomy and Nature Conservation Centre of the Institute of Biology (Bucharest).

Recent data about the biocoenotic differentiation of *Quercus petraea* and of mixed *Quercus petraea* and *Fagus sylvatica* deciduous forests from the lower Doftana Valley (Prahova county) were published by VASILIU-OROMULU et al. (2007-2008).

Also, information concerning the biological diversity of shrub lands dominated by *Salix purpurea* and *Hippophaë rhamnoides* along the collinar floodplain of the Prahova and the Doftana rivers can be found in the paper of PAUCĂ-COMĂNESCU et al. (2008).

#### List of the collecting sites:

- Cornu, Câmpina, Valley of the Prahova river (km 94 on DN1): shrub lands dominated by *Salix purpurea*, 488m altitude (I);
- Nistorești, Valley of the Prahova river (km 98 on DN1): shrub lands dominated by *Hippophaë rhamnoides*, includes in the 3240<sup>th</sup> European Habitats (GAFTA & MOUNTFORD, 2008); 558 m altitude (II);
- Câmpina forestry department, Valley of the Doftana river: *Quercus petraea* forest, included in *Quercus petraea*-*Carpinetum* Soó et Pócs 1957 association, 500 m altitude (III);



- Câmpina forestry department, Valley of the Doftana river: the mixed *Quercus petraea* and *Fagus sylvatica* forest, included in *Petraeo-Fagetum* Scam./1956/1959 association, 500 m altitude (IV);
- Lunca Mare, Valley of the Doftana river: shrub lands dominated by *Salix purpurea*, 437 m altitude (V);
- Teșila, Valley of the Doftana river: shrub lands dominated by *Myricaria germanica* (VI);
- Șotriile, Valley of the Doftana river: *Fagus sylvatica* forest, included in *Hieracio rotundati-Fagetum* (Vida 1963 Tăuber 1987) associations (VII);
- Glodeasa forest, Valley of the Doftana river: mixed *Abies alba* and *Fagus sylvatica* forest (VIII);
- Valea Largă, Posada, Valley of the Prahova river: alluvial vegetation on the right bank of the Prahova river (IX);
- Doftana Gorges, Valley of the Doftana river: pasture under cliff (X);
- Breaza Gorges, Valley of the Prahova river: shrub lands under cliff (XI).

The specimens were collected by the author by means of entomological net, shaking the shrubs and by hand directly from the soil or vegetation. They were determined on the basis of external morphology and of genitalia (aedeagus from males), using the keys of KIPPENBERG & DÖBERL's paper (1994) and WARCHAŁOWSKI's monographies (1985, 1995, 1998, 2003).

The examined material is deposited in the collection of the Institute of Biology, Bucharest.

Subfamilies are ordered according to SEENO & WILCOX (1982). The used nomenclature and systematic are according to WARCHAŁOWSKI (2003).

Information about the general distribution and host plants of the chrysomelid species are presented according to MOHR (1966), WARCHAŁOWSKI (2003) and SASSI (2007).

The systematic presentation of each identified species is accompanied with information regarding biology (the host plants) and the general distribution.

## RESULTS

As a result of faunistic researches made within 2007-2008, in some phytocoenoses situated along the Prahova and the Doftana rivers, 41 leaf beetles species, from 24 genera and 7 subfamilies were recorded.

The taxonomic structure of Chrysomelidae fauna in the investigated sites is presented in the Table 1.

The best represented subfamilies were: Chrysomelinae, generally including meso-hygrophilous species (15 species), followed by Cryptocephalinae and Alticinae (with 9 species each). The other subfamilies have fewer species: Clythrinae (4 species), Cassidinae (2 species), Criocerinae and Galerucinae (with one species each).

The highest number of species was found in the following sites: the shrub lands from Lunca Mare, Valley of the Doftana river (20 species), alluvial vegetation on the right bank of the Prahova river from Valea Largă (16 species) and pasture under cliff from Doftana Gorges, the Doftana Valley (10 species).

In the shrubs dominated by *Salix purpurea* from Lunca Mare, the life cycle of chrysomelids is favoured by the presence of higher number of vegetal species (*Salix purpurea*, *Cornus sanguinea*, *Ligustrum vulgare*, *Alnus incana*, *Populus alba*, *Crataegus monogyna*, *Rubus caesius*), representing the characteristic host plants and trophic basis for certain species and genera of leaf beetles.

*Pachybrachis hippophaeus* SUFFRIAN (whose host plant is *Hippophaë rhamnoides*) was not found in the shrubs dominated by *Hippophaë rhamnoides* from Nistorești.

Among the most important species from a faunistic point of view the following were recorded: *Clytra quadripunctata* LINNAEUS, *Smaragdina flavicollis* CHARPENTIER, *Cryptocephalus quinquepunctatus* SCOPOLI, *Gonioctena linnaeana* (SCHRANK) and *Longitarsus kutscherae* (RYE).

All the chrysomelid species are mentioned for the first time in the investigated areas.

In order to fill in the information about the specific diversity of the Chrysomelidae family from the Prahova and the Doftana river valleys, more systematic studies are necessary in the future.

## CONCLUSIONS

The paper presents faunistic data about the occurrence of 41 species (from 24 genera) of the Chrysomelidae family collected between 2007 and 2008 from some forests phytocoenosis and shrub lands situated on the middle courses of the Prahova and the Doftana rivers, Romania.

The leaf beetles species belong to the following subfamilies: Criocerinae (one species), Clythrinae (four species), Cryptocephalinae (nine species), Chrysomelinae (15 species), Galerucinae (one species), Alticinae (nine species) and Cassidinae (two species).

In addition, for every chrysomelid species cited in the taxa list, information about the present distribution range and the biology of these species are mentioned.

All the leaf beetles species are recorded from the first time in the researched areas.

Table 1. The taxonomic structure of Chrysomelidae fauna in the researched sites.

Tabel 1. Structura taxonomică a faunei de Chrysomelidae în siturile cercetate.

Taxa (subfamily/species)	Collection sites											Host plants	Chorotype/ General distribution
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI		
CHRYSOMELIDAE													
CRIOCERINAE													
<i>Oulema melanopus</i> (LINNAEUS, 1758)					.			.				Poaceae ( <i>Agropyron</i> , <i>Lolium</i> , <i>Dactylis</i> , <i>Avena</i> , <i>Hordeum</i> )	West Palaearctic
CLYTHRINAE													
<i>Clytra quadripunctata</i> (LINNAEUS, 1758)					.					.		Betulaceae ( <i>Betula</i> ), Rosaceae ( <i>Crataegus</i> , <i>Prunus</i> ), Salicaceae ( <i>Salix</i> ), Fagaceae ( <i>Quercus</i> )	Euro-Siberian
<i>Labidostomis longimana</i> (LINNAEUS, 1761)					.							Fabaceae ( <i>Lotus</i> , <i>Trifolium</i> ), Brassicaceae	Turanic- European
<i>Smaragdina flavicollis</i> (CHARPENTIER, 1825)					.							Betulaceae ( <i>Alnus glutinosa</i> ); probably monophagous	European
<i>Smaragdiuna salicina</i> (SCOPOLI, 1763)								.				Rosaceae ( <i>Crataegus</i> ), Salicaceae ( <i>Salix</i> )	European
CRYPTOCEPHALINAE													
<i>Cryptocephalus bipunctatus</i> (LINNAEUS, 1758)										.		Salicaceae, Betulaceae, Corylaceae, Rosaceae, Fagaceae, Fabaceae; polyphagous	Euro-Siberian
<i>Cryptocephalus flavipes</i> FABRICIUS, 1781					.							Salicaceae, Betulaceae, Fagaceae, Corylaceae, Cistaceae; polyphagous	Europe, Asia Minor, Caucasus, South Russia, Central Asia east to Altai
<i>Cryptocephalus frenatus</i> LAICHARTING, 1781									.			Betulaceae ( <i>Alnus</i> ), Salicaceae ( <i>Salix</i> )	European
<i>Cryptocephalus hypochoeridis</i> (LINNAEUS, 1758)					.							Ranunculaceae ( <i>Ranunculus</i> )	European
<i>Cryptocephalus moraei</i> (LINNAEUS, 1758)									.			Guttiferae ( <i>Hypericum</i> ); oligophagous	Euro-Siberian
<i>Cryptocephalus ocellatus</i> DRAPIEZ, 1819					.				.			Salicaceae ( <i>Salix</i> , <i>Populus</i> ), Corylaceae ( <i>Corylus</i> ), Fagaceae ( <i>Quercus</i> ), Betulaceae ( <i>Betula</i> , <i>Alnus</i> ), Ulmaceae ( <i>Ulmus</i> ); polyphagous	Turanic- European
<i>Cryptocephalus quinquepunctatus</i> (SCOPOLI, 1763)									.			Salicaceae ( <i>Salix</i> ), Betulaceae ( <i>Alnus</i> )	Central-European (mostly mountains and submountains)
<i>Cryptocephalus parvulus</i> MÜLLER, 1776									.			Betulaceae, Salicaceae, Fagaceae, Corylaceae, Rosaceae; polyphagous	European (excepting Mediterranean Subregion but occurs in Corsica, and Sardinia), from North Spain to South Russia, Central Asia, East Siberia, Japan
<i>Pachybrachis sinuatus</i> (MULSANT, 1859)					.	.			.	.		Tamaricaceae ( <i>Myricaria germanica</i> ), Salicaceae ( <i>Salix</i> )	Europe, Asia Minor

Taxa (subfamily/species)	Collection sites											Host plants	Chorotype/ General distribution
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI		
CHRYSOMELINAE													
<i>Gonioctena linnaeana</i> (SCHRANK, 1781)										.	.	Salicaceae ( <i>Salix</i> )	Europe, from North Spain and Norway to Sakhalin, South to Mongolia
<i>Gonioctena pallida</i> (LINNAEUS, 1758)										.		Rosaceae ( <i>Sorbus aucuparia</i> )	European
<i>Linaeidea aenea</i> (LINNAEUS, 1758) [syn: <i>Plagiosterna aenea</i> LINNAEUS, 1758]				.	.		.	.	.			Betulaceae ( <i>Alnus</i> )	Euro-Siberian
<i>Phaedon cochleariae</i> (FABRICIUS, 1792)									.			Brassicaceae ( <i>Nasturtium officinale</i> , <i>Rorippa</i> , <i>Armoracia</i> , <i>Brassica</i> , <i>Sinapis</i> ), <i>Veronica beccabunga</i>	Euro-Central Asian
<i>Chrysolina fastuosa</i> (SCOPOLI, 1763)										.	.	Lamiaceae ( <i>Galeopsis</i> , <i>Lamium</i> )	Euro-Asian
<i>Chrysolina herbacea</i> (DUFTSCHMID, 1825)					.			.	.	.	.	Lamiaceae ( <i>Mentha</i> , <i>Marrubium</i> , <i>Calamintha</i> )	European
<i>Chrysolina polita</i> LINNAEUS, 1758					.							Lamiaceae ( <i>Mentha</i> , <i>Nepeta</i> , <i>Melissa</i> , <i>Origanum</i> , <i>Lycopus</i> , <i>Salvia</i> , <i>Glechoma</i> )	Euro-Siberian
<i>Chrysomela populi</i> LINNAEUS, 1758				.								Salicaceae ( <i>Populus</i> , <i>Salix</i> )	Euro-Asian; India (GRUEV & TOMOV, 1986)
<i>Chrysomela tremula</i> FABRICIUS, 1787				.								Salicaceae ( <i>Salix</i> )	from Ireland to Kamchatka
<i>Chrysomela saliceti</i> SUFFRIAN, 1849	.	.		.	.							Salicaceae ( <i>Salix</i> )	from France to Mongolia
<i>Chrysomela vigintipunctata</i> (SCOPOLI, 1763)										.		Salicaceae ( <i>Salix</i> , <i>Populus</i> )	Euro-Asian
<i>Plagiodera versicolora</i> (LAICHARTING, 1781)		.										Salicaceae ( <i>Salix</i> , <i>Populus</i> )	Holarctic
<i>Phratora tibialis</i> (SUFFRIAN, 1851)	.	.			.							Salicaceae ( <i>Salix</i> )	Europe, Asia Minor
<i>Gastrophysa viridula</i> (DE GEER, 1775)					.	.	.	.	.	.		Polygonaceae ( <i>Rumex</i> , <i>Polygonum</i> , <i>Oxyria</i> )	Holarctic
<i>Timarcha rugulosa</i> HERRICH-SCHAEFFER, 1838										.			South-eastern Poland, Ukraine, Slovakia, Moldavia, South Carpathians, Romania
GALERUCINAE													
<i>Galerucella pusilla</i> DUFTSCHMID, 1825					.							Lythraceae ( <i>Lythrum salicaria</i> )	West Palaearctic
ALTICINAE													
<i>Aphtona flava</i> GUILLEBEAU, 1895						.		.				Euphorbiaceae ( <i>Euphorbia</i> )	North Italy, Romania, Moravia, South Ukraine, basin of Danube, Croatia, Serbia, Bulgaria, Asia Minor; introduced in Canada and U.S.A.
<i>Aphtona venustula</i> (KUTSCHERA, 1861)					.							Euphorbiaceae ( <i>Euphorbia</i> )	European

Taxa (subfamily/species)	Collection sites											Host plants	Chorotype/ General distribution
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI		
<i>Chaetocnema chlorophana</i> (DUFTSCHMID, 1825)	.											Poaceae, Juncaceae, Cyperaceae	Mediterranean Subregion, Central Europe, Asia Minor, Caucasus
<i>Crepidodera aurata</i> (MARSHAM, 1802)					.				.	.		Salicaceae ( <i>Salix</i> , <i>Populus</i> )	Palearctic
<i>Longitarsus kutscherae</i> (RYE, 1872)					.								Palearctic
<i>Neocrepidodera ferruginea</i> (SCOPOLI, 1763)					.			.				Poaceae, Fabaceae, Polygonaceae, Urticaceae, Asteraceae, Boraginaceae	European
<i>Neocrepidodera transversa</i> (MARSHAM, 1802)						.	.					Asteraceae ( <i>Cirsium</i> )	European
<i>Phyllotreta tetrastigma</i> (COMOLLI, 1837)									.			Brassicaceae ( <i>Rorippa</i> , <i>Cardamine</i> , <i>Nasturtium</i> )	Euro-Siberian
<i>Sphaeroderma testaceum</i> (FABRICIUS, 1775)					.					.		Asteraceae ( <i>Carduus</i> , <i>Cirsium</i> )	European
<b>CASSIDINAE</b>													
<i>Cassida vibex</i> LINNAEUS, 1767		.										Asteraceae ( <i>Cirsium</i> , <i>Carduus</i> , <i>Centaurea</i> , <i>Arctium</i> , <i>Tanacetum</i> , <i>Achillea</i> )	Euro-Siberian
<i>Cassida viridis</i> LINNAEUS, 1758			.			.	.	.	.			Lamiaceae ( <i>Stachys</i> , <i>Salvia</i> , <i>Mentha</i> , <i>Galeopsis</i> , <i>Lycopus</i> ); hygro- mesophilous	Euro-Asian

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## MACROLEPIDOPTERA SPECIES CHARACTERISTIC FOR THE MONTANE, SUBALPINE AND ALPINE LEVELS OF THE MASSIFS SITUATED IN HUNEDOARA COUNTY (ROMANIA)

SILVIA BURNAZ

**Abstract.** The author presents *Macrolepidoptera* species (Ord. *Lepidoptera*) characteristic for the montane, subalpine and alpine levels of the mountains situated on the territory of Hunedoara County (Romania). The study is based on data published by Romanian entomologists and by personal researches effectuated in Retezat, Șureanu, Parâng (Southern Carpathians), Poiana Ruscă and Metaliferi Mountains (Western Carpathians). Some endemic species and subspecies were recorded from these mountains: *Coenonympha rhodopenis*, *Erebia cassioides neleus*, *Glacies coracina dioszeghyi* and *Apamea maillardi carpatobrunnea*.

**Keywords:** *Macrolepidoptera*, mountainous, subalpine, alpine, levels, Hunedoara County, Romania.

**Rezumat.** Specii de *Macrolepidoptere* caracteristice etajelor montan, subalpin și alpin din masive aflate pe teritoriul județului Hunedoara. Autorul prezintă speciile de *Macrolepidoptere* (Ord. *Lepidoptera*) caracteristice etajelor montan, subalpin și alpin din masive montane situate pe teritoriul județului Hunedoara. Studiul este bazat pe datele publicate de entomologi români și pe cercetările personale efectuate în Munții Retezat, Șureanu, Parâng (Carpații Meridionali), Poiana Ruscă și Metaliferi (Carpații Occidentali). Câteva specii și subspecii endemice, au fost identificate în acești munți: *Coenonympha rhodopenis*, *Erebia cassioides neleus*, *Glacies coracina dioszeghyi* și *Apamea maillardi carpatobrunnea*.

**Cuvinte cheie:** *Macrolepidoptera*, montane, subalpin, alpin, etaje, județul Hunedoara, România.

### INTRODUCTION

Hunedoara County is situated in the western part of Romania and in the south-western part of Transylvania. It is crossed by the Mureș River from East to West. In its northern part, there are located the Metaliferi and Zarand Mountains (the Apuseni Mountains). In the southern part of the Mureș River, a large surface is occupied by the Retezat Mountains and a part of the Țarcu-Godeanu, Șureanu and Parâng Mountains (Southern Carpathians). The eastern part of the Poiana Ruscă Mountains (Western Carpathians) is also situated in Hunedoara County. The relief of the county is especially mountainous, but almost all the mountains border large depressions and couloirs as Hațeg, Brad and Petroșani Depressions and the Strei and the Mureș Couloirs. The hydrography of Hunedoara County is represented by the Mureș River, the Crișul Alb River and the Strei River.

The Retezat Mountains (Southern Carpathians) cover a surface of 800 km<sup>2</sup> and have more than 30 peaks. Among them we mention Retezat (2,484 m alt.), Peleaga (2,509 m) and Păpușa (2,502 m alt.). In the mountainous and subalpine levels, there are spread more than 80 natural glacial lakes. In 1935, the National Park of Retezat Mountains (38,047 ha) was created in order to protect the natural ecosystems, flora and fauna of these mountains.

The Șureanu Mountains (Southern Carpathians) are situated on the territory of Hunedoara and Alba Counties. In the south-eastern part of Hunedoara County, these mountains are characterized by the presence of a large surface of calcareous zones. Here, The Natural Park of Grădiștea Muncelului-Cioclovina was set up in 1979 and later legislated by the Decision of the Romanian Government no. 230/2003. The natural park covers an area of 38,000 ha.

The Parâng Mountains are situated in the southern part of Hunedoara County, being a part of the mountain group Parâng-Șureanu-Lotrului Mountains. The highest peak is Parângu Mare (2,518 m altitude). The total area is about 1,100 km<sup>2</sup>.

The Metaliferi Mountains and Zarand Mountains (Western Carpathians), situated in the northern part of the Mureș River, are characterized by calcareous and volcanic rocks. In the calcareous area, spectacular gorges crossed by the tributaries of the Mureș River are situated. The altitude is between 500 m and 1,000 m.

The Poiana Ruscă Mountains (Western Carpathians) are located on the territory of Hunedoara, Caraș and Timiș Counties. They are considered as a linking bridge between the Apuseni Mountains and the Southern Carpathians. The total area of these mountains is 2,640 km<sup>2</sup>. The altitude oscillates between 700 m and 1,000 m.

Studies about the *Lepidoptera* fauna of the mountainous massifs of Hunedoara County have been published by different authors. DIÓSZEGHY (1929-1930, 1933-1934), KÖNIG (1959, 1969), BURNAZ & KÖNIG, (1984) have published data about the *Lepidoptera* fauna of the Retezat Mountains. 680 species of *Macrolepidoptera* have been recorded from the mountainous, subalpine and alpine levels of the Retezat Mountains (RÁKOSY, 1993a, 1997). Some very rare species as *Abrostola agnorista*, *Conisania poelli*, *Colostigia aqueata*, *C. collariaria*, *Yezognophos anderregaria*, *Baptria tibilae*, *Parexarnis fugax*, *Hydraecia petasitis vindelica* and *Apamea sicula syriaca* were recorded from the Retezat Mountains. 729 species were recorded from the natural habitats of the Șureanu Mountains (BURNAZ, 2008). Some rarities as *Coscinia cribraria pannonica*, *Gortyna borelli lunata*, *Endromis versicolora*, *Tyria jacobaeae*, *Pseudochropleura musiva*, *Xestia castanea*, etc. were recorded in these mountains. 206 species were recorded from the Parâng Mountains (RÁKOSY, 1995). In the limestone and volcanic areas of the Poiana Ruscă Mountains a number of

104 Rhopalocera species was recorded (BURNAZ, 2000). *Lycaena helle* was recorded from two sites of these mountains (the Cerna Valley and the Dobra Valley). 302 species were recorded especially from the limestone areas of the Metaliferi Mountains (BURNAZ, 1992). Data about ecological, biological and zoogeographical aspects the Macrolepidoptera fauna of Hunedoara County have been published by BURNAZ (2002, 2006).

## MATERIAL AND METHODS

Personal researches about the Macrolepidoptera species characteristic to the mountainous, subalpine and alpine levels have been conducted between 1985 and 2008.

The specimens have been collected in various sites specific to the mountainous, subalpine and alpine levels of the massifs:

- Ponorici-Cioclovina - a limestone area located in the western part of the Șureanu Mountains (900 m altitude);
- Crivadia Gorges - a limestone area situated in the southern part of the Șureanu Mountains (500-700 m altitude);
- Bănița Gorges and Bolii Hill (904 m) - a limestone area situated in the southern part of the Șureanu Mountains. It represents a couloir between Hațeg and Petroșani Basins;
- Godeanu Valley - Anineș, close to the fortress of Sarmizegetusa Regia; In this area, the coniferous and mixed forests are predominant;
- The Hill of Grădiștea Muncelului and Sarmizegetusa Regia (1,200 m altitude). Deciduous forests and especially beech forests are present;
- Godeanu Mountain (1,656 m) in the central part of the Șureanu Mountains;
- Mada Gorges - a limestone protected area situated in the southern part of the Metaliferi Mountains; the maximum altitude is in the Pleșa Mare Hill (712 m);
- Crăciunești Gorges - a limestone protected area situated in the Metaliferi Mountains;
- Ribicioara and Uibărești Gorges - two protected areas situated in the northern part of the Metaliferi Mountains;
- Cerna Gorges - a protected area situated in the eastern part of the Poiana Ruscă Mountains, near Hunedoara town;
- Muncelu Valley and Muncelu Hill (1149 m) situated in the northern part of the Poiana Ruscă Mountains;
- Gura Zlata Chalet - situated at 775 m altitude in the Retezat Mountains. It is one of the principal route to the National Park of the Retezat Mountains;
- Cărnic Chalet - situated at 1005 m altitude, on the Nucșoara Valley (the Retezat Mountains);
- Pietrele Chalet - situated at 1480 m altitude in the Retezat Mountains;
- Gemelele - scientific reserve situated at 1780 m altitude in the National Park of the Retezat Mountains.

Samples were made using the entomological net for the butterflies and a light trap (250 Watt) for the nocturnal species.

Species recorded by Diószeghy Ladislau and Frederic König, especially from the habitats of the Retezat Mountains (Berhina, Radeș, Slăvei and other sites), are also presented. The specimens collected by these entomologists and our lepidopterological material are kept in the entomological collection of Deva Museum.

## RESULTS AND DISCUSSIONS

Lepidoptera species have optimal conditions of their life-cycle development in the habitats of Hunedoara County. Based on personal researches and published papers of other Romanian entomologists we may highlight the diversity of the Lepidoptera species characteristic of the mountainous, subalpine and alpine stages of Hunedoara County. Especially, the Retezat, Șureanu, Poiana Ruscă, Parâng and Metaliferi Mountains have been researched. But some mountainous areas as the Vulcan and the Tarcu-Godeanu are less known concerning the Macrolepidoptera fauna.

In Hunedoara County and especially in the area of the mountains, various phytosociological formations are preferred or characteristic habitats for Macrolepidoptera communities.

A large surface of the Retezat, Șureanu, Poiana Ruscă, Parâng and Metaliferi Mountains is occupied by beech forests (As. *Carpino-Fagetum* PAUCĂ, 1941 and As. *Symphyto cordati-Fagetum silvaticae* VIDA, 1959) that are spreading between 500 m-700 m and 1,200 m altitude. Coenoses of As. *Phylitidi-Fagetum* VIDA (1959) 1963 are widespread in Ponorici-Cioclovina limestone area and also in the Gorges of Crivadia, Bănița and Taia (the Șureanu Mountains). A lot of species such as *Ennomos autumnaria*, *E. fuscantaria*, *E. erosaria*, *Campaea margaritata*, *Cyclophora albipunctata*, *Phalera bucephala*, *Stauropus fagi*, *Amphipyra perflua*, *Pseudoips prasinana*, *Acronicta aceris*, *A. tridens*, *Polia nebulosa*, *Colocasia coryli*, *Calliteara pudibunda*, *Endromis versicolora*, *Aglia tau*, *Falcaria lacertinaria* have a preference for this type of habitats. These species are related in their larval stage to *Fagus sylvatica*, *Carpinus betulus*, *Betula pendula* and other deciduous trees.

Mixed forests with beech, spruce and fir trees occupy large areas of the upper limit of beech forests, in the Retezat, Parâng, Șureanu and Poiana Ruscă Mountains. This type of forests is spread at 800 m-1,200 m altitude but in some areas the forests climb up to 1,400 m. The coenoses are represented by *Pulmonario rubrae-Abietum-Fagetum*

SOÓ, 1964, *Chrysanthemo rotundifolio-Piceo-Fagetum* SOÓ, 1964, VIDA, 1959 and *Leucanthemo waldsteinii-Piceo-Fagetum* SOÓ, 1964 associations. In these phytosociological formations we meet both species characteristic to deciduous forests and coniferous one. *Odontopera bidentata*, *Plemysia rubiginata*, *Chloroclysta siterata*, *C. truncata*, *Trichopteryx carpinata*, *Endromis versicolora*, *Nododonta dromedarius*, *Amphipyra pyramidea*, *Polia trichoma* and *Arctornis l-nigrum* were identified in mixed forests.

The coniferous forests have the greatest extension in the Retezat Mountains (1,200 m-1,850 m altitude), but they are also widespread in the Șureanu Mountains (in the area of the Godeanu Valley) and the Parâng Mountains. Spruce fir forests are represented by As. *Hieracio rotundati-Piceetum* BR.-BL. et TX. 1939 (alt. 1500-1600 m) and (As. *Bruckenthalio-Piceetum* BORHIDI 1969 (alt. 1750 m-1850 m); Some mono and oligophagous species as *Macaria signaria*, *M. liturata*, *Peribatodes secundaria*, *Deileptenia ribeata*, *Hylaea fasciaria fasciaria*, *Puengeleria capreolaria*, *Thera variata*, *T. obeliscata*, *Panolis flammea*, *Panthea coenobita*, *Hyloicus pinastri*, *Alcis jubata jubata*, *Dendrolimus pini montana* and *Cosmotriche lunigera* are typical for these ecosystems.

Meadows are spread in all the mountainous area of the Retezat, Parâng, Șureanu, Poiana Ruscă and Metaliferi Mountains. Coenoses of *Scorzonero roseae-Festucetum nigricantis* (PUȘCARIU et al. 1956) COLDEA, 1987 and *Violo declinatae-Nardetum* SIMON, 1966 associations are spread at 1000 m-1200 m altitude in the Retezat, Parâng and Șureanu Mountains. In the area of beech and spruce fir forests, instead the cut forests, *Fectuco rubrae-Agrostietum capillaris* HORV., 1951, *Poo-Trisetetum flavescens* KNAPP, 1951 and *Anthoxantho-Agrostietum capillaris* SILLINGER 1933 associations are spread. Characteristic of mesophyllous meadows are *Scopula immorata*, *Idaea biselata*, *I. emarginata*, *Scotopteryx chenopodiata*, *Xanthorhoe fluctuata*, *Perizoma minoratum minoratum*, *Minoa murinata*, *Hemaris fuciformis fuciformis*, *Parasemia plantaginis carpathica*, *Diachrysia chryson chryson*, *Paradrina clavipalpis*, *Photodes captiuncula*, *Hada nana nana*, *Cerapteryx gramminis gramminis*, *Neuronia decimalis*, *Lasionycta proxima*, *Noctua pronuba*, *Autographa gamma*, *Diachrysia chrysis*, *Agrotis segetum*, *A. exclamationis* and *A. ipsilon*.

Flowery plants of these meadows are nectar source for various species of butterflies as *Erynnis tages tages*, *Colias croceus*, *C. hyale*, *Pieris napi napi*, *P. rapae*, *Boloria dia dia*, *Boloria e.*, *B. selene*, *Melanargia galathea*, *Erebia aethiops aethiops*, *Coenonympha arcania*, *C. glycerion glycerion*, *Argynnis adippe*, *A. niobe niobe*, *Issoria lathonia*, *Erebia euryale syrmyia* and *Polyommatus icarus*.

Subalpine and alpine meadows (As. *Violo declinatae-Nardetum strictae* SIMON, 1966, As. *Potentillo chrysocraspedae-Festucetum airoidis* BOȘCAIU, 1971 and As. *Primulo-Caricetum curvulae* BR.-BL. 26 em. OBERD., 59) are spread in the Retezat, Parâng and Șureanu Mountains. Some species of Macrolepidoptera as *Apamea lateritia*, *A. maillardi carpatobrunnea*, *A. rubrireana*, *Erebia euryale syrmyia*, *E. gorge frederickoenigi*, *E. pandrose roberti* and *E. epiphron transsylvanica* are characteristic for subalpine meadows. They are related to various Poaceae as trophic source for their larvae. Some of these species as *Erebia pandrose roberti* and *E. gorge frederickoenigi* have been also identified in alpine meadows. Other species as *Scotopteryx chenopodiata*, *Hada nana*, *Leucania comma*, *Noctua fimbriata*, *Xestia speciosa*, *Papestra biren*, *Gnophos obfuscatus* were also identified in the subalpine meadows.

Subalpine shrubs (As. *Rhododendro myrtifolii-Pinetum mugii* BORZA, 1959 em COLDEA, 1985, As. *Vaccinio-Pinetum mugii* HADAC, 1956, JENK, 1961 and As. *Rhododendro myrtifolii-Vaccinietum* BORZA, (1955, 1959) are spreading in the subalpine level of the Retezat, Parâng and Șureanu Mountains at 1650 m-1950 m altitude.

Species of Macrolepidoptera have been identified in the habitats of subalpine shrubs of the Retezat and Șureanu Mountains. The community of Macrolepidoptera is represented by species characteristic for subalpine level as *Apamea maillardi carpatobrunnea*, *Thera variata*, *Scopula ternata*, *Xestia speciosa*, *Lasiocampa quercus f. alpina*, *Xanthorhoe montanata*, *Hydriomena impluviata*, *Rheumaptera hastata*, *Eupithecia tenuiata*, *Aplocera plagiata*, *Cleorodes lichenarius*, *Peribatodes secundaria*, *Puengeleria capreolaria*, *Elophos vittarius mendicarius*, *Parasemia plantaginis carpathica*, *Polia trichoma*, *Diarsia mendica mendica*, *D. brunnea brunnea*, *Eurois occultus*, *Hypena proboscidalis*, *Anaplectoides prasina*. *Erebia euryale syrmyia*, *E. epiphron transsylvanica*, *E. pandrose roberti* are very common in June-July. The adults of these species visit especially the flowers of *Vaccinium myrtillus* and *Rhododendron myrtifolium*.

Macrolepidoptera communities specific to the habitats of mountainous rocks were studied especially in the limestone area of the Șureanu Mountains. Here, the vegetation is represented by *Asplenio-Cystopteridetum fragilis* OBERD. (1939, 1949), *Melico-Phleetum montani* BOȘCAIU et al., 1966 and *Asperulo capitatae-Seslerietum rigidae* (ZOLY 1939) COLDEA 1991 (at the Ponorici-Cioclovina Karst Complex, Crivadia Gorges, Taia Gorges and Bănița Gorges). The diversity of the mono and dicotyledonata herbaceous plants and shrubs as well as the favourable local climate offer optimal conditions for a rich and various Lepidoptera species. In these ecosystems we have identified 335 Macrolepidoptera species. Most of them are spread only in limestone habitats as *Polymixis rufocincta*, *Xestia ashworthii candelarum*, *Sideridis lampra*, *Triphosa sabaudia*, *Orthostixis cribraria*, *Coscinia cribraria pannonica* *Scopula incanata*, *Ochroleptura musiva musiva*, *Chersotis multangula*, *Xestia castanea*, *Hadena perplexa perplexa*, *Episema glaucina glaucina*, *H. compta*, *H. albimacula*, *H. perplexa perplexa*, *Pachetra sagittigera*. Some of these species as *Coscinia cribraria pannonica*, *Xestia ashworthii candelarum*, *Polymixis rufocincta* have also been identified by RÁKOSY (1993) in the calcareous area of the Retezat Mountains. Flowers of Dicotyledonata species are visited by *Zerynthia polyxena*, *Polyommatus coridon coridon*, *P. daphnis*, *Scoliantides orion lariana* and *P. bellargus*. But the mountainous rocks situated in the crystalline area of the Șureanu Mountains also offer optimal conditions for Macrolepidoptera species. In the habitats situated on the southern slopes of the mountains *Thetidia smaragdaria*,

*Scopula nigropunctata*, *S. marginipunctata*, *S. rubiginata*, *Chlorissa cloraria*, *Thalera fimbrialis*, *Idaea ochrata*, *I. trigeminata*, *I. straminata*, *Scotopteryx moeniata*, *Entephria flavicinctata* *flavicinctata*, *Anticlea badiata*, *Nebula salicata* *salicata*, *N. tophaceata*, *N. nebulata*, *Euphyia scripturata*, *Perconia strigillaria*, *Hyles lineata* *livornica*, *Eilema lurideolum*, *Spiris striata*, *Arctia villica*, *Phragmatobia caesarea*, *Dysauxes ancilla*, *Cryphia fraudatricula*, *C. muralis*, *Calymma communimacula*, *Euchalcia modestoides*, *Cucullia asteris*, *Shargacucullia lychnitis*, *Calophasia lunula*, *Hoplodrina superstes*, *Apamea lithoxilea*, *A. anceps*, *Calamia tridens tridens*, *Hecatera bicolorata*, *Hadena luteago* and *Heliophobus reticulata* *reticulata* have been identified.

In the Metaliferi Mountains and especially in the Gorges of Mada, Crăciunești, Ribicioara and Uibărești, *Zerynthia polyxena*, *Euphydryas maturna partiensis*, *E. aurinia aurinia*, *Polyommatus coridon coridon*, *P. daphnis*, *Scoliantides orion lariana* and *P. bellargus* are widespread.

Characteristic of subalpine and alpine rocks of the Șureanu, Retezat and Parâng Mountains are *Psodos canaliculata schwingenschussi*, *Gnophos obfuscatus obfuscatus*, *Erebia pandrose roberti*, *E. gorge fredericikoenigi* and *E. epiphron transsylvanica*. In the Retezat Mountains, endemic taxa are spread: *Glacies coracina dioszeghyi* and *E. cassioides neleus*.

Subalpine hygrophilous meadows (As. *Sphagnetum magellanici* MALCUIT, 1928) are isolated in the Retezat and Șureanu Mountains. Characteristic of these meadows are *Hyppa rectilinea*, *Leucania comma*, *Papestra biren*, *Mnyotipe adusta* and *Syngrapha interrogationis interrogationis*.

In the valleys of the mountain rivers, coenoses of alder trees and various Salicaceae are widespread. As. *Alnetum viridis* (RUBEL) BR.-BL., 1918 and As. *Acereto-Ulmetum* BEGER, 1922 were identified on the Godeanu Valley, between Anineș and Grădiștea de Munte localities (Șureanu Mountains). Here, *Tethea ocularis*, *T. or or*, *Gastropacha populifolia*, *Poecilocampa populi*, *Laothoe populi*, *Stegania dilectaria*, *Pheosia tremula*, *Cerura vinula*, *C. erminea*, *Furcula furcula forficula*, *Clostera anastomosis*, *Acronicta megacephala*, *Scoliopteryx libatrix*, *Xanthia icterita*, *X. ocellaris*, *Agrochola lota*, *Leucoma salicis* find optimal conditions for their life-cycle.

The checklist presents some taxa recorded from the mountainous, alpine and subalpine levels of the mountain massifs of Hunedoara County. The specimens are kept in the collection of Deva Museum.

## LASIOCAMPIDAE

*Cosmotriche lunigera* (ESPER, 1784): 2♂♂ Grădiștea Muncelului-the Godeanu Valley (the Șureanu Mts.), July 25, 1995, leg. Burnaz (Fig. 1). This species is characteristic for coniferous forests and it is rare in the Șureanu Mountains. It was also recorded in the Retezat and Parang Mountains (RÁKOSY, 1993, 1995, 1997). The adults fly in June-August. The larvae feed on *Pinus*, *Picea* and *Abies*. In Central Europe it has become rare during recent decades.

## ENDROMIDAE

*Endromis versicolora versicolora* (LINNAEUS, 1758): 2♂♂ Grădiștea Muncelului (the Șureanu Mts.), May 15, 1994, leg. Burnaz (Fig. 2). It is a rare species characteristic of deciduous forests. Adults fly in April-May. Female are nocturnal but males can be observed during the day. The larvae feed on *Betula*, *Alnus*, *Tilia*, *Fagus*, *Corylus*.

## SPHINGIDAE

*Hyloicus pinastri* (Linnaeus, 1758): 3♂♂ Ponorici-Cioclovina Karst Complex (the Șureanu Mts.), July 14, 1999, leg. Burnaz. The adults fly in a single generation in May-July and prefer the edge of the coniferous forests. The larvae feed on *Pinus* sp.

## PAPILIONIDAE

*Parnassius mnemosyne transsylvanica* SCHMIDT, 1930: 5♂♂, 2♀♀, the Godeanu Valley (the Șureanu Mts.) June 8, 1989; 3♂♂, Mada Gorges May 29, 1990; 2♂♂, Crivadia Gorges (the Șureanu Mts.), June 27, 1997; 4♂♂ 1♀, Muncelu Hill (Poiana Ruscă Mts.), June 24, 2007; 3♂♂, 1♀ Crăciunești Gorges June 14, 2008, leg. Burnaz (Fig. 3). It is a Carpathian endemite, common in the the Retezat, Parâng, Metaliferi, Șureanu and Poiana Ruscă Mountains. Adults fly in May-August and prefer wet meadows, the edge of the deciduous and coniferous forests and subalpine grasslands. The larvae feed on Papaveraceae (*Corydalis* sp.).

## NYMPHALIDAE

*Erebia epiphron transsylvanica* REBEL, 1908: 3♂♂ Retezat Mts., August 3, 1927, leg. Diószeghy; Gura Zlata (Retezat Mts.), July 29, 1978, July 27, 1979, leg. König; 3♂♂ Gemenele Scientific Reserve (the Retezat Mts.), August 24, 1985; 5♂♂ Cârnic (the Retezat Mts.), July 24, 1995, leg. Burnaz. This subspecies is a Carpathian endemite. It is very common in the Retezat Mountains, Parâng and Șureanu Mountains. The adults fly in July and August in montane and subalpine meadows. The larvae feed on Poaceae.

*Erebia medusa psodea* (HÜBNER, 1804). 3♂♂ Bănița Gorges (Șureanu Mts.) July 17, 1986; 5♂♂ Taia Gorges (the Șureanu Mts.) July 19, 1989; 6♂♂, 2♀♀ Muncelu Hill (the Poiana Ruscă Mts.), July 17, 2008, leg. Burnaz. This species is very common at a low altitude (600-1,000 m) in all the mountainous area of Hunedoara County. The adults fly in July-August in damp meadows but they also prefer the edge of the deciduous forests. The larvae feed on Poaceae.

*Erebia gorge frederickoenigi* VARGA, 1999 – 3♂♂ Gemenele (the Retezat Mts.), July 22, 1991, leg. Burnaz. It is an endemic subspecies found only at the highest altitude of the Retezat, Parâng and Șureanu Mountains, in subalpine and alpine rocks with mesophilous vegetation. Adults fly in July. The larvae feed on various Poaceae. In the Red List of the butterflies of Romania it is listed as a vulnerable taxon (RÁKOSY, 2003).

*Erebia pandrose roberti* PESCHKE, 1929: 2♂♂ the Retezat Mts., July 13, 1921, leg. Diószeghy; 2♂♂ Slăvei (Retezat Mts.), July 21, 1972, August 3, 1980, leg. König; 3♂♂, 1♀ Gemenele (the Retezat Mts.), July 25, 1991, leg. Burnaz; 1♂, 1♀ Retezat Peak, July 24, 1991, 1,900 m, leg. Șuster, det. Burnaz. It is a boreo-alpine subspecies common in Southern and Western Carpathians. Adults fly in July and the first decade of August in subalpine and pastures, up to 2,000 m. The larvae feed on Poaceae.

*Erebia cassioides neleus* FREYER, 1844: 2♂♂ Radeș (the Retezat Mts.), July 18, 1979, leg. König; 3♂♂, 1♀, the Retezat Mts., Gemenele, August 20, 1985; 3♂♂ Godeanu Mt. (the Șureanu Mts.), July 18, 1994, leg. Burnaz. It is an endemic species localized in the western part of the Southern Carpathians, especially in the Retezat and Țarcu-Godeanu Mountains. The adults fly in July-August in subalpine meadows and shrubs. The larvae feed on Poaceae (*Festuca* sp.).

*Erebia sudetica radnaensis* (REBEL, 1915): 4♂♂ Retezat Mts., July 30, 1927, leg. Diószeghy; 5♂♂ Berhina (Retezat Mts.), July 28, 1978, leg. König; 3♂♂ Pietrele (Retezat Mts.), July 18, 1995, leg. Burnaz. It prefers montane and subalpine meadows. The adults fly in July-August. The larvae feed on Poaceae. This subspecies is a Carpathian endemite, spread in the Southern and Eastern Carpathians (SZÉKELY, 2008).

*Coenonympha rhodopensis rhodopensis* ELWES, 1900: 2♂♂, 1♀ Radeș (the Retezat Mts.), July 19, 1979, leg. König. The adults fly in June-August in mesophilous grassy meadows, at 1,400 m altitude and up to 2,000 m. The larvae feed on Poaceae. This species has a restricted area, recorded from our country only of the Retezat Mountains. It was also recorded from the central part of Italy, ex. Yugoslavia and Bulgaria (RÁKOSY, 1993 b, SZÉKELY, 2008).

## GEOMETRIDAE

*Bupalus piniaria* (LINNAEUS, 1758): 2♂♂ Godeanu Valley (the Șureanu Mts.). It is a rare species characteristic for coniferous forests. In this area of the Șureanu Mountains it is a relative rare species. The adults fly in June. The larvae feed on *Pinus* sp.

*Cleorodes lichenaria* (HUFNAGEL, 1767): 1♂ Ponorici-Cioclovina (the Șureanu Mts.). This species is rare in the Șureanu Mountains. The adults fly at the edge of the forests but also prefer rocks habitats. The fly period is June-August. Larvae are lichenophagous.

*Deileptenia ribeata* (CLERCK, 1759): 4♂♂, 1♀ the Godeanu Valley (the Șureanu Mts.), August 3, 1998, leg. Burnaz. This is a very common species that inhabits deciduous and coniferous forests. The adults fly in June-August. The larvae feed on *Picea* and *Abies*.

*Peribatodes secundaria* (DENIS & SCHIFFERMÜLLER, 1775): 3♂♂ the Godeanu Mt. (the Șureanu Mts.), July 14, 1999. It inhabits in the area of coniferous forests. The food plants of larvae include *Picea* and *Abies*.

*Hylaea fasciaria fasciaria* (LINNAEUS, 1758): 6♂♂, 1♀ the Godeanu Valley-Anineș (the Șureanu Mts.) August 18, 1984; 8♂♂ Gura Zlata (the Retezat Mts.) July 29, 1985; Cărníc (the Retezat Mts.) August 22, 1995, leg. Burnaz. It is a mountain species, very common in the level of the coniferous forests. The adults fly in June-August. The larvae feed on Pinaceae.

*Puengeleria capreolaria* (DENIS & SCHIFFERMÜLLER, 1775): 4♂♂ the Godeanu Valley-Anineș (the Șureanu Mts.), July 18, 1994; 1♂ Grădiștea Muncelului (the Șureanu Mts.), July 24, 1998, leg. Burnaz. It is a common species in the level of the coniferous species and mixed forests. The adults fly in June-August. The larvae feed on Pinaceae.

*Gnophos obfuscata obfuscata* (DENIS & SCHIFFERMÜLLER, 1775): 1♂ Gemenele (the Retezat Mts.), August 19, 1985; 1♂ Pietrele (Retezat Mts.), August 20, 1995, leg. Burnaz. This taxon is characteristic for montane and subalpine rocks. The adults fly in July-August. The larvae feed on various herbaceous plants.

*Glacies coracina diószeghyi* (SCHMIDT 1930). 1♂ the Retezat Mts., Slăvei, August 3, 1980, leg. König. This is an endemic taxon widespread in Retezat Mountains. The adults fly in June-July in the area of subalpine rocks. The larvae feed on *Empetrum nigrum*.

*Glacies canaliculata schwingenschussi* WEHRLI, 1919: 2♂♂ Godeanu Mt. (the Șureanu Mts.), 1,650 m, July 28, 1999, leg. Burnaz. It is an endemic subspecies of Carpathians and a boreo-alpine element. The adults fly in June-July especially in the area of subalpine rocky habitats. The larvae feed on *Pedicularis* sp.

*Elophos vittarius mendicarius* (HERRICH-SCHÄFFER, 1852): 2♂♂ the Șureanu Mts. (Godeanu Mt.) July 20, 1995, leg. Burnaz. The adults fly in July and prefer subalpine rocks. The larvae are polyphagous and feed on various herbaceous plants and Ericaceae.

*Scopula ternata* (SCHRANK, 1802): 3♂♂ Godeanu Mt. (the Șureanu Mts.), July 19, 1995, leg. Burnaz. It is characteristic for the subalpine level. The adults fly in July-August and prefer shrubs area and mesohygrophilous meadows. The larvae feed on Ericaceae.



*Colostygia olivata* (DENIS & SCHIFFERMÜLLER, 1775): 1 ♂ the Godeanu Mt. (the Șureanu Mts.), July 19, 1995, leg. Burnaz. This species is characteristic for montane and subalpine meadows. The larvae feed on various herbaceous plants.

*Thera stragulata* (HÜBNER, 1809): 1 ♂ the Godeanu Valley (the Șureanu Mts.), July 19, 1995. It is a rare species in the area of the Șureanu Mountains. It occurs in the level of the coniferous forests. Larvae feed on Pinaceae.

## NOCTUIDAE

*Hypena obesalis* (TREITSCHKE, 1829): 3 ♂♂ Cârnic (the Retezat Mts.), August 22, 1995, leg. Burnaz. It occurs in the montane and subalpine levels. The adults fly in July-August in mesophilous meadows. The larvae feed on various herbaceous plants as *Urtica* and *Lamium* sp.

*Autographa iota* (LINNAEUS, 1758): 2 ♂♂ Grădiștea Muncelului (the Șureanu Mts.), July 22, 1999, leg. Burnaz. This is a rare species in the area of montane and subalpine levels of the Șureanu Mountains. The adults fly in June-July. The larvae feed on *Urtica* and other herbaceous plants.

*Syngrapha interrogationis interrogationis* (LINNAEUS, 1758). It is a very common taxon that occurs in all the Carpathian Mountains, in the area of montane and subalpine meadows. The adults fly in June-August. The larvae feed on Ericaceae.

*Apamea maillardi carpatobrunnea* RÁKOSY, 1996 – This subspecies has been described by RÁKOSY (1996) on the basis of the specimens collected in the Parâng, Retezat and Făgăraș Mountains; 1 ♂ Retezat Mts., Berhina, July 26, 1975, 2 ♂♂ Retezat, Gura Apei July 28, 1979, July 27, 1979, leg. König; 4 ♂♂, 2 ♀♀ the Șureanu Mts. (Godeanu Mt.) July 27, 1997, leg. Burnaz (Fig. 4). It is a montane-subalpine subspecies. The adults fly in June-September and prefer mesophilous subalpine pastures. The larvae feed on *Poa alpina*, *Nardus stricta* and *Molinia caerulea* (RÁKOSY 1996).

*Apamea lateritia* (HUFNAGEL, 1766): 2 ♂♂ Godeanu Mt. (the Șureanu Mts.), July 25, 1996, leg. Burnaz. It is a xeromontane species. The adults fly in montane-subalpine grassy meadows, in June-August. The larvae feed on Poaceae (RÁKOSY 1996).

*Pseudochroleura musiva* (HÜBNER, 1803): 2 ♂♂ Ponorici-Cioclovina (the Șureanu Mts.) July 22, 1998, leg. Burnaz. It is a xeromontane species. The adults fly in July-August in limestone rocks and grasslands. The larvae feed on various herbaceous plants.

*Pseudochroleura flammata flammata* (DENIS & SCHIFFERMÜLLER, 1775): 4 ♂♂, 1 ♀, Ponorici-Cioclovina (the Șureanu Mts.), July 25, 2000, leg. Burnaz. It is a xerothermophilous species that prefers open grasslands and the edge of the forests. The adults fly in July-August. The larvae feed on various herbaceous plants.

*Eurois occulta* (LINNAEUS, 1758): 3 ♂♂ Cârnic (the Retezat Mts.), August 22, 1995, leg. Burnaz; 2 ♂♂ the Godeanu Mt. (the Șureanu Mts.), July 28, 1999, leg. Burnaz. This species is characteristic for montane and subalpine shrub associations. The adults fly in July-August. The larvae feed on Ericaceae.

*Xestia speciosa* (HÜBNER, 1813): 3 ♂♂ Berhina (the Retezat Mts.), July 21, 1978, July 27, 1978, July 28, 1978, 1 ♀ July 28, 1978, leg. König; 5 ♂♂, 1 ♀ the Șureanu Mts. (Godeanu Mt.), July 24, 1995, leg. Burnaz. It is a boreo-montane species very common in the montane-subalpine level. The adults fly in July-August. The larvae feed on various herbaceous plants and shrubs as *Vaccinium*, *Lonicera*, etc. (RÁKOSY 1996).

*Xestia ashworthii candelarum* (STAUDINGER, 1871): 2 ♂♂ Mada Gorges (Metaliferi Mts.), July 19, 1992; 2 ♂♂ Ponorici-Cioclovina Karst Complex (the Șureanu Mts.), at 900 m altitude, July 24, 1998, leg. Burnaz. This species is characteristic for limestone grasslands. The adults fly in June-August. The larvae feed on various herbaceous plants. It extends throughout Europe from Scandinavia to Turkey and the Caucasus, Russia, but is very localised.

*Xestia castanea* (ESPER, 1798): 2 ♂♂ Ponorici-Cioclovina (the Șureanu Mts.), July 22, 1994, leg. Burnaz. It is a xerothermophilous species characteristic for the habitats of rocks with xerophile vegetation. The adults fly in June-August. Larvae feed on various herbaceous plants.

*Xestia collina* (BOISDUVAL, 1840): 1 ♂, 2 ♀♀ the Godeanu Mt. (the Șureanu Mts.), July 25, 1996. This species is found in montane and subalpine mesohygrophilous meadows. The adults fly in June-August. The larvae feed on various herbaceous plants and Ericaceae.

## PANTHEIDAE

*Panthea coenobita* (ESPER, 1785). 4 ♂♂, 1 ♀ the Godeanu Valley (the Șureanu Mts.), July 23, 1995, leg. Burnaz. This very common species is characteristic for the habitats of coniferous forests. The adults fly in June-July. The larvae feed on Pinaceae.

## ARCTIIDAE

*Parasemia plantaginis carpathica* (DANIEL, 1939): 6 ♂♂ the Godeanu Valley, July 17, 1994; 5 ♂♂ Grădiștea Muncelului June 25, 1995, leg. Burnaz. This is a Carpathian endemite. The male adults are diurnal and they are not attracted to light. They prefer the edge of the forests, montane and subalpine meadows. The flight period is June-July.

The larvae feed on various herbaceous plants and shrubs as *Vaccinium myrtillus*, *V. uliginosum*, *Polygonum* spp., *Rumex* spp., *Plantago* ssp.

## CONCLUSIONS

The research conducted in the habitats of montane, subalpine and alpine levels of the Carpathian Mountains situated on the territory of Hunedoara County emphasizes the diversity of the Macrolepidoptera fauna. But some mountainous areas as the Vulcan and Țarcu-Godeanu Mountains are less known concerning the Macrolepidoptera fauna. Therefore, future research must be conducted in these mountains.

*Apamea maillardi carpatobrunnea*, *Erebia cassioides neleus*, *E. gorge fredericikoenigi*, *Parnassius mnemosyne transsylvanica*, *Glacies coracina dioszeghyi* and other Carpathian endemites must be protected together with their characteristic habitats. Some of them as *Erebia pandrose roberti*, *E. cassioides neleus*, *E. gorge fredericikoenigi* are listed as vulnerable in the Red List of the butterflies of Romania. On the basis of our personal researches, especially in the Șureanu Mountains, there were recorded rare species as *Cosmotriche lunigera*, *Endromis versicolora versicolora*, *Thera stragulata*, *Xestia castanea*, *Pseudochropleura musiva*.

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Figure 1. *Cosmotriche lunigera* (ESPER, 1784)-♂  
Figura 1. *Cosmotriche lunigera* (ESPER, 1784)-♂

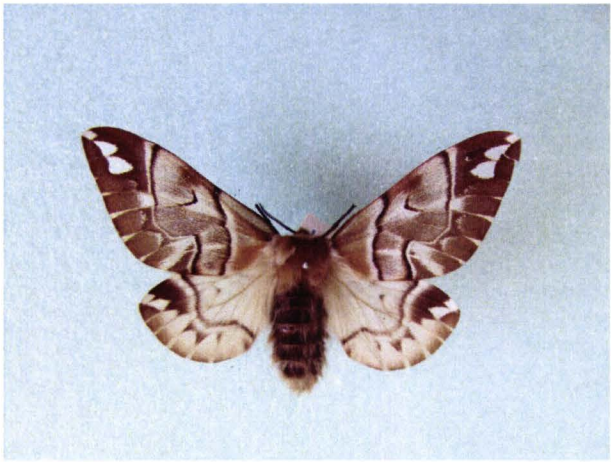


Figure 2. *Endromis versicolora versicolora* (LINNAEUS, 1758)-1♀  
Figura 2. *Endromis versicolora versicolora* (LINNAEUS, 1758)-1♀



Figure 3. *Parnassius mnemosyne transylvanica* SCHMIDT, 1930-♂  
Figura 3. *Parnassius mnemosyne transylvanica* SCHMIDT, 1930-♂



Figure 4. *Apamea maillardi carpatobrunnea* RÁKOSY, 1996-♂  
Figura 4. *Apamea maillardi carpatobrunnea* RÁKOSY, 1996-♂

## THE CHIRONOMIDAE DIVERSITY IN LENTHIC AND LOTHIC ECOSYSTEMS FROM NORTH DOBROUDJA, ROMANIA

VICTORIA TATOLE

**Abstract.** The Chironomidae taxonomic diversity from nine different aquatic ecosystems in Northern Dobroudja is analyzed comparatively. The stations were: Smârdan Arm, Sulucului Valley, Pojârâta Brook, Luncavița Pond, Telincea Lake, Alba River, Babadag Lake, Taița Dam Lake and Sărat Lake. The presented results were obtained processing the 36 samples collected in 2005 and 2006. 22 macrotaxa of aquatic invertebrates were identified. For each station the relative abundances were calculated; the amphipods and chironomids proving to be the dominant groups. The taxonomic diversity of the chironomids was established by the 125 identified taxa: 4 families, 2 tribes, 39 genera, 19 subgenera and 61 species; among them the representatives of the Chironominae subfamily are clearly dominant. The taxonomic structure is thoroughly analyzed, emphasizing the similarities and differences among stations and in the same time establishing the structural configuration in relation to the ecological characteristics. The diversity of the Chironomidae fauna was estimated by calculating the Shannon-Wiener (H) diversity and Lloyd-Gheraldi (E) equitability indices.

**Keywords:** Chironomidae, aquatic invertebrates, taxonomic research, Northern Dobroudja.

**Rezumat.** Diversitatea chironomidelor în ecosisteme lentice și lotice din Dobrogea de Nord, România. Este analizată comparativ diversitatea taxonomică a chironomidofaunei în nouă ecosisteme acvatice de tip diferit din Dobrogea de Nord, și anume: brațul Smârdan, Valea Sulucului, pârâul Pojârâta, balta Luncavița, lacul Telincea, râul Alba, lacul Babadag, lacul de acumulare Taița și lacul Sărat. Rezultatele au fost obținute prin prelucrarea unui număr de 36 de probe, prelevate în anii 2005 și 2006. S-au identificat 22 de macrotaxoni de nevertebrate acvatice. Pentru fiecare stație sunt calculate abundențele relative, evidențiindu-se crustaceele-amfipode și dipterele-chironomide, ca macrotaxoni dominanți. Diversitatea taxonomică a chironomidelor este definită prin cei 125 de taxoni, reprezentați prin 4 subfamilii, 2 triburi, 39 de genuri, 19 subgenuri și 61 de specii, între care domină net reprezentanții subfamiliei Chironominae. Este analizată în detaliu structura taxonomică, evidențiindu-se asemănările și deosebirile pe stații și totodată stabilită configurația structurii chironomidofaunei în funcție de caracteristicile ecologice. S-a calculat diversitatea chironomidofaunei cu ajutorul indicelui de diversitate, Shannon-Wiener (H) și echitabilitatea Lloyd-Gheraldi (E).

**Cuvinte cheie:** Chironomidae, nevertebrate acvatice, cercetări taxonomice, Dobrogea de Nord.

### INTRODUCTION

The data were collected in the frame of the project "Assessment of aquatic, terrestrial and ecotonal fauna from Northern Dobroudja". The project, part of the thematic plan of the "Grigore Antipa" National Museum of Natural History, aims to update and complete the existing taxonomical information, thus creating a base for the protection, monitoring and sustainable management of the area.

A short history of the area reveals that intensive studies took place in Crapina-Jijila, the Danube flooding zone, in the '60 by a research team coordinated by Acad. N. Botnariuc. The research comprised also the study of chironomids, larvae and adults, the obtained data being published in a significant number of papers, among which the following worth mentioning: ALBU, 1964; ALBU, 1980; TATOLE, 2003.

### MATERIAL AND METHODS

Three field trips were made in May and September 2005 and July 2006, the following nine ecosystems in Northern Dobroudja being investigated (Fig. 1):

1. **Smârdan Arm** – component of the Old Danube; the station was placed halfway between Smârdan and Măcin. Riverbed about 40 m wide, bordered by willows and poplars; shallow water; rich organic detritus; aquatic vegetation represented mainly by *Nephrodium thelypteris*, *Lemna minor*, *Ceratophyllum demersum*.

2. **Sulucului Valley** – looking like a brook; narrow valley, about 0.50-0.70 m; relatively low flow, with drained sectors; alternating stony sandy-muddy riverbed; completely transparent water.

3. **Pojârâta Brook** – station in a forested area, about 1.5 km away from the Forestry Office; about 1-1.5 m wide; pond-like; low flow; muddy water, no transparency; compact riverbed, sparsely with small stones. Amphipods visibly dominant.

4. **Luncavița Pond** – covered by vegetation; 10-20 cm deep; substratum formed by coarse sand, small stones.

5. **Telincea Lake** – placed between Isaccea and Tulcea, is part of Niculițel-Parcheș lacustrine complex (GĂTESCU, 1971); it is a puddle with a surface of about 140 ha, linked to other similar water bodies; significantly covered by floating reeds; used for fishing and tourism.

6. **Alba River** – the station was located upstream of Alba village; variable width, with sectors of about 0.80-1.5 m and others of 3-5 m wide; steep banks, covered in grass, bushes; relative rapid flow; substratum variable: pebbles, clay, mud; low water temperature. Amphipods visibly dominant.

7. **Babadag Lake** – open areas alternating with reeds (excessively developed at the end of the lakes); shallow waters, about 0.60-0.80 m; sandy-muddy substratum; low transparency, high level of suspensions and detritus.

8. **Taița Lake** – dam lake on the Taița River; shallow littoral water, about 0.40 m; covered by vegetation: *Potamogeton crispus*, *P. pusillus*, *Ceratophyllum demersum*, etc.; sandy-muddy substratum, relatively hard.

9. **Sărat Lake** – placed between Greci and Măcin localities, it is a permanent lake, the same type as Greci and Murighiol lakes, but with a lower chloride-sodium-magnesium salinity, comparing to the other elements of the complex (GĂȘTESCU, 1971), it is considered today a recreation lake; salt marsh vegetation present, *Salicornia herbacea*; the samples were collected near the shore, towards Măcin; shallow water.

A number of 36 samples were collected. The sampling was done using a Haveneau type hydrobiologic net with a surface of 0.500 m<sup>2</sup>.

The relative abundances were calculated both for all the aquatic invertebrates identified in each of the nine stations, and for the chironomid fauna.

The Shannon-Wiener (H') diversity was calculated, using the formula:

$$H' = - \sum p_i \ln (p_i),$$

where: H' = the Shannon-Wiener Index

p<sub>i</sub> = the relative abundance of the species

(TATOLE, 2004).

Because the variation domain of the SHANNON-WIENER (H') index is between [0, +∞), for standardization the use of the LLOYD-GHERALDI (E) equitability index is recommended, its variation domain being [0, - 1]. The calculation formula is:

$$E = H'/\ln S,$$

where: E = the index of evenness (equitability)

H' = the Shannon-Wiener Index

S = total number of identified species

(TATOLE, 2004).

The Fam. Chironomidae taxa (larvae) was identified using the following references: ASHE & CRANSTON, 1990; BOTNARIUC & CURE, 1999; CHERRNOVSKIJ, 1949; PANKRATOVA, 1970, 1977, 1983; WIEDERHOLM, 1983; SAETHER & SPIES, 2004.

## RESULTS AND DISCUSSIONS

### The taxonomic structure of invertebrate fauna

In the nine studied aquatic ecosystems from Northern Dobroudja the following groups were identified: Turbellaria; Nematoidea; Oligochaeta; Hirudinea; Mollusca; Crustacea: Mysidacea, Amphipoda, Copepoda, Ostracoda; Insecta: Heteroptera, Odonata, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera and from Diptera: Ceratopogonidae, Liriopidae, Simuliidae, Chironomidae and Tabanidae (Table 1; Fig. 2).

Table 1. The relative abundance of the invertebrate taxa.  
Tabel 1. Abundența relativă a macrotaxonilor de nevertebrate.

Taxa	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
Turbellaria	2.75	2.95	4.46	2.88	0	7.45	0	0	0
Nematoidea	0	0	0	0	6.17	0	0	0	0
Oligochaeta	10.44	0	7.59	0	33.33	0	6.6	0	6
Hirudinea	1.09	0	0	0	0	0	0	0	0
Mollusca	10.99	0	3.57	3.85	29.63	2.39	0	2.67	0
Mysidacea	0	0	0	0	0	0	3.29	19.46	0
Amphipoda	0	67.65	62.5	0	0	51.66	10.99	0	0
Copepoda	1.65	0	0	0	0	0	0	0	0
Cladocera	34.06	0	0	0	0	0	0	4.22	0
Ostracoda	0	0	0	0	14.82	2.08	0	0	36
Heteroptera	0	0	0	17.31	0	0	24.18	20.99	0
Odonata	0	0	0	2.88	0	0	0	1.91	0
Ephemeroptera	12.64	0	10.27	0	0	21.33	0	0	0
Plecoptera	0	20.57	2.23	0	0	3.32	0	0	0
Coleoptera	0	0	2.23	6.73	0	0	3.29	7.63	0
Trichoptera	0	0	1.79	0	0	3.88	0	0	0
Ceratopogonidae	0	0	0	0	3.7	0	0	1.14	0
Liriopidae	0	0	1.34	0	0	0	0	0	0
Simuliidae	0	0		0	0	2.49	0	0	10
Chironomidae	26.38	8.83	2.68	66.35	12.35	5.4	51.65	41.98	48
Tabanidae	0	0	1.34	0	0	0	0	0	0



The number of macrotaxa per station, in a descending order is: 11 in Pojărâta Brook, 9 in the Alba River, 8 in Smârdan Arm and Taița Lake, 6 in Luncavița Pond and Babadag Lake, 5 in Telincea Lake, and 4 in Sulucului Valley and Sărat Lake.

Considering the relative abundances presented in Table 1, the representation level of the different aquatic invertebrate groups identified in the studied ecosystems differentiate itself in three categories, as follows:

- **Dominant** are the amphipods in Sulucului Valley (67.65%), Pojărâta Brook (62.5%), the Alba River (51.66%) and the chironomids in Luncavița Pond (66.35%), Babadag Lake (51.65%), Sărat Lake (48%) and Taița Lake (41.98%);
- **Intermediate values** comprised between 36.0% and 10.0% were registered for the following groups: oligochaets and mollusks in Telincea Lake and Smârdan Arm; mysids in Taița Lake; amphipods in Babadag Lake, cladocerans in Smârdan Arm; ostracods in Sărat and Telincea lakes; heteropterans in Babadag and Taița lakes and in Luncavița Pond; ephemeropterans in Alba River, Pojărâta Brook and Smârdan Arm; plecopterans in Sulucului Valley; simuliids in Sărat Lake; chironomids in Smârdan Arm and Telincea Lake;
- **Low values**, below 10%, have registered the turbellarians, nematods, hirudineans, copepods, odonates, coleopterans, trichopterans, ceratopogonids, simuliids and tabanids in all the stations where they were identified, and all the other groups in the stations not mentioned above.

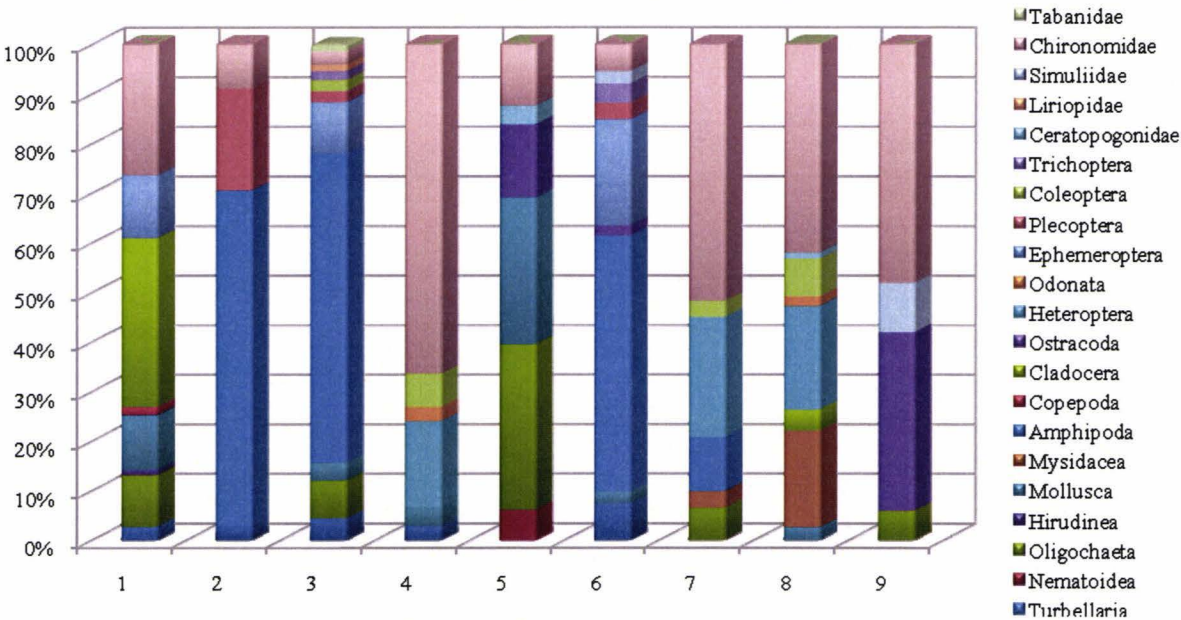


Figure 2. The relative abundance of the identified aquatic invertebrate groups.  
Figura 2. Abundența relativă a grupelor de nevertebrate acvatice identificate.

Characterization of the Chironomidae fauna

Fam. Chironomidae exhibits a high taxonomic diversity (REISS, 1977). In larval stages, the chironomids are characterized by a high ecological plasticity, being able to inhabit any type of aquatic ecosystem, and face even strongly anthropized environmental conditions. Thus, they are widely distributed and in the same time dominant in most ecosystems, representing over 50% of the benthic macroinvertebrates. The chironomids communities are used as indicators of the biocoenotic succession, classification of lakes trophicity, water quality etc. (COFFMAN et al., 1966; KRUGLOVA, 1977; SAETHER, 1979).

As already mentioned, chironomids were identified in all the nine studied ecosystems, being one of the dominant groups, along with the amphipods.

In the nine aquatic ecosystems from Northern Dobroudja, the taxonomic diversity is represented by 125 taxa: 4 subfamilies, 2 tribes, 39 genera, 19 subgenera and 61 de species (Table 2).

Table 2. The list of the Chironomidae taxa identified and their relative abundances.  
Tabel 2. Lista taxonilor aparținând fam. Chironomidae identificați și abundențele lor relative.

Taxa	Station	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
<b>SUFAM. PRODIAMESINAE</b>										
<i>Prodiamesa olivacea</i> (MEIGEN, 1818)		2.08								
<b>SUBFAM. TANYPODINAE</b>										
<i>Ablabesmyia</i> ( <i>Ablabesmyia</i> ) <i>longistyla</i> FITTKAU 1962			11.1				12.82			
<i>Ablabesmyia</i> ( <i>Ablabesmyia</i> ) <i>phatta</i> (EGGER 1863)			11.1							
<i>Anatopynia plumipes</i> (FRIES. 1823)				16.67						
<i>Clinotanypus nervosus</i> (MEIGEN, 1818)		6.25								
<i>Clinotanypus pinguis</i> (LOEW. 1861)							17.95			

Taxa	Station	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
<i>Labrundinia longipalpis</i> (GOETGHEBUER. 1921)		4.17					7.69			
<i>Monopelopia tenuicalcar</i> (KIEFFER. 1918)			22.2							
<i>Procladius (Holotanypus) choreus</i> (MEIGEN 1804)			11.1	16.67	11.59	20	10.26	6.38	4.50	
<i>Tanypus (Tanypus) kraatzi</i> (KIEFFER 1912)					7.25					
<i>Tanypus (Tanypus) punctipennis</i> MEIGEN 1818								6.38		
<i>Tanypus (Tanypus) vilipennis</i> (KIEFFER 1918)								6.38		
<i>Thienemannimyia lentiginosa</i> (FRIES. 1823)							15.38			
<b>SUBFAM. ORTHOCLADIINAE</b>										
<i>Corynoneura celeripes</i> WINNERTZ 1852		12.5								
<i>Corynoneura scutellata</i> WIENNERTZ. 1846		6.25								
<i>Cricotopus (Cricotopus) algarum</i> (KIEFFER 1911)									1.80	
<i>Cricotopus (Cricotopus) bicinctus</i> (MEIGEN 1818)									7.21	
<i>Cricotopus (Cricotopus) flavocinctus</i> (KIEFFER 1924)						10		8.51		
<i>Cricotopus (Cricotopus) fuscus</i> (KIEFFER 1909)									0.90	
<i>Cricotopus (Cricotopus) tibialis</i> (MEIGEN 1804)		4.17								
<i>Cricotopus (Isocladius) sylvestris</i> (FABRICIUS 1794)										16.67
<i>Limnophyes minimus</i> (MEIGEN 1818)									7.21	
<i>Metriocnemus (Metriocnemus) eurynotus</i> (HOLMGREN 1883)							17.95			
<i>Metriocnemus scirpi</i> (KIEFFER. 1899)		6.25				30				
<i>Nanocladius (Nanocladius) dichromus</i> (KIEFFER 1906)									2.70	
<i>Orthocladius (Orthocladius) rubicundus</i> (MEIGEN 1818)		2.08	22.2							
<i>Psectrocladius (Psectrocladius) psilopterus</i> (KIEFFER 1906)									5.40	
<b>SUBFAM. CHIONOMINAE</b>										
<b>TRIBE CHIRONOMINI</b>										
<i>Chironomus (Camptochironomus) pallidivittatus</i> EDWARDS 1929					21.74			10.64		8.33
<i>Chironomus (Chironomus) plumosus</i> (LINNAEUS 1758)									6.31	
<i>Chironomus (Chironomus) annularius</i> MEIGEN 1818								6.38	1.80	
<i>Chironomus (Chironomus) anthracinus</i> ZETTERSTEDT 1860										12.5
<i>Chironomus (Chironomus) riparius</i> MEIGEN 1804					10.15			8.51		8.33
<i>Chironomus (Lobochironomus) dorsalis</i> MEIGEN 1818		8.33							12	
<i>Cryptochironomus albofasciatus</i> (STAEGER. 1839)								6.38	7.21	
<i>Cryptochironomus defectus</i> (KIEFFER 1913)								8.51		
<i>Demicryptochironomus (Demicryptochironomus) vulneratus</i> (ZETTERSTEDT 1838)				16.67					2.70	
<i>Dicrotendipes nervosus</i> (STAEGER. 1939)					5.80					
<i>Dicrotendipes tritonus</i> (KIEFFER. 1916)		8.33		16.67	34.78				4.50	
<i>Einfeldia pagana</i> (MEIGEN 1838)						10				
<i>Endochironomus tendens</i> (FABRICIUS. 1775)										4.17
<i>Glyptotendipes (Glyptotendipes) barbipes</i> (STÆGER 1839)										29.17
<i>Glyptotendipes (Glyptotendipes) cauliginellus</i> (KIEFFER 1913)					8.69					
<i>Harnischia curtilamellata</i> (MALOCH. 1915)								2.13		
<i>Harnischia fuscimana</i> KIEFFER 1921									1.80	
<i>Kiefferulus (Kiefferulus) tendipediformis</i> (GOETGHEBUER 1921)								4.25	3.60	
<i>Lauterborniella agrayloides</i> (KIEFFER. 1911)				33.33						
<i>Microchironomus tener</i> (KIEFFER. 1918)								2.13	0.90	
<i>Parachironomus arcuatus</i> (GOETGHEBUER. 1919)		4.17							6.31	
<i>Parachironomus vitiosus</i> (GOETGHEBUER 1921)		2.08						4.25	2.70	
<i>Paracladopelma camptolabis</i> (KIEFFER 1913)								2.13	2.70	
<i>Paratendipes albimanus</i> (MEIGEN 1818)								4.25	1.80	
<i>Polypedilum (Pentapedilum) exsectum</i> (KIEFFER 1916)		4.17							3.60	
<i>Polypedilum (Pentapedilum) sordens</i> (VAN DE WULP. 1874)									8.11	
<i>Polypedilum (Polypedilum) nubeculosum</i> (MEIGEN. 1804)										8.33
<i>Polypedilum (Polypedilum) pedestre</i> (MEIGEN 1830)		8.33						4.25	1.80	
<i>Polypedilum (Uresipedilum) convictum</i> (WALKER 1856)								2.13		
<i>Polypedilum (Tripodura) scalaenum</i> (SCHRANK. 1803)								6.38		
<i>Pseudochironomus prasinatus</i> (STÆGER 1839)										12.5
<b>TRIBE TANITARSINI</b>										
<i>Cladotanytarsus mancus</i> (WALKER 1856)							10.26			
<i>Micropsectra radialis</i> GOETGHEBUER. 1939		20.83							3.60	
<i>Stempellina almi</i> BRUNDIN 1947			22.2							
<i>Paratanytarsus</i> sp.						30				
<i>Tanytarsus</i> sp.							7.70			

The chironomids fauna structure in the nine studied ecosystems comprises representatives of the subfamilies Prodiamesinae, Tanypodinae, Orthocladiinae and Chironominae (Table 3, Fig. 3.). It is obvious that every station is defined by a unique configuration, but similarities do exist. Thus, a first cluster is formed by Pojărâta Brook, Luncavița Pond and Babadag Lake, the second by the Taița and Sărat lakes communities, and the third by Sulucului Valley and the Alba River. The clustering follows the ecosystem types, conditions and specific resources similarities.



Table 3. The chironomid fauna numeric taxonomic structure.  
Tabel 3. Structura numerică taxonomică a chironomifaunei.

Subfamily	Station	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
Prodiamesinae		1	0	0	0	0	0	0	0	0
Tanypodinae		2	4	2	2	1	5	3	1	0
Orthoclaadiinae		5	1	0	0	2	1	1	6	1
Chironominae		7	1	3	5	2	2	14	17	7

Clearly dominant are the Chironominae species-58, followed by Tanypodine-20, Orthoclaadiinae-17, the Prodiamesinae being represented by only one species.

The highest number of species was recorded in Taița Lake, followed by Babadag Lake and Smîrdan Arm, in all the other stations the number is fairly modest, the lowest being recorded in Pojărâta Brook and Telincea lake-5 species.

Regarding the ecological characteristic, the identified species exhibit certain preferences for ecosystem types (lentic, lotic and lentic+lotic) (Fig. 4.) and/or the existence of certain resources and conditions (pelophilous, psamphilous, pelo-psamphilous, phytophilous, pelophytophilous, detritophilous, oxyphilous, hypo-oxyphilous, distrophilous, euribionts, stenothermophilous) (Fig. 5.).

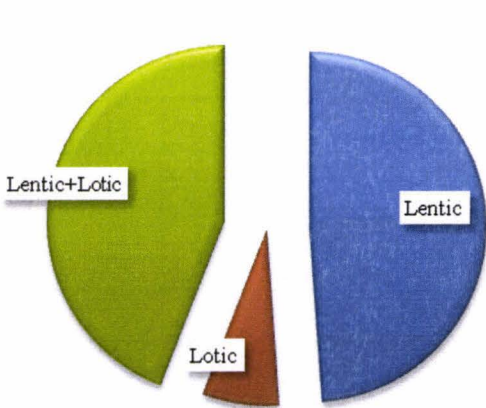


Figure 4. The chironomid fauna structure in relation to the ecosystem type.  
Figura 4. Structura chironomidofaunei după tipul de ecosistem.

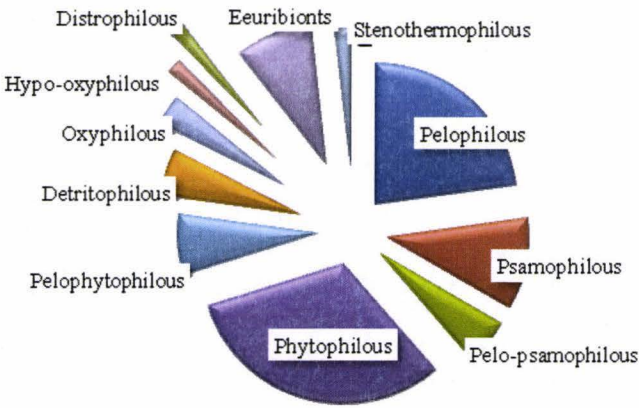


Figure 5. The chironomid fauna structure in relation to the diverse environmental factors.  
Figura 5. Structura chironomidofaunei după diferiți factori de mediu.

As one can notice, the lentic and lentic+lotic species are codominant, followed by the lotic ones.

Regarding the ecological characteristic, clearly dominant are the phytophilous and pelophilous species, followed by the psamphilous, euribiontas, pelo-phytophilous, detritophilous, oxyphilous and with the same value by the hypo-oxyphilous, distrophilous and stenothermophilous ones.

To emphasize the potential structural differences among the nine studied ecosystems, the diversity of the chironomidae fauna was considered. Starting from the empirical data (species number and relative abundances), relevant for the chironomid fauna structure in each of the studied ecosystems, the SHANNON-WIENER ( $H'$ ) diversity index was considered, starting from the premise that the empirical data was gathered by analyzing a sample randomly extracted from a given ecosystem. Thus, the value of the diversity index ( $H'$ ) will give an estimate of the real diversity of the chironomids fauna. Table 4 lists the values calculated for each ecosystem. As one can observe, the values are high, being comprised between 1.505 in Telincea Lake and 3.008 in Taița Lake.

Table 4. The Values of the Shannon-Wiener ( $H'$ ) and Lloyd-Gheraldi (E) indexes, calculated for the chironomid fauna of the studied ecosystems from Northern Dobroudja.  
Tabel 4. Valorile indicilor de diversitate, Shannon-Wiener ( $H'$ ) și de echitabilitate Lloyd-Gheraldi (E), calculate pentru chironomidofauna ecosistemelor studiate din Dobrogea de Nord.

Index	Station	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	St. 8	St. 9
H		2.499	1.734	1.561	1.749	1.505	2.030	2.786	3.008	1.931
E		0.923	0.968	0.970	0.899	0.935	0.976	0.964	0.947	0.929

Because the variation domain of the Shannon-Wiener ( $H'$ ) index is between  $[0, +\infty)$ , for standardization the use of the Lloyd-Gheraldi (E) equitability index is recommended. The calculated values are presented also in Table 4. The values are high, close to 1, in all the nine studied ecosystems, a fact that indicates a high diversity in all of them.

## CONCLUSIONS

1. In the nine studied aquatic ecosystems from Northern Dobroudja the following groups were identified: Turbellaria; Nematodea; Oligochaeta; Hirudinea; Mollusca; Crustacea: Mysidacea, Amphipoda, Copepoda, Ostracoda; Insecta: Heteroptera, Odonata, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera, Diptera: Ceratopogonidae, Liriopidae, Simuliidae, Chironomidae and Tabanidae. The amphipods (Crustacea) and the chironomids (Diptera) were dominant.

2. The taxonomic diversity of the chironomid fauna is represented by 125 taxa: 4 subfamilies, 2 tribes, 39 genera, 19 subgenera and 61 species. Clearly dominant are the representatives of the Chironominae Subfamily.

3. From the type of ecosystem point of view, the lentic and lentic+lotic species are codominant, followed by the lotic ones.

4. Regarding the ecological characteristic, clearly dominant are the phytophilous and pelophilous species, followed by the psamphilous, euribionts, pelo-phytophilous, detritophilous, oxyphilous and with the same value by the hypo-oxyphilous, distrophilous and stenothermophilous ones.

5. The Shannon-Wiener diversity index ( $H'$ ) values, calculated for the chironomid species, is very high in all analyzed ecosystems.

6. The Lloyd-Gheraldi equitability index ( $E$ ) has similar high values in all the nine studied ecosystems.

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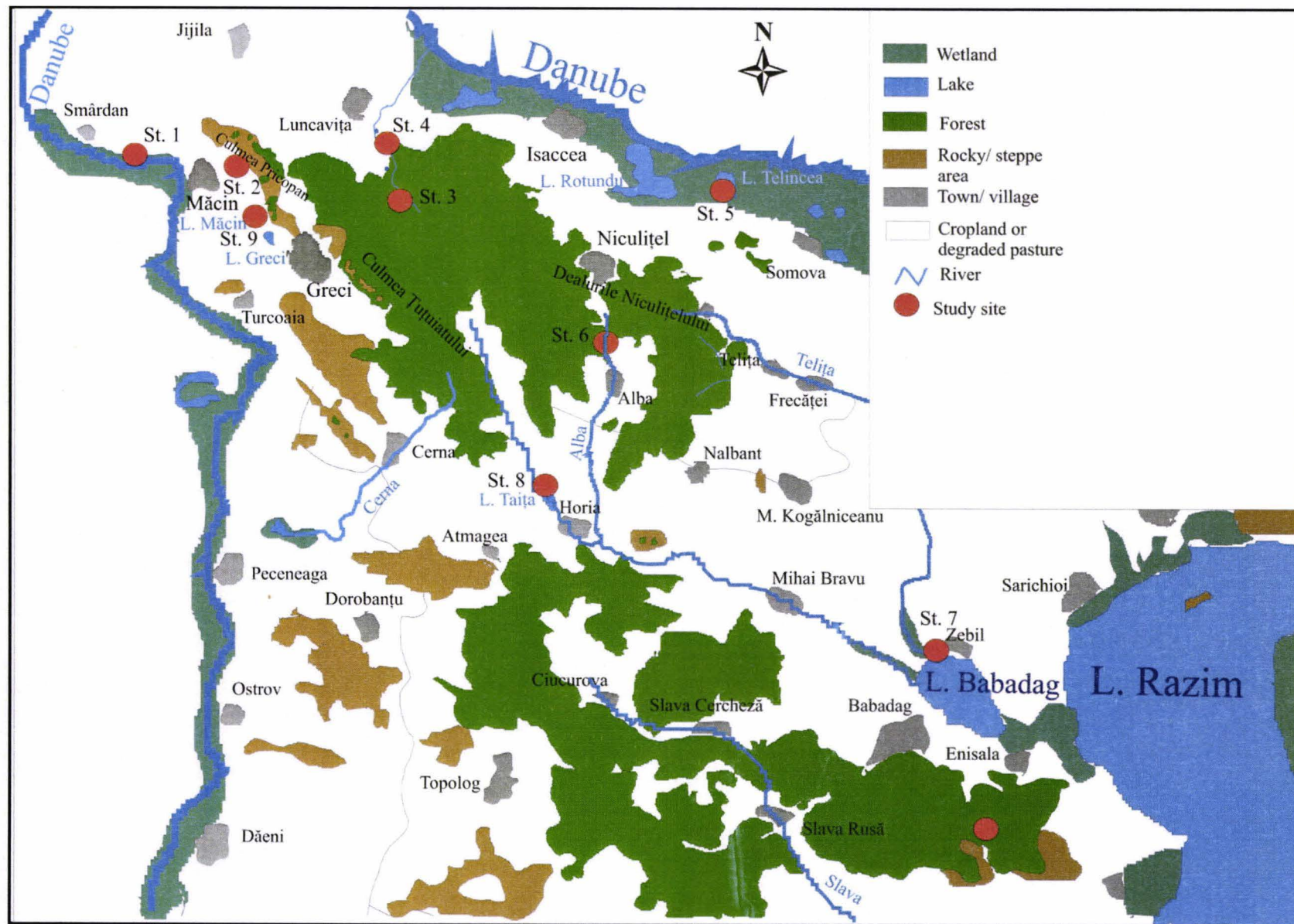


Figure 1. The map of the aquatic invertebrates (and implicitly chironomids-larvae) sampling stations.  
 Figura 1. Harta stațiilor de prelevare a probelor de nevertebrate acvatice și implicit de chironomide (larve).



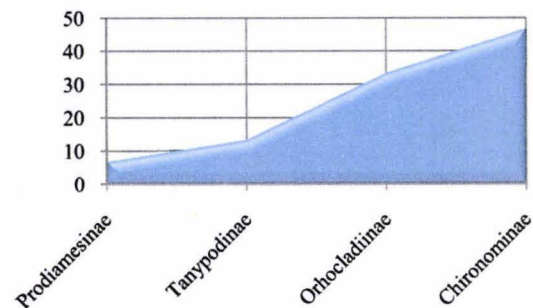
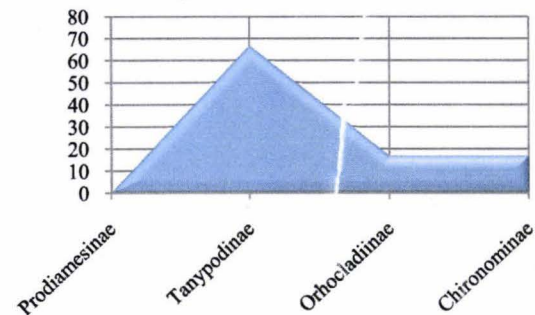
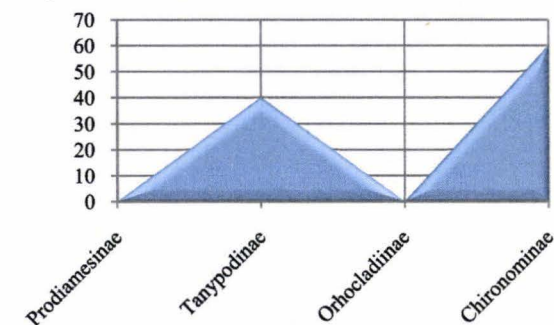
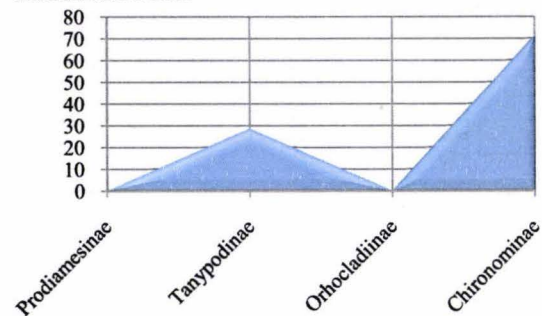
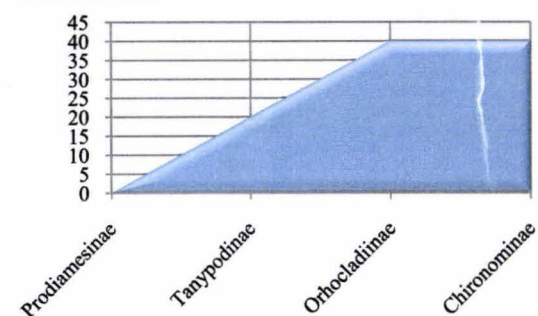
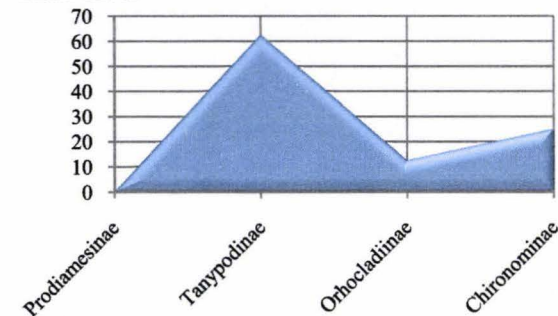
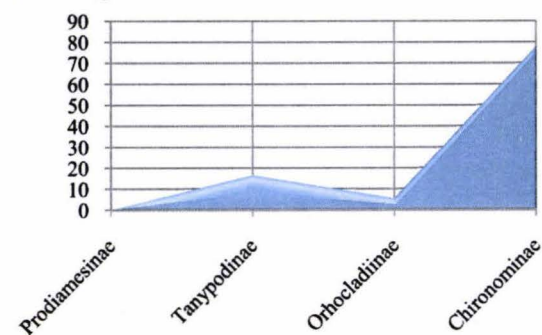
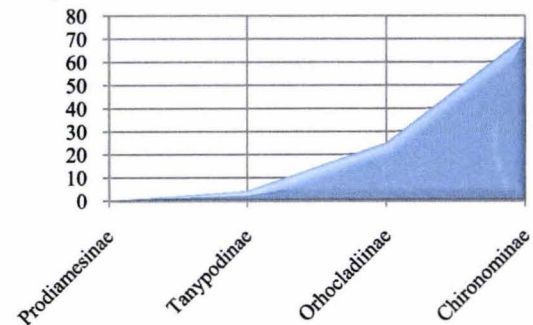
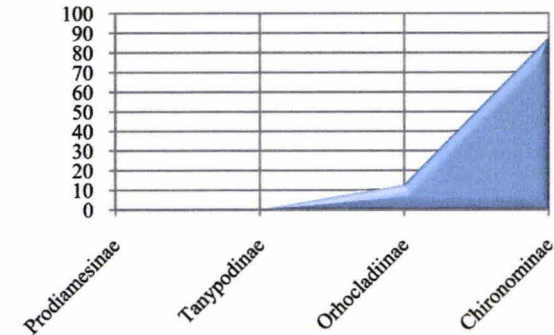
**Smârdan Arm****Sulucului Valley****Pojărâta Brook****Luncavita Pond****Telincea Lake****Alba River****Babadag Lake****Taița Lake****Sărat Lake**

Figure 3. The structure of the chironomid fauna subfamilies.  
 Figura 3. Aspectul structural al chironomidofaunei, pe subfamalii.

## DISTRIBUTION OF THE SPECIES *TELESTES SOUFFIA* (Risso, 1827) (PISCES: CYPRINIDAE) IN THE UPPER TISA RIVER AND ITS TRIBUTARIES (MARAMUREȘ COUNTY - NORTH ROMANIA)

ILIE C. TELCEAN, DIANA CUPȘA

**Abstract.** The species *Telestes souffia* (Risso, 1827) is represented by three subspecies across the European rivers (*T. souffia souffia* from the Rhone and the Var rivers; *T. souffia muticellus* in north-Italy and Switzerland; *Telestes souffia agassizi* VALENCIENNES 1844 from the Danube river and the uppermost Rhine drainage). In the Romanian rivers this species was one of the roughly recent recorded cyprinid fishes. Based on a few morphological features, the Romanian populations of this species were assimilated with those from the Upper Danube and the Rhine, respectively the subspecies *Telestes souffia agassizi*. However, a morphological study and the diagnosis on these populations are necessary. The range of *T. souffia agassizi* in the Romanian rivers was initially noted as covering only the northern rivers, respectively the upper Tisa and the river mouth of its main tributaries the Săpânța, the Iza and the Vișeu. After the first record of this species in 1959, during three decades there are no new investigations on the species range in the Maramureș rivers. The recent studies (1995-2008) focused on the fishfauna from the upper Tisa and its tributaries the Vișeu, the Iza, the Mara and the Săpânța reveals the actual range of *T. souffia agassizi* on these rivers. The new data prove also that the species distribution is wide than it was noted before. The species was recorded in 27 localities along the tributaries of the upper Tisa river.

**Keywords:** the Upper Tisa, *Telestes souffia*, species range.

**Rezumat.** Răspândirea speciei *Telestes souffia* (Pisces: Cyprinidae) în Tisa Superioară și afluenții săi din județul Maramureș – Nordul României. Specia *Telestes souffia* (Risso, 1827) este reprezentată în râurile Europei prin trei subspecii: *T. souffia souffia* în bazinul Rhonului și al Varului, *T. souffia muticellus* în nordul Italiei și *T. souffia agassizi* VALENCIENNES 1844 în bazinul Dunării și al Rinului superior. La noi în țară a fost una dintre speciile de ciprinide relativ recent semnalate în nordul României respectiv în Tisa superioară și afluenții săi. Pe baza unor caractere morfologice, populațiile de aici sunt considerate ca aparținând subspeciei *Telestes souffia agassizi* din Rinul superior și cursul superior al Dunării. Datele asupra morfologiei indivizilor necesită a fi completate. Aria de răspândire a acestei specii pe teritoriul României a fost inițial considerată ca acoperind numai cursul principal al Tisei superioare și sectorul de vărsare al afluenților Săpânța, Iza și Vișeu. După semnalarea speciei în 1959 o perioadă de aproximativ trei decenii nu au fost realizate studii asupra răspândirii acestei specii în râurile Maramureșului. Cercetările ihtiologice recente, desfășurate în perioada 1995-2008 în lungul Tisei superioare și în afluenții Vișeu, Iza, Mara și Săpânța au evidențiat actuala răspândire a speciei *Telestes souffia agassizi* care este mai extinsă comparativ cu datele existente anterior. Specia a fost identificată în 27 de localități în lungul afluenților Tisei superioare.

**Cuvinte cheie:** râul Tisa, *Telestes souffia*, răspândirea speciei.

### INTRODUCTION

The species *Telestes souffia agassizi* VALENCIENNES 1844 is one of the recently recorded cyprinid species from the Romanian rivers. BĂNĂRESCU & BICHICEANU (1959) identified this fish species from the Săpânța brook, a tributary on the left of the Tisa river. The first indications available regarding the species range are restricted to the upper Tisa stretch and the river mouth of the main tributaries the Vișeu and the Iza. Some of the morphological characteristics of specimens from the Tisa suggest a relationship with the populations originated from the upper Danube and the Rhine (especially those from the tributary Neckar) (BĂNĂRESCU, 1964). As a consequence, the populations from the upper Tisa were provisory considered as belonging to the subspecies *T. souffia agassizi*. In spite of their close resemblance, there are some differences in the morphology and meristic features of these populations and a supplementary morphological study is necessary. Recently, it was presumed that the populations from the upper Tisa are representatives of one species with disjunctive distribution in the Danube drainage (ranged in the Tisa and the Sava rivers) or it represents a quite distinct monophyletic superspecific taxon (BĂNĂRESCU, 2002). Up to now, the genetic studies has confirmed the pertaining of the populations from the upper Rhone and the Var rivers to the nominated subspecies *T. souffia souffia* and those from Slovenia to the subspecies *T. s. agassizi* (MACHORDOM et al. 1999). A distinct clade of *Telestes* species is represented by *Telestes muticellus* that is ranged in north Italy (GILLES et al., 1998, ZARDOYA & DOADRIO 1998, SALZBURGER et al. 2003, ZACCHARA et al. 2007).

Regarding the species distribution, the first records indicated only the upper Tisa river and its tributary the Săpânța in Maramureș county (BĂNĂRESCU & BICHICEANU, 1959). The subsequent studies are not covering the entire range of the species in the upper Tisa drainage area. Further records of *T. souffia agassizi* refer to the lower reach of tributaries, the Iza and also from the river Vișeu downstream the locality Vișeu de Sus. In the drainage area of the Vișeu river (tributary on the left side of the Tisa) this species is mentioned in the Vaser and Novăț brooks. The presence of *T. souffia agassizi* in the Iza drainage area remains mentioned just as possible but there are no reliable data (BĂNĂRESCU, 1964). During the followings three decades there are no advances regarding the study of the distribution of this species. The presence of *T. souffia agassizi* in the main tributaries of the Tisa river was not sustained by new data. The presumable presence of this species in some rivers from the upper Tisa drainage area is based mainly on the

ascertaining of a less noticeable presence of human impact on these rivers (BĂNĂRESCU, 1994). In spite of this presumption, the recent investigations revealed the strong decline of *T. souffia agassizi* from the Vișeu river due to the mining activities (TELCEAN & GYÖRE, 2000, TELCEAN & BĂNĂRESCU, 2002). The presence of the species in the middle rivers, the Iza and the Vișeu was recent mentioned by HARKA & BĂNĂRESCU (1999) and further papers (CRISTEA, 2004) refer mainly to the previous data available from the literature. Consequently, the distribution of *T. souffia agassizi* in the upper rivers from the upper Tisa drainage system remains less studied and vaguely presented in different papers.

## MATERIAL AND METHODS

The investigations on the fish fauna from the upper Tisa drainage area was carried out by multiple collecting trips during the years 1995, 1998, 2000, 2007 and 2008. There were attained numerous observations on the general fish fauna composition and abundance. The main purpose was the study on the *T. souffia agassizi* distribution and their characteristic habitat from the Tisa river and its tributaries. The fishing methods combine the electro-narcosis and the fishing nets. The electro-narcosis equipment was the low power type IUP 12 V 4-10 A, 360W (manufactured by RADET-Poland) and the medium-power electric gear FEG 5000 (manufactured by EFKO-Germany). The used catching nets have the mesh size of 5 mm. The specimens of *T. souffia agassizi* caught were directly recorded at the sampling sites and then released.

## RESULTS AND DISCUSSIONS

The distribution of the fish species *Telestes souffia agassizi* in the upper Tisa drainage system is larger than it was considered initially. Nearby the Tisa river main channel, this species spread along the tributaries and their drainage system. In the fast-flowing brooks this fish is accompanied by the brown trout *Salmo trutta* and *Phoxinus phoxinus*. The characteristic habitat of this species is represented by upper and middle rivers with gravel bottom and swift current. The presence of the large stones on the riverbed is favourable for this species. In those places the specimens can find an anchorage during the flash flood. The rivers stretches with rubble bottom are not permanently inhabited by this species.

The actual distribution of the species *T. souffia agassizi* covers the Săpânța river, the entire drainage system of the Iza tributary and the lower stretch of the Vișeu tributary (Fig. 1). The species was identified in 34 localities along the Romanian sector of the upper Tisa and its tributaries from the Romanian territory (Table 1). The locations of these sites along the rivers are as follows:

In the **upper Tisa**: the species *T. souffia agassizi* are distributed along the entire Romanian sector of the river from the village Valea Vișeuului to Tecu. The species range in this river is wide and exceeds the Romanian stretch of river. The uppermost site in which the species was captured is near the locality Broboia in Ukraine and the lowermost locality is Vilok, close to the Hungarian border. The population of *T. souffia agassizi* from the lowermost stretch of the upper Tisa remains less numerous comparing to those from the Romanian territory.

In the **Vișeu river** the presence of *T. souffia agassizi* is restricted in the lower part of river downstream the junction between the Tisa and its tributary, the Ruscova. The upper river is affected by water pollution from the mining industry and these populations became extinct. The species was mentioned also in the Vaser and the Novăț tributaries (BĂNĂRESCU, 1964). Recent investigations cannot identify this species in these rivers.

In the **Iza river**, the species *T. souffia agassizi* are well represented. In this river the species was identified between the localities Săcel and Sighet. The same wide distribution was observed in some tributaries, such as the Mara and the Cosău. In the Mara river the species *T. souffia agassizi* is distributed downstream the locality Mara along the entire river. In the Cosău river between the localities Budești and Sârbi, it was identified a spawning area of this species. In this river it was captured a female with numerous eggs late in June. It is possible that some populations to have a retarded spawning period in the cold water of the brooks. In the Rona rivulet, a tributary of the Iza in the lower sector, few specimens of *T. souffia agassizi* were captured. It is presumable that these specimens ascend from the Iza river.

**The Săpânța** is the river where the species *T. souffia agassizi* was initially recorded. The population from here maintains its former abundance downstream the Săpânța village. The uppermost site in which this species spread is located approximately three kilometres upstream the local trout fish-farm (or seven kilometres from the Tisa). The ascending of *T. souffia agassizi* far upstream in this river was not observed. This river represents a suitable site for the spawning of the populations from the Tisa.

### The main threatening factors

The populations of *T. souffia agassizi* from the upper Tisa drainage area are threatened by human activities which indirectly affect these rivers. The sawdust storage close to the riverbed is the most extensive practice that threatens the entire fish fauna. In the upper part of the Vișeu tributary, due to the wastewaters spills from the mining activities the populations of *T. souffia agassizi* became extinct. The remaining populations from downstream are less abundant than in the Iza river. Another threatening factor is represented by stone extractions directly from the riverbed. Fortunately, this practice is restricted in few sites near the localities and the impact is reduced.

Table 1. The localities where *Telestes souffia agassizi* appears.  
Tabel 1. Localitățile în care a fost întâlnită specia *Telestes souffia agassizi*.

River	Locality
TISA	Downstream the junction with the Vișeu river: Lunca la Tisa: Downstream the junction with the Iza river: Sarasău: Teceul Mic: Săpânța junction.
IZA	Săcel: Dragomirești: Bogdan Vodă: Rozavlea: Strâmtura: downstream the junction with the Slătioara river: Bârsana: Oncești: Vadul Izei: Cearda.
RONA	upstream Sighetu Marmatei
MARA	Mara village: Hărniciești: Desești: Berbești
COSĂU	Budești: Sârbi: Călinești: Comești: Ferești
VIȘEU	Ruscova river junction: Leordina: Petrova: Bistra: Valea Vișeului village.
SĂPÂNȚA	upstream the junction with the Tisa: upstream the Săpânța village

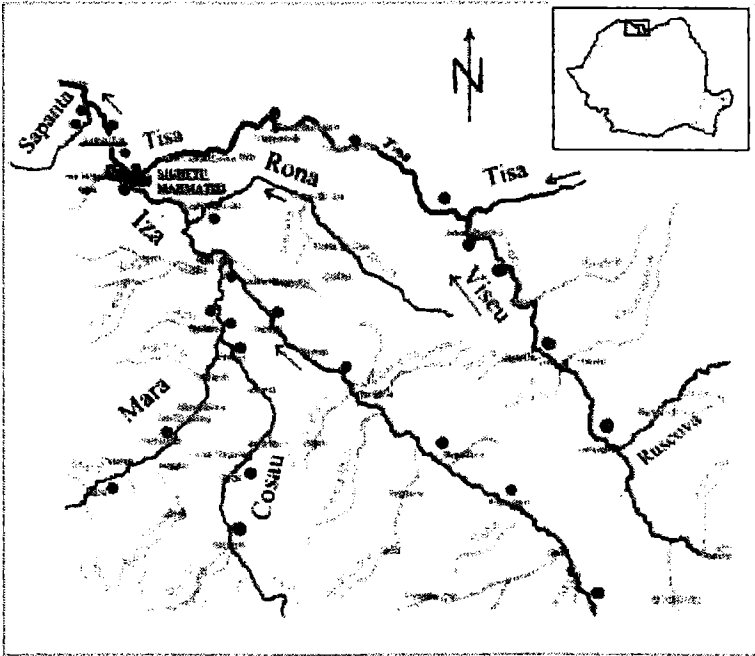


Figure 1. The distribution of species *Telestes souffia agassizi* in the upper Tisa and in the Romanian tributaries.  
Figura 1. Răspândirea speciei *Telestes souffia agassizi* în Tisa superioară și afluenții de pe teritoriul României.

CONCLUSIONS

The range of *Telestes souffia agassizi* in the Upper Tisa drainage area is considerable wider than it was initially described. A number of 28 localities from the Iza, the Vișeu and the Săpânța tributaries and 6 from the Tisa were added in the species distribution list. Our observations on this species are synthesized below:

The range of this species in Tisa river exceeds the Romanian territory and it occurs between localities Broboia and Villok (Ukraine);

The uppermost brooks from the tributaries drainage area are suitable for spawning of this fish. A retarded spawning period was observed in the Cosău upper tributary;

The most extensive threatening factor is represented by sawdust released in the rivers. The stone extractions directly from the riverbed have also a negative impact on the fish fauna near the localities;

The most endangered population is that from the Vișeu due to the mining spill. The water pollution affects the entire river in which *T. souffia agassizi* has less abundant population.

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## BASIC DATA ON THE FISH COMMUNITIES FROM THE HYDROGRAPHIC BASIN OF THE PREAJBA VALLEY

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**Abstract.** *The paper presents the preliminary results of an ecological study developed between July 2008 and September 2009, which aims at rendering as accurately as possible the situation of the fish communities from a special category of ecosystems (small basins located along the Preajba Valley). There have been studied the 11 basins built along the Preajba Valley and two basins from the Bătrâna Strem, which is a tributary of the Preajba River; we have identified 10 fish species so far. The lacustrine complex called the Preajba Valley is included on the list of protected areas from Dolj County because of its ecological features and geographical location.*

**Keywords:** *the Preajba Valley lacustrine complex, eutrophic, ichthyofauna.*

**Rezumat. Date preliminare referitoare la comunitățile piscicole din bazinul hidrografic Valea Preajba.** *Lucrarea prezintă rezultatele preliminare ale unui studiu ecologic început în perioada iulie 2008-sept.2009, încercând să redea cât mai exact situația comunităților piscicole dintr-o categorie specială de ecosisteme (lacurile mici de baraj Valea Preajba). S-au luat în studiu cele 11 lacuri formate pe cursul râului Valea Preajba și 2 lacuri formate pe cursul pârâului Valea Bătrâna afluent al râului Valea Preajba, fiind identificate un număr de 10 specii de pești. Complexul lacustru Valea Preajba este inclus în lista ariilor protejate din județul Dolj, datorită particularităților sale ecologice și a poziției geografice.*

**Cuvinte cheie:** *Complex lacustru Valea Preajba, eutrof, ihtiofauna.*

### INTRODUCTION

The Preajba Valley lacustrine complex makes part of the category of aquatic eutrophic ecosystems; it is characterized by a great production of the aquatic and paludous macrophytes, of the planktonic and benthonic populations, which led to the colmatage of the first basin of this lacustrine complex and then of the last two basins, where water surface has almost entirely disappeared. The analysis of the physical-chemical indicators allowed us to establish a correlation between the obtained results and the fish populations present within the basins.

### MATERIAL AND METHOD

The obtained data are the direct result of the field research; we used different tools for fishing, such as fishing rod, semi-automatic shooting rod, landing net, as well as repeated surveys among fishermen with regard to the fish communities, as the area in question is well known for sport and entertaining fishing. We took water samples from the most representative basin (basin IV) and from the streams' area in order to establish the correlations between the fish populations and the water chemistry as an indicator of the basins' quality; the samples were analysed in the laboratory of Dolj EPA, the data allowing us to draw preliminary conclusions with regard to the fish communities and their relation with the water quality of the basins.

### RESULTS AND DISCUSSIONS

The Preajba Valley lacustrine complex is located 6 km south of Craiova, between the settlements of Cârcea and Făcăi; it is characterized as a geographical unit belonging to the Oltenia Plain (Fig. 1).

The ecological feature is that, within a limited geographical space, no larger than 30 sq km, there appears a great diversity of aquatic ecosystems (springs, streams, rivers, basins, and marshes), each of these imposing their own features to the biocoenoses and to the plant and animal populations. Through the damming of the Preajba Valley river, a tributary of the Jiu River in its lower sector, and of the Bătrâna Valley Stream, there appeared 13 small basins (Fig. 2) the surfaces of which varies between 0.4 and 4.2 hectares.

Hydrobiological research occurred in the area ten years ago (CIOBOIU, 1999) and the analysis of the main physical-chemical indicators emphasized that the water was characteristic to eutrophic ecosystems. The values of the pH oscillate between 7.29 and 8.64, in concordance with the content of bicarbonates of 414-695 mg/l. The amount nitrogen is relatively high, 18.5 mg/l, due to the nutrients resulted from the utilization of mineral and organic fertilizers in the neighbouring agricultural fields. The presence of the nitrites is the consequence of the oxidation activity of the abundant organic matter from water and soil. The same explanation is valid also for the presence of the phosphate ions ( $\text{PO}_4^{3-}$ ) the concentration of which reaches even 7.9 mg/l. From the surface water quality point of view, the small basins from the Preajba Valley belong to the 2<sup>nd</sup> category and they can be used for pisciculture, as well as for tourist and entertainment purposes (CIOBOIU & BREZEANU 2002). Taking into account that the main supply source of the basins is represented by the 50 terrace springs, we took water samples from both the basin (VI), the most representative one, and

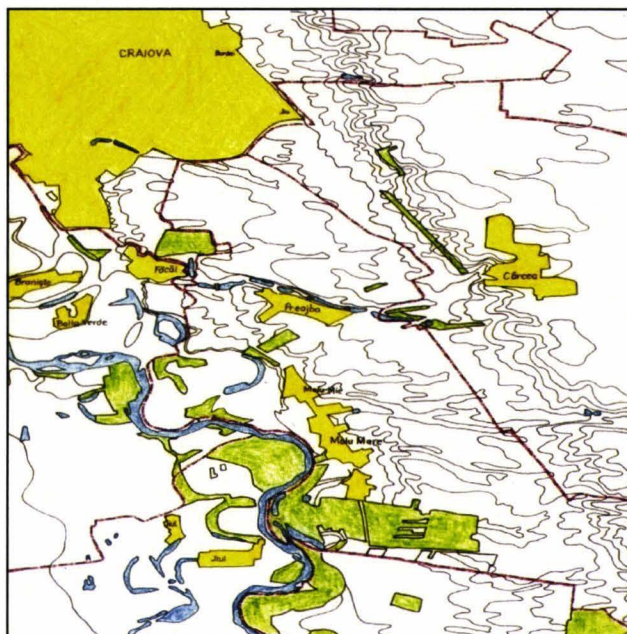


Figura 1. Localizarea Complexului lacustru în zonă (după CIOBOIU, 2002).

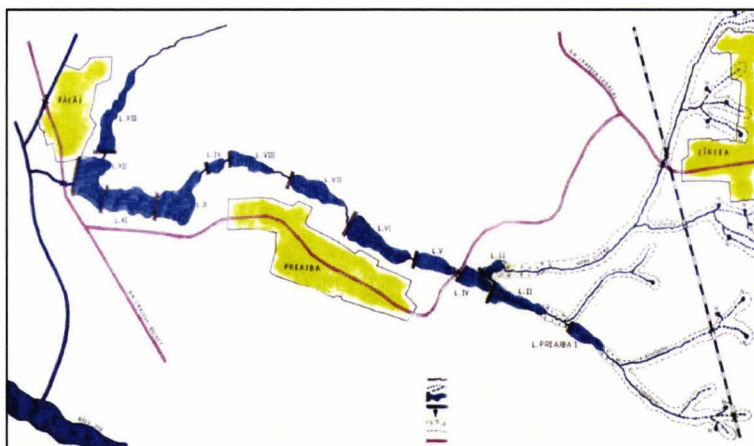


Figura 2. Schița complexului lacustru Valea Preajba din Câmpia Olteniei (după CIOBOIU, 2002).

Tabel 1. Indicatori fizico-chimici analizați în proba apei lacului VI.

Crt. no.	Analysed indicators – sample basin VI	Measured value	Admitted limits According to O 161/2006 2 <sup>nd</sup> quality class	Analysis method	Used equipments
1.	pH	7.5	6.5	SR.ISO 10523 - 97	ORION 420A, series 049576
2.	CCOCr mgO <sub>2</sub>	9.5	25	SR ISO 6060- 96	-
3.	Fixed residue mg/L	375	750	STAS 9187 - 84	Electronic scales PRECISA 205A, series 69674
4.	Conductivity μS/cm	750	-	STAS 7722 -84	-
5.	Nitrites mg/L	0.023	0.1	STAS 3048 -90	Spectrophotometer DR 2000, nr. Series 930700025411
6.	Nitrates mg/L	10.5	13	Method 355	Spectrophotometer DR 2000, nr. Series 930700025411
7.	Ammonium ion mg/L	0.35	1.0	STAS 3049- 86	Spectrophotometer DR 2000, nr. Series 930700025411
8.	Hardness German degrees	21.78	-	STAS 3026-76	-
9.	Calcium mg/L	83	100	STAS 3662- 62	-
10.	Magnesium mg/L	45	50	STAS 66-74	-

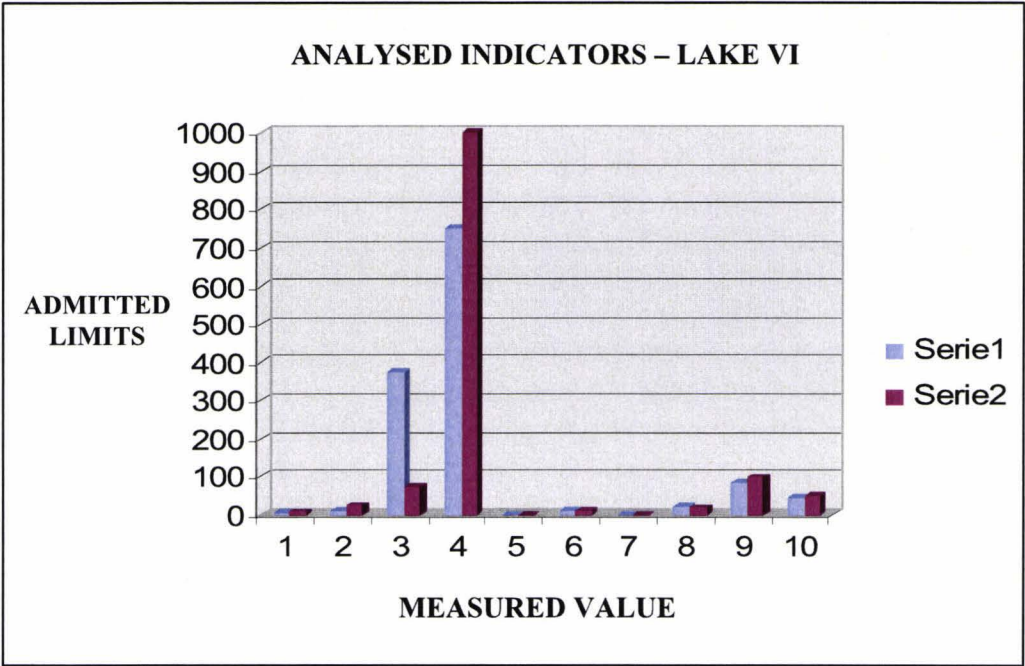


Figure 3. Graphic representation of indicators analysed in the sample taken from basin VI.  
Figura 3. Reprezentarea grafică a indicatorilor analizați în proba apei lacului VI.

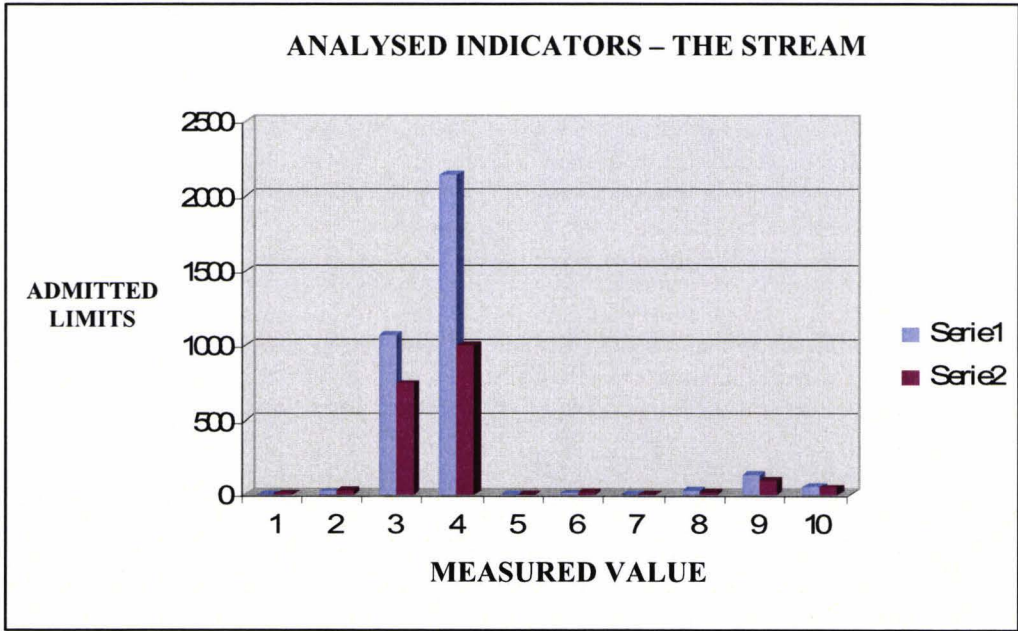


Figure 4. Graphic representation of indicators analysed in the sample taken from the stream.  
Figura 4. Reprezentarea grafică a indicatorilor analizați în proba apei de pârau.

Table 2. Physical-chemical indicators analysed in the sample taken from the stream.  
Tabel 2. Indicatori fizico-chimici analizați în proba apei de pârau.

Crt. no.	Analysed indicators – sample basin VI	Measured value	Admitted limits According to O 161/2006 2 <sup>nd</sup> quality class	Analysis method	Used equipments
1.	pH	7.5	6.5	SR.ISO 10523 - 97	ORION 420A, seria 049576
2.	CCOCr mgO <sub>2</sub>	21.6	25	SR ISO 6060- 96	-
3.	Fixed residue mg/L	1070	750	STAS 9187 - 84	Electronic scales PRECISA 205A, seria 69674
4.	Conductivity $\mu$ S/cm	2140	-	STAS 7722 -84	-
5.	Nitrites mg/L	0.023	0.03	STAS 3048 -90	Spectrophotometer DR 2000, nr. Series 930700025411
6.	Nitrates mg/L	10	13	Method 355	Spectrophotometer DR 2000, nr. Series 930700025411
7.	Ammonium ion mg/L	1.99	1.0	STAS 3049- 86	Spectrophotometer DR 2000, nr. Series 930700025411
8.	Hardness German degrees	33.44	-	STAS 3026-76	-
9.	Calcium mg/L	142	100	STAS 3662- 62	-
10.	Magnesium mg/L	61	50	STAS 66-74	-

There were analysed the most representative physical-chemical indicators rendering the quality of the water from the lacustrine complex. Thus, in the group “oxygen regime”, we measured the chemical consumption of oxygen; in the group “general ions, salinity”-electric conductivity, dry fixed residue, calcium, magnesium; for the acidification state-pH and for nutrients-nitrates + nitrites and ammonium (Table 1, 2; Fig. 3, 4).

The water reaction is alkaline, pH<8.5, which emphasizes a satisfactory dissolving of the oxygen that is favourable from the piscicultural point of view.

Oxygen consumption is much higher in the stream area as compared to the one in the basin, which means there is no risk of fish asphyxiation.

With regard to the fixed residue, there are high values that exceed the maximum admissible ones in the area of the stream, which means an increased content of mineral salts induced by the climatic factors; thus, the water of the basin belong to the 2<sup>nd</sup> category of quality, while that of the stream to the 3<sup>rd</sup> category (MĂLĂCEA, 1969).

As for the values of the ammonium ion, the stream sample indicated a concentration higher than the maximum admissible one, which proved the decomposition of the organic matter.

Nitrates represent the final oxidation stage of the organic nitrogen and the low registered values do not represent a danger for the flora and fauna of the area.

The value of the electric conductivity exceeds the maximum admissible value as it is a result of the stream water mineralization degree.

Total hardness is higher than normal in both cases due to the presence of the metallic cations. With regard to the presence of calcium ions, the sample from the stream indicates higher values than the maximum limit of < 100 mg/l, which means the water belongs to the 2<sup>nd</sup> category of quality corresponding to the  $\beta$ -mezosaprobe zone (appropriate impurification) (MĂLĂCEA, 1969).

Magnesium ions impose water hardness meaning the basin water belongs to the 4<sup>th</sup> category of quality corresponding to the polysaprobic zone (extremely high impurification). Thus, by analysing the most representative physical-chemical indicators we may conclude that the values of the stream sample exceed the maximum admissible values, which means they influence certain organoleptic indicators, as well (taste, smell, colour, turbidity, and pH), but these indicators do not hold a great importance for the aquatic biota, including fish populations, as the supply of the basin is made from many sources and the dilution and physical-chemical transformations modify the discharge of the basin.

Most of the basins are invaded by paludous and aquatic macrophytes, which is a feature of the eutrophic ecosystems (ANTONESCU, 1963); but, phytoplankton does not have proper development conditions here. 20-30 percent of the basins' surface is covered by paludous macrophytes that develop within shallow areas that surround as a thick belt the shore of the basins (especially in the upstream area of the basins). The main species of paludous and aquatic macrophytes are – *Phragmites communis* TRIN, *Typha angustifolia* L., *T. latifolia* L., *Nuphar luteum* L., *Scirpus lacustris* L., *Polygonum amphibium* L., *Heleocharis palustris* L., *Juncus effuses* L., *Potamogeton natans* L., *Mentha aquatica* L., *Carex riparia* L., *C. hirta* L., *Sagittaria sagittifolia* L., *Miriophyllum spicatum* L., *Ceratophyllum submersum* L.

The geomorphologic, hydrologic, and hydrochemical features, macrophytes areas, as well as the structure of the benthic facies emphasize the environment where fish populations develop, which represents one of the most important components of the basin biological production.

Thus, the presence or the absence of the fish populations from one or another basin represents characteristics determined by their ecological structure and the pressure exerted by the abiotic and biotic environment. By seasonal fishing, there were identified 10 fish species in the basins from the Preajba Valley (Table 3).



Table 3. Species from the basins (lakes) located in the Preajba Valley basin.  
Tabel 3. Speciile întâlnite în lacurile din bazinul Valea Preajba.

Cypriniformes Order Cyprinoidei Sub-order Cyprinidae Family	<i>Cyprinus carpio</i> LINNAEUS, 1758
	<i>Carassius gibelio</i> (BLOCH, 1782)
	<i>Alburnus alburnus</i> (LINNAEUS, 1758)
	<i>Pseudorasbora parva</i> (TEMMINK & SCHLEGEL, 1848)
	<i>Rutilus rutilus</i> (LINNAEUS, 1758)
Percidae Family	<i>Scardinius erythrophthalmus</i> (LINNAEUS, 1758)
	<i>Abramis brama</i> (LINNAEUS, 1758)
Centrarchidae Family	<i>Perca fluviatilis</i> LINNAEUS, 1758
	<i>Sander lucioperca</i> (LINNAEUS, 1758)
	<i>Lepomis gibbosus</i> (LINNAEUS, 1758)

## CONCLUSIONS

- The Preajba Valley lacustrine complex is located 6 km south of Craiova, between the settlements of Cârcea and Făcăi; it is characterized as a geographical unit belonging to the Oltenia Plain.
- The ecological feature is that, within a limited geographical space, no larger than 30 sq km, there appears a great diversity of aquatic ecosystems (springs, streams, rivers, basins, and marshes).
- Through the damming of the Preajba Valley River, a tributary of the Jiu along its lower sector, and of the Bătrâna Valley Stream, there appeared 13 small basins the surface of which varies between 0.4 and 4.2 hectares.
- We took water samples from one basin (basin IV) and from the streams' area in order to analyse the main physical-chemical indicators and to establish a correlation between the results and the fish populations present in the basins.
- From the surface water quality point of view, the small basins from the Preajba Valley belong to the 2<sup>nd</sup> category and they can be used for pisciculture, as well as for tourist and entertainment purposes.
- 20-30 percent of the water surface is covered by paludous macrophytes that develop in shallow water that surrounds like a large belt the shores of the basins (especially in the upstream areas of the basins).
- In the 13 basins from the Preajba Valley, there were made seasonal fishing which led to the identification of 10 species belonging to one order and three families.

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## COMPARATIVE CHARACTERISTICS OF REPRODUCTIVE SYSTEM OF *ABRAMIS BRAMA* FEMALES FROM DIFFERENT POPULATIONS IN ANNUAL CYCLE PERIOD

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**Abstract.** There is provided the comparative characterisation of the reproductive system of *A. brama* female, which populates different types of water reservoirs of the Republic of Moldova. Differences in oocyte development intensity were established in females from different populations during a year cycle period.

**Keywords:** *Abramis brama*, females, oocyte development, water reservoir.

**Rezumat.** Caracterizarea comparativă a sistemului reproductiv al femelelor de *Abramis brama* din diferite populații în perioada ciclului anual. Este dată caracterizarea comparativă a sistemului reproducător al femelelor de *A. brama*, care populează diverse bazine acvatice ale Republicii Moldova. Au fost stabilite diferențe în intensitatea dezvoltării oocitelor la femelele din diferite populații în perioada ciclului anual.

**Cuvinte cheie:** *Abramis brama*, femele, dezvoltarea oocitelor, lac de acumulare.

### INTRODUCTION

It is known that under the influence of anthropogenic factors in the reconstructing water basins changes in fish reproduction, various kinds of disturbances in the development and functioning of their reproductive system occur in the first place (KOSHELEV, 1984).

Our researches revealed changes in the development of reproductive system in *Abramis brama* (LINNAEUS) females from Dubasari aquatic reservoir after the construction of Dnestrovsk Hydro-power Station (FULGA, 2004). To emphasize the peculiarities of the reproductive system development in industrially valuable fish species, in Danube *A. brama* in particular, from the aquatic reservoir Costești-Stânca, we studied seasonal changes in oocyte development during a year period by comparing with their development in fish from Dubasari water reservoir.

### MATERIAL AND METHODS

Sexually adult females were collected from trammel nets between 2003 and 2008. The ovaries of 58 and 35 sexually mature females from the water reservoirs Dubasari and Costești-Stânca, respectively, were studied. The gonad pieces were fixed in Buen liquid with subsequent processing according to the appropriate methodology. The gonad maturity stages were established after MEYEN (1939) with the definitions of SAKUN & BUTSKAIA (1963), while the degree of oocyte maturity after the classification of KAZANSKII (1949). The gonadosomatic index (GSI) was calculated through the proportion of gonad weight to carcass weight.

### RESULTS AND DISCUSSIONS

In Dubasari water reservoir, after the spawning in the second half of June, the ovaries of Nistru bream pass into the 2<sup>nd</sup>-3<sup>rd</sup> maturity stage. Along with the oocytes of protoplasmic growth period the oocyte in the vacuolization phase are present. Altogether with the developments of the new generation oocytes there continues the resorption of free follicular membranes and of unspawned yolk oocytes (Fig. 1).



Figure 1. Oocyte after the spawning at 2<sup>nd</sup>-3<sup>rd</sup> maturity stage in females from Dubasari water reservoir.

Figura 1. Oocitul după depunerea icrelor în stadiul II-III de maturitate la femelele din lacul de acumulare Dubasari.

The gonadosomatic index in spawned females decreases up to  $2.24 \pm 0.05$ . The missing of the 2<sup>nd</sup> maturity stage of gonads in sexually adult females of *A. brama* from Dubasari water reservoir was recorded in the first years after the

reservoir creation (ZELENIN, 1960). The following development of the oocytes takes place asynchronously. In August, the gonads on 3<sup>rd</sup> stage of development contain oocytes, the cytoplasm of which is completely vacuolated (D<sub>3</sub>), and oocytes with one or two vacuoles rows (D<sub>1</sub> – D<sub>2</sub>).

The asynchronization in sexual cells development of Nistru *A. brama* inhabiting Dubasari water reservoir continues even in autumn period. In the process of yolk granules accumulation, along with the oocyte of intense vitellogenesis phase (D<sub>5</sub> – D<sub>6</sub>), there are also present oocytes in the primary phase of yolk accumulation (D<sub>4</sub>). Such a composition of the oocytes characterizes the 4<sup>th</sup> stage of gonad maturity that takes place at the end of October. GSI in this period corresponds to a value of  $15.95 \pm 1.20$ . In April in sexually adult females the main gonad mass is constituted by the oocytes of one generation in the phase of finished vitellogenesis. GSI reaches maximum values in May.

In the past years, in *A. brama* from Dubasari water reservoir the 4<sup>th</sup> stage of gonad maturity lasted for five months (ZELENIN, 1960), actually – about six months, fact which is connected with the decreasing of the water temperature in the reservoir after the construction of Dubasari Hydro-Power Station.

After spawning, the gonads of Danube *A. brama* from Costești-Stânca water reservoir, in contrast to the Nistru one, pass into the 2<sup>nd</sup> maturity stage that lasts till the second half of June (Fig. 2).

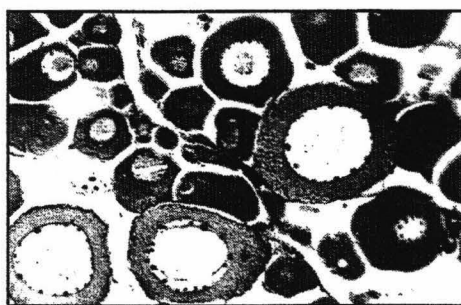


Figure 2. The ovary after the spawning in the 2<sup>nd</sup> maturity stage at females from Costești-Stânca water reservoir.  
Figura 2. Ovarul după depunerea icrelor în stadiul II de maturitate la femelele din lacul de acumulare Costești-Stânca.

In repeatedly maturing females of Danube *A. brama* the development of sexual cells in the period of primary growth occurs synchronously (Fig. 3), while in Nistru females the oocyte development in this period occurs asynchronously. In contrast to the last ones in females from Costești-Stânca water reservoir the beginning of cytoplasm vacuolization in oocyte occurs in the second half of June, i.e. 2-3 weeks earlier.

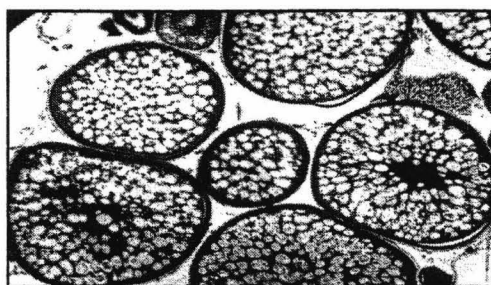


Figure 3. Synchronic development of oocytes on the 3<sup>rd</sup> stage of gonad maturity in females from Costești-Stânca water reservoir.  
Figura 3. Dezvoltarea sincronă a oocitelor în stadiul III de maturitate a gonadei la femelele din lacul de acumulare Costești-Stânca.

Therefore, in females from Costești-Stânca water reservoir at the synchronic development of oocytes in vacuolization phases their transition in the phase of vitellogenesis beginning occurs at the end of August of the current year. As a result, the 4<sup>th</sup> stage of gonad maturity occurs one month earlier than in females inhabiting Dubasari water reservoir.

## CONCLUSIONS

In repeatedly maturing females of *A. brama* from Costești-Stânca water reservoir differences in the oocyte development were established during a year period.

In females from Costești-Stânca water reservoir, the gonads pass into the 2<sup>nd</sup> stage of maturity after the spawning and the following oocyte development, of the primary growth period, occurs synchronously.

For the females of *A. brama* from both reservoirs it is the creation of unique oocyte generation ready for spawning in certain spawning seasons.

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# DATA UPON THE COMPOSITION AND THE GEOGRAPHIC DISTRIBUTION OF THE HERPETOFAUNA OF THE ALMAS-AGRIJ DEPRESSION (SALAJ COUNTY, ROMANIA)

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**Abstract.** The herpetofauna of the Almas-Agrij Depression from Salaj County comprises 11 species of amphibians (*Salamandra salamandra*, *Triturus alpestris*, *T. cristatus*, *T. vulgaris*, *Bombina variegata*, *Bufo bufo*, *B. viridis*, *Hyla arborea*, *Rana ridibunda*, *R. dalmatina* and *R. temporaria*) and 6 species of reptiles (*Lacerta agilis*, *L. viridis*, *Zootoca vivipara*, *Anguis fragilis*, *Natrix natrix*, *Coronella austriaca*). The herpetofauna of the investigated region is rather poor, but characteristic to the hill and plateau regions from western Romania. The distribution of the identified species is conditioned by the same factors that generally affect it in the western part of the country. It is important that we discovered a new *Triturus alpestris* population in the Meses Mountains. The identification of the *Zootoca vivipara* species is also of great importance. This is a premier for the mountainous areas from Sălaj County. The species descends in the area at even 543 m altitude, which is very reduced in comparison to other mountainous areas from the country. This fact, connected to that of the appearance of *T. alpestris*, indicates that at least the higher area from the level of Agrij valley, has a distinct status and history, therefore belonging to the western sector of Romania, in which the mountainous elements decrease at low altitudes.

**Keywords:** herpetofauna, Almas-Agrij, human activities, *Zootoca vivipara*, *Triturus alpestris*.

**Rezumat.** Date despre compoziția și distribuția geografică a herpetofaunei din Depresiunea Almăș-Agrij (Județul Sălaj, România). Herpetofauna Depresiunii Almăș-Agrij din Județul Sălaj cuprinde 11 specii de amfibieni (*Salamandra salamandra*, *Triturus alpestris*, *T. cristatus*, *T. vulgaris*, *Bombina variegata*, *Bufo bufo*, *B. viridis*, *Hyla arborea*, *Rana ridibunda*, *R. dalmatina* and *R. temporaria*) and 6 species of reptiles (*Lacerta agilis*, *L. viridis*, *Zootoca vivipara*, *Anguis fragilis*, *Natrix natrix*, *Coronella austriaca*). Herpetofauna regiunii investigate este săracă, dar caracteristică pentru regiunile de deal și podiș din partea de vest a țării. Este important faptul că am descoperit o nouă populație de *Triturus alpestris* în Munții Meseș. De asemenea, o importanță deosebită o are identificarea speciei *Zootoca vivipara*. Aceasta este o premieră pentru regiunile montane din județul Sălaj. În zonă specia coboară chiar și la 543 de m altitudine, altitudine foarte redusă în comparație cu alte zone montane din țară. Acest fapt colaborat cu descinderea lui *T. alpestris* indică că cel puțin zona înaltă de la nivelul văii Agrijului are un statut și o istorie aparte, aparținând sectorului din vestul României în care elemente montane coboară la altitudini reduse.

**Cuvinte cheie:** herpetofauna, Almăș-Agrij, activități umane, *Zootoca vivipara*, *Triturus alpestris*.

## INTRODUCTION

Romania's biodiversity is, presently, little known comparing it to the European level (HARTEL et al., 2008), despite the fact that in the country there still are vast surfaces little affected by human activities (HARTEL et al., 2006). The herpetofauna is a group with a large conservation importance, many species being endangered, included in different protection categories at a national level (GUD no. 27 / 2007). However, detailed studies about this particular group were done only in the last years, focused more on certain regions of the country- e.g. the north-west, Moldova or Dobroudja (e.g. COVACIU-MARCOV et al., 2003a, b, 2004, 2005, 2006a, b, c, 2007, 2008a, STRUGARIU et al., 2006, 2007, 2008, GHERGHEL et al., 2007, 2008). Salaj County was partially comprised in some of these recent studies and therefore there are explicit data referring to the herpetofauna of the entire county (GHRIA & GHILE, 1997), or of only its north-west sector (COVACIU-MARCOV et al., 2006d). Dissipated information which partially interest the Salaj County is included in the general volumes on the herpetofauna, particularly on the amphibians of Romania (FUHN, 1960, FUHN & VANCEA, 1961, COGĂLNICEANU et al., 2000). In the case of the endangered species, such information is found in the Red Book of Romania's Vertebrates (IFTIME, 2005). As such, we set out to contribute to establishing the composition and the geographic distribution of the herpetofauna from Salaj County. The present paper shows the results of the studies made in the Almas-Agrij Depression. The objectives were to establish the composition and the geographic distribution of the herpetofauna, of its particularities and differences from other regions of the country and to analyze its threats.

## MATERIAL AND METHODS

Our study took place between 2007 and 2009. The investigated region is found in the centre of Salaj County, comprising the hydrograph basins of the Almas and the Agrij Rivers (Fig. 1), tributaries of the Somes River. Our research area contains the entire Almas-Agrij Depression plus a little bit of the surrounding relief-e.g. parts of the Meses Mountains, Cluj Hills or Dej Hills (POSEA & BADEA, 1984). The altitude of the region is not too high, reaching 996 m a.s.l. in the Priei Hummock (FEY et al., 2001). The minimum altitude is found in the Somes Floodplain, near the town of Jibou, and is about 180 m a.s.l.

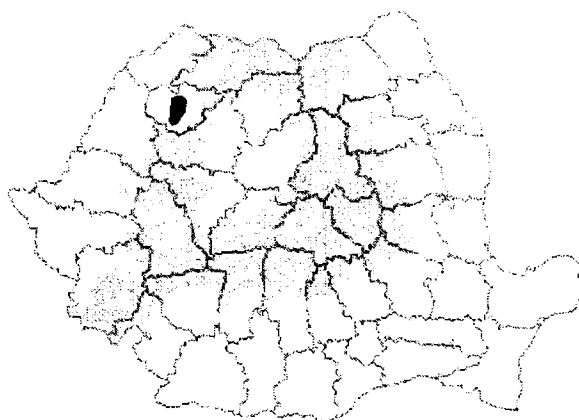


Figure 1. The researched area.  
Figura 1. Zona cercetată.

In our 3 years of study, we investigated the herpetofauna from 68 localities from the Almas-Agrij Depression. We used the transect method (COGĂLNICEANU, 1997), making many such searches in the habitats from the region. The transect method was recently used in other similar studies, being very efficient with the exception of the snakes, due to their way of life (KATI et al., 2007). The animals were not generally captured, since we mostly used the direct observation method (BROWN, 1997). In the situations in which capturing the animals was necessary, this was usually done by hand. We also used nets for capturing newts in spring, when these animals can't be identified visually, or for capturing large green frogs, because of their fast reactions. After determining, the captured animals were sometimes photographed and all released back in their own habitat. Also, we sometimes determined the animals killed by the locals or by the traffic in the area.

## RESULTS

In the Almas-Agrij Depression from Salaj County we encountered 17 species belonging to the herpetofauna. Amongst these, 11 are amphibians - *Salamandra salamandra*, *Triturus alpestris*, *T. cristatus*, *T. vulgaris*, *Bombina variegata*, *Bufo bufo*, *B. viridis*, *Hyla arborea*, *Rana ridibunda*, *R. dalmatina* and *R. temporaria* - and 6 are reptiles - *Lacerta agilis*, *L. viridis*, *Zootoca vivipara*, *Anguis fragilis*, *Natrix natrix* and *Coronella austriaca*.

We analyzed the distribution of the 17 species in all the 68 localities from the Almas-Agrij Depression. After this study, we identified a total of 282 localities for the encountered species in the 67 field locations (Table 1). Most of the distribution localities of the 17 species (188 localities) represent premieres for Romania's herpetofauna. Further more, even the number of reconfirmed localities in this present study-192-is a very high one.

## DISCUSSIONS

The herpetofauna of the Almăș-Agrij Depression from Sălaj County is a typical one for the hill and plateau regions of Romania. Thus, the species we have identified in the area are the same ones as signalled in other similar geographic conditions (GHIRA et al., 2002, COVACIU-MARCOV et al., 2003a, 2004, 2005, 2006d, 2007). Some typical species for these regions are present in the Almăș-Agrij Depression, too: *Salamandra salamandra*, *Triturus cristatus*, *Bombina variegata* or *Rana temporaria*. Alongside these, some other species common in our country are to be found, species like *Rana ridibunda*, *Hyla arborea*, *Bufo viridis*, *Lacerta agilis* and *Natrix natrix*. Only the typically plain species are missing from the investigated region. This fact is a consequence of the special uniformity of the area, where the altitude and climate differences (MÂNDRUȚ, 2006, STOENESCU et al., 1966) are relatively reduced and where the human activities have severely affected the landscape, but in a rather even way. As such, the investigated region represents a very uniform area from the zoogeographic and ecologic point of view. The geographic and climate conditions, together with the human activities have conditioned the poor herpetofauna of this territory.

The lack of plain species from the Almăș-Agrij Depression is, however, rather difficult to explain because the lowest altitude here is around 180 m a.s.l. while those particular species are to be found upstream the Someș River, in the Transylvanian Plateau. The absence of some of these species, like *Triturus dobrogicus*, is a consequence of its impossibility of reaching upstream the Someș River due to the narrow areas (e.g. the Țicău-Benesat gorges) situated a bit more downstream from our research area. Other species, like *Bombina bombina*, have probably recently disappeared from the region because of climate changes, because of *Bombina variegata* entering the territory or due to the human activities. *Bombina bombina* was however most likely present in the area, it being indicated upstream the Someș River, all the way to Cluj (FUHN, 1960, GHIRA et al., 2002). The low areas alongside the Someș River represent the most probable routes of this species towards the higher areas of the Transylvanian Plateau. This aspect can be confirmed by the previous results encountered in Maramureș County, 30 km north of our research area (COVACIU-MARCOV et al.,



2007). In that area, *Bombina bombina* is extremely rare in the Someș floodplain, but a proof for its former presence lays in the hybrid populations that live there. The rarity of the species from the region is probably, just like in the case of the Almăș-Agrij Depression, a consequence of the human activities which, in a hilly area, improper for agriculture, have affected exactly this lower sector near the Someș River, thus, the species' habitats. The situation is therefore similar to that described previously in Maramureș County (COVACIU-MARCOV et al., 2007).

The large number in which the species were previously indicated for and re-identified by us indicates that the regions was quite well researched before, being one of Romania's well studied herpetofauna areas. Generally for our country, the number of re-identified localities for a species is very low in comparison to the number of new localities (COVACIU-MARCOV et al., 2003a, b, 2004, 2005, 2006a, b, c, 2007). The relatively high level of knowledge of the herpetofauna from the Almăș-Agrij Depression is a consequence of the area being included in recent article on Transylvania's herpetofauna (GHIRA et al., 2002).

The results we obtained were mainly expectable by comparing to what we knew before about Romania's herpetofauna. With two exceptions, there are no surprises in the distribution of the species or about the limiting factor of this distribution (e.g. altitude, presence of suitable habitats etc). Further more, there are no particularities recorded about the ecology or biology of the identified species in comparison to other regions of Romania or of their general area. This is how *Salamandra salamandra* and *Rana temporaria* come down to about 200-220 m a.s.l., being absent from the low, cleared areas from the meadows of the rivers. The situation is general for the entire region, representing the lowest altitude limit for the two species in the country (COGĂLNICEANU et al., 2000). However, the salamander is rarer than *Rana temporaria*, the common frog being better represented in numbers in all the areas where it is present. This is the effect of the relative scarceness of the characteristic habitat for the species-the mountain valleys inside forests. These are more numerous in the western part of the Agrij Valley, near the limit with the Meseș Mountain, where the salamanders are better represented; in some cases here we even counted hundreds of larvae in the streams.

Our most important discovery is represented by the identification of the mountain lizard, *Zootoca vivipara*. The species was also encountered in the higher area of the Agrij valley, near Poic and Huta localities, at the limit between the depression and Meseș Mount.



Figure 2. Habitat (a) and specimen (b) of *Zootoca vivipara*.

Figura 2. Habitat (a) și exemplar (b) de *Zootoca vivipara*.

This is the first notice of the species in the mountainous zones from Sălaj County. Previously, the mountain lizard was mentioned in the northwestern part of the county, in the plain insinuated along side the Crasna River, where however is represented by plain populations (COVACIU-MARCOV et al., 2006d). The closest mountainous populations from Almăș-Agriș Depression are found at approximately 30 km distance, in Vlădeasa Mount, in Lunca Vișagului locality, Cluj County (GHIRA et al., 2002). Therefore, the continuity of these populations is practically assured, the populations from Sălaj being probably connected, or at least in the recent past they were related to the populations near the level of the Drăgan Valley. Obviously, however, the populations from Meseș Mount do not appear to be and probably are not connected to the plain populations from the northwestern part of the county. In Almăș-Agriș Depression, the species descends to extremely low altitudes, in comparison to other mountainous areas from Romania. Thus, at Poic, *Z. vivipara* was identified at 602 m, while at Huta at just 543 m altitude. These altitudes are unusual for the mountainous populations, being similar just to the ones at which the species decreases in Oaș Mount (COVACIU-MARCOV et al., 2004). Still, the two regions are climatically different, in Oaș the average temperatures being lower and the precipitations richer than in the studied sector from Sălaj (STOENESCU et al., 1966). Therefore, probably the cause of the appearance of the species at low altitudes is not an actual one, but it has to be related to the appearance of the mountain newts and to the general situation from the northwestern part of Romania, where in certain areas the mountainous elements descends at low altitudes (COVACIU-MARCOV et al., 2008b). It seems that the northwestern part of the Agrij Valley is also inserted in this sector with zoogeographical particularities. The explication that we consider is offered by the dynamics of the fauna in the last ice age and in the after-glacial period.

Another special result of our study is the indication of some *Triturus alpestris* populations at altitudes of about 400 m. The identification of populations found under the "classic" limit of distribution in Romania adds to the recent data regarding to the distribution of the species at low altitudes in the western part of the country (COVACIU-MARCOV & CICORT-LUCACIU, 2009). This offers a different image to the entire distribution of this species that does not come down to lower altitudes only in the Western Hills but apparently also in the depression regions. This new data here prove once more that the alpine newt relates differently to altitude in the western part of the country than the rest of Romania.

Although these results are only preliminary, a certain contrast can be distinguished by looking at them, between the herpetofauna of the Almăș and the Agrij hydrograph basins. Thus, the existing situation in the Agrij basin is closer to one typical to the western Romania, a closeness demonstrated by the descent of the alpine newt to lower altitudes. The Almăș basin seems to lack such particularities, consisting in a typical Transylvanian herpetofauna. The differences are the effect of the relief the Almas region being a bit more uniform and with lower altitudes. Unlike it, the Agrij River valley benefits from the nearby Meses Mountain which determines the presence of some species like the alpine newt. The particularities, at least in the northwestern part of the Agrij basin, are also confirmed by the presence of the *Zootoca vivipara* populations. Although, geomorphically the Almăș-Agrij Depression represents a unit, zoogeographically this is separated in a reduced-sized part, but with a distinct herpetofauna and a much bigger but homogenous area. The difference is an actual one, but it is also caused by the distinct evolution in the past of the two sectors.

The Almăș-Agrij Depression, similar to the entire Sălaj County, represents an area strongly affected and modified by human activities. This fact is obvious despite the fact that there isn't a highly developed industry or a transport infrastructure comparable to other regions of Romania. The human impact is represented by clearings of forests or by excessive agriculture. Although initially this was a vast forest area, the investigated territory is presently mostly deforested; at least in the lower sectors, the forests are completely gone or occupy very little surfaces here and there. The wood cutting still continues and it permanently affects species that are bond to forests-e.g. *Salamandra salamandra*, *Triturus alpestris* and *Rana temporaria*. Excessive gazing is another negative factor that impacts on species that live in meadows or swamplands. Deposited wastes are a reality near practically every human locality, affecting in many cases breeding habitats for amphibians. Last but not least, road kills are another general and global cause for the decline of most amphibians (KRECSÁK et al., 2004, SOS, 2007). This is also the case here, even if it is less visible due to the bad quality of the roads. Traffic impacts mostly on the *Bufo* toads and, among the reptiles, the grass snake. Thus, the majority of the species belonging to the herpetofauna are vulnerable to these human activities and the greatest impact is on the species found in a small number of localities.

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Table 1. The distribution of the recorded amphibian and reptile species in the Almas-Agrij Depression.  
Tabel 1. Răspândirea speciilor de Amfibieni în localitățile investigate din Depresiunea Almăș-Agrij.

Localities	S s	T a	T c	T v	B v	B u f	B u v	H a	R r	R d	R t	L a	L v	Z v	A f	N n	C a
Adalin	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
Agrij	O	-	S	X	S	S	S	S	S	S	S	S	S	-	S	S	O
Almașu	-	-	-	-	X	-	-	-	X	X	-	X	-	-	-	-	-
Baica	-	-	-	-	X	-	-	-	X	X	-	-	-	-	-	-	-
Băbiu	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
Bălan	S	-	S	-	S	O	O	S	S	S	S	S	S	-	O	S	-
Bicălatu	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Bodia	O	-	S	-	S	S	S	S	S	S	S	S	S	-	S	S	-
Bogdana	S	-	O	S	S	S	O	S	S	S	S	S	O	-	S	S	-
Borza	-	-	-	-	X	X	-	-	X	X	-	-	-	-	-	-	-
Bozna	X	-	-	-	X	-	-	-	-	X	X	-	-	-	-	-	-
Brebi	X	-	-	-	X	X	-	X	-	X	X	-	-	-	-	-	-
Brusturi	O	-	O	-	S	O	O	O	S	S	O	-	O	-	O	S	O
Buciumi	O	X	S	X	S	S	O	S	S	S	S	S	O	-	-	S	-
Ciglean	X	-	X	X	X	X	-	X	X	X	-	S	-	-	-	X	-
Cechiș	S	-	S	X	S	O	O	O	S	S	S	S	S	-	O	S	-
Chendrea	O	-	O	X	S	O	O	O	S	S	S	S	-	-	O	S	-
Chichișa	-	-	-	X	X	-	-	-	X	X	-	-	-	-	-	-	-
Ciumârna	X	-	-	-	S	-	S	-	O	S	S	S	S	-	-	O	-
Creaca	-	-	-	X	X	X	-	-	X	X	-	-	-	-	-	-	-
Cubleșu	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
Cuțiș	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Cuzăplac	-	-	-	-	X	-	-	-	X	X	-	-	-	-	-	-	-
Dragu	-	-	-	X	X	-	-	-	X	X	X	-	X	-	-	-	-
Fildu de Jos	-	-	-	-	X	-	-	-	-	X	-	X	-	-	-	-	-
Fildu de Mijloc	-	-	-	-	X	-	-	-	-	X	-	X	-	-	-	-	-
Fildu de Sus	X	-	-	-	X	-	-	-	-	-	X	X	-	-	-	-	-
Gâlgău Almașului	S	-	-	-	X	X	-	-	X	X	X	-	X	-	S	X	-
Gălășeni	-	-	X	X	X	-	-	-	-	X	-	-	-	-	-	-	-
Gălpăia	-	-	X	-	X	-	-	-	-	X	X	X	-	-	-	-	-
Huta	S	X	S	X	S	S	O	S	S	S	S	S	O	X	S	S	-
Hida	-	-	-	-	X	-	-	-	X	X	-	-	X	-	-	-	-
Jac	-	-	X	-	X	-	-	-	S	X	-	O	-	-	O	-	-
Jebucu	-	-	X	-	X	-	-	-	-	X	-	X	-	-	-	-	-
Jibou	S	-	X	-	S	X	X	-	-	X	X	X	-	-	-	S	O
Lupoaia	O	-	O	-	S	S	O	S	S	S	O	O	-	-	-	S	O
Mesteacănu	X	-	X	X	X	-	-	-	-	X	X	X	X	-	-	-	-
Mierța	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
Moigrad	S	-	X	-	X	-	-	X	O	X	X	S	-	-	O	-	-
Păușa	O	-	O	-	S	O	S	O	S	S	O	S	S	-	O	S	O
Petrindu	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
Poarta Sălajului	-	-	-	-	S	-	-	-	S	S	-	S	O	-	-	O	-
Poic - Satu Hurez	X	X	-	X	X	X	-	-	-	X	X	-	-	X	X	X	-
Prodănești	S	-	S	X	S	S	O	S	S	S	S	S	O	-	O	S	-
Racăș	O	-	S	-	S	O	O	O	S	S	S	-	-	-	-	-	-
Răstolț	O	-	O	-	S	S	O	O	S	S	O	S	S	-	O	S	X
Românași	-	-	-	-	S	-	X	-	S	S	-	S	-	-	-	-	-
Romița	O	-	O	-	S	O	S	S	S	S	O	S	O	-	O	S	-
Ruginoasa	-	-	X	-	X	-	-	X	X	X	-	-	-	-	-	-	-
Sângeorgiu de Meseș	X	-	-	-	X	-	-	-	X	X	X	X	-	-	-	X	-
Sânmihailu Almașului	-	-	-	-	-	-	O	-	S	S	X	O	-	-	O	O	-
Sânpetru Almașului	O	-	O	-	S	O	O	O	S	S	S	S	S	-	O	S	-
Sfăraș	-	-	X	X	X	-	-	-	-	X	-	-	-	-	-	-	-
Stana	X	-	-	-	X	-	-	-	-	X	X	X	-	-	-	-	-
Stâna	S	X	X	X	S	-	S	-	O	S	X	S	O	-	O	-	O
Stoboru	-	-	X	X	X	-	-	-	-	X	-	-	-	-	-	-	-
Stupini	-	-	-	-	X	-	-	-	-	-	-	S	O	-	O	O	-
Sutoru	O	-	-	X	S	O	O	S	S	S	-	S	O	-	O	O	-
Târnaș	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Tetișu	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Tihău	O	-	-	-	S	S	O	S	S	S	O	O	O	-	O	O	-
Treznea	S	-	-	-	X	X	-	-	-	X	X	S	S	-	-	-	-
Țăudu	-	-	-	-	X	-	-	-	-	X	X	-	-	-	-	-	-
Ugruțiu	-	-	-	-	X	-	-	-	-	X	X	X	X	-	-	-	-
Var	S	-	S	-	S	S	O	S	S	S	S	S	O	-	O	S	-

Viile Jacului	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
Voivodeni	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
Zimbor	O	-	S	-	S	O	O	S	S	S	-	S	-	-	O	-	-
$\Sigma X$	9	4	1	1	4	8	2	4	1	3	1	1	5	2	1	4	1
			2	7	0				2	9	7	1					
$\Sigma S$	1	-	1	1	2	1	6	1	2	2	1	2	9	-	5	1	-
	1		0		5	0		3	4	5	3	3			7		
$\Sigma O$	1	-	8	-	-	1	1	7	3	-	6	4	1	-	1	6	6
	4					0	7					2		8			

**Legend:**

**Ss** = *Salamandra salamandra*, **Ta** = *Triturus alpestris*, **Tc** = *Triturus cristatus*, **Tv** = *Triturus vulgaris*, **Bv** = *Bombina variegata*, **Buf** = *Bufo bufo*, **Buv** = *Bufo viridis*, **Ha** = *Hyla arborea*, **Rr** = *Rana ridibunda*, **Rd** = *Rana dalmatina*, **Rt** = *Rana temporaria*, **La** = *Lacerta agilis*, **Lv** = *Lacerta viridis*, **Zv** = *Zootoca vivipara*, **Af** = *Anguis fragilis*, **Nn** = *Natrix natrix*, **Ca** = *Coronella austriaca*.

Geographical localities (86), 38 investigated for the first time

New localities (X): 188

Localities in which we reconfirmed the presence of the species (S): 192

The sum of localities (X+S): 380

Localities in which we did not reconfirm the presence of the species (O): 105

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# THE TROPHIC SPECTRUM OF A *HYLA ARBOREA* POPULATION FROM THE FOIENI AREA, SATU MARE COUNTY, ROMANIA

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**Abstract.** In the course of this study we analyzed the food composition of 146 subjects belonging to the *Hyla arborea* species, which were captured in the perimeter of the sand dunes of Foieni in Satu Mare County from May until September 2008. Of the 526 consumed preys, the Araneide have the highest share. These are important regardless of the period or gender of the frogs. Other preys that were consumed in large quantities were the Formicida and the Nematocera. The diversity of the food has a high value during this study, in this habitat the frogs having access to a large variety of prey.

**Keywords:** *Hyla arborea*, feeding, period.

**Rezumat.** Spectrul trofic al unei populații de *Hyla arborea* din zona Foieni, județul Satu Mare, România. Pe parcursul acestui studiu am analizat compoziția hranei la 146 de exemplare aparținând speciei *Hyla arborea*, începând din luna mai și până în luna septembrie a anului 2008, brotăceii fiind capturați din perimetrul Dunelor de Nisip de la Foieni din județul Satu Mare. Din cele 526 de prăzi consumate cea mai mare pondere o au araneidele. Acestea sunt importante indiferent de perioadă sau sexul brotăceilor. Alți taxoni pradă care au fost consumați în cantitate mare sunt și formicidele și nematocerele. Diversitatea hranei are o valoare ridicată pe întreg parcursul studiului, în acest habitat broaștele având la dispoziție a gamă variată de prăzi.

**Cuvinte cheie:** *Hyla arborea*, hrănire, perioadă.

## INTRODUCTION

Amphibians are considered to be potential indicators for modifications in the environmental conditions of the ecosystem in which they live (VITT et al., 1990; BOWERS et al., 1998). Therefore data that presents aspects of the ecology of these species are important for preventing the extinction of certain populations as well as for establishing management plans regarding the preservation of habitats or regarding the impact modifications to these habitats have on amphibians (STORK & SAMWAYS, 1995).

The *H. arborea* species registers a considerable decline in most of Europe, especially due to destruction of habitats, urbanization, climate changes etc. (BORGULA, 1993; STUMPEL, 1993; KUZMIN, 1999). Because this species is sensitive to pollution and drought, in Romania it requires local measures of protection (COGĂLNICEANU et al., 2000a).

In the expert literature there are few papers referring to the trophic specter of this species (KOVÁCS & TÖRÖK, 1997; CLAUSNITZER, 1986). However there are some studies that analyse other specters, like the consequences of habitat fragmentation (ANDERSEN et al., 2004), estimations regarding the number of individuals in a population (PELLET et al., 2007) or estimations about the disposition of the frogs in the trees crown (SCHMIDT et al., 2003).

In our country, papers on the seasonal variation of the trophic spectrum of these frogs are very few. There is only one paper dedicated to this theme (KOVACS et al., 2007). Comparative studies between the food of this frog and the food of other amphibian species are also few (COGĂLNICEANU et al., 2000b; NICOARĂ & COSTICĂ, 2005); therefore it is important to follow the seasonal variations in the frog's feedings. Herpetological studies have recently been done in this area, but they refer only to the composition of the herpetofauna (COVACIU-MARCOV et al., 2008, 2009).

The purpose of this study was to observe the variations in the composition of the food in the different periods of the study as well as the differences between the food of the males and that of the females.

Even if the population the trophic spectrum of which was observed during this study is in a protected area, the quantitative information referring to the role of the amphibians in the ecosystem is important (WHILES et al., 2006), therefore through observation we can obtain useful information about the habitat's state or about the positive or negative changes that appear at the biotope level.

## MATERIAL AND METHODS

The samples were collected in 2008 during five periods at the following dates: May 10, June 8, July 4, August 10 and September 6. During the field trips the stomach content of 146 individuals was sampled, of these individuals 92 were females and 54 males. The habitat is situated on the flank of an oak forest from the sand dunes of Foieni (47°42'0" N, 22°23'0" E, 118 m a.s.l.). Near the habitat there is also a water canal, as well as several puddles, therefore this biotope also confers the necessary conditions for laying eggs in the reproductive season. The tree frogs were captured by hand from the bushes situated on the two sides of a forest road, but a few individuals were found on the ground.

The method used to extract the stomach content was the stomach flushing method (SOLÉ et al., 2005). The advantage of this method is that it allows amphibian feeding studies to be conducted without killing the researched

individuals (COGĂLNICEANU et al., 2000b). 20-50 cm<sup>3</sup> syringes with a perfusion tube of different lengths and exterior diameters attached, according to the frog's dimensions, were used to extract the stomach content. Considering the fact that frogs can digest food in a short period of time (CALDWELL, 1996), which can determine errors in results, we tried to shorten the length of time between capture and the stomach flushing as much as possible. The collected samples were preserved separately in a 4% formalin solution, and stored in sealed test tubes with labels containing information about the frog's sex.

After taking the stomach content, the frogs were released back to their environment, thus trying to diminish as much as possible the impact of our activity on the amphibians. The material was examined in the laboratory with the aid of a binocular magnifying glass. Determining the prey was done by using the expert literature (RADU & RADU, 1967).

The trophic specter was analysed according to the frequency and weight of the preyed taxa, and the diversity and similarity of the food was estimated using the Shannon-Wiener (1949) diversity index (*H*) and the similarity with Sorrensen index (CHAO et al. 2005). The similarity between the feeding of the males and females was calculated with the Mann-Whitney (*U*) test using EstimateS 7.0 software (COLWELL, 2005).

## RESULTS AND DISCUSSIONS

During the study the analysed individuals' feeding was intense, but in the first period of the study there were 7 individuals, and in the last period there were 2 individuals with no stomach content. Generally, the lack of food is caused by certain less than favourable conditions in the environment (too low or too high temperatures) that does not allow some prey, which is sensible to the environmental conditions to become active. Considering that specimens without stomach content were found only at the beginning and the end of the study, we consider this to be the cause of the lack in prey. Still, the small number of individuals that did not eat a prey indicates that the frogs have optimal feeding conditions in this habitat. Individuals without a stomach content were also found by KOVÁCS & TÖRÖK (1997) and by KOVÁCS et al. (2007), and same as here this was more the case of tree frogs collected off the ground at the beginning and at the end of the active period.

In the case of the tree frogs with stomach content, alongside the animal prey we identified vegetal fragments, shed skin and minerals. The vegetal fragments were present in every period, their weight increasing with the number of preys, suggesting that the vegetal fragments were accidentally consumed with the prey or because they were confused with the intended prey. Also we observed that the weight of vegetal fragments is higher in females, because of consuming a higher number of preys than males. There were not found vegetal fragments alone in any of the investigated individuals, which underlines their accidental consumption. Vegetal remains were also identified in the stomach content of tree frogs by other authors (CHIMINELLO & GENERANI, 1992) as well as in other amphibian species (COVACIU-MARCOV et al., 2003a, b).

Shed skin remains were identified in the first two periods of the study, in the stomachs of 13.8% and respectively 11.1% of the analysed tree frogs as well as in September when their weight was a lot smaller (Table 1). In the last period there was one specimen whose stomach content contained only shed skin fragments. Some authors consider that shed skins are consumed to recycle the epidermal proteins (WELDON, 1993), these have nutritional value and are consumed when the trophic offer is low (CICORT-LUCACIU et al., 2007), but in this case the shed skin consumption is low, the frogs having at their disposal enough animal preys to fulfil their energetic necessities.

Table 1. Number of samples and prey taxa; maximum and average number of prey/individual.  
Tabel 1. Numărul de probe și de taxoni pradă; numărul mediu și maxim de prăzi/individ.

	The periods of the study					The sex of the frogs		
	10.05	8.06	04.07	10.08	6.09	Females	Males	Total
No. Sample	29	45	22	20	30	92	54	146
No. Taxon Prey	56	267	27	59	131	388	138	526
No. max. prey/ individual	5	11	4	10	14	14	11	14
Average No. Prey/individual	1.93	5.93	2.45	5.9	4.37	4.79	3.37	4.43

Inorganic materials were identified only in one period (June), and were accidentally ingested.

The maximum and average prey per individual number registers modifications according to period and sex, their highest value being 8, in June, and 10, in August (Table 1). Therefore, we can consider that in these two periods during the study, the analysed population had the best feeding conditions because the environmental conditions were favourable for the development of a large number of preys. In July, the average number prey/individual was only 2.27, this period not being favourable for frog activity, as well as for the invertebrates they consumed because of high temperatures. For the females the average number of preys is 4.79, for the males this number is lower (3.37), females needing more energy in the mating season (VANCEA et al., 1961). The 526 identified preys from the analysed stomach content were classified in 33 taxonomical categories.

Regarding the taxonomical prey weight, it registers variations according to period and gender. Among the most important preys in the trophic spectrum of the studied population are the Araneida, which were consumed during the

entire duration of the study and also have a high weight (Table 2). In July, their weight was 25.9%. Also in the case of the males, the Araneida have the first place from the total of consumed taxa.

Table 2. The weight of the prey taxa.

Tabel 2. Ponderea taxonilor pradă.

Prey Taxa Category	The periods of the study					The sex of the frogs		Total
	V 10	VI 8	VII 4	VIII 10	IX 6	Females	Males	
Gasteropoda-snails	1.79	2.62	3.7	5.08	2.29	2.58	3.62	2.78
Gasteropoda-Limax	-	0.37	-	-	-	0.26	-	0.19
Crustacean-Izopoda(t)	-	4.49	3.7	25.4	11.5	7.99	8.7	7.96
Arahnida Pseudoscorpionida	-	0.37	-	-	-	0.26	-	0.19
Arahnida-Acarian	-	0.37	-	-	-	0.26	-	0.19
Arahnida-Araneida	19.6	16.9	25.9	11.9	14.5	15.7	19.6	16.5
Myriapoda-Chilopoda	-	-	-	-	0.76	0.26	-	0.19
Myriapoda-Diplopoda	-	-	-	5.08	4.58	1.29	2.9	1.67
Ephemeroptera	-	0.37	-	-	-	-	0.72	0.19
Orthoptera	-	-	-	1.69	-	-	0.72	0.19
Plecoptera	-	0.37	-	-	-	0.26	-	0.19
Heteroptera(t)	-	4.49	-	-	-	2.58	1.45	2.22
Homoptera-Cicadina	1.79	0.75	18.5	1.69	2.29	2.06	2.9	2.22
Lepidoptera (L)	7.14	5.24	-	1.69	19.8	6.96	13	8.33
Lepidoptera	-	3.75	3.7	10.2	3.82	4.12	3.62	4.07
Trihoptera	-	-	-	-	0.76	0.26	-	0.19
Coleoptera-undet.	14.3	3.37	3.7	3.39	2.29	3.35	7.25	4.26
Coleoptera-Carabidae	-	2.25	3.7	-	0.76	2.06	-	1.48
Coleoptera-Cryzomelidae	10.7	3.37	-	-	1.53	2.58	2.9	3.15
Coleoptera-Coccinellidae	-	0.75	-	-	-	0.52	-	0.37
Coleoptera-Curculionidae	5.36	5.62	-	1.69	0.76	4.12	2.17	3.7
Coleoptera-Elateridae	7.14	2.62	7.41	-	-	2.58	1.45	2.41
Coleoptera-Stafilinidae	-	-	-	-	0.76	0.26	-	0.19
Coleoptera-Cantaridae	3.57	0.75	7.41	-	-	1.55	-	1.11
Diptera-Nematocera	10.7	24	-	-	5.34	16.5	6.52	14.3
Diptera-Brahicera (L)	-	1.5	3.7	-	0.76	1.55	-	1.11
Diptera-Brahicera	16.1	4.87	3.7	6.78	9.92	5.93	11.6	7.41
Neuroptera	-	-	-	1.69	-	0.26	-	0.19
Hymenoptera-undet.	1.79	1.5	3.7	-	1.53	1.03	2.17	1.48
Hymenoptera-Formicidae	-	5.24	11.1	18.6	16	10.3	6.52	9.07
Hymenoptera-Apidae	-	0.37	-	-	-	0.26	-	0.19
Panorpata	-	-	-	5.08	-	-	2.17	0.56
Blatoidea	-	3.75	-	-	-	2.32	-	1.85

Regarding the females, although spiders have a high weight, the prey that was consumed in the largest quantity was Diptera Nematocera. Because these are of smaller dimensions, they are consumed in larger numbers which leads to an increase in the value of their weight. If we refer to the consumption frequency of this taxonomical category, we can observe that it is situated, in all five periods of the study, on the first or on the second position. Spiders were found in 50% of the analysed tree frogs. Both in the case of the males and females, the most consumed preys were spiders. We can observe a connection between the frequency and the weight of this group in the composition of the tree frog's food. Spiders are accessible to a large number of individuals and are also available in large quantities. Spiders also have an important value for a population of *Pelophylax kl. esculenta* which is also located in the forest of Foeni (SAS et al., 2009). In this way we can observe the opportunistic character of the Amphibians, which feed on the most abundant preys in their habitat.

The Araneida are a largely spread group of arthropods, which are not pretentious to the environmental conditions and are present in the food of the frogs during the entire length of their active period. Spiders also represented an important trophic category in the food of other populations of tree frogs, like the one from Resighea (KOVACS et al., 2007) but also in the trophic spectrum of other Amphibian species (COVACIU-MARCOV et al., 2000).

The Nematocera are situated on the second position, according to the quantity in which they were consumed, during the study, even though they are missing in the third and forth months because of bad environmental conditions. The high temperatures led to the drying up of the pools, prohibiting their reproduction in that period. Unlike the males,

the females were the ones that consumed the mosquitoes in high number and quantity. In periods favourable for reproduction, the Nematocera are abundant in the habitat, being a small and flying species, they can be consumed in large quantity by the frogs. In June, mosquitoes were consumed by 75.6% of the individuals, meaning the highest frequency at which a prey was consumed.

The Formicida are situated on the third place both as frequency and as weight. Because they are small preys, they can be consumed in large quantities, but also by many tree frogs, because they are also spread evenly through the habitat (Table 3). Ants are missing from the first part of the study, but after that, they are consistently found in the stomach content of the tree frogs. This situation was also observed by COGĂLNICEANU et al. (2000b), who, following a study, identified Formicida in a high weight in the stomach content of tree frogs.

Table 3. The frequency of the vegetal, shed skin, mineral and prey taxa.  
Tabel 3. Frecvența fragmentelor vegetale, exuvie, minerale și taxoni pradă.

	The periods of the study					The sex of the frogs		Total
	V 10	VI 8	VII 4	VIII 10	IX 6	Females	Males	
%Vegetal	24.1	55.6	27.3	20	26.7	40.7	24.4	36.9
%Shed skin	13.8	11.1	-	-	6.67	7.41	12.2	9.02
%Mineral	-	2.22	-	10	-	1.23	2.44	1.64
<b>Prey taxa</b>								
Gasteropoda-snails	3.45	11.1	9.09	30	10	9.88	12.2	10.7
Gasteropoda-Limax	-	2.22	-	-	-	1.23	-	0.82
Crustacean-Izopoda (t)	-	20	9.09	70	26.7	21	19.5	20.5
Arahnida-Pseudoscorpionida	-	2.22	-	-	-	1.23	-	0.82
Arahnida-Acariena	-	2.22	-	-	-	1.23	-	0.82
Arahnida-Araneida	31	66.7	63.6	50	36.7	54.3	41.5	50.8
Myriapoda-Chilopoda	-	-	-	-	3.33	1.23	-	0.82
Myriapoda-Diplopoda	-	-	-	30	20	6.17	9.76	7.38
Ephemeroptera	-	2.22	-	-	-	-	2.44	0.82
Orthoptera	-	-	-	10	-	-	2.44	0.82
Plecoptera	-	2.22	-	-	-	1.23	-	0.82
Heteroptera (t)	-	22.2	-	-	-	9.88	4.88	8.2
Homoptera-Cicadina	3.45	4.44	36.4	10	6.67	8.64	7.32	8.2
Lepidoptera (L)	10.3	22.2	-	10	50	22.2	26.8	23.8
Lepidoptera	-	22.2	9.09	50	16.7	18.5	12.2	17.2
Trioptera	-	-	-	-	3.33	1.23	-	0.82
Coleoptera-undet.	24.1	17.8	9.09	20	10	13.6	24.4	17.2
Coleoptera-Carabidae	-	11.1	9.09	-	3.33	8.64	-	5.74
Coleoptera-Cryzomelidae	13.8	15.6	-	-	6.67	9.88	7.32	10.7
Coleoptera-Coccinellidae	-	2.22	-	-	-	1.23	-	0.82
Coleoptera-Curculionidae	6.9	26.7	-	10	3.33	14.8	7.32	13.1
Coleoptera-Elateridae	10.3	13.3	18.2	-	-	9.88	4.88	9.02
Coleoptera-Stafilinidae	-	-	-	-	3.33	1.23	-	0.82
Coleoptera-Cantharidae	6.9	4.44	9.09	-	-	6.17	-	4.1
Diptera-Nematocera	17.2	75.6	-	-	16.7	42	17.1	36.1
Diptera-Brahicera (L)	-	8.89	9.09	-	3.33	7.41	-	4.92
Diptera-Brahicera	24.1	24.4	9.09	40	33.3	24.7	29.3	27
Neuroptera	-	-	-	10	-	1.23	-	0.82
Hymenoptera-undet.	3.45	6.67	9.09	-	6.67	4.94	4.88	5.74
Hymenoptera-Formicidae	-	28.9	27.3	40	26.7	29.6	9.76	23
Hymenoptera-Apidae	-	2.22	-	-	-	1.23	-	0.82
Panorpata	-	-	-	20	-	-	4.88	1.64
Blatoidea	-	20	-	-	-	9.88	-	7.38

Another category of prey that presents interest for the tree frogs diet are Lepidoptera; these are consumed in either form, adult or larva. Even so, between the two forms, the caterpillars are predominant. In the last part of the study, their weight was 19.8% and they were present in half of the analysed stomach content, situating themselves on the first position according to both frequency and weight. They are consumed by both males and females, and are easy to capture because of their slow movements. They are important preys because of the high content in lipids (BROOKS et al., 1996).

The Coleoptera are also present during the entire length of the study. They are represented by a few families, among which the most important are the Chryzomelida, Curculionida and Elaterida. This can be explained because of the abundance of Coleoptera in nature, the order with the most species in nature (RADU & RADU, 1967).

It is also interesting the presence of terrestrial Isopoda, which have a high frequency and weight, especially in August and September. In the fourth period, their weight was 25.4% and their frequency was 70%, therefore they are an important prey for the studied population. Also we can observe that the values are similar for both genders, this can be explained through the fact that Isopoda are easy to capture and are widely spread through the habitat, therefore accessible to a large number of individuals. Being dependent on humidity, we can deduce the fact that only in these periods the conditions were favourable for the development of this prey category, in all the other periods they are missing or have little importance in the trophic spectrum of the population. Isopoda were also identified in the population from Resighea, but unlike our case, they were present in March when the analysed specimens were captured off the ground or from the water in the mating season (KOVACS et al., 2007).

In July, when the high temperature confined the activity of potential prey, we noted that the Cicada and the Araneida represent the main trophic category for the tree frog, due to these taxonomical groups being linked to heat and dryness. They were also identified in the diet of other populations of *H. arborea* especially during the summer months (KOVACS et al., 2007; COGĂLNICEANU et al. 2000).

Hereby we can deduce that the individuals of this species are general and opportunistic predators, which consume the preys that are available at that time in the habitat. This is a characteristic trait of the *Hyla* Genus species (HIRAI & MATSUI, 2000) as well as of other Amphibian species (TÖRÖK & CSÖRGŐ, 1992).

Regarding the gender of the frogs, even though the females had greater food diversity, we observed that the base trophic categories for this population were similar, fact that also resulted from the use of the Mann-Whitney (U) test. We obtained  $p=0.11$ ,  $p>5$  so the differences that appear in the trophic spectrum of the two genders are negligible.

The greatest diversity was registered in June, 2.48. In this period, the environmental conditions were favourable for the development of different taxonomical groups of prey. In this month, a more intense feeding of the tree frogs was also observed. In the next month the diversity value was lower (Table 4), probably because of the high temperatures that reduced the trophic offer.

In the first period of the study the food similarity index between analysed individuals had a value of 0.10, the lowest value, because in this period there was not a taxonomical category of prey with a high frequency, the frogs consuming different types of prey from different categories.

Table 4. Food diversity and similarity between individuals.  
Tabel 4. Diversitatea și similaritatea hranei între indivizi.

The periods of the study	V 10	VI 8	VII 4	VIII 10	IX 6
Diversity (Shannon)	1.95	2.48	1.83	1.99	2.17
Similarity (Sorrensen)	0.10	0.33	0.25	0.31	0.19

CONCLUSIONS

There is a season variation of the trophic spectrum composition of *H. arborea*, primarily determined by the variations in availability of the taxonomical groups of prey in the tree frogs environment, due to environmental conditions as well as due to the invertebrates' growth cycles. The tree frogs have an opportunistic and general feeding style, consuming the prey that is more abundant in their perimeter, reflecting the food sources that are available in their habitat.

There are no notable differences between males and females, both having a similar life style, roughly equal body dimensions and populating the same microhabitats, so there are no major differences between taxonomical groups of prey they consume.

During the five periods of the study, the tree frogs intensively fed, having available in this habitat, regardless of the environmental conditions, different categories of prey. Therefore, this habitat offers the necessary conditions for feeding and reproduction for the tree frogs, conditions that in time led to the maintenance and development of the population.

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## RESEARCH REGARDING THE YELLOW-BELLIED TOAD, *BOMBINA VARIEGATA*, FROM LEREȘTI AREA, ARGEȘ COUNTY, ROMANIA

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**Abstract.** The present study follows the determination of two aspects regarding a *Bombina variegata*-like population from Lerești locality, Argeș County. These two directions of analysis aim to establish the trophic spectrum and the affiliation of this population. The toads used very efficiently the food resources from the habitat. Thus, the stomach samples highlighted an overwhelming majority of larvae, respectively those of *Nematocera* and *Ephemeroptera*, which are an energetic source easy to obtain and rich from a trophic aspect. The aquatic preys register a majority, being in a direct relation with these data. Moreover, the two grids that define the affiliation of the population emphasized the existence of a typical *Bombina variegata*-like population. This aspect is in relation with the high altitude of the area.

**Keywords:** *Bombina variegata*, trophic spectrum, population affiliation.

**Rezumat.** Cercetări privind izvoarașul cu burtă galbenă, *Bombina variegata*, din zona Lerești, județul Argeș, România. Studiul de față urmărește cunoașterea a două aspecte cu privire la o populație de *Bombina variegata*-like din localitatea Lerești, județul Argeș. Aceste două direcții de analiză vizează determinarea spectrului trofic și respectiv stabilirea apartenenței acestei populații. Populația de buhai s-a folosit foarte eficient de resursele de hrană din habitat. Astfel probele stomacale au evidențiat o majoritate covârșitoare a larvelor, respectiv cele de nematocere și efemeroptere, acestea fiind o sursă energetică ușor accesibilă și bogată din punct de vedere trofic. În relație directă cu aceste date se află și prezența majoritară a prăzilor acvatice. Totodată, cele două grile care conturează apartenența populației au evidențiat existența unei populații tipice de *Bombina variegata*-like. Acest lucru este în concordanță cu altitudinea mare a zonei.

**Cuvinte cheie:** *Bombina variegata*, spectru trofic, apartenența populației.

### INTRODUCTION

The two European species of the *Bombina* gender, respectively *Bombina bombina* and *Bombina variegata* are distinct through various aspects, such as morphology, anatomy, ecology and behavior (FUHN, 1960). Thus, the fire-bellied toad, *Bombina bombina* (LINNAEUS, 1761) has adapted to the lower, field areas, preferring altitudes up to 150m (MADEJ, 1973), whereas the yellow-bellied toad, *Bombina variegata* (LINNAEUS, 1758) has characters specific to the higher, hilly and mountainous areas (COGĂLNICEANU et al., 2000). Although they are different because of the distinct areas that they ecologically occupy, however there is an overlapping of the areas, therefore creating a hybridizing zone between the two species (SZYMURA, 1993).

In order to successfully protect a species, it is necessary to know certain aspects regarding its development parameters, such as the way of feeding. At the same time, the existence, or on the contrary the lack of a trophic diversity can suggest certain connections between these aspects and the quality of the environment (INGER & COLWELL, 1977). The majority of the amphibian species from Romania is nationally protected, therefore an expansion of the data regarding their habitats, trophic spectrum, ecological limits of development is required, as well as other information which could contribute to their protection. Studies such as the feeding ones realized by different researchers (SAS et al., 2005, FERENȚI et al., 2007, COVACIU-MARCOV et al., 2004) are of great importance in the accomplishment of this fact. Moreover, *Bombina variegata*-like populations are signalled beginning with low altitudes of approximately 120-350m (COVACIU-MARCOV et al., 2001, 2002) in the western part of the country, at the contact area of the hills with the plain, where the aspect of the habitat allows the existence of these populations.

Therefore, the objectives of this study aim at the following aspects: 1. the establishment of the affiliation of the population at one of the two species; 2. the determination of the trophic spectrum and the outlining of some connections within the trophic elements.

### MATERIALS AND METHODS

Our observations were made in august 2008, when we investigated a *Bombina* population composed of 50 individuals (13 females, 37 males) from Lerești locality, Argeș County. The habitat lies in the SE part of the Iezer Mountains at 773 m altitude. The biotope comprises a system of two puddles, being strongly influenced by man. Thus, it is situated between electric pillars and the secondary road 734, which leads to Voina chalet. At the same time, the domestic animals come here and drink water. Moreover, remains of construction materials could be found near the pond at the time of study. Therefore, populations like this one can become vulnerable, especially if they are found within or near a locality.

The analysed habitat is formed of two ponds of different sizes, in a whole covering approximately 5 m wide and 15 m long. The vegetation is very rich, being formed of submersed and immersed species. This aspect encourages

the appearance of invertebrates. The substratum of the pond is formed from a layer of silt, therefore the yellow-bellied toad finds refuge in case of danger.

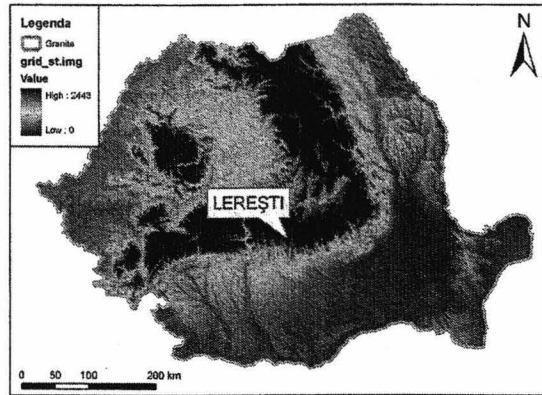


Figure 1. The location of the studied population.  
Figura 1. Localizarea populației studiate.

### The analysis of the trophic spectrum

The toads were captured using the limnological dredger, and afterwards they were released in their habitat in order to reduce as much as possible the influence of our study. We used the stomach flushing method in order to draw the samples. This method is recommended because of the low rate of injured animals (SOLÉ et al., 2005). This aspect is very important, mainly for the protected amphibians, such as *Bombina variegata*, which is a Natura 2000 species, the method allowing the study of the toads without endangering the status of the species. The stomach contents were stored in airtight test tubes, and afterwards determined in the laboratory using the scientific literature (RADU & RADU, 1967; CRIȘAN & MUREȘAN, 1999; CRIȘAN & CUPȘA, 1999; IONESCU & LĂCĂTUȘU, 1971) and the microscope. The results were statistically processed, following the weight and the frequency of the prey taxa, their origin as well as the relation between these elements.

### The analysis of the *Bombina* population affiliation

The study of this aspect was realised in concordance with two grids (the first one was worked out by Szymura & Gollmann, and the second one by STUGREN, 1980), each containing 10 characters which emphasize the chromatic and morphological characters of the two species (SZYMURA, 1993). The grids contain specific features for the parental species, respectively that aspect which is typical for *Bombina bombina* will be graded with 0, and that one that is standard for *Bombina variegata* will be marked with 1. Therefore each individual can raise a score that varies between 0 (for a pure *B. bombina* individual) and 10 (for a pure *B. variegata* sample). The individuals that gathered a score between 2-3 are *B. bombina*-like, between 4-6 are hybrids, and between 7-8 are *B. variegata*-like. These results can be transformed in percentage data and afterwards, the general affiliation of the entire population can be determined.

The first grid analyses 10 chromatic characters regarding the morphology, dimensions and ratio of the light ventral spots. They are red ones at *B. bombina* and yellow at *B. variegata* (FUHN, 1969). A majority holds the black pigmy in the case of the first species, in which isolated islands of light pigment appear. Concerning the second species, the yellow pigment prevails, at the level of which black spots appear accidentally. If the black pigment separates the light spots then the character is specific for *B. bombina*, and if the spots are united then the character is a *B. variegata* one.

Moreover, two aspects have been analyzed regarding the results of the two grids. Thus an average has been made both vertically (in order to determine the percentage of *B. variegata* in each individual) and horizontally (so that to realize a general situation of the characters expressed within the whole population).

## RESULTS AND DISCUSSIONS

### The analysis of the trophic spectrum

Within the trophic niche, the amphibians are secondary consumers, therefore their diet is primarily composed of animal preys. The identified elements in the stomach contents of the studied population are of animal, vegetal, inorganic nature and respectively shed-skin remains. Within this population there is a strong interrelation between the most important element of the trophic spectrum and the prey origin. Therefore a valuable connexion is set between the high weight of the larvae preys and the mainly aquatic origin of them. This fact suggests that the trophic offer was overwhelmingly rich in larvae forms, thus the toad population did not have to leave the aquatic medium and hunt in the terrestrial one. Because of the different environmental conditions (drought, the lack of an aquatic trophic variety) other

*Bombina* populations left the aquatic medium, thus the weight of the preys is mainly terrestrial (GROZA et al., 2008, SAS et al., 2004).

From 50 individuals, two samples did not present animal content, registering a relatively low percentage (4%) within the population. Thus, one of the individuals consumed only vegetal matter, while the second one ingested exclusively shed-skin fragments. These cases can be considered as accidental. However, on a whole the weight of the stomachs with content was 100%, thus it can be insinuated that optimum feeding conditions were present. This situation is not a general one, populations that had very high weights of empty stomachs being signalled in the scientific literature (SAS et al., 2003). The maximum number of preys was determined at a male that consumed 28 preys, while the average one was established at 10 preys/individual. Therefore, despite the anthropic factor, the ecological conditions of the pond managed to successfully sustain life development.

On the one hand, the low consumption of minerals (2%) suggests the fact that these were accidentally ingested (SAS et al., 2003, GROZA et al., 2008). On the other hand, the shed skin consumption has higher values, respectively 12%, appearing even an individual that consumed only this type of element. The value is higher in the case of the males, therefore 13.51% of them consumed this element. The relatively high ratio of this type of food can be attributed to epidermal recycling (WELDON et al., 1993), but usually it is considered that it was accidentally swallowed (SAS et al., 2005, FERENȚI et al., 2007).

Regarding the stomach frequency with vegetals, more than half of the individuals (62%) presented this type of content. The most plausible explanation is given by the rich presence of vegetation in this habitat. They do not represent a substantial food element, being accidentally ingested together with the prey (WHITAKER et al., 1977). Generally, the rate is relatively high in comparison to the other elements of the trophic spectrum (shed skin and minerals), cases when their frequency exceeded 80% have been reported (SAS et al., 2005).

In direct relation to these data is the prey origin, which is mainly aquatic (87.60%). Thus, because of the favourable conditions that allowed the persistence of the aquatic habitat, the toads are not forced to leave the medium, the preys being at their hand.

Considering the fact that the amphibians are predators (COGĂLNICEANU et al., 2000), the majority of their diet is composed of animal prey. Thus, within the studied population, the samples revealed a total number of 518 preys. These are composed of invertebrates, from which 98.65% are grouped in the Insect class. The Nematocera (46.20%), respectively the Ephemeroptera (37.40%) larvae, held the biggest weight. Because of the large presence of Ephemeroptera larvae, which are an indicator for clean water, it can be deduced that the respective environment provides healthy development conditions, despite the obvious influence of man. The overwhelming majority of these larvae (together accumulating over 80% from the total prey amount) suggests that the toads had good feeding conditions within the aquatic medium. Therefore, although *B. variegata* is a more terrestrial species than *B. bombina*, still due to the rich trophic offer, they left the aquatic biotope only rarely. The same fact can also be observed at a hybrid *Bombina* population from Oradea, when in August the Nematocera larvae registered very high weights (SAS et al., 2005). At the same time, the larvae stage of the insects is considered to be richer in lipid, and therefore have a higher nutritional content (REDFORD & DOREA, 1984). Regarding the difference between the sexes, the variations are very low, thus they are preferred by both of them due to their accessibility.

The following prey categories are consumed in very low quantities, the majority being swallowed just once by only one individual, thus their value in the trophic spectrum is negligible (0.20%). For this reason, it can be deduced that they were accidentally consumed. Within these low weights, the Formicidae and aquatic Heteroptera register high values, being clearly distinct from the rest of the preys. The ants are small, gregarious animals, therefore they can be consumed in larger quantities and by many individuals. These are important preys for the toads because they represent an easily captured prey, thus they do not make a high effort, maintaining their energy for the large-sized preys. The same situation can be observed at the hybrid population, where the Formicidae occupy second place after the Nematocera larvae, representing approximately 4% of the total consumed preys (SAS et al., 2005).

Within this population, almost the same preys occupy first places in the case of the frequency with which they were consumed. This constancy in the high weight of certain prey taxa and the high number of toads that fed with these preys suggests a homogenous trophic spectrum. Therefore, although *Bombina variegata* lives in reduced aquatic sectors, being thus constrained to search for food in the terrestrial medium, however here at approximately 750m altitude it manages to find optimum conditions so that it does not have to leave its medium. Analyzing the data, it can be noticed that the Nematocera and Ephemeroptera larvae register very high values, therefore they have been consumed due to their richness and high accessibility. Thus, these preys have not been accidentally swallowed in large numbers by few individuals, 86% from the total of 50 individuals have consumed the larvae of these insects. This connection between the frequency and weight of certain taxa is very important, suggesting the toads' opportunistic behavior. Through the fact that it takes advantage of this rich offer, it preserves its energy and on a whole it increases its chances of survival.

However, there are preys that were consumed in a small number by the individuals, but register a relatively high frequency. Thus, the Coleopterans, because of their larger size were consumed in lower quantities by 16% of the toad population. Therefore, it can be observed the presence of preys of different sizes, both small and large, which suggests the fact that the toads do not hunt selectively, but regarding the prey that comes in sight and has the proper size



to be swallowed (ZIMKA, 1966). The fact that the toads capture the preys without preference has been signalled in other feeding studies as well (SAS et al., 2003, FERENȚI et al., 2007).

Table 1. The stomach frequency with vegetals, shed-skin and minerals, the amount (A%) and frequency (F%) of the preys; the origin of the prey taxa.

Tabel 1. Frecvența stomacurilor cu vegetale, exuvie și minerale, ponderea (A%) și frecvența (F%) prăzilor, proveniența taxonilor pradă.

	A (%)			F (%)		
	F	M	T	F	M	T
Vegetals				77	56.76	62
Minerals				-	2.70	2
Shed-skin				7.69	13.51	12
Gasteropoda-snail	-	0.26	0.20	-	2.70	2.00
Gasteropoda-Limax	-	0.26	0.20	-	2.70	2.00
Arahnida-Araneida	-	1.02	0.80	-	10.81	8.00
Miriapoda-Diplopoda	0.92	-	0.20	7.69	-	2.00
Collembola	-	0.26	0.20	-	2.70	2.00
Ephemeroptera (L.)	42.20	36.06	37.40	53.85	56.75	56.00
Odonata (L.)	0.92	0.26	0.40	7.69	2.70	4.00
Homoptera-Afidina	-	0.26	0.20	7.69	2.70	4.00
Homoptera-Cicadina	-	1.02	0.80	-	8.10	6.00
Heteroptera (aq.)	-	4.09	3.20	-	16.21	12.00
Heteroptera	-	1.28	1.00	-	13.51	10.00
Coleoptera	-	1.53	1.20	15.38	16.21	16.00
Coleoptera-Carabidae	-	0.77	0.60	-	5.40	4.00
Coleoptera-Cantharidae	-	0.26	0.20	-	2.70	2.00
Coleoptera-Dytiscidae (L.)	-	0.26	0.20	-	2.70	2.00
Diptera-Nematocera	-	0.26	0.20	-	2.70	2.00
Diptera-Nematocera (L.)	44.95	46.55	46.20	84.62	81.08	82.00
Diptera-Nemat. Typulidae	1.83	-	0.40	7.69	-	2.00
Diptera-Brahicera	1.83	1.28	1.40	15.38	13.51	14.00
Diptera-Brahicera (L.)	0.92	-	0.20	7.69	-	2.00
Himenoptera	1.83	0.77	1.00	15.38	5.40	8.00
Himenoptera-Formicida	4.59	3.58	3.80	23.07	27.02	26.00
Terrestrial	11.01	12.79	12.4			
Aquatic	88.99	87.21	87.6			

### The analysis of the population affiliation

The individuals were analysed according to two grids, taken from scientific literature. The studied characters within the grids proved that the population taken into discussion has aspects mainly from *B. variegata*. This fact is determined both by the specific altitude for this species and the habitat's morphology, which influences the type of toad that is found (MACCALLUM et al., 1998). Thus, in some cases, the aspect of the biotope can be even more valuable than the altitude at which it is found. In this respect, populations of *B. variegata*-like have been studied at much lower altitudes in comparison to the studied population (COVACIU MARCOV et al., 2001). In the case of the *B. variegata*-like populations, they reach even 150-160m in Oradea area, because of the fact that in these contact sectors between hills and plains, suitable habitats can be found for this species.

No pure *B. variegata* individual was identified within the population. Thus, three had a close value to that of the hybrids between the two species (respectively 57.5%), 45 individuals were closer to *B. variegata*-like (registering values between 65%-87.5%) while two samples had 90% *B. variegata* characters. On a whole, the population is a typical *B. variegata*-like, having an average of the grids of 75.1%. This situation can also be observed at altitudes of approximately 155m, within the populations from Oradea area, which are also closer to *B. variegata* (COVACIU MARCOV et al., 2001). In comparison, a study from Ier plain upon several hybrid populations identified a reduced percentage of *B. variegata* characters (generally under 10%) at altitudes of approximately 120-130m (COVACIU MARCOV et al., 2002). This fact is due both to the low altitude, type of present relief (field) and the biotope's morphology (large and deep puddles). In the case of the Leresti population, there is not an individual that approaches the fire-bellied toad, the lowest average being over 50% *B. variegata* characters.

Regarding the first grid, the majority of the characters (1, 4, 5, 7, 8, 9 and 10) are expressed as *B. variegata* ones, registering values that vary between 68-100%. A very interesting situation can be observed within this grid, where major differences occur between the features of the two species. Thus, the second (the spots around the chin-chest area), third (the ones from the chest area) and the sixth character (the spots from the chest-abdomen area) are expressed in a proportion of 97%, 90% respectively 75% as *B. bombina* ones. The same situation can be observed in the case of the population near Oradea. This important difference is explained by STUGREN & VANCEA (1968) through the mutation phenomenon, thus the different features of the two species are sensed regarding the intensity selection, determined by the choice of the most advantageous characters.

The second grid also analyses 10 aspects. In this case there were 4 individuals that presented 100% *B. variegata* characters. The majority of the population comprises individuals that have *B. variegata* - like characteristics. Certain aspects were present at all of the individuals in a percentage of 100%, such as the first (it refers to the ventral colouring, which is yellow at *B. variegata* and red at *B. bombina*), second (the colour of the upper part of the first fingers and the top of fingers, which is yellow at *B. variegata* and black at *B. bombina*), third (the dorsal colouring is black at *B. bombina* and pale grey at *B. variegata*), sixth (the relation between the length and width of the head) and ninth character (the dorsal verrucae: sharp at *B. variegata* and smoothed at *B. bombina*). The 4<sup>th</sup> (the light spots from the tarsian and planter, which are united at *B. variegata* and separated through black pigment at *B. bombina*), 5<sup>th</sup> (the ratio between the dark pigment and the light one at the ventral side) and 10<sup>th</sup> character (the ratio of tibia-tarsian joints when the stylopode and zeugopode are parallel) are expressed as *B. variegata* ones, registering values between 75-90%. While character 7 (the presence at *B. bombina* of small white spots around the lateral-ventral verrucae and their absence at *B. variegata*) is a strong feature of *B. bombina* species, being present at 74% of the population. This situation can also be noticed at the *B. variegata*-like population from Oradea. Character 8 (the drawing of the dorsal part) is present at 48% half the population, thus at half of the individuals it is expressed as a *B. bombina* feature (regulated black tubercles) and at the other half as a *B. variegata* aspect (black scattered verrucae). Thus, the reduced weight of the 8<sup>th</sup> character is probably compensated by the exclusive presence of the sharp verrucae from the dorsal part of the individuals (character 9). Thus, as an adaptive feature it can be noticed the presence of the spines which secrete the highest quantities of toxic substances. At the same time, a refuge for the toad is presented through the grey silt, therefore a stained back with tubercles could represent a disadvantage for the population.

### CONCLUSIONS

The trophic spectrum highlighted an overwhelming presence of the aquatic preys due to the rich content in larvae forms. Thus, because of the environmental conditions, the toads found plenty of trophic resources in the habitat, and therefore they did not have to leave the aquatic medium. However, the high weight of stomachs with content also suggests the existence of favourable conditions for the unfolding of the feeding activities. Secondly, the two grids emphasized a typical *Bombina variegata* - like population. Moreover, characters specific to this species could have been noticed, aspects which are determined by the relief and habitat's morphology.

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## DATA UPON THE FEEDING OF TWO *EPIDALEA VIRIDIS* POPULATION FROM DOBROUDJA, ROMANIA

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**Abstract.** We analysed the trophic spectrum of two *Epidalea viridis* populations from Dobroudja, around St. Ap. Andrei and Cocoș monasteries, during the period of 08-25 August 2007. The appearance of the different preys is influenced by the environmental conditions, the frogs feeding mostly terrestrial. The taxa with the highest weights were the Formicida, the formic acid from their body being used for the venom secretion of the frogs' skin. The prey diversity depends on the habitat, the maximum one being registered in the case of the Cocoș monastery.

**Keywords:** trophic spectrum, Dobroudja, *Epidalea viridis*.

**Rezumat.** Date asupra hrănirii unei populații de *Epidalea viridis* din Dobrogea, România. Am analizat spectrul trofic la două populații de *Epidalea viridis* din Dobrogea, din jurul manastirilor Sf. Ap. Andrei și Cocoș în perioada 08-25 August 2007. Apariția diferitelor prăzi este influențat de condițiile mediului, hrana broaștelor fiind majoritar de proveniență terestră. Taxonul cu ponderea cea mai mare erau Formicidele, acidul formic din corpul lor fiind folosit pentru secretarea veninului din pielea broaștelor. Diversitatea prăzilor depinde de habitat, maximul fiind înregistrat în cazul mănăstirii Cocoș.

**Cuvinte cheie:** spectrul trofic, Dobrogea, *Epidalea viridis*.

### INTRODUCTION

It is known that amphibians can successfully inhabit dry environments, characterized by intermittent availability of water (SICILIA et al., 2006). The amphibians have diverse adaptations in order to successfully survive in the terrestrial medium, such as the modification of the skin permeability and the decrease of urine secretion (JORGENSEN, 1997). Moreover, other adaptations are the usage of temporary puddles only for reproduction and the rapid metamorphose of the tadpoles (HUSSEIN & DARWISH, 2000). Further research shows that the way in which the amphibians use the terrestrial habitats can be much more complex than it was previously thought to be (HOPKINS, 2007). This was the reason that many authors started to reassess the importance of the terrestrial habitats near the moist areas (SEMLITSCH & ROTHERMEL, 2003; GIBBONS, 2003).

*Epidalea viridis* is an eurithop species, it is considered to be a pioneer species, having the characteristic to live in regions with a dry and warm climate (PUKY et al., 2005), including on sandy substratum (ARNOLD, 2002a). The *Epidalea viridis* species is a xerothermophilous element, being considered one of the most common species from Dobroudja (COVACIU-MARCOV et al., 2006 a), while in the western and northern part of the country it is less commonly encountered, due to the colder and wetter climate (COVACIU-MARCOV et al., 2003 a, 2004 a). Its typical reproductive sites are temporary and shallow water bodies (BOLOGNA & GIACOMA, 2006). Studies about the trophic spectrum of this species have been published by many authors (COVACIU-MARCOV et al., 2005; HUSSEIN & DARWISH, 2000; NICOARĂ et al., 2005; DAVID et al., 2008).

The objective of our study is to analyse the trophic spectrum of two *Epidalea viridis* populations, highlighting the differences between them, respectively the adaptations of their trophic spectrum towards the terrestrial environment.

### MATERIAL AND METHODS

We analysed two *Epidalea viridis* populations from Dobroudja, from Constanța and Tulcea County during 8-25 August 2007. The investigated frogs from each population were collected around St. Ap. Andrei, respectively Cocoș monasteries.

St. Apostle Andrei monastery is surrounded on one side by an agricultural field, and on the other side by a forest, which is partly affected by the presence of the refuse. The humidity of the area is maintained by fountains, a canal that dries out in the droughty period, and by temporary puddles that are mainly situated inside the forest.

The habitat from Cocoș Monastery is slightly different from the previous one, being less anthropically affected. The forest is richer near the monastery, the reproducing habitats also being represented by the temporary puddles from the forest.

The collecting of the analysed samples was made directly by hand after nightfall, at the electric lights. The stomach samples were drawn with the help of the stomach flushing method, which is recommended by many authors (SOLÉ et al., 2005, SOLÉ & PELZ, 2007, CAPUTO & VOGT, 2008, CECALA et al., 2007). This is a non lethal technique for the analysed frogs. The stomach contents were preserved in formaldehyde and analysed using the scientific literature (RADU & RADU, 1967, STEINBACH et al., 2000; CHINERY, 1998; PAULIAN, 1971).

The results were statistically analysed, the followed parameters being the taxonomic affiliation of the preys, the feeding intensity, the rate of the feeding activity, the origin, weight and frequency of preys, the food diversity (the Shannon Wiever index) (SHANNON & WEAVER, 1949), food similarity (the Sorrensen index) (CHAO et al. 2005) and the differences that appear between the two habitats (the Mann Whitney test), using Estimates 7.0 software (COLWELL 2005). Thus, the obtained data were comparatively explained, analysing the differences that appear between the trophic spectrums of the two *Epidalea viridis* populations.

## RESULTS

The *Epidalea viridis* population from St. Apostle Andrei Monastery was studied between the 8<sup>th</sup> and 9<sup>th</sup> of August 2007, while the one from Cocos Monastery was investigated on the 25<sup>th</sup> of August 2007. We captured 19 individuals, respectively 12 samples of *P. viridis* from St. Apostle Andrei Monastery, while 56 individuals from Cocos Monastery. Although, at St. Ap. Andrei Monastery, the difference between the drawing of the samples is of one day, relatively high differences appear, which suggest that in order to obtain a better picture of the trophic spectrum of this population, it is necessary to repeatedly perform stomach flushing, probably also due to the lower number of individuals.

In the case of St. Ap. Andrei Monastery, the consumed preys were grouped in 28 taxonomical categories, while regarding the other population they belong to 21 categories. The preys were classified only until an order or family level, eventually specifying their stage of development, respectively their origin.

Regarding the feeding intensity, we analysed several parameters. The number of consumed preys was much higher in the case of the population from St. Ap. Andrei Monastery, even if the number of studied individuals was much lower. The average number of preys/individual, similar to the previous data was very high, being over 40 on every date, while at Cocos Monastery it was 6.51. The maximum number of preys is also very high at St. Ap. Andrei Monastery (311).

Concerning the feeding activity rate, at St. Ap. Andrei Monastery it is of 100 %, which corresponds with the very high feeding intensity. In the case of the population from Cocos Monastery, 7 individuals did not present stomach contents, the weight of the empty stomachs registering a value of 3.36 %.

Generally, the preys are 100 % terrestrial, just in the case of St. Ap. Andrei Monastery, on the first day 0.25 % preys appear with an aquatic origin.

Table 1. The feeding intensity, the food diversity and similarity, the frequency of vegetal and shed skin fragments.  
Tabelul 1. Intensitatea hrănirii, diversitatea și similaritatea hranei, frecvența fragmentelor de vegetale și exuvie.

Locality	St. Ap. Andrei Monastery			Cocos Mon.
Date	August 8	August 9	TOTAL	August 25
No. of studied individuals	19	12	31	56
Total no. of preys	786	1.148	1.934	365
No. of empty stomachs	-	-	-	7
Maximum no. of preys/individual	115	311	311	28
Average no. of preys/ individual	41,36	95,66	62,38	6,51
Diversity	1.62	0.67	1.14	1.78
Similarity	0.47	0.54	0.49	0.23
Vegetal	84.21	41.66	67.74	48.2
Minerals	10.52	16.66	12.90	7.14
% Aquatic preys	0,25	-	-	-
% Terrestrial preys	99,75	100	100	100

Regarding the weight of the prey taxa, we can observe certain differences between the habitats, but also some variations in the trophic spectrum of the population from St. Ap. Andrei Monastery. Depending on the habitat, there are certain preys that appear only in the case of one habitat. The Hymenoptera Formicida held the maximum weight at St. Ap. Andrei Monastery, preys that also appear at Cocos Monastery, but with a much lower weight. The Coleoptera Carabida registers a second place, followed by the Heteroptera. The weight of the Coleoptera is higher at Cocos Monastery. In addition, in the case of this habitat, the Araneida appear with a relatively high weight, followed by the terrestrial Heteroptera, respectively the Brahicera adults. The weight variation of the Coleoptera from day to day is interesting at the population from St. Ap. Andrei Monastery, when in the first day it was almost 20% and in the second day just 6%. Similar with this aspect is the weight variation of the Formicida, when the value was lower in the first day than in the second one.



Table 2. The weight and frequency of the preys.  
Tabel 2. Pondere și frecvență prăzilor.

Locality	WEIGHT				FREQUENCY			
	St. Ap. Andrei Monastery			Cocoș Mon.	St. Ap. Andrei Monastery			Cocoș Mon.
Date	August 8	August 9	TOTAL	August 25	August 8	August 9	TOTAL	August 25
Nematoda	0.13	-	0.05	-	5.26	-	3.23	-
Anelida-Oligocheta	0.38	0.17	0.26	-	5.26	16.67	9.68	-
Crustacea-Izopoda (t)	3.31	0.35	1.55	-	52.63	25.00	41.94	-
Arahnida-Araneida	1.27	0.09	0.57	7.94	31.58	8.33	22.58	28.6
Arahnida-Pseudoscorpionida	-	-	-	0.82	-	-	-	5.35
Arahnida-Opilionidae	-	-	-	0.54	-	-	-	1.78
Myriapoda-Chilopoda	2.04	-	0.83	0.27	42.11	-	25.81	1.78
Myriapoda-Diplopoda	0.13	0.26	0.21	-	5.26	25.00	12.90	-
Collembola	-	-	-	0.27	-	-	-	1.78
Orthoptera	0.38	0.35	0.36	-	15.79	33.33	22.58	-
Dermoptera	1.40	0.17	0.67	-	42.11	16.67	32.26	-
Mantodea	-	-	-	0.27	-	-	-	1.78
Heteroptera (t)	6.23	2.79	4.19	6.84	78.95	66.67	74.19	28.57
Homoptera-Cicadina	0.76	-	0.31	0.54	10.53	-	6.45	3.57
Lepidoptera (L)	0.13	-	0.05	1.09	5.26	-	3.23	5.35
Lepidoptera	1.02	0.17	0.52	-	31.58	8.33	22.58	-
Trioptera (L)	0.13	-	0.05	-	5.26	-	3.23	-
Coleoptera-undet.(L) t	0.51	-	0.21	-	15.79	-	9.68	-
Coleoptera-undet	4.45	0.96	2.38	1.64	52.63	5-	51.61	8.92
Coleoptera-Carabidae	17.68	6.10	10.81	12.10	89.47	91.67	90.32	42.90
Coleoptera-Cryzomelidae	-	0.09	0.05	0.27	-	8.33	3.23	1.78
Coleoptera-Coccinellidae	0.64	0.09	0.31	0.82	10.53	8.33	9.68	5.35
Coleoptera-Curculionidae	2.29	1.13	1.60	-	47.37	41.67	45.16	-
Coleoptera-Elateridae	0.64	-	0.26	-	15.79	-	9.68	-
Coleoptera-Stafilinidae	0.13	-	0.05	0.54	5.26	-	3.23	3.57
Coleoptera-Scarabeidae	-	-	-	0.54	-	-	-	3.57
Coleoptera-Lampyridae	0.13	-	0.05	-	5.26	-	3.23	-
Diptera-Nematocera	-	0.09	0.05	6.02	-	8.33	3.23	21.40
Diptera-Brahicera (L)	0.13	0.09	0.10	-	5.26	8.33	6.45	-
Diptera-Brahicera	0.25	0.09	0.16	4.38	5.26	8.33	6.45	23.20
Hymenoptera-undet.	0.13	-	0.05	0.54	5.26	-	3.23	3.57
Hymenoptera-Formicidae	55.73	86.93	74.25	41.60	84.21	10-	90.32	48.20
Hymenoptera-Apidae	-	0.09	0.05	0.27	-	8.33	3.23	1.78
Hymenoptera-Vespidae	-	-	-	0.27	-	-	-	1.78

The frequency of the preys presents lower values than the weight of the same taxa. Regarding St. Ap. Andrei Monastery, after the Formicida appear some taxa with very low weight, such as the Carabida, Isopoda or Curculionida. In comparison with this habitat, the population from Cocoș Monastery presents a much lower frequency of all of the taxa. Moreover, the appearance of the Carabida with a very high frequency is interesting.

Beside the animal prey, we also observed the presence of the vegetal and mineral fragments. A very interesting fact appeared at St. Ap. Andrei Monastery regarding the vegetal remains. Thus, their value was double on the first day than on the second one. Parallel to this situation, the minerals appear with a higher frequency on the second day. In comparison to this habitat, at Cocoș Monastery a much lower value of the two elements was registered.

The food diversity is connected with the feeding intensity. Therefore, St. Ap. Andrei Monastery registers a very high intensity, but the Shannon Wiever index is higher at Cocoș Monastery. Beside this, we can also observe that the food similarity is lower where the diversity is higher.

In order to estimate the differences between the trophic spectrum of the two populations we performed the Mann Whitney test (U test), from which we can state that the differences are valuable between these two habitats ( $p < 0.05$ ,  $p = 0.009$ ).

## DISCUSSIONS

After HUSSEIN & DARWISH (2000) the environmental factors greatly influence the development of the amphibians, factors such as temperature, food density and accessibility. In our case, the very high rate of the feeding activity underlines the presence of very good feeding conditions. However, some *Epidalea viridis* individuals appear at Cocos Monastery with an empty stomach. This fact can also be connected with the much lower feeding intensity, which suggests that this habitat is less favourable regarding the feeding. The reduced frequency of empty stomachs in the case of the amphibians has been encountered in many situations (COVACIU-MARCOV et al., 2002a, 2003b; CICORT-LUCACIU et al., 2005b). According to some authors, the lack of empty stomachs at a population indicates a positive energy balance (HUEY et al., 2001).

The very high feeding intensity at the habitat from St. Ap. Andrei Monastery is caused by the presence of very small preys, Formicida, which were consumed in high numbers by the frogs. Their amount also influenced the weight value of other preys. Thus, their weight was lower on the first day, when other preys with important value also appeared (Coleoptera, Heteroptera). While the weight of the Formicida was much higher on the second day, this determined the much lower weight of the other preys. The lower amount of the Formicida on the first day can be attributed to the higher humidity of the environment.

The Formicida from Cocos Monastery appear with a lower weight, in comparison, other typical forest preys are also registered in this habitat (Araneida, Brahicera). This biotope has a stronger connection with the forest, practically these larger preys replacing the Formicida. Due to this cause, the number of consumed preys is also smaller. The spiders and flies, which are larger-sized, have the necessary nutritive value to satisfy the energetic needs of the frogs.

The very high Formicida consumption is characteristic to the *Epidalea viridis* species, because the formic acid is also used to secrete its venom (JONES et al., 1999; BONANSEA & VAIRA, 2007). This fact suggests that the feeding of these frogs is selective, consuming the preys that are more advantageous for their survival.

Together with the smaller-sized preys, there are also larger-sized ones, their weight varying on the habitat. This fact insinuates that the feeding of these frogs is not selectively made regarding on prey-size, but depending on their accessibility, respectively on the advantages that they present.

Some preys appear only in the habitat from St. Ap. Andrei Monastery, for example the Oligochetae, their weight being higher on the first day. This fact can be due exclusively to the higher air humidity after it had rained. Their appearance only in this biotope can also be explained through the presence of several agricultural fields. On the other hand, at Cocos Monastery, the study was made after more than two weeks after the first study, this being a droughty period, the low environmental humidity not being favourable for the worms.

The weight of a prey does not correspond with its frequency. This fact can firstly be observed at the Curculionida and Carabida. These have a very low weight, while their frequency is very high. This fact suggests that because of the larger size of these Coleopterans, having a higher nutritious value, are consumed in a lower number, but by many frogs. The Coleopterans are also considered very important preys in the case of other amphibian species (COVACIU-MARCOV et al., 2005a; SAS et al., 2005b; HODAR et al., 1990).

Following the Mann Whitney test, we can state that the differences between the two populations are important. Firstly, in the case of the Cocos Monastery habitat, preys that are characteristic to the forest appear (Araneida, Pseudoscorpionida, Brahicera), because of the strong connections of this habitat with the woods. Regarding the biotope from St. Ap. Andrei Monastery, very different preys appear, being represented by the Coleoptera Carabida, Heteroptera, terrestrial Isopoda, Anelida, therefore preys that are also found outside the abundant vegetation areas. The differences noticed in the weight of the preys can indicate the fact that the feeding methods of the frogs vary depending on the prey density (ÇIÇEK & MERMER, 2006).

The variation of the vegetal frequency is very interesting at St. Ap. Andrei Monastery. This fact is due to the weather conditions, which also influenced the invertebrates' accessibility. On the first day, the frog collecting was made after it had rained. This determined the potential preys to be the ones from the surface of the plants, thus the vegetal fragments being accidentally swallowed together with the pursued prey (STEBBINS & COHEN, 1995). While others consider that the remains help to crush the insects' exoskeleton (EVANS & LAMPO, 1996), or constitute an additional water source (ANDERSON et al., 1999). This fact is in connection with the low frequency of the minerals, which can also be regarded as accidentally swallowed, not having a nutritious content. On the second day, we can already observe the presence of several preys that prefer dryness (Formicida), simultaneously with the decrease of the vegetal frequency and the increase of the mineral frequency. In concordance with this fact, we can explain the appearance of some aquatic preys on the first day.

The diversity is higher in the habitat from Cocos Monastery, despite the fact that the feeding intensity is lower. Firstly, the very high number of consumed Formicida determines the decrease of this value. On the other hand, this difference can also be explained by the fact that the habitat from Cocos Monastery, having more abundant vegetation,

also offers potential preys from their surface, but also from areas with poorer vegetation. Even if less taxonomic groups appear in this habitat, they have been consumed on a well-balanced scale, being fewer but ingested by many individuals, which also influences the diversity value. In comparison to another study upon the trophic spectrum of the *Epidalea viridis* species, where  $H = 2.11$  (COVACIU-MARCOV et al., 2005), we can observe that in our case this value is relatively low. In addition, in the case of the mentioned study, we can notice a fluctuation of the diversity, the lowest values being registered in summer. In the case of other amphibian species, the value is higher (SAS et al., 2005c; COGĂLNICEANU et al., 2000b).

The similarity between the individuals is lower when the diversity is higher. This fact is easily understood, because the higher is food diversity in the case of a population, the less are the chances that any two individuals have similar food.

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## CONTRIBUTIONS TO THE STUDY OF POSTEMBRYONIC DEVELOPMENT OF CHIFFCHAFF NESTLINGS (*PHYLLOSCOPUS COLLYBITA*, SYLVIIDAE)

LARISA BOGDEA

**Abstract.** Our study followed the postembryonic development of chiffchaffs nestlings during the period when they are into the nest. We also studied some behavior aspects in this period, corresponding with the cavity type of the nest. We analysed the data gathered in two recreation areas between 2007 and 2009; 28 nestlings from 7 nests were under our observation. Parents attended, fed and protected nestlings during 12 days, time necessary for their development into the nest. In the case of the chiffchaff as in other nidicolous species, it can be noticed a correlation between behavior peculiarities, formation of sonorous and motor reaction with specific ecological condition of the nestling type, even in early period of postembryonic development.

**Keywords:** chiffchaff, postembryonic development, nestling, body mass, plumage.

**Rezumat.** Contribuții la studiul dezvoltării postembrionare a puilor de pitulice mică (*Phylloscopus collybita*, Sylviidae). Lucrarea de față prezintă descrierea morfologiei externe, modificărilor, abilitățile motorii și de percepție ale puilor în perioada dezvoltării lor postembrionare. De asemenea sunt prezentate și unele aspecte de comunicare părinți-pui. Studiul s-a realizat în anii 2007-2009; măsurătorile biometrice au fost efectuate sistematic la 28 de pui. Încă din perioadele timpurii ale dezvoltării postembrionare a puilor de pitulice mică, cât și la alte specii de păsări nidicole, se observă interdependența dintre particularitățile comportamentului puilor, termenii de formare a reacțiilor sonore și motorii cu condițiile ecologice ale cuibăritului caracteristice speciei.

**Cuvinte cheie:** pitulice mică, dezvoltare postembrionară, pui, masa corporală, penaj.

### INTRODUCTION

Some aspects about postembryonic development of Passerine and biometric indices of this period were separately investigated more times and interested many authors (PORTMAN, 1938; POZNANIN, 1948; SERPOKRIIL, 1985). Although this phenomenon has been well documented, precedent studies established fundamental regularities of growth. Relatively few studies have been systematically accomplished, but not detailed studies were performed to clear up the biological peculiarities of postembryonic development. Moreover, there were not described and studied certain behaviour aspects in the period when nestlings are into nest, corresponding to the cavity type of nest. It would be important to make a comparative analysis between related species.

*Phylloscopus collybita* (VIEILLOT, 1817) is a common species widespread on the territory of the Republic of Moldova; it has relatively high density. Being a less cautious species, we managed to observe and analyse growth and behavior peculiarities of chiffchaff nestlings during twelve days.

### METHODS AND MATERIALS

Our field observations were made within the green periphery of Chișinău city (2007) and cemetery "St. Lazar" (2008-2009). Seven nests were under our observation permanently: five with 5 nestlings and two with 4. Biometric measurements and length of feathers were made by means of the compasses. Nestling behaviour and measurements were done daily. We took into account the average values of the nestlings' morphology, which indicate growth. The average length of the most important pteryxae (feathers tracts) – flights feathers (primary and secondary remiges, primary and greater coverts), rectrices and contour feathers were also included.

### RESULTS AND DISCUSSIONS

The obtained results gave us the possibility to describe external morphology, occurred modifications, behaviour and motor abilities of nestlings in each of the twelve days, when nestlings are into the nest. Postembryonic development includes three periods (ILICEV et. al. 1982): - the 1<sup>st</sup> early postnatal period – till hatching from appearance of chemical thermoregulation, it is about 6-8 days at chiffchaff nestlings; - the 2<sup>nd</sup> late postnatal period – appearance of major elements of homoeothermy, development of nervous system, complexity of activities and behavior responds (9-12 day). These two periods correspond with nestlings' staying into the nest; - the 3<sup>rd</sup> period – offspring get away from nest, but parents continue feeding them for another 7 days. In the early postnatal period, the female spent more time with the nestlings, for warming them up.

#### The first day

The skin colour of just hatched chiffchaff nestlings is light pink-yellowish with orange nuance, the legs and claws are yellow and the bill is yellowish-grey. The nostrils have oval shape. The membrane around the bill is obviously yellow and quite big (0.4 mm). Its size is in direct dependence with the nestlings' growth biometric indices. All morphological elements are in correlation with the type of nesting. In the period when they are in the nest, the size



of the membrane is bigger than in the case of the blackcap nestlings. This could be explained through the closed type of the nest, which is quite common at hollow species (MALCEVSKII, 1959). Each nestling has three downy feathers in the back of eyes, nape and wings. Pterylae were not clearly noticeable; external auditory meatus and eyelids are closed, but not jointed. In the first day, chiffchaff nestlings produce very weak sounds sporadically, when they want food, sounds that human auditory perception can hardly perceive. Nestlings beg for food more in response to parental calls, less to nest vibration and very rarely at touching stimulants. Female produces several types of calls, short and muffled, alike with "uit-uit". We can speak about acoustic communication held by parents and their nestlings. Calls produced by brood are orientated to stimulate parents to supply food. Parents also call to stimulate nestlings to beg for food. The presence of vocal communication system between nestlings and parents has an important biological function (MARTY et al., 1997; KUMAR, 2003), especially at the species that have a terrestrial nestling type.

#### The second day

Beginning with the second day, humeral and alar pterylae clearly appear as an agglomeration of grey points mainly in the ventral and crural parts of the body. Those on the head, neck and calf are not visible. Alar pterylae have an interrupted line shape, in case of both primary and secondary remiges. Nestlings are rather mobile; when they are taken out of the nest, they have a tendency to coil. In the most cases their response motions at different external stimulants are chaotic and uncoordinated. Fig.1: Chiffchaff nestling is 2 days old.

#### The third day

At this age, dorsal and ventral pterylae look like a grey and yellow interrupted line. In the head and neck regions they look like bulging points, as crural pterylae are weakly visible. The sheaths of primary and secondary remiges penetrate skin and appear as small bulges. Auditory meatus is opened; nestlings begin to differentiate sounds and respond with begging just to those sounds which are similar with their parents' calls. Eyelid is very narrow and opening the eyes supposes physical effort.

#### The fourth day

At this age, on the scapula and the other body parts of the little chiffchaffs there appear sheaths of coverts. Colour of the skin-covered parts does not change greatly – rhamphotheca is grey-yellowish, claws acquire grey nuance, skin is pale pink with orange nuance, and tarsus is light pink-yellowish. Sheaths of primary and secondary remiges have about 1.5-2 mm, primary coverts ~1mm. We present the increasing and development rhythm of some feathers tracts (pterylae); the remiges appear first followed by coverts and rectrices (tail feathers), which appear in the 4<sup>th</sup> day (Table 1). The feathers increase averagely with about 1.5-3mm daily.

Table 1. The size of pterylae and some feathers at chiffchaff nestlings.

Tabel 1. Dimensiunile pterilelor și ale unor pene la pitulice mică.

Age/days	Primary remiges length /mm	Secondary remiges/mm	Primary coverts mm	Greater coverts mm	Dorsal pteryla/mm	Femoral Pteryla /mm	Rectrices (tail) mm
I-III	0 - 0.5	0 - 0.5	-	-	-	-	-
IV	1.5 - 2	1.5	1.0	1.0	1.0	1.0	0.2
V	4 - 5	5 - 2	2 - 3	3 - 2	1.2	1.8	0.8
VI	7 - 9	9 - 3	4 - 5	4.5	3	2.5	2.0
VII	11 - 13	14 - 4	6 - 7	6.5	6	3.0	4.0
VIII	15 - 18	14 - 5	7 - 9	10	7.5	4.5	5.5
IX	20 - 23	22 - 10	10 - 12	13	11	6	8
X	21 - 26	22 - 8	12 - 13	15	12	7	11
XI - XII	23 - 28	27 - 14	12 - 14	15	14	10	13

#### The fifth day

At this age eyelids are more opened, nestlings evince photo sensibility, because they responded with begging if they stay in overshadowed nest. Nestlings are not so active. Tarsus, claws and beak keep yellow-grey nuance. We suppose they are not quite lively because their nervous system undergoes changes (development of the nervous system and visual organs) (MALCEVSKII, 1959). Fig. 2: Four day's chiffchaff nestlings.

#### The sixth day

Chicks have opened eyes during the entire day, not just when they beg for food. Begging reflex does not last long at visual stimulants. Movements become more coordinated, when it is pulled out from nest. Nestlings try to do crawling motions supported by tarsus and elbows of the wings.

#### The seventh day

At this age eyes are permanently opened, begging reflex may be prolonged through visual stimulants. This index appeared in chiffchaff nestling one day later than in blackcap nestlings. The explication may be the closed type of chiffchaff nest, which is less illuminated. Also, acoustic communication is present, the female calls produce begging collective reaction, which is actively manifested. Nestlings in their turn make sounds that can be heard between feedings. When we try to move the nestling from place to place it often beat wings and holds itself with the clenched toes. On the ground, they crawl with partially overt wings and support themselves on tarsus and toes. The colour of the beak and tarsus begin to change to grey-yellowish.

**The eight day**

Fright reaction and ability to crouch on the bottom of nest, especially, are quite obvious in the eight day. When approaching the nest, they largely open the mouth and produce short, shrill sounds like a hiss of enemy. It is so unpleasant, that every time heard it provokes a wince. All these are meant to frighten the enemy and, probably, are determinated genetically. Fear is provoked by objects of different shapes (microphone, finger, hand, etc.) and less by branches. If enemy is insistent or tries to draw them out of the nest, the nestlings' hiss changes into a screech for help. This draws parents' attention, which become very excited and try to do different strategies, to make the enemy leave away from their nest and territory. Little chiffchaffs have in their sonorous vocabulary contact call, but it is short, hoarse and creaked. With contact calls nestlings find each other and the parents. Their orientation and mobility increase very much, nestlings which just crawled days ago, try to run even on all four "legs". Eyelids' opening has an oval-ellipse shape. Fig. 3: Eight day old chiffchaff nestling.

**The nine day**

As nestlings grow they become noisier. Begging reflex is accompanied by murmured peeping and shrill whistling, which is observed not just at fright reaction. Starving nestlings produce shrill sounds, which can be heard 1-2 m away from the nest. In this period they are very alive, movable, they can jump, propped on tarsus, and slightly raise the thoracic region. When they are taken from the nest, they have a specific behavior – they try to find shelter no matter where (box, bag, sleeve, etc.) and gather together using contact calls. Only when they are together they become quiet. Such reflexes and reactions are observed at the age when not just visual but and these motor abilities reach more advanced development stage.

**The ten day**

In their sonorous vocabulary, there appear new contact calls with high notes, clearly, resounding but whining, such as a "uit". This contact call is used by nestlings to announce parents about their place. We also observed a clear trend to get away from the nest. When one of them is taken out from the nest, the others immediately spread in different directions through jumping, crawling motions and produce shrill calling sounds, although, in this period nestlings usually do not abandon the nest.

**The eleven-twelve days**

In this time little chiffchaffs abandon the nest. The most developed nestlings, with the greatest body size spread, while the smallest can stay for another day. Offspring can do short flights, but at low height, often fluttered with wings. Most of flights are done from branch to other, accompanied by specific squeaky calls. Nestlings permanently produce contact calls and gather on one branch. The feathers are going out from sheaths; the juvenile plumage has the same colour as that of the adults.

Biometrical data of 23 nestlings are presented in Table 2. According to the data we can establish that body mass increases very fast, about 1,000 mg per day until the age of 5-6 days, after that, growth is about 400-600 mg. In the same upward rhythm the plumage develops. Fig. 4: Chiffchaff nestling is 12 days old.

Table 2. Dynamics of the chiffchaff nestlings' growth during the period they stay in the nest.  
Tabel 2. Dinamica creșterii puilor de pitulice mică în perioada aflării în cuib.

Age/day	No. nestlings	Body mass/g	Total length/mm	Wing length /mm	Tarsus length /mm	Beak length /mm
I	28	1.2-1.5	21.3- 26.1	5.2- 9.6	6.7 -7.1	3
II	28	1.8	27.2	6.7	7.8-8.0	3.3
III	28	2.9	32.4	8.2	9.6- 11.2	3.9
IV	28	3.7	39.1- 44.5	9.1-11.2	11.8 – 12.4	4.6
V	28	4.35	50.5	12	12.5	5.0
VI	28	4.85 – 5.0	46.9	12.3-13.2	14.5 – 16.4	6.3
VII*	28	5.4	47.3	13.6	16.4	6.5
VIII	27	6.1	48.5	13.9-14.1	17.4	6.9
IX	27	6.8	48.9	14.1-14.8	18.2	6.9
X	27	7.2- 7.8	50.2- 53.5	15.1- 15.7	20.1- 21.1	7.1
XI**	17		57.2- 59.4	13.9-15.6	20.5 – 21.8	7.3

\* a nestling disappeared from the nest in next day  
\*\* in two nests, nestlings have spread when one of them was taken out

**CONCLUSIONS**

Parents attend, feed and protect nestlings during 12 days, time (interval) necessary for their development into nest. Increase of body mass is about 800-1,000 mg in the first 5-6 days, after that 400-600 mg daily, while the plumage increases with about 1.5-3 mm. Communication between parents and nestlings begin since the first day of postembryonic development and helps the coordination of both their behaviour. 11-12 day old nestlings get outside the nest and can make short flights on small distances, about 2-3 m, and low height staying together.

Even in the early period of postembryonic development, in the case of chiffchaff as well as of other nidicolous species there was observed a correlation between behavior peculiarities, formation of sonorous and motor reaction and the specific ecological condition of nestling type.

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Figure 1. Baby chiffchaff (2 days old).  
 Figura 1. Pui de pitulice mică (vârsta de 2 zile).



Figure 2. Baby chiffchaff (4 days old).  
 Figura 2. Pui de pitulice mică (vârsta de 4 zile).

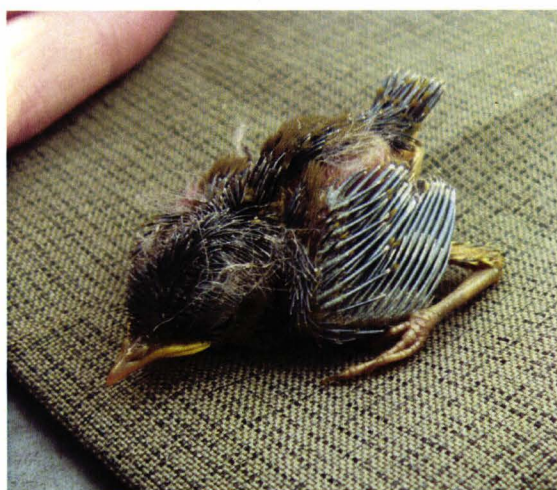


Figure 3. Baby chiffchaff (8 days old).  
 Figura 3. Pui de pitulice mică (vârsta de 8 zile).

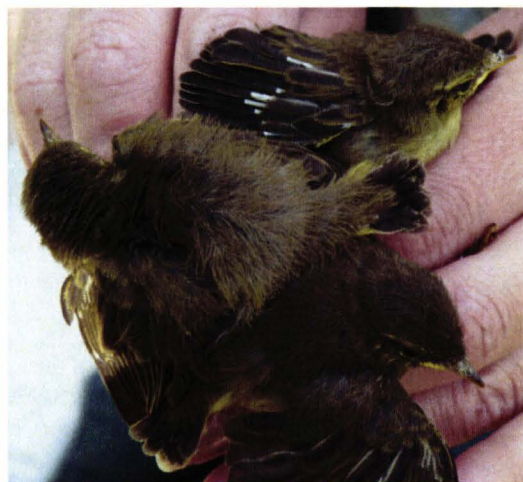


Figure 4. Baby chiffchaff (12 days old).  
 Figura 4. Pui de pitulice mică (vârsta de 12 zile).



## PRELIMINARY DATA REGARDING THE AQUATIC BIRD FAUNA OF STOENEȘTI LOCALITY – OLT COUNTY

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**Abstract.** *The paper renders the results of the observations regarding the aquatic avifauna from Stoenesti locality - Olt County during 2007-May 2009. It includes the taxonomic list, the phenologic status, and the protective status of the aquatic bird species. Most of the 52 observed aquatic species that stay here or are in passage have a secure status within Europe. 18 species have a certain endangerment status (endangered, vulnerable, declining, limited territory species) and they are found on different protection international or national lists.*

**Keywords:** *aquatic birds, phenology, diversity, conservation status.*

**Rezumat.** *Date preliminare privind păsările acvatice din localitatea Stoenesti – județul Olt. Lucrarea prezintă rezultatele observațiilor referitoare la avifauna acvatică din zona localității Stoenesti-județul Olt în perioada 2007-mai 2009. Include lista taxonomică, statutul fenologic, statutul protectiv al speciilor de păsări acvatice. Din cele 52 de specii acvatice observate, care staționează sau sunt în trecere, majoritatea are un statut sigur pe plan european. 18 specii au un anumit statut de periclitate (specii periclitare, vulnerabile, în declin, cu teritoriu limitat), fiind trecute pe diferite liste protecționiste internaționale și naționale.*

**Cuvinte cheie:** *păsări acvatice, fenologie, diversitate, statut de conservare.*

### INTRODUCTION

Stoenesti locality is situated in the southern part of Olt County and the eastern part of the Romanati Plain, on the right side of the Olt Valley (Fig. 1). It is made up of a single village holding the same name. The administrative territory of the locality covers a total surface of 3,531 hectares. It is also here a road junction. The main access routes are – The European Road E70 and the County Road DJ 342, which ensure the link between the settlement and the other settlements from the region (12 km away there is Caracal town, 10 km Drăgănești Olt, and 48 km Slatina). It is also a railway station on the route Bucharest-Timișoara.



Figure 2. Pool and acacia plantation within Stoenesti locality.  
Figura 2. Balta și plantația de salcâm din comuna Stoenesti.

At the periphery of Stoenesti locality, there is a wet habitat characterized by the presence of many permanent pools. Some of them are continuous with small interruptions marked by bridges surrounded by reed and bulrush that represent an excellent environment for the aquatic and semi-aquatic birds. In the East, there is the Olt River and migratory birds frequently rest on its islands and banks.



Figure 1. Map of Olt County. Stoenesti locality is underlined.

Figure 1. Harta jud. Olt. Comuna Stoenesti este subliniată.

The Olt flows parallel with the locality for about 3–4 km. The annual discharge of the river (oscillating between 160 m<sup>3</sup>/s and 190 m<sup>3</sup>/s,) allowed the construction of an irrigation system supplied by the Olt. In the area, there is also a canal of the same length as the Olt within the locality, surrounded by paludous vegetation within certain parts. In the proximity of the locality, there is also an acacia forest (Fig. 2).

There are quite a few data about the ornithological fauna of the Olt Valley within the county with the same name. They are simple information referring to the presence of the species mentioned at the winter and autumn censuses organized by the Romanian Ornithological Society.

The bird fauna of Stoenesti area has not been studied from the biological point of view yet. This is the main reason for elaborating of the first list of the aquatic species of the area.

The target of this study is to inform the ornithologists about the main aquatic, semi-aquatic and reed bird species from Stoenesti Locality, Olt County between 2007 and May 2009. In order to reach this target, we aimed at identifying and establishing the specific compenence of the aquatic bird fauna, at clarifying the phenological categories, the diversity of the bird communities during different seasons, at achieving a list rendering the protective status of the identified aquatic bird species.

## MATERIAL AND METHODS

The main used materials were a binocular (Norconia 10x50), a camera Fuji FinePix S5700, a video camera Panasonic SDR-H20-EP-S, and PETERSON (1984) and BRUUN et al. (1999) field guides for the identification of species.

The most frequently used work methods were the transect method and the direct observation method. The trips were made seasonally, in the morning and more rarely in the afternoon. Most of the visits took place between 9 a.m. and 2 p.m. and between 4 p.m. and 8 p.m. in summer and between 11 a.m. and 2 p.m. in winter.

The observations were made from stationary points, visually or by means of the binoculars.

The species were identified using the specific guides or the literature in the field. We took into account the model elaborated by HAGEMEIJER & BLAIR (1997) for the systematic of the species.

We wrote down the field observations regarding the number of aquatic species, the number of the individuals belonging to the respective species, the points where it was observed, the date when it was seen, data related to the behaviour of the species, meteorological data etc. All the data gathered in the field were then processed from the systematic, biological, and ecological points of view.

## RESULTS AND DISCUSSIONS

The location of the settlement, the vegetation from the studied area, which is characterized by a great variety of habitats and a large number of vegetal associations, allowed us to emphasize a great number of birds.

We identified 52 aquatic species grouped in 8 orders and 14 families from the systematic point of view (Table 1 and 2). Anseriformes and Charadriiformes orders are the best represented – 14 and 15 species. We also considered as aquatic birds the species that breeding in the reed – the marsh harrier, reed bunting, warblers and the wagtails that are more frequent along the rivers and around the pools.

Table 1. Numerical distribution of the observed bird species on superior taxonomic units (families, orders).  
Tabel 1. Repartiția numerică a speciilor de păsări observate pe unități taxonomice superioare (familiile, ordine).

Crt. no.	Order	Family	Number of species
1.	Podicipediformes	Podicipedidae	2
2.	Pelecaniformes	Phalacrocoracidae	2
3.	Ciconiiformes	Ardeidae	7
		Ciconiidae	1
4.	Anseriformes	Anatidae	14
5.	Falconiformes	Accipitridae	1
6.	Gruiformes	Rallidae	2
7.	Charadriiformes	Recurvirostridae	1
		Charadriidae	2
		Scolopacidae	7
		Laridae	2
		Sternidae	3
8.	Passeriformes	Motacillidae	2
		Sylviidae	5
		Emberizidae	1



The aquatic avifauna undergoes seasonal modifications. Sometimes, climatic conditions, food, human activities influence the presence or the absence of the aquatic birds in the area during certain periods, as well as the numerical variations of the same species.

During the winter period (November-February), the Anseriformes represented the most numerous group of aquatic species. There were observed 12 species of Anatidae. The common species monitored during the study were *Anas platyrhynchos*, *A. acuta*, *A. crecca*, *A. querquedula*, *A. penelope*, and *A. anser*. The common goldeneye (*Bucephala clangula*) was observed in January 2007 on the island located in the middle of the Olt – 8 individuals, while in February 2008, there were 15 individuals. During the winter 2008, there stationed a family of mute swan, *Cygnus olor*, with 6 juveniles. Among the rallidae, *Fulica atra* and *Gallinula chloropus* are the dominant species. *Ardea cinerea*, *Egretta alba*, *Tachybaptus ruficollis*, *Podiceps cristatus* etc. were noticed (in winter) as separate individuals or in small groups of maximum four individuals. In the winter of 2008, there stationed 40 individuals of *Phalacrocorax pygmaeus* and 27 of *P. carbo*. In February 2007, there were seen 2 individuals of Eurasian curlew (*Numenius arquata*) in the proximity of the irrigation system. Tens of individuals of *Larus ridibundus* and *L. cachinnans* were noticed along the Olt River and on the island by the beginning of November and by the end of winter (February).

It is worth mentioning that the Olt River represents an extremely important migration route. This area is crossed by the bird species migrating towards Central and Northern Europe. This is why there were noticed numerous aquatic species during the spring and autumn passage.

In spring (March, April), some birds that come from the wintering places, remain to breed in the area (little bittern, white stork, lapwing, warbler species, grebe etc). Others are just in passage between the nesting and wintering areas (shoveler, ferruginous duck, little ringed plover, etc.). During this period, the species that are winter visitors and were observed in the cold season, usually prepare to leave gradually; some of them in February (*Aythya marila*, *A. fuligula*, *Bucephala clangula*, *Anser albifrons* etc.), most of them in March and by the beginning of April (*Anas penelope*, *A. crecca*, *Anser anser*). The garganey (*Anas querquedula*) left the area in May in 2007. In 2008, it was seen during summer as well. In May 2009, it has not left the aquatic habitat from Stoenești yet.

In summer, most of the species have an intense activity around the nest and the chicks. After the nesting period, many species make local trips for a trophic purpose. The juveniles and the adults move between the nesting (which become spots for staying over night) and the feeding places. This is why, in the habitat, there were noticed other species that nest in the neighbouring areas and come here in search for food – the great bittern (*Botaurus stellaris*), the great egret (*Egretta alba*), the grey heron (*Ardea cinerea*), the black tern (*Chlidonias niger*) etc.

Autumn (September, October) is the proper migration period with an accelerated dynamics. The visitor populations leave the field in favour of winter visitors and passage species.

Autumn migration lasts longer. According to the climatic factors, for some species migration starts by the end of July and the beginning of August, while for the other species it takes place by the beginning of October and the end of November. In the autumn passage, in August, there appear the cormorant species (that in the winter of 2008 did not leave the habitat). The snipe and great snipe species, with a reduced number of individuals (2-6) were noticed in August and September in the area of the forest located near the pool.

The insufficient research does not allow us to establish a precise grouping of the observed birds in clear phonological categories, because, the species phenology being flexible, the same species can be both passage bird in certain years and summer or winter visitors in other years. By analysing Table 2 that renders the phenology of the birds, one may notice that there predominate migratory birds: summer visitors, winter visitors, passage birds (47 species), followed by resident and partially migratory birds (5 species).

The data referring to the breeding/non-breeding aquatic birds indicate the fact that there predominate the non-breeding species. Of the summer visitor species, 11 are breeding, some in the aquatic vegetation, in the reed beds – *Tachybaptus ruficollis* (in 2007), *Podiceps cristatus* (in 2008), *Ixobrychus minutus*, *Nycticorax nycticorax*, *Locustella luscinioides*, species of *Acrocephalus* sp., others species breeding in the agricultural fields – *Vanellus vanellus* (in 2008). *Motacilla alba* nests on the soil among herbs, in cracks of walls etc. *Motacilla flava* nests on wet meadows on the soil. As yellow wagtail, it predominates *Motacilla flava feldegg*. There were also seen the sub-species of *Motacilla flava thunbergi* and *M. flava flava*. The white stork (*Ciconia ciconia*) built its nest at a top of an electric pole from the village. It used the same nest for many years. In 2007, there were 5 chicks, while in the summer of 2008 there were 4 chicks. In 2009, the white stork came on the 27<sup>th</sup> of March. Although there are proper conditions, we have seen only one pair of storks nesting in the area so far.

The human impact upon the area refers to hunting (especially of the duck and goose species – see Table 2), fishing, entertainment. The pools and meadows are often used by domestic animals, poultry, cows and sheep that graze in the neighbourhood. The reed is cut and used in the households or it is burnt. The area does not benefit from a protection regime.

Part of the identified birds is included on the national and international protection lists as having an unfavourable conservation status in Europe.

According to the table, most of the species, 32, are in the category Non SPEC, which means that their populations are not concentrated within Europe, thus being secure (S). There are not necessary special and immediate measures for their protection. The other 20 species are included in the 4 SPEC categories.

With regard to the conservation status (European Threat Status), it can be noticed according to the table: 9 species are vulnerable: *Phalacrocorax pygmaeus*, *Botaurus stellaris*, *Ixobrychus minutus*, *Ardeola ralloides*, *Ciconia ciconia*, *Anas acuta*, *A. querquedula*, *Aythya nyroca*, *Gallinago media*; 5 species are declining: *Nycticorax nycticorax*, *Numenius arquata*, *Tringa glareola*, *Chlidonias hybridus*, *C. niger*; one species with a limited location area: *Aythya marila*. 8 bird species are mentioned in the Red Book of the Vertebrates from Romania as endangered (*Egretta garzetta*, *E. alba* and *Himantopus himantopus*) and vulnerable species (*Phalacrocorax pygmaeus*, *Nycticorax nycticorax*, *Ardeola ralloides*, *Ciconia ciconia*, *Aythya nyroca*). In Fig. 3 there are presented some bird species (from the studied area) that have unfavourable conservation status in Europe.

According to law 197/ 2007, 37 of the emphasized species cannot be hunted as they are nationally protected.

Consequently, there should be taken protection measures able to favour the maintenance of the bird populations in a state of balance with the sustainable capitalization of the natural resources by the locals.

Table 2. Aquatic avifauna of Stoenesti locality (Olt).  
Tabel 2. Avifauna acvatică a localității Stoenesti (Olt).

Crt. No.	Species	Phenological Status	Spec Category	Threat Status	R.B.V. Romania	Law.No 197/2007
1.	<i>Tachybaptus ruficollis</i>	SV, RWV	Non SPEC	S		*
2.	<i>Podiceps cristatus</i>	SV, RWV	Non SPEC	S		*
3.	<i>Phalacrocorax carbo</i>	P, RWV	Non SPEC	S		
4.	<i>Phalacrocorax pygmaeus</i>	P, RWV	SPEC 2	V	V	*
5.	<i>Botaurus stellaris</i>	SV	SPEC 3	(V)		*
6.	<i>Ixobrychus minutus</i>	SV	SPEC 3	(V)		*
7.	<i>Nycticorax nycticorax</i>	SV	SPEC 3	D	V	*
8.	<i>Ardeola ralloides</i>	SV	SPEC 3	V	V	*
9.	<i>Egretta garzetta</i>	SV	Non SPEC	S	E	*
10.	<i>Egretta alba</i>	P, RWV	Non SPEC	S	E	*
11.	<i>Ardea cinerea</i>	SV, RWV	Non SPEC	S		*
12.	<i>Ciconia ciconia</i>	SV	SPEC 2	V	V	*
13.	<i>Cygnus olor</i>	SV, RWV	Non SPEC	S		*
14.	<i>Anser albifrons</i>	WV	Non SPEC	S		
15.	<i>Anser anser</i>	WV, P	Non SPEC	S		
16.	<i>Anas penelope</i>	P, WV	Non SPEC	S		
17.	<i>Anas crecca</i>	WV, P	Non SPEC	S		
18.	<i>Anas platyrhynchos</i>	PM	Non SPEC	S		
19.	<i>Anas acuta</i>	P, WV	SPEC 3	V		
20.	<i>Anas querquedula</i>	P, SV	SPEC 3	V		
21.	<i>Anas clypeata</i>	P	Non SPEC	S		
22.	<i>Aythya ferina</i>	P, WV	SPEC 4	S		
23.	<i>Aythya nyroca</i>	P	SPEC 1	V	V	*
24.	<i>Aythya fuligula</i>	WV	Non SPEC	S		
25.	<i>Aythya marila</i>	WV	SPEC 3	L		
26.	<i>Bucephala clangula</i>	WV	Non SPEC	S		
27.	<i>Circus aeruginosus</i>	OV	SPEC 4	S		*
28.	<i>Gallinula chloropus</i>	PM	Non SPEC	S		
29.	<i>Fulica atra</i>	PM	Non SPEC	S		
30.	<i>Himantopus himantopus</i>	P, SV	Non SPEC	S	E	*
31.	<i>Charadrius dubius</i>	P	Non SPEC	(S)		*
32.	<i>Vanellus vanellus</i>	SV	Non SPEC	(S)		*
33.	<i>Calidris temminckii</i>	P	Non SPEC	(S)		*
34.	<i>Gallinago gallinago</i>	P	Non SPEC	(S)		
35.	<i>Gallinago media</i>	P	SPEC 2	(V)		*
36.	<i>Numenius arquata</i>	P, RWV	SPEC 3	D		*
37.	<i>Tringa ochropus</i>	P, SV	Non SPEC	(S)		*
38.	<i>Tringa glareola</i>	P	SPEC 3	D		*
39.	<i>Actitis hypoleucos</i>	P, SV	Non SPEC	S		*
40.	<i>Larus ridibundus</i>	R	Non SPEC	S		*
41.	<i>Larus cachinnans</i>	R	Non SPEC	S		*
42.	<i>Sterna hirundo</i>	SV	Non SPEC	S		*
43.	<i>Chlidonias hybridus</i>	SV	SPEC 3	D		*
44.	<i>Chlidonias niger</i>	SV	SPEC 3	D		*
45.	<i>Motacilla flava</i>	SV	Non SPEC	S		*
46.	<i>Motacilla alba</i>	SV	Non SPEC	S		*
47.	<i>Locustella luscinioides</i>	SV	SPEC 4	(S)		*
48.	<i>Acrocephalus schoenobaenus</i>	SV	SPEC 4	(S)		*
49.	<i>Acrocephalus palustris</i>	SV, P	Non SPEC	S		*
50.	<i>Acrocephalus scirpaceus</i>	SV	SPEC 4	S		*
51.	<i>Acrocephalus arundinaceus</i>	SV	Non SPEC	S		*
52.	<i>Emberiza schoeniclus</i>	WV, P	Non SPEC	S		*

**Legend:**

Phenological status: SV – summer visitors, WV – winter visitors, RWI – rare winter visitors, P – passage visitors, R – resident, PM – partial migrant.

Threat status: S – secure, V – vulnerable, D – declining, E – endangered, L – localized ( ) temporary status.

SPEC category: SPEC 1 – species of global conservation concern, SPEC 2 – unfavourable conservation status concentrated in Europe, SPEC 3 – unfavourable conservation status not concentrated in Europe, SPEC 4 – favourable conservation status concentrated in Europe, NonSPEC – favourable conservation status not concentrated in Europe

R.B.V. Romania: Red Book of Vertebrates from Romania.

Law no. 197/2007: \* – protected species; the rest are game species.

**Legendă:**

Statut fenologic: SV – oaspeți de vară; WV – oaspeți de iarnă; RWI – oaspeți de iarnă rari; P – specii de pasaj; R- specii sedentare; PM – migrator parțial.

Statut de amenințare: S - în siguranță; V – vulnerabil; D – în declin; E- periclitat; L – cu areal limitat.

Categoria SPEC: SPEC 1 – specii care necesită conservare globală, SPEC 2 - statut de conservare nefavorabil concentrat în Europa, SPEC 3 - statut de conservare nefavorabil care nu e concentrat în Europa, SPEC 4 - statut de conservare favorabil care e concentrat în Europa, NonSPEC – statut de conservare favorabil care nu e concentrat în Europa.

Legea nr. 197/2007: \* – specii protejate; restul sunt specii de vânat.

**CONCLUSIONS**

The location of Stoenesti on the right bank of the Olt River, the pools, reed, meadows, all these offer trophic resources, shelter and nesting place for numerous aquatic bird species. The area lies on the migration route of certain species.

From the systematic point of view, the aquatic birds from Stoenesti, observed between 2007 and May 2009, count 52 species belonging to 8 orders and 14 families.

The number of species and individuals oscillated according to the climatic factors and feeding conditions.

15 species are found on the international lists as having a certain endangerment status: 9 vulnerable species: *Phalacrocorax pygmaeus*, *Botaurus stellaris*, *Ixobrychus minutus*, *Ardeola ralloides*, *Ciconia ciconia*, *Anas acuta*, *A. querquedula*, *Aythya nyroca*, *Gallinago media*; 5 declining species: *Nycticorax nycticorax*, *Numenius arquata*, *Tringa glareola*, *Chlidonias hybridus*, *C. niger*, one species with limited location area: *Aythya marila*.

Of the total number of aquatic species, 15 present cynegetic interest (they can be hunted). Most of them belong to Anatidae.

Three species observed within the territory of Stoenesti are nature monuments (Commission of Nature Monuments – The Romanian Academy): *Egretta alba*, *E. garzetta* and *Himantopus himantopus*.

The monitoring of aquatic birds should continue in order to monitor the evolution of their dynamics and to take the most important measures for their protection.

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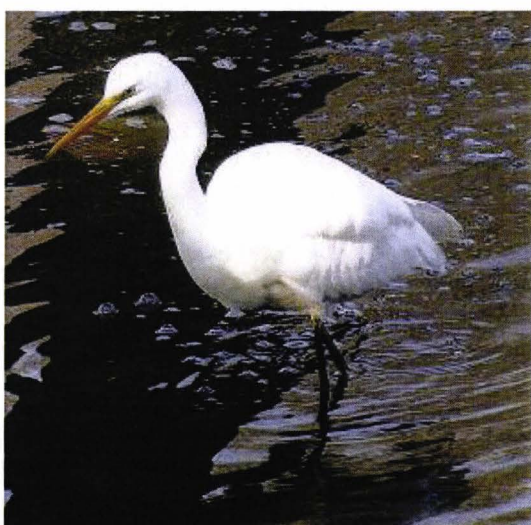




*Ardeola ralloides* (juvenile) – vulnerable species.



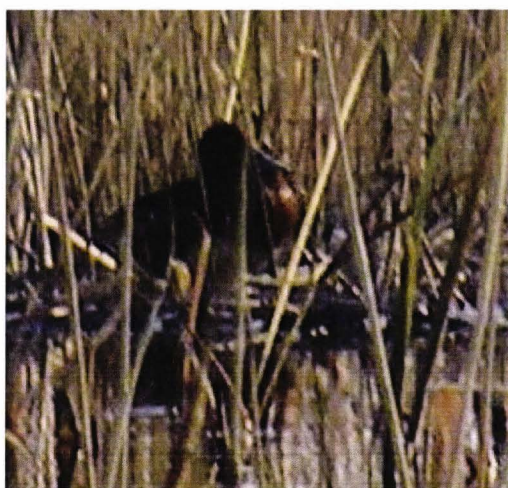
*Phalacrocorax pygmaeus* – vulnerable species.



*Egretta alba* – Nature monument.



*Egretta garzetta* – Nature monument.



*Aythya nyroca* – vulnerable species.



*Ciconia ciconia* (juvenile) – vulnerable species.

Figure 3. Some species with unfavourable conservation status in Europe (Original photo).  
Figura 3. Câteva specii cu statut nefavorabil de conservare în Europa (Fotografii originale).

## BIRDS COLLECTED BY DIONISIE LINȚIA PRESERVED IN THE MUSEUM OF OLTENIA, CRAIOVA (ROMANIA)

ANGELA PETRESCU, MIRELA SABINA RIDICHE

**Abstract.** *This study contributes to the completion of the documentary device of the items donated by the naturalist Dionisie Linția to the museum of Craiova, in the first half of the last century. The "rehabilitated" items are in this way enriched with scientific value, passing from the category of museum items that can be used as didactic or exhibition material, to the category of important preparations, with historic and documentary value that can be classified in the national cultural patrimony.*

**Keywords:** *collection, birds, museum, Romanian fauna, Dionisie Linția.*

**Rezumat.** *Păsări colectate de Dionisie Linția conservate în Muzeul Olteniei, Craiova (România). Studiul de față contribuie la completarea aparatului documentar al pieselor donate de naturalistul Dionisie Linția muzeului din Craiova, în prima jumătate a secolului trecut. Piese "reabilitate", capătă astfel valoare științifică, trecând de la categoria de piese muzeale care pot fi folosite ca material didactic sau expozițional, la aceea de preparate importante, cu valoare istorică și documentară care pot fi clasate în patrimoniul cultural național.*

**Cuvinte cheie:** *colecție, păsări, muzeu, fauna României, Dionisie Linția.*

### INTRODUCTION

The Natural Sciences department was founded in 1926 by the members of the Scientific Society of Craiova, led by Marin Demetrescu, under the name of the Natural History Museum, which became a department of the Oltenia Museum in 1928. The patrimony of the department, proceeded from donations, acquisitions, transfers, exchanges but especially from the collectings made by the experts of the department, during the research activities, includes more than 110,000 items nowadays.

The ornithological collection of the Oltenia Museum includes now more than 1,746 items (stuffed birds, skins, trophies, skeletons, eggs) most of them prepared in the taxidermy - restoration laboratory of the museum; they belong to 222 species, 55 families, and 17 orders. Analysed from the point of view of affiliation of species at the types of habitats, the birds are divided as it follows: 146 species come from terrestrial habitats and 76 species come from aquatic habitats.

The first scientific information, referring to the ornithological collection was introduced in the informational circuit by BAZILESCU et al. (1980) in the paper "*The Methodical Catalogue of Vertebrates Collections of the Oltenia Museum*". Back then, in 1980, the ornithological collection had 863 items. The ornithological material introduced in the collection until 1998, respectively 592 items (representing 148 species, 38 families, 16 orders) was published in the paper "*The Catalogue of Ornithological Collection of the Oltenia Museum*", the second part 1978 / 1998 (RIDICHE 1999). In 2003, RIDICHE also published the catalogue of egg collection, including 352 eggs (160 species, 98 types, 45 families, 15 orders, representing 64.46% of the total amount of nesting birds species in our country). Most of them were collected by I. P. Licherdopol, respectively 312 items, the rest of the items being collected by the museum experts, during the field research.

The oldest items in the ornithological patrimony of the Oltenia Museum Craiova, in a good state of preservation, are dated beginning with the 20<sup>th</sup> century (1909: *Pastor roseus*; 1910: *Loxia curvirostra*; 1912: *Alectoris graeca*, *Himantopus himantopus*, *Calandrella brachydactyla*, *Oenanthe hispanica*, *Phylloscopus sibilatrix*, *Emberiza cirrus*; 1915: *Burhinus oedicephalus* etc.) and were prepared and donated by the famous naturalist Dionisie Linția. The bird collection enriched along the decades by various donations and acquisitions of stuffed birds (e.g. Constantina Sorescu collection) or skins (Mircea Popescu collection) but also by field collectings, as a result of scientific research (avifaunistic, ecologic etc.) made by the experts of the museum in different areas of the county. A significant number of birds from the collection are the result of the collaboration with authorised hunters (independent ones, hired by AGVPS).

### MATERIAL AND METHODS

As work support we have used the information supplied by the specialized literature (DOMBROWSKI 1946, LINȚIA 1954, 1955; GROSSU 1946, 1963, 1983; BAZILESCU et al., 1981; CĂTUNEANU 1983, GAROVNOKOV 1983; PAPADOPOLO 1983; VASILIU 1983; KISS 1983, 1998, 1999, 2002-2005; RIDICHE 1999, 2003) and preserved ornithological material in the patrimony of the Oltenia Museum.

### RESULTS AND DISCUSSIONS

Dionisie Linția was born on August 13, in Cacova village (today Gradinari village) in Caraș Severin county. In 1896 he began to study at the State Teachers School in Timișoara.



In 1899, he visited for the first time the Museum of Natural Sciences Society, in Timișoara. In 1902 he was visited in Moldova Noua, where he was working as a teacher, by the engineer Lodovic Forster, the governor of Banat Domains, who recommended Dionisie Lintia to the Hungarian specialists in Budapest. In 1903, he was elected as an ordinary member of the Natural Sciences Society in Timișoara. Starting with that moment, his life became inseparable from the museology activities of Banat. In 1904, he was invited to Budapest for a few weeks long specialisation class in order to improve his taxidermy and birds methodology knowledge: here he worked with Ph.D. Gyula Madarasz in Ornithological Collection and Dermoplastic Laboratory.

In 1926, he supplied the Scientific Museum in Craiova with 54 stuffed birds (Table 1). By examining the collection, we have discovered that 8 items from this list are missing, but, on the other hand, there are other items prepared by Lintia and donated probably on a different occasion (Table 2).

The list of the items donated by Dionisie Lintia on January 3, 1926 was published by Andrei Kiss in a volume dedicated to Dionisie Lintia, that includes the ornithological observations or his field work notes (KISS 2005). This list includes both the scientific name of the preparations and the dates of their collecting. We have compared this list with the catalogue published in 1980 and with the preserved ornithological material and we have noticed that almost all items prepared and offered by Lintia still exist in the collection, but, of these, only two have complete information and are known as originated from Dionisie Lintia, 36 have incomplete information, respectively the origin from Lintia is not certain or they only have partial collecting information and a number of eight items has absolutely no information (*Gavia stellata* 1313/135, *Phalacrocorax carbo* 1307/129; *Platalea leucorodia* 1272/103 și 1358/168; *Falco peregrinus* 1254/91; *Porzana parva* 1339/155; *Limosa limosa* 9343/1018; *Calandrella brachydactyla* 1209/54).

In this way, the "rehabilitated" items gained scientific value, passing from the museum items category that can be used as didactic or exhibition material, to the category of important preparations, with historical and documentary value that can be classified in the national cultural patrimony.

Thus, two species of rare birds (the Rock Partridge - *Alectoris graeca* and the little bustard - *Otis tetrax*), collected, prepared and published by the ornithologist Dionisie Lintia, are in present classified in the category of thesaurus items of the national cultural patrimony, being considered avifaunistic rarities in our country. In the category of the exquisite items in Lintia Collection we can also quote a specimen of rose-coloured starling - *Pastor roseus*, captured at Padina Matei (Banat) on June 8 (rare species in the Romanian fauna, usually preferring steppe habitats and a sample of jackdaw - *Corvus monedula*, captured in Tirol (Austria) on June 24, having completely white feathers (leucistic specimen of jackdaw).

In the ornithological collection of the Oltenia Museum there are also other two birds collected in the research area of the naturalist Dionisie Lintia, in the first half of the last century: *Plegadis falcinellus* collected at Satchinez (Banat) on August 25, 1924, inventory no. 1274/104 and *Anser f. fabalis* collected at Becicherecul Mic (Banat), on October 2, 1920, inventory no. 1287/113, for which we assume that they were also offered to the museum by the famous ornithologist, although this detail missed from the documents.

In 1980, Andrei Kiss, the curator of the bird collection from the Banat Museum Timsoara, the chief of the Natural Sciences Department of this museum, organised a Scientific Session of homage for the 100 years anniversary of Dionisie Lintia's birth. Many famous Romanian ornithologists and biologists that met him in person, shared their memories. CĂTUNEANU (1983) met him in 1930 in the laboratory of professor Andrei Popovici - Bâznoșanu, the chief of the Zoology Department of the Faculty of Biology in Bucharest. In the same place, in 1931, he met George Vasiliu, back then an assistant of professor Bâznoșanu (VASILIU 1983). In 1939, Alexandru Grossu met him at the Zoological Station in Sinaia, where he was invited by his professor, Popovici - Bâznoșanu, the founder of the station, when he was preparing his Phd in malacology. Lintia contributed to the endowment of the station with a collection of birds from the Romanian fauna, naturalised by him, which was kept until today. Friend of professor Bâznoșanu, he used to come to the station especially in autumn, in order to observe and to gather birds. A beautiful friendship started between them, which lasted until the end of maestro's life (GROSSU, 1963, 1983). Birds collected by Lintia were also donated to the Zoology Museum in Bucharest and to the museum of Vârșeț, Serbia. We have found information regarding these collections and their importance in the articles of GAROVNOKOV (1983) and PAPADOPOL (1983).

Andrei Kiss, the present curator of the bird collection from the Banat Museum, the continuer of the masterpiece initiated by Lintia, dedicated to the famous researcher numerous articles about his life and especially about his work (KISS, 1983, 1998a, 1998b, 2002, 2003). Besides these articles, he also published three volumes, one with the correspondence of Dionisie Lintia (KISS 1999) where he commented upon over 570 letters delivered or received by him from various ornithologists, a volume with observations, field work notes and materials collected by him along his life (KISS 2004) and a third volume about the collection donated by Lintia (KISS 2005). From his field work notes and from his correspondence we find out important information about some of the items now found in the collection of the Museum of Craiova. *Callandrella brachydactyla* (1209/54), *Phylloscopus sibilatrix* (1226/68) collected by Dionisie Lintia in Moldova Noua on April 24-25, 1912 and *Emberiza cirrus* (1208/52) from Svinița. *Monticola saxatilis* (1231/72) and *Oenanthe hispanica* (1232/73) from Divici, in May 1912, were collected during the study trip with Max Hugo Weigold (1886-1973) (KISS, 2004). Lintia met Hugo Weigold in 1907 during a trip by ship on the Danube to Orșova (KISS 1999). Back then, the future manager of the Ornithological Observatory in Helgoland and of the Natural Sciences Museum in Hanovra, was a student in Leipzig. Their friendship lasted all their lives. In 1912 they started together a collecting trip to Serbia and in the area of the Lower Danube which lasted six weeks. (KISS quoted work). All

the collected material was prepared by Linția and a part of it ended up in the bird collection of Craiova museum, according to the offer in 1926.

*Porzana porzana* (1339/155) from March 1917 was brought to him by a soldier that had caught the bird with his hat, in a hutment. Linția noted that the animal was not scared at all, he was arranging his feathers and was pecking in his aviary together with more Fringillidae. It was very calm and he could take it with him everywhere. Because of a snow storm that suddenly started on March 15, he could not feed it anymore so he had to sacrifice it.

*Anthus spinoletta* (1210/55) was collected during the ornithological trip in the Retezat Mountains, July 6-22, 1917. In the trip to Stana Radeș and Fata Radeș in July 22, on the plateau from the Cioaca saddle, he observed many Water Pipits. He shot seven birds, among which a flying young bird. At the same time, he believed there were still many nests with nestlings birds and maybe with still unhatched eggs, because he had noticed many adults of *Anthus spinoletta* that were carrying food in their peaks. (KISS quoted opera).

About *Anser erythropus* (1286/112) collected in March 1918, we have found out from his notes that it was shot by the public notary Köfalusy from Giroc who delivered it to Linția for his collection (KISS quoted opera).

The observations made upon the items collected in 1921: *Gavia stellata* (1312/134 și 1313/135), *Gavia actica* (1311/133) and *Otis tetrax* (1336/153) are also interesting. These were noted in Linția's correspondence with The Hungarian Ornithological Head Office in Budapest in 1922 (KISS 1999). About *Otis tetrax*, Linția wrote that they appeared in 2-3 places in 1921 and they were shot. In this way, the sample from Comloșul Mare (a female) was shot by a frontier guard. KISS (quoted work) noted that he could not find it in the catalogue of the collection in Bucharest, and now we know that it is in the collection in Craiova. Linția also noted in this correspondence about an invasion of *Colymbus arcticus* and *Colymbus septentrionalis* (today synonyms with *Gavia actica* and *Gavia stellata*) on November 12-14, 1921, which appeared in large groups around Timișoara, on the running waters, on lakes and moors. During those days he received for preparation 12-14 samples from more places (Timișoara, Remetea Mare, Șag Timișeni, Giroc, Utvin). KISS (quoted opera) noted that from all the 6 samples that got in Linția's hands, only one was a *Gavia stellata*, which he could not find in the catalogue of the collection. It seems like it was not lost, because we have now found it in the patrimony of the Oltenia Museum Craiova.

*Platalea leucorodia* (1272/103 and 1358/16) was collected by Linția during his expedition to Dobrogea in May 14-25, 1923. In this period he had many trips on Șerban Lake, Filipoiu Moor, Măcin Mountains and Greci. He collected the spoonbills at Cernofca Moor, in the last day of the trip when he also collected 2 nests of spoonbills, three of *Ardea purpurea* and a nest of *Podiceps nigricollis*. The nests were all sat on the reeds broken at the height of 90 cm at the surface of the water (KISS 2004).

All these observations are taken from the already published works and we hope they complete the missing information of these preparations and enrich their scientific and documentary value, especially in the field of history of sciences.

## CONCLUSIONS

The collection of the captured and prepared birds donated by Dionisie Linția to the museum of Craiova in the first half of the last century has an exquisite historic, documentary, scientific and also memorial value, being the proof of the meticulousness and the passion with which the great naturalist approached the field of the ornithological research.

This study contributes to the completion of the documentary device of the above mentioned items, making in this way possible, the passing from the category of museal items to the category of national cultural patrimony.

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Table 1. List of stuffed birds offered by Dionisie Linția to the Scientific Museum of Craiova, the 3<sup>rd</sup> January 1926.  
 Tabel 1. Lista speciilor de păsări naturalizat-montate oferite Muzeului Științific din Craiova de Dionisie Linția, la 3. I. 1926.

No.	Species	Sex	Locality	Sampling data
1.	<i>Gavia stellata</i>	Imm.	Giroc (Banat)	November 13, 1921
2.	<i>Gavia arctica</i>	♂	Utvín (Banat)	November 13, 1921
3.	* <i>Phalacrocorax carbo</i>	♂	Lake Șerban (Brăila)	May 17, 1925
4.	* <i>Phalacrocorax carbo</i>	♀	Lake Șerban (Brăila)	May 17, 1925
5.	<i>Platalea leucorodia</i>	♀	Chilia Veche (Dobrogea)	May 25, 1923
6.	<i>Cygnus olor</i>	Pull.	Ciamurlia (Dobrogea)	May 22, 1925
7.	<i>Anser erythropus</i>	♂	Giroc (Banat)	March 10, 1918
8.	<i>Anser erythropus</i>	♂	Becicherecu Mic (Banat)	November 21, 1924
9.	<i>Anas penelope</i>	♀	Satchinez (Banat)	October 25, 1918
10.	<i>Anas acuta</i>	♂	Giroc (Banat)	April 1, 1918
11.	<i>Anas clypeata</i>	♂	Becicherecu Mic (Banat)	March 17, 1918
12.	<i>Anas querquedula</i>	♂	Ghiroda (Banat)	March 29, 1925
13.	<i>Anas querquedula</i>	♀	Ghiroda (Banat)	March 30, 1925
14.	<i>Mergus albellus</i>	♂ juv.	Vinga (Banat)	February 26, 1922
15.	<i>Mergus serrator</i>	♂	Giroc (Banat)	November 9, 1924
16.	<i>Mergus merganser</i>	♀	Timișoara (Banat)	December 23, 1924
17.	<i>Falco peregrinus</i>	♀	Timișoara (Banat)	December 29, 1924
18.	<i>Coturnix coturnix</i>	♂	Timișoara (Banat)	June 20, 1924
19.	<i>Alectoris graeca saxatilis</i>	♂	Bosnia	November 11, 1912
20.	<i>Porzana parva</i>	♂	Timișoara (Banat)	March 13, 1917
21.	<i>Otis tetrax</i>	♀	Comloșu Mare (Banat)	December 7, 1921
22.	<i>Calidris testacea</i>	♂	Novi Bečej	May 22, 1908
23.	<i>Philomachus pugnax</i>	♀	Săcălaz (Banat)	March 9, 1924
24.	<i>Tringa erythropus</i>	♂	Satchinez (Banat)	May 20, 1918
25.	<i>Limosa limosa</i>	♂	Satchinez (Banat)	May 17, 1918
26.	<i>Lymnocyrtus minimus</i>	♀	Satchinez (Banat)	September 8, 1912
27.	<i>Himantopus himantopus</i>	♂	Biled (Banat)	June 23, 1912
28.	<i>Burhinus oedicnemus</i>	♂	(Banat)	November 10, 1915
29.	<i>Larus argentatus</i>	♂	Jurilovca (Dobrogea)	May 26, 1925
30.	<i>Columba livia</i>	♂	Doberdo (Carst)	January 26, 1925
31.	<i>Merops apiaster</i>	♂	Deliblata (Serbia)	June 12, 1914
32.	<i>Calandrella brachydactyla</i>	♀	Moldova Nouă (Banat)	April 24, 1912
33.	<i>Nucifraga caryocatactes</i>	-	Weldes (Kraina)	January 1, 1912
34.	<i>Corvus monedula</i>	♂	Tirol (Austria)	June 24, 1918
35.	* <i>Corvus frugilegus</i>	♀	Timișoara (Banat)	March 15, 1914
36.	* <i>Panurus biarmicus</i>	♂	Biled (Banat)	April 6, 1924
37.	* <i>Panurus biarmicus</i>	♂	Biled (Banat)	April 6, 1924
38.	<i>Parus lugubris</i>	♂	Grădinari (Banat)	February 1, 1917
39.	<i>Oenanthe hispanica</i>	♂	Divici (Banat)	May 28, 1912
40.	<i>Monticola saxatilis</i>	♂	Divici (Banat)	May 21, 1912
41.	<i>Sylvia atricapilla</i>	♂	Timișoara (Banat)	April 11, 1917
42.	<i>Phylloscopus sibilatrix</i>	♂	Moldova Nouă (Banat)	April 25, 1912
43.	<i>Prunella collaris</i>	♂	Mts. Retezat (Peak Zănoaga)	December 29, 1924
44.	<i>Anthus spinoletta</i>	♂	Mts. Retezat (Fata Radeș)	July 11, 1917
45.	<i>Motacilla flava</i>	♂	Covaci (Banat)	June 5, 1924
46.	<i>Motacilla cinerea</i>	♂	Moldova Nouă (Banat)	April 24, 1912
47.	<i>Lanius excubitor</i>	♀	Giroc (Banat)	December 14, 1924
48.	<i>Pastor roseus</i>	♀	Padina Matei (Banat)	June 8, 1909
49.	<i>Carduelis flammea</i>	♂	Giroc (Banat)	February 2, 1924
50.	* <i>Loxia curvirostra</i>	♂	Marila (Banat)	September 5, 1910
51.	* <i>Loxia curvirostra</i>	♀	Marila (Banat)	September 5, 1910
52.	<i>Coccothraustes coccothraustes</i>	♂	Fibiș (Banat)	December 29, 1924
53.	<i>Emberiza cirius</i>	♂	Șvinița (Banat)	May 7, 1912
54.	<i>Emberiza cia</i>	♂	Moldova Nouă (Banat)	December 29, 1916

\* Biogroup; ° with deformed beak, squinting

Table 2. List of stuffed bird species in the ornithological collection of the Oltenia Museum (Craiova), preparations by

Dionisie Linția.

Tabel 2. Lista speciilor de păsări naturalizat-montate din colecția ornitologică a Muzeului Olteniei (Craiova) preparate de

Dionisie Linția.

No.	Species	Sex	Locality	Sampling data	Collection number
1.	<i>Gavia stellata</i>	1 im	Giroc (Banat)	November 13, 1921	1312/134
2.	<i>Gavia stellata</i>	1 im	Giroc (Banat)	November 13, 1921	1313/135
3.	<i>Gavia arctica</i>	♂	Utvin (Banat)	November 13, 1921	1311/133
4.	<i>Phalacrocorax carbo</i> - trofeu	♂	Lake Șerban (Brăila)	May 17, 1925	1307/129
5.	<i>Platalea leucorodia</i>	♀	Chilia Veche (Dobrogea)	May 25, 1923	1272/103
6.	<i>Platalea leucorodia</i>	♀	Chilia Veche (Dobrogea)	May 25, 1923	1358/168
7.	<i>Anser erythropus</i>	♂	Giroc (Banat)	March 10, 1918	1286/112
8.	<i>Anser erythropus</i>	♂	Becicherecu Mic (Banat)	November 21, 1924	together with no. 1254/91
9.	<i>Anas acuta</i>	♂	Giroc (Banat)	April 1, 1918	1299/124
10.	<i>Anas querquedula</i>	♂	Ghiroda (Banat)	March 29, 1925	1296/121
11.	<i>Mergus albellus</i>	♂ juv	Vinga (Banat)	February 26, 1922	1304/128
12.	<i>Mergus serrator</i>	♂	Giroc (Banat)	November 9, 1924	1303/127
13.	<i>Mergus merganser</i>	♀	Timișoara (Banat)	December 23, 1924	1307/125
14.	<i>Falco peregrinus</i> (with prey / Lesser White-fronted Goose)	♀	Timișoara (Banat)	December 29, 1924	1254/91
15.	<i>Alectoris graeca</i>	♂	Koronik (Banat)	November 11, 1912	1346/161
16.	<i>Porzana parva</i>	♂	Timișoara (Banat)	March 13, 1917	1339/155
17.	<i>Otis tetrax</i>	♀	Comloșu Mare (Banat)	December 7, 1921	1336/153
18.	<i>Philomachus pugnax</i>	♂	Săcălăz (Banat)	March 9, 1924	1322/140
19.	<i>Philomachus pugnax</i>	♀	Săcălăz (Banat)	March 9, 1924	1323/141
20.	<i>Tringa erythropus</i>	♂	Satchinez (Banat)	May 20, 1918	1324/142
21.	<i>Limosa limosa</i>	♂	Satchinez (Banat)	May 17, 1918	9343/1018
22.	<i>Himantopus himantopus</i>	♂	Biled (Banat)	June 23, 1912	1326/144
23.	<i>Burhinus oedipnemos</i>	♂	Uliuc - Banat	November 10, 1915	1317/139
24.	<i>Larus cachinnans</i>	♂	Jurilovca (Dobrogea)	May 26, 1925	1332/149
25.	<i>Calandrella brachydactyla</i>	♀	Moldova Nouă (Banat)	April 24, 1912	1209/54
26.	<i>Nucifraga caryocatactes</i>	-	Retezat (Banat)	January 1, 1912	1193/40
27.	<i>Corvus monedula</i>	♂	Tirol (Austria)	June 24, 1918	1189/39
28.	<i>Corvus frugilegus</i>	♀	Timișoara (Banat)	March 15, 1914	1188/38
29.	<i>Panurus biarmicus</i>	♂	Biled (Banat)	April 6, 1924	1219/63
30.	<i>Panurus biarmicus</i>	♂	Biled (Banat)	April 6, 1924	1352/164
31.	<i>Parus lugubris</i>	♂	Grădinari (Banat)	February 1, 1917	1217/61
32.	<i>Oenanthe hispanica</i>	♂	Divici (Banat)	May 28, 1912	1232/73
33.	<i>Monticola saxatilis</i>	♂	Divici (Banat)	May 21, 1912	1231/72
34.	<i>Sylvia atricapilla</i>	♂	Timișoara (Banat)	April 11, 1917	1229/70
35.	<i>Phylloscopus sibilatrix</i>	♂	Moldova Nouă (Banat)	April 25, 1912	1226/68
36.	<i>Prunella collaris</i>	♂	Mts. Retezat (Peak Zănoaga)	July 19, 1917	1233/74
37.	<i>Anthus spinoletta</i>	♂	Mts. Retezat (Fata Radeș)	July 11, 1917	1210/55
38.	<i>Motacilla flava</i>	♂	Covacița (Banat)	June 5, 1924	1211/56
39.	<i>Motacilla alba</i>	0	-	June 1925	1214/58
40.	<i>Lanius excubitor</i>	♀	Giroc (Banat)	December 14, 1924	1220/64
41.	<i>Lanius collurio</i>	♂	Ilfov (Muntenia)		1222/65
42.	<i>Pastor roseus</i>	♀	Padina Matei (Banat)	June 8, 1909	1196/42
43.	<i>Carduelis flammea</i>	♂	Giroc (Banat)	February 2, 1924	1201/46
44.	<i>Loxia curvirostra</i>	♂	Marila (Banat)	September 5, 1910	1203/48
45.	<i>Loxia curvirostra</i>	♀	Marila (Banat)	September 5, 1910	1204/49
46.	<i>Coccothraustes coccothraustes</i>	♂	Fibiș (Banat)	December 29, 1924	1199/44
47.	<i>Emberiza cirrus</i>	♂	Șvinița (Banat)	May 7, 1912	1208/52
48.	<i>Emberiza cia</i>	♂	Moldova Nouă (Banat)	December 29, 1916	1207/53



## THE EXOTIC BIRDS' COLLECTION OF THE ZOOLOGICAL MUSEUM (UNIVERSITY BABEȘ-BOLYAI) FROM CLUJ-NAPOCA (ROMANIA)

ANGELA PETRESCU, DELIA CEUCA

**Abstract.** We present the bird collection catalogue of the world fauna from the patrimony of the Zoological Museum of Cluj (founded in 1859). The studied collection includes 221 specimens belonging to 172 species, 59 families, 18 orders. Especially, we mention a small hummingbird collection made of 45 specimens, 38 species; some endemic species, three from Brazil (*Malacoptila striata*, *Hemithraupis ruficapilla*, *Paroaria dominicana*) and *Apteryx oweni* (New Zealand). Also, the collection includes other distinguished species as: *Goura victoriae*, *Argusianus argus grayi*, *Tragopan melanocephalus*, *Lophophorus impejanus*.

**Keywords:** catalogue, collection, exotic bird, museum, Cluj (Romania).

**Rezumat.** Colecția de păsări exotice a Muzeului Zoologic (Universitatea Babeș-Bolyai) din Cluj (România). Prezentăm catalogul colecției de păsări din fauna mondială din patrimoniul Muzeului de Zoologie din Cluj (înființat în 1859). Colecția studiată cuprinde 221 de exemplare încadrate în 172 de specii, 59 de familii, 18 ordine. Remarcăm în mod deosebit o mică colecție de colibri alcătuită din 45 de exemplare, 38 de specii; câteva endemite, trei din Brazilia (*Malacoptila striata*, *Hemithraupis ruficapilla*, *Paroaria dominicana*) și *Apteryx oweni* (Noua Zeelandă). Colecția conține și alte specii deosebite ca: *Goura victoriae*, *Argusianus argus grayi*, *Tragopan melanocephalus*, *Lophophorus impejanus*.

**Cuvinte cheie:** catalog, colecție, păsări, fauna mondială, muzeu, Cluj (România).

### INTRODUCTION

The Zoological Museum of Cluj belongs to the „Babeș-Bolyai” University and it was founded in 1860; it was only one part of the Museum of Transylvanian Society. The department of natural sciences of the Transylvanian Society Museum developed then, separately, affiliated to the University (because the museum had several sections: archaeology, art, etc.). The department of natural sciences began its activity in 1861 after the museum got some small donations. From 1864, HERMAN OTTO (1835-1914) organized the collection of zoology as aid director delegated, who also began to lay the foundation of the ornithological collection (MUNTEANU, 1979-1980). While working at the museum until 1871, HERMAN OTTO had a rich publishing and museological activity. He collected zoological material and published many works of ornithology and about other groups of invertebrates. His activity was recalled by MUNTEANU (op.cit.) in a very well documented study.

LUDWIG FÜHRER had a special part in the organization of this remarkable collection; he was a passionate ornithologist, who collected a large number of birds (naturalized and mounted exhibits or skins) between 1904 and 1911, as long as he worked at the Transylvanian Society Museum (FILIPAȘCU, 1966.). Since 1922, the museum has been subordinated to the Zoology Chair of the faculty of Natural Sciences and Geography (University of King Ferdinand I), renamed „Babeș-Bolyai” University after 1950.

Although it has an obvious educational character, the museum can be visited by the general public. Scientifically and according to the number of the preserved specimens, the Zoological Museum is the second after „Grigore Antipa” Museum, continuously enriching its patrimony by collecting, donations and acquisitions (CEUCA, 2006). For the time being, the ornithological collection includes birds from Romania, especially from Transylvania, thousands of naturalized-mounted specimens, some hundreds of skins and about 4,000 bird eggs. Besides, in the public exhibition and in scientific collection there are more than 221 birds of the world fauna, most of them unidentified. The entire collection was a little studied, and the results were published in a few papers: FILIPAȘCU et al., (1965), FILIPAȘCU (1966), MUNTEANU (1979-1980), GHERGHEL (1988, 1989a, b, c, 1997), CEUCA (2006, 2007).

### MATERIAL AND METHOD

Studied material includes over 221 specimens, out of which 153 are in the public exhibition, partially identified, and 68 specimens of the scientific collection, which are were unidentified. Unfortunately, many of them have no data. For each specimen, I mentioned the scientific name, author, English, French and Romanian name. I took the Romanian name from a few publications of science popularization, which were released in Romania (RIETSCHER et al., 1964; RADU, 1983). For many species I have not found proper Romanian names. For some of them I have updated their scientific names, but also I let the old name, which is in the collection register book, for not creating confusions. With regard to the taxonomy, I used the papers signed by SIBLEY & MONROE (1990), DICKINSON (2003) and web page ALAN P. PETERSON (zoonomen.net).

Used abbreviation: w.d.=without data; m=naturalized-mounted specimen; s=skin; ♂=male; ♀=female; sp=specimen; sps=specimens; coll. no.=collection number; w. coll. no.=without collection number; juv.=juvenile; ad.=adult; Zoological Garden=Zoo.

## RESULTS AND DISCUSSIONS

The 221 birds of the world fauna included in the patrimony of the Zoological Museum of Cluj belong to 172 species, 59 families and 18 orders. We present the catalogue of this collection as a taxonomical list. The birds are naturalized and mounted, and only four are skins. From the zoogeographical point of view, the 172 species originate in different continents: South America, Africa, Asia, Europe, Australia. Those from South America are prevalent, as a matter of fact from the neotropical region. The hummingbirds collection distinguishes. It includes 45 specimens of 38 species and *Eudocimus ruber*, *Crax fasciolata*, *Coragyps atratus*, *Ara macao*, *Crotophaga ani*. Also from this region there are three endemic species of Brazil: *Malacoptila striata* (Fam. Bucconidae), *Hemithraupis ruficapilla* (Fam. Thraupidae), *Paroaria dominicana* (Fam. Emberizidae). The collection includes other rare species, too: *Goura victoriae*, *Argusianus argus grayi*, *Tragopan melanocephalus*, *Lophophorus impejanus* from Asia and *Apteryx oweni* (endemic species from New Zealand) acquired in 1877/78. During the same period, *Struthio camelus* was also acquired. In 1961, the Museum of Cluj received a donation of 9 birds from „Grigore Antipa” Museum of Bucharest. From these items we mention two: *Lagopus mutus* from Canada, donated by Nicolae Ghica Comănești and *Streptopelia chinensis* (Sumatra) donated by C. Eberle, two great donors of the museum of Bucharest.

## Ord. STRUTHIONIFORMES

## Fam. STRUTHIONIDAE

- *Struthio camellus* LINNAEUS, 1758 - Ostrich, Autruche d'Afrique, Struț african: 1 sp., coll. no. 625/3, m., w.d.

## Fam. RHEIDAE

- *Rhea americana* (LINNAEUS, 1758) - Greater Rhea, Nandou d'Amérique, Nandu: ♂, coll. no. 136720, Zoo. Bucharest (Romania); ♀, coll. no. 136723, Zoo. Bucharest (Romania); 1 juv., coll. no. 625/1, m., Zoo. Bucharest (Romania), w.d.

## Fam. CASUARIDAE

- *Casuarus casuarus* (LINNAEUS, 1758) - Southern Cassowary, Casoar à casque, Casuar: 2 sps., coll. no. 625/2, 625/3, Australia, Zoo. Bucharest (Romania), m., A.G.V.P.S., Bucharest.

## Fam. APTERYGIDAE

- *Apteryx oweni* GOULD, 1847 - Little Spotted Kiwi, Kiwi d'Owen, Kiwi: 1 sp., coll. no. 1531, m., w.d.

## Ord. GALLIFORMES

## Fam. CRACIDAE

- *Crax fasciolata* SPIX, 1825 - Bare-faced Currassow, Hocco à face nue, Cocos Hoccas: *Crax schlateri*, 1 sp., coll. no. 703, m., Brazil, w.d.

## Fam. NUMIDIDAE

- *Numida meleagris* (LINNAEUS, 1758) - Helmeted Guineafowl, Pintade de Numidie, Bibilică: coll. no. 11312, m., 1 sp., w.d.

## Fam. PHASIANIDAE

- *Meleagris ocellatus* CUVIER, 1820 - Ocellated Turkey, Dindon ocellé: *Meleagris gallopavo*, 1 sp., coll. no. 930 (D25), m., w.d.
- *Lagopus mutus* (MONTIN, 1781) - Rock Ptarmigan, Lagopède alpin, Potârniche de tundră: 1 sp., ♂, 3 sps, ♂♂, m., w.d.
- *Alectoris rufa* (LINNAEUS, 1758) - Red Legged Partridge, Perdrix rouge, Potârniche cu picioare roșii: 1 sp, coll. no. 711, S-W Europe, w.d.
- *Alectoris chukar sinaica* (BONAPARTE, 1858) - Chukar Partridge, Perdrix choukar, Potârniche de stâncă asiatică: ♂, no coll. 705/2, m., Israel, 19. 12. 1962.
- *Alectoris chukar cypriotes* (HARTERT, 1925), 1 sp., no coll. 705/1, m., Israel, 28.VI.1965.
- *Francolinus francolinus* (LINNAEUS, 1766) - Black Francolin, Francolin noir, Francolin negru: 1 sp., w. coll. no., Asia Minor, w.d.; ♂, coll. no. 700/1, m., Norway, 1969, Schimb - RFG, W. Lehne.
- *Tragopan melanocephalus* (J. E. GRAY, 1829) - Western Pheasant, Tragopan de Hastings: 1 sp., coll. no. 1933, m., w.d.
- *Lophophorus impejanus* (LATHAM, 1790) - Himalayan Monal, Lophophore resplendissant, Păun himalaian; 1 sp., m., coll. no. 1800, w.d.
- *Gallus gallus bankiva* TEMMINCK, 1813 - Red Junglefowl, Coq bankiva, Găină: ♂♀, coll. no. 700/2, Indochina.
- *Lophura nycthemera* (LINNAEUS, 1758) - Silver Pheasant, Faisan argenté, Fazan argintiu: *Genaes nycthemerus* 2 sps, coll. no. 710/1 and 138787/1, C Asia, from captivity of Tinra (Bihor, Romania), 10. 03. 1972.; *G. nycthemerus* , ♀, coll. no. 1334.
- *Chrossoptilon auritum* (PALLAS, 1811) - Blue Eared Pheasant, Hokki bleu, Fazan urecheat albastru: ♀, coll. 125957, m., China, w.d.

- *Syrnaticus reevesii* (J. E. GRAY, 1829) - Reeves's Pheasant, Faisan vénéré, Fazan regal: 1 sp., coll. no. 137658, m., China, Zoo. București (Romania), w.d.
- *Chrysolophus pictus* (LINNAEUS, 1758) - Golden Pheasant, Faisan doré, Fazan auriu: ♂♂, coll. 709, m., China, w.d.
- *Chrysolophus amherstiae* (LEADBEATER, 1829) - Lady Amherst's Pheasant, Faisan de Lady Amhers, Fazan Amherst: 1 sp., coll. no. 710, C Asia, w.d.; ♀ juv., coll. no. 1131/1, Zoo. Turda (Romania), 1975, w.d.
- *Chrysolophus amherstiae* x *Chrysolophus pictus* - Pheasant hybrid: ♂, no. col. 103291, Zoo. Bucharest (Romania), 10. 12. 1967.
- *Argusianus argus grayi* (ELLIOT, 1865) - Great Argus, Argus géant, Fazan Argus: 1 sp., coll. no. 713, Borneo, w.d.
- *Pavo cristatus* LINNAEUS, 1758 - Indian Peafowl, Paon bleu, Păun: 1 sp., coll. no. 262/129353, m., Zoo. Turda (Romania), 23. 04. 1970; ♀ juv., coll. no. 712/1, m., Zoo. Turda (Romania); 1 sp., w. coll. no., m., Cluj, w.d.; ♀ (albinism), coll. no. 125951, m., w.d.; 1 sp., coll. no. 712/2, m., 22. 06. 1970, donated Rudolf Palocsay; 2 sps, coll. no. 712/3, m., w.d.; 1 sp., coll. no. 712/4, m., Cluj (Romania), 2. 02. 1971, donated Tiberiu Persecă.

## Ord. ANSERIFORMES

## Fam. ANATIDAE

- *Anser indicus* (LATHAM, 1790) - Bar-Headed Goose, Oie à tête barrée, Gâscă de India: 1 sp., coll. no. 654, m., w.d.
- *Cairina moschata* (LINNAEUS, 1758) - Muskovy Duck, Canard musqué, Rață leșească: 1 sp., coll. no. 655/1, m., Argentina, w.d.
- *Netta peposaca* (VIEILLLOT, 1816) - Rosybill, Nette demi-deuil: *Fuligula metopis*, 1 sp., coll. no. 671, m., Santiago (Chili) w.d.
- *Somateria mollissima* (LINNAEUS, 1758) - Common Eider, Eider à duvet, Eider: ♂, ♀, coll. no. 667/1-2, m., Norway, change with W. Lehne, Germany.
- *Clangula hyemalis* (LINNAEUS, 1758) - Long-tailed Duck, Harelde boréale, Rață de ghețuri: Transylvania, 1 sp., coll. no. 668, m., w.d.

## Ord. SPHENISCIFORMES

## Fam. SPHENISCIDAE

- *Eudyptes chrysochome* (J. F. FORSTER, 1781) - Rockhopper Penguin, Gorfou sauteur, Manșot sprâncenat: 1 sp., coll. no. 1531, m, w.d.

## Ord. PROCELARIIFORMES

## Fam. DIOMEDEIDAE

- *Diomedea exulans* LINNAEUS, 1758 - Wandering Albatross, Albatros hurleur, Albatros: 1 sp., coll. no. 961/6, w.d.

## Fam. PROCELARIIDAE

- *Calonectris diomedea* (SCOPOLI, 1769) - Cory's Shearwater, Puffin cendré, Puțin cenușiu: *Puffinus kühlii* BOIE, 3 sp.s, Coll. no. 1061, m., w.d.

## Ord. PHOENICOPTERIFORMES

## Fam. PHOENICOPTERIDAE

- *Phoenicopterus ruber* (LINNAEUS, 1758) - Greater flamingo, Flamant rose, Flaming roșu: 1 sp., coll. no. 137656, m., Zoo. București (A.G.V.P.S.) (Romania), 1972, S Asia.

## Ord. PELECANIFORMES

## Fam. THRESKIORNITHIDAE

- *Eudocimus ruber* (LINNAEUS, 1758) - Scarlet Ibis, Ibis rouge, Ibis roșu: 2 sp.s, ♀♀, coll. no. 639/1-2, Venezuela, 25.V.1969, Leg. PAKAY.

## Fam. SULIDAE

- *Morus bassanus* (LINNAEUS, 1758) - Northern Gannet, Fou de Bassan, Corb de mare: *Sula bassana* L., 1 sp., coll. no. 638, m., Zoo. București (Romania), w.d.

## Fam. PHALACROCORACIDAE

- *Phalacrocorax aristotelis desmarestii* (PAYRAUDEAU, 1826) - European Shag or Common Shag, Cormoran de Desmarest, Cormoran moțat: 1 sp., coll. no. 1069, m., w.d.

## Ord. CICONIIFORMES

## Fam. CATARTHIDAE

- *Coragypus atratus* (BECHSTEIN, 1793) - Black Vulture, Urubu noir: 1 sp., coll. no. 1010, m., America de Sud, w.d.

## Fam. ACCIPITRIDAE

- *Neophron percnopterus* (LINNAEUS, 1758) - Egyptian Vulture, Vautour percnoptère, Hoitar: 2 sp.s, coll. no. 698/1-2, m., Southern Europe, w.d.
- *Aquila rapax* (TEMMINCK, 1828) - Tawny Eagle, Aigle ravisseur, Acvilă răpitoare, 1 sp., coll. no. 136722, m., Zoo. București (Romania), w.d.

## Fam. CHARADRIIDAE

- *Vanellus spinosus* (LINNAEUS, 1758) - Spur-winged Plover, Vanneau à éperons, Nagăț sudic, Nagăț cu pinten: *Hoplopterus spinosus*, 1 sp., coll. no. 920, m., Africa, w.d.
- *Jacana jacana* (LINNAEUS, 1766) - Wattled Jacana, Jacana noir, Jacana: 1 sp., coll. no. 919, m., South America, w.d.

## Fam. SCOLOPACIDAE

- *Arenaria interpres* (LINNAEUS, 1758) - Ruddy Turnstone, Tournepierre à collier, Pietruș: 1 sp., coll. no. 729/1, m., Norway, 1969, W. Lehne, change with Germany.
- *Phalaropus fulicarius* (LINNAEUS, 1758) - Grey/Red Phalarope, Phalarope à bec large, Notatiță cu cioc lat: 1 sp., coll. no. 740/1, m., Norway, Leg. W. LEHNE, change with Germany.

## Fam. LARIDAE

- *Larus hyperboreus* GUNNERUS, 1767 - Glaucous Gull, Goéland bourgmestre, Pescăruș de ghețuri: 1 sp., coll. no. 1157, m., w.d.
- *Thalasseus sandvicensis* LATHAM 1787, syn. *Sterna sandvicensis* - Sandwich Tern, Sterne caugek, Chiră de mare: *Sterna cantiana* GMELIN., 2 sps, coll. no. 755, m., w.d.

## Fam. ALCIDAE

- *Alca torda* LINNAEUS, 1758 - Razorbill, Petit Pingouin, Alcă: Arctic Ocean, 2 sps, coll. no. 749, m., w.d.
- *Alle alle* (LINNAEUS, 1758) - Little Auk, Mergule nain, Garia: (Fundar pitic), Arctic Ocean, 1 sp., coll. no. 750, m., w.d.
- *Cepphus grylle* (LINNAEUS, 1758) - Black Guillemot, Guillemot à miroir, Alcă cu oglindă: *Aria grylle*, 1 sp., coll. no. 750, m., Arctic Ocean, w.d.
- *Cepphus columba* PALLAS, 1811 - Pigeon Guillemot, Guillemot colombin, Alcă porumbel: 1 sp., coll. no. 1315, m., w.d.

## Fam. PTEROCLIDIDAE

- *Pterocles orientalis arenarius* (PALLAS, 1775) - Black-bellied Sandgrouse, Ganga unibande, Găinușă de stepă: *Pterocles arenarius* PALLAS, 1 sp., coll. no. 777, m., w.d.
- *Pterocles alchata* LINNAEUS, 1766 - Pintailed Sand-Grouse, Ganga cata, Găinușă de stepă: *Pterocles setarius* Temminck, 1 sp., coll. no. 922, m., w.d.

## Ord. GRUIFORMES

## Fam. RALLIDAE

- *Porphyrio porphyrio* (LINNAEUS, 1758) - Purple Swamphen, Talève sultane, Găinușă albastră: 1 sp., coll. no. 1278, m., w.d.

## Fam. GRUIDAE

- *Balearica pavonina* (LINNAEUS, 1758) - Black Crowned Crane, Grue couronnée, Cocor cu coroană: 1 sp., coll. no. 93753, m., Zoo. București (Romania), Africa.

## Ord. COLUMBIFORMES

## Fam. COLUMBIDAE

- *Streptopelia senegalensis* (LINNAEUS, 1766) - Laughing Dove, Turturică africană: ♂, no. coll. 774/1, m., Israel, 17.02.1969, Leg. Salmo Helwig.
- *Streptopelia chinensis* (SCOPOLI, 1786) - Spotted-necked Dove, Tourterelle tigrine, :1 sp., coll. no. 1263, Sumatra, don. C. Eberle, gift from "Grigore Antipa" Museum, w.d.
- *Geopelia cuneata* (LATHAM, 1802) - Diamond Dove, Géopélie diamant, Papagal diamant: 1 sp., coll. no. 137659, m., Australia, Leg. SALMO HELWIG.
- *Goura victoriae* (FRASER, 1844) - Victoria Crowned Pigeon, Goura de Victoria, Porumbel cu coroană: 1 sp., Coll. no. 775, m., New Guinea, w.d.
- *Treron vernanas* (LINNAEUS, 1771) - Pine-necked Green Pigeon, Colombar giouanne, 1 sp., coll. no. 1322, m., w.d.
- *Treron griseocauda* BONAPARTE, 1854 - Gray cheeked Green Pigeon, Colombar à face grise: 1 sp., coll. no. 1323, m., w.d.
- *Treron capellei* (TEMMINCK, 1840) - Large Green Pigeon, Colombar de Capelle: 1 sp., coll. no. 1321, m., w.d.

## Ord. PSITTACIFORMES

## Fam. PSITTACIDAE

- *Cacatua tenuirostris* (KUHL, 1820) - Long-Billed Corella, Cacatoès nasique, Papagal alb-roz: *Licmatis nasica* TEMMINCK, 1 sp., coll. no. 778, m., w.d.
- *Cacatua moluccensis* (J. F. GMELIN, 1788) - Salmon-crested Cokatoo, Cacatoès à huppe rouge, Cacaduș alb moțat, 1 sp., coll. no. 1839, m., w.d.; endemic from Moluccas.

- *Melopsittacus undulatus* (SHAW, 1805) - Budgerigar, Perruche ondulée, Peruș: 2 sps, coll. no. 1852, m., w.d.; 2 sps, coll. no. 1843, m., w.d.; 1 sp., coll. no. 1332, s., w.d.
- *Psittinus cyanurus* (J. F. Forster, 1795) - Blue rumped Parrot, Perruche à croupion bleu, Peruș cu spate albastru 1 sp., coll. no. 1278, m., w.d.
- *Agapornis lilianae* SHELLEY, 1894 - Nyasa Lovebird, Inséparable de Lilian, Inseparabili: 1 sp., coll. no. 1330, m., w.d.
- *Ara macao* (LINNAEUS, 1758) - Scarlet Macaw, Ara rouge, Papagal Ara: 1 sp., coll. no. 80997, gift from „Grigore Antipa” Museum, București, m., w.d.

## Ord. CUCULIFORMES

## Fam. CUCULIDAE

- *Crotophaga ani* LINNAEUS, 1758 - Smooth-billed Ani, Ani à bec lisse, : 1 sp., coll. no. 1306, m., w.d.
- *Zanclostomus (Phaenicophaeus) curvirostris* (SHAW, 1810) - Chestnut-breasted Malkoha, Malcoha rouverdin: 1 sp., coll. no. 1263, m., w.d.
- *Clamator glandarius* (LINNAEUS, 1758) - Great Spotted Cuckoo, Coucou geai: *Coccyzus glandarius* GMELIN, 1 sp., coll. no. 917, m., Asia Minor, w.d.
- *Surniculus lugubris* (HORSFIELD, 1821) - Asian Drongo-Cuckoo, Coucou surnicou: ad. ♂, coll. no. 1326, m., 1 juv., coll. no. 1328, w.d.

## Ord. STRIGIFORMES

## Fam. STRIGIDE

- *Nyctea scandiaca* (LINNAEUS, 1758) - Snowy Owl, Harfang des neiges, Bufnița zăpezilor: *Nyctea nyctea* L., 1 sp., coll. no. 788, m., Arctic region, w.d.; 1 sp., coll. no. 1024(D.82), m., w.d.

## Ord. APODIFORMES

## Fam. TROCHILIDAE

- *Glaucis hirsuta* (J.F. GMELIN, 1788) - Hairy Hermit, Ermite hirsute: ♂, coll. no. 1772, m., Brazil, w.d.
- *Eutoxeres aquila* BOURCIER, 1847 - White-tipped Sickbill, Bec-en-faucille aigle: ♂, coll. no. 1781, Colombia, m., w.d.
- *Phaethornis guy* DE LATTRE, 1843 - Green Hermit, Ermite vert: 1 sp., coll. no. 1766, m., w.d.
- *Androdon aequatorialis* Gould, 1863 - Tooth-billed Hummingbird, Colibri d'Équateur: *Phaeolema equatorialis* J. Gould, 1 sp., coll. no. 1782, m., w.d.
- *Phaethornis eurynome* (LESSON, 1832) - Scale throated Hermi, Ermite eurynome: 1 sp., coll. no. 1758, m., Brazil, w.d.
- *Doryfera ludovicae* BOURCIER et MULSANT, 1847 - Green fronted Lancebill, Porte-lance de Louise: ♂, Coll. no. 1780, m., New Granada, w.d.
- *Campylopterus falcatus* (SWAINSON, 1821) - Lazuline Sabrewing, Campyloptère lazuline: *Campylopterus lazulus* VIEILLOT, 1 sp., ♂, coll. no. 1755, m., w.d.; Indet., ♀, w. coll. no., m., w.d.
- *Anthracothorax nigricollis* VIEILLOT, 1817 - Black throated Mango, Mango à cravate noire: *Lampornis nigricollis* VIEILLOT, ♂, coll. no. 1776, m., w.d.; Colibri indet, ♂ ad., coll. no. 1301, m., w.d.; Colibri indet, 1 juv., coll. no. 1302, m., w.d.
- *Eulampis jugularis* LINNAEUS, 1766 - Purple-throated Carib, Colibri madder: ♂, coll. no. 1765, m., Martinica, w.d.
- *Eulampis holosericeus* (LINNAEUS, 1758) - Green throated Carib, Colibri falle-vert: *Sericotes holosericeus* LINN. 1 sp., w. coll. no., w.d.
- *Chrysolampis mosquitos* (LINNAEUS, 1758) - Ruby Topaz, Colibri rubis topaze: ♂, coll. no. 1759, m. Brazil, w.d.
- *Orthorhyncus cristatus exilis* (J. F. GMELIN, 1788) - Antillean Crested Hummingbird, Colibri huppé: *Belone cristata exilis* GMELIN, ♂, coll. no. 1754, m., Arizona, w.d.
- *Stephanoxis lalandi* VIEILLOT, 1818 - Plovercrest, Colibri de Delalandi: ♂, coll. no. 1756, m., Brazil, w.d.
- *Lepidopyga goudoti* BOURCIER, 1843 - Shining-green Hummingbird, Colibri de Goudot: ♂, coll. no. 1785, m., New Granada, w.d.
- *Hylocharis cyanus* VIEILLOT, 1818 - White chinned Sapphire, Saphir azuré: ♂, coll. no. 1774, m., Brazil, w.d.
- *Leucochloris albicollis* VIEILLOT, 1818 - White-throated Hummingbird, Colibri à gorge blanche: ♂, coll. no. 1773, m., Ecuador; 1 sp., w. coll. no., w.d.
- *Agyrtria brevirostris* LESSON, 1829 - White-chested Emerald, Ariane à poitrine blanche: ♂, coll. no. 1769, m., Brazil, w.d.
- *Saucerottia cyanifrons* BOURCIER, 1843 - Indigo capped Hummingbird, Ariane à front bleu: ♂, coll. no. 1762, m. Colombia and ♀, New Granada, w.d.
- *Amazilia saucerrottei* (DELATTRE & BOURCIER, 1846) - Steely-vented Hummingbird, Ariane de Sophie: *Saucerothera chlorocephala* BOURCIER, ♂, coll. no. 1760, m., New Granada, w.d.
- *Chalibura buffonii* LESSON, 1832 - White-vented Plumeleteer, Colibri de Buffon, ♂, coll. no. 1787, m., Colombia, w.d.
- *Adelomya melanogenys maculata* GOULD, 1861 - Speckled Hummingbird; Colibri moucheté: ♂, coll. no. 1783, m., New Granada, w.d.
- *Clytolaema rubricauda* BODDAERT, 1783 - Brazilian Ruby, Colibri rubis-émeraude: *Clytolaema rubinea* GMELIN, ♂, coll. no. 1786, m., New Granada, w.d.



- *Aglaeactes cupripennis* (BOURCIER, 1843) - Shining Sunbeam, Colibri étincelant: ♂, coll. no. 1788, m., Rio Napo, w.d.
- *Lampornis clemenciae* LESSON, 1828 - Blue-throated Hummingbird, Colibri à gorge bleue, Colibri cu gât albastru: *Coeligena clemenciae* LESSON, ♂, coll. no. 1779, m., Mexic, w.d.
- *Coeligena torquata* (BOISSONNEAU, 1840) - Collard Inca, Inca á collier: *Helianthea torquata* BOISS., 1 sp., coll. no. 1764, m., Colombia, w.d.
- *Coeligena bonapartei* BOISSONNEAU, 1840 - Golden-bellied Starfrontlet; Inca de Bonaparte: *Helianthea bonapartei* Boisso. 2 sp.s, ♂ and ♀, coll. no. 1763, m., New Granada, w.d.
- *Ensifera ensifer* (BOISSONNEAU, 1840) - Sword-billed Hummingbird, Colibri porte-épée: *Dociomastes longifer* BOISSONNEAU, 1 sp., coll. no. 1751, m., Rio Napo, w.d.
- *Pterophanes cyanopterus* (FRASER, 1840) - Great Sapphire wing, Colibri á ailes saphir: *Pterophanes temminckii* BOISS., ♂, coll. no. 1771, m., Colombia, w.d.
- *Patagona gigas* VIEILLOT, 1824 - Giant Hummingbird, Colibri géant: 1 sp., coll. no. 1761, m., Ecuador, w.d.
- *Helianthus clarisse* LONGMARE, 1841 - Longuemare's Sunangel, Héliange de Clarisse: 1 sp., coll. no. 1768, m., Colombia, w.d.
- *Eriocnemis vestitus* (LESSON, 1838) - Glowing Puffleg, Ériane pattue: *Eriocnemis vestita* LESSON, ♂, coll. no. 1757, m., Bogota, w.d.
- *Lesbia nuna gouldii* (LODDIGES, 1832) - Green-tailed Trainbearer, Port-traîne nouna: *Psalidophrymna gouldii* LODDIGES, ♂, coll. no. 1767, m., New Granada, w.d.
- *Rhamphomicron microrhynchum* (BOISSONNEAU, 1840) - Purple-backed Thornbill, Colibri á petit bec: 1 sp., coll. no. 1777, m., New Granada, w.d.; ♀, coll. no. 1318, m., w.d.
- *Oxygogon guerini* BOISSONNEAU, 1840 - Bearded Helmetcrest, Colibri casque: 1 sp., coll. no. 1784, m., New Granada, w.d.
- *Metallura williami* DE LATTRE & BOURCIER, 1846 - 1 sp., coll. no. 1766, m., Colombia, w.d.
- *Calothorax lucifer* SWAINSON, 1827 - Lucifer Hummingbird, Colibri Lucifer: ♂, coll. no. 1778, m., Mexic, w.d.
- *Archilochus colubris* LINNAEUS, 1758 - Ruby-throated Hummingbird, Colibri á gorge rubi: *Trochilus colubris*, 1 sp., coll. no. 1752, m., Mexico, w.d.
- *Calypte anna* LESSON 1832 - Anna's Hummingbird, Colibri d'Anna: *Trochilus anna* LESSON, 1 sp., w. coll. no., m., w.d.

\* New Granada was a centralist republic consisting primarily of present-day Colombia and Panama with smaller portions of today's Ecuador, Peru, Brazil, Costa Rica, Venezuela and Nicaragua.

#### Ord. GALBULIFORMES

##### Fam. BUCCONIDAE

- *Malacoptila striata* (SPIX, 1824) - Crescent-Chested Puffbird, Tamatia rayé: 1 sp., coll. no. 1287, w.d. (Brazil).

#### Ord. CORACIIFORMES

##### Fam. CORACIIDAE

- *Euristomus orientalis* LINNAEUS, 1766 - Dollarbird, Rolle oriental: 1 sp., coll. no. 1329, m., w.d.

##### Fam. ALCEDINIDAE

- *Ceryle rudis* LINNAEUS, 1758 - Pied Kingfisher, Martin-pêcheur pie, Pescar cenușiu: 1 sp., coll. no. 904, m., Asia Minor, w.d.; 1 sp., coll. no. 1270, m., gift from "Grigore Antipa" Museum, w.d.; 1 sp., coll. no. 1271, m., gift from "Grigore Antipa" Museum, w.d.

##### Fam. MOMOTIDAE

- *Eumomota superciliaris* (SANDBACH, 1837) - Turquoise-browed Motmot, Motmot à sourcils bleus: 1 sp., coll. no. 1293, m., Honduras, gift from "Grigore Antipa" Museum, w.d.

##### Fam. MEROPIDAE

- *Merops persicus* PALLAS, 1773 - Blue-cheeked Bee-eater, Guêpier de Perse: 1 sp., coll. no. 1272, m., Africa, gift from "Grigore Antipa" Museum, w.d.

#### Ord. BUCEROTIFORMES

##### Fam. BUCEROTIDAE

- *Anthracoceros coronatus* (BODDAERT, 1783) (head) - Malabar Pied Hornbill, Calao de Malabar: *Anthracoceros malabaricus*, 1 sp., coll. no. 969, m.

#### Ord. PICIFORMES

##### Fam. RAMPHASTIDAE

- *Ramphastos toco* STATIUS MÜLLER, 1776 - Toco Toucan, Toucan Toco, Tucan: 1 sp., coll. no. 914, m., w.d.
- *Aulacorhynchus haematopygus* (GOULD, 1835) - Crimson-rumped Toucanet, Toucanet à croupion rouge: *Ramphastos haematopygius*, 1 sp., Coll. no. 915, m., w.d.

- *Pteroglossus aracari* (LINNAEUS, 1758) - Black-necked Aracari, Araçari grigri: *Ramphastos aracari*, 1 sp., coll. no. 916, m., w.d.
- *Andigena laminirostris* GOLUD, 1851 - Plate-billed Mountain Toucan, Toucan montagnard: 1 sp., coll. no. 1324, m., w.d.

## Fam. PICIDAE

- *Dendrocopos moluccensis nanus* (VIGORS, 1832) - Brown-capped Woodpecker, Pic à calotte brune: 1 sp., coll. no. 1305, m., w.d.
- *Celeus brachyurus* (VIEILLOT, 1818) - Rufous Woodpecker, Pic brun: 1 sp., coll. no. 1320, m., w.d.
- *Celeus flavescens* (GMELIN, 1788) - Blond-crested Woodpecker, Pic ocré: 1 sp., coll. no. 1292, m., w.d.
- *Blythipicus pyrrhotis* (HODGSON, 1837) - Bay Woodpecker, Pic à oreillons rouges: 1 sp., coll. no. 1294, m., w.d.
- *Picus miniaceus* PENNANT, 1769 - Banded Woodpecker, Pic minium: 1 sp., coll. no. 1295, w.d.
- *Picus rivoli* (BOISSONNEAU, 1840) - Crimson-mantled Woodpecker, Pic de Rivoli: 1 sp., coll. no. 1296, m., w.d.
- *Meiglyptes tukki* (LESSON, 1830) - Buff-necked Woodpecker, Pic tukki: 1 sp., coll. no. 1284, m., w.d.

## Ord. PASSERIFORMES

## Fam. PIPRIDAE

- *Manacus manacus* (LINNAEUS, 1766) - White-bearded Manakin, Manakin casse-noisette: 2 sps, coll. no. 1276 and 1308, m., w.d

## Fam. COTINGIDAE

- *Tityra cayana* (LINNAEUS, 1766) - Black-tailed Tityra, Tityre gris: 1 sp., coll. no. 1274, m., w.d.
- *Phibalura flavirostris* VIEILLOT, 1816 - Swallow-tailed Cotinga, Phibalure à queue fourchue: 1 sp., coll. no. 1298, m., w.d.
- *Pipreola aureopectus* (LAFRESNAYE, 1843) - Golden-breasted Fruiteater, Cotinga à poitrine d'or: ♀, coll. no. 1283, w.d.
- *Pipreola arcuata* (LAFRESNAYE, 1843) - Barred Fruiteater, Cotinga barré: 1 sp., coll. no. 1311, m., w.d.

## Fam. TYRANNIDAE

- *Pitangus sulphuratus* (LINNAEUS, 1766) - Great Kiskadees, Tyran quiquivi: *Pitangus balivanus* Klem, 1 sp., coll. no. 903, Mexico, w.d.

## Fam. MENURIDAE

- *Menura novaehollandiae* LATHAM, 1801 - Superb Lyrebird, Ménure superbe: *Menura superba* Davis, 1 sp., coll. no. 779, m., Australia, w.d.

## Fam. POMATOSTOMIDAE

- *Pomatostomus superciliosus* (VIGORS & HORSFIELD, 1827) - White-browed Babble, Pomatostome bridé: 1 sp., coll. no. 1280, s., w.d.

## Fam. PLATYSTEIRIDAE

- *Tephrodornis pondicerianus* (GMELIN, 1789) - Common Woodshrike, Téphrodorne de Pondichéry: Indet., 1 sp., coll. no. 1304, m., w.d. previously placed in fam. Campephagidae.

## Fam. PLOCEIDAE

- *Ploceus philippinus* (LINNAEUS, 1766) - Baya Weaver, Tisserin baya: Indet., 1 sp., coll. no. 1277, m., w.d.
- *Quelea quelea* (LINNAEUS, 1758) - Red-billed quelea, Quéléa, Travailleur à bec rouge: Indet., 1 sp., coll. no. 1286, m., Africa, w.d.

## Fam. ESTRILDIDAE

- *Amadina fasciata* (J. F. GMELIN, 1789) - Cut-Throat, Amadine cou-coupé: Indet., 1 sp., ♂, Africa, coll. no. 1307, m., w.d.
- *Amandava subflava* (VIEILLOT, 1819) - Zebra Waxbill, Bengali zébré: *Fringilla sanguinolenta* Temminck 1823, 1 ex., coll. no. 911, m., w.d.
- *Lagonosticta senegala* (LINNAEUS, 1766) - Red-billed Firefinch, Amarante du Sénégal, Cinteză ornată roșie: ♀, coll. no. 906, m., Africa, w.d.
- *Uraeginthus bengalus* (LINNAEUS, 1766) - Red-Cheeked Cordon-bleu, Cordonbleu à joues rouges: Indet., ♂, coll. no. 1285, Africa, m., w.d.
- *Estrilda astrild* (LINNAEUS, 1758) - Common Waxbill, Astrild ondulé: Indet. 1 sp., coll. no. 1309, m., w.d.
- *Estrilda melpoda* (VIEILLOT, 1817) - Orange-Cheeked Waxbill, Astrild à joues orange: *E. cinerea*, coll. no. 909, Africa, 1 sp., m., w.d.
- *Amandava amandava* (LINNAEUS, 1758) - Red Avadavat, Bengali rouge: *A. punctata*, 1 sp., coll. no. 908, m., w.d.
- *Neochmia phaeton* (HOMBRO& JACQUINOT, 1814) - Crimson Finch, Diamant phaéton: *Estrilda phaëton*, 1 sp., coll. no. 910, m., w.d.
- *Neochmia temporalis* (LATHAM, 1802) - Red-browed Finch, Diamant à cinq couleurs: *Fringilla oryzivora*, ♂, coll. no. 912, 1 sp., Africa, 2 sp.

- *Taeniopygia guttata* (VIEILLOT, 1817) - Zebra Finch, Diamant mandarin: Indet., 1 sp., coll. no. 1312, m., May 1913, i. d.; Indet. 1 sp, coll. no. 1313, m., w.d.
- *Erythrura gouldiae* (GOULD, 1844) - Gouldian Finch, Diamant de Gould: *Chloebeia gouldiae*, ♂, coll. no. 907/1, Australia, leg. et.det. Puică Constantin, 13.02. 1987.
- *Lonchura oryzivora* (LINNAEUS, 1758) - Java Sparrow, Padda de Java, Cinteză de orez: *Munia oryzivora*, ♂, coll. no. 1842, m., E Asia, w.d.
- *Lonchura fringilloides* (LAFRESNAYE, 1835) - Magpie Mannikin, Capucin pie: Indet., 1sp., coll. no. 1317, w.d.

## Fam. PACHYCEPHALIDAE

- *Pachycephala jacquinoti* (BONAPARTE, 1850) - Tongan Whistler, Siffleur des Tonga: Indet., 1 sp., coll. no. 1327, w.d.

## Fam. ORIOLIDAE

- *Oriolus oriolus kundoo* (SYKES, 1832) - Golden Oriole, Lorient d'Europe, Grangur indian: Indet., 2 sp.s, coll. no. 1840, m., E India, w.d.

## Fam. PARADISAEIDAE

- *Paradisaea minor* SHAW, 1809 - Lesser Bird of Paradise, Paradisier petit-émeraude, Pasărea paradisului: *P. apoda* New Guinea, 1 sp., Coll. no. 1790, m., w.d.; *P. apoda*, New Guinea, 1 sp., coll. no. 1897, m., w.d.
- *Paradisaea raggiana augustaevictoriae* CABANIS 1888 - Raggiana Bird-of-paradise, Paradisier de Raggi: *P. augustaevictoriae*, New Guinea, 1sp., coll. no. 1838, w.d.

## Fam. PETROICIDAE

- *Eopsaltria australis* (SHAW, 1790) - Eastern Yellow Rob, Miro à poitrine jaune: 1 sp., coll. no., s., w.d.

## Fam. PYCNONOTIDAE

- *Pycnonotus capensis* (LINNAEUS, 1766) - Cape Bulbul, Bulbul du Cap: ♂, coll. no. 875/1, Israel, 16. 12. 1968, Leg. Salmo Helwing.
- *Pycnonotus cafer* (LINNAEUS, 1766) - Red-vented Bulbul, Bulbul à ventre rouge: *Ixos cafer*, 1 sp., coll. no. 1279, s., w.d.
- *Pycnonotus atriceps* (TEMMINCK, 1822) - Black-headed Bulbul, Bulbul cap-nègre: Indet., 1 sp., coll. no. 1331, m., w.d.

## Fam. TIMALIIDAE

- *Stachyris nigricollis* (TEMMINCK, 1836) - Black-throated Babbler, Timalie à gorge noire: 1 sp., coll. no. 1300, m., w.d.

## Fam. IRENIDAE

- *Irena puella* (LATHAM, 1790) - Asian Fairy Bluebird, Irène vierge: Indet., 1 sp., coll. no. 1273, w.d.

## Fam. STURNIDAE

- *Aplonis panayensis* (SCOPOLI, 1783) - Asian Glossy Starling, Stourne bronzé: Indet., 1sp., juv., coll. no. 1303, m., w.d.
- *Gracula religiosa* LINNAEUS, 1758 - Hill Myna, Mainate religieux: *Eulabes reliogiosa*, 1 sp., coll. no.1841, m., South India, Ceylon, w.d.

## Fam. TURDIDAE

- *Sialia sialis* (LINNAEUS, 1758) - Eastern Bluebird, Merlebleu de l'Est: Indet., ♂, coll. no. 1314, w.d.

## Fam. NECTARINIIDAE

- *Aethopyga gouldiae* (VIGORS, 1831) - Gould's Sunbird, Souimanga de Gould: Indet., 1sp.,w. coll. no., m., w.d.
- *Arachnothera affinis* (HORSFIELD, 1822) - Grey-breasted Spiderhunter, Arachnothère à poitrine grise: Indet., 1sp., coll. no. 1310, m., w.d.

## Fam. ICTERIDAE

- *Molothrus bonariensis* (J. F. GMELIN, 1789) - Shiny Cowbird, Vacher luisant: Indet., 1sp., coll. no. 1288, m., w.d.
- *Icterus cayanensis* (LINNAEUS, 1766) - Epaulet Oriole, Oriole à épaulettes: *Xanthornus pyzophus* LINN., La Plata, 1sp., coll. no. 920, m., w.d.

## Fam. EMBERIZIDAE

- *Paroaria coronata* (MILLER, 1776) - Red-crested Cardinal, Paroaire huppé: Indet., 1 sp., coll. no. 1325, w.d.
- *Paroaria dominicana* (LINNAEUS, 1766) - Red-cowled Cardinal, Paroaire dominicain: Indet., 1 sp., coll. no. 1297, w.d.

## Fam. THRAUPIDAE

- *Tachyphonus cristatus* (LINNAEUS, 1766) - Flame-crested Tanager, Tangara à huppe ignée: Indet., 1 sp., coll. no. 1282, m., w.d.

- *Tachyphonus rufiventer* (SPIX, 1825) - Yellow-crested Tanager, Tangara à crête jaune: Indet., 1 sp., coll. no. 1275, w.d.
- *Hemithraupis ruficapilla* (VIEILLOT, 1818) - Rufous-headed Tanager, Tangara à tête rousse: Indet., 1 sp., coll. no. 1316, w.d., endemic to Brazil.
- *Hemithraupis flavicollis* (VIEILLOT, 1818) - Yellow-backed Tanager, Tangara à dos jaune: Indet., ♀, coll. no. 1291.
- *Euphonia violacea* (LINNAEUS, 1758) - Violaceous Euphonia, Organiste téité, Pasărea organist: ♂♀, coll. no. 905, South America, w.d.

## Fam. CARDINALIDAE

- *Pheucticus ludovicianus* (LINNAEUS, 1766) - Rose-Breasted Grosbeak, Cardinal à poitrine rose: *Zamelodia ludoviciana* (LINNAEUS, 1766), 2 sps., ♂, ♀, coll. no. 907, North America, w.d.

## CONCLUSIONS

We present the catalogue of the exotic birds preserved at the Zoological Museum of Cluj (founded in 1859) as a taxonomic list together with the item data. Studied collection includes 221 specimens belonging to 172 species, 59 families, 18 orders. Especially, we point out a small hummingbirds collection consisting of 45 specimens of 38 species, and some endemic species, three from Brazil (*Malacoptila striata*, *Hemithraupis ruficapilla*, *Paroaria dominicana*), and *Apteryx oweni* from New Zealand. Collection also includes other interesting species as: *Goura victoriae*, *Argusianus argus grayi*, *Tragopan melanocephalus*, *Lophophorus impejanus*. The species from the Neotropical region (South America) are prevalent in this collection.

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## BIOTOPIC DISTRIBUTION OF URBAN BIRD FAUNA IN THE REPRODUCTIVE PERIOD

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**Abstract.** *The ornithological observations accomplished on bird populations from different biotopes of Chisinau city allow us to present the actual characteristic of bird population distribution and density from the urban territories in breeding period. The biotopic distribution of bird fauna in Chisinau city is conditioned by the phytocenotic structure of green spaces within the city, as well as by the vegetal structure of its surroundings, which provide nest places and shelters for various bird species. In the breeding period 64 bird species were registered on the territory of Chisinau city. The most abundant and various is the bird fauna from the green zone of the city that includes several parks in different areas of the city, which represent the main link in the process of creation, development and conservation of urban bird fauna by comparing with residential districts, where the reproduction conditions are limited.*

**Keywords:** *distribution, diversity, density, ornithofauna, urban environment.*

**Rezumat. Distribuția biotopică a ornitofaunei urbane în perioada de reproducere.** *Observațiile ornitologice efectuate asupra populațiilor de păsări în zona de cercetare în diverse biotopuri din orașul Chișinău ne-au permis să prezentăm o caracteristică actualizată a distribuției și densității populațiilor de păsări din teritoriul urban în perioada de cuibărit. Distribuția biotopică a ornitofaunei din orașul Chișinău este condiționată de structura fitocenotică a spațiilor verzi din raza orașului, cât și de structura vegetală a culoarului din jurul lui, care oferă locuri de cuibărit și adăpost pentru diverse specii de păsări. În perioada de reproducere pe teritoriul orașului Chișinău au fost identificate 64 specii de păsări. Cea mai reprezentativă și mai variată este ornitofauna din zona verde a orașului care include câteva parcuri din diverse zone, acestea reprezentând veriga de bază în procesul de formare, dezvoltare și conservare a ornitofaunei urbane, comparativ cu spațiile verzi din sectoarele de locuit unde condițiile de reproducere a ornitofaunei sunt limitate.*

**Cuvinte cheie:** *distribuție, diversitate, densitate, ornitofaună, mediu urban.*

### INTRODUCTION

The biologic diversity represents a specific peculiarity of our planet that insures the optimum functioning of the ecosystems, the existence and development of the biosphere as a whole. In the last decades as far as the man changes the natural landscapes, thus disturbing the normal development of the vital process of the animals, it was established that more and more bird species find refuge in the anthropogenic environment that still remains hospitable for many species.

At present in the Republic of Moldova practically did not remain any ecosystem which was not affected by man. The territory was modified in such a degree that the modern ecosystems represent a combination of natural and artificial elements. The proportion of urban ecosystems in Moldova is almost equal to the forest one and constitutes 9.4% of the republic territory. The urban ecosystems have a substantial importance and are a significant component of environment creation in the sectors occupied by buildings under construction; they create favourable life conditions for bird species with high adaptive potential.

### MATERIAL AND METHODS

The studies concerning the biotopic distribution of urban bird fauna were accomplished in Chisinau city. The city territory was divided in several sectors, the routes were determined for the estimation of bird population number. The identification of the species was realized in the first hours of the morning when the bird activity is the highest (6 – 11 a.m.). The bird population number estimations were accomplished by the method of routes and squares after KLAUSNITZER (1990). The recording of bird singing was also accomplished.

The index of bird population density (ind/sq.km.) was calculated after the formulas proposed by NAUMOV (1965) and SHCHEGOLEV (1977). The density (M) was calculated according to the formula:  $M = n/l \times 2d \times A$ , (SHCHEGOLEV, 1977), where: M is species abundance; n – number of individuals of certain species; 2d – identification strip (according to the singing activity of the birds); l – length of the route; A – species activity.

### RESULTS AND DISCUSSIONS

The ornithological observations accomplished on bird populations in the study zone in various biotopes from Chisinau city allow showing the actual characteristics of bird populations' distribution and density within the urban territories. The bird number estimation was realized in breeding periods starting with year 2006. As study area, parks from different city sectors were selected.



The park "Valea Morilor" ("Mills' Valley") is situated in the north-western part of the city near the central district, on a terrain with accidental relief. The park occupies an area of about 120 ha, including 36 ha occupied by the lake. The alley around the lake consists of several tree species, as poplar, acacia, locust tree, pagoda tree, elm, birch. About half of the park territory includes a great variety of tree and bush species. Within the park area there are some fir sectors, where the 2<sup>nd</sup> and 3<sup>rd</sup> vegetation levels are missing. In the first vegetation level in different sectors of the park *Populus nigra*, *Betula pendula*, *Ulmus carpinifolia*, *Acer platanoides* etc. dominate. The 2<sup>nd</sup> level is represented by *Picea* sp., *Salix alba*, *Sophora japonica* etc. The 3<sup>rd</sup> level is represented by small bushes and scrub, which is rare because of its intense cutting in the last years that determined the decreasing of the number of bush birds. The park is bounded on one side by a district with residential buildings and from another side – by a commercial center. The park, in spite of its relief and vegetation peculiarities, has a rather rich bird fauna and serves as corridor for bird incursions in city.

The park "Valea Trandafirilor" ("Rose valley") is situated in the south-eastern part of the city between Center and Botanica districts and occupies an area of 148 ha. It is formed by various tree communities, which alternate with open areas and three lakes with a total surface of 10.85 ha; they represent an attraction for water birds coming on the park territory. More than half of the park area is covered by plantations formed by trees, bushes and grassy vegetation arranged in parcels, each of them formed by different species. The urban park "Valea Trandafirilor" represents a complex of ecosystems favourable for many bird species that offer sufficient food supply, places for breeding and permanent shelter for resident and migratory bird species.

The Dendrological park is placed in the south-western part of the city near "Valea Morilor" park, and includes 4 phytocenotic complexes: decorative plants, cultivated plants, arboretum and spontaneous vegetation. The trees are grouped in parcels, and open spaces there are between them. The parcels are formed by *Populus pyramidalis*, *Acer tataricum*, *Populus alba*, *Malus sylvestris*, *Picea abies*, *Salix* sp., *Pinus* sp., *Betula* sp. The bush vegetation form separate assemblage and is represented by *Crataegus* sp., *Thuja* sp., *Salix* sp., *Syringa* sp., *Berberis* sp. The herbage is well developed and forms glades similar to meadows. The aquatic ecosystem is represented by a lake having an area of 2 ha, and by Durlashti rivulet that passes along the park. The high variety of trees and bush species, and the limited access of people on the park territory allow the existence of various bird species from different ecological groups.

The public garden "Ștefan cel Mare" is the oldest park of the city. It was planted in 1818 and for long time it was the only park in the city. The vegetal compound of the park is particularly diverse and comprises about 50 tree and bush species, including some rare species, such as *Gleditsia* sp., *Libocedrus endl*, *Juniperus virginiana* etc. The park is placed in the centre of the city and occupies 7 ha. The trees form two levels, the first one is formed by *Betula* sp., *Acer tataricum*, *Robinia* sp., *Ulmus* sp., *Fraxinus* sp., *Populus* sp., the second one – by *Castanea* sp., *Salix* sp., *Platanus* sp., *Picea abies*, *Morus* sp., *Betula* sp., *Quercus* sp. There are also shrubs: *Buxus* sp., *Spirea* sp., *Cotinus coggygia*, *Syringa* sp. A fountain of 0.09 ha situated in centre of the park serves as aquatic source.

The vegetal structure, small area and unlimited access of people have a direct or indirect influence upon bird populations of this park. Therefore, the species numbers as well as birds' density are much lower by comparing to other parks of the city. The above mentioned floristic diversity of the parks allows the existence of rather rich bird fauna by comparing the squares, alleys, residential districts, where the phytocenotic variety is much lower or missing completely because of intense constructions.

The parks, at their turn, have an important role in urban climat softening, regulate the temperature, retain and fix the substances that pollute the air, increase the humidity and serve as recreation places.

The results of our studies on distribution process of bird fauna from different biotopes of the city are presented in Table 1.

According to the accomplished studies 64 bird species were registered during the breeding period. The most abundant and diverse was the bird fauna from the green area of the city – parks, botanical gardens, squares, alleys etc. In the Dendrological park 58 bird species were recorded, in „Valea Morilor” park – 44, in „Valea Trandafirilor” park – 43, and in public garden „Ștefan cel Mare” was recorded the lowest number of bird species within the green sectors – only 10 species. This fact is due to several factors: its placement in the central zone of the city, influence of disturbing factors, reduced area, poor vegetation structure, the absence of aquatic biotope – all these factors lead to number limitation of bird species breeding in this park. Thus, the public garden „Ștefan cel Mare”, according to the species number is more similar to the residential district than to other studied parks. The sector of urban buildings was as expected – with much lower number of species by comparing to the green areas. The 5 floor building district offers nest conditions for 26 species, the 9 floor building district – for 19 species, the private sector – for 21 bird species. The compared studies of breeding bird populations from different biotopes shows that at the city limits there were registered many species that were not observed breeding in the central part of the city – *Corvus corax*, *Corvus monedula*, *Jynx torquilla*, *Emberiza calandra*, *Saxicola ruberta*, *Saxicola torquata* etc. The mentioned bird species are more frequently attracted by the forest plantations that joint with the urban environment.

Studying the floristic diversity of the investigated areas, which include several city parks in different city zones, we can see that the parks represent the main link in the process of creation, development and conservation of urban bird fauna, by comparing with the green areas from residential districts, where the breeding conditions of the birds are limited.

Depending on the preference toward nesting places, the birds recorded during breeding period can be divided in several ecological groups:

- a) arboreal species – bird species nesting in tree crowns;
- b) shrubby species – bird species nesting in bushes or shrubbery;
- c) terrestrial species – bird species nesting on soil surface, between herbs or near tree trunks;
- d) species nesting in holes – bird species with high plasticity, nesting on poles, in pipes and conducts, under house roof;
- e) species nesting in buildings – this bird group is connected to human settlements, and places their nests on buildings;
- f) hollow species – bird species nesting in tree hollows. Some species from this group are not able to make themselves hollows in tree trunks, so they use the existent hollows;
- j) water birds – species connected with aquatic biotopes and nesting in reed vegetation.

Table 1. Distribution of bird species within the studied biotopes.

Tabel 1. Distribuția speciilor de păsări în biotopurile studiate.

Species	P.V.M.	P.V.T.	Dendrol.	P.S.C.M.	9 floor district	5 floor district	Priv. sectors
<i>Ixobrychus minutus</i>	-	+	-	-	-	-	-
<i>Anas platyrhynchos</i>	+	+	+	-	-	-	-
<i>Accipiter nisus</i>	+	-	+	-	-	-	-
<i>Falco subbuteo</i>	+	-	+	-	-	-	-
<i>Gallinula chloropus</i>	+	+	+	-	-	-	-
<i>Fulica atra</i>	+	+	+	-	-	-	-
<i>Columba livia domestica</i>	+	+	+	+	+	+	+
<i>Columba palumbus</i>	-	+	+	-	-	-	+
<i>Streptopelia turtur</i>	-	+	-	-	-	-	-
<i>Streptopelia decaocto</i>	-	-	+	-	-	-	+
<i>Athene noctua</i>	-	-	+	-	-	-	+
<i>Strix aluco</i>	-	+	+	-	-	-	-
<i>Asio otus</i>	+	-	+	-	-	-	-
<i>Tyto alba</i>	-	-	-	-	-	-	+
<i>Apus apus</i>	-	-	-	-	+	+	+
<i>Alcedo atthis</i>	+	+	+	-	-	-	-
<i>Upupa epops</i>	+	-	+	-	-	-	-
<i>Dendrocopos syriacus</i>	+	+	+	-	+	+	-
<i>Dendrocopos major</i>	+	+	+	-	-	+	-
<i>Dendrocopos medius</i>	-	-	+	-	-	-	-
<i>Dendrocopos minor</i>	-	+	+	-	-	-	-
<i>Picus canus</i>	+	+	+	-	-	-	-
<i>Jynx torquilla</i>	+	+	+	-	-	-	-
<i>Hirundo rustica</i>	+	-	+	-	+	+	+
<i>Delichon urbica</i>	-	-	+	-	+	+	+
<i>Motacilla alba</i>	+	+	+	-	+	-	-
<i>Lanius collurio</i>	+	+	+	-	-	+	-
<i>Oriolus oriolus</i>	+	+	+	-	-	-	-
<i>Sturnus vulgaris</i>	+	+	+	+	+	+	+
<i>Garrulus glandarius</i>	+	+	+	-	+	+	+
<i>Pica pica</i>	+	+	+	+	+	+	+
<i>Corvus monedula</i>	+	-	+	-	-	-	-
<i>Corvus frugilegus</i>	+	+	+	+	+	+	+
<i>Corvus corone cornix</i>	+	+	+	-	-	-	-
<i>Troglodytes troglodytes</i>	+	-	+	-	-	+	-
<i>Acrocephalus arundinaceus</i>	-	+	+	-	-	-	-
<i>Sylvia atricapilla</i>	+	+	+	-	-	+	-
<i>Sylvia curruca</i>	+	+	+	-	+	-	-
<i>Sylvia borin</i>	-	-	+	-	-	-	-
<i>Sylvia hortensis</i>	-	+	-	-	-	-	-
<i>Phylloscopus collybita</i>	+	+	+	-	+	+	+
<i>Phylloscopus sibilatrix</i>	-	-	+	-	-	-	-
<i>Muscicapa striata</i>	+	+	+	-	-	-	-
<i>Ficedula albicollis</i>	+	+	+	-	-	+	-
<i>Ficedula hypoleuca</i>	-	-	+	-	-	-	-
<i>Phoenicurus phoenicurus</i>	+	+	+	-	+	+	-
<i>Phoenicurus ochruros</i>	+	+	-	-	-	+	-
<i>Luscinia luscinia</i>	+	+	+	-	-	+	-
<i>Erithacus rubecula</i>	+	+	+	-	+	-	-
<i>Turdus merula</i>	+	-	+	-	-	-	+
<i>Turdus philomelos</i>	+	+	+	-	-	-	-
<i>Parus major</i>	+	+	+	+	+	+	+
<i>Parus caeruleus</i>	+	+	+	+	+	+	+
<i>Parus palustris</i>	+	-	+	-	-	+	-
<i>Remiz pendulinus</i>	-	-	+	-	-	-	-
<i>Sitta europaea</i>	+	+	+	-	-	-	-

<i>Certhia familiaris</i>	+	+	+	+	-	+	-
<i>Passer domesticus</i>	+	+	+	+	+	+	+
<i>Passer montanus</i>	+	+	+	+	+	+	+
<i>Fringilla coelebs</i>	+	+	+	+	-	+	+
<i>Carduelis chloris</i>	-	+	+	-	+	+	+
<i>Carduelis carduelis</i>	+	+	+	-	-	-	+
<i>Carduelis canabina</i>	-	-	+	-	-	-	-
Species number	64	44	43	58	10	19	21

The data presented in Fig. 1 show that the majority of bird species belongs to arboreal group (29%) and to hollow group (24%), while the lowest number of species (7%) belongs to water birds group, which is determined by reduced water surface and reed vegetation, but also by disturbing factors (stray dogs, cats, people). The species number that nest in holes is not stable, because the birds prefer the tree hollows from natural biocoenoses. In the anthropogenic ones, because of the lack of natural hollows, the birds can breed in various types of cavities of anthropogenic origin. For example, the species with higher adaptation plasticity as *Parus major*, *P. palustris*, *Phoenicurus ochruros* can occupy various cavities such as pipes, conducts, poles; *Passer domesticus* nests in hollows, under the house roof overhang, in artificial nests etc.

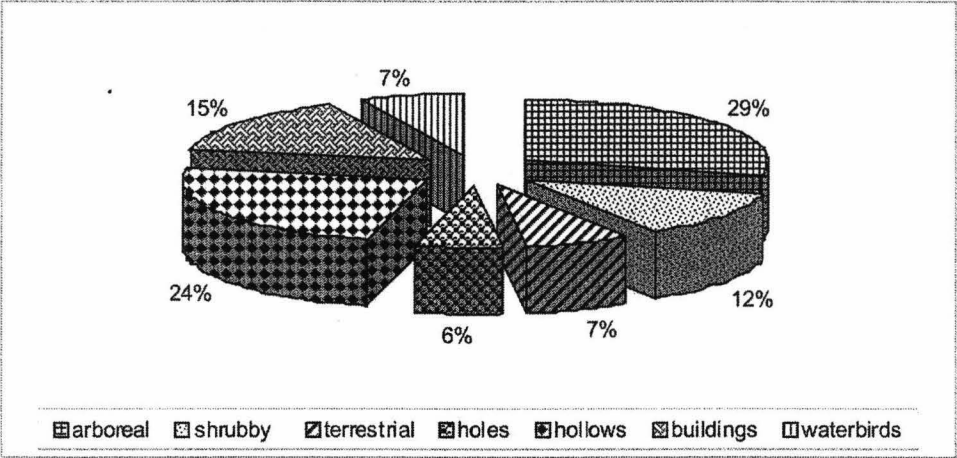


Figure 1. Proportion of bird ecological groups according to their nesting preferences.  
 Figura 1. Ponderea grupurilor ecologice de păsări în dependență de preferințele de cuibărit.

At present can be observed the intense process of intrusion into the city of some species usually less common in urban areas, such as *Turdus merula*, *T. philomelos*, *Carduelis carduelis*, *Phoenicurus ochruros*, *Coccothraustes coccothraustes*. Inside the urban area, the number of individuals of these species grows every year in breeding period, thus contributing to the increasing of urban bird fauna diversity. These species will probably become more common in the future.

The information concerning bird density from various ecological groups in different studied ecosystems is presented in table no. 2. The analysis of table data revealed that the highest value of bird density belongs to the hole nesting species group (753.35 ind./km<sup>2</sup>) registered in “Valea Morilor” park. This fact can be explained by the existence of many hollow trees, lamps, poles and conducts that offer many nesting places for hole nesting species. The lowest value of this index (5.95 ind./km<sup>2</sup>) was recorded in arboreal ecological group in 9 floor building district, because here the bushes are practically missing (they were cut out to arrange parking places for cars).

Table 2. Density of bird population (ind./km<sup>2</sup>) and their distribution by ecological groups in nesting period.  
 Tabel 2. Densitatea populațiilor de păsări și repartizarea lor pe grupuri ecologice în perioada nidicolă.

Study sectors	Ecological bird group according to nest places						
	Arboreal	Shrubby	Soil	Holes	Buildings	Hollow	Paludous
Park V.M.	214.27	25.5	74.82	753.39	180.28	212.57	108.84
Park V.T.	112.69	14.29	29.37	445.25	96.03	72.13	121.43
Dendrol. Park	65.29	36.72	12.24	158.77	22.45	216.32	4.08
Park Stefan c. M.	140.00	30.00	40.00	580.00	80.00	100.00	0
5 floor district	85.76	19.6	0	437.50	49.09	76.47	0
9 floor district	74.4	5.95	0	502.97	26.78	17.85	0
Private sector	122.25	11.90	0	327.37	35.7	127.37	0

After comparing the bird density recorded in park biotopes with the density from residential districts it can be observed that in parks the density of arboreal and hollow species is higher due to the structural diversity of tree crown and of tree age, while in residential areas the density of bird species is much lower because of low diversity of trees.

## CONCLUSIONS

– The biotopic distribution of bird fauna in Chishinau city is conditioned by the phytocenotic structure of green areas within the city area, as well as by the vegetation structure of the corridor around it, which all provide breeding and shelter places for various bird species.

– On the territory of Chishinau city 64 bird species were recorded during the breeding season.

– The most abundant and diverse bird fauna lives in the green area of the city, the Dendrological park – 59 species, “Valea Morilor” park – 45, “Valea Trandafirilor” park – 44 species.

– The highest value of bird density belongs to the hole nesting species (753.35 ind./km<sup>2</sup>) recorded in “Valea Morilor” park and it can be explained by the existence of many hollows in trees, lamps, poles and pipes, that offer many nesting places for this kind of birds. The lowest value of this index (5.95 ind/km<sup>2</sup>) was recorded in arboreal ecological group in 9 floor building district, because here the bushes are practically missing.

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## SOME OBSERVATIONAL DATA ABOUT THE DIVERSITY OF SEDENTARY AND PASSAGE BIRD FAUNA IN “MICRODELTA”- MUSEUM COMPLEX OF NATURAL SCIENCES OF CONSTANȚA

VERONICA ANTONE, ANCA MIHAI, ANCUȚA CAISIN

**Abstract.** This paper presents the ornithological comments made between January 2008 and January 2009 in Microdelta - Museum of Natural Sciences Constanța. Within this territory with a surface of 4 ha, 2 ha being represented by water surface, there was found a number of 44 species of birds, which belong to 26 families and 12 orders. Some of species are migratory, the studied area belonging to Sarmatic-Maritime migration route.

**Keywords:** Microdelta, aquatorium, aquatic birds, phenological category.

**Rezumat.** Date privind diversitatea avifaunei sedentare și de pasaj din aria Microdeltei Complexul Muzeal de Științele Naturii din Constanța. Lucrarea de față prezintă date privind ornitofauna Microdeltei - obiectiv al C.M.S.N Constanța, în perioada ianuarie 2008 - ianuarie 2009. În acest teritoriu cu o suprafață de 4 hectare, dintre care 2 hectare reprezintă luciul de apă, s-a determinat un număr de 44 de specii avifaunistice ce se încadrează în 26 familii și 12 ordine. Unele dintre acestea sunt migratoare, aria studiată de noi înscriindu-se pe calea de migrație sarmato-maritimă.

**Cuvinte cheie:** Microdelta, acvatoriu, avifauna, categorie fenologică.

### INTRODUCTION

Inaugurated in 1985, “Microdelta” is a component of the Museum of Natural Sciences from Constanța and it is located in the proximity of holiday resort Mamaia. It covers a surface of 4 ha, 2 ha being represented by water surface coming from Tabacarie Lake. The two aquatic systems are still connected (Fig. 1).

“Microdelta” is an urban “oasis” in an ever-changing environment dominated by human beings.

It has terrestrial and aquatic biotopes like natural reserves from the Dobroudja. It also represents an effort made for protecting wild birds and their habitats from the human-induced changing behaviour of the environment.

With regard to the terrestrial biotopes, there can be noticed arboreal and herbaceous vegetation. The arboreal vegetation is represented by planted trees, such as: *Populus* sp. (poplar), *Betula* sp. (birch), *Salix* sp. (willow), shrubs of *Tamarix ramosissima* (salt cedar), *Elaeagnus angustifolia* (russian silverberry). The heterogeneous herbaceous layer is mosaic-like and it is formed from gramineous species, such as *Agropyron junceum* (rushy wheat grass), *Stipa* sp. (spear grass), *Festuca* sp. (fescue grasses) associated with ruderal species as *Cichorium intibus* (wild chicory), *Papaver* sp. (field poppy), *Taraxacum* sp. (dandelion) and so forth.

The shoreline is pointed by a belt of immerse hydrophytes, which covers the largest surface. The most common species is *Phragmites* sp. (reed). In the opening space of the belt, there grow *Typha* sp. (cattail) and *Schoenoplectus* sp. The high density of these plants offers ideal places for birds' nesting and hiding e.g.: *Anas platyrhynchos* (mallard).

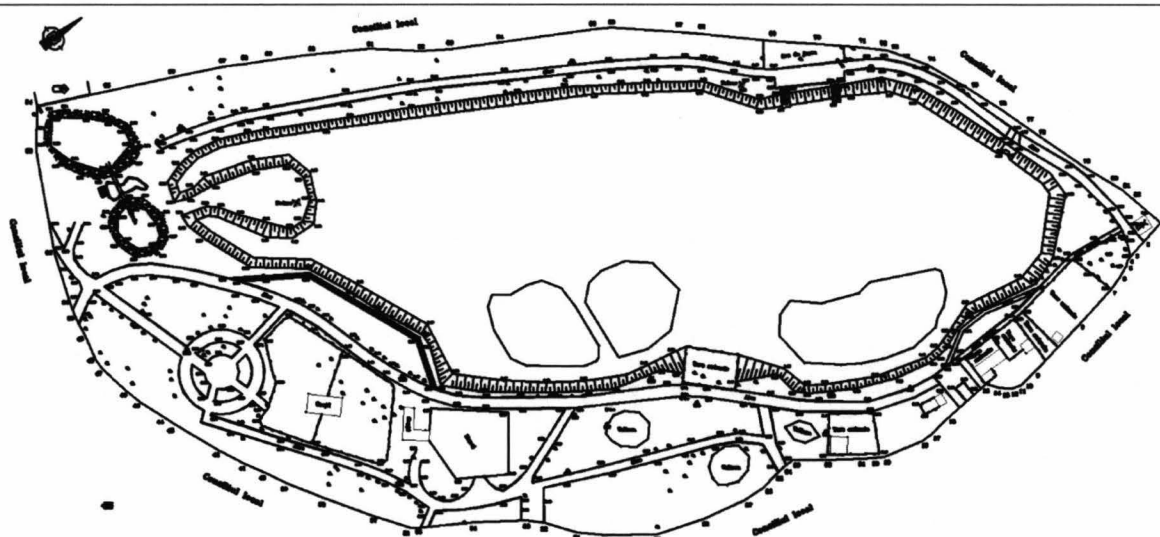


Figure 1. “Microdelta” map.  
Figura 1. Harta “Microdelta”.



## MATERIAL AND METHODS

The present paper aims at rendering the wild birds' species which were observed in Microdelta for twelve months (January 2008, January 2009); the observations were concluded with data collections. Observations were made twice a day, between January and May, between October and September and four times a day between June and September from the water level and from 3 meters height above the water surface, in two observation points specially built in this aim on the adjacent area to aquatorium (Photo 1).



Photo 1. Observation points (1 and 2) - "Microdelta".

Foto 1. Punctele de observare (1 și 2) - "Microdelta".

We used a field binocular Bresser 7x21x40 and a digital camera Fuji Finepix S 1000FD. Direct observations (BIBBY et al., 2000) from both set points (the two observation points) and moving points (in our route within Microdelta) lasted minimum an hour following a daily schedule - between 8 a.m. and 9 a.m., 2 p.m. and 3 p.m. - during off season. In summer, we made these determinations at every 3 hours, between 8 a.m. and 8 p.m.

The data processing and the classification of the bird fauna (LINTIA, 1954; LINTIA, 1955) were made according to taxonomic phenological (BRUUN, 1999), qualitative, quantitative principles and rules (DOMBROWSKI 1946; CIOCHIA, 1992; CIOCHIA, 2001).

## RESULTS AND DISCUSSIONS

In the mentioned period of time, the structure of bird fauna consisted in 44 species pertaining to 26 families, respectively 12 orders (Table 1).

Most of them were water migratory species, such as *Anas platyrhynchos* (mallard), *Ardea cinerea* (heron), *Phalacrocorax carbo sinensis* (cormorant), *Gallinula chloropus* (common moorhen), and *Fulica atra* (coot) (Table 2).

During our study, the species *Anas platyrhynchos* (mallard) recorded the best representation. Ducks were noticed daily. Most of the time, they swam in groups either near reed belt or in the centre of the aquatorium. Generally, they formed couples till March, when females sheltered in the reed thicket for laying eggs. In May, the first ducklings could be seen on water.

Table 1. The list of the observed bird species (classification, according with CIOCHIA, 1992).

Tabel 1. Lista speciilor avifaunistice observate (poziția sistematică după CIOCHIA, 1992).

No.	Order	Family	Species	Popular name	Phen.	Denumire populara	Fen
1	Pelecaniformes	Phalacrocoracidae	<i>Phalacrocorax carbo sinensis</i> LINNAEUS, 1766	Cormorant	SV	cormoran mare	OV
2			<i>Phalacrocorax pygmaeus</i> (PALLAS, 1773)	Pygmy Cormorant	SV	cormoran mic	OV
3		Pelecanidae	<i>Pelecanus onocrotalus</i> LINNAEUS, 1758	White Pelican	SV,FM	pelican comun	OV,DH
4			<i>Pelecanus crispus</i> BRUCH, 1832	Dalmatian Pelican	SV,FM	pelican creț	OV,DH
5	Ciconiiformes	Ardeidae	<i>Botaurus stellaris</i> (LINNAEUS, 1758)	Bittern	SV	buhai de baltă	OV
6			<i>Nycticorax nycticorax</i> LINNAEUS, 1758	Night Heron.	SV	stârc de noapte	OV
7			<i>Ardeola rallioides</i> (SCOPOLI, 1769)	Squacco Heron	SV	stârc galben	OV
8			<i>Egretta alba</i> (LINNAEUS, 1758)	Great Egret	SV	egretă mare	OV
9			<i>Ardea cinerea</i> LINNAEUS, 1758	Heron	SV	stârc cenușiu	OV
10		Ciconiidae	<i>Ciconia ciconia</i> (LINNAEUS, 1758)	White Stork	SV	barză albă	OV
11	Anseriformes	Anatidae	<i>Tadorna ferruginea</i> (PALLAS, 1764)	Ruddy Shelduck	SV,P	călifar roșu	OV,P
12			<i>Anas platyrhynchos</i> LINNAEUS, 1758	Mallard	PM	rață mare	MP
13	Lariformes	Laridae	<i>Larus cachinnans</i> PALLAS, 1811	Caspian Gull	R	pescarușul argintiu	S
14	Charadriiformes	Sternidae	<i>Sterna albifrons</i> PALLAS, 1764	Little Tern	SV	chiră mică	OV
15			<i>Sterna hirundo</i> LINNAEUS, 1750	Common Tern	SV	chiră de baltă	OV
16		Glareolidae	<i>Glareola pratincola</i> (LINNAEUS, 1766)	Collared Pratincole	SV	ciuvică ruginie	OV
17	Gruiformes	Rallidae	<i>Gallinula chloropus</i> LINNAEUS, 1758	Moorhen	SV	găinușă de baltă	OV
18			<i>Fulica atra</i> LINNAEUS, 1758	Coot	PM	lișită	MP
19			<i>Porzana porzana</i> (LINNAEUS, 1766)	Spotted Crane	SV	cristelul pestriț	OV
20			<i>Rallus aquaticus</i> LINNAEUS, 1758	Water Rail	PM	cristel de baltă	MP
21	Falconiformes	Accipitridae	<i>Accipiter nisus</i> (LINNAEUS, 1758)	Sparrowhawk	R, WV	uliu păsărar	S, OI
22	Cuculiformes	Cuculidae	<i>Cuculus canorus</i> LINNAEUS, 1758	Cuckoo	SV	cuc	OV
23	Piciformes	Picidae	<i>Dendrocopos syriacus</i> (HEMPRICH et EHRENBURG, 1833)	Syrian Woodpecker	R	ciocanitoare de grădină	S
24			<i>Dendrocopos major</i> (LINNAEUS, 1758)	Great Spotted Woodpecker	R	ciocanitoare mare	S
25	Coraciiformes	Coraciidae	<i>Coracias garrulus</i> LINNAEUS, 1758	Roller	SV	dumbrăveancă	OV
26		Meropidae	<i>Merops apiaster</i> LINNAEUS, 1758	Bee-eater	SV	prigorie	OV
27		Upupidae	<i>Upupa epops</i> LINNAEUS, 1758	Hoopoe	SV	pupăză	OV
28	Columbiformes	Columbidae	<i>Streptopelia decaocto</i> FRIVALDSZKY, 1838	Collared dove	R	guguștuc	S
29	Passeriformes	Corvidae	<i>Corvus frugilegus</i> LINNAEUS, 1758	Rook	R	cioară de semănătură	S
30			<i>Pica pica</i> (LINNAEUS, 1758)	Magpie	R	coțofană	S
31			<i>Corvus monedula</i> LINNAEUS, 1758	Jackdaw	R	stâncuță	S
32			<i>Corvus corax</i> LINNAEUS, 1758	Raven	R	corb comun	S
33		Motacillidae	<i>Motacilla alba</i> LINNAEUS, 1758	White Wagtail	SV	codobatură	OV
34		Sturnidae	<i>Sturnus vulgaris</i> LINNAEUS, 1758	Starling	MP	graur	MP
35		Fringillidae	<i>Carduelis carduelis</i>	Goldfinch	R,WV	sticlete	S,OI

			LINNAEUS, 1758				
36			<i>Carduelis spinus</i> LINNAEUS, 1758	Siskin	MP,W V	scatiu	MP,OI
37		Paridae	<i>Parus major</i> LINNAEUS, 1758	Great Tit	R	pițigoi mare	S
38		Hirundinidae	<i>Hirundo rustica</i> LINNAEUS, 1758	Swallow	SV	rândunică	OV
39		Sylviidae	<i>Sylvia borin</i> (BODDAERT, 1783)	Garden Warbler	SV	silvie de zăvoi	OV
40			<i>Sylvia curruca</i> (LINNAEUS, 1758)	Lesser Whitethroat	SV	silvie mică	OV
41			<i>Luscinola melanopogon</i> TEMMINCK, 1823	Moustached Warbler	SV	privighetoare de baltă	OV
42		Ploceidae	<i>Passer domesticus</i> LINNAEUS, 1758	House Sparrow	R	vrabie de casă	S
43		Lanidae	<i>Lanius collurio</i> LINNAEUS, 1758	Red-backed Shrike	SV	sfrâncioc roșiatic	OV
44		Oriolidae	<i>Oriolus oriolus</i> (LINNAEUS, 1758)	Golden Oriole	SV	grangur	OV

The other mentioned species had quite a constant occurrence in winter but their number was much more diminished in comparison with *Anas platyrhynchos* (mallard).

Coots (*Fulica atra*) were observed in groups consisting of 14 to 17 individuals in different zones of "Microdelta", mostly between our observation points, at 2 meters from the shoreline and on water surface. When the air temperature fell below 0 degrees (Celsius) and the water surface was covered by ice, the moorhens withdrew in the lateral channel. Sometimes individuals of this species interfered with mallard.

Table 2. Occurrence frequency of water species between January 2008 and January 2009.  
Tabel 2. Frecvența de apariție a speciilor acvatice în perioada ianuarie 2008 – ianuarie 2009.

No	Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Number of occurrences	%
1	<i>Phalacrocorax carbo sinensis</i>	X	X		X	X	X	X	X	X				8	66.7
2	<i>Phalacrocorax pygmaeus</i>		X	X										2	16.7
3	<i>Pelecanus onocrotalus</i>					X	X		X					3	25
4	<i>Pelecanus crispus</i>						X							1	8.3
5	<i>Botaurus stellaris</i>					X	X	X						3	25
6	<i>Nycticorax nycticorax</i>			X		X	X	X	X					5	41.7
7	<i>Ardeola ralloides</i>				X	X								2	16.7
8	<i>Egretta alba</i>	X						X						2	16.7
9	<i>Ardea cinerea</i>	X	X	X	X	X	X		X		X	X	X	10	83.3
10	<i>Ciconia ciconia</i>					X	X	X	X					4	33.3
11	<i>Tadorna ferruginea</i>	X		X	X								X	4	33.3
12	<i>Anas platyrhynchos</i>	X	X	X	X	X	X	X	X	X	X	X	X	12	100
13	<i>Larus cachinans</i>	X	X	X	X	X	X	X	X	X	X	X	X	12	100
14	<i>Sterna albifrons</i>					X	X	X	X	X				5	41.7
15	<i>Sterna hirundo</i>					X	X	X	X	X				5	41.7
16	<i>Glareola pratincola</i>					X	X	X	X	X				5	41.7
17	<i>Gallinula chloropus</i>	X	X	X	X	X	X	X	X	X	X	X	X	12	100
18	<i>Fulica atra</i>	X	X	X	X						X	X	X	7	58.3
19	<i>Porzana porzana</i>						X	X						2	16.7
20	<i>Rallus aquaticus</i>					X	X	X	X					4	33.3

Herons (*Ardea cinerea*) were hardly represented in "Microdelta". During January and February, they did not exceed 4 individuals and, most of the times, they were seen near the reed belt, between observation points 1 and 2 on the right of water surface.

During April and May, only a single specimen of *Ardeola ralloides* stopped in "Microdelta". This specimen was observed in different areas with shallow water or under the branches of the willows.

Between the 11<sup>th</sup> and 25<sup>th</sup> of June, 24 pelicans took a rest on water for 14 days. Disturbed by the faintest noises, they flew away, but always returned in the same group.

We also noticed other migratory or sedentary birds that inhabited the highest range of habitats.



In Romania, the ornithologists registered two species of pelicans as migratory - summer species nesting in the Danube Delta. In “Microdelta” these species pass only temporary, during their feeding migration (phenological subgroup SV-FM) (Table 3 and Fig. 2) .

Table 3. Phenological classification of bird fauna.  
Tabel 3. Încadrarea fenologică a avifaunei.

No	Phenological classification		Number of species	%
1	summer visitors	SV	24	54.50%
2	passage and summer visitors	P-SV	1	2.30%
3	summer visitors for feeding	SV-F	2	4.50%
4	partial migrants	PM	4	9%
5	partial migrants and/or winter visitors	PM-WV	1	2.30%
6	resident	R	10	22.70%
7	winter visitors and/or resident	WV-R	2	4.50%
8	passage birds	P	0	0%
9	occasional	OCC	0	0%
	TOTAL		44	100%

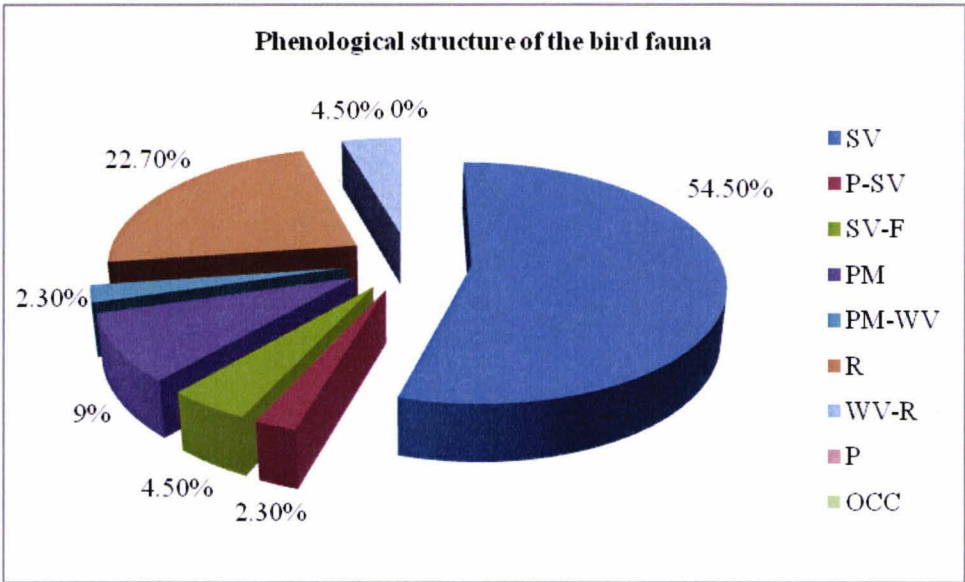


Figure 2. Phenological structure of the bird fauna.  
Figura 2. Structura fenologică a avifaunei.

Most species observed in winter were appreciated as migratory ones, winter species or/and species of passage though for our country they are registered as winter visitors e.g. (geese, ducks). Among aquatic wild birds, migratory species – summer visitors were the most numerous, after that it follows in decreasing numerical order: partial migratory summer visitors of passage, species of passage, winter species and/or winter visitors of passage. The other phenological subgroups have a small number of representatives.

CONCLUSIONS

According to the presented data we could conclude that in “Microdelta“, the bird fauna and particularly water species has a special structure. Among them, migrant summer visitors are numerically dominant (*Anas platyrhynchos* and *Gallinula chloropus*).

The two species of pelicans were registered in the phenological subgroup SV-F (*Pelecanus onocrotalus* and *P. crispus*).

The birds species observed in winter were appreciated as winter species or/and species of passage for Microdelta - winter visitors for Romania (*Phalacrocorax pygmaeus*, *Tadorna ferruginea* and *Fulica atra*).

Future studies will bring new data relating taxonomy and phenology of wild bird species in “Microdelta“, as well as information about their biology and ecology.

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## THE EVALUATION OF SOIL GENOTOXICITY BY MODIFIED *ALLIUM* TEST

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**Abstract.** In Romania, the Middle Jiu River Valley is a well-known coal basin in active exploitation. Nearby the surface coal exploitations there are placed TEPP (Thermo Electric Power Plant) Rovinari and Turceni - surrounded by ash and sterile waste dumps of different ages. Plant bioassays, which are most sensitive in detecting genotoxicity of environmental agents, can serve as the first alert for the presence of environmental hazards in water, air and soil. The aim of this paper was to study the impact of the pollution with radionuclides from ash and sterile waste dumps on vegetation in nearby villages Rosia de Jiu and Turceni, and to find correlations between the frequency of chromosomal aberrations and soil radioactivity, in *Allium cepa*, exposed to pollution in situ. For genotoxicity evaluation, the *Allium* test (FISKESJÖ, 1995) was modified, because the onion bulbs with roots were harvested from 10 different gardens near the TEPP (area considered to be contaminated). The amount of radionuclides from TEPP nearby village soil induced chromosomal aberrations in *A. cepa*. Very significant correlations between the percentage of aberrant cells in *Allium cepa* mitosis and the total content of radionuclides were found, the highest values for the correlation coefficient being recorded in Pb-210, Pb-214, Bi-214, Ra-226, Th-234.

**Keywords:** radionuclides, power industry, genotoxicity, modified *Allium* test.

**Rezumat.** Evaluarea genotoxicității solului prin testul *Allium* modificat. Valea Jiului Mijlociu este un binecunoscut bazin de exploatare minieră din România. În vecinătatea exploatărilor miniere se află amplasate două Centrale Electrotermice (CET) - Rovinari și Turceni, înconjurată de halde de cenușă și de steril de vârste diferite. Biotestele la plante, care sunt foarte sensibile în detectarea genotoxicității agenților de mediu, pot servi ca o primă alertă, pentru prezența hazardelor de mediu în apă, aer și sol. Scopul acestei lucrări este studiul impactului poluării solului și vegetației din satele limitrofe, cu radionuclizi, proveniți din cenușă haldată și/sau cenușă ușoară eliberată, utilizând testul *Allium* modificat. Pentru evaluarea genotoxicității testul *Allium* (FISKESJÖ, 1984, 1995) a fost modificat, datorită faptului că bulbi de ceapă cu rădăcini au fost recoltați din 10 grădini diferite, din vecinătatea CET (suprafața considerată contaminată). Radionuclizii din sol induc aberații cromosomiale la *A. cepa*. Între conținutul în radionuclizi ai solului și procentul de aberații în mitoză la *A. cepa*, au fost găsite corelații semnificative, cele mai mari valori înregistrându-se pentru Pb-210, Pb-214, Bi-214, Ra-226, Th-234.

**Cuvinte cheie:** radionuclizi, industria energetică, genotoxicitate, testul *Allium* modificat.

### INTRODUCTION

The extractive and power industries contribute to the dislocation of a large amount of soil, as well as to the artificial modifications of the soil, by forming sterile and ash waste that present a high content of heavy metals and radionuclides, a permanent pollution source. CHALUPNIK et al. (2001) reported researches on solid waste material with increased natural radioactivity, that have been produced in the power and coal industries and studied the Ra concentration in Poland coal mines and settling ponds. MICHALIK et. al. (2005) studying the same area environmental pollutions concluded that the mining of the coal sometimes causes a significant increase in natural radioactivity in the environment, induced mainly by the release of radium-bearing waste water, as well as the storage of solid waste products on the surface. This phenomenon was observed not only in the Upper Silesian Coal Basin (Poland), but also in the Ruhr District (Germany) (SCHMID & WIEGAND, 2003), and other countries where coal is the only natural resource and fossil fuel available in abundance, as in India (MISHRA, 2003).

In Romania, the Middle Jiu River Valley is a well-known coal basin in active exploitation. Nearby the surface coal exploitations there are placed TEPP Rovinari and Turceni - surrounded by ash waste dumps of different ages. Mining activity in the Jiu Valley had an important impact both on environmental and socio-economic terms. In this respect, RĂDULESCU & BUIA (2002) supported the opinion that the main problem is to identify the correct and significant impact of the mining activity, defining also the ways to mitigate and monitor the process associated with coal extraction. Plant bioassays, which are most sensitive in detecting genotoxicity of environmental agents, can serve as the first alert for the presence of environmental hazards in water, air and soil (GOPALAN, 1999). Therefore meristematic and sporogenic tissues of plants generally show patterns of cytotoxic response similar to those of embryogenic and spermatogenic tissues of vertebrates (KRISTEN, 1997). *Allium cepa* ( $2n=2x=16$ ) is a proper plant bioassay due to the low number of large chromosomes, radiosensitive and cultivated in the most gardens. The aim of this paper was to study the impact of pollution with radionuclides from ash waste dumps on vegetation in nearby villages Rosia de Jiu and Turceni, and to find correlations between the frequency of chromosomal aberrations and soil radioactivity, in *Allium cepa*, exposed to pollution in situ.

## MATERIAL AND METHODS

The experiments were performed in spring 2007. The stations from which samples were collected – soil and plants - belong to different areas surrounding TEPP Rovinari and Turceni (Table 1). As Control, there were used soil and plants harvested from Stramba Monastery, Stramba Village and as absolute Control from Craiova.

**The content of radionuclides** from soil was established by the DUGGAN (1988) method, in conformity with IAEA TECDOC 1092 directives, with a gamma spectrometry system, analyzer SPECTRUM-MASTER-ADCAM, model 92X. The work method was elaborated by the National laboratory of Reference for Environment Radioactivity in the framework of the National Agency for Environment Protection, being in conformity with the IAEA TECDOC 1092 directives. For the energy and efficiency calibration we used standard gamma punctiform and volume sources with energies of the gamma radiation in the range of interest (5-20.000 keV);  $\text{Am}^{241}$ ,  $\text{Cs}^{137}$ ,  $\text{Co}^{60}$ ,  $\text{Eu}^{152}$ ,  $\text{Ba}^{133}$ . The collecting time of the natural background amounted to 2000.000 s. Radionuclide activity was expressed in Bq/kg, confidence level 95%.

**For genotoxicity** evaluation, the *Allium* test (FISKESJÖ G., 1995) was modified, due to the fact that the onion bulbs with roots were harvested in March 2007 from 10 different gardens near the TEEP (area considered to be contaminated) and Stramba village. The 1-2 cm roots harvested from young onion bulbs were fixed in Carnoy II fixing solution and coloured with Carr reactive. The cytogenetic observations were performed to an Olympus optical microscope. Observations were performed on all cells in division in ten tips (belonging to different bulbs) and there were recorded the number of cells in mitosis/tip, the percentage of chromosomal mutations in anaphase and telophase (dicentric, ring chromosomes, fragments), C-mitosis phase, micronuclei and metabolic alterations in prophase and metaphase. 300-400 cells/tip were analysed.

**Statistical analyses** were performed with STATISTICA 7.0 by Windows.

Table 1. The stations from which samples were collected.

Tabel 1. Stațiunile de unde au fost colectate probele.

Station	Sample type	Specification
Turceni (fresh ash pit)	Fresh ash	3 km West of TEEP Turceni
Ceplea (Ash waste)	Ash waste	Surrounding the ash pit, 5 years old
Cocoreni surface exploitation	Brown coal	Surface exploitation between TEEP Rovinari and TEEP Turceni
Turceni village	Soil <i>Allium cepa</i> bulbs	The gardens of the population surround the TEEP Turceni, in the East and South
Unchiasului Pool (fresh ash pit)	Fresh Ash	3 km East of TEEP Rovinari
Rosia de Jiu village	Soil <i>Allium cepa</i> bulbs	The village and the gardens of the populations are in the vicinity of TEEP Rovinari, in the South of it
Stramba village – Control	Soil <i>Allium cepa</i> bulbs	Considered to be a clean area, situated 25 km far from the experimental area

## RESULTS AND DISCUSSIONS

Both TEEP (Turceni and Rovinari) started their activity 30 years ago. TEEP Turceni has 6 working groups x 330 MWatt each (900-1,200 MWatt/day) and there are 30,000 inhabitants in the surrounding area. TEEP Rovinari has 4 working groups x 330 MWatt each (800-900 MWatt/day) and there are 25,000 inhabitants in the surrounding area (Plate 1).

### Radionuclides activity in solid waste and soil

Artificial radionuclides, appeared as a result of nuclear energy production ( $\text{Cs-137}$ ,  $\text{Cs-134}$ ,  $\text{Sr-90}$ ,  $\text{I-131}$  a.o.), as well as due to the natural ones from by-products or wastes ( $\text{Ra-226}$ ,  $\text{Ra-228}$ ,  $\text{U-238}$ ,  $\text{Th-232}$ ,  $\text{Ac-228}$ ,  $\text{Pb-214}$ ,  $\text{Bi-212}$ ) having physicochemical properties similar to some constituent chemical elements of living organisms, are metabolized and arrive finally, through different natural trophic chains, into the human organism (CHIOSILA, 2004). Many of these radionuclides mentioned before were found in the samples collected from our considered area (Table 2). From artificial radionuclides,  $\text{Cs-137}$  and  $\text{U-235}$  registered a higher activity in villages and in the Ceplea Valley, these ones resulting from the nuclear accident of Chernobyl, 1987. In most Romanian regions, the amount of  $\text{Cs-137}$  decreased under 1 Bq/kg in the last decade, but there are regions in the Subcarpathians where the values are still high (CHIOSILA, 2004).

During coal combustion, most uranium, thorium and their decay products are released from the coal matrix and distributed in gas phase, as well as in solid combustion products (fly ash and bottom ash). The highest amount of natural radionuclides was found in the bottom ash collected from the ash pit. The highest radioactivity was presented by  $\text{Th-234}$ ,  $\text{Pb-214}$ ,  $\text{Ra-226}$ ,  $\text{Bi-214}$  (Table 2).  $\text{Ra-226}$  is accumulated in bones and its gaseous decay products are accumulated in soft tissues, inducing lung cancer in time. A relatively small amount of radionuclides was found in the nearby village gardens, in this case significant differences in comparison with the rest of the samples being registered for  $\text{Cs-137}$ . The towns Turceni, Rovinari and the village Rosia de Jiu are affected by pollution because of the fly ash and bottom ash from the pit, which are dissipated by the wind, as well as by the gases. At the same time, because the ash pit and ash

dumps are not restricted areas, the people from the villages use the ash in constructions, under the floor, to keep the rats away, being exposed themselves to a chronic irradiation with Ra-226.

It has to be mentioned that in solid combustion waste the concentration of radionuclides is three times (U-235) to nine times (Pb-214) higher than in the original coal. These findings are in accordance with those of ZIELINSKI & FINKELMAN, (1997), for two coal zones in the USA. According to UNSCEAR (1982) the average concentration in K-40, U-238 and Th-232 in coal is estimated to be 50, 20 and 20 Bq·kg<sup>-1</sup>, respectively, based on the analysis of coal samples from 15 countries, with a variation of more than two orders of magnitude (FLUES et al., 2006). The coal that was analyzed, from Cocoreni mine, registered values under the coal world range.

Table 2. The radioactivity (Bq·kg<sup>-1</sup>) of the solid combustion waste, brown coal and soil (0-20cm) in the considered area.  
Tabel 2. Radioactivitatea (Bq·kg<sup>-1</sup>) cenușii, lignitului și a solului (0-20cm) în aria considerată.

Site	Radionuclides content (mean ± standard deviation)											
	K-40	Cs-134	Cs-137	Pb-210	Bi-212	Pb-212	Bi-214	Pb-214	Ra-226	Ac-228	Th-234	U-235
Turceni ash (pit)	67.1 ± 14.3	<1.73	<1.88	18.9± 1.5	56.7± 7.67	81.1± 2.55	112.6± 3.35	132.7± 3.61	122.7± 3.5	47.9± 3.44	137.8± 14.9	6.5± 0.2
Ceplea Ash dump -5y	212.8± 17.8	<1.34	0.88± 0.26	9.06± 0.89	32.1± 4.9	40.4± 1.64	35.1± 1.5	42.6± 1.6	38.9± 1.6	28.4± 2.35	44.2± 5.8	7.1± 0.7
Turceni Village	155.4± 15.9	<1.35	46.9± 0.96	7.87± 0.97	26.6± 4.83	37.1± 1.0	19.9± 0.98	22.9± 0.82	21.4± 0.9	26.3± 1.99	<11.0	4.42± 0.28
Balta unchiasului ash (pit)	416.9± 38.8	<1.56	74.9± 4.0	127.5± 7.95	20.0± 3.95	90.8± 8.47	86.8± 4.82	97.3± 5.67	102.3± 33.8	72.7± 7.52	130.1± 15.1	8.46± 1.48
Rosia Village	341.2± 19.9	<1.67	32.1± 1.12	10.8± 1.64	36.1± 6.99	53.4± 1.63	40.0± 1.58	43.9± 1.53	42.0± 1.5	38.8± 2.84	50.3± 6.88	7.53± 0.43
Stramba village	239.8± 18.9	<1.55	51.2± 3.21	6.86± 0.74	27.1± 4.91	37.7± 1.54	20.2± 1.18	24.3± 1.09	22.2± 1.1	26.8± 2.34	<12.7	3.23± 0.39
Brown coal Cocoreni mine	<43.8	-	<1.4	-	-	-	23.5± 2.5	14.8± 1.4	19.1± 2.0	8.7± 0.9	<10.5	2.18± 0.4
Average natural radioactivity for Romania	330-800	*	*	*	*	*	*	*	10-90	13-65	*	*

\* No available data

Genotoxicity evaluation

The analysis of mitotic normal and aberrant stages, as well as of the metabolic modifications, offers interesting data for genotoxicity evaluation in *A. cepa*. The amount of radionuclides from TEPP nearby village soil induced chromosomal aberrations in *A. cepa*, such as: acentric fragments, minutes, simple or double bridges (dicentric chromosomes), centromere and/or kinetocor inactivation, inactivation or destruction of the mitotic spindle, having as a result characteristic aspects of C-mitosis, as well as metabolic modifications of the chromosomes, such as: alteration of the condensation degree of the chromatine fibers (premature chromosome condensation - PCC or delay in chromosome condensation - DCC), parallel disposal of the chromatine fibers with obvious euchromatine and heterochromatine bands, suprachromosomal organisation of the genetic material in prophase, due to the links between telomeres, chromatine fiber depolymerisation, a.o. (Table 3, Plate 2). CARRUYO et al. (2008) evidenced the induction of stickiness, as the effect of different lead concentration (0.25-1.00 ppm) on apical root tips of *A. cepa*, more than 12 hours. The phenomenon was described as chromosome agglutination displaying the sticky appearance and has been reported as an indicator for high toxicity (MARCANO, 1999).

A comparison of data obtained two years ago (2005) in a preliminary study of the village Rosia de Jiu area showed that the percent of metabolic disorder increased, as well as the inhibition of the mitotic spindle formation, phenomenon that was absent in the past experiment (Table 3).

Table 3. Chromosome aberrations (%) in *Allium cepa* L. harvested from villages near the TEPP.  
Tabel 3. Aberații cromosomiale (%) înregistrate la *Allium cepa* L. recoltată din satele din vecinătatea CET.

Site	Normal mitosis %	Prophase MM %	Metaphase %			Anaphase %		Telophase %		MN %
			MM	CA	C-M	CA	C-A	CA	C-T	
Control 2007	98.36	0.5	1.7	-	-	1.3	-	2.1	-	0.2
Turceni-2007	89.6	8.4	24.1	-	3.6	22.6	-	2.9	2.3	0.0
Rosia de Jiu -2005	94.9	3.7	2.0	2.0	-	9.0	-	4.3	-	2.7
Rosia de Jiu -2007	93.8	6.0	4.8	-	1.8	8.6	1.6	1.4	2.1	0.2
Stramba 2007	95.1	0.4	1.9	3.8	-	4.1	-	0.8	-	0.4
LEGEND: MM = metabolic modifications, CA = chromosomal aberrations, C-M = C-metaphase, C-A = C-anaphase C-T = C-telophase, MN = Micronuclei										

A decrease in normal mitosis percentage was observed in the case of populations that registered a high percentage of metabolic disorders in metaphase, as well as structural modifications of the chromosomes in anaphase and telophase (Turceni 2007) (Table 4). CHAKRABORTY et al. (2009) reported that the proportion of cells in metaphases, anaphases and telophases taken together decreased dramatically with the content of the ash fly in heavy metals. In the case of *A. cepa* population collected from Stramba (2007), a village considered to be in a clean area, 95.1% normal mitosis was registered, a relatively high percentage of structural modifications in metaphase, mainly due to the metabolic disorders in prophase, which affected the packing degree of the chromatin fibers and chromosome structure (parallel disposal of the chromatin fibers, PCC, DCC). All these resulted in a relatively high number of acentric fragments in anaphase, the value of BR index being 50.99 (number of fragments in anaphase/ number of bridges in anaphase). The BR index was introduced by LAZÁNYI (1966) to characterize the efficiency of radioprotective substances, being utilised in cytogenetics and radiobiology (CORNEANU, 1979; IMREH, 1989). The BR value can offer information on the evolution of the mutational process at chromosome level, in the case of radiosensitivity analysis of some populations belonging to the same species.

The comparative analysis of the metabolic disorder percentage (especially PCC and DCC type) and the anaphase aberration percentage reveals the existence of a causal relation between these two types of modifications. Thus *A. cepa*, Turceni 2007, registered PCC in 30.48% prophase cells and a high number of fragments (41.51/100 anaphases) and bridges (26.46 bridges/100 anaphases).

Table 4. The causal relation between metabolic modifications (in prophase, prometaphase and metaphase) and structural modifications of the chromosomes (in anaphase and telophase) in *Allium cepa*.

Tabel 4. Relațiile cauzale între modificările metabolice (în profaza, pro-metafaza și metafaza) și modificările structurale ale cromosomilor la *Allium cepa*.

Variant	% Normal Mitosis	Metabolic modifications						Structural modifications			
		Prophase %		Prometaphase %		Metaphase %		Anaphase %		Telophase %	
		Cond.	Oth.	Cond.	Oth.	Cond.	Oth.	CF	CB	CF	CB
Control 2007	98.4	0.28	0.00	0.00	0.00	0.00	0.00	1.30	0.00	0.80	0.00
Turceni 2007	89.6	5.37	2.58	0.00	0.00	3.61	20.48	41.51	26.42	7.83	2.61
Rosia de Jiu 2005	94.9	0.82	3.27	0.00	0.00	3.85	7.70	12.23	5.77	9.78	1.09
Rosia de Jiu 2007	93.8	0.35	4.12	3.85	3.85	4.13	1.20	12.60	10.24	1.73	1.30
Stramba 2007	95.1	0.40	0.00	0.00	0.00	2.73	3.18	4.11	1.20	0.80	0.40

LEGEND: Cond. = DNA condensation process alterations, Oth. = other metabolic modifications  
CF = chromosomal fragments, CB = chromosomal bridges

Table 5. The correlations (r) between the radionuclides content in soil and the percent of metabolic modifications and chromosomal aberrations in mitosis in *Allium cepa*.

Tabelul 5. Corelațiile dintre conținutul de radionuclizi în sol și procentul de modificări metabolice și aberații cromosomiale înregistrate în mitoza la *Allium cepa*.

Mitotic phase	Prophase	Metaphase		Anaphase				Telophase				MN
RN	MM	CA	C-M	CA	C-A	CF	CB	CA	C-T	CF	CB	
K40	0.3455 p=0.029	0.2297 p=0.154	0.0613 p=0.707	0.1187 p=0.466	0.6401 p=0.000	0.0297 p=0.856	0.0812 p=0.618	0.0458 p=0.779	0.2775 p=0.083	0.2275 p=0.158	0.2641 p=0.100	0.4140 p=0.008
Cs137	0.5286 p=0.000	0.1098 p=0.500	0.4621 p=0.003	0.3671 p=0.020	0.6866 p=0.000	0.3118 p=0.050	0.3911 p=0.013	-0.3446 p=0.029	0.6355 p=0.000	-0.0189 p=0.908	0.4857 p=0.001	-0.0488 p=0.765
Pb210	0.3863 p=0.014	-0.3496 p=0.027	0.2645 p=0.099	0.0020 p=0.990	0.9974 p=0.000	-0.0295 p=0.857	0.1053 p=0.518	-0.3331 p=0.036	0.5765 p=0.000	-0.2688 p=0.093	0.1636 p=0.313	-0.1970 p=0.223
Bi212	0.3738 p=0.018	0.5160 p=0.001	0.1503 p=0.355	0.4679 p=0.002	-0.0820 p=0.615	0.3844 p=0.014	0.3291 p=0.038	0.3997 p=0.011	0.0992 p=0.543	0.6799 p=0.000	0.5009 p=0.001	0.7181 p=0.000
Pb212	0.5187 p=0.001	-0.0183 p=0.911	0.2862 p=0.073	0.2389 p=0.138	0.8017 p=0.000	0.1663 p=0.305	0.2502 p=0.119	-0.0516 p=0.752	0.5260 p=0.000	0.1448 p=0.373	0.3951 p=0.012	0.2361 p=0.142
Bi214	0.4557 p=0.003	-0.1635 p=0.313	0.2235 p=0.166	0.1074 p=0.510	0.9041 p=0.000	0.0454 p=0.781	0.1495 p=0.357	-0.0915 p=0.575	0.5087 p=0.001	0.0229 p=0.889	0.2753 p=0.086	0.1421 p=0.382
Pb214	0.4610 p=0.003	-0.1182 p=0.468	0.2215 p=0.170	0.1271 p=0.435	0.8792 p=0.000	0.0610 p=0.708	0.1594 p=0.326	-0.0734 p=0.653	0.4982 p=0.001	0.0570 p=0.727	0.2934 p=0.066	0.1790 p=0.269
Ra226	0.4474 p=0.004	-0.1858 p=0.251	0.2310 p=0.152	0.0922 p=0.572	0.9253 p=0.000	0.0339 p=0.835	0.1434 p=0.377	-0.1337 p=0.411	0.5225 p=0.001	-0.0232 p=0.887	0.2605 p=0.104	0.0904 p=0.579
Ac228	0.5061 p=0.001	-0.0644 p=0.693	0.2810 p=0.079	0.2048 p=0.205	0.8438 p=0.000	0.1361 p=0.402	0.2284 p=0.156	-0.0853 p=0.601	0.5364 p=0.000	0.0930 p=0.568	0.3651 p=0.021	0.1871 p=0.248
Th234	0.3879 p=0.013	-0.2409 p=0.134	0.1549 p=0.340	0.0057 p=0.972	0.9347 p=0.000	-0.0489 p=0.765	0.0631 p=0.699	-0.0993 p=0.542	0.4610 p=0.003	-0.0474 p=0.772	0.1764 p=0.276	0.0964 p=0.554
U235	0.5702 p=0.000	-0.0098 p=0.952	0.2513 p=0.118	0.3335 p=0.035	0.6189 p=0.000	0.2507 p=0.119	0.2990 p=0.061	0.2804 p=0.080	0.4320 p=0.005	0.4458 p=0.004	0.4736 p=0.002	0.5437 p=0.000

Marked correlations are significant at  $0.010 < p < 0.050$ ; distinct significant at  $0.001 < p < 0.010$ ; very significant  $p < 0.0010$ ;

LEGEND: RN = radionuclide, MM = metabolic modifications, CA = chromosomal aberrations, C-M = C-metaphase, C-A = C-anaphase, CF = chromosomal fragments, CB = chromosomal bridges, C-T = C-telophase, MN = Micronuclei

The values of BR index in the case of *Allium* populations can be explained by the relationship between metabolic disorders in prophase and metaphase and the percentage of fragments and bridges in anaphase and telophase. The analysis of table 4 reveals a causal relation between the percentage of metabolic disorders and structural modifications in *Allium cepa*.

Correlations

There were found very significant correlations between the percent of aberrant cells in *Allium cepa* mitosis and the content in radionuclides in soil. All analyzed radionuclides induced metabolic disorders, especially concerning the condensation degree of DNA, in prophase, the highest values for the correlation coefficient being recorded for Cs-137, Pb-212, Ac-228 and U-235 (Table 5). Data analysis showed significant correlations between the contamination of the soil with radionuclides and the inhibition of mitotic spindle formation (C-metaphase, C-anaphase, C-telophase). This phenomenon is similar with the one observed by CHAKRABORTY et al. (2009), who reported that fly ash seems to have an effect on fragmoplast that is a complex assembly of microtubules, microfilaments and endoplasmic reticulum. DOVGALIK et al. (2001) reported an increase of binuclear cells in *A. cepa* apical meristems, after treatment by salts of Cd, Al, Pb, Cu and Zn, where cytoskeleton could be a cell target for salts of some metals.

The analysis of the correlations between the metabolic modifications, represented by the different degree of DNA fibers compaction and mitotic spindle alteration, on one hand and the structural modification of the chromosomes (chromosomal aberrations), on the other hand pointed out that our first hypothesis was right, that there exist causal relations between the phenomena. The percent of chromosomal fragments and bridges counted in anaphase and telophase are very significantly correlated with the percent of cells in prophase and metaphase, which present metabolic disorders (Table 6). Very significant correlations were found also, between the percent of chromosomal fragments in anaphase and telophase and the percent of cells with micronuclei.

Table 6. The correlations (r) between metabolic modifications (in prophase and metaphase) and structural modifications of the chromosomes (in anaphase and telophase) in *Allium cepa*.

Tabel 6. Corelațiile între modificările metabolice (în profază și metafază) și modificările structurale ale cromosomilor la *Allium cepa*.

Mitotic phase	Metaphase	Anaphase				Telophase				MN
	C-M	CA	C-A	CF	CB	CA	C-T	CF	CB	
MM	0.9155	0.9098	0.3533	0.8958	0.9367	0.3334	0.9045	0.5569	0.9603	0.2410
Prophase	p=0.000	p=0.000	p=0.025	p=0.000	p=0.000	p=0.035	p=0.000	p=0.000	p=0.000	p=0.134
MM	0.9308	0.9419	-0.1210	0.9689	0.9615	0.2067	0.7506	0.4469	0.8932	-0.0030
Metaphase	p=0.000	p=0.000	p=0.457	p=0.000	p=0.000	p=0.201	p=0.000	p=0.004	p=0.000	p=0.985
CA	0.9023	1.0000	-0.0355	0.9951	0.9831	0.3891	0.7564	0.6600	0.9853	0.2800
Anaphase	p=0.000	p= —	p=0.828	p=0.000	p=0.000	p=0.013	p=0.000	p=0.000	p=0.000	p=0.080
CA	0.0614	0.3891	-0.3684	0.3617	0.2822	1.0000	-0.0773	0.9123	0.3648	0.8844
Telophase	p=0.707	p=0.013	p=0.019	p=0.022	p=0.078	p= —	p=0.635	p=0.000	p=0.021	p=0.000
Marked correlations are significant at 0.010< p < 0.050; distinct significant at 0.001< p < 0.010; very significant p < 0.0010;										
LEGEND: MM = metabolic modifications, CA = chromosomal aberrations, C-M = C-metaphase, C-A = C-anaphase, CF = chromosomal fragments, CB = chromosomal bridges, C-T = C-telophase, MN = Micronuclei										

CONCLUSIONS

The highest radioactivity was presented by Th-234, Pb-214, Ra-226, Bi-214 (Table 2). Ra-226 is accumulated in bones and its gaseous decay products are accumulated in soft tissues, inducing lung cancer in time. A relatively small amount of radionuclides was found in nearby village gardens, in this case significant differences in comparison with the rest of the samples being registered for Cs 137.

In the solid combustion waste, the concentration of radionuclides is three times (U-235) to nine times (Pb-214) higher than in the original coal.

The amount of radionuclides from TEEP nearby village soil induced chromosomal aberrations in *A. cepa*, such as: acentric fragments, minutes, simple or double bridges (dicentric chromosomes), centromere and/or kinetocor inactivation, inactivation or destruction of the mitotic spindle, as well as metabolic modifications of the chromosomes, such as: alteration of the condensation degree of the chromatine fibers (premature chromosome condensation - PCC or delay in chromosome condensation - DCC), parallel disposal of the chromatine fibers with obvious euchromatine and heterochromatine bands, suprachromosomal organisation of the genetic material in prophase, due to the links between telomeres, chromatine fiber depolymerisation, a.o.

A decrease in normal mitosis percentage was observed in the case of populations that registered a high percentage of metabolic disorders in metaphase, as well as structural modifications of the chromosomes in anaphase and telophase.

There were found very significant correlations between the percent of aberrant cells in *Allium cepa* mitosis and the content in radionuclides in soil. All analyzed radionuclides induced metabolic disorders, especially concerning the condensation degree of DNA, in prophase, the highest values for the correlation coefficient being recorded for Cs-137, Pb-212, Ac-228 and U-235.



Using the biological material, harvested from the polluted area, *Allium* test offers a more accurate image on the presence of environmental hazards.

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**PLATE 1 / PLANȘA 1**



Photo 1.



Photo 2.



Photo 3.

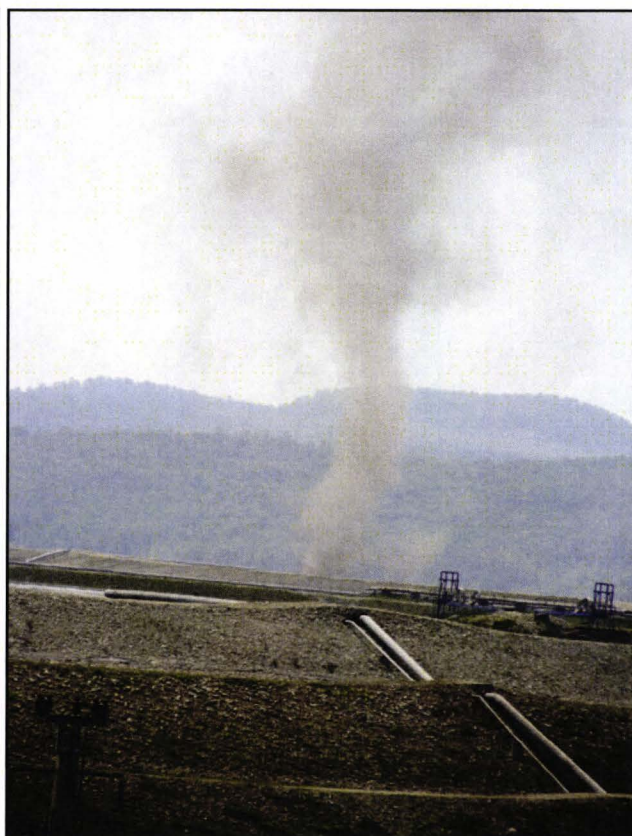


Photo 4.

Photo 1. TEPP Turceni; Photo 2. TEPP Rovinari: Ash pit Ceplea (Turceni); Photo 4. Ash pit Balta Unchiasului (Rovinari) in a windy day.

Foto 1. CET Turceni; Foto 2. CET Rovinari; Foto 3. Depozitul de cenușă Ceplea (Turceni); Foto 4. Depozitul de cenușă Balta Unchiasului (Rovinari) într-o zi cu intensificări ale vântului.



PLATE 2 / PLANȘA 2



Photo 5.

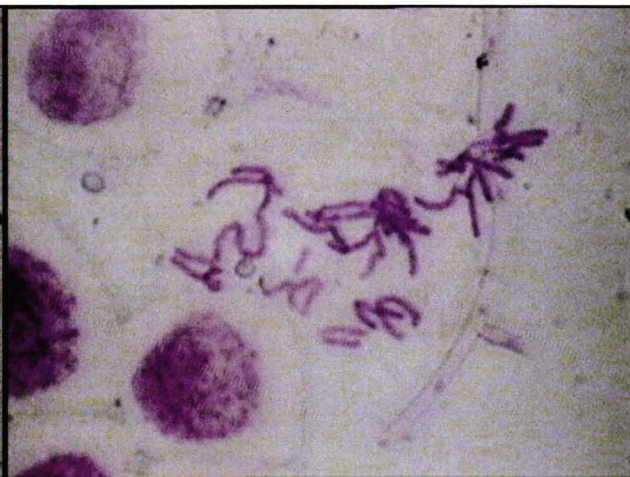


Photo 6.

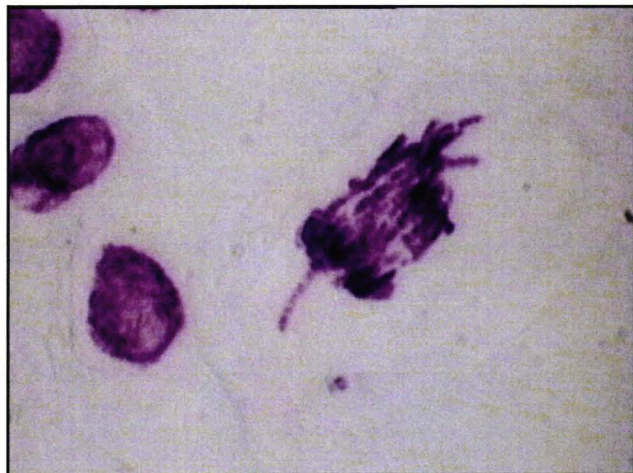


Photo 7.



Photo 8.



Photo 9.

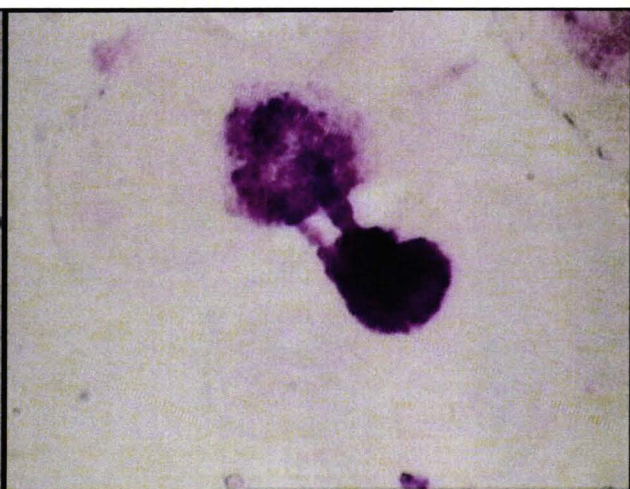


Photo 10.

Photo 5. Prometaphase – delay in chromosome condensation (DCC); Photo 6. C-Metaphase; Photo 7. Anaphase with bridges and aspect of banded chromosomes; Photo 8. Anaphase with double bridges; Photo 9. Polyploid anaphase; Photo 10. Son nuclei linked by chromatine double bridge and asincrony in chromosome decondensation.

Foto 5. Prometafaza – întârziere în condensarea cromosomilor; Foto 6. C-metafaza; Foto 7. Anafaza cu punți și aspectul de cromosomi bandati; Foto 8. Anafaza cu punți duble; Foto 9. Anafaza poliploida; Foto 10. Nuclei fii legați prin punte dublă de cromatina și asincronie în decondensarea cromosomilor.

## DIVERSITY AND PROTECTION IN TÂRNOVU STONE (THE CĂPĂȚÂNII MOUNTAINS, VÂLCEA COUNTRY)

GHEORGHE PLOAIE, CLAUDIA NINCIULEANU

**Abstract.** The paper represents a new contribution to the knowledge of natural floristic patrimony of Târnovu Stone from the Căpățâanii mountains, Vâlcea county. There are first presented the 16 new species that grow in this massif and thus increase the biological diversity and ecoprotection potential.

**Keyword:** limestones, landscape, trees, shrubs, grass vegetation, new species.

**Rezumat.** Diversitate și protecție în Piatra Târnovului (Munții Căpățâanii, județul Vâlcea). Lucrarea reprezintă o nouă contribuție la cunoașterea patrimoniului vegetal al Masivului Piatra Târnovului din Munții Căpățâanii, județul Vâlcea. Este menționată prezența a 16 specii de plante necunoscute până acum din acest masiv, care sporesc diversitatea biologică și potențialul natural ecoprotectiv.

**Cuvinte cheie:** calcare, peisaj, arbori, arbuști, vegetație ierboasă, specii noi.

Târnovu Stone is a limestone outlier located on the interfluvium between the Latorița and the Repedeș within the Căpățâanii Mountains, which reaches 1,880 m altitude (Fig. 1). There predominates karst landforms: walls, pinch, troughs, slopes, needles, grottoes, caves, avens. This legendary mountain was first noticed by the famous geologist Gh. Munteanu-Murgoci (1902) who made a good description, after an attempt to explore Haiducilor Cave. The first observations on flora items and phytocoenoses belong to Bielz, Krauss, Hergotta and Klotz, who collected plants from Piatra Târnovului in a trip made in 1874; presently, the herbarium is preserved at the Bruckenthal Museum in Sibiu.

The Târnovu Stone was named "the vigilant eye of the mountain" by the writer Doru Moțoc and the author Gheorghe Stănescu dedicated it a poem (PLOAIE & MOȚOC, 1992).

Our research in Târnovu Stone began over 30 years ago together with prof. univ. PhD. Traian Ștefureac from the University of Bucharest. The geomorphologic and floristic value was presented in PLOAIE & ȘTEFUREAC (1983).

The landscape is particularly known for the brilliant white limestone, which is crystalline within certain perimeters and appears from the spruce forests located at the foot. The Tithonic – Neocomian limestone is strongly modified by tectonic processes with broad diaclasses and with layers tilted to the north-west at an angle of 70 degrees from the vertical. Congelifraction phenomena grind permanent walls, causing the accumulation of rocks on both mountainsides. Vegetation covers 40-50% of total area.

Of trees, the spruce fir develops on both slopes, to the walls, and in some eastern troughs up to the top. Some isolated specimens of larch (*Larix decidua* MILL. ssp. *carpathica* (DOM.) ŠIMAN) go up to 1,800 m. A compact cluster of larch also appears on the eastern slope. Shrubs are represented by *Pinus mugo* TURRA, which grow on the main ridge and on the western slope, while juniper (*Juniperus communis* L.) covers smaller areas on the eastern side. In wet troughs, there can be noticed: mountain alder (*Alnus viridis* (CAIX) LAM. & DC.), coronet (*Spiraea ulmifolia* SCOP.), dwarf willow tree (*Salix retusa* L.) and rhododendron (*Rhododendron myrtifolium* SCH. & KY.). The species *Cotoneaster integerrimus* has been recently identified on steep rocks at 1,750 m altitude.

Grass vegetation is predominantly developed on rocky belts; there abound saxicolous graminaceae (*Festuca violacea* GAUD., *Sesleria coerulans* BAUMG.) and other plants (*Cerastium alpinum* SCHUR, *Thymus comosus* SCHUR, *Carex sempervirens* VILL., *Saxifraga aizoon* JACQ., *Dianthus spiculifolius* SCHUR, *Aster alpinus* L., etc.). In the rock cracks near the summit, there grows the Carpathian-Dacian *Papaver corona sancti-stephani* ZAP., yellow poppy, but there were also found *Galium anisophyllum* VILL., *Cerastium alpinum* L. etc. We have recently discovered other interesting species like *Lilium martagon* L., *Epipactis atrorubens* (HOFFM.) SCHULT., *Cotoneaster integerrimus* MEDIK, *Centaurea atropurpurea* W. & K., *Trollius europaeus* L., *Neottia nidus-avis* (L.) RICH., *Anemone narcissiflora* L., *Veronica bachofeni* HEUFF., *Geranium macrorrhizum* L., *Ceterach officinarum* (L.) WILLD., *Asplenium ruta muraria* L., *Behen vulgaris* MNCH., *Hieracium villosum* JACQ., *Juniperus sabina* L., *Aconitum tauricum* WULF. and others. The limestone slide rocks from the southern slope are marked by the presence of the species *Rumex scutatus* L. All these species are new for Piatra Târnovului (Plate I and II).

Among animals, there were observed: the chamois (*Rupicapra carpathica*), common viper (*Vipera berus*) and the horn viper (*Vipera ammodytes*), wallcreeper (*Tichodroma muraria* L. 1766), raven (*Corvus corax* L.), blackcock (*Tetrao urogallus* L. 1758), kerstel (*Falco tinnunculus* L. 1758), jay (*Garulus glandarius* L.), woodpecker (*Picus viridis* L. 1758, *P. canus* GMEL. 1788), crossbill (*Loxia recurvirostra* L. 1758), mountain eagles (*Aquila chrysaetos* L. 1758) etc.

A surface of 1,300 ha of this area has recently been declared Natura 2000 site, but the study of the entire biodiversity is still at the beginning. A full inventory of species and habitats has not been achieved yet. Research is much more difficult because of rocky terrain and rock instability. The summit tourist paths no longer exist and thus, the tourist flux has considerably decreased. The sheep breeding does no longer have the intensity registered in the past years. All these make up the richness of the vegetal cover and we are glad that the area has regained its previous natural



state, which is characteristic for the regions no longer exposed to humans' aggression. A certain number of rare plants and animals, which have patrimony value, found shelter in this area. It is a good reason to further investigate this mountain massif and to ensure respect for natural values. In addition, our research aims at contributing to the setting up of a nature reserve as we proposed years ago (PLOAIE, 1999). We are convinced we shall enhance the protected natural heritage of Romania and we will militate to increase environmental awareness on behalf of humanity.

### CONCLUSIONS

16 new species from the Târnovu Stone, the Căpățâni Mountains, Vâlcea county are presented in this paper. These species increase the biological diversity and ecoprotection potential of this region.

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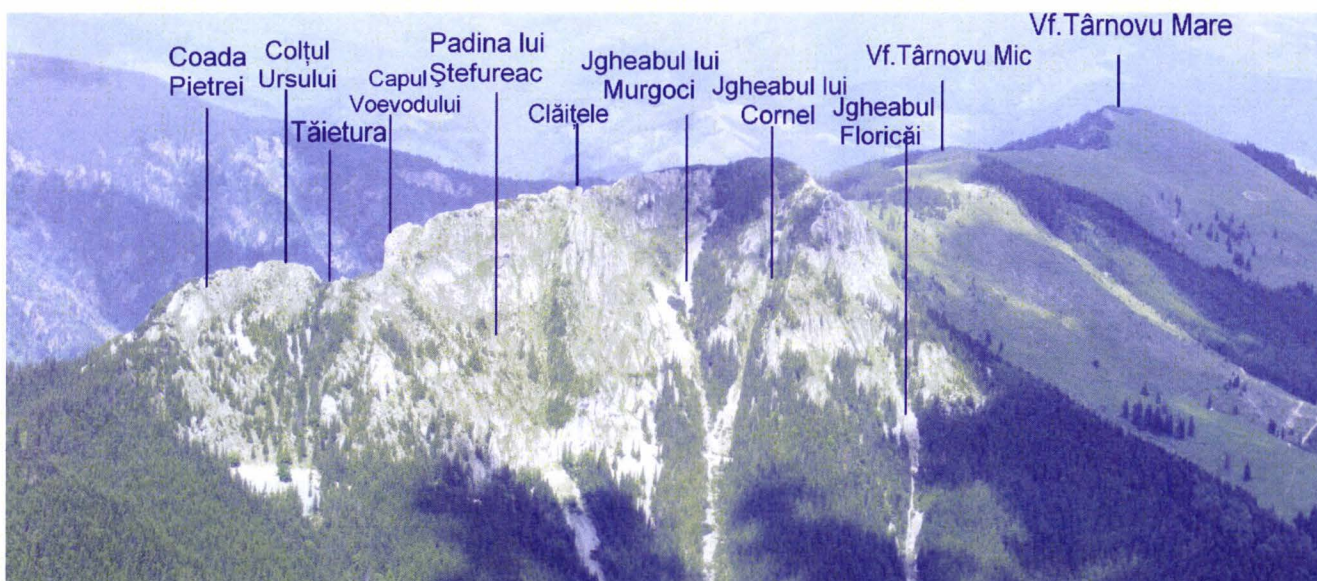
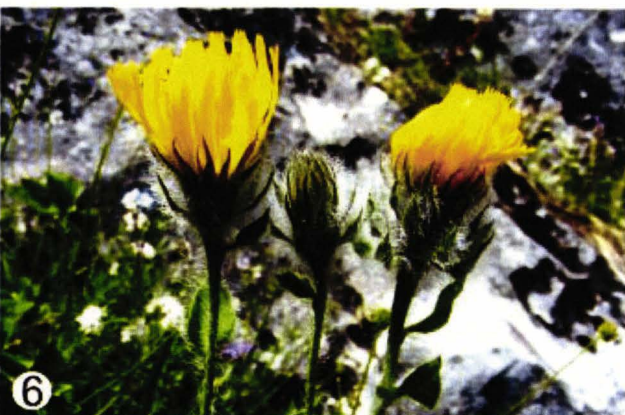
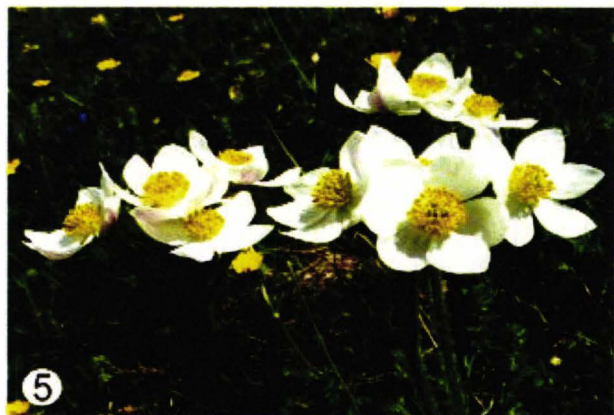
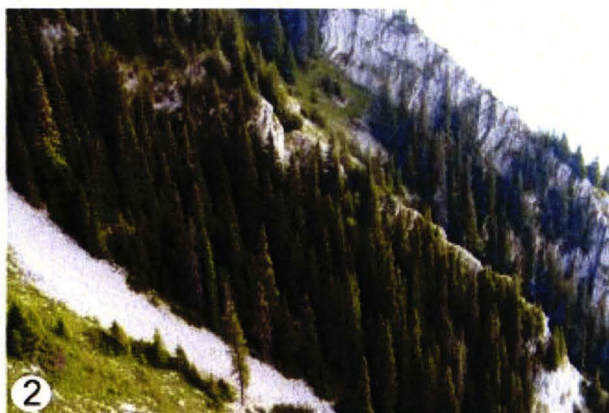


Figure 1. The Târnovu Stone – view from Nedeia Peak.  
 Figura 1. Piatra Târnovului – vedere de pe Vârful Nedeia.





**PLATE I / PLANȘA I**

1. The ridge of Piatra Târnovului / Creasta Pietrei Târnovului
2. Spruce fir (*Picea abies* (L.) Karst. on the south slope / Molidiș (*Picea abies* (L.) Karst. pe versantul sudic
3. Piles (*Neottia nidus-avis* (L.) Rich. / Trânji (*Neottia nidus-avis* (L.) Rich.
4. *Epipactis atrorubens* (Hoffm.) Schult.
5. *Anemone narcissiflora* L.
6. *Hieracium villosum* Jacq.

Photos by GH. PLOAIE





## PLATE II / PLANSA II

1. Lily (*Lilium martagon* L.) / Crin de pădure (*Lilium martagon* L.)
2. *Eryssimum transsilvanicum* Schur / Mixandră de munte (*Eryssimum transsilvanicum* Schur)
3. *Veronica bachofenii* Heuff.
4. Larch tree (*Larix decidua* Mill. ssp. *carpathica* (Dom.) Siman / Larice (*Larix decidua* Mill. ssp. *carpathica* (Dom.) Siman)
5. *Calamintha alpina* (L.) Lam.
6. *Hedysarum hedysaroides* (L.) Sch. et Th.
7. *Behen vulgaris* Mnch.
8. *Rumex scutatus* L.

Photos by GH. PLOAIE

## APPLICATION OF PHYTOSOCIOLOGICAL PRINCIPALS ON THE SPATIAL PLANNING AND SUSTAINABLE USE OF THERMOPHILOUS FOREST VEGETATION

ALKEDA KALAJNXHIU, ARSEN PROKO, PETRIT HODA, LIRIKAKUPE, ALMA IMERI

**Abstract.** *Dajti National Park (DNP) is one of the most interesting protected areas, Second Category of IUCN, located on the central part of Albania. The vegetation of DNP, especially thermophilous broadleaves forests represent different degradation stages because unsustainable practices, fires, overgrazing and traditional use in the past. Basic part of the study is the ecology and life history of Quercus tree species in the landscape of DNP, which is related to abiotic site factors and human land use. This includes recording of abiotic site factors by field methods, the identification of the vegetation and land use systems of the area plots. A comprehensive analysis on plant communities has been necessary. Combined floristic, ecological site data and human factors, inform us about the landscape history and present situation. Classification of vegetation types defining species groups and plant communities, through principals of Zurich–Montpellier school, have been done. Potential vegetation have been identified, by using Map of the Natural Vegetation of Europe. Statistical analysing, ordination and classification are realised by Turboveg, Juice, Syntax software. As a result, 5 plant associations of thermophilous broadleaves vegetation, belonging to 4 alliances of Querco-Fagetea Class, all related to site factors and human use, are defined. The environmental situations have been correlated with the regeneration ecology of the main canopy species, and particularly of Quercus species. The Quercus forests and their degradation stages has been evaluated by criteria of nature conservation.*

**Keywords:** *vegetation association, ordination and classification, sustainable use.*

**Rezumat.** *Aplicarea principiilor fitosociologice în amenajarea teritoriului și utilizarea durabilă a vegetației forestiere termofile. Parcul Național Dajti (PND) este unul dintre cele mai interesante zone protejate, Categoria a II-a IUCN, situat în partea centrală a Albaniei. Vegetația Parcului Național Dajti, în particular pădurile de foioase termofile prezintă faze diferite de degradare datorită practicii eco-nimicitoare, incendiilor, pășunării și utilizării tradiționale în trecut. Partea fundamentală a studiului este ecologia și biologia speciei Quercus în peisajul PND-ului, care sunt legate de factorii abiotici ai mediului și utilizarea antropică a pământului. Aceasta cuprinde monitorizarea factorilor abiotici prin intermediul metodelor de teren, identificarea vegetației și modul de utilizare al pământului. O analiză comprehensivă despre comunitățile vegetale a fost necesară. Au fost combinate datele floristice, ecologice ale terenului și factorii umani, informându-ne despre istoria peisajului și situația prezentă. Clasificarea tipurilor de vegetație este făcută prin definirea grupelor de specii și comunitățile plantelor urmând principiile școlii Zurich–Montpellier. Vegetația potențială a fost identificată utilizând Harta Vegetației Naturale din Europa. Analiza statistică, ordinea și clasificarea au fost realizate de către Turboveg, Juice, Syntax software. Ca rezultat, au fost identificate 5 asociații de plante ale pădurilor de foioase termofile, aparținând a 4 alianțe, anume Clasa Querco-Fagetea, toate legate de factorii mediului și utilizării antropice. Situațiile ambientale au fost corelate cu regenerarea ecologică a speciilor principale baldachin și în particular a speciilor genului Quercus. Pădurile de Quercus și stadiile lor de degradare au fost evaluate conform criteriilor de conservare a naturii.*

**Cuvinte cheie:** *asociație vegetală, ordonare și clasificare, utilizare durabilă.*

### INTRODUCTION

Dajti National Park (DNP) is one of the most interesting protected areas, Second Category of IUCN, located on the central part of Albania, 5 km far from Tirana, Capital city of the country. Due to the high amplitude of elevation, from 860 ft – 4700 ft, a high level of biodiversity take place, not only specific but ecological so far (KALAJNXHIU et al., 2008). The Dajti National Park provides a framework to conserve and enhance the special qualities of the natural values and sets out to secure the varied biodiversity found within its boundaries so that they could be enjoyed by the present and future generations. The vegetation of DNP, especially thermophilous broadleaves forests represent an important vegetation type in different degradation stages because unsustainable practices, fires, overgrazing and traditional use in the past.

Basic part of the study is the ecology and life history of *Quercus* tree species in the landscape of DNP. The occurrence, regeneration and size (growth) of the oak tree is related to abiotic site factors and human land use. This includes recording of abiotic site factors mainly by field methods, and the identification of the vegetation and land use systems of the area and plots.

This study is an effort for the gathering, analyzing and assessment of the aspects concern the concept of natural quality of an ecosystem, and their organisation according to a logical scheme, in order to establish an “expert system” as a tool for the assessment of ecosystems natural quality. The digital systems that use logical models are defined as expert system or knowledge-based systems.



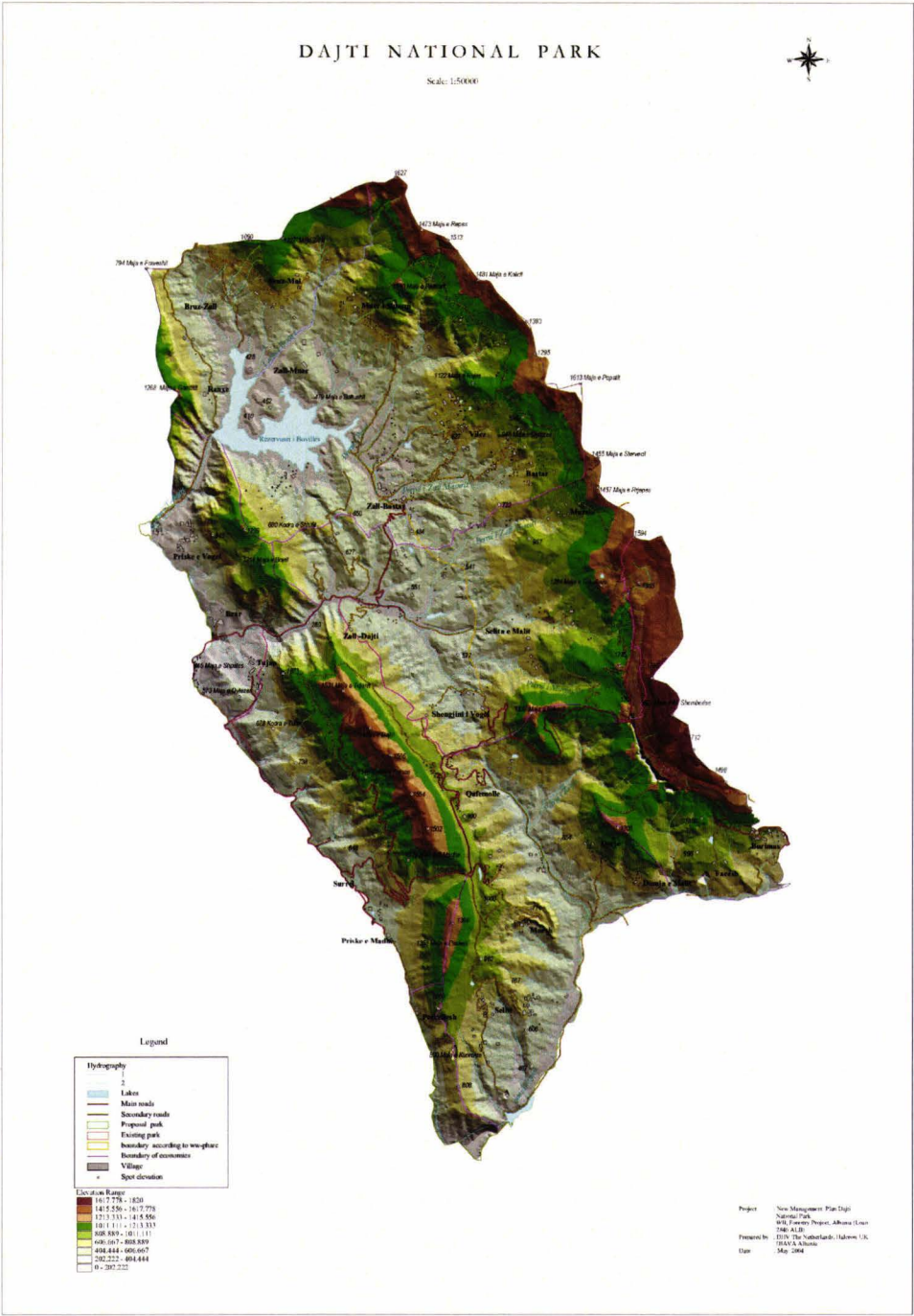


Figure 1. Physic map of DNP.  
Figura 1. Harta fizică a PND-ului.

The establishment of an “expert system” to assess the level of biodiversity per plant association and to manage on a sustainable way the natural resources on DNP, represents the innovation aspect of the study.

The identification of the best managerial alternatives of the landscape needs over all the division of territory in homogenous area units and then the inventory of specific biodiversity values per each areas unit. Homogenous units for biodiversity assessment and spatial planning, the principles of SIGMA school are used.

The definition of degradation stages, within vegetation series, and assessment of the biodiversity are the most important steps in managing of natural resources on the areas with specific protection status (NP).

**The goal of the paper**

The main goal of this paper is to involve the application of phytosociological principle for spatial division, planning and evaluation of the biodiversity, as well as sustainable use of natural resource in DNP.

**Objectives:**

1. Identification of ecological biodiversity of the broadleaves thermophyllous forests, (richness on plant association) as an important indicator for the sustainable management of DNP;

2. Identification of the overall value of the biodiversity, per each association and then “hot spot”, “warmish spot” and “cold spot” in terms of biodiversity;
3. Identification of the degradation stage, within vegetation series, of all derived vegetation types (Braun-Blanquet 1936);
4. Improved information on, and awareness of, biological and landscape diversity issues, and increased public participation in actions to conserve and enhance such diversity.

## MATERIAL AND METHODS

For the realization of the study, to perform a comprehensive analysis on plant communities has been necessary. The plant associations based on multivariate analysis, status and distribution of vegetation types, as well as on the abiotic, historical and silvicultural aspects are defined.

For each syntaxon (vegetation type), a representative number of sample plots was recorded. An inventory of site parameters, flora, size and number of woody species, and information about land uses took place. In total 74 relevés are provided, based on the principles of sample design. The size of the plot by “Minimum area” method was defined.

All the plots are registered at TURBOVEG program and the database was created. The computer software package TURBOVEG (HENNKEN, 1995, HENNEKENS & SCHAMINEE, 2001) was used for designing the storage, selection, and export of vegetation data (relevés). The data from TURBOVEG (Vegetation archive) are exported to JUICE for clustering of the similar relevés according to Euclidian Distance.

The analysis included the classification of floristic and forest data, based on computation JUICE and CANOCO. JUICE (TICHY, 2002), a statistical program optimized for use in association with TURBOVEG, offers the possibility for editing, classification and analysis of large phytosociological tables and databases. This software, with a current maximum capacity of 30 000 relevés in one table, includes many functions for easy manipulation of table and header data. Floristic data with ecological data (temperature, rainfall, soil type, relief) and human factors, e.g., frequency and intensity classes of disturbances like grazing, fire, and cutting, were combined. This can give us, a comprehensive information about the landscape history and present situation. Classification of vegetation types defining species groups and plant communities have been done. The floristic structure of the dataset, was displayed by a synoptic table and by ordination. To identify the potential vegetation, Map of the Natural Vegetation of Europe, has been used too.

The environmental situations and the regeneration ecology of the main canopy species (particularly of *Quercus* species), were correlated (MITCHELL et al., 2002).

The *Quercus* forests and their degradation stages have been evaluated by criteria of nature conservation. These data have been compared with local community needs and ideas for the development of their region, considering Natural ecosystem (requirements), Economical system (production and profit) and Social system (human needs) as part of the same global system (SCHULZE, 1996). The result has been a multifunctional sustainable management of the natural resources of DNP that respect the basic criteria of sustainable management “Economically viable-Environmentally sound-Socially just”. The development of sustainable management concepts has been a major task of this work (PROKO & DIDA, 2002).

Evaluation of plant communities, associations and habitat types is based on qualitative and quantitative characteristics (GATZOJANNIS et al., 2001). Classification of vegetation types through principals of Zurich–Montpellier school (Braun-Blanquet, 1936), has been done. Statistical analysing, ordination and classification are realised by Turboveg, Juice, Syntax and GIS software. For each plant association levels of potential, real and overall biodiversity are estimated, based on the suitability and relative weight of the external and internal factors. For the standardization the measurement units four interval classes are used and a hierarchical system is established.

The syntheses of the evaluation results along the levels of the hierarchy can only be achieved at a common scale in which all factors could be expressed.

Based on the quality ( $q_i$ ) and the relative weight ( $g_i$ ) of the lower level factor; the quality of an upper level factor can be estimated by the function.

$$N = \sum (q_i \cdot g_i)$$

Successive evaluation along the hierarchy results to the evaluation of the two aspects of a given function. The assessment of external factors results to the value of the function potential while the assessment of the internal ones gives the suitability class of a vegetation type. (GATZOJANNIS et al., 2001)

Depending on the value of  $y = N = \sum (q_i \cdot g_i)$  a function can then be ranked into four classes.

Analyses of floristic data and ecological characteristics attest the studied area as a border between Mediterranean and Sub-Mediterranean vegetation types.

## RESULTS

### The classification of plant associations

The result is the classification of forest types, regeneration and growth patterns of thermophilous broadleaves forests, all related to site factors and human use.



According to the methodology, data collected from the 74 relevés were archived on TURBOVEG programme. For each relevé, both, general data about the ecology, geo-morphology, etc., and the list of species with A-D index as well as biological forms were collected and registered.

Data from Turboveg are exported and statistical ordinated to JUICE. Twispan analyse is used in this case.

TWINSpan category:

[illegible]

Figure 2. Statistical analyse of the relevès.

Figura 2. Analiza statistică a releveelor.

Identification of Fidel species (significant or characteristic species of association) was based on the synoptic analysis from the synthetic table, just the first analysing stages of which we have represented in the table below.

Number of relevés:	1	8	2	1	5	1	3	19	14	9	9
relevés 72											
Species 332	1	2	3	4	5	6	7	8	9	10	11
<i>Ajuga reptans</i>	58.6	30.2	20.7								
<i>Trifolium pumantii</i>	58.2							7.9	20.5	16.3	
<i>Rosa species</i>	50.3				8.2			26.9		42.5	
<i>Epilobium montanum</i>		70.6								5.6	
<i>Populus tremula</i>		69.0									
<i>Doronicum columnae</i>		68.9						6.2		1.3	
<i>Hypericum perforiatu</i>		65.1						0.3			
<i>Trifolium angustifol</i>		59.4									
<i>Knautia drymeia</i>		56.1			5.7		17.9				
<i>Hyosotis sylvatica</i>		55.1	24.9		16.9				1.9		
<i>Potentilla erecta</i>		54.6	41.5								
<i>Campanula persicifol</i>		54.6	41.5								
<i>Brachypodium sylvati</i>		54.1						5.8	44.5		
<i>Potentilla micrantha</i>		53.9	31.1						12.1		
<i>Juniperus communis</i>		50.2							4.4	33.6	5.1
<i>Hieracium cymosum</i>		49.5	37.2								
<i>Cephalanthera rubra</i>		48.6	27.6		19.2						
<i>Primula acaulis</i>			100.0								
<i>Trifolium species</i>			97.2								
<i>Galium mollugo</i>			90.8						3.5		
<i>Lathyrus nissolia</i>			82.1		5.7						8.8
<i>Luzula multiflora</i>			81.5					17.3			
<i>Ranunculus ficaria s</i>		29.7	73.1								
<i>Helictis melissophyl</i>		43.1	62.8							1.6	
<i>Asyneura limonifoliu</i>			100.0								
<i>Sedum album</i>			100.0								
<i>Rubus species</i>			97.2								
<i>Calamintha grandiflo</i>			97.2								
<i>Vinca minor</i>			97.2								
<i>Melica ciliata</i>		2.4	93.7								
<i>Digitalis lanata</i>		7.7	72.3							24.5	
<i>Petrohradja saxifrag</i>			66.1	1.1		39.0					
<i>Saxifraga rotundifol</i>			64.8	32.7		11.3					
<i>Ostrya carpinifolia</i>			60.7					12.0		43.6	
<i>Lathyrus venetus</i>		16.7	52.5	9.6		4.8					
<i>Ceterach officinarum</i>			47.8	20.3		24.9	15.2				9.6
<i>Ranunculus species</i>				61.4							
<i>Carex species</i>				57.1			1.8				
<i>Hieracium murorum</i>				53.1						9.7	
<i>Luzula species</i>		1.9		50.6		23.3				0.5	

Figure 3. Sintetic table.

Figura 3. Tabel sintetic.

Cluster analysis was performed with SYNTAX 2000. The ecological analysis was an important step for the classification of the vegetation types.

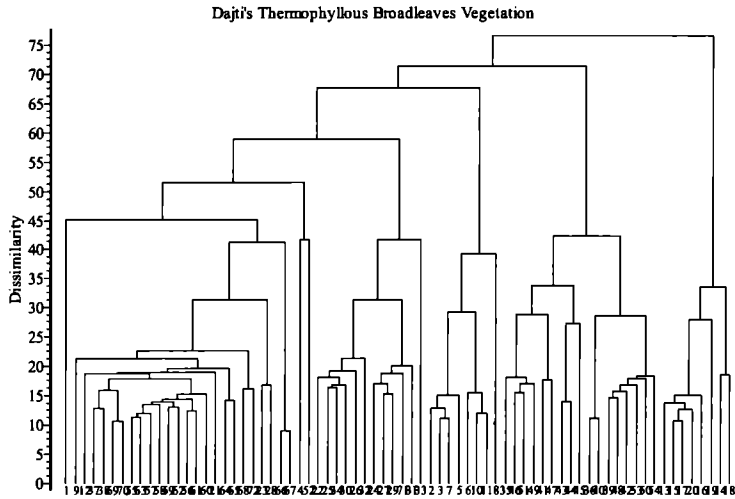


Figure 4. Dendrogram of Dajti's NP Thermophyllous Broadleaves Vegetation.  
Figura 4. Dendrograma vegetației de foioase termofile din Parcul Național Dajti.

Vegetation types must to be clearly distinguished on the context of ecological factors and historic traditional use. Ellenberg's factors are identified for each vegetation type, temperature, light, moisture and continentally.

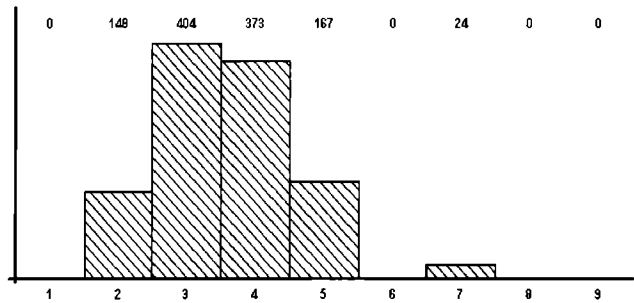
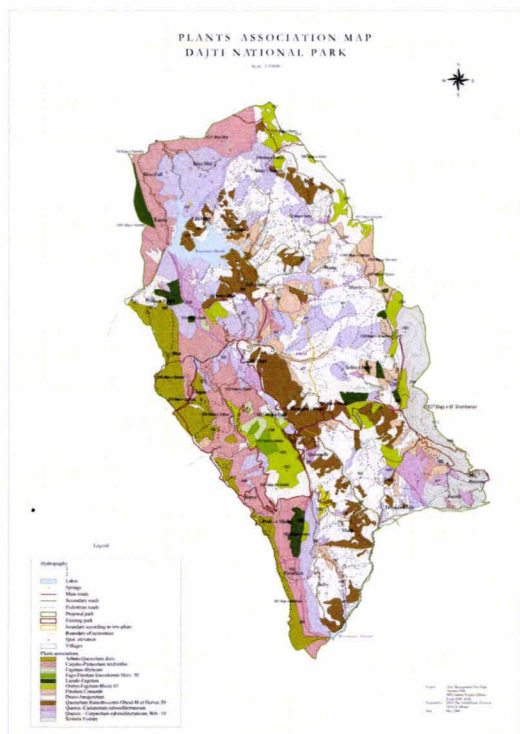


Figure 5. Ellenberg's Factors.  
Figura 5. Factorii lui Ellenberg.

As result of statistical ordination of the plots, using update software (Turboveg, Juice) and phytosociological analyze of thermophilous vegetation of DNP, 5 plant associations, Braun Blanquet sensu strictu, belonging to 4 alliances of *Quercio-Fagetea* CLASS, are defined.  
Here below the synoptic table is represented:  
Class: *Quercio-Fagetea* BR.-BL. et VLIEGER 37  
Order: *Quercetalia pubescentis* BR.- BL. 31  
Alliance: *Ostryo-Carpinion orientalis* BR. -BL. 32  
Association: *Quercetum-Ostrya carpinifolia* HORVAT 38  
Association: *Fraxino-Carpinetum orientalis*  
Alliance: *Quercion frainetto-cerris* (HORV. 1939).  
Association: *Quercetum frainetto-cerris* OBERD. 48 et HORVAT 59  
Order : *Quercetalia robori-petraeae* TX. 31  
Alliance: *Quercion robori- petraeae* BR.-BL. 32  
Association: *Quercio-Castanetum submediterraneum* WRABER 54  
Order: *Prunetalia spinosae* TX. 52  
Alliance: *Prunion spinosae* FAB. et FUKAREK 68  
Association: *Pruno-Juniperetum* FAB. et FUK. 68  
All the végétation associations are represented on the végétation Mapp:



**Figure 6. Distribution of the plants association on Dajti's NP.**  
**Figura 6. Distribuția asociației plantelor în PN Dajti.**

### Dynamism of the vegetation

The identification of the degradation stages within vegetation series has been an important aspect of the study considering that this could serve as a basis on choosing the best managerial alternative (BINDER, 1997).

Based on the floristic list comparison of defined vegetation associations, the regressive stages within this vegetation series (dynamic scheme), as result of perturbations or catastrophes, is provided (GUALDI et al., 2001).

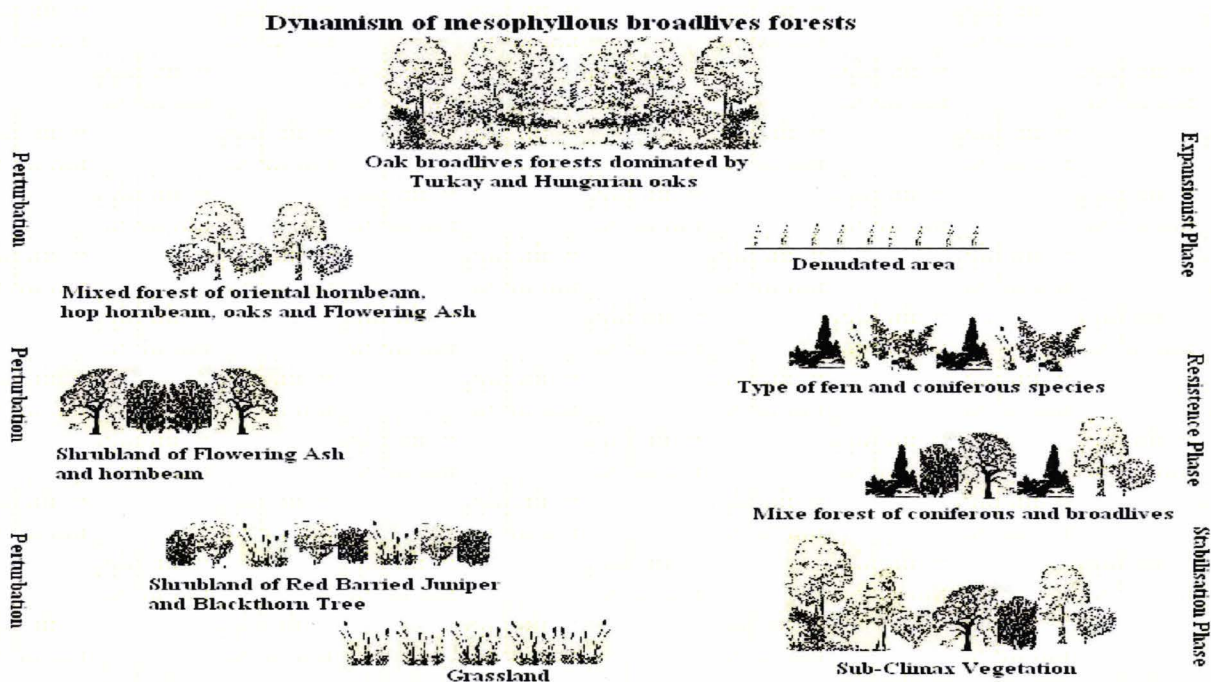


Figure 9. Dynamic stages of thermophyllous broadleaves forests.  
Figura 9. Stadiile dinamice ale pădurilor de foioase termofile.

Evaluation of the biodiversity

A. External factors

The target system of the external factors for the biodiversity is standardized. Although the classification of the factors was based on the means-to-objective relationships, possible interdependencies among the factors were examined during the evaluation procedure to avoid double evaluation. The possible values of each factor are classified into 4 categories and a quality of 1, 2, 3, and 4 is assigned to each category. This classification is rather empirical and resulted after consultation of the specialists and biodiversity experts. Values are assigned to the lower level factors, indicated with two-digit codes in table (e.g. [2.1], [2.2]...). The quality of the next level factors as well as the function class is calculated in succession, by combining the qualities with relative weights of the factors. The relative weights ( $c_i$ ) of the lower level factors are used for the calculation of the quality of the factors in the next level, while the relative weights ( $P_i$ ) of the higher level are used for the calculation of the biodiversity class.

Table 1. Evaluation of external factors of biodiversity per *Querco-frainetum cerris*.  
Tabel 1. Evaluarea factorilor externi de biodiversitate la *Querco-frainetum cerris*.

	ci	pi	ci*pi	Ci	Pi	Ci*Pi
[1]. Rock (Rock Formation	Sum	100	300	3	8.75	26.25
[1.1] Mother rock	3	100	300			
[2] Soil	Sum	100	273.05	2.731	20.25	55.2926
[21] Soil type	2	32.25	64.5			
[22] Soil structure	4	18.55	74.2			
[23] Soil deep	2	13.25	26.5			
[24] Humus content	3	15.15	45.45			
[25] Soil moisture	3	12.35	37.05			
[26] Soil compactness	3	8.45	25.35			
[3] Clime	Sum	100	269.45	2.695	33.25	89.5921
[31] Dry period	2	15.35	30.7			
[32] Vegetation period	3	45.3	135.9			
[33] Average temperature	3	24.15	72.45			
[34] Annual precipitation	2	15.2	30.4			
[4] Landscape	Sum	100	300	3	14.25	42.75
[41] Phyto-climatic zone	3	47.85	143.55			
[42] Structure of soil cover	3	27.5	82.5			
[43] Altitude	3	24.65	73.95			
[5] Land use	2	100	200	2	23.5	47
					100	260.885
$C = \sum Ci*Pi / 100 = 2.61 = 3$						

B. Internal factors of the biodiversity

The evaluation of the factors within each evaluation unit, by the help of the key in table 2, was done in a similar way to the external factors. The calculations are presented in table 3. What was stated for the relative weights in external factors stands also for the weights of the internal one.

Table 2. Evaluation of internal factors per *Quercetum frainetto-cerris*.  
Tabel 2. Evaluarea factorilor interni la *Quercetum frainetto-cerris*.

	ci	pi	ci*pi	Ci	Pi	Ci*Pi
[1] Structure of soil cover	Sum	100	200	2	11.86	23.72
[11] % of forest cover	2	56.5	113			
[12] Soil cover in non forest zones	2	43.5	87			
[2] Forest structure		100	186.8	1.87	17.65	32.97
[21] Structure type	2	34.7	69.4			
[22] Type (species composition)	2	15.56	31.12			
[23] Cover closure	2	12.34	24.68			
[24] Dynamic stage	2	24.2	48.4			
[25] Vertical structure	1	13.2	13.2			
[3] Surface cover	Sum	100	214.5	2.15	13.22	28.36

[31] Shrub /density of regeneration	3	57.25	171.8						
[32] Grass cover	1	27.89	27.89						
[33] Deed biomass	1	14.86	14.86						
[4] Management	Suma	100	300	3	34.73	104.2			
[41] Management system	3	100	300						
[5] Harvesting conditions	Sum	100	200				2	22.54	45.08
[51] Perturbation	2	100	200						
[1] Specific Biodiversity	Sum	100	210.68	2.107	35.61	75.023			
[11] Species richness	3	45.67	137.01						
[12] Family richness	2	6.89	13.78						
[13] Biologic spectrum	2	4.74	9.48						
[14] Chorological spectrum	2	7.71	15.42						
[15] Endemic status	1	22.43	22.43						
[16] Endangerment status	1	12.56	12.56						
[2] Ecologic Diversity	Shuma	100	204.42	2.044	44.87	91.723			
[21] Provenience	2	30.67	61.34						
[22] Origin	1	12.03	12.03						
[23] Rarity	2	17.15	34.3						
[24] Regeneration scale	3	3.36	10.08						
[25] Representativeness	1	7.53	7.53						
[26] Esthetic value	2	8.76	17.52						
[27] Shannon Index	3	20.54	61.62						
[3] Special Factors	Shuma	100	142.24				1.422	19.52	27.765
[31] Scientific Value	1	25.64	25.64						
[32] Medicinal plants	2	42.24	84.48						
[33] Recreative functions	1	32.12	32.12						
				100	211.51				
C = ΣCi*Pi / 100 = 2.11 = 2									

As the conclusion, an average value per external, internal of biodiversity factors and per each vegetation type will be given. In this way we are able to distinguish in a comparative way the biodiversity value per each vegetation type and, as the result, hot spot, worming spot and could spot identification. (See table below)

Table 3. Overall evaluation of the biodiversity.  
Tabel 3. Evaluarea generală a biodiversității.

Associations	Extrenal factors	Biodiversity values	Level of Biodiversity
Corylo-Carpinetum	2.61	2.416666667	2
Fraxino-Carpinetum	2.86	2.4	3
Pruno-Juniperetum	2.03	1.76	2
Quercetum frainetto-cerris	2.64	2.2	2
Ostryo-Carpinetum	2.5	2.4	2
Querco-Castanetum	2.56	2.2	3

## CONCLUSIONS AND RECOMANDATIONS

Thermphyllous broadleaves forests of DNP, should be considered as an important part in terms of biodiversity, specific and ecologic so far.

Based on the statistical analyse (Juice 6.4), ecological biodiversity is rather rich, consisting of 5 associations, from which *Querco-Castanetum submediterraneum* Wraber 54, and *Fraxino-Carpinetum orientalis* must to be considered as "hot spot".

Comparing values of the biodiversity per each vegetation association, in general the level of the biodiversity rather potentially high is actually low because the unsustainable use of nature resources on the past as Wild fire, over grazing and intensive harvesting.



The intervention to regenerate the biodiversity is cost effectiveness particularly in *Fraxino-Carpinetum orientalis*, *Quercetum frainetto-cerris* OBERD. 48 et HORVAT 59, and *Querco-Castanetum submediterraneum* WRABER 54.

Dissemination of the results of this study would lead to strengthening the public awareness in protection and rehabilitation of the biodiversity and participatory on decision making process.

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SEASONAL NUMERICAL DYNAMICS OF THE GASTROPODA POPULATIONS FROM AN EUTROPHIC LACUSTRINE ECOSYSTEM (CASE STUDY)

OLIVIA CIOBOIU

**Abstract.** The present paper renders the results of the research regarding the seasonal numerical dynamics of the Gastropoda populations from Cilieni pool. There are emphasized the date referring to the numerical and percentage distribution of the species, the individuals' number from the seasonally drawn samples, the dimensional values for the pre-productive, productive, and post-productive age categories.

**Keywords:** gastropods, seasonal dynamics.

**Rezumat.** Dinamica numerică sezonală a populațiilor de gastropode dintr-un ecosistem lacustru eutrof (Studiu de caz). În lucrare sunt prezentate rezultatele cercetărilor cu privire la dinamica numerică sezonală a populațiilor de gastropode din balta Cilieni. Sunt precizate datele referitoare la distribuția numerică și procentuală a speciilor, numărul de exemplare din probe prelevate sezonal, valorile dimensionale pentru categoriile de vârstă prerreproducătoare, reproducătoare și postreproducătoare.

**Cuvinte cheie:** gastropode, dinamică sezonală.

INTRODUCTION

The research took place within Cilieni Pool (Fig. 1). It makes part of the category of eutrophic ecosystems due to the high biological production of the macrophytes primary producers, as well as that of the phytoplankton, zooplankton, and zoobenthos (CIOBOIU, 2007). The Gastropoda populations represent an important group for the biological production of the pool.

From the ecological point of view, it is well known the fact that the presence of different species is closely related to the structural features of the ecosystems. Cilieni pool is representative especially due to the fact that macrophytes represent the dominant element. This is a major factor that explains the presence of phytophilous species (Fig. 2).

MATERIAL AND METHOD

In order to establish the seasonal numerical dynamics, there have been collected gastropods in three characteristic stages: spring, summer, and autumn. We have determined the species and established the morphometrical features (dimensions: h, w).

The Seasonal Numerical Dynamics

The structure of Gastropoda populations reveals the fact that the dominant species are the following ones: *Viviparus acerosus*, *Physella (Costatella) acuta*, *Radix balthica*, *Lymnaea stagnalis*, *Planorbis planorbis*, *Planorbarius corneus* (CIOBOIU 2002, GROSSU 1993). The ratio between groups and species proves that the families *Thiaridae*, *Physidae*, *Lymnaeidae*, *Planorbidae* hold the highest number of species (Table 1).

Table 1. The numerical and percentage distribution of the species in families.  
Tabel 1. Distribuția numerică și procentuală a speciilor pe familii.

Family	Number of species	%
<i>Viviparidae</i>	1	10
<i>Valvatidae</i>	1	10
<i>Thiaridae</i>	2	20
<i>Physidae</i>	2	20
<i>Lymnaeidae</i>	2	20
<i>Planorbidae</i>	2	20

By analysing the seasonal numerical distribution, it results that the greatest number of individuals is registered by the species *Viviparus acerosus* – 189 individuals in spring, 87 in summer, and 72 in autumn. All the other species display the same dynamics of the individuals' number, namely the greatest numerical densities are registered in spring (Table 2).

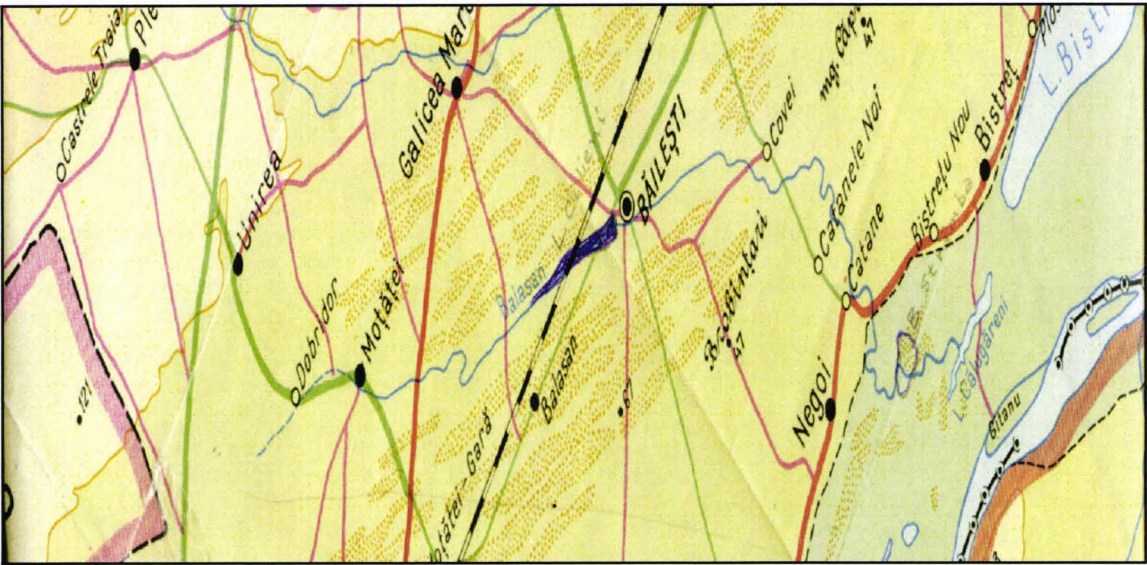


Figure 1. The location of the Cilieni pool.  
Figura 1. Localizarea bălții Cilieni.



Figure 2. Large surfaces covered by macrophytes.  
Figura 2. Suprafețe mari acoperite cu macrofite.

Table 2. The seasonal numerical dynamics of the Gastropoda populations from Cilieni pool.  
Tabel 2. Dinamica numerică sezonală a populațiilor de gastropode din balta Cilieni.

Species	Number of individuals / season		
	Spring	Summer	Autumn
<i>Viviparus acerosus</i>	189	87	72
<i>Physella (Costatella) acuta</i>	114	37	27
<i>Lymnaea stagnalis</i>	110	35	25
<i>Planorbarius corneus</i>	105	30	22
<i>Radix balthica</i>	100	26	17
<i>Planorbis planorbis</i>	10	25	20
<i>Physa fontinalis</i>	6	5	-
<i>Valvata (Cincina) piscinalis</i>	17	3	-
<i>Esperiana esperi</i>	3	8	-
<i>Esperiana (Microcolpia) daudebardii acicularis</i>	10	6	-

A significant fact of the seasonal numerical density is that the species *Physa fontinalis*, *Valvata (Cincina) piscinalis*, *Esperiana esperi*, *Esperiana (Microcolpia) daudebardii acicularis* were not registered in autumn. It is also worth mentioning that, generally, all the other species register the greatest number of individuals in autumn.

The largest number of individuals registered in spring may be explained by the fact that this is the characteristic period for reproduction, which is also reflected by the dimensional values for different age categories (Table 3).

Table 3. Dimensional values for different age categories at the Gastropoda populations from Cilieni pool.  
Tabel 3. Valorile dimensionale pentru diferite categorii de vârstă la populațiile de gasteropode din balta Cilieni.

Species	The characteristic dimensions of different age categories (h, w = mm)		
	Pre-productive	Productive	Post-productive
<i>Viviparus acerosus</i>	h = 10 - 20 l = 7 - 15	h = 20.1 - 40 l = 15.1 - 30	h = more than 40 l = more than 30
<i>Valvata (Cincina) piscinalis</i>	h = 1.5 - 5 l = 1 - 3	h = 5.1 - 8 l = 3.1 - 5	h = more than 8 l = more than 5
<i>Esperiana esperi</i>	h = 0.1 - 10 l = 0.1 - 5	h = 10.1 - 18 l = 5.1 - 8	h = more than 18 l = more than 8
<i>Esperiana (Microcolpia) daudebardii acicularis</i>	h = 0.1 - 10 l = 0.1 - 3	h = 10.1 - 17 l = 3.1 - 6	h = more than 17 l = more than 6
<i>Physa fontinalis</i>	h = 0.1 - 5 l = 0.1 - 3	h = 5.1 - 9 l = 3.1 - 7.5	h = more than 9 l = more than 7.5
<i>Physella (Costatella) acuta</i>	h = 0.1 - 5 l = 0.1 - 4	h = 5.1 - 11 l = 4.1 - 6	h = more than 11 l = more than 6
<i>Lymnaea stagnalis</i>	h = 10 - 25 l = 70 - 10	h = 25.1 - 50 l = 10.1 - 25	h = more than 50 l = more than 25
<i>Radix balthica</i>	h = 0.1 - 15 l = 0.1 - 10	h = 15.1 - 21 l = 10.1 - 15	h = more than 21 l = more than 15
<i>Planorbis planorbis</i>	h = 0.1 - 1.5 l = 0.1 - 9	h = 1.6 - 3.5 l = 9.1 - 17	h = more than 3.5 l = more than 17
<i>Planorbarius corneus</i>	h = 1.5 - 5 l = 3 - 7	h = 5.1 - 11 l = 7.1 - 20	h = more than 11 l = more than 20

The lower values of the individuals' number registered in summer and especially in autumn for all the species are induced by the fact that the senescent samples disappeared, thus the young and adult individuals predominating (CIOBOIU, 2006, NEGREA, 1971).

## CONCLUSIONS

According to the seasonal numerical dynamics we underline that the greatest number of individuals is registered by the species *Viviparus acerosus*. The greatest numerical densities are registered in spring, when the reproduction process takes place. The lower values characteristic for summer and autumn are mainly induced by the disappearance of the senescent individuals.

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## ASSESSMENT AND PROTECTION OF THE AQUATIC BIRD SPECIES WITH UNFAVOURABLE PRESERVATION STATUS, WHICH ARE PRESENT IN THE NATURA 2000 SITE BISTREȚ (DOLJ COUNTY)

MIRELA SABINA RIDICHE, MIHAELA LICURICI

**Abstract.** *The present study deals with the results of the monitoring of the water bird species that are preserved within the Natura 2000 Site Bistreț; the work was supported by data from our own observations, conducted between 2004 and 2009, which permitted the formulation of certain conclusions regarding the dynamics of the bird populations and the influence of the environmental conditions on the intensity of the passage and/or of the nesting of the water species. At the same time, our research allowed for the elaboration of the protection measures, taking into account the factors that threaten each and every species. The paper may represent a reference point in the demarche for the sustainable management of the Bistreț agro-piscicultural reservoir, which received the status of Special Protection Area (SPA) in 2007, the Museum of Oltenia being its custodian.*

**Keywords:** *assessment, conservation, aquatic birds, Bistreț.*

**Rezumat. Evaluarea și protecția speciilor de păsări acvatice cu statut de conservare nefavorabil prezente în situl Natura 2000 Bistreț (județul Dolj).** *Studiul de față prezintă rezultatele monitorizării speciilor de păsări acvatice care fac obiectul conservării în situl Natura 2000 Bistreț; ca suport de lucru s-au folosit datele observațiilor proprii, efectuate în anii 2004-2009, care ne-au permis formularea unor concluzii privind dinamica efectivelor de păsări și influența condițiilor de mediu asupra intensității pasajului și/sau cuibăritului speciilor acvatice, pe de o parte, iar pe de altă parte elaborarea măsurilor de protecție în raport cu factorii de amenințare ai fiecărei specii. Lucrarea poate fi un reper pentru demersurile unui management durabil al acumulării agropiscicole Bistreț, desemnată în anul 2007 ca Arie de Protecție Specială Avifaunistică (SPA), pentru care Muzeul Olteniei a fost desemnat custode.*

**Cuvinte cheie:** *evaluare, conservare, păsări acvatice, Bistreț.*

### INTRODUCTION

Bistreț Lake, located in the Danube Floodplain, near the settlements of Cârna, Plosca and Bistreț, represents both an economic objective that is appreciated for fish farming and a scientific objective of ornithological interest, the Museum of Oltenia, based in Craiova, being its custodian since July 10<sup>th</sup> 2008. The ornithological importance of Bistreț Lake is explained by the presence, in this area, of a great number of birds (more than 20,000 during the spring and autumn migration periods), while some of the bird species are endangered, rare or vulnerable in Romania, as well as at global scale (HAGEMEIJER & BLAIR, 1997; MUNTEANU 2009). Some of these species (*Pelecanus onocrotalus*, *P. crispus*, *Egretta alba*, *E. garzetta*, *Platalea leucorodia*, *Tadorna tadorna*, *Recurvirostra avosetta*, *Himantopus himantopus*) have the status of Nature Monuments and are included on the Red List of Vertebrates in Romania (BOTNARIUC & TATOLE, 2005).

Given the fact that many of the birds recorded within the Bistreț wetlands are included in the Annex I of the EU Birds Directive, in 2007 Bistreț Lake was integrated in the Natura 2000 ecological network, with the status of Special Protection Area (SPA) (code ROSPA0010 Bistreț), according to the Governmental Decision no. 1284/ 24. X. 2007.

The avifaunistic importance of Bistreț Lake was intensely mediated and underlined in various national and international publications and by many specialists (HEATH & EVANS, 2000; MUNTEANU, 2004; RIDICHE, RIDICHE et al. 2004-2009; TÂLPEANU, 1963 and others).

### MATERIAL AND METHODS

The present study includes the results of our own observations, conducted within the Bistreț site mainly during the last five years, respectively between 2004 and 2009, the time period being marked by certain hydro-climatic extreme phenomena (abundant rainfalls, floods, prolonged drought) and, implicitly, by changes of the aquatic ecosystems under study.

The main materials used to identify and document the bird species were the binocular (Zeiss Jena 10x50 and Bushnell 12x40), the catalogues for determining birds (BRUUN, 1999, PETERSON et. al., 1988) and the photo camera (Sony 15 x).

The quantitative and qualitative observations regarding the bird species and populations were done in all ecological aspects of the year, in two ways:

- The observation from a fixed point: it was mainly conducted from the high points (observatory, protection dams) and near the feeding, roosting or station places of the birds. This method allowed for the achievement of certain conclusions regarding the qualitative and quantitative aspects of populations, their dynamics, the intensity of the passage, the influence of the biotope conditions on the passage and/or on the nesting etc.



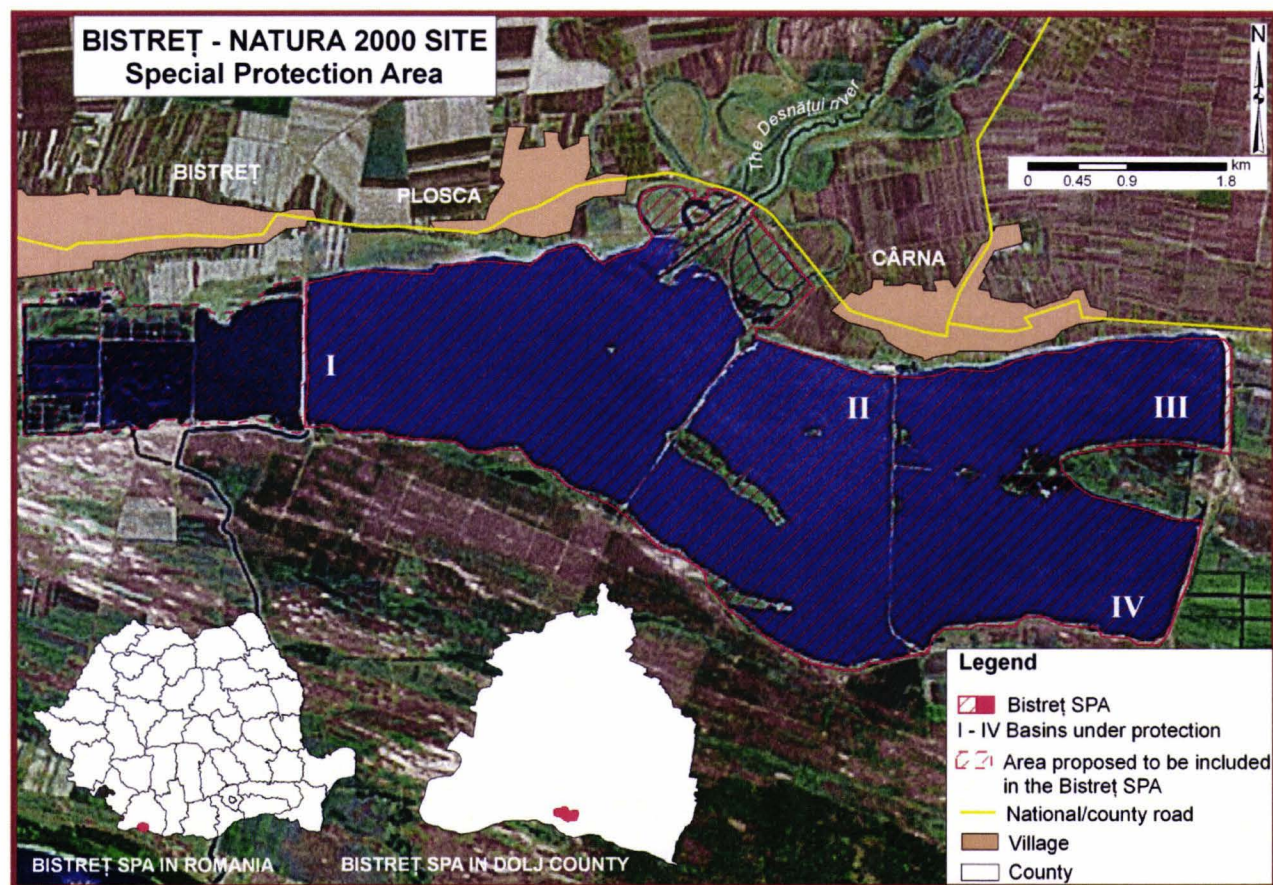
- The observation in movement, on routes beforehand established: the itinerary was respected during each observation route; all species observed along the route were recorded, this allowing for the achievement of a situation regarding the frequency of their observation.

Some of the results of our research were obtained during the implementation of the scientific project *Managing a NATURA 2000 site – Elaboration of the conservation measures for the Special Protection Area (SPA) Bistreț*, to which we participated as partners, under the coordination of L. Gheorghe – main counsellor at the Romanian Ministry of Environment and Sustainable Development (2008). The project was conducted between March and September 2008 and it was financed by the Alfred Toepfer Foundation and the German Environment Foundation Deutsche Bundesstiftung Umwelt (DBU), in the framework of the NatuRegio Programme – *Nature conservation and regional development in South East Europe*.

## RESULTS AND DISCUSSIONS

The present study discusses only the aquatic bird species that are the object of conservation in the Natura 2000 sites, in accordance with the Birds Directive of EEC 79/409.

Following the field investigation, it is necessary to mention the fact that, although only the basins 1-4 (surface 1,915 ha) are included in the Bistreț site, the western parts of the lake, which functioned a long time, until 2006, as special ponds for fingerling (surface of about 315 ha) within the agro-piscicultural farm Bistreț-Cârna, represent highly attractive points for the aquatic avifauna (Map 1).



Map. 1. Bistreț Special Protection Area (Background Image-Landsat7).

Harta 1. Bistreț, Arie de protecție specială avifaunistică.

During the last years, respectively after the big flash flood of the Danube from the spring of 2006, when an important surface of the Danube Floodplain was covered by water after the collapse of the protection dams in Rast (Dolj County) area, it is to be noticed a spectacular vegetation regeneration on the eastern and western basins of the lake, which, together with the debouching area of the Desnățui river, represent the key-points for the concentration of the aquatic bird populations. This vegetation recovery (spreading of the aquatic macrophytes: *Typha* sp., *Scirpus* sp., *Salix* sp.), which is mainly caused by the lack of interest from the part of the administration of the lake, with regard to the management of the basins, led to an increase in the population of certain bird species (Fam. Ardeidae, Fam. Threskiornithidae, Fam. Anatidae), which had been rather limited until 2006.

We present some details regarding the biology, ecology and distribution of the recorded species in the site, as well as the situation concerning their number and protection (threatening factors, conservation measures).

***Phalacrocorax pygmaeus* (PALLAS, 1773) - Pygmy Cormorant**

**Taxonomical classification:** Order Pelecaniformes, Family Phalacrocoracidae

**Biology, ecology and situation of the species**

It is a Sarmatic type of species, frequent in the Bistreț site mainly between April and October in populations that oscillate, depending on the season, from a few individuals (7-20) up to a couple of hundreds (+ 500); the highest density is registered in the passage period.

Within the precincts of the Bistreț SPA, there are nesting conditions in the basin 3 (abundant swamp macrophytes in the north-eastern part of the lake), but there are no proofs concerning the reproduction of the species within the site.

**Threat status:** species that is vulnerable at national and European level.

**Factors of potential threat:** the drainage of the ponds, the cutting of the willows, the burning of the reed, the control campaigns against the fish-eating birds, the accidental catching in the fishing nets.

**Proposed conservation measures:** to maintain an optimal hydrological level of the lake, to preserve the refuge points of the species within the precincts of the site (willows, reed plots, osier plots), to properly manage the area in order to increase the food resources, to maintain the water quality.

***Pelecanus onocrotalus* LINNAEUS, 1758 - White Pelican**

**Taxonomical classification:** Order Pelecaniformes, Family Pelecanidae

**Biology, ecology and situation of the species**

It is a Sarmatic type of species, recorded in the basins with extensive water surfaces, especially during the summer, when the water level is low; small groups can be also seen during the spring – autumn passage period. The populations vary (2 minimum, 70-80 maximum), being frequently associated with the Dalmatian Pelican. The juvenile individuals that accompany the adult birds, which travel to find food, prevail in the populations registered by us.

**Threat status:** species that is vulnerable in Romania and at European level; in our country, it was declared Nature Monument.

**Factors of potential threat:** the inappropriate hydrological regime, the diminution of the trophic resources, the control campaigns against the fish-eating birds in the fishery.

**Proposed conservation measures:** to preserve the lake, to maintain the piscicultural fund of the basins, to properly manage the basins that bear piscicultural exploitation in order to increase the trophic resources, to maintain the optimum level and the quality of the waters, to strictly follow the protectionist legislation.

***Pelecanus crispus* BRUCH, 1832 - Dalmatian Pelican**

**Taxonomical classification:** Order Pelecaniformes, Family Pelecanidae

**Biology, ecology and situation of the species**

It is a Sarmatic type of species, which was observed in the Bistreț site between March and October; the populations annually registered oscillate (minimum 2 and maximum 300 birds), depending on the hydro-climatic and food conditions.

Part of the birds (both adult and juvenile) that travel to find food in this area, may have their nesting places in Bulgaria, in the Srebarna Reserve (44° 06' N 27° 04' E), the proof being represented by a blue plastic ring taken from a juvenile individual; the ring had the code 55EJ and was put up in the cub phase, at the nest, in the above mentioned reserve.

**Threat status:** species that is critically endangered at national level, declared Nature Monument; at European level it is a vulnerable species.

**Factors of potential threat:** the inappropriate hydrological regime of the basins, the diminution of the trophic resources, the control campaigns against the fish-eating birds in the fishery.

**Proposed conservation measures:** to preserve the lake, to maintain the piscicultural fund of the basins, to properly manage the basins that bear piscicultural exploitation in order to enrich the trophic resources, to maintain the water quality, to strictly observe the protectionist legislation.

***Ixobrychus minutus* (LINNAEUS, 1758) - Little Bittern**

**Taxonomical classification:** Order Ciconiiformes, Family Ardeidae

**Biology, ecology and situation of the species**

This species is native to the Old World, being a summer visitor (between April and September/October) in the Bistreț site; it is assumed that the species nests in isolated pairs, in the reed/osier plots of the eastern basins (2 and 3) and/or at the western end of the lake; the population of the species is uncertain because of its hidden existence and it varies in dependence with the conditions offered by the habitat.

**Threat status:** species that is vulnerable in all Europe.

**Factors of potential threat:** the cutting and burning of the reed and/or the osier, the flooding of the nesting areas, the fishing around the nesting places.

**Proposed conservation measures:** to maintain the reed screens within the precincts of the site, to control the hydrological level of the basins, to interdict the fishing activities during summer in the places that are favourable to nesting.

*Nycticorax nycticorax* (LINNAEUS, 1758) - Night Heron**Taxonomical classification:** Order Ciconiiformes, Family Ardeidae**Biology, ecology and situation of the species**

It is a cosmopolitan species and a summer visitor (between March and September/October) in the area under study; during the last years, it has been mostly registered in the basin 3 of the lake, which is rich in wooden aquatic vegetation. The populations registered around 120-150 individuals.

**Threat status:** species that is vulnerable in Romania and declining at European level.

**Factors of potential threat:** the cutting of the wood vegetation, the degradation of the aquatic environment (eutrophication and/or clogging of the basins).

**Proposed conservation measures:** to achieve and maintain the protection forests and the reed screens inside or on the margins of the basins, as well as along the dams, to maintain an appropriate water level in the basins.

*Ardeola ralloides* (SCOPOLI, 1769) - Squacco Heron**Taxonomical classification:** Order Ciconiiformes, Family Ardeidae**Biology, ecology and situation of the species**

This is a species of Ethiopian type and a summer visitor (between April and September-October) in the Bistret wet area. During the last two years, between 5 and 20 individuals have been constantly observed in the area of the western basins; the population might be more important and it might extend towards the eastern basins (2 and 3), where there are favourable breeding conditions (rich vegetation and shallow water), but the information is uncertain because of the hidden existence of the species.

**Threat status:** species that is vulnerable at national and European level.

**Factors of potential threat:** the cutting and burning of the reed and of the cane, the flooding of the nesting areas, the fishing near the places that are favourable to nesting.

**Proposed conservation measures:** to maintain the reed screens within the precincts of the site, to control the hydrological level of the basins, to prohibit the fishing during summer, in the places where the nesting of this species is possible.

*Egretta garzetta* (LINNAEUS, 1766) - Little Egret**Taxonomical classification:** Order Ciconiiformes, Family Ardeidae**Biology, ecology and situation of the species**

The species is native to the Old World and it is a summer visitor (from April to September) in the Bistret wet area, where there is to be noticed an increase in its population; thus, in the summer of 2008, the population was estimated at more than 150 individuals, most of them being concentrated in the eastern part of the lake (basin 3), as well as in the western basins that are not included in the site. Although the proof that the nesting occurs here does not exist yet, it is to be noticed that the basins 3 and 2, with shallow water and with dense aquatic macrophytes, present favourable conditions for the reproduction of the species.

**Threat status:** the species is endangered at national level and it is declared Nature Monument.

**Factors of potential threat:** the increase of the water level in the basins, the burning or the cutting of the swamp macrophytes.

**Proposed conservation measures:** to protect the species and the habitats that it prefers, to maintain an optimal water level.

*Egretta alba* (LINNAEUS, 1758) - Great White Egret**Taxonomical classification:** Order Ciconiiformes, Family Ardeidae**Biology, ecology and situation of the species**

It is a cosmopolitan species and it has been recorded only in passage and rarely as isolated individuals during winter. The number of birds recorded in the Bistret site, as well as beyond its limits, varies (from minimum 3 to maximum 55 individuals), depending on the breeding conditions.

**Threat status:** the species is endangered at national level and it is declared Nature Monument.

**Factors of potential threat:** the limitation and the degradation of the aquatic habitats.

**Proposed conservation measures:** to follow the legislation, to maintain the natural conditions of the wetlands under research.

*Ardea purpurea* LINNAEUS, 1766 - Purple Heron**Taxonomical classification:** Order Ciconiiformes, Family Ardeidae**Biology, ecology and situation of the species**

It is a species of Turkestan-Mediterranean type and a summer visitor (from April to September); in 2001, on Bistret lake there was discovered a colony made up 35 pairs that had their nest in the aquatic macrophytes (osier plots) from the island located on the basin 1; during the last years (i.e. after the 2006 spring floods), the species was relatively rarely recorded and as isolated individuals, the nesting activity being uncertain at present.

**Threat status:** the species is endangered in Romania and vulnerable at European level.

**Factors of potential threat:** the cutting and burning of the reed and osier, the flooding of the nesting areas, the fishing near the nesting places.



Proposed conservation measures: to preserve the aquatic macrophytes from the precincts of the site, to control the hydrological level of the basins, to prohibit the drainage or of the fishing during summer, in the places where nesting colonies may be installed.

***Ciconia nigra* (LINNAEUS, 1758) - Black Stork**

**Taxonomical classification**: Order Ciconiiformes, Family Ciconiidae

**Biology, ecology and situation of the species**

It is a species of Palearctic type and it was recorded in passage (from July to August) in the western part of the lake, in small number of individuals (1 to 7).

In 1981, there appeared mentions of the Black Stork nesting in Braniște forest, which is located about 3 kilometres north of the Bistreț SPA, but we do not have recent proofs of the nesting activity near the site.

Threat status: the species is vulnerable in Romania and rare at European level.

Factors of potential threat: the disturbance of the nesting places, the cutting of the old trees on which nests are installed, the excessive human-induced transformations of the wet areas and of their surroundings.

Proposed conservation measures: to keep silence in the nesting area, to avoid cutting the trees on which nests are placed, to maintain the natural conditions of the wetlands.

***Ciconia ciconia* (LINNAEUS, 1758) - White Stork**

**Taxonomical classification**: Order Ciconiiformes, Family Ciconiidae

**Biology, ecology and situation of the species**

It is a species of Palearctic type and a summer visitor (from March/April to October). The White Stork nests on the concrete pillars of the low tension power networks, in the settlements located near the Bistreț site; although some of the nests were destroyed, their number is still important, so that the species registers an increase of its population.

Threat status: the species is vulnerable both at national and European level.

Factors of potential threat: the deliberate destruction of the nests by the inhabitants, the ingestion of pesticides or other toxic substances with the food.

Proposed conservation measures: to protect the nests, to avoid the use and the abandonment of toxic substances on the agricultural fields or in the aquatic basins.

***Plegadis falcinellus* (LINNAEUS, 1766) - Glossy Ibis**

**Taxonomical classification**: Order Ciconiiformes, Family Threskiornithidae

**Biology, ecology and situation of the species**

It is an Old World type of species and it was observed in the Bistreț wetlands only towards the end of the summer season (from July to August), probably travelling to find food; the number of individuals that were recorded varies between 7 and 11.

Threat status: the species is vulnerable in Romania and rare at European level.

Factors of potential threat: the human activities (disturbing activities, water pollution, cutting the aquatic macrophytes), which lead to the degradation and limitation of the habitats preferred by the species.

Proposed conservation measures: to maintain conditions that are close to the natural ones in the aquatic habitats.

***Platalea leucorodia* LINNAEUS, 1758 - Spoonbill**

**Taxonomical classification**: Order Ciconiiformes, Family Threskiornithidae

**Biology, ecology and situation of the species**

It is a Sarmatic type of species and it was recorded as a passage species in the Bistreț SPA. The most important populations were registered in July-August 2007, September 2008, July 2009 (80-150 individuals), being concentrated on the basin 1, 3 and on the western basins of the lake (outside the site). During the spring passage, when the hydrological level of the lake was higher, the Common Spoonbill was recorded in small number of individuals (4 to 8). The high number of birds recorded at the end of the summer is explained by the food resources availability in the basins with oozy muddy bottom and low water level.

Threat status: the species is endangered at national level and it was declared Nature Monument; at European level is also endangered.

Factors of potential threat: the reduction of food accessibility, as a consequence of water level increase.

Proposed conservation measures: to preserve the aquatic ecosystems, to maintain an optimum hydrological level in the basins, to protect the species.

***Cygnus cygnus* (LINNAEUS, 1758) - Whooper Swan**

**Taxonomical classification**: Order Anseriformes, Family Anatidae

**Biology, ecology and situation of the species**

It is a Palearctic type of species, being a winter guest or a passage species (from December to March) that frequently passes through the researched area or it even stops in relatively low number of individuals (from minimum 2 to maximum 15-18 individuals, both adults and juvenile) on Bistreț lake and at the mouth of the Desnățui river.

Threat status: the species is safe at European level (least concern category of risk).

Factors of potential threat: the limitation and change of the aquatic habitats, the poaching.

Proposed conservation measures: to maintain the natural conditions of the wetlands, to respect the protectionist laws.

***Anser erythropus* (LINNAEUS, 1758) - Lesser White-fronted Goose****Taxonomical classification:** Order Anseriformes, Family Anatidae**Biology, ecology and situation of the species**

It is a Palearctic type of species and a winter visitor (from December to March). The number of individuals that are in transit in the area under research or stop on the grassland near the Desnățui river and in the surroundings of the aquatic basins is uncertain (minimum 12-25 individuals), the difficulty being even greater as the species is frequently present together with the White-fronted Goose.

**Threat status:** the species is critically endangered in Romania and in Europe.

**Factors of potential threat:** the deliberate or accidental shutting, the diminution of the trophic resources in the passage or wintering areas.

**Proposed conservation measures:** to avoid shutting them while hunting Geese/White-fronted Geese, to inform the population living in the areas transited by the species or where the species is stationary.

***Branta ruficollis* (PALLAS, 1769) - Red-breasted Goose****Taxonomical classification:** Order Anseriformes, Family Anatidae**Biology, ecology and situation of the species**

It is an Arctic type of species, winter visitor (from November to March). We did not collect data on this species, but the birds captured by the hunters in the Bistreț wet area and naturalized at the Museum of Oltenia prove the presence of the species on this area. The field survey showed that some individuals had been observed on the fields near the lake, in mixed populations, together with other species of Geese or White-fronted Geese.

**Threat status:** the species is endangered in Romania and in Europe.

**Factors of potential threat:** the poaching, the food resources lack or are insufficient.

**Proposed conservation measures:** to penalize the poaching, to inform the population with regard to the statute and the protection of this species.

***Tadorna tadorna* (LINNAEUS, 1758) - Common Shelduck****Taxonomical classification:** Order Anseriformes, Family Anatidae**Biology, ecology and situation of the species**

It is a Sarmatic type of species and it was observed during winter, as well as in passage (from January to March), on Bistreț lakeside and at the mouth of the Desnățui river, in small groups: 3 birds on January 24<sup>th</sup>, 2004, 2 birds on January 17<sup>th</sup>, 2005, 12 birds on January 16<sup>th</sup>, 2006 and 25 birds on March 20<sup>th</sup>, 2008.

**Threat status:** the species is endangered in Romania, but safe at European level (Least Concern Category of Risk).

**Factors of potential threat:** the poaching, the limitation and change of the aquatic habitats.

**Proposed conservation measures:** to penalize the poaching, to preserve the wet area, to inform the population with regard to the statute and protection of this species.

***Aythya nyroca* (GULDENST, 1769) - Ferruginous Duck****Taxonomical classification:** Order Anseriformes, Family Anatidae**Biology, ecology and situation of the species**

It is a species of Turkestan-Mediterranean type and a summer visitor (from March to October). For the Bistreț site, it can be assessed a constant population of at least 3-5 brooding pairs (with the exception of 2006 and 2007 summers when the swamp vegetation was destroyed as a consequence of the Danube flood). It prefers the eutrophic basins that are rich in swamp vegetation (reed, willow).

**Threat status:** the species is vulnerable in Romania and in Europe.

**Factors of potential threat:** the limitation or depreciation of its nesting habitats.

**Proposed conservation measures:** to preserve the aquatic habitats with swamp vegetation, to severely penalize the poaching.

***Mergus albellus* LINNAEUS, 1758 - Smew****Taxonomical classification:** Order Anseriformes, Family Anatidae**Biology, ecology and situation of the species**

It is a Palearctic type of species and a winter visitor (from November to March), stationary on the lake or on the canals until the appearance of the ice bridge. There are no exact data concerning the population number within the Bistreț site, but the field inquiry shows that it is estimated as relatively small (7 to 30 individuals).

**Threat status:** the species is vulnerable in Romania, as well as in Europe.

**Factors of potential threat:** the limitation and the degradation of the wet areas, the poaching.

**Proposed conservation measures:** to preserve the aquatic habitats which are used in passage or for wintering, to severely penalize the poaching, to follow the present legislation.

***Himantopus himantopus* (LINNAEUS, 1758) - Black-winged Stilt****Taxonomical classification:** Order Charadriiformes, Family Recurvirostridae**Biology, ecology and situation of the species**

It is a species of cosmopolitan type and a summer visitor (from April to September). According to the populations recorded during the last years, there can be noticed a significant increase of the population number in the area under study; this increase went from a few individuals (3-5 pairs) until 2005, up to more than 120 birds during the 2008 passage.



In the Bistreț SPA there are favourable conditions for the species' nesting in the area of the Desnățui river mouth, as well as on the sandbanks located between the eastern basins (3 and 4), but also between the western ones (located outside the limits of the site). The mating behaviour and that connected to the defence of the territory, well expressed at the adult birds that station in the site, prove the nesting activity of the species.

**Threat status:** the species is endangered in Romania and it was declared Nature Monument.

**Factors of potential threat:** the sudden and very important increase of the water level in the nesting areas (caused by natural or artificial factors), the grazing near the water.

**Proposed conservation measures:** to stop the access of the herbivorous domestic animals in the areas where the species nests (using wire fencing, guard, water ditches), to maintain constant water level in the piscicultural basins near which broody pairs are installed during summer.

***Recurvirostra avosetta* LINNAEUS, 1758 - Avocet**

**Taxonomical classification:** Order Charadriiformes, Family Recurvirostridae

**Biology, ecology and situation of the species**

It is a species of Turkestan-Mediterranean type and a summer visitor (between April and October). During the last years, in the Bistreț wet area, the most important populations were registered during April-May 2008 (about 220-250 individuals), but their number faces significant decrease during the summer (30-50 individuals).

The behaviour of certain individuals located in the Bistreț site (basins 1 and 2) during the entire summer season represents a proof of the species' nesting in the precincts of the basins or near them (minimum 6-8 pairs).

**Threat status:** the species is vulnerable at national level and with limited area at European level.

**Factors of potential threat:** the sudden and very important increase of the water level near the nesting areas (caused by natural or artificial factors), the grazing near the water.

**Proposed conservation measures:** to protect the areas where the species nests (by forbidding the grazing, avoiding the flooding of the fields that are near the piscicultural basins, as a consequence of the sudden filling with water).

***Philomachus pugnax* (LINNAEUS, 1758) - Ruff**

**Taxonomical classification:** Order Charadriiformes, Family Scolopacidae

**Biology, ecology and situation of the species**

It is a Palearctic type of species and it is frequent in the Bistreț site during the spring (March-April) and autumn (August/September - October) passages. It is the most numerous species among the waders, the population registering thousands of individuals (compact flocks); during the summer season (May-July), only isolated individuals were observed.

**Threat status:** the species is safe at European level (Least Concern Category of Risk).

**Factors of potential threat:** the important raise of the water level in the stationing areas (caused by natural or artificial factors), the grazing and other disturbing activities on the lakeside or near the basins.

**Proposed conservation measures:** to stop the access of the herbivorous animals and of other disturbing factors in the territories where the birds feed.

***Sterna hirundo* LINNAEUS, 1758 - Common Tern**

**Taxonomical classification:** Order Charadriiformes, Family Sternidae

**Biology, ecology and situation of the species**

It is a species of Holarctic type, more numerous in passage, hundred of individuals being observed both in the precincts of the protected area and outside its limits, i.e. on the western basins and along the drainage canal; during the nesting period, there were registered 80-100 pairs at the most.

In the area under research, the species mainly nests in the western part of the lake, as well as in the debouching area of the Desnățui river, where there are sand islands.

**Threat status:** the species is safe at European level (Least Concern Category of Risk).

**Factors of potential threat:** the limitation and systematization of wet areas, the modernisation of water courses.

**Proposed conservation measures:** to preserve the natural conditions of the wetlands, to prohibit fishing and other disturbing activities in the nesting areas.

***Chlidonias hybridus* (PALLAS, 1776) - Whiskered Tern**

**Taxonomical classification:** Order Charadriiformes, Family Sternidae

**Biology, ecology and situation of the species**

It is an Old World type of species and a summer visitor (April - September) in the Bistreț wet area. During the nesting period, few individuals (20-25) were seen in the site, i.e. on the basins 3 and 2, while outside the protected area, respectively on the western basins of the lake, there were observed more nests colonies, i.e. 50-60 pairs.

**Threat status:** the species faces decline at European level.

**Factors of potential threat:** the systematization and drainage of the wet areas, the modernization of the watercourses.

**Proposed conservation measures:** to preserve the wetlands and the natural conditions in the aquatic habitats, to forbid fishing and other disturbing activities in the territories where the birds nest.

***Chlidonias niger* LINNAEUS, 1758 - Black Tern**

**Taxonomical classification:** Order Charadriiformes, Family Sternidae

**Biology, ecology and situation of the species**

It is a species of Holarctic type and a summer visitor (between April and September), with small populations but with constant presence during the summer. During the 2008 aestival season, in the precincts of Bistret lake, there were observed between 6 and 22 individuals, both within the protected area, as well as beyond its limits, i.e. on the western basins.

**Threat status:** the species faces decline at European level.

**Factors of potential threat:** the modernization of the watercourses, the drainage and the systematization of the wetlands.

**Proposed conservation measures:** to preserve the wetlands and the natural conditions in the aquatic habitats, to forbid the fishing and other disturbing activities in the territories where the birds nest.

***Alcedo atthis* (LINNAEUS, 1758) – Common Kingfisher**

**Taxonomical classification:** Order Charadriiformes, Family Alcedinidae

**Biology, ecology and situation of the species**

It is an Old World type of species, sedentary. In the area under research, the species was rarely recorded, i.e. only one exemplary at a time, flying above the western part of the lake.

Nests belonging to the Common Kingfisher were observed in the holes carved in the banks of certain evacuation canals from the Bistret wet area, but some of them were damaged during the 2006 spring floods.

**Threat status:** the species faces decline at European level.

**Factors of potential threat:** the bank-sloping, the water pollution.

**Proposed conservation measures:** to preserve the habitats that are favourable to the nesting of the species, to maintain the proper water quality, that, in its turn, ensures the trophic resources.

The analysis of the quantitative and qualitative distribution of the bird species that are protected according to the EEC Birds Directive shows that some of them extend their specific spreading area for feeding and nesting beyond the limits of the Bistret SPA, i.e. on the western basins of the lake; thus, we propose that the limits of the site be reconsidered, so that this area could be also put under protection (Map 1).

Moreover, we suggest that the standard record of the Bistret site be supplemented with the species *Philomachus pugnax*, *Sterna hirundo*, *Chlidonias hybridus*, *C. niger*, which are well represented in the precincts of the site and near it.

## CONCLUSIONS

The paper deals with data related to the biology, ecology and distribution of the aquatic bird species from the Bistret area that are protected through the ECC Birds Directive and with bird population assessments, which depend on the seasonal dynamics and on the biotope conditions. Moreover, there are presented specific factors of threat and there are proposed certain measures for the conservation of the species and of the habitats; these measures can be included in the management plan of the site and, subsequently, they can be materialized.

The knowledge concerning the bird spectrum and the concentration areas that are important for the feeding, roosting and nesting of the aquatic species fundamentals our proposal regarding the reconsideration of the limits of the Special Protection Area for birds, so that it would include the basins located towards the western neighbourhood of the site (about 315 ha); at the same time, we insist on the update on the standard record of the site, so that it would correspond with the real field situation.

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## DISTRIBUTION AND DIVERSITY OF BATS' SPECIES FROM POLOVRAGI CAVE (CĂPĂȚÂNII MOUNTAINS, ROMANIA) AND SOME REMARKS ON THE MICROCLIMATIC CONDITIONS OF HIBERNATION

CHACHULA OANA, MEȘTER LOTUS, DUMITRU RADU

**Abstract.** *The Polovragi cave is an important site for the presence of bat species in the south-western part of Romania, included in the National Monitoring Programme in 2002. We describe the bat colonies from this cave, one of them for the first time in literature. The study was conducted between 2002 and 2009 and we compared our observations with the old data from literature. This cave is also a tourist site, being protected by two caretakers. The first part of the cave has a tourist management implemented by the Gorj County Museum. One of the bat colonies lives in this part of the cave; the second bat colony is present in the second part of the cave that is natural and it is in the custody of the Speleological Association "Focul Viu" – Bucharest. We describe new species for this cave forming the second bat colony. We estimate the colonies size. We give ecological and behavioural observations viewing these two distinct parts of the cave.*

**Keywords:** *bats, species, colonies, conservation.*

**Rezumat.** *Distribuția și diversitatea speciilor de lilieci (Ord. Chiroptera) din Peștera Polovragi (Munții Căpățânii, România) și câteva aspecte asupra condițiilor microclimatice din timpul hibernării. Peștera Polovragi este un sit important pentru lilieci, mai ales pentru partea de SV a României, care a fost inclusă în programul național de monitorizare în anul 2002. Descriem coloniile de lilieci din această peșteră, una din ele pentru prima dată în literatură. Studiile au fost făcute între anii 2002-2009 și am comparat observațiile noastre cu cele existente în bibliografie. De asemenea, am urmărit aspectele ecologice și etologice ale chiropterelor, precum și cele legate de habitatul de hibernare.*

**Cuvinte cheie:** *lilieci, specii, colonie, conservare.*

### INTRODUCTION

Polovragi Cave is situated in Gorj County, at 1.2 kilometres from Polovragi village. In the system UTM, it is GR20. In terms of geographic location, the cave is situated in Căpățânii Mountains, on the left side of the Olteț Gorges, at about 200 m from the entrance of the gorges downstream, at an altitude of 650 m.

Polovragi Cave was declared Natural Reserve by the Government of Romania by Law 5/2000 concerning the approval of the national territory arrangement plan - Section III - protected areas, according to which it is part of the "protected natural areas of national interest." It is classified according to Law 462 as a natural reserve, IUCN category IV, Class B.

The cave presently has a development of 10,350 m and a level oscillation of 90 m (-62, +28); it is a fossil meander of the Olteț river, probably dug in upper Quaternary in the same time with the formation of the 20-25 m terrace upstream and downstream of the Olteț gorges. It is a large cave formed of a main gallery oriented NW-SE, with many lateral ramifications where three sectors can be distinguished: south-eastern sector, which begins with "The downstream entrance", approximately 10 m wide and 2-8 m high and hosts in the Touristic Gallery; the central and north-western sectors with galleries and halls. The cave has two openings: the main one, downstream "Downstream Entry" of 8/8 m and another one upstream "Upstream Entry" (Fig. 1).

Although the first chiropterological reports in Oltenia area appear in the work of MEHELY, 1900, this draws the attention of the specialists from the "Emil Racoviță" Institute of Speleology in 1950. In the reference paper belonging to DUMITRESCU et al., 1963 "Răspândirea chiropterelor în R.P. Română", there is rendered information about the area, but only from a cave near Polovragi, Muierii Cave from Baia de Fier. The first chiropterological reports from Polovragi cave are made by BAZILESCU, 1974 who signals the species *Rhinolophus ferrumequinum* (SCHREBER, 1774) and in 1982, for the first and last time the species *Pipistrellus pipistrellus* (SCHREBER, 1774), (BAZILESCU, 1982).

The cave gets back in the chiropterologists' attention in 2001, when *Rhinolophus hipposideros* (BECHSTEIN 1800) species is mentioned in the work "Contribution to the knowledge of Chiroptera Distribution from the Romanian sector of the Carpathian Mountains" (GHEORGHIU et al., 2001).

In 2002, occasional visits within the framework of the research projects "Survey of Romania's underground bat habitats (Status and distribution of cave dwelling bats) 2002-2004", NAGY et al. (2003), reconfirms the existence of *Rhinolophus ferrumequinum* species in the Tourist Gallery.

In the absence of a comprehensive study of chiropters found in the Polovragi cave, in 2002, Focul Viu Speleological Association begins systematic visits to monitor bats throughout the whole cave, both Tourist Gallery and the galleries and halls upstream. In the visits conducted until 2009 throughout the year, there have been made detailed comments on the specific composition of the existing colonies, it has been followed the bats' dynamics during hibernation in the cave galleries and there have been made measurements of microclimatic factors.

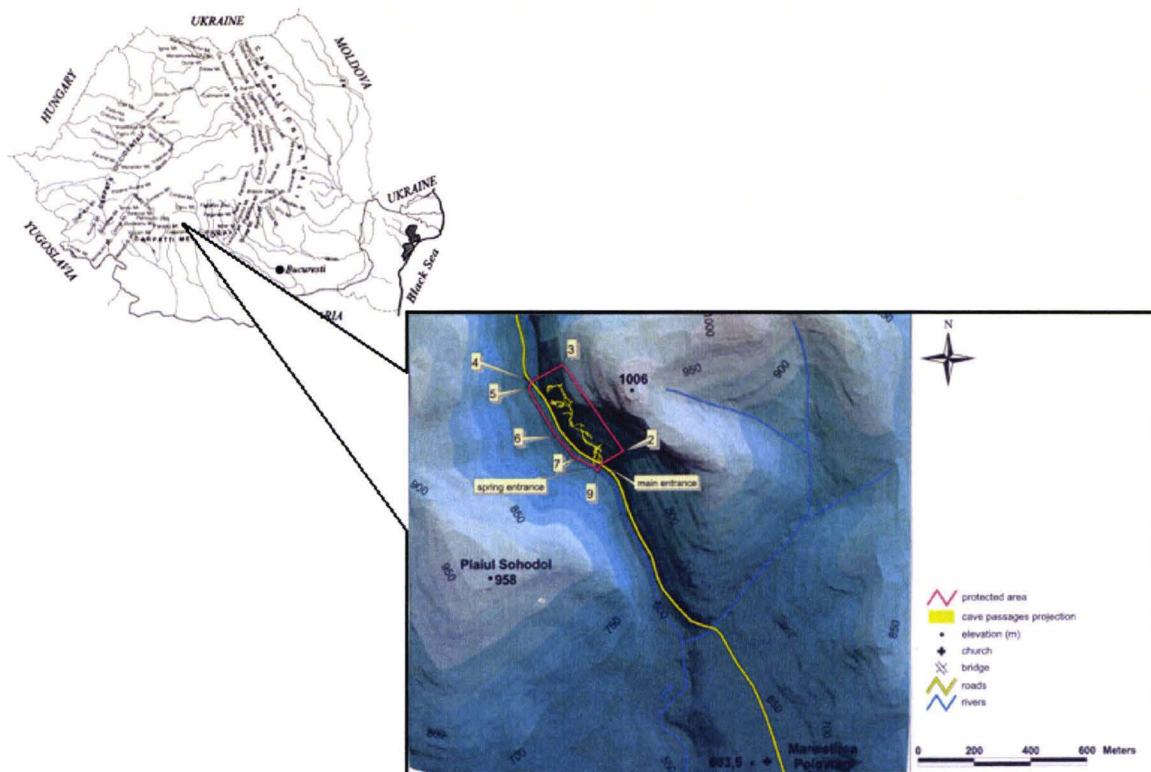


Figure 1. The location of the cave.

Figura 1. Localizarea peșterii.

## MATERIAL AND METHODS

The materials used in the field were a thermo-hygrometer and a photo camera. Species were determined using identification keys (VALENCIUC, 2002; MURARIU et al., 2003) and morphometrical measurements.

The cave was divided into seven sectors from the downstream to the upstream entry to make observations in fixed points, as it follows: 1. Tourist Gallery, 2. Downstream access Gallery, 3. Gour's Hall, 4. Wonder Room, 5. Gallery 27, 6. Great Hall, 7. Upstream Access Gallery (Fig. 4). As we studied colonies of bats during hibernation, this was done with minimal trouble, and only a few specimens were handled.

This paper presents information obtained between 2002 and 2009, on the occasion of the 11 field trips: the 30<sup>th</sup> of November 2002, the 1<sup>st</sup> of March 2003, the 12<sup>th</sup> of March 2004, the 1<sup>st</sup> of May 2004, the 30<sup>th</sup> of October 2004, the 30<sup>th</sup> of November 2004, the 12<sup>th</sup> of March 2005, the 1<sup>st</sup> of December 2007, the 26<sup>th</sup> of January 2008, the 1<sup>st</sup> of February 2009, the 1<sup>st</sup> of March 2009.

## RESULTS AND DISCUSSIONS

Specific composition and population estimates. The cave has three colonies of bats, differentiated both from an ecological point of view and by their position in the habitat: two colonies for hibernation and one colony of birth.

The colonies are mixed, consisting of the following species: *Myotis myotis* (BORKHAUSEN 1797), *M. blythii* (TOMES 1857), *M. emarginatus* (GEOFFROY SAINT-HILAIRE 1806), *M. bechsteinii* (KUHLE 1817), *Rhinolophus ferrumequinum* and *R. hipposideros* (Fig. 3).

The first colony is located in the visitable sector, Tourist Gallery. We observed the largest number of bats on the 12<sup>th</sup> of March 2005, 380 individuals (Fig. 6). The dominant species in this sector is *Rhinolophus ferrumequinum*. Species are found both in the form of colony, small groups of individuals, but also isolated specimens of *Myotis myotis* / *Myotis blythii* and *Rhinolophus hipposideros*. They are found on the ceiling at heights varying between 2 and 8 m.

The second colony is situated in the protected upstream sector - in the area called by us Gour's's Hall, because of this speleothem, with a diameter of 1m. This includes 155 individuals observed on the 26<sup>th</sup> of January 2008 belonging to the species *Myotis myotis* / *M. blythii* and is located on the ceiling at a height of 4 m (Fig. 5). The colony is not mentioned in literature, because that part of the cave was not discovered when the research was done in the 50's, and according to the discussions with the present experts, who visited the cave, no one knows this gallery, found after the 70's. The colony is more sensitive to human presence; individuals react very quickly to stress factors, compared with the colony from the Tourist Gallery, which hibernates under reflectors and in the middle of tourist path.



On the rest of sectors, such as Downstream Access Gallery, Wonder Room, Gallery 27, Great Hall, Upstream Access Gallery, there were found isolated specimens of *Rhinolophus hipposideros* and *R. ferrumequinum*. Only in the Great Hall, *Myotis myotis* is encountered, the species preferring wide spaces. Their number does not exceed 10 individuals (the 1<sup>st</sup> of March 2009) (Fig. 2).

The third colony, the nursery one, is situated in the Bat Gallery, near the “Downstream entry”. We avoided visiting this gallery, because the stress of the visits endangers too much the life of the new born bat babies.

The new species listed during this study are: *Myotis bechsteinii* (det. Oana Chachula / the 30<sup>th</sup> of November 2002) and *M. emarginatus* (det. Oana Chachula & Victor Gheorghiu / the 30<sup>th</sup> of November 2004). So, for *M. bechsteinii*, male specimen, we considered it necessary to take some biometric data as forearm length (La) = 61.42 mm, ear length (Lu) = 20.11 mm, and for *M. emarginatus*, male specimen, the length of the forearm (At) = 37.29 mm, ear length (Lu) = 12.95 mm. Both species were found on the Tourist Gallery and Downstream Access Gallery.

The fewest individuals were noticed on the 1<sup>st</sup> of May 2004, when the outside temperature already exceeded 20°C and along the entire length of the cave we encountered a maximum of 10 isolated individuals or groups of 2-3 individuals.

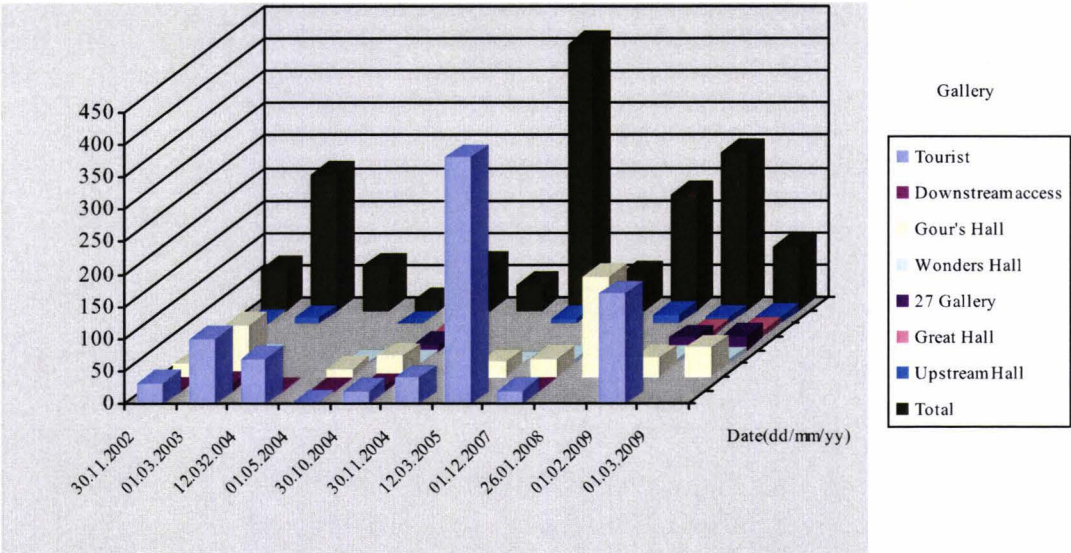


Figure 2. Seasonal dynamics of Chiroptera inside Polovragi cave between 2002 and 2009.  
Figura 2. Dinamica sezonieră a chiropterelor pe sectoarele peșterii Polovragi între 2002-2009.

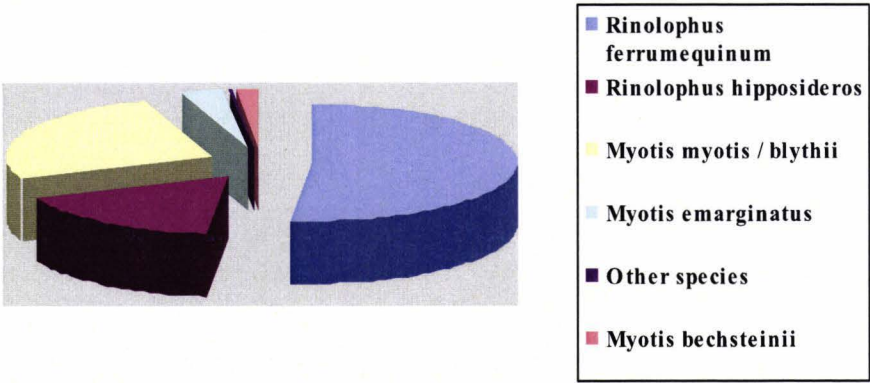


Figure 3. The specific composition of the hibernation colony from Polovragi cave.  
Figura 3. Compoziția specifică a coloniei de hibernare din Peștera Polovragi.

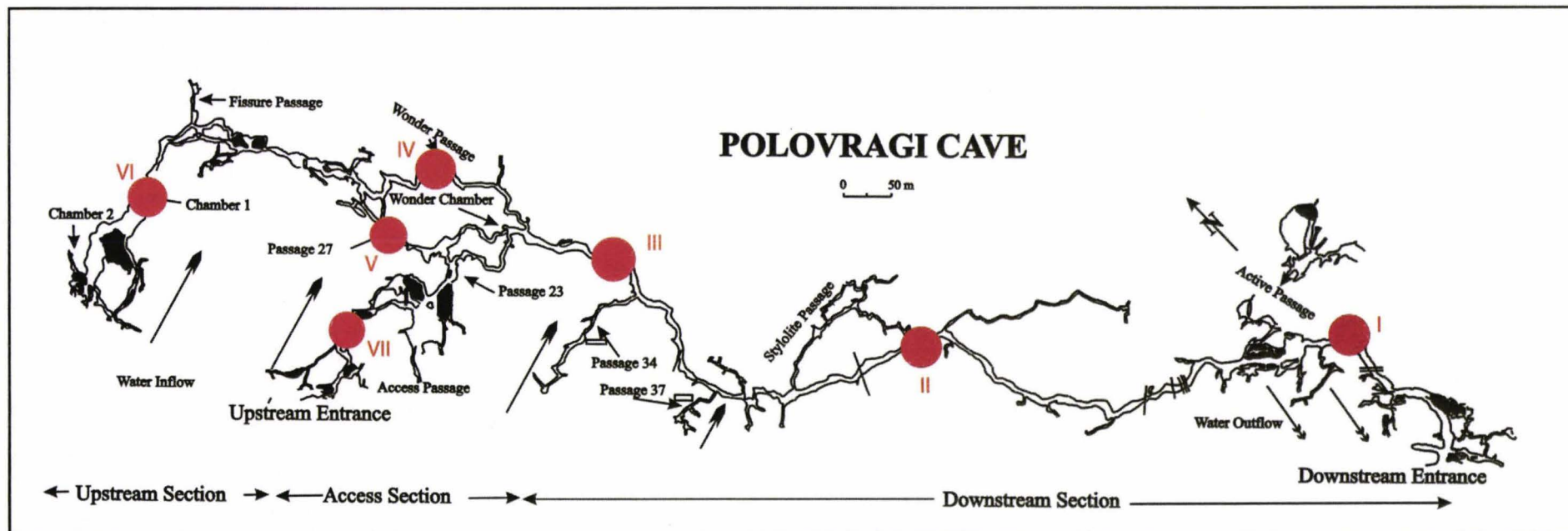


Figure 4. The map of the cave and representation of the observation points (mapped by Focul Viu Speleological Association).

Figura 4. Harta peșterii cu reprezentările locurilor de observații (cartare de Asociația speologică Focul Viu).

**Legend:**

1. Tourist gallery
2. Downstream access gallery
3. Gour's Hall
4. Wonders' Hall
5. Gallery 27
6. Great Hall
7. Upstream access gallery

**Legendă:**

1. Galeria turistică 2. Galeria de acces aval
3. Sala Gurului 4. Sala Minunilor
5. Galeria 27 6. Sala Mare
7. Galeria de acces amonte

Aspects of the cave microclimate and the influence on chiropters. The values from the access galleries and the relative humidity are influenced by the outside temperature fluctuations. Air temperature in Gour's Hall, where the second colony is situated, and in other deep areas of the cave, remains constant around 8°C in all periods. The highest temperature in the cave is registered in the Great Hall, where it reaches 9.2°C (the 1<sup>st</sup> of March 2009). Moreover, in these areas, the relative air humidity is almost 100%. As temperature increases outside during the spring months, fewer bats are found in the galleries of the cave; they wake up from the state of hibernation and leave the shelter. The majority is found in deep areas of the cave, the largest groups being observed here. Meanwhile, solitary individuals, mostly belonging to the species *Rhinolophus hipposideros* were encountered even at low temperatures of 2°C of the vestibular areas. Dynamics of the total number of Chiroptera and changes in the specific composition are, apparently, closely related to changes in the environmental temperature, and fluctuations in the number of bats from one year to another, is a natural phenomenon.

Table 1. The values of air temperature and relative humidity inside the cave during the study.  
Tabel 1. Valorile temperaturii și umidității relative a aerului din peșteră pe perioada studiului.

Date	T°C/H° outside	T°C/H° Tourist Gallery	T°C/H° Downstream access Gallery	T°C/H° Gour's Hall	T°C/H° Gallery 27	T°C/H° Great Hall
October 10, 2004	19.9°/ 63%	8.1°/ 95%	9.5°	7.9°	-	8.4°/92%
November 30, 2004	7°/ 59%	8°/ 90%	-	-	-	-
March 12, 2005	2.5°/ 69%	-	-	8.5°	-	-
December 1, 2007	3.6°/ 57%	-	3°(vestib.)/ 67%	-	-	-
January 26, 2008	-2°	-	7.6°	-	-	-
March 1, 2009	4,2°	-	6.1°	8.7°	8.9°	9.2°

Conservation and protection of the bats from Polovragi cave. To ensure effective protection, the buffer area of Polovragi Cave Speleology Reserve is represented by the upstream entrance in the cavity from the Olteț gorges and the final electrified segment of Tourist Gallery.

Internal zoning is a function of the need of speleogenetic resource conservation, protecting wildlife and tourism activities, namely cave tourism:

- Area I, Protection and conservation: all galleries with public access, the access being made through the downstream entry, only with the cave guide, employed by the Gorj County Museum, the custodian of the visitable part of the cave, called Tourist Reserve.
- Area II, Speleological Reserve, Ecotourist route: Tourist Gallery, Main Gallery, Upstream Entry. The following activities are permitted: wildlife protection, speleogenetic conservation, scientific research, training, cave tourism.
- Area III, Speleological Reserve, Speleological tourist route: Sectors of galleries from the entrance in Wonder Gallery / Gallery 27 and the end of the cavity. "Crocodile" segment from Tourist Gallery to Hall Lake. The following activities are permitted: wildlife protection, speleogenetic conservation, scientific research, speleological education.

In the table below, we render the conservation status of the species present on this site, both European and national (TEMPLE & TERRY, 2007; MURARIU et al., 2005).

Table 2.The conservation status of the bat species recorded in Polovragi cave.  
Tabel 2. Statutul de conservare a speciilor de lilieci existente în Peștera Polovragi.

No.	Species	Bern Convention	Bonn Convention	Red Book Romania	Eurobats	Habitats Directive
1.	<i>Myotis myotis</i>	Annex 3	Annex 2	T	+	Annex 2 & 4
2.	<i>Myotis blythii</i>	Annex 3	Annex 2	T	+	Annex 2 & 4
3.	<i>Myotis emarginatus</i>	Annex 3	Annex 2	T	+	Annex 2 & 4
4.	<i>Myotis bechsteinii</i>	Annex 3	Annex 2	T	+	Annex 2 & 4
5.	<i>Rhinolophus ferrumequinum</i>	Annex 2	Annex 2	V	+	Annex 2 & 4
6.	<i>Rhinolophus hipposideros</i>	Annex 2	Annex 2	V	+	Annex 2 & 4

Legend: T – threatened species; V – vulnerable species.  
Legendă: T – specie amenințată; V – specie vulnerabilă.



We observe that the all recorded bat species appear in the Annex II of the Bonn Convention (migratory species with poor conservation status in the European region), in the Annexes 2 and 3 of the Bern Convention (strictly protected and protect bat species in Europe) and in the Eurobats Agreement (London, 1991, till now, being adopted by 30 countries) that follows to develop and implement an integrate common strategy in order to preserve the diversity of the European bat species.

All the bat species identified in this site appear in the Habitats Directive, too - in the Annex 2, like species of community interest for which it is necessary to appoint special conservation areas and all in the Annex 4, being strictly protected species in the European Union.

In time, we tried to do wherever possible – to hold education campaigns, to increase the visitors' awareness-level through informative panels and presentations made locally and to protect the cave and its fauna by gates. For this purpose, three metal gates were installed by Focul Viu Speleological Association, one located between the Tourist Gallery and Downstream Access Gallery, one at the Upstream entry (Fig. 7) and the other one on the Upstream access Gallery (Fig. 8). Polovragi cave provides such important information on the spread of bats in the area, as well as of rare species of national importance.



Figure 5. *Myotis myotis* colony.  
Figura 5. Colonie de *Myotis myotis*.



Figure 6. *Rhinolophus ferrumequinum* colony.  
Figura 6. Colonie de *Rhinolophus ferrumequinum*.



Figure 7. Upstream entry.  
Figura 7. Intrarea amonte.

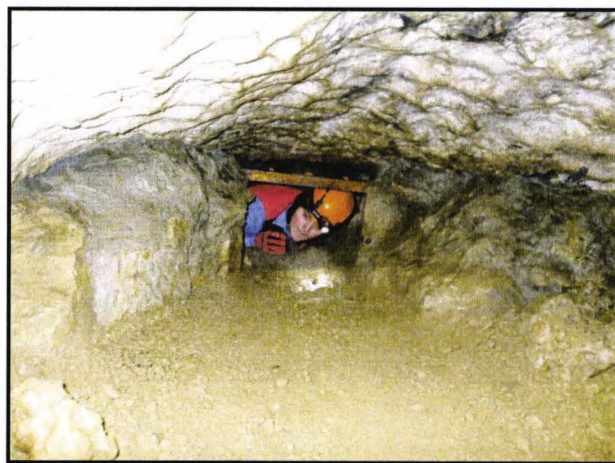


Figure 8. Gate III on Upstream access Gallery.  
Figura 8. Poarta III pe Galeria de acces amonte.

## CONCLUSIONS

We achieved an eight year study in order to monitor the number of bats, to observe the ecological aspects of the population and the habitat during hibernation. Thus, we estimated the total number to approximately 700 bats, divided into two distinct colonies. They are located in different areas of the cave, one unknown by the specialists till now. Six species are found, among which we mention *Myotis bechsteinii*, *M. emarginatus* (new housing).

All bat species recorded in Polovragi cave are included in the Romanian Red Book of Vertebrates, being threatened species (the national effectives are estimated at about no more than 2,000 individuals) or vulnerable species (the national effectives are about 3,000 individuals maximum).

Starting with 2008, the Gorj County Museum closed the cave for tourist visits during bat hibernation, more specifically during December, January and February.

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# STRUCTURAL – FUNCTIONAL TRANSFORMATIONS OF RODENT COMMUNITIES IN ECOSYSTEMS OF MOLDOVA ON THE BACKGROUND OF ANTHROPOGENIC AND CLIMATIC CHANGES

ANATOL SAVIN, VICTORIA NISTREANU

**Abstract.** *The transformations of anthropogenic ecosystems in the last decades provoked significant structural-functional changes, favouring an evolution of rodent community species structure, as well as a reorganisation of the mechanisms of the number dynamics of the main species. In the 80s the species of the genus Apodemus were dominant in agrocoenoses ( $D = 63.1\%$ ), where *A. sylvaticus* and *A. uralensis* had the abundance of 55.1%, being constant ( $W > 25$ ) on the agricultural fields and in the majority of natural coenosis of the agrocoenoses. The genus Mus species had the dominance of 25% and were background species on agricultural fields, while the species *M. musculus* was more frequent and more abundant ( $D = 15\%$ ). After 2000 the dominance of some rodent species increased (*A. agrarius* from 2.1% to 25.8%, *M. spicilegus* from 12.7% to 28.8%) and the dominance of other rodent species decreased (*A. sylvaticus*, *A. uralensis* and *M. musculus*: 12.1%, 5.2% and 2.8% respectively). At present, certain species, such as *M. spicilegus*, prove to be less adapted and thus their ecological significance clearly decreases, while other species, *A. sylvaticus* for example, prove a high adaptive potential under these conditions due to its trophic universalism, active mode of distribution in different activity periods, and capacity to determine the optimal condition station for each existence period.*

**Keywords:** *small rodents, community structure, ecosystem and climatic changes.*

**Rezumat.** *Transformări structural-funcționale ale comunităților de rozătoare în ecosistemele Republicii Moldova pe fundalul schimbărilor antropo-climatice. Transformările în ecosistemele antropizate din ultimele decenii au provocat importante schimbări structural-funcționale, favorizând o evoluție a structurii specifice a comunităților de rozătoare cât și o restructurare a mecanismelor dinamicii numerice a speciilor de fond. În anii 80 dominante în agrocoenoze erau speciile genului Apodemus ( $D = 63,1\%$ ) unde *A. sylvaticus* și *A. uralensis* aveau o dominanță de 55,1%, fiind constante ( $W > 25$ ) pe câmpurile agricole și în majoritatea cenozelor naturale ale agrocoenozei. Speciile genului Mus aveau o dominanță de 25% fiind specii de fondal pe câmpurile agricole, iar specia *M. musculus* era mai frecvent și mai abundent întâlnită ( $D = 15\%$ ). După 2000 a crescut dominanța unor specii de rozătoare (*A. agrarius* de la 2,1% la 25,8%, *M. spicilegus* de la 12,7% la 28,8%) și a scăzut dominanța altor specii (*A. sylvaticus*, *A. uralensis* și *M. musculus*: 12,1%, 5,2% și 2,8% corespunzător). În prezent unele specii (*M. spicilegus*) dovedesc un potențial slab de acomodare micșorându-și brusc semnificația ecologică, iar alte specii (*A. sylvaticus*), din contră, grație universalismului trofic, modului activ de distribuție în diferite perioade de activitate, capacității de identificare a stațiunii cu condiții optime pentru fiecare perioadă de existență, demonstrează un potențial adaptativ sporit în aceste condiții.*

**Cuvinte cheie:** *rozătoare mici, structura comunităților, modificări ale ecosistemelor și climatice.*

## INTRODUCTION

The modifications of climatic and economic conditions of the last decades lead to the changes of ecosystems' structure and to the modification of the Republic of Moldova landscape. Vast single-crop agricultural fields from the agrarian complex of 70-80's that occupied large territories are currently divided in parcels cultivated with various annual, biannual and perennial cultures, many of which are abandoned and uncultivated. Many used lands are abandoned and at present revert to their more or less natural state as natural biotopes, such as pastures, meadows, grazing lands etc. At the same time, the processes of anthropization, urbanization and degradation of the natural ecosystems occur all over the territory of the republic.

In this context modification of the specific structure of the communities occurs, as well as changes of the social structure of small mammals, which represent an intra- and interspecific phenomenon and are determined by the adaptive capacities of the species, as well as by the relations between the populations of these species. The transition from one form of population organisation to another, from one phase of population number dynamics to another is conditioned by the adaptation strategy of the species to the environmental condition changes that include populational factors, as well as environmental factors (MUNTEANU, 1997; MUNTEANU et al., 2003, 2007; SAVIN, 2003).

## MATERIAL AND METHODS

The material was collected between 1977 and 2008 in different types of natural and anthropogenic ecosystems of the Republic of Moldova. To characterize the biotopic distribution of the species there were used the index of

frequency (BALOGH, 1958):  $F = \frac{100p}{P}$ , where  $P$  – number of samples,  $p$  – samples in which the species is present and

the index of species dominance (abundance)  $D = \frac{100n}{N}$ , where  $n$  – number of individuals of certain species in the sample,  $N$  – total number of individuals (both indexes are expressed in percents). The importance of a certain taxonomic group in ecosystems was emphasized by calculating the ecological significance ( $W_a$ ) according to the following formula

$W_a = F_a \cdot D_a / 100$ , where  $F_a$  – frequency of the group<sub>a</sub> and  $D_a$  – abundance index. The species of the taxonomic groups with the significance less than 1% was considered accidental; 1.1 – 5% – accessory; 5.1-10% – characteristic and  $W > 10\%$  – constant for the studied biocoenosis. The statistical and factorial analyses, the graphic interpretation of the results were accomplished using the computer programs Statgraf, Microsoft Excel, Word.

## RESULTS AND DISCUSSIONS

The rodents are an important element of terrestrial ecosystems and have fundamental functional importance. They are secondary and tertiary production users and serve as main trophic resource for many carnivore mammals and predatory birds, thus being important links within the trophic chain. The rodents have a significant role in the formation and fertilization of the soil. The ecological significance of the rodents in various ecosystems of the republic is constant or characteristic (Table 1); this taxonomic group has the highest proportion among mammal fauna of the ecosystems.

In the ecological conditions of the 80s-90s the structure of rodent communities from natural and anthropogenic ecosystems was determined by the mosaicity of the biotope, the degree and type of their exploitation, the background of predatory pressure and anthropogenic factors (MUNTEANU et al., 1992; SAVIN, 2001; 2004).

In the conditions of large areas (about 50-150 ha) of gramineae, cultivated crops, perennial fodder herbs, multiannual culture plants (vineyards, orchards, gardens) the species of genus *Apodemus* (KAUP, 1829) were dominant in agrocoenoses ( $D = 63.1\%$ ), where *A. sylvaticus* (LINNAEUS, 1758) and *A. uralensis* (PALLAS, 1811) had the abundance of 55.1%, being constant ( $W > 25$ ) on the agricultural fields and in the majority of natural coenoses of the agrocoenoses (Fig. 1). The genus *Mus* (LINNAEUS, 1758) species had the dominance of 25% and were background species on agricultural fields, while the species *M. musculus* (LINNAEUS, 1758) was more frequent and more abundant ( $D = 15\%$ ) due to refuge stations that had existed in the mentioned period (haystacks formed after the cereals harvesting, which were available during August-May period, and sometimes even several years) with the density of 3-5 per 1,000 ha.

Table 1. Ecological significance ( $W_A$ , %) of mammal taxonomic groups in natural and anthropogenic ecosystems.  
Tabel 1. Semnificația ecologică ( $W_A$ , în %) a grupurilor taxonomice de mamifere în ecosistemele naturale și antropizate.

Types of coenosis	Ecological significance of mammal taxonomic groups ( $W_a$ )				
	Insectivores	Rodents	Carnivores	Artiodactyles	Cheiroptera
Arboreous-shrubby	6.22	19.4	10.8	3.7	5.9
Rocky	0.66	8.5	6.5	0.3	9.7
Pastures	1.32	13.7	4.1	-	1.1
Steppe	0.8	9.3	1.4	-	0.8
Aquatic and paludous	0.2	3.7	0.9	0.4	1.4
Synanthrope	1.1	20.8	1.1	-	5.1
Multiannual cultural plants	2.3	21.4	2.3	0.2	2.1
Annual cultural plants	0.5	37.2	0.7	-	0.7

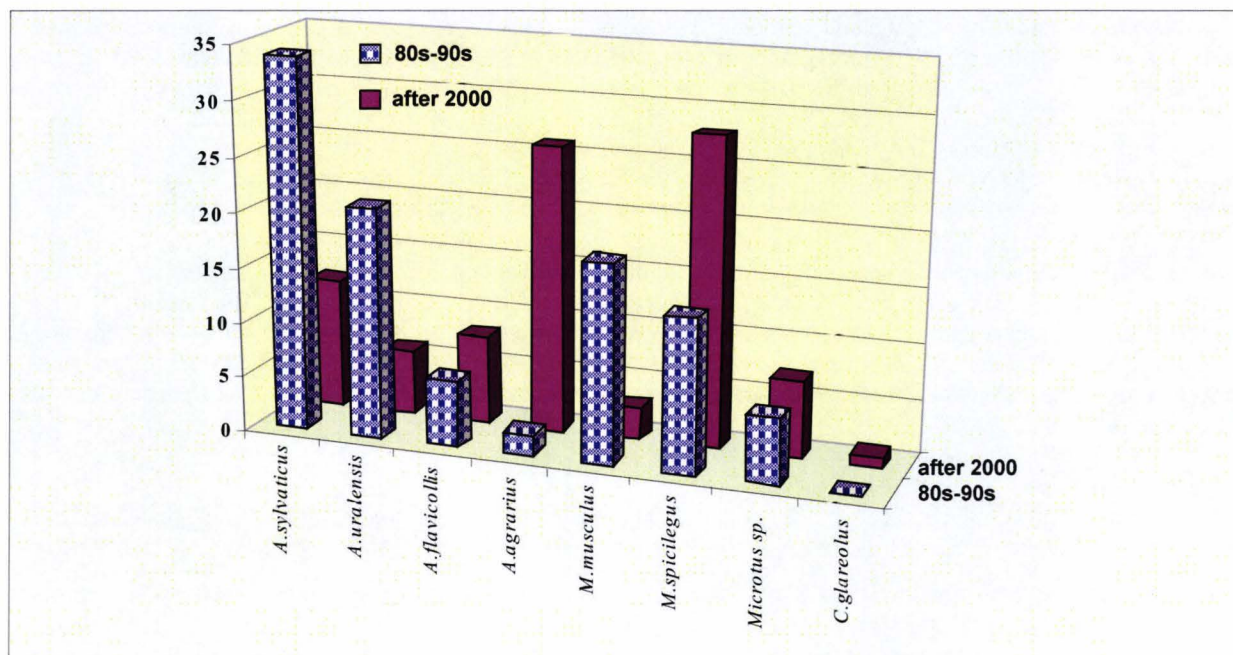


Figure 1. Evolution of rodent community structure ( $D$ , %) in agrarian ecosystems.  
Figura 1. Evoluția structurii comunităților de rozătoare ( $D$  în %) în ecosistemele agrare.

The species *A. agrarius* (PALLAS, 1771) in this period had an accidental significance ( $W < 1\%$ ) as it was recorded in some acacia shelter belts and in border sectors of clear forests.

It was established that the agrocoenosis modifications from the last two decades provoked structural changes in terrestrial vertebrate animal communities. The dominance of some rodent species increased (*A. agrarius* from 2.1% to 25.8%, *M. spicilegus* (PETENYI, 1882) from 12.7% to 28.8%) and the dominance of other rodent species decreased (*A. sylvaticus*, *A. uralensis* and *M. musculus*: 12.1%, 5.2% and 2.8% respectively).

Between 2004 and 2006, in agrocoenoses and in forest ecosystems some structural-functional modifications of rodent communities were recorded by comparing with the last decades of the past century. The abundance and the frequency of the species *A. agrarius* increased considerably (Figs. 1, 3); this species was constantly recorded in agrocoenoses, as well in forests. *A. uralensis* in the republic agrocoenoses is presented as low dominance species, less than 8%. In forest ecosystems this species was recorded seldom, only at the forest edges. *A. sylvaticus* has high abundance in agrocoenoses with annual cultivated plants, where it is the dominant species, while in woods it was recorded in proportion of about 16%. In agroecosystems, *C. glareolus* (SCHREBER, 1780) was registered during the reproductive period on several fields of forage at distances of 200m away from the woods and *A. flavicollis* (MELCHIOR, 1834) was present in rather low proportion ( $D = 5-8\%$ ). In agroecosystems, due to the modifications of agrocoenosis structure, the abundance of the species *M. spicilegus* increased (Fig. 1). The dominance of *M. musculus*, along with the disappearance from the agricultural landscape of the haystacks, decreased considerably ( $D = 2-3\%$ ).

Along with the disappearance from the agricultural landscape of the vast alfalfa fields and emergence of many small fragmented abandoned sectors, the number cyclicity of *Microtus* (SCHRANK, 1798) genus species is deregulated and favours a slight increase of the dominance of the species, the population of which underwent a phase of numerical growth between 2004 and 2008.

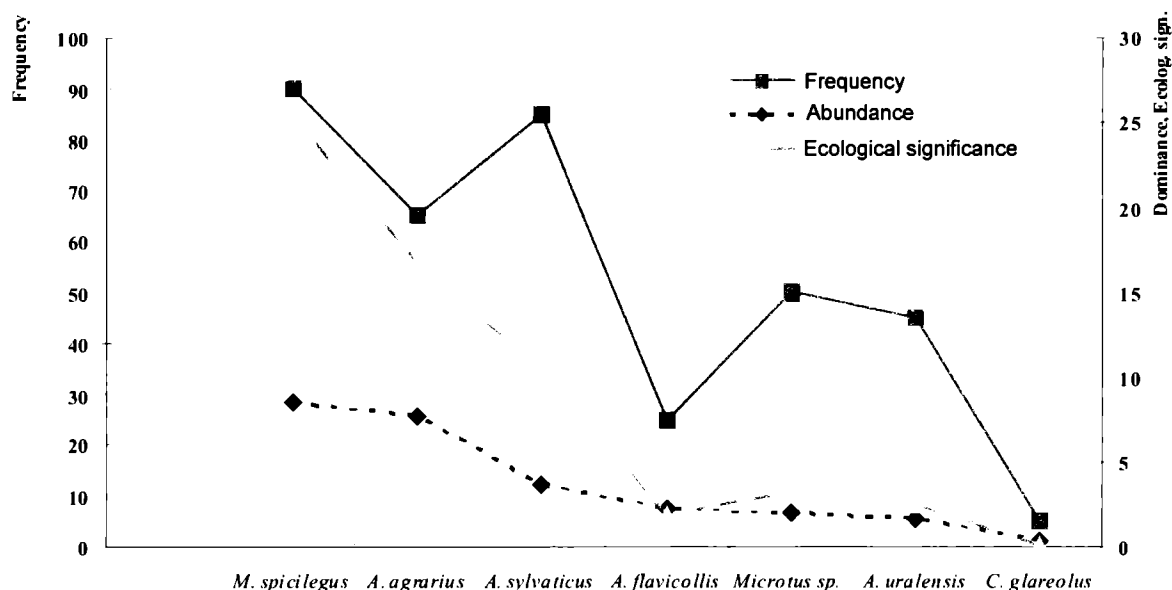


Figure 2. Species structure of small rodent communities in agrarian ecosystems in 2000-2006.

Figura 2. Structura specifică a comunităților de rozătoare mici în ecosistemele agrare în anii 2000-2006.

In 2000-2006 in the agrocoenoses all over the country (Fig. 2) *M. spicilegus* is the most abundant and numerous species, its ecological significance in agroecosystems is the highest ( $W = 25\%$ ). In all the regions of Moldova the adaptation of this species to the new ecological conditions caused by the modification of the economy type can be observed in the last years. If in the previous decades the mounds of this species could be registered in autumn period after the harvest gathering only on the edges of the large one-crop fields, at present the mounds can be observed in large quantity on the whole surface of the lands after harvesting, starting with the second half of the summer. The mound building mouse starts to build the mounds from the beginning of August till October, when it can reach considerable dimensions (about 3 m in diameter and several meters under the soil surface). In such lands the density of *M. spicilegus* is very high – about 150-250 individuals per ha).

The species *M. musculus*, which 20 years ago found favourable conditions in the spring – autumn season in agricultural lands and reached high densities in the autumn period, at present it can be recorded rather rarely and in low frequency in agrocoenoses. This fact is due to the changes in the agriculture type, to the mosaicity of agrocoenoses, to the disappearance of the haystacks that offered shelter and trophic resources in cold period, as well as to the competition with *M. spicilegus* species. The last one, on the contrary, increased considerably in abundance and density in the last years and evolved from the structural-functional organisation point of view. Due to its higher ecological tolerance by comparing to the majority of other rodent species, the mound building mouse find favourable conditions in various types of agrocoenoses. Due to its higher aggressiveness by comparing to all rodent species, including *M. musculus*, *M. spicilegus* eliminates the house mouse from the optimal biotopes, and other rodent species that occupy similar



ecological niches are suppressed and forced to move to marginal biotopes. The mound building mouse possess a number of adaptive characters, which allow them to survive under the conditions of intense agriculture (SOKOLOV et al., 1990). Some of these peculiarities are:

- building of the mounds with trophic supply for winter period; the underground galleries and nidicole chambers are relatively deeply situated, which protect them from being destroyed during the land working;
- higher reproductive potential that allows them to restore in a short time period the population number after the winter period and after the agro-technical activity of the man;
- intense migratory activity – migration on other lands and in survival stations after the land working activities;
- diverse composition of the trophic base (vegetation), which allows the mound building mouse to populate the lands cultivated with various agricultural and forage plants, as well as the abandoned, virgin lands etc.; they easily shift from one food type to another;
- the phenomenon of torpor in the cold period of the year as physiological adaptation to surviving in unfavourable conditions (MUNTEANU & LARION, 2007; KOTENKOVA & MUNTEANU, 2007).

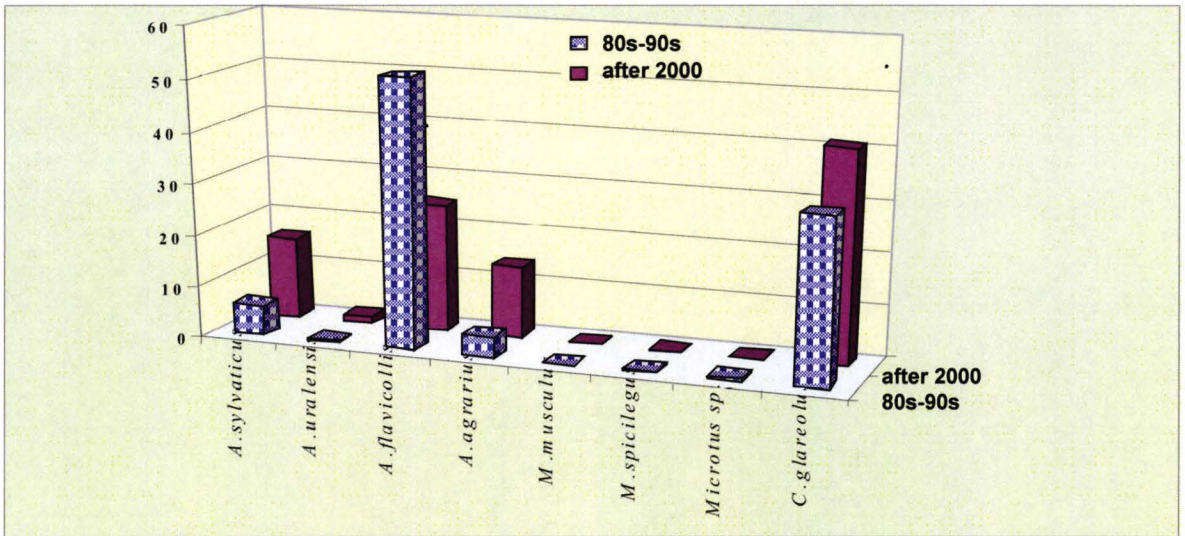


Figure 3. Evolution of rodent community structure in forest ecosystems.  
Figura 3. Evoluția structurii comunităților de rozătoare în ecosistemele silvice.

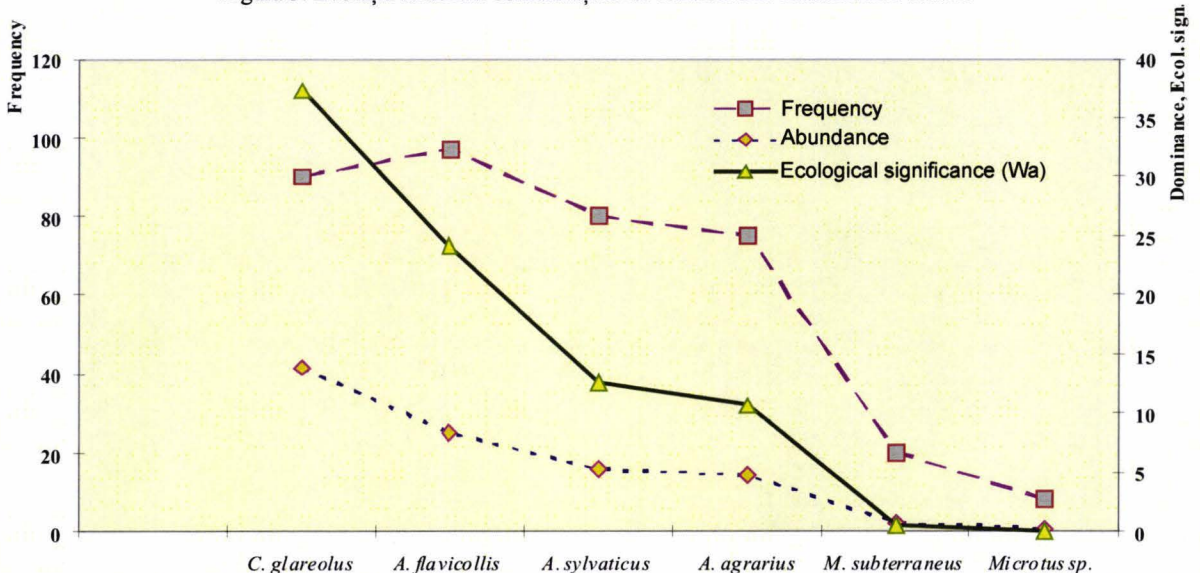


Figure 4. Species structure of small rodent communities in forest ecosystems between 2004 and 2006.  
Figura 4. Structura specifică a comunităților de rozătoare mici în ecosistemele silvice în anii 2004-2006.

*A. agrarius* became the second dominant species in agroecosystems. Although it is more a hygrophilous species its adaptation to the existence in more arid biotopes can be observed, where it find favourable trophic and shelter conditions. The characteristic significance ( $W_a = 9.8$ ) for *A. uralensis* in agrocoenoses was recorded only in southern regions of the republic in specific biotopes. The forest ecosystems suffered in this period less pronounced changes, still the massive forest cuttings and clearings, the recreational factors from the central woods also caused some changes in the structure of rodent communities, where it can be recorded (Figs. 3, 4) an increase of the species *A.*



*sylvaticus* and *A. agrarius* abundance along with the proportion decrease of the typical forest species *A. flavicollis*, which points out the vulnerability of forest ecosystems particular for the last decade. Under the pressure of the climatic conditions from the last years, characterized by severe drought during the summer, a total depression in rodent population in agrocoenoses, as well as in forest ecosystems can be observed (Fig. 5). Under such conditions dense rodent communities are forming in some biotopes with wet microclimate near various aquatic basins.

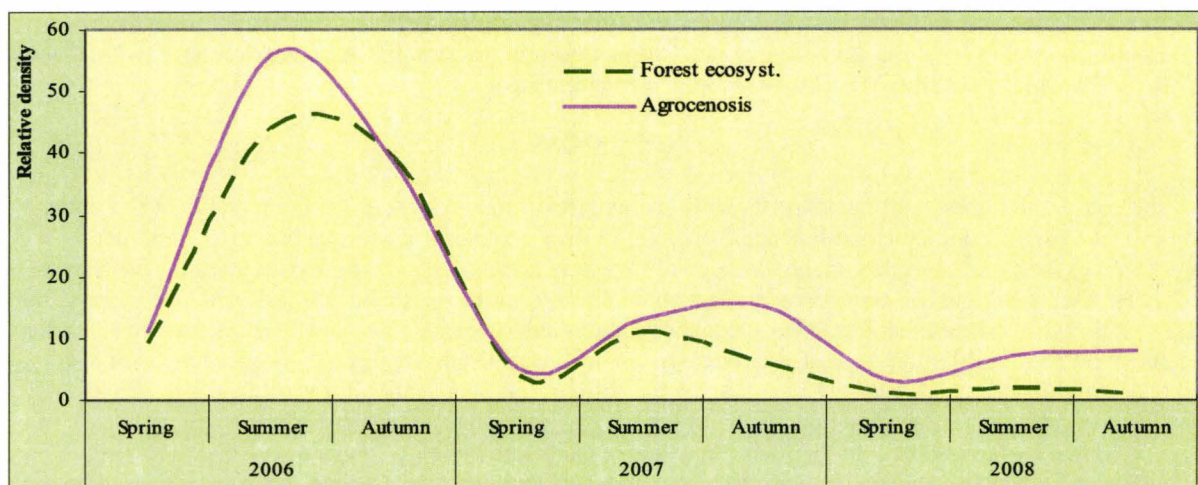


Figure 5. Multiannual dynamics of small rodent density in the ecosystems of the Republic of Moldova.

Figura 5. Dinamica multiannuală a densității rozătoarelor mici în ecosistemele Republicii Moldova.

In the last years under the influence of exceptional climatic conditions some species (*M. spicilegus*) prove poor adaptive potential; they suddenly decrease their ecological significance, in spite of some adaptations recorded in the last few years to the conditions of modern agrocoenoses. Other species (*A. sylvaticus*) on the contrary increase their limits of ecological valence.

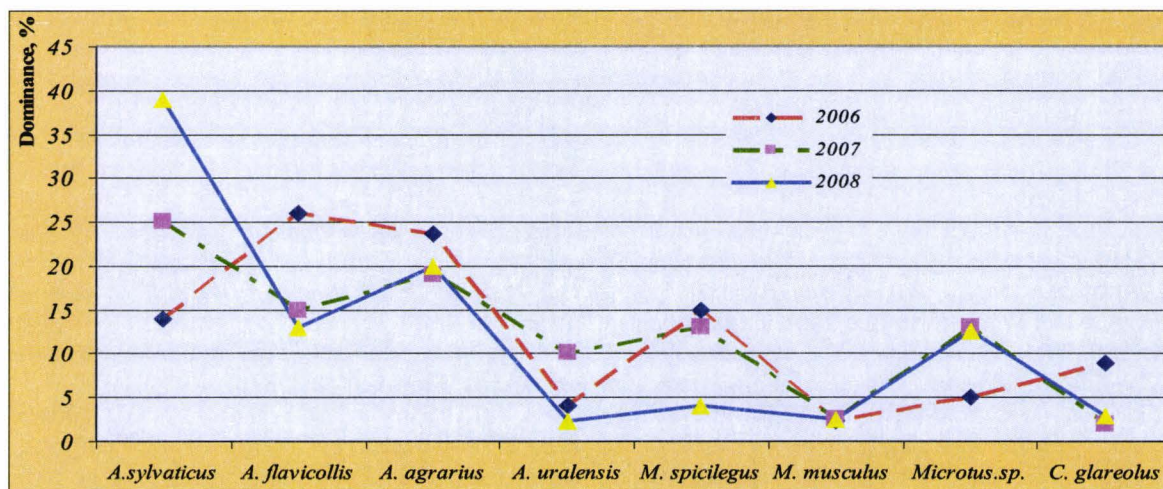


Figure 6. Structure dynamics of small rodent communities in the last years in the ecosystems of Moldova under the influence of environmental factors.

Figura 6. Dinamica structurii comunităților de rozătoare mici în ultimii ani în ecosistemele R. Moldova sub influența factorilor de mediu.

After analysing the species structure of rodent communities in the republic ecosystems (Fig. 6) from the last years, we observe a dominance decrease of the sylvicolous species (*A. flavicollis* and *C. glareolus*) and of the species *M. spicilegus*. The considerable reduction of the dominance and, especially, of the density of these species populations is caused, along with the climatic factors that influence the trophic regime of the mentioned species, by the increasing number (by tenfold times) of myophagous predators (fox, marten, weasel). The populations of *M. spicilegus* species, adapting to the ecological conditions from the last years, intensely inhabits the gramineae fields and build on the stubbles summer mounds, which are already finished toward September. The late ploughing of the stubbles (September-October), particular for the last years, leads practically to the destruction of this species population that cannot re-establish its mounds toward the cold period of the year.

Under these conditions *A. sylvaticus* manifests remarkable adaptive capacities and have the dominance of about 40% in various ecosystems. This species with large limits of ecological valence has the ability to quickly adapt to



the modifications of the ecological conditions. Therefore, in the last two years, in spite of extremely droughty and arid conditions, the wood mice are the most prosperous species among the rodents, being dominant and constant in the republic ecosystems. The adaptive potential of *A. sylvaticus* consists in the solitary way of life, the use of a large trophic resources spectrum, use of most various biotopes as refuge stations, intense migration to optimal habitats during the year, the high reproductive potential, as well as the extensive period of reproduction activity. (MUNTEANU et al., 2007; SAVIN, 2001; 2003). Among the ethological adaptations of the species there can be mentioned the high degree of exploratory activity that is manifested by a high mobility of the individuals, to faster explore and to better orientate in new conditions, as well as by the high degree of "suspiciousness" toward the new environment (MUNTEANU & CEMIRTAN, 1997), which made them less exposed to the predator attacks.

## CONCLUSIONS

The social and agricultural transformations in the anthropogenic ecosystems of the republic at the millennium transition provoked significant structural-functional changes in their ecological aspect, favouring an evolution of rodent community species structure, as well as a reorganisation of the mechanisms of the number dynamics of the main species.

Under the conditions of ecosystem aridization *M. spicilegus* prove to be less adapted, the trophic deficit connected to the vegetations peculiarities under drought conditions and several agrotechnical factors that are characteristic for the moment became fatal for this species. *A. sylvaticus* due to its trophic universalism, to its active mode of distribution in different activity periods, to its capacity to determine the optimal condition station for each existence period, proves a high adaptive potential under these conditions. Thereby we have to mention that the stability and equilibrium state of each ecosystem is insured by the optimum of its biodiversity and is maintained in biotic and abiotic conditions favourable for the quantitative and qualitative biologic balance between producers and consumers within the trophic chains. The applied aspects of these relationships consist in the ecological rehabilitation of the degraded ecosystems under the influence of anthropogenic pressure, in the formation of artificial ecosystems that could optimise the environment and in the determination of exploitation parameters of the functional elements with the aim to preserve the ecosystem stability.

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## OLFACTORY BEHAVIOUR IN *MUS SPICILEGUS* PETENYI, 1882 MALES WITH CENTRAL NERVOUS SYSTEM OF VARIOUS TYPE

ALINA LARION

**Abstract.** The following olfactory contacts were studied: nasal-nasal (N-N), nasal-anal (N-A), nasal-lateral (N-L) and the approaching to the partner. The positions during the olfactory contacts depend on the situation and on the social status of the partners and are particular for individuals from different mounds, as well as for individuals inhabiting the same mound. Among all the olfactory contacts the most numerous are the nasal-nasal ones. The approaching to the partner is an index that indicates the rank of the individual in group and in mound. The most numerous approaching to partners, as well as other olfactory contacts were registered in the first 5 minutes of the experiment. The individuals with weak CNS type are more curious, they more frequently approach to the partner. Thus, the olfactory contacts and approach to the partner is of great importance for *Mus spicilegus*, because in the cold period of the year the individuals live in groups.

**Keywords:** olfactory contacts, *Mus spicilegus*, CNS type.

**Rezumat.** Comportamentul olfactiv la masculii de *Mus spicilegus* Petenyi, 1882 cu sistem nervos central de tip diferit. Au fost studiate următoarele contacte olfactive între indivizi: nazo-nazale, nazo-anale, nazo-laterale, precum și apropierea de partener. Poziția indivizilor la toate contactele olfactive depinde de situație și de statutul social al partenerilor, sunt caracteristice atât pentru indivizii din diferite mișuni, cât și pentru cei din aceeași mișună. Dintre toate contactele olfactive cele mai numeroase sunt nazo-nazale. Apropierea de partener este un indice care indică rangul individului în grup și în mișună. Cele mai numeroase apropieri de partener, cât și celelalte contacte olfactive au fost înregistrate în primele 5 minute ale experienței. Indivizii cu sistem nervos central slab sunt cei cu inițiativă, cel mai frecvent ei se apropie de partener. Astfel, contactele olfactive și apropierea de partener au o importanță mare pentru *Mus spicilegus*, care în perioada rece a anului trăiesc în grup.

**Cuvinte cheie:** contacte olfactive, *Mus spicilegus*, tipul SNC.

### INTRODUCTION

The study of social behaviour, which is based on intraspecific informational relations, has the aim to reveal the adaptation strategies of the animals in different life conditions. The selective olfactory reaction of the individuals can play the role of isolation mechanisms of the related forms (MOORE, 1965; DOTY, 1973; BANKS, 1980; SOKOLOV et al., 1983a, b; 1984a, b; KOTENKOVA & LYALIUKHINA, 1983; KOTENKOVA et al., 1983; KOTENKOVA, 1988a, b etc). *Mus spicilegus* PETENYI, 1882 in the cold period of the year live in groups (average of 7-8 individuals). The individual recognition and the stable structure of the relationships between the group members do not allow the intrusion of foreign individuals and of the representatives of other species (SOKOLOV et al., 1990).

The aim of the paper is to elucidate the importance of olfactory contacts in *M. spicilegus*.

### MATERIAL AND METHODS

*M. spicilegus* was selected as study object. The type of central nervous system (CNS) was determined after KAMENOV (1973). The description of elements, positions, movements were made in experiments of male-male interactions after GOLTSMAN et al. (1977). 317 male individuals were tested during the experiment.

### RESULTS AND DISCUSSIONS

The olfactory contacts nasal-nasal (N-N), nasal-anal (N-A), nasal-lateral (N-L) and the approaching to the partner are behavioural peculiarities during the partner analysis.

The number of olfactory contacts is the highest in the first 5 minutes of the experiment, thus in the period of stabilization and formation of mutual relations between animals. Only in male-male experiments with individuals with strong type of CNS (S-S), the number of nasal-nasal contacts is higher toward the end of the experiment (Fig. 1).

After the 5 first minutes some differences occur: at the individuals from the same mound these contacts decrease and toward the end of the experiment (after 15 minutes) they remain stable at a certain level. At individuals from different mounds the individual activity and the frequency of the contacts between them increases. The maximum number of nasal-nasal contacts according to the obtained data was registered in the first 5 minutes of the experiment in the males with strong CNS type and with medium CNS type and between males with strong CNS type and with weak CNS type (5 contacts on average). The lowest number of nasal-nasal contacts was recorded between males with strong CNS type and with weak CNS type toward the end of the experiment (at 15 minute). The frequency of nasal-nasal contacts depends on the individual status: the lower the individual rank in the hierarchic system the more frequent are its contacts with other animals.

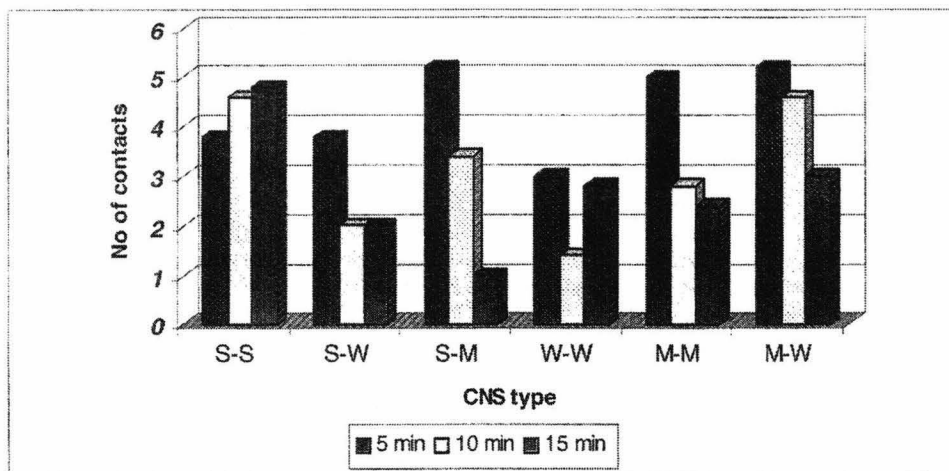


Figure 1. Nasal-nasal contacts in *M. spicilegus* males with various CNS type.  
 Figura 1. Contactul nazal-nazal la *M. spicilegus* cu tip diferit de SNC.

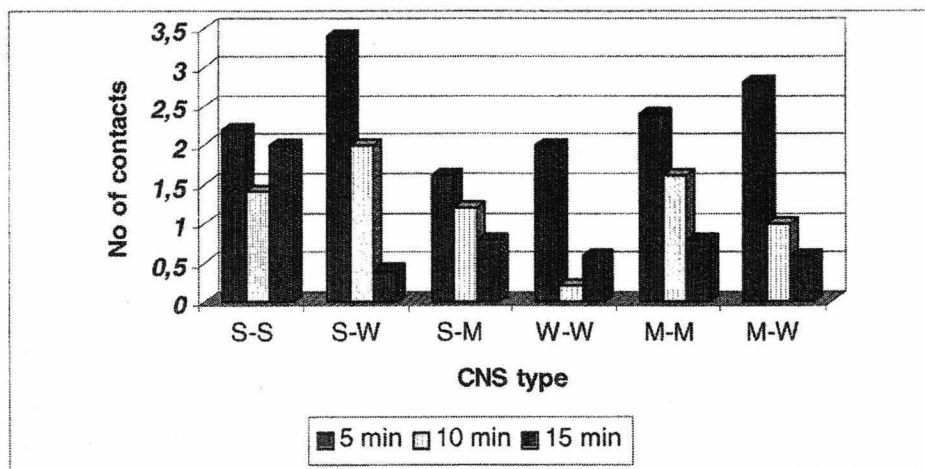


Figure 2. Nasal-anal contacts in *M. spicilegus* males with different CNS type.  
 Figura 2. Contactul nazal-anal la *M. spicilegus* cu tip diferit de SNC.

Besides the nasal-nasal contacts the nasal-anal contact were also analyzed. The highest number of nasal-anal contact was registered during the experiment between males with strong CNS type and with weak CNS type (S-W) (Fig. 2). As in the case of the nasal-nasal contacts the highest number of nasal-anal contacts was recorded in the first 5 minutes, than it decreased gradually toward the end of the experiment regardless of CNS type.

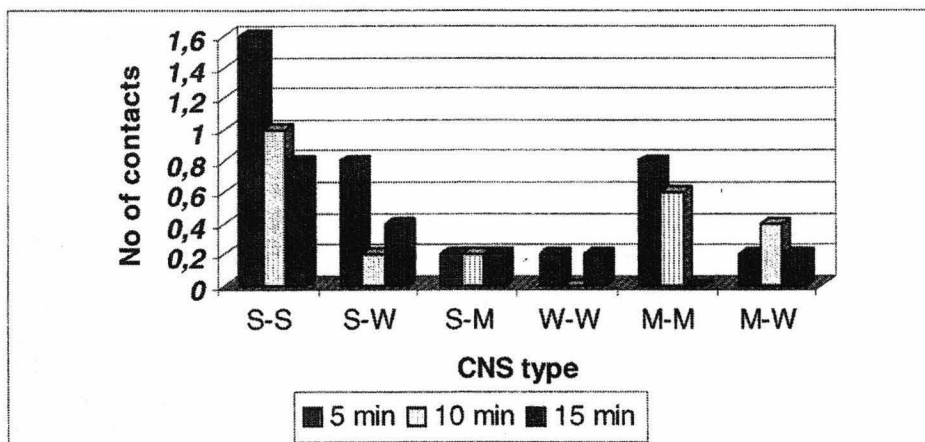


Figure 3. Nasal-lateral contacts in *M. spicilegus* males with different CNS type.  
 Figura 3. Contactul nazal-lateral la *M. spicilegus* cu tip diferit de SNC.

The olfactory contacts of various parts of partner body-nasal-lateral contacts are more frequent in individual couples with strong CNS type (S-S) in the first 5 minutes of the experiment (Fig. 3). In male coupling with strong CNS type and with medium CNS type (S-M) the number of nasal-lateral contacts is the same. The nasal-lateral contacts completely miss at the male couples with weak CNS type (W-W) in the middle of the experiment (at 10 minutes) and between males with medium CNS type at the end of the experiment (at 15 minutes).

While analysing the frequency of olfactory contacts during 15 minutes (Fig. 4) we can see that the most numerous contacts are the nasal-nasal ones, followed by nasal-anal contacts and the lowest number of contacts are the nasal-lateral ones no matter the CNS type.

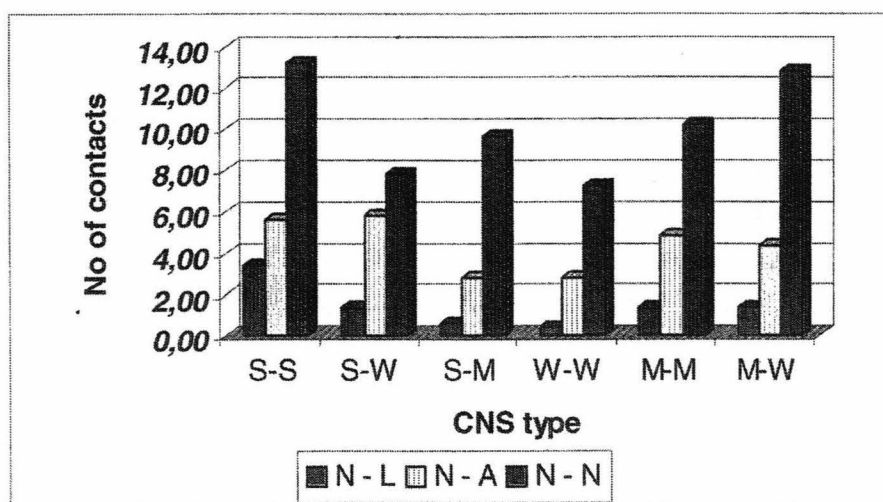


Figure 4. Olfactory contacts in *M. spicilegus* males with different CNS type.  
Figura 4. Contacte olfactive la masculii de *M. spicilegus* cu tip diferit de SNC.

## CONCLUSIONS

The olfactory contacts and approaching to the partner is of great importance for *M. spicilegus*, because in the cold period of the year the individuals live in groups. The positions during the olfactory contacts depend on the situation and on the social status of the partners and are particular for individuals from different mounds, as well as for individuals inhabiting the same mound. Among all the olfactory contacts the most numerous are the nasal-nasal ones. Between familiar individuals these contacts are short in time, less numerous and no-tense, by comparing with those between unknown individuals from different mounds. According to the obtained data, if the individuals are from different mounds, than the nasal-nasal contacts last 1-2 minutes, the individuals rise on posterior members and "scan" each other.

The approaching to the partner is an index that indicates the rank of the individual in group and in mound. The most numerous approaching to partners, as well as other olfactory contacts were registered in the first 5 minutes of the experiment. The individuals with weak CNS type are more curious, they more frequently approach to the partner.

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## ORIENTATION – EXPLORATORY BEHAVIOUR OF THE MAIN SMALL RODENT SPECIES INHABITING THE AGROECOSYSTEMS

ANDREI MUNTEANU, NELLI CEMIRTAN, ANATOL SAVIN, VICTORIA NISTREANU

**Abstract.** *The orientation-exploratory behaviour of the most spread four species of small rodent inhabiting the agroecosystems of Moldova was studied by open field method. These species have a significant economic importance and their populations' social-ethological structure is different. The sex and species differences of the studied indexes were emphasized.*

**Keywords:** *small rodents, orientation-exploratory behaviour, agroecosystems.*

**Rezumat.** *Comportamentul de orientare-cercetare a speciilor de fondal de rozătoare mici din agroecenoze. Prin metoda "câmpului deschis" a fost studiat comportamentul de orientare-cercetare a celor mai răspândite patru specii de rozătoare mici care populează agroecenozele Moldovei. Aceste specii au o importanță economică semnificativă, iar structura social-etologică a populațiilor lor este diferită. Au fost evidențiate diferențe de sex și de specie ale indicilor studiați.*

**Cuvinte cheie:** *rozătoare mici, comportament de orientare-cercetare, agroecenoze.*

### INTRODUCTION

In the life of every animal the capacity of orientation in time and space is of great importance. It is based on the orientation reflex, which after Pavlov's words is the reflex "what is it?" that allows to quickly react to the environment modifications, to adapt, to duly avoid the danger etc. Therefore we decided to study out if there are some sex and species related differences in exploratory behaviour of the animals with different social-ethological structure of the populations. As research objects individuals of both sexes of four small mammal species inhabiting the Moldova agroecoenoses were selected: *Apodemus uralensis* (PALLAS, 1811), *Microtus arvalis* (PALLAS, 1879), *Mus spicilegus* (PETENYI, 1882) and *Mus musculus* (LINNAEUS, 1758). The first species is widely spread in agro- and zoocoenoses, has a dynamic social structure: before the beginning of reproduction it has a solitary way of life, in the reproduction period it forms family groups with various social structure (MUNTEANU & CEMIRTAN, 2001; MUNTEANU, 2006). In summer, the new born individuals migrate on new territories for reproduction and restoring the species number after the winter period, while in autumn the species form numerous groups for more successful surviving during the winter. *M. arvalis* is a colonial species that inhabits the biotopes with abundant vegetation (alfalfa fields, abandoned gardens with tall herbaceous vegetation etc.) in separate colonies. The population social structure of this species is more static: the animals reproduce and survive the unfavourable winter conditions in colonies.

The next study objects are two representative of the house mouse that are closely related species with various degree of synanthropy: the true synanthrope *M. musculus* (after the classification of KOTENKOVA & MUNTEANU, 2007), inhabiting the human buildings, and *M. spicilegus*-typical inhabitant of agroecoenoses. The population structure of the last two species is also different. *M. spicilegus* have a solitary-family way of life during the vegetation period, while at the end of summer-beginning of autumn, the representatives of this species start to build mounds from stalks and seeds of cereal. The mounds have a raised above ground part that contains the food reserves and a complex levelled underground architecture of galleries and nests, where the animals survive during the unfavourable winter conditions and where the first generation of new vegetative year is forming. The social-ethological structure of *M. musculus* population is different: the house mouse forms the so called "demes", which represent relatively stable family groups with complex hierarchic structure (ZORINA et al., 2002). Therefore, it was interesting to compare the characteristics of the above mentioned animal species exploratory behaviour.

### MATERIAL AND METHODS

The studies were accomplished in summer and autumn period. The field vole was caught in alfalfa fields (20 males and 20 females), *A. uralensis* (17 males and 18 females) and *M. spicilegus* (15 males and 15 females) - in forest shelter belts around these fields, and *M. musculus* (11 males and 12 females)-in human buildings.

The exploratory behaviour of the adult individuals from both sexes of the four analysed species was studied in open field (HUGHES, 1978). The animals were placed for 15 min in the open field device and during every 3 minutes the following indexes were noted: *the horizontal activity* (e.g. the number of crossed squares that characterize the locomotor activity and is formed by two components: the proper exploratory behaviour and the emotional reaction to new environment and wish to escape from it), *the vertical activity* (the number of vertical stands that characterise the exploratory behaviour) and the latent period of exit from the portable cage into the open field chamber (seconds).

## RESULTS AND DISCUSSIONS

**Latent period.** At the comparison of latent period values in the four studied small mammal species some sex and species differences were registered. The more significant oscillations were observed in females: from  $37.5 \pm 3.53$  sec in *M. musculus* to  $180.0 \pm 37.0$  in *A. uralensis*, in *M. spicilegus* the latent period was  $106.0 \pm 18.0$  sec and  $85.9 \pm 18.9$  sec in *M. arvalis*. In males the index fluctuation was lower: from  $84.31 \pm 1.45$  sec in *M. musculus* to  $160.0 \pm 31.8$  sec in *M. spicilegus* and  $146.24 \pm 28.41$  sec in *A. uralensis*. In field vole the latent period was  $116.0 \pm 22.4$  sec. Thus, except the herb field mouse, the latent period values of the females are lower than those of the males, while the increasing of the latent period values was recorded in the following succession: *M. musculus*, *M. arvalis*, *M. spicilegus*, *A. uralensis*, furthermore, at the last species the female latent period index was slightly higher than that of the males (Fig. 1).

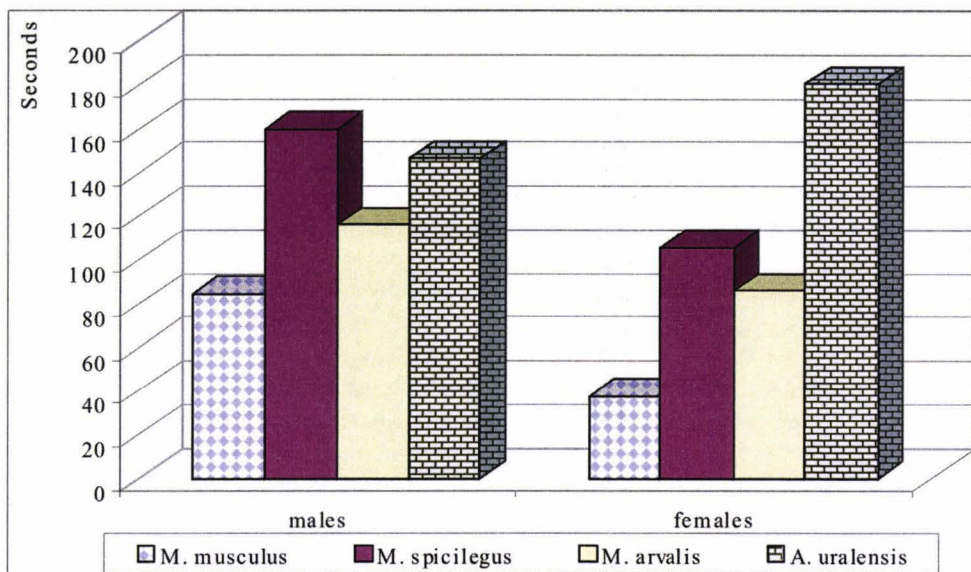


Figure 1. Latent period of males and females in the studied species.

Figura 1. Perioada de latență la masculii și femelele speciilor studiate.

**Horizontal activity.** The total horizontal activity (number of crossed squares during 15 min as a whole) and the index dynamics every 3 minutes of the individual activity in open field chamber were studied. In males the values of the total horizontal activity varied from  $233.84 \pm 19.3$  (in *A. uralensis*) to  $453.0 \pm 66.1$  (in *M. musculus*, Fig. 2), while in females—from  $300.3 \pm 27.8$  (in *M. spicilegus*) to  $429.4 \pm 33.4$  (in *M. musculus*). We have to mention that the absolute values of female and male total horizontal activity of the same species showed practically no differences, except *A. uralensis*, where in the females this index was 1.5 times higher than in males ( $362.25 \pm 49.86$  and  $233.84 \pm 19.3$  respectively).

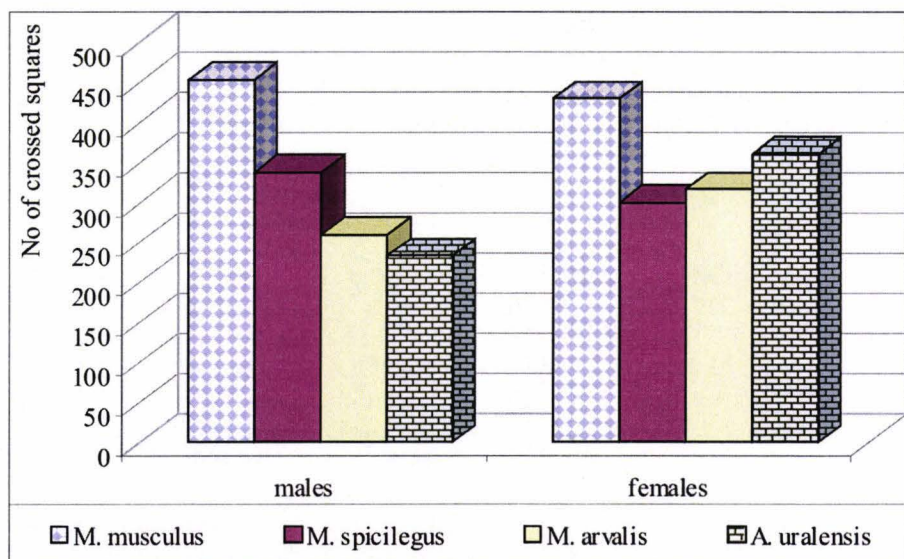


Figure 2. Total horizontal activity of the studied species.

Figura 2. Activitatea orizontală sumară la speciile studiate.



The open field behaviour strategy of both sexes of the studied species was similar, e.g. the highest values of the motor activity index was registered in the first minutes of the experiment, then smooth or sharp decreasing of the indexes occurred and reached minimum values at the end of the experiment (Fig. 4-7, A). Also, species and sex differences in horizontal activity dynamics were recorded.

Hence, in *M. arvalis* and *M. spicilegus* the curves of male and female indexes of the same species and the interspecific indexes were as a whole similar after their configuration, as well as after the absolute values (Fig. 5-6, A).

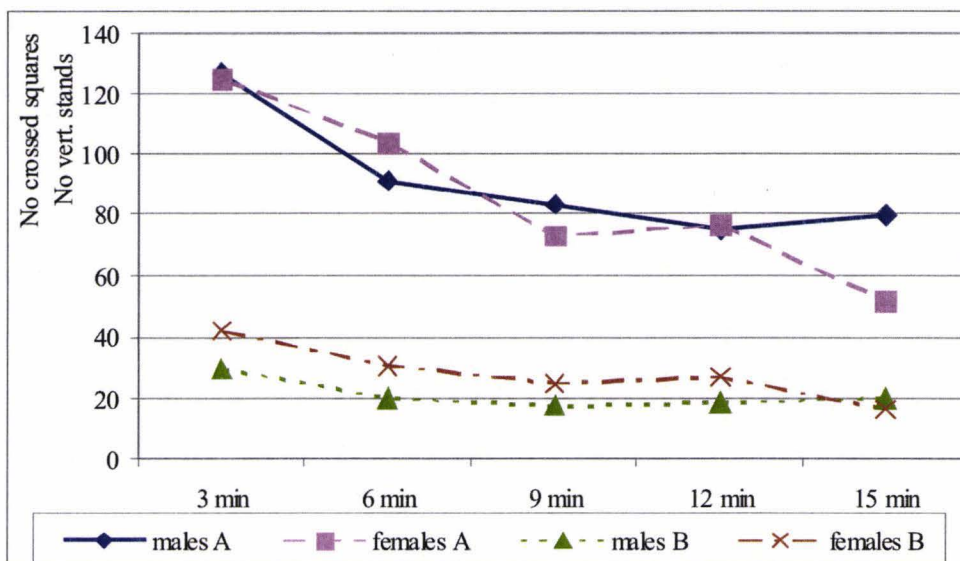


Figure 3. Dynamics of horizontal (A) and vertical (B) activity in *M. musculus*.

Figura 3. Dinamica activității orizontale (A) și verticale (B) la *M. musculus*.

In *A. uralensis*, although the index dynamics had the analogical configuration with the above mentioned species, the absolute values of female horizontal activity were significantly higher then those of the males (Fig. 7, A), which, at it turn, correlated with the mentioned above peculiarities of total locomotor activity of the species. The females were more emotive and more curios then the males (the first one was confirmed by the higher indexes of locomotor activity and the second one-by the last minutes of open field activity).

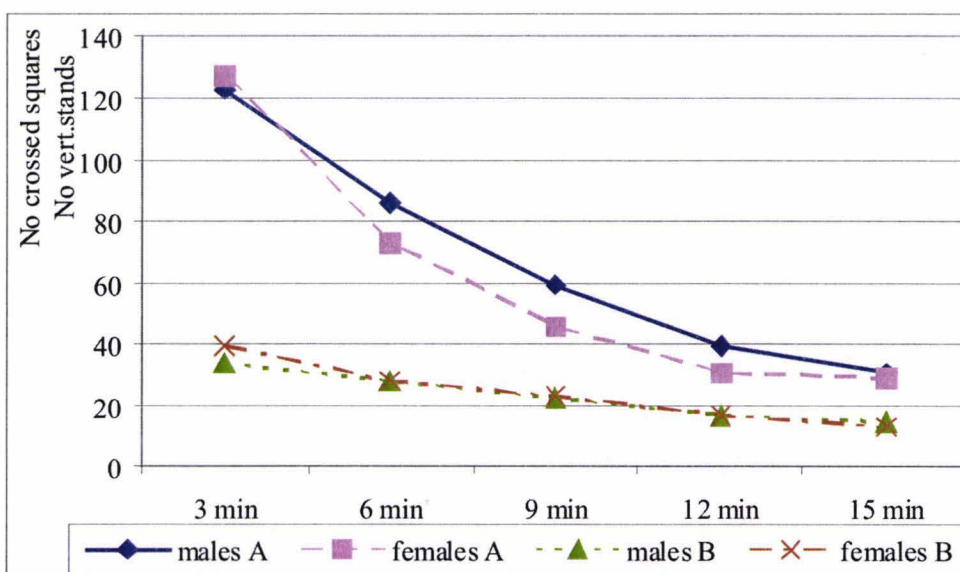


Figure 4. Dynamics of horizontal (A) and vertical (B) activity in *M. spicilegus*.

Figura 4. Dinamica activității orizontale (A) și verticale (B) la *M. spicilegus*.

The open field behaviour of *M. musculus* was different from that of other studied species. Although the values of horizontal activity in the first minutes of the experiment were practically similar to the above species, the index dynamics is different: in males at the 6<sup>th</sup> minute the decreasing of the horizontal activity was recorded, after that its value practically did not change until the end of the experiment. In females up to the 12<sup>th</sup> minute gradual decreasing of locomotor activity was registered, but after that its value remained to the analogous one of the males, and only on the

15<sup>th</sup> minute more significant decreasing of the horizontal occurred, although its absolute value still was high and significantly exceeded the similar index of the other three studied species (Fig. 4, A). The higher levels of horizontal activity dynamics revealed in *M. musculus* males and females match with the previously registered maximum indexes of total locomotor activity of this species.

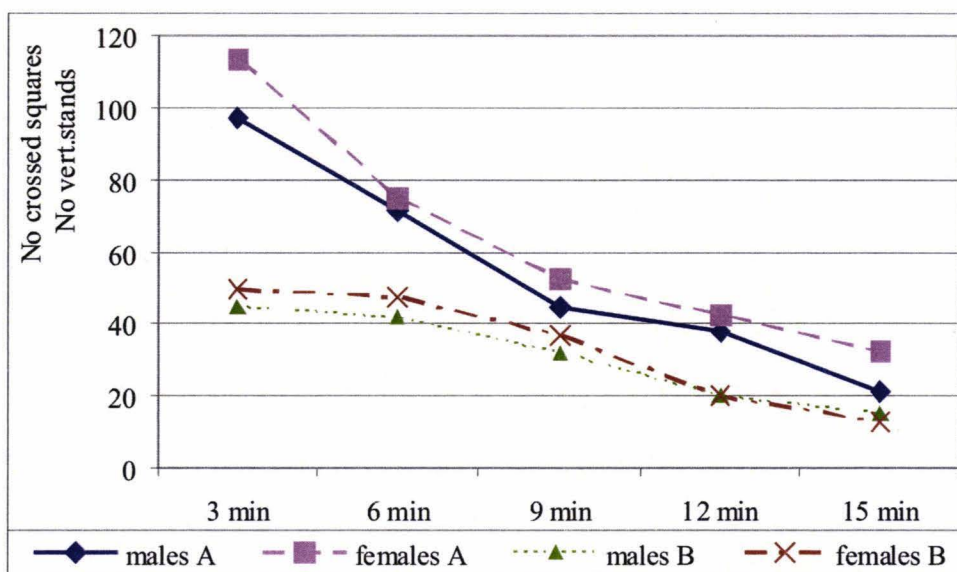


Figure 5. Dynamics of horizontal (A) and vertical (B) activity in *M. arvalis*.

Figura 5. Dinamica activității orizontale (A) și verticale (B) la *M. arvalis*.

The high indexes of locomotor activity in the first minutes of presence in a new environment prove high emotional reaction of the animals toward new conditions, while the decreasing of the index proves the gradual accustoming to it and the low values in the last minutes of the experiment prove the adaptation to the new conditions. That is the behaviour strategy of three of the studied species, except the house mouse. The high indexes of horizontal activity during practically the whole experiment and, especially, toward its end allow to conclude that to adapt to new conditions *M. musculus* needs significantly more time than other species, fact that is probably justified from evolutionary point of view, taking into account the life way of the animal and its proximity to human beings.

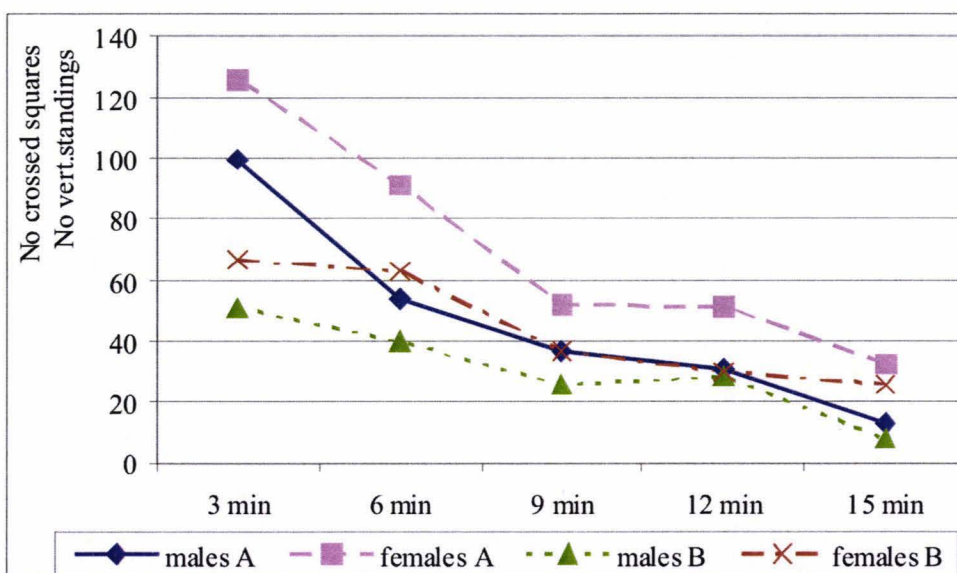


Figure 6. Dynamics of horizontal (A) and vertical (B) activity in *A. uralensis*.

Figura 6. Dinamica activității orizontale (A) și verticale (B) la *A. uralensis*.

**Vertical activity.** If the horizontal activity is a summarized index, the vertical activity characterizes the proper exploratory behaviour of the animals in open field conditions. Fig. 7 reflects the total vertical activity of the studied species. The minimum indexes of exploratory activity were revealed at the representatives of genus *Mus* in males, as well as in females, the higher ones-in field vole and in males of herb field mouse and the maximum indexes-in females



of herb field mouse. At the comparison of total vertical activity values with the similar values of horizontal activity (Fig. 2) it was obviously revealed the high emotionality of *M. musculus* representatives (the highest among the studied species), followed by *M. spicilegus* males and females. The males of *M. arvalis* and *A. uralensis* showed low levels of emotional reaction and high values of exploratory activity, while the females of these species showed high degree of emotional reaction toward new environment, as well as high level of exploratory activity. Furthermore, the females of the last species proved to be the most curious among the studied animals.

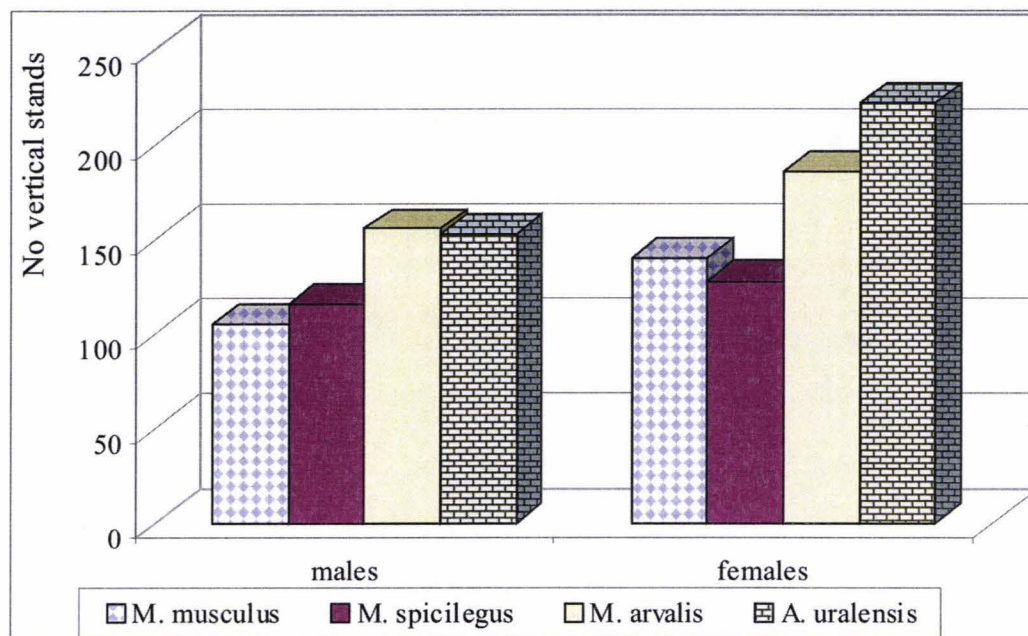


Figure 7. Total vertical activity of the studied species.  
Figura 7. Activitatea verticală sumară a speciilor studiate.

The curves of vertical activity dynamics of the studied animal species (Figs. 4-7, B) correspond to the logic of summarized activity. Thus, in *Mus* representatives the lowest exploratory behaviour values were registered by comparing them with other species. The low values of exploratory behaviour at the beginning of the experiment even decreased toward the 6<sup>th</sup> and 9<sup>th</sup> minutes then remained practically at the same level up to the end of the experiment (Figs. 4 B, 5 B). In *M. spicilegus* there were no sexual differences in vertical activity dynamics, while in house mouse females its indexes were slightly higher than in males up to the 12<sup>th</sup> minute of animal activity in the experimental chamber. In the first 9 minutes in *M. arvalis* and the first 12 minutes in *A. uralensis* the levels of exploratory activity in open field were significantly higher than in *Mus* representatives, furthermore in *A. uralensis* the sexual differences of the index are obvious.

## CONCLUSIONS

Taking into account the above results we can conclude that in spite of the universality of orientation-exploratory reflex, each studied species has its own qualitative and quantitative characteristics.

### 1. Latent period

As a whole the latent period in the females was lower than in the males of all the studied species except *A. uralensis*. The species differences of the index consisted in the increasing of its value in the following sequence: *M. musculus*, *M. arvalis*, *M. spicilegus*, *A. uralensis*.

### 2. Horizontal activity

The maximum indexes of total horizontal activity were emphasized in *M. musculus* males and females, the minimum ones-in *A. uralensis* males.

The absolute values of this index in representatives of different sexes of the same species were practically similar, except *A. uralensis* which registered a 1.5 times higher index in females than in males.

The strategy of individuals from both sexes in open field was similar (high emotional reaction toward new conditions in the first minutes of the experiment, gradual habituation and complete adaptation at the end of the experiment), although it had species (*M. musculus*) and sex (*A. uralensis*) differences.

### 3. Vertical activity

Minimum indexes of total exploratory activity were revealed in *M. musculus* and *M. spicilegus* at the representatives of both sexes and the maximum ones-in *A. uralensis* females.



The dynamics of vertical activity in the studied animals corresponded to the summarized one: in *Mus* individuals the lowest values of exploratory behaviour were registered, in other two species-higher values and in *A. uralensis* males -the highest ones. In the last species the sexual dimorphism of the index was also recorded.

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## THE ROLE OF MICROMAMMALS IN THE MAINTENANCE OF LEPTOSPIROSIS FOCI IN THE REPUBLIC OF MOLDOVA

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**Abstract.** The study was conducted between 2006 and 2008 using the zoological and ecological-epizootological methods. In the study period 22 micromammal species (15 rodents and 7 insectivores) were registered on the territory of the republic. Out of these species 18 were caught in traps in all studied zones, including Chisinau city. The study revealed the intense circulation of leptospirosis causative agent in 2 of 3 geographical zones of the republic: the northern (7.9%) and central-Chisinau city (2.8%). In epizootic circulation of leptospirosis on the territory of the Republic 12 MM species from 18 studied are involved. High leptospirosis contamination rates were identified in species with major epidemiologic potential-*R. norvegicus* (32.7%), *A. sylvaticus* (21.8%) and *A. agrarius* (20.9%). The relevant serological groups belong to *L. gryppotyphosa*-40.9%, *L. icterohaemorrhagiae*-34.5%, which are frequently determined in outbreaks of human leptospirosis. On the republic territory there are biocenotic microcomplexes with favourable conditions for the development and maintenance of pathogen agent, but the intense anthropogenic activities place them closer and closer to localities, where there is permanently necessary to accomplish combating measures of the reservoir and epidemiologic surveillance.

**Keywords:** leptospires, leptospirosis, biotope, natural outbreaks, epizootological study, micromammals.

**Rezumat.** Rolul micromamiferelor în menținerea focarelor de leptospiroze în Republica Moldova. Cercetările au fost efectuate în 2006-2008 cu utilizarea metodelor zoologice și ecologo-epizootologice. În perioada de studiu pe teritoriul republicii au fost înregistrate 22 specii de micromamifere (15 rozătoare și 7 insectivore). Dintre acestea 18 specii au fost capturate cu capcane în toate zonele studiate, inclusiv municipiul Chișinău. Studiul a evidențiat circulația intensă a agentului cauzal al leptospirozei în 2 din 3 zone geografice a republicii: de nord (7,9%) și centrul municipiului Chișinău (2,8%) cu antrenarea în circuitul epizootic a 12 specii de mamifere mici din cele 18 investigate pe teritoriul republicii. Cote înalte de contaminare cu leptospire au fost identificate la specii cu potențial epidemiologic major *R. norvegicus* (32,7%), *A. sylvaticus* (21,8%) și *A. agrarius* (20,9%). Grupele serologice relevante aparțin *L. gryppotyphosa*-40,9%, *L. icterohaemorrhagiae*-34,5%, frecvent determinate în focarele de leptospiroză umană. Pe teritoriul republicii există microcomplexe biocenotice cu condiții favorabile pentru dezvoltarea și menținerea agentului patogen, însă activitățile antropogene intense le apropie tot mai mult de localități, unde sunt necesare măsuri permanente de combaterea a rezervorului și supravegherea epidemiologică.

**Cuvinte cheie:** leptospire, leptospiroză, biotop, focar natural, cercetare epizootologică, micromamifere.

### INTRODUCTION

Leptospirosis is a zoonosis with global distribution that affects human population from the continents with tropical and temperate climate, being presently identified as an important emerging infectious disease in many countries (LEVETT, 2001; RICALDI & VINETZ, 2006). This disease is known as a global public health problem, because of its increasing incidence in both developing and economically advanced countries.

Leptospirosis reservoir includes a great number of wild animal species, especially small mammals and domestic animals (cattle and swine), which after infecting with the pathogenic agent of leptospirosis survive and disseminate the pathogenic agent with the urine in the environment during a long period (MAGDEI et al., 1998; VIEIRA et al., 2006; VINETZ et al., 2005; SHLYAKHOV, 1986).

In nature, practically all mammal species can be indicated as a leptospirosis source, but the most important are the rodents and the insectivores that represent the true living environment, particularly favourable for leptospirosis hosting, reproduction and dissemination (WHO, 2003).

In the Republic of Moldova, a potential risk of infection is maintained on the territories where leptospirosis carrier status was registered in wild animals and in domestic animals diseases or where the status of asymptomatic carriers was registered. These territories are considered as leptospirosis foci and are classified in natural, anthropogenic and mixed ones. According to the data published in the Republic of Moldova two foci types can be mentioned: natural and anthropogenic (COTOFANA et al., 1987; PRISACARI, 1993).

The natural leptospirosis outbreaks can be usually traced in swampy zones, floated meadows, near streams or stagnant water basins. In these outbreaks the pathogen agent circulates within the population of wild animals (BELOUS et al., 1989; PRISACARI, 1993; SHLYAKHOV, 1986). The micromammal (MM) species from Rodentia and Insectivora orders, the spreading area of which includes wet biotopes, constitute the infection reservoir: the rat (*Rattus* sp.), mice and vole species (*Mus* sp., *Apodemus* sp., *Arvicola* sp., *Microtus* sp.). The limits of these outbreaks are determined by landscape-geographical and climatic conditions (humidity, temperature etc.), as well as by faunistic ones (diversity of vertebrate populations as hosts for leptospirosis pathogenic agent) (BHARTI et al., 2003; LEVETT, 2001; PRISACARI, 1986).

The anthropogenic outbreaks are not characterized by landscape-geographic peculiarities of the territory and can occur in rural localities, as well as in urban ones. The formation of these outbreaks is determined by the appearance of infected or leptospirosis carrier animals in farms, enterprises, etc. The sick animals eliminate the leptospire in urine thus contaminating the environment components (water, forage plants, grass etc.) through which the healthy animals are infected. The infection of animals in anthropogenic foci is registered all over the year, while in the case of animals kept in pasturage the infection occurs during pasturing.

The intense anthropogenic activity in the Republic of Moldova from the last decades contributed to the considerable reduction of the territories in which natural outbreaks were registered. The intensification of anthropogenic activity such as large swamp area drying up and their use, partial land cultivation with formation of mosaic aspect of cultivated and abandoned sectors led to the involvement of a large number of people contacting with the elements of natural biotypes.

Still, in the Republic there remain meadow-swamp, forest and steppe biotopes that allow the existence of stable zoonoses outbreaks including leptospirosis.

The recent results of ecological-epizootological studies confirm the existence of mixed outbreaks in our country at present, determined by the absence of large areas inaccessible for man. Practically all the country territories, including the forests and wet ecosystems are subject of anthropogenic transformations, fact that excludes the possibility of strict delimitation of natural and artificial outbreaks.

## MATERIAL AND METHODS

To accomplish the study different territories were selected in order to determine the evolution and peculiarities of leptospirosis event at present. With this purpose, 380 various biotopes in different ecosystems from all the zones of Moldova were studied. The study was conducted between 2006 and 2008 using the following methods: zoological and ecological-epizootological. Small mammals were caught using Hero snap traps. After sacrificing the trapped mammals, blood was collected from heart. The serological examination was done using microagglutination test (MAT). MAT was performed on all samples using a panel of 15 serovars of *Leptospira*: *L. icterohaemorrhagiae*, *L. pomona*, *L. hebdomadis*, *L. grippityphosa*, *L. australis*, *L. canicola*, *L. iavanica*, *L. ballum*, *L. autumnalis*, *L. tarassovi*, *L. batavia*, *L. cynopteri*, *L. sejroe sejroe*, *L. hardjo*, *L. wolffi*.

As a whole 19,920 traps/day were performed and 3,691 MM were caught. 3,473 specimens were examined in laboratory; the rest of MM could not be determined and examined due to their damaged conditions. Nevertheless, these specimens were taken into account while determining seasonal, annual and multiannual population density indices.

During species identification the following statistical parameters of corporal biometric indices were calculated: body length (LCORP), tail length (LCD), tarsus length (LTARS) in millimetres and body weight (G) in grams. To characterize the biotopic distribution of the species the frequency index was calculated (BALOGH, 1958):

$F = \frac{100p}{P}$ , where  $P$  - number of samples,  $p$  - samples in which the species is present, and the index of species

dominance (abundance) after the formula  $D = \frac{100 n}{N}$ , where  $n$  - individual number of certain species in sample,  $N$  -

total individual number. Trappability index:  $C_c = \frac{100 n}{N}$  where  $n$  - number of traps that have caught animals,  $N$  - total

number of traps. All indices are expressed in percents.

## RESULTS AND DISCUSSION

In the study period 2006-2008, on the territory of the republic there were registered 22 MM species (15 rodents and 7 insectivores). Out of these species 18 MM species were caught in traps in all the studied zones, including Chisinau city (Table 1).

Table 1. Species diversity and number of micromammals registered in different zones of the Republic of Moldova.  
Tabel.1 Diversitatea speciilor de micromamaliai întâlnite în diferite zone a Republicii Moldova.

Nr	MM species	Northern zone	Central zone	Southern zone	Chisinau	Total
1.	<i>Dryomys nitedula</i>	0	5	1	0	6
2.	<i>Muscardinus avellanarius</i>	4	1	0	1	6
3.	<i>Clethrionomys glareolus</i>	130	147	34	25	336
4.	<i>Arvicola terrestris</i>	7	7	6	1	21
5.	<i>Microtus arvalis</i>	43	35	38	26	142
6.	<i>Microtus subterraneus</i>	3	16	0	1	20
7.	<i>Apodemus uralensis</i>	86	82	249	9	426
8.	<i>Apodemus sylvaticus</i>	158	137	191	258	744
9.	<i>Apodemus flavicollis</i>	140	175	217	66	598
10.	<i>Apodemus agrarius</i>	410	220	88	71	789
11.	<i>Mus musculus</i>	118	70	134	15	337

12.	<i>Micromys minutus</i>	3	10	8	4	25
13.	<i>Rattus norvegicus</i>	76	9	11	4	100
14.	<i>Sorex minutus</i>	17	18	9	15	59
15.	<i>Sorex araneus</i>	16	28	10	1	55
16.	<i>Crocidura suaveolens</i>	13	2	4	0	19
17.	<i>Crocidura leucodon</i>	1	0	4	0	5
18.	<i>Neomys anomalus</i>	0	1	1	0	2
	Total individuals	1225	963	1005	497	3691

The species that were determined by direct field observations or as a result of vital activity traces and were not included in table 1 are the following: squirrel (*Sciurus vulgaris*), mound building mouse (*Mus spicilegus*), hedgehog (*Erinaceus europaeus*) and mole (*Talpa europae*).

In 12 species of 18 MM recorded in the country, leptospirosis positive results were registered, which suggests high species diversity involved in the epizootic process (Table 2). From the total number (3,473 MM) of the studied MM in 3.2% were established leptospirosis positive results. Among the species with *Leptospira*, some species were dominant and subdominant in various biotopes.

Table 2. Micromammal species diversity with leptospirosis positive results.  
Tabel 2. Diversitatea speciilor de micromamalii cu rezultate pozitive de leptospiroză.

Nr.	MM species	caught MM	studied MM	infected MM	% of MM species with <i>Leptospira</i> out of the total no of positive results
1.	<i>Dyromys nitedula</i>	6	6	-	-
2.	<i>Muscardinus avellanarius</i>	6	6	1	0.9
3.	<i>Clethrionomys glareolus</i>	336	307	2	1.8
4.	<i>Arvicola terrestris</i>	21	21	2	1.8
5.	<i>Microtus arvalis</i>	142	132	3	2.7
6.	<i>Microtus subterraneus</i>	20	16	-	-
7.	<i>Apodemus uralensis</i>	426	415	2	1.8
8.	<i>Apodemus sylvaticus</i>	744	733	24	21.8
9.	<i>Apodemus flavicollis</i>	598	593	10	9.1
10.	<i>Apodemus agrarius</i>	789	703	23	20.9
11.	<i>Mus musculus</i>	337	298	5	4.5
12.	<i>Micromys minutus</i>	25	25	-	-
13.	<i>Rattus norvegicus</i>	100	98	36	32.7
14.	<i>Sorex minutus</i>	59	45	1	0.9
15.	<i>Sorex araneus</i>	55	48	1	0.9
16.	<i>Crocidura suaveolens</i>	19	19	-	-
17.	<i>Crocidura leucodon</i>	5	5	-	-
18.	<i>Neomys anomalus</i>	2	2	-	-
	Total MM	3691	3473	110	100.0

The obtained data confirm that in one species more *Leptospira* serogroup can be detected (Table 3). In harvest field mouse (*A. agrarius*) species, it was registered the highest diversity of leptospire species (*Leptospira icterohaemorrhagiae*, *L. pomona*, *L. gryppotyphosa*, *L. ballum*). In the case of house mouse (*M. musculus*) and yellow necked mice (*A. flavicollis*), 3 *Leptospira* serogroups were revealed, while in rat (*R. norvegicus*) and water vole (*A. terrestris*) - 2 *Leptospira* serogroups.

Table 3. The etiological structure of leptospirosis in micromammals.  
Tabel 3. Structura etiologică a leptospirelor la micromamalii.

Nr	MM Species	caught MM	studied MM	infected MM	Serogroups					
					<i>L. gryppotyph</i>	<i>L. icterohaem</i>	<i>L. ballum</i>	<i>L. pomona</i>	<i>L. automnalis</i>	<i>L. javanica</i>
1.	<i>M. avellanarius</i>	6	1	16.7	1	-	-	-	-	-
2.	<i>C. glareolus</i>	307	2	0.7	2	-	-	-	-	-
3.	<i>A. terrestris</i>	21	2	9.5	1	1	-	-	-	-
4.	<i>M. arvalis</i>	132	3	2.3	3	-	-	-	-	-
5.	<i>A. uralensis</i>	415	2	0.5	2	-	-	-	-	-
6.	<i>A. sylvaticus</i>	733	24	3.3	22	-	-	2	-	-
7.	<i>A. flavicollis</i>	593	10	1.7	5	-	-	4	1	-
8.	<i>A. agrarius</i>	703	23	3.3	6	4	1	12	-	-
9.	<i>M. musculus</i>	298	5	1.7	2	1	-	2	-	-
10.	<i>R. norvegicus</i>	98	36	36.7	-	32	-	-	-	4
11.	<i>S. minutus</i>	45	1	2.2	-	-	-	-	-	1
12.	<i>S. araneus</i>	48	1	2.1	1	-	-	-	-	-
	Total	3399	110		45	38	1	20	1	5



It is necessary to mention that in some species, for example in *Rattus norvegicus*, the highest proportion among leptospire belongs to *L. icterohaemorrhagiae*, which constitute 32.7% from the total number of studied MM. This fact proves the importance of *R. norvegicus* species in *L. icterohaemorrhagiae* maintaining in the environment. The *L. icterohaemorrhagiae* serogroup was detected in 3 more species from the 12 studied.

The tableau analysis of leptospirosis in MM in 2006-2008 (Fig. 1) revealed the presence of 6 leptospire serogroups (*L. icterohaemorrhagiae*, *L. pomona*, *L. gryppotyphosa*, *L. javanica*, *L. batavia*, *L. autumnalis*).

In the epizootic process 12 MM species caught in the northern zone of the country are involved (Table 4). In 7.9% of studied MM, 4 leptospire serogroup were detected from the 6 ones recorded on the territory of our country. Out of the total number of infected MM the highest infection rate-47.4% was recorded in *R. norvegicus* species, followed by *A. terrestris* (28.6%). Among the MM species with positive results out of total number with *Leptospira* the highest ratio was recorded by *R. norvegicus*, *A. agrarius* and *A. sylvaticus*, the last two species being dominant in the mentioned areas.

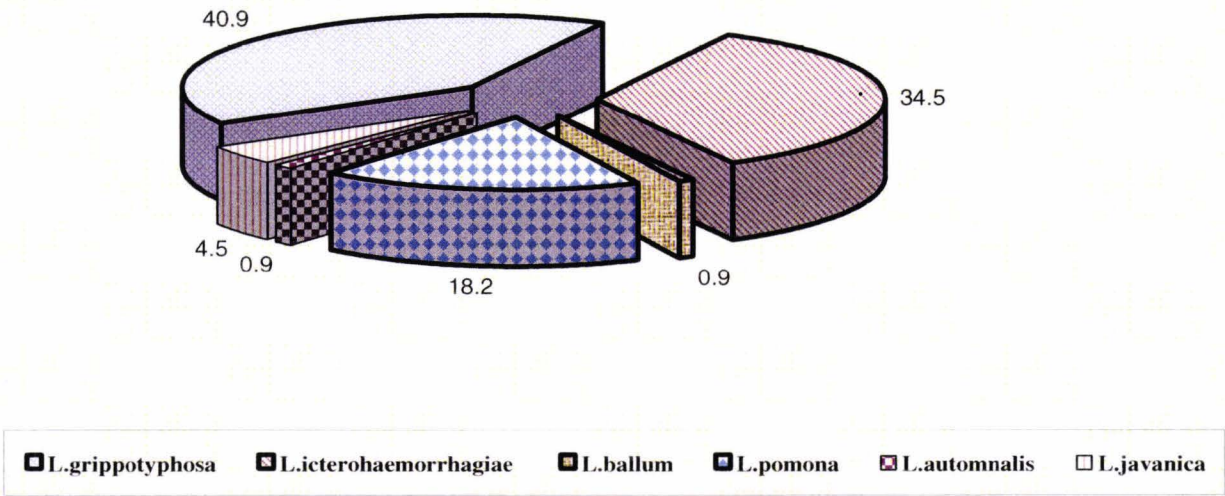


Figure 1. The leptospirosis representation in MM.  
Figura 1. Reprezentarea leptospirelor la MM.

It is necessary to mention that the highest significance was registered in *L. gryppotyphosa*-40.9% and *L. icterohaemorrhagiae*-34.5% serogroups.

These data confirm the relatively intense circulation of leptospirosis agent among various populations of MM species in the northern zone that maintain the risk of environmental objects contamination and leptospirosis contact by humans.

In laboratory conditions 1,910 MM individuals were investigated from the central and southern zones. There were not detected positive results at leptospirosis in these zones of the Republic of Moldova.

Table 4. Results of leptospirosis epizootological studies in the northern zone.  
Tabel 4. Rezultatele cercetărilor epizootologice la leptospiroză în zona de nord.

MM diversity	studied MM	No of positive results	% of infected MM	% of MM species with <i>Leptospira</i> out of total no of positive results	serogroups			
					L. gryppotyph.	L. icterohaem	L. pomona	L. javanica
<i>M. avellanarius</i>	4	1	25.0	1.0	1	-	-	-
<i>C. glareolus</i>	130	2	1.5	2.1	2	-	-	-
<i>A. terrestris</i>	7	2	28.6	2.1	1	1	-	-
<i>M. arvalis</i>	43	3	7.0	3.1	3	-	-	-
<i>M. subterraneus</i>	3	-	-	-	-	-	-	-
<i>A. uralensis</i>	86	2	2.3	2.1	2	-	-	-
<i>A. sylvaticus</i>	158	17	10.8	17.5	17	-	-	-
<i>A. flavicollis</i>	140	9	6.4	9.3	5	-	4	-
<i>A. agrarius</i>	410	18	4.4	18.6	3	4	11	-
<i>M. musculus</i>	118	5	4.2	5.2	2	1	2	-
<i>M. minutus</i>	3	-	-	-	-	-	-	-
<i>R. norvegicus</i>	76	36	47.4	37.1	-	32	-	4
<i>S. minutus</i>	17	1	5.9	1.0	-	-	-	1
<i>S. araneus</i>	16	1	6.3	1.0	1	-	-	-
<i>C. suaveolen.</i>	13	-	-	-	-	-	-	-
<i>C. leucodon</i>	1	-	-	-	-	-	-	-
Total	1,225	97	7.9	-	37	38	17	5
Serogroup rate (%)	-	-	-	-	38.1	39.2	17.5	5.2



In Chisinau city the ecological-epizootological studies in various biotypes were accomplished only in 2008. The capture rate in the first semester proved to be 3.4% (Table 5).

The average indexes of MM number in the winter-spring period in different biotypes (agroconoses, urban biotopes, wet biotopes and forest biotopes-forest shelter belts, recreational sectors) represented 3.6% in February and 4.4% in March versus multiannual average of the index (8.8% in the last 8 years). In forest biotopes this index was 2.9%, in wet biotypes-7.3% and in agroconoses with scrub and tree vegetation it constituted 6.0%. Among the registered MM species caught in Chisinau city the dominant species proved to be the red vole (*C. glareolus*) with 48.3%, and the subdominant species-the yellow necked mouse (*A. flavicollis*) with 17.1%. During the first half of the year 7 MM species were registered, in the second one-13 MM species. The mean trappability rate in the second semester was 39.4%. The dominant species was the wood mice with 54.8%, the subdominant ones were the harvest field mice (*A. agrarius*)-14.8% and the yellow necked mouse (*A. flavicollis*)-12.9% from the total number of caught MM.

Table 5. Results of leptospirosis epizootological studies in Chisinau city in 2008.  
Tabel 5. Rezultatele cercetărilor epizootologice la leptospiroză în orașul Chișinău în anul 2008.

MM species	1 <sup>st</sup> semester		2 <sup>nd</sup> semester			serogroups			
	No of caught MM	No of studied MM	No of caught MM	No of studied MM	No of positive results	<i>L. grippotyph.</i>	<i>L. batavia</i>	<i>L. pomona</i>	<i>L. autumnalis</i>
<i>M. avellanarius</i>	-	-	1	1	-	-	-	-	-
<i>C. glareolus</i>	14	14	11	11	-	-	-	-	-
<i>A. terrestris</i>	-	-	1	1	-	-	-	-	-
<i>M. arvalis</i>	-	-	26	26	-	-	-	-	-
<i>M. subterraneus</i>	-	-	1	1	-	-	-	-	-
<i>A. uralensis</i>	5	5	4	4	-	-	-	-	-
<i>A. sylvaticus</i>	3	3	255	255	7	5	-	2	-
<i>A. flavicollis</i>	6	6	60	60	1	-	-	-	1
<i>A. agrarius</i>	2	2	69	69	5	3	1	1	-
<i>M. musculus</i>	-	-	15	15	-	-	-	-	-
<i>M. minutus</i>	-	-	4	4	-	-	-	-	-
<i>R. norvegicus</i>	-	-	4	4	-	-	-	-	-
<i>S. minutus</i>	1	1	14	14	-	-	-	-	-
<i>S. araneus</i>	1	1	-	-	-	-	-	-	-
Total MM	32	32	465	465	13	8	1	3	1
Total traps/days	955	-	1,180	-	-	-	-	-	-
Rate of caught MM (%)	3.4	-	39.4	-	-	-	-	-	-
Species no	7	-	13	-	-	-	-	-	-
No of species carriers of leptospire	-	-	-	-	13	2	2	3	2
Rate of species carriers of leptospire (%)	-	-	-	-	2.8	-	-	-	-
Serogroup rate (%)	-	-	-	-	-	61.5	7.7	23.1	7.7

The laboratory studies revealed the presence of leptospire in 2.8% of MM investigated samples. 4 serogroups were emphasized: *L. gryppotyphosa*-61.5%, *L. pomona*-23.1%, *L. batavia* and *L. autumnalis*-7.7%.

Comparing the obtained dates with previous results (PRISACARI, 1993) the rates of infected MM decrease from North to South and specimens with leptospirosis were found in all geographical zones (PRISACARI, 1993). In our study, there were not detected positive results at leptospirosis in southern zones. We can conclude that similar data were obtained about the intense circulation of leptospirosis agent among various populations of MM species in the northern zone; this fact maintains the risk of environmental objects contamination and leptospirosis contact by humans.

## CONCLUSIONS

The study revealed the intense circulation of leptospirosis causative agent in 2 of 3 geographical zones of the republic: the northern (7.9%) and central-Chisinau city (2.8%). In epizootic circulation of leptospirosis on the territory of the Republic 12 MM species from 18 studied are involved.

High leptospirosis contamination rate were identified in species with major epidemiologic potential-*R. norvegicus* (32.7%), *A. sylvaticus* (21.8%) and *A. agrarius* (20.9%)

The relevant serological groups belong to *L. gryppotyphosa*-40.9%, *L. icterohaemorrhagiae*-34.5%, which are frequently determined in outbreaks of human leptospirosis.

On the republic territory there are biocenotic microcomplexes with favourable conditions for the development and manifestation of the pathogen agent and the intense anthropogenic activities place them closer and closer to localities, where permanent epidemiologic surveillance is necessary to be accomplished.

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## CONSIDERATIONS UPON THE TEMPERATURE HUMIDITY INDEX IN OLTENIA IN THE PERIOD 2000-2007

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**Abstract.** *This paper analyses the temperature humidity index (THI), frequently used in the last 9 years in meteorological bulletins with the purpose of informing the population. We analyse the evolution of the values of this bioclimatic index in relation with heat waves, absolute maximum temperatures, monthly average temperatures, canicular days and drought in the period 2000-2007. This paper can be successfully used by specialists in climatology, meteorology, biology, by those who try to achieve a master or a doctor's degree, by students and in general by all who are interested in the problems of climatic evolution and its effects on the biosphere.*

**Keywords:** *considerations, temperature humidity index (THI), Oltenia, the period 2000-2007.*

**Rezumat.** *Considerații privind indicele de temperatură umezeală (ITU) în Oltenia în intervalul 2000-2007. Lucrarea prezintă Indicele de temperatură umezeală ITU, frecvent utilizat în buletinele meteorologice pentru informarea populației în ultimii 9 ani. Este analizată evoluția valorilor acestui indice bioclimatic, corelată cu valurile de căldură, temperaturile maxime absolute, temperaturile medii lunare, canicula și seceta, în perioada anilor 2000-2007. Lucrarea este utilă specialiștilor în domeniul climatologiei, meteorologiei, biologiei, doctoranzilor, masteranzilor, studenților și tuturor celor interesați de problemele evoluției climatice și efectele ei asupra biosferei.*

**Cuvinte cheie:** *considerații, indicele de temperatură umezeală ITU, Oltenia, perioada 2000-2007.*

### INTRODUCTION

The climate of a territory is a true resource-as the production of things necessary for the existence of the human society depends on it, this is why knowing the climatic conditions needed for the best development of multiple activities (like agriculture, viticulture, pomiculture, pisciculture, tourism) is imperative. When evaluating the climatic conditions the characteristics of diverse climatic elements are to be considered. The impact of weather and climate conditions on living organisms, including people, is monitored by bioclimatology, which studies the bioclimate.

The living organisms, the climate and the weather are complexly correlated, as the human body is constantly adapting to the environment in order to maintain its homeostasis. At present, in order to characterize the real climate conditions which might or might not be favourable to activities specific for the human society, a multitude of climatic indexes are defined and used.

Among those, the temperature humidity index (THI) or the thermal comfort index temperature humidity which is frequently used in meteorological bulletins in the warm season, has a special meaning in what concerns the effect of high temperatures on the human organism and not only. The temperature humidity index (THI), as a bioclimatic index, is a unit which indicates the human thermal comfort or discomfort, also depending on the water vapours in the atmosphere.

Starting with the summer of 2000, ANM Bucharest and the regional meteorological centres emit meteorological warnings mentioning the reaching and exceeding of the critical threshold of the thermal comfort index. These warnings are passed over to Prefectures and mass-media so that the needed protection measures mentioned in the Emergency Ordinance No 99/2000 can be taken.

The thresholds of the important values of this index and their meanings in the warning system are the following:

THI  $\leq$  65-low risk, the values between 60 and 65 are considered comfortable.  $66 \leq$  THI  $\leq$  79-state of alert. THI  $\geq$  80-high risk. The physiological meaning of the THI is shown in Table 1:

Table 1. The meaning of the THI in relation to the physiological sensation.

Tabel 1. Semnificația lui ITU după senzația fiziologică.

Values of the THI	Physiological Sensation
>85	Suffocation
80-85	Extreme Heat
75-80	Heat
60-75	Comfort
50-60	Cool
40-50	Chill
<40	Cold

As a bioclimatic index, the THI is used in Romania to establish the risk situations during the canicular days of summer. In general, in meteorological bulletins the THI is expressed adimensionally, but, concerning the physical meaning of this index we mention that it represents the temperature felt by the human body, which is calculated by dividing the value of the THI by 2. The resulting value-which exceeds the real temperature by little, is the actual

temperature felt by the human body in days with air temperatures higher than 25°C (meaning the summer days). The difference between the felt temperature (half of THI) and the actual temperature shown by thermometers in meteorological shelter, appears because of the Greenhouse Effect created by the important percentage of water vapours in the atmosphere, which, in addition, in the canicular days frequently leads to an improper ventilation of the human body, as the evaporation of the perspiration of the organism is prevented.

## MATERIAL AND METHODS

The materials which represented the base of this paper are the existent data in the archives of CMR Oltenia for the years 2000-2007 and the references to other speciality papers we consulted (BOGDAN & MARINICĂ, 2007; MARCHAND, 1986; MASTERSON & RICHARDSON, 1979; MARINICĂ & CHIMIȘLIU, 2008; MARINICĂ & MARINICĂ, 2008; STRAHLER, 1973). In the following we will present the registered temperature data in the canicular periods of 2000 and 2007. We will mention the air temperature and precipitation values which are used in the evaluation of the temperature-humidity index (THI).

### *Air temperature and precipitation values of June 2000*

In June 2000 three canicular periods were registered : June 4-10 (the canicular days were characteristic mainly to the South of Oltenia), June 13-16 and June 21-25 (BOGDAN & MARINICĂ, 2007).

The hottest days in almost all of Oltenia were on June 23, 24 and 25. The highest temperature value was 38.7°C registered at Băilești on the 23<sup>rd</sup> of June. The highest number of canicular days of June was 12, registered in Caracal. The canicular days of June determined the apparition and the installation of drought.

All the monthly average values of temperature in June 2000 exceeded the normal average values with positive differences: +1.3°C at Bechet and Calafat in Dolj County and values of almost +4.3°C at Apa Neagră in Gorj County and Băcleș in Mehedinți County.

The minimum values of precipitations (< 5 l/m<sup>2</sup>) were registered at Vârful Cozia, Târgu Jiu, Râmnicu Vâlcea, Drobeta Turnu-Severin, Halânga, Băcleș, Slatina, Caracal (and, on the whole, in the entire Olt County), mostly in the first few days of the month (and there were even areas where rains have fallen only on the 1<sup>st</sup> of June). Generally, the rains have fallen in just one day, so their effects were too small to be considered.

The highest monthly average temperature value of June was 23.3°C registered at Băcleș.

The smallest number of days with precipitations was 1, in the hills of Mehedinți, at Băcleș on the 1<sup>st</sup> of June 2000. The highest number of days with precipitation was 9 in Craiova, at the southern limit of the hilly area, but here the total monthly value was of only 12.0 l/m<sup>2</sup> (out of which 10.0 l/m<sup>2</sup> have fallen on 1<sup>st</sup> of June 2000). In 47.8% of the localities of Oltenia, most of the precipitations have fallen on 1<sup>st</sup> of June 2000. In 39.1% of the localities of Oltenia, most of the precipitations have fallen in the last three days of the month.

In 30.4% of the localities of Oltenia, the total monthly precipitation values were less than 10 l/m<sup>2</sup>. Precipitations reaching and exceeding 30 l/m<sup>2</sup> were registered only in the mountain area. None of the total monthly values exceeded 40 l/m<sup>2</sup> (40.0 l/m<sup>2</sup> being reached at only one station, Vf. Negovanu). In 52.2% of the localities of Oltenia, the precipitations were less than 20 l/m<sup>2</sup> in all June (Source-Processed Data) which in conditions of a very warm month are not to be considered.

### *Air temperature and precipitation values of July 2000*

In July 2000, two extremely intense canicular periods were recorded: the period 2-12 and the period 22-27.

The maximum temperatures reached and exceeded 43°C (43.0°C at Bechet, 43.1°C at Băilești, 43.2°C at Calafat). The maximum temperature of July 2000 for Oltenia was 43.2°C registered on the 4<sup>th</sup> of the month, at Calafat, a value very close to the absolute maximum of July, which represented a new thermal record for Oltenia (Table 2).

The highest number of days with maximum temperatures  $\geq 30^\circ\text{C}$  was 19 at Halânga-Mehedinți County, Băilești in Dolj County and Caracal in Olt County. The highest number of days with maximum temperatures  $\geq 33^\circ\text{C}$  was 15 registered at Bechet in Dolj County. The maximum values of temperature of the canicular days of July 2000 are shown in Table 2.

The highest number of days with maximum temperatures  $\geq 35^\circ\text{C}$  was 12 registered at Calafat and Bechet, in Dolj County.

The highest number of days with maximum temperatures  $\geq 40^\circ\text{C}$  was 5 registered in Bechet, in Dolj County.

The hottest days in Oltenia were the 4<sup>th</sup> and the 5<sup>th</sup> of July 2000, when the maximum temperatures exceeded 40°C in all Oltenia except the mountain area.

Toward the East and South-East of Oltenia this was the most intense canicular period in the whole meteorological observations period.

It is notable that the old absolute maximum of July in Oltenia-41.8°C, which was registered at Strehaia, Mehedinți County, in 1916 on the same date-the 5<sup>th</sup> of July, was reached and exceeded in many localities of Oltenia as it follows: 41.8°C/the 4<sup>th</sup> of July 2000 at Apa Neagră in Gorj County, 42.1°C/ the 4<sup>th</sup> of July 2000 at Halânga in Mehedinți County, 42.3°C/ the 4<sup>th</sup> of July 2000 at Caracal in Olt County, 42.4°C/ the 4<sup>th</sup> of July 2000 at Vânju Mare in Mehedinți

County, 42.6°C/ the 4<sup>th</sup> of July 2000 in Drobeta-Turnu Severin in Mehedinți County, 43.0°C/the 5<sup>th</sup> of July 2000 at Bechet, 43.1°C/ the 4<sup>th</sup> of July 2000 at Băilești, 43.2°C/ the 4<sup>th</sup> of July 2000 at Calafat, all these in Dolj County.

For Oltenia the hottest day of the summer of 2000 was the 4<sup>th</sup> of July 2000, which is, actually, the hottest day of July in the last 84 years. 43.2°C is a value very close to the absolute maximum of July.

Table 2. The maximum values of temperature in the canicular days of July 2000.  
Tabel 2. Valorile maxime de temperatură din perioadele de caniculă ale lunii iulie 2000.

Station Meteo	No of days with T <sub>max</sub> ≥ ...				Variation of T <sub>max</sub> . (°C) in the period		T <sub>max</sub> . °C /data
	≥30°C	≥33°C	≥35°C	≥40°C	I : 2-12.07.2000	II: 22-27.07.2000	
Petroșani	7	4	1	0	23.6≤T <sub>max</sub> ≤35.8/July 4	23.0≤T <sub>max</sub> ≤34.0/July 27	35.8/July 4
Obârșia Lotrului	0	0	0	0	21.0≤T <sub>max</sub> ≤29.0/July 5	10.0≤T <sub>max</sub> ≤27.4/July 26	29.0/July 5
Cozia Peak	0	0	0	0	17.4≤T <sub>max</sub> ≤29.6/July 4	14.8≤T <sub>max</sub> ≤25.0/July 26	29.6/July 4
Voineasa	11	6	2	0	27.2≤T <sub>max</sub> ≤36.7/July 4	24.2≤T <sub>max</sub> ≤33.9/July 26	36.7/July 4
Parâng Peak	0	0	0	0	20.4≤T <sub>max</sub> ≤27.0/July 4	18.0≤T <sub>max</sub> ≤25.4/July 26	27.0/July 4
Negovanu Peak	0	0	0	0	9.8≤T <sub>max</sub> ≤21.0/July 4	10.1≤T <sub>max</sub> ≤21.3/July 26	21.3/July 4
Târgu Jiu	18	11	6	1	29.4≤T <sub>max</sub> ≤40.6/July 4	27.0≤T <sub>max</sub> ≤37.8/July 26	40.6/July 4
Apa Neagră	17	12	6	1	33.2≤T <sub>max</sub> ≤41.8/July 4	30.8≤T <sub>max</sub> ≤37.8/July 26	41.8/July 4
Polovragi	15	6	4	0	31.0≤T <sub>max</sub> ≤39.2/July 4	29.0≤T <sub>max</sub> ≤35.4/July 26	39.2/July 4
Rm. Vâlcea	17	12	5	2	32.5≤T <sub>max</sub> ≤40.6/July 4	29.4≤T <sub>max</sub> ≤36.0/July 26	40.6/July 4
Târgu Logrești	14	7	5	1	32.2≤T <sub>max</sub> ≤40.0/July 4	29.5≤T <sub>max</sub> ≤36.0/July 26	40.0/July 4
Drăgășani	18	12	7	1	31.4≤T <sub>max</sub> ≤40.7/July 4	30.0≤T <sub>max</sub> ≤37.7/July 26	40.7/July 4
Dr. Tr. Severin	18	13	10	2	34.1≤T <sub>max</sub> ≤42.6/July 4	31.8≤T <sub>max</sub> ≤39.7/July 26	42.6/July 4
Halânga	19	13	7	3	34.1≤T <sub>max</sub> ≤42.1/July 4	32.0≤T <sub>max</sub> ≤40.0/July 26	42.1/July 4
Bicleș	15	11	6	2	32.5≤T <sub>max</sub> ≤40.0/July 5	29.6≤T <sub>max</sub> ≤37.3/July 26	40.0/July 5
Băilești	16	12	6	2	31.7≤T <sub>max</sub> ≤41.0/July 4	30.2≤T <sub>max</sub> ≤37.0/July 26	41.0/July 4
Vinju Mare	17	13	9	2	34.1≤T <sub>max</sub> ≤42.4/July 4	30.5≤T <sub>max</sub> ≤39.0/July 26	42.4/July 4
Slatina	18	12	9	2	32.0≤T <sub>max</sub> ≤41.4/July 4	30.4≤T <sub>max</sub> ≤38.6/July 26	41.0/July 4
Caracal	19	14	10	4	33.5≤T <sub>max</sub> ≤42.3/July 5	31.3≤T <sub>max</sub> ≤40.6/July 26	42.3/July 4
Craiova	15	11	7	2	34.0≤T <sub>max</sub> ≤40.5/July 4	29.4≤T <sub>max</sub> ≤37.6/July 26	40.5/July 4
Băilești	19	14	11	2	36.0≤T <sub>max</sub> ≤43.1/July 4	31.1≤T <sub>max</sub> ≤39.9/July 26	43.1/July 4
Calafat	18	13	12	3	35.6≤T <sub>max</sub> ≤43.2/July 4	31.5≤T <sub>max</sub> ≤40.3/July 26	43.2/July 4
Bechet	16	15	12	5	34.5≤T <sub>max</sub> ≤43.0/July 5	32.0≤T <sub>max</sub> ≤41.0/July 26	43.0/July 4

In the second canicular period of July 2000 (22<sup>nd</sup>-27<sup>th</sup>), values close to the maximum value of the THI were reached at: Bechet 88.1 on the 25<sup>th</sup>; 89.2 on the 26<sup>th</sup>; 86.6 on the 26<sup>th</sup> at Calafat and 86.0 on the 26<sup>th</sup> at Caracal (in conformity with the processed data in the achieves of CMR Oltenia).

In this second period, the canicular days affected intensely the South of Oltenia and in the first period the extremely intense canicular days affected almost all of Oltenia. On the whole, in July, 16 canicular days were registered.

By a comparison between the average values of temperature of the two canicular periods we are able to notice positive deviations of 1-4°C, the smallest being +0.8°C at Tg. Logrești, and the highest, in the mountain area, +3.9°C in Parâng.

The very high temperatures of above 40°C in the plain, piedmont and Sub-Carpathian region, above 35°C in intermountain depressions and of above 25°C in the mountain regions caused and determined the apparition of drought. In July 2000, the drought was particularly intense for long periods of time. Significant precipitations have fallen in the noon of the 12<sup>th</sup> of July 2000, the night of the 12<sup>th</sup>/the 13<sup>th</sup> of July 2000 and also on the 13<sup>th</sup> of July 2000 (at an exact distance of a year from the torrential rains in Mehedinți and Gorj County which, in 36 hours, have reached values close to the absolute maximum of July, yet with no effect on the already-compromised farming cultures).

#### *Air temperature and precipitation values of August 2000*

August 2000 has brought, also, canicular periods and drought. Regarding this aspect, in August 2000, two canicular periods were registered – between the 3<sup>rd</sup> and the 7<sup>th</sup> and between the 18<sup>th</sup> and the 24<sup>th</sup>. The highest number of days with maximum temperatures ≥ 30°C was 26 days registered at Drobeta-Turnu Severin and Halânga.

The highest number of days with maximum temperatures ≥ 33°C was 20 registered at Băilești.

The highest number of days with maximum temperatures ≥ 35°C was 14 registered at Băilești and Drobeta-Turnu Severin.

The highest number of days with maximum temperatures ≥ 40°C was 1 registered in Drobeta-Turnu Severin, Băilești, Calafat and Bechet.

The hottest day of August 2000, was the 23<sup>rd</sup>, when four meteorological stations-Drobeta-Turnu Severin, Băilești, Calafat and Bechet in Oltenia, registered temperatures of and above 40°C.

The most intense canicular period of August 2000, was 19-24.

In Oltenia, the longest canicular period was registered in Drobeta-Turnu Severin, between the 11<sup>th</sup> and the 25<sup>th</sup>, meaning 15 consecutive canicular days. It is to mention that in the South of Tg. Logrești, in the Getic Piedmont, the second canicular period of August began on the 11<sup>th</sup>, the 12<sup>th</sup>, the 13<sup>th</sup> and lasted for 12 and 15 consecutive days.



In comparison with July, the number of days when the maximum temperatures exceeded the thresholds of 30°C, 33°C and 35°C was bigger, but the number of days, in which the temperature exceeded 40°C, was smaller, which leads us to the conclusion that the intensity of the canicular days of August was reduced relatively to the canicular days of July.

The monthly average values of temperature exceeded the normal thermal monthly averages by positive deviations between +1.3°C at Tg. Logrești and +4.6°C at Apa Neagră in Gorj County. Significant differences were also registered at Băcleș in Mehedinți County (4.2°C) and at Calafat in Dolj County (+4.0°C).

#### *The evolution of the air temperature in July 2007*

The maximum values of temperature registered in Dolj County on the 24<sup>th</sup> of July 2007 were outstanding at all the meteorological stations: 42.6°C in Craiova, 44.0°C at Băilești, 44.2°C at Bechet and 44.3°C at Calafat, all of these becoming absolute maximum temperature values for July at each station, and the value registered at Calafat is the new absolute thermal maximum of July for the whole country.

The highest thermal minimum values recorded in the morning of July 25 were registered in Dolj County: 23.5°C in Craiova, 24.3°C at Bechet, 24.4°C at Băilești and 24.7°C at Calafat. At Calafat the highest thermal minimum of July 2007 was 25.0°C registered one day earlier than the 23<sup>rd</sup> of July as a consequence of the fact that the advection of the extremely hot air mass began on the 22<sup>nd</sup> of July.

The highest daily average temperatures registered in July 2007 were reached on the 24<sup>th</sup>: 32.8°C in Craiova, 33.4°C at Băilești, 33.6°C at Bechet and 33.9°C at Calafat (the deviations from the multiannual averages being of 11-13°C, for example, for Craiova the daily multiannual average for the 24<sup>th</sup> of July is 21.8°C), which represents absolute thermal record for the averages of July at these stations, and for the whole country the average value of 34.2°C registered at Caracal is the absolute thermal record in matters of average temperatures of July. These values equal those of a hot summer day.

Concerning the days with average values of temperature  $\geq 30^\circ\text{C}$ , we mention: 3 days at Bechet, 6 days at Băilești, 8 days in Craiova (as well as at Caracal and Băcleș) and 9 days at Calafat (as well as at Apa Neagră, the Sub-Carpathian depression), this last value representing a national record regarding this aspect.

When calculating the THI we have been using the following formulas given by INMH in the year 2000:

THI =  $(T_{\text{dry}} \cdot 1.8 + 32) - (0.55 - 0.0055U)[(T_{\text{dry}} \cdot 1.8 + 32) - 58]$ ; (this comes from the re-evaluation of I.c and it is the currently used formula for the THI.)

Some other formulas for finding the THI are:

I. Strahler's formulas, 1973:

I.a)  $\text{THI} = 0.4 (T_{\text{dry}} - T_{\text{wet}}) + 15$ ;

I.b)  $\text{THI} = 0.55 T_{\text{dry}} + 0.2 T_{\text{dew}} + 17.5$ ;

I.c)  $\text{THI} = T_{\text{dry}} - (0.55 - 0.55UR) (T_{\text{dry}} - 58)$ .

II) The formula used by the European model of weather prognosis (ECMWF) is:

$\text{THI} = 0.81 T_{\text{dry}} + 0.01U (0.99 T_{\text{dry}} - 14.3) + 46.3$ .

These formulas express the THI adimensionally.

The I.c formula is easy to use for anyone, as  $T_{\text{dry}}$  is actually the air temperature measured normally, in standard conditions in meteorological shelters, and for this calculation of the THI the data in weather bulletins of radio and television are enough.

Yet another index which correlates the values of temperature and humidity is the Humidex ( $H_{\text{um}}$ ) index, also used in some speciality papers.

III) The calculation formula for Humidex ( $H_{\text{um}}$ ), expressed in C degrees:

$H_{\text{um}} = T_{\text{dry}} + 0.5555x (6.11x e^{5417.7530(1/273.16 - 1/TD)} - 10)$ .

This formula has been established and implemented by J. MASTERSON & RICHARDSON (1979), from the Meteorological Service in a collaboration with the Health Ministry of Canada and its values and characteristic thresholds are indicated in Fig. 1.

**Abbreviations** we used:

$T_{\text{dry}}$  = the air temperature at a height of 2 m, read on the dry thermometer (in Fahrenheit degrees, F);

$T_{\text{wet}}$  = the temperature read on the wet thermometer (in Fahrenheit degrees);

$T_{\text{dew}}$  = the temperature of the dew point (in Fahrenheit degrees);

UR = the relative humidity expressed in decimals fractions - we consider 0.35 instead of 35% (Fig. 1);

U = the relative humidity at a level of 2 m above the ground;

TD = the temperature of the dew point in Kelvin degrees, at a level of 2 m above the ground.

Considering that the values given by the VI formula are different from those given by the first five, as well as the scale of the appreciations of the effects (Fig. 1), we see useful the introduction of the Humidex index which has  $H_{\text{um}}$  as a notation, for these results.

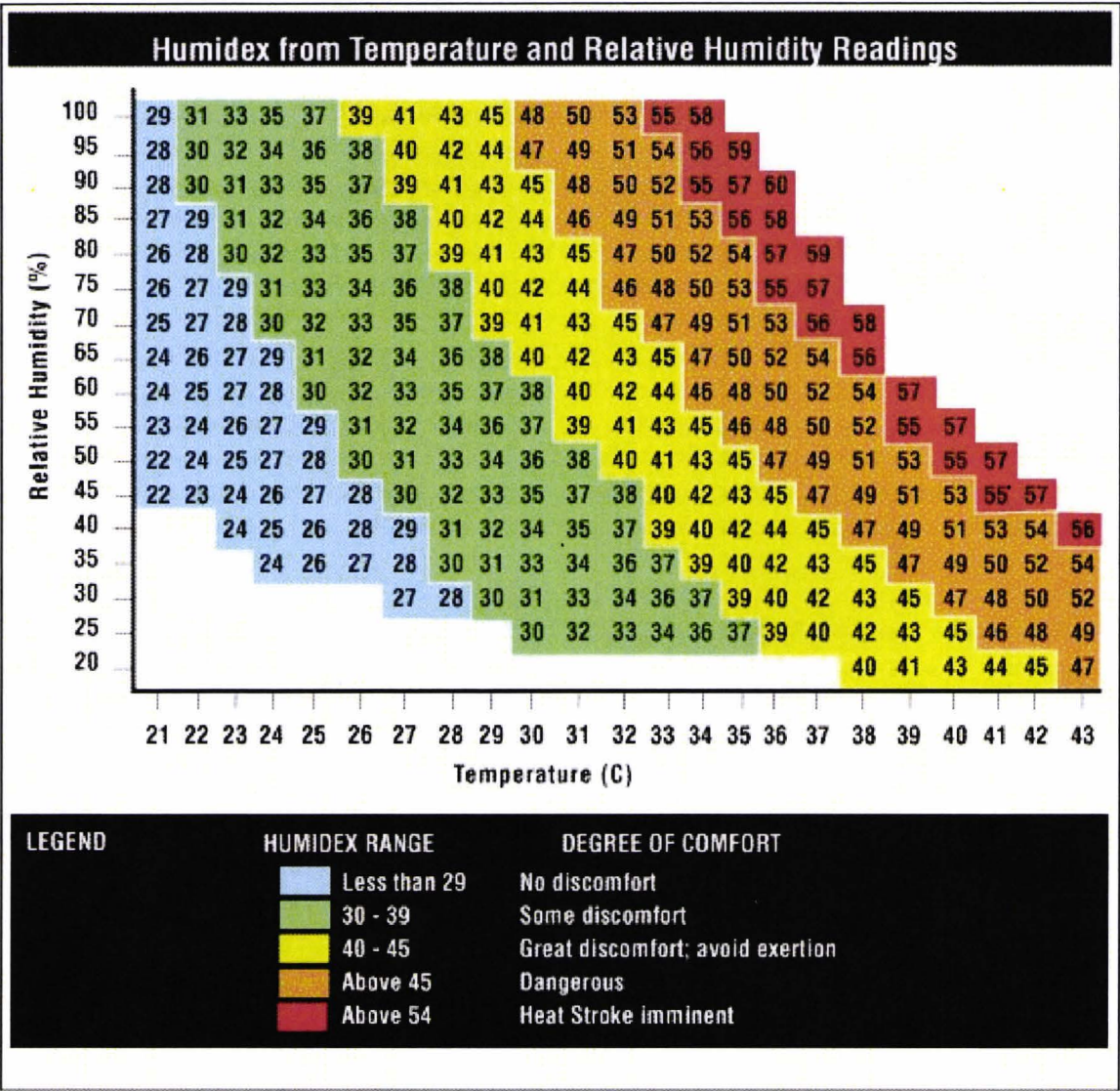


Figure 1. The Humidex ( $H_{um}$ ) correlation between the temperature and the relative humidity of air (according to MASTERSON & RICHARDSON, 1979).

Figura 1. Corelația Humidex ( $H_{um}$ ) cu temperatura și umiditatea relativă a aerului (după MASTERSON & RICHARDSON, 1979).

RESULTS AND DISCUSSIONS

As a result of the gathering, processing and interpretation of data the next values of the THI in Oltenia were obtained:

In June 2000, in the three canicular periods, the THI exceeded 80 units in most areas of Oltenia. The highest values of the THI were reached at Slatina 85.5 on the 24<sup>th</sup> and Caracal 86.1 on the 23<sup>rd</sup> and the 24<sup>th</sup>.

By calculating  $THI/2$  for the meteorological station at Slatina at the maximum temperature of 36.8°C, a value of 42.7 is obtained, ( $ITU/2=85.5:2=42.7$ ). The 5.9°C difference ( $42.7-36.8 = 5.9^{\circ}C$ ) between the value of  $THI/2$  and the maximum temperature represents the degrees felt by the human body in addition to the maximum temperature. This difference appears as a result of the Greenhouse Effect caused by water vapours in the atmosphere.

By calculating  $THI/2$  for the meteorological station at Caracal at the maximum temperature of 37.5°C a value of  $ITU/2=86.1:2=43.5$ . The difference of 6.0°C ( $43.5-37.5 = 6.0^{\circ}C$ ) between the value of  $THI/2$  and the maximum temperature represents the degrees felt by the human body in addition to the maximum temperature. This difference appears as a result of the Greenhouse Effect caused by the high percentage of water vapours in the atmosphere.

For July, the highest values of the THI were: 89.7 at Bechet reached on the 5<sup>th</sup>, 89.4 at Apa Neagră (Gorj County-the 4<sup>th</sup> of July 2000), as well as at Caracal on the 5<sup>th</sup>. For Slatina, it was reached on the 4<sup>th</sup> and it was of 86.8.

By calculating  $THI/2$  for the meteorological station at Caracal ( $89.4:2=44.8$ ) at the maximum temperature of 42.3°C, a value of  $THI/2 =44.8$  is obtained resulting in a difference of 2.5°C due especially to the air temperature and in a small way to the percentage of water vapours in the atmosphere, which was smaller than the one of June calculated

in the previous paragraphs. At Apa Neagră, the maximum temperature of that day was 41.8°C. The difference between the THI and the maximum temperature (44-41.8) was of 3.0°C. In this case, the positioning of Apa Neagră in the Oltenia Sub-Carpathian Depression (where the air ventilation is a slowed process, determined a much bigger concentration of water vapours caused especially by the evaporespiration process, resulting in an more important thermal difference.

By calculating THI/2 for the meteorological station of Slatina ( $86.8:2=43.4$ ), at the maximum temperature of 41.4°C, the 2°C resulting difference is due especially to the air temperature and in a small share to the percentage of water vapours in the atmosphere, which was smaller than the one of June calculated in the previous paragraphs

During the most intense heat wave which affected Romania in July (the 24<sup>th</sup> of July 2007), the THI exceeded the high risk threshold in most of the country excepting the high mountain area. On this date at Calafat, the THI reached the value of 91-the absolute record for this index in Oltenia, and the maximum temperature was 44.3°C.

By calculating THI/2 for the meteorological station of Calafat at the maximum temperature of 44.3°C ( $91.0:2=45.5$ ) the 1.2°C resulting difference is due especially to the air temperature and in a small share to the percentage of water vapours in the atmosphere, which was smaller than the one of June calculated in the previous paragraphs, the air mass was particularly hot and dry (tropical continental advection from the Northern Africa).

#### *The evolution of the THI values in Oltenia starting with the year 2000*

The climatic evolutions in Oltenia marked new aspects in each year. In the following paragraphs we mention some of the important remarks for the values of the THI:

The year 2000 is best characterised by: the massive heating in the summer, intense canicular days<sup>1</sup>, dryness<sup>2</sup> and drought.

The period June 1-September 1 2000 (and all the summer that followed), brought for Oltenia an intense canicular period leading to a drastic drought during which two absolute thermal records for our country were registered. The summer of 2000 meant for both Oltenia and Romania in general, long canicular and droughty periods. The drought had a slow evolution in the first three months of the year (January, February, March), the precipitation level being below its normal values. The early spring arrival in February, the late frosts of April, the droughty spring months April and May "opened" the way for the canicular days at the end of June, July and August, came with prolonged canicular periods which, in their succession, mingled with short "colder"-relatively to the canicular days temperatures-periods.

In Romania, a new thermal record for July was registered -43.5° C in Giurgiu on the 5<sup>th</sup> of July 2000, becoming the new absolute maximum of July for the whole country.

Exactly one year after the "flood" in Western Oltenia (on the July 12-13, 1999), the date is no coincidence-this is the normal cooling period of July important rain falls being registered in the whole region of Oltenia, but their effect on the already compromised farming cultures was insignificant, and in a short time the canicular days and the drought were back.

These greatly intense canicular days took place in the year of maximum Solar activity (which is roughly reached once every 11 years, yet this maximum was outstanding for its century-exceeding even that of 1946, which astronomers considered the most important), resulting in amplified thermal effects and canicular periods. The peak of the canicular period was the days of July 4 and 5, 2000.

The high air temperature brought about maximum values for the THI in the two canicular periods of August 2000. In this month the canicular period lasted for 12 days in Oltenia. The highest number of days when the maximum THI exceeded 80, in August was 23 registered in Caracal-Olt County.

On the whole, during the summer of 2000, 46 out of 92 days with temperatures of above 33°C were registered-a percentage of 50%, which leads us to the conclusion that half of the summer days were canicular or almost canicular<sup>3</sup>.

The high air temperatures of August 2000 indicated the extreme drought the effects of which were widely amplified by the canicular periods. Some of the results obtained from the analysis are:

*The highest exceeding of the monthly normal average* of temperature of the summer of 2000 was registered in Apa Neagră-Gorj County in August the monthly average value exceeding the normal by +4.6°C.

Moreover, the THI has exceeded the critical thresholds for long periods of time each summer.

The values of the THI have varied between 80 and 91 in the canicular period of 2007 (Fig. 2).

In Oltenia, in Dolj County, at Calafat, on the 24<sup>th</sup> of July 2007 in just 10 minute from 16<sup>10</sup> OVR to 16<sup>20</sup> OVR<sup>4</sup> the air temperature raised from 43.6°C to 44.3°C (0.7°C in 10 minutes), which shows on the one hand the intensity of the advection of hot air, and on the other hand the quickness in the rise of the air temperature.

<sup>1</sup> When the air temperature reaches 35°C we speak about *canicular days*.

<sup>2</sup> **Dryness phenomena** is registered when it does not rain for 5 days in a row, or if the precipitation quantities are below the respective daily average (in conformity with Hellmann quoted by DONCIU in 1928, BOGDAN & NICULESCU, 1999).

<sup>3</sup> Meteorological instructions before the year 2000, qualified as "canicular day" a day in which the air temperature reached or exceeded 33°C. Subsequently, the threshold became 35°C. If the air temperature exceeds 32°C, the phenomena of **intense heat** takes place; (this term is used in agrometeorology); In intense heat days the plants frequently fade and sometimes plants even parch (irreversibly).

<sup>4</sup> OVR= The summer hour of Romania



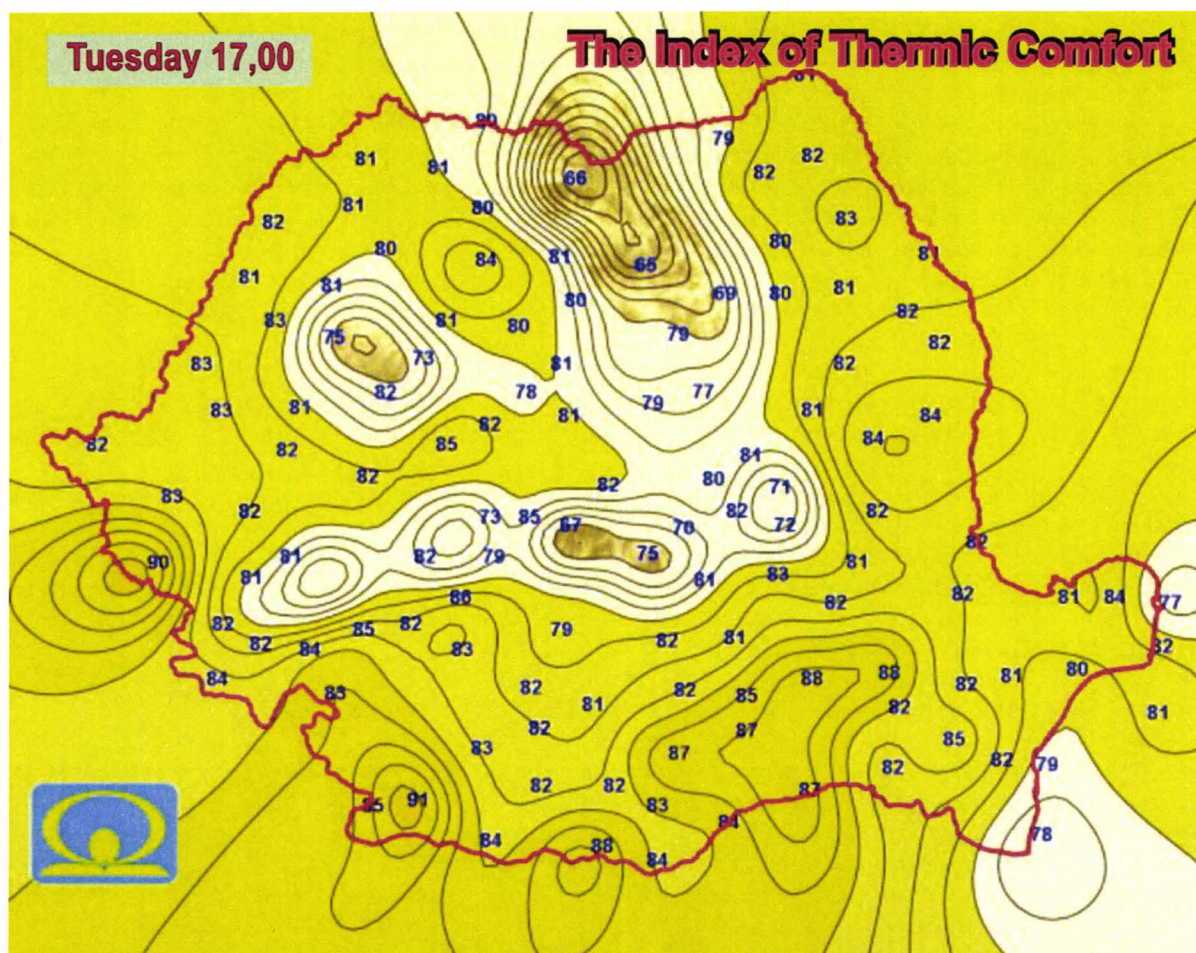


Figure 2. The values of the THI on the 24<sup>th</sup> of July 2007 17 OVR, at the peak of the heat wave. (At Calafat THI = 91, the maximum value for the whole country, bioclimatic record) (scale 1:1 000 000) (according to ANM).

Figura 2. Valorile indicelui de confort termic ITU, la 24.07.2007 ora 17 OVR, la momentul apogeeului fazei maxime a valului de căldură. (La Calafat ITU = 91, valoarea maximă pentru întreaga țară, record bioclimatic) (scara 1:1 000 000) (după ANM).

Knowing the evolution of temperature is extremely important, as it is strongly related to the environment and the living organisms. We mention some of the effects of the heat waves:

For the spontaneous vegetation, but also the farming and forest cultures such situations might lead to fading and parching phenomena at a quick and irreversible pace.

In the biotope of the lakes the quantity of dissolved oxygen decreases and this often leads to the suffocation or death of vegetal and animal organisms. Their quick decay due to the rise of temperature leads to pollution with harmful substances amplifying the effects of the lack of oxygen in lakes' water. The damages can be significant or even irreversible. There is a little number of methods of fighting against these phenomena and we mention: the introduction of air in the water using special pumps, yet this action often leads to an increase of the water temperature, the pumping of cold water from underground wells-but its quantity of oxygen is reduced, a slightly more efficient solution is the pumping of river water-especially for the lakes near the Danube and other important rivers but this is not always possible.

For human population thermal discomfort appears and it increases in relation with the temperature and the humidity of air. It can induce hypocaloric shock and even death to the people with health problems. The deaths generally happen at night, when the secretion of life-maintaining hormones is minimal and the THI is high as a consequence of the high concentration of water vapours in the warm air, despite the decrease in temperature.

## CONCLUSIONS

As climate changes are tackled with in many scientific papers, the use of the bioclimatic index THI in meteorological bulletins in order to inform the population about the weather situations of major risk in the warm season as well as the use of the proper colour code related to the potential risk are useful measures created to protect the people, the animals and sometimes the crops. Showing the measures that could be taken in order to enable all these actions is equally important. In the warm season the use of the THI is welcome in situations of hot weather or canicular days.

Pointing out the RED CODE situations for canicular days determined a series of special measures created to protect and inform the population, the setting up of first aid points in cities, the application of a special program for the police, firemen and rescue services etc.

The absolute record for Oltenia and the whole country of the bioclimatic index THI (91), and also of the maximum air temperature 44.3°C were both recorded in the year 2007.

The year 2000 was the starting year for the registering of heat waves associated with long-lasting canicular periods, and 2007 was the year in which the most intense heat waves of July in the history of meteorological observations in Romania was recorded (MARINICĂ & CHIMIȘLIU, 2008).

Knowing the meaning of frequently-used bioclimatic indexes in weather forecasts and warnings (which since the year 2000 has become mandatory by law-by the E.O 99/2000) is vital for a good understanding of the importance and the possible effects of heat or coolness waves.

Especially after the year 2000 in Oltenia, in the warm season, the intense heat waves became frequent marking the increase of the influence of the Mediterranean climate in this part of the country with important consequences on the biosphere (MARINICĂ & CHIMIȘLIU, 2008). It is notable the year 2007, for Oltenia, was a typical Mediterranean year on the whole.

*The use of these bioclimatic indexes in weather bulletins is mandatory because of the reality of clear changes in the climate of Romania.*

The canicular summer of 2000 made the Government of Romania to issue the E.O. no 99 regarding the protection of those people who work in extreme conditions, this being the first document to reflect the application of specific measures in outstanding climatic situations and also the acknowledgement of the appearance of changes in the Romanian climate (MARINICĂ & MARINICĂ, 2008).

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# SPATIAL APPROACH TO THE ASSESSMENT OF ANTHROPOGENIC IMPACT ON BIODIVERSITY BASED ON THE NOMENCLATURE OF TERRITORIAL UNITS FOR STATISTICS (NUTS) APPLICABLE TO ROMANIA

ALEXANDRU-IONUȚ PETRIȘOR

**Abstract.** Based on the spatial scale, authors distinguish several levels of biodiversity:  $\alpha$  diversity (for an ecosystem),  $\beta$  diversity (for ecosystems within a complex),  $\gamma$  diversity (for a regional complex of ecosystems), and  $\delta$  diversity (for a macro-regional complex of ecosystems). Taking into account this "diversity of diversities", the paper recommends a hierarchy of methods that could be used to assess the impact of urban and spatial plans on biodiversity. Based upon the classification of the Nomenclature of Territorial Units for Statistics (NUTS), anthropogenic impact could be measured for urban plans (NUTS V) and county plans (NUTS III) by looking at changes in land use, e.g., using CORINE data. At regional (NUTS II) and national (NUTS I) levels, diversity can be assessed within the biogeographical regions, and the impact on it by the decrease of the areas covered by less represented or vulnerable classes, such as the Black Sea and alpine regions.

**Keywords:** biodiversity, NUTS, CORINE, biogeographical region.

**Rezumat.** Abordarea spațială a evaluării impactului asupra biodiversității pe baza nomenclaturii unităților teritoriale aplicabile României. În funcție de scala spațială se disting mai multe niveluri ale diversității biologice: diversitatea de tip  $\alpha$  (diversitatea unui ecosistem), diversitatea de tip  $\beta$  (diversitatea ecosistemelor din cadrul unui complex de ecosisteme), diversitatea de tip  $\gamma$  (diversitatea unui complex de ecosisteme regional) și diversitatea de tip  $\delta$  (diversitatea unui complex de ecosisteme macroregional). Având în vedere existența acestei „diversități a diversităților”, prezentul articol recomandă o ierarhizare a metodelor folosite pentru evaluarea impactului planurilor de urbanism și amenajarea teritoriului asupra biodiversității. Astfel, în funcție de clasificarea nomenclaturii unităților teritoriale (NUTS), impactul antropocentric poate fi măsurat în cadrul planurilor de urbanism (NUTS V) și amenajare a teritoriului județean (NUTS III) prin schimbarea destinației terenurilor, un exemplu în acest sens fiind oferit de utilizarea datelor europene din cadrul programului CORINE. La nivel regional (NUTS II) și național (NUTS I), diversitatea poate fi evaluată la nivelul regiunilor biogeografice, iar impactul asupra acesteia prin diminuarea suprafețelor regiunilor biogeografice mai slab reprezentat sau vulnerabile, cum ar fi cele specifice zonei Mării Negre sau regiunii alpine.

**Cuvinte cheie:** biodiversitate, NUTS, CORINE, regiune biogeografică.

## INTRODUCTION

Based on the spatial scale, MAGURRAN (1998) and PUSCEDDU (2008) distinguish several levels of diversity; the first five levels include a spatial (scale) component:

- ❖ Alpha ( $\alpha$ ) diversity – diversity of an ecosystem, community, taxonomic or functional group or biocoenosis,
- ❖ Beta ( $\beta$ ) diversity – diversity of ecosystems within a complex of ecosystems, diversity of habitats or diversity along gradients,
- ❖ Gamma ( $\gamma$ ) diversity – diversity of a regional complex of ecosystems, a large area, e.g. biogeographical regions within continents, presented below,
- ❖ Delta ( $\delta$ ) diversity – diversity of higher rank (macro-regional) complexes of ecosystems, e.g. global biogeographical regions, presented below,
- ❖ Epsilon ( $\epsilon$ ) diversity – diversity of life environments (oceanic, terrestrial),
- ❖ Omega ( $\omega$ ) diversity – phylogenetic diversity / diversity of the global taxonomical hierarchy.

Urban and spatial planning is governed in Romania by several legislative instruments. Law no. 350 of 2001 on urban and spatial planning distinguishes based on the spatial scale between spatial planning, aiming to balance socioeconomic, ecological and cultural policies in order to ensure a balanced polycentric development, and increase territorial cohesion and socioeconomic efficiency, and urban planning, aiming to stimulate the complex evolution of urban settlements by phrasing short, average and long term strategies of development. The main difference between the two categories is that spatial plans consist of proposals establishing the general strategies, guidelines and principles, whilst urban plans concretely implement these proposals at the local level through operative regulations. Spatial plans are produced for the national territory, regions and counties, while urban plans cover urban and rural settlements, inner zones or the placement of a specific construction or assembly. Some of these areas are defined by the Constitution as base administrative territorial units, i.e., counties and urban or rural settlements.

The Statistical Office of the European Communities (EUROSTAT) had defined and developed a Nomenclature of Territorial Units for Statistics (NUTS), establishing five common levels applicable to all countries within the European Union. Three levels correspond to the Romanian territorial organization. The first one, NUTS I, corresponds to the national territory. The second one, NUTS II, corresponds to the eight Romanian regions of development. These regions do not have a Constitutional base (are not base administrative territorial units), but are useful for the elaboration of development strategies. The third level (NUTS III) corresponds to the 42 Romanian counties, while the fifth one

(NUTS V) corresponds to the smallest base administrative territorial units, *i.e.* urban and rural settlements (3174 municipalities, cities and communes in 2008, according to Eurostat).

The purpose of this paper is to propose a methodology for evaluating the impact on biodiversity based on the special scale, creating a correlation between the spatial levels of biodiversity and the NUTS territorial level, and provide examples on its application in Romania.

### β DIVERSITY: URBAN AND COUNTY-LEVEL PLANS

The diversity of the types of ecosystems ( $\beta$  diversity) is also reflected by the diversity of habitats corresponding to biotopes and evaluated by land cover. The European Union uses the CORINE (Coordinated Information on the European Environment) classification, used initially for biotopes and applied today to land parcels to reflect their *cover* and *use*, presented in Table 1 (DE LIMA, 2005). Land use shows how man uses land; land cover indicates what lies on that surface, from a biophysical viewpoint (JENSEN, 2000) – *e.g.*, in a field, land could be covered by herbaceous vegetation, but used in agriculture (as a pasture or cropland), as a green space or park (if it lies within a city), or could be a natural pasture. CORINE classification has three levels, allowing for a very detailed classification. The first level distinguishes between five classes: artificial surfaces, agricultural areas, forest and semi natural areas, wetlands, and water bodies. Within the first class (artificial surfaces), for example, level 2 defines four categories (urban fabric, industrial, commercial and transport units, mine, dump and construction sites, and artificial, non-agricultural vegetated areas), while for each of these sub-classes are defined at the third level: continuous urban fabric, discontinuous urban fabric, industrial or commercial units, road and rail networks and associated land, port areas, airports, mineral extraction sites, dump sites, construction sites, green urban areas, and sport and leisure facilities. Generally, the categories of level 1 describe land cover, while the classes and sub-classes corresponding to the next levels define land use.

Taking into account that the development of a coherent approach at the European level, involving data acquisition and processing using a common methodology, requires extensive funds and takes a long time – 2000 dataset was made accessible in 2004 (DE LIMA, 2005) – updated information cannot be produced every year. The first two databases are based on 1990 and 2000 data. In the example provided below, a subset of data was used to analyze the changes in Vrancea county, as a part of the environmental report included in the spatial plan of the county (PETRIȘOR, 2008b). Fig. 1a presents changes according to level 3 of CORINE classification, in order to indicate the overall magnitude of all changes. Nevertheless, changes at an inferior level (2 or 3) present only a local relevance if the upper level is not changed – *e.g.* changing an urban function into another one would not affect the “urban ecosystem” status of the settlement. This is why Fig. 1b displays changes of the level 1 class; such changes, even though lesser in magnitude, are more relevant at the level of the entire county and are figured as points and not as areas.

### γ DIVERSITY: REGIONAL AND NATIONAL PLANS

The evaluation of the European biodiversity is the output of successive studies, concluded with presentations delivered at DOBRIS (1995), AARHUS (1998), KIEV (2003) and BELGRADE (2007) and published by the European Environment Agency. The information used in these assessments is derived from satellite imagery or received from specialized agencies (DE LIMA, 2005). The spatial component of the assessment consists of mapping Europe's biodiversity based on 11 biogeographical regions, five of which can be found in Romania and are underlined: Arctic, Boreal, Continental, Atlantic, Macaronesian, Mediterranean, Alpine, Pannonian, Steppic, Black Sea, and Anatolian (PINBORG & LARSSON, 2002).

The diversity of biogeographical regions corresponding to the Romanian regions of development was performed as a part of the pilot study for the Strategic Concept of Territorial Development in Romania 2007-2030 (PETRIȘOR, 2008c) and is displayed in Fig. 2. The analysis of these maps leads to the conclusion that Romania possesses a high diversity of biogeographical regions (PETRIȘOR, 2008a). Even smaller regions of development include at least two biogeographical regions and the largest ones, four (South-East). Their complete characterization is summarized in Table 1. While assessing biodiversity changes, particular attention must be paid to vulnerable and smaller regions, such as the Black Sea region and the Alpine region. Even if it is lesser represented in Romania, the Pannonian region covers most of the Hungarian territory.

Table 1. Characterization of the complexes of ecosystems within the regions of development.  
Tabel 1. Caracterizarea complexelor de ecosisteme caracteristice regiunilor de dezvoltare.

Region of development	Biogeographical region
Bucharest	Steppic and Continental. High diversity despite of reduced surface.
Center	Alpine and Continental (in the center).
North-East	Alpine and Continental (predominant).
North-West	Alpine, Continental (predominant, central position) and Pannonian (West). High diversity.
South	Alpine (North), Continental (predominant, South) and Steppic (East). High diversity.
South-East	Alpine, Continental, Steppic and Black Sea, disposed in this order as parallel bands from NE to SW. Highest diversity.
South-West	Alpine (North, poorly represented), Continental (predominant, in the South). High diversity.
West	Alpine, Continental and Pannonian, disposed in this order as parallel bands, relatively equal, from NE to SW. High diversity.

## CONCLUSIONS

The spatial approach to assessing environmental impact on biodiversity benefits upon the availability of data from the European Union, through the CORINE program. Such data finds a special relevance when analyzing  $\beta$  diversity at the level of a county or even a smaller unit (urban or rural settlement). However, limitations are due to the impossibility to update information frequently, especially when aiming to investigate the immediate impact of urbanization.  $\gamma$  diversity can be analyzed spatially by investigating the biogeographical regions. However, such analyses do not exhibit a high potential for detecting changes.

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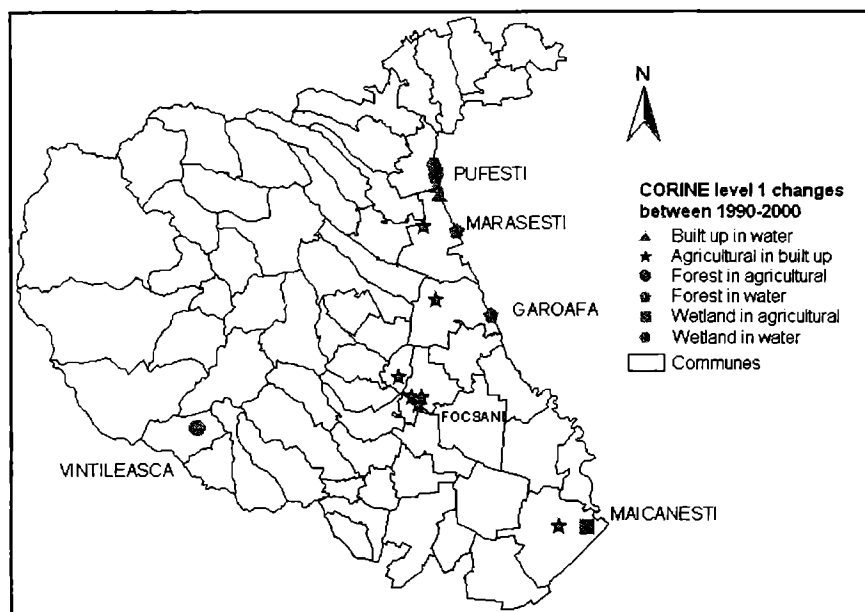


Figure 1a. Changes in land cover and use in Vrancea county between 1990 and 2000 (level 1 of CORINE classification).

Figura 1a. Modificări în acoperirea și utilizarea terenurilor în jud. Vrancea în perioada 1990-2000 (nivelul 1 al clasificării CORINE).

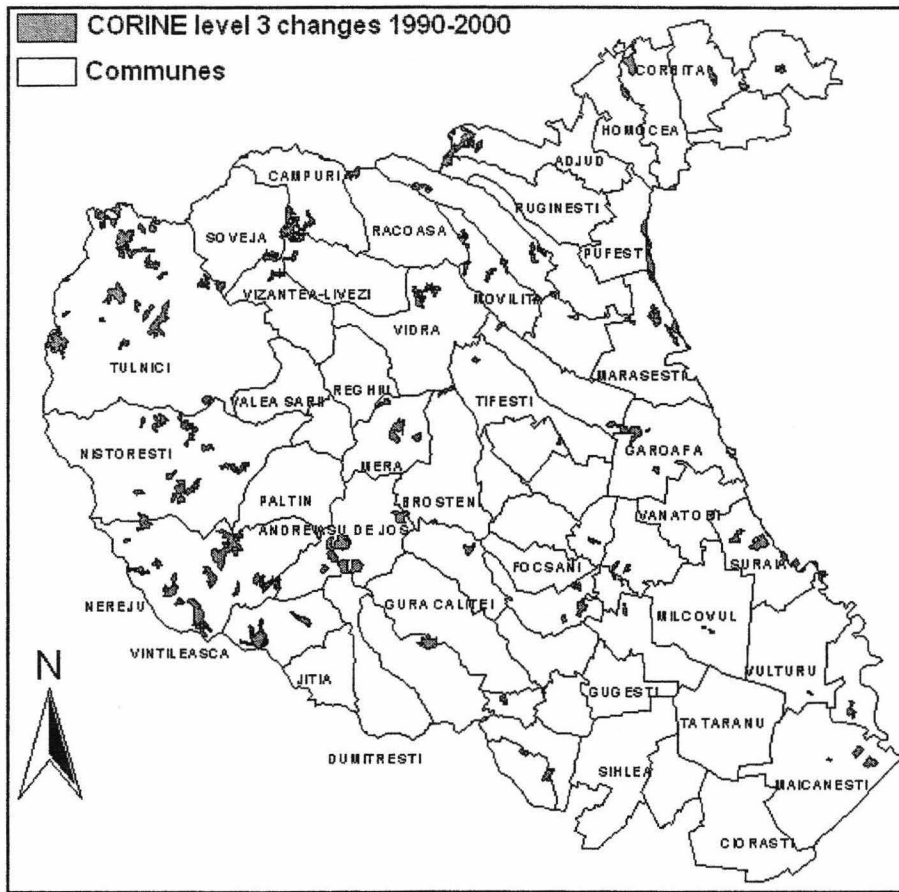


Figure 1b. Changes in land cover and use in Vrancea county between 1990 and 2000 (level 3 of CORINE classification).

Figura 1b. Modificări în acoperirea și utilizarea terenurilor în jud. Vrancea în perioada 1990-2000 (nivelul 3 al clasificării CORINE).

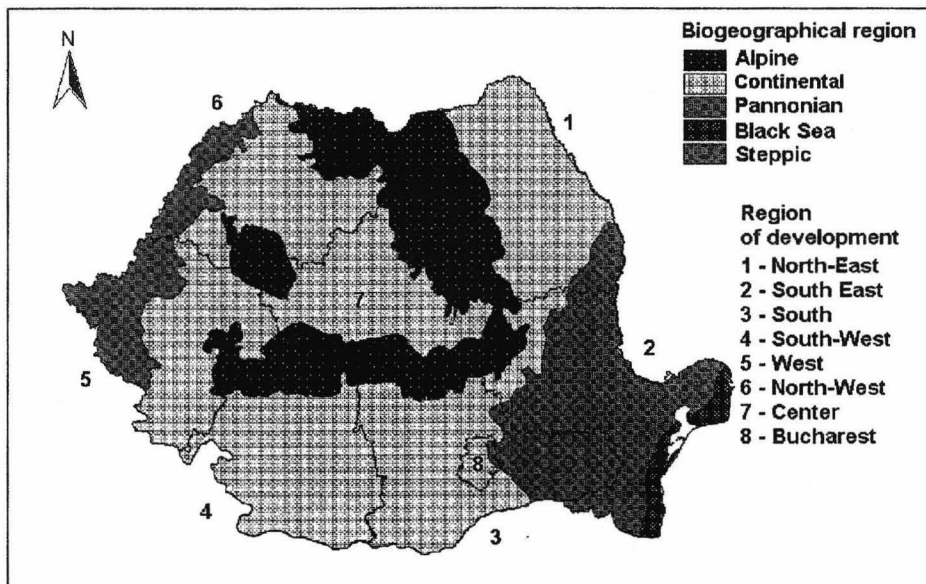


Figure 2. Biogeographical regions corresponding to the regions of development.

Figura 2. Regiuni biogeografice corespunzătoare regiunilor de dezvoltare.

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## THE EFFECT OF THE ZOO-ANTHROPOGENOUS IMPACT IN RAST LOCALITY, COUNTY DOLJ, ROMANIA

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**Abstract.** *In this paper we present the consequences of the irrational action exerted by man upon certain areas within the locality of Rast. The main directions where the zoo-anthropogenous impact is exerted upon the nature in the researched territory are the following: the modification of the natural area of some vegetative and animal species, the change of the ecosystems' structure up to the limit which exceeds the recover ability of nature, the climate becoming arid due to the elimination of the forests from large areas of land and so on.*

**Keywords:** *zooanthropogenous impact, Rast locality, Romania.*

**Rezumat.** *Efectul impactului zooantropogen în localitatea Rast, județul Dolj, România. În această lucrare prezentăm consecințele acțiunii iraționale exercitate de om asupra unor suprafețe din perimetrul localității Rast. Principalele direcții unde se exercită impactul zooantropogen asupra naturii în teritoriul cercetat sunt următoarele: modificarea arealului natural a unor specii vegetale și animale, schimbarea structurii ecosistemelor până la limita ce depășește puterea de refacere a naturii, aridizarea climei datorită eliminării pădurilor de pe mari suprafețe de teren etc.*

**Cuvinte cheie:** *impact zooantropogen, localitatea Rast, România.*

### INTRODUCTION

The term of impact is used in this case with the meaning of depreciation of phytocoenosis nature and stability. Along with the growth of the anthropogenic impact there takes place a decrease of the naturalist grade.

The alteration of the quality of the environment factors following the direct or indirect influence of human activities or of natural factors occurs by the appearance of some more or less serious ecological disequilibria (CIPLEA & CIPLEA, 1978).

Since the oldest times, man has tried to shape the nature to his benefit. For ages, he admitted his dependence on nature, whose harsh laws had to be followed in order to survive. Over the last two centuries, man tried to dominate nature by conduct and conception using all its natural resources in the real way.

Rast locality belongs, from the administrative point of view, to Dolj county. It has an area of over 85 sq km. With these dimensions, Rast is one of the largest settlements from the country. It is located at 43°50' North latitude and 23°30' East longitude.

Related to the country's territory, Rast is located in the South part, on the Danube's bank, and within the county, it is in its southwestern part, south of Bailesti town and east of Calafat town.

Within the physical-geographical units, this settlement is located in the South of the Oltenia Plain, at the contact between the South of Bailesti Plain and the Danube's bank.

Through its position in the southwestern part of the country, namely in the west of the large Carpathian-Balkan depression, the territory undergoes the influences of the Mediterranean maritime air masses and of the wet oceanic ones, as well as the influences of the east warm air masses, which are dry continental. Along the Danube's terraces and floodplain, there can be felt the föhn effects, which take place during the western and southwestern invasions.

From the point of view of the soils, chernozems are widely spread within the territory of the settlement; calcareous chernozems cover the terrace area located north of the village precincts, while west of the precincts, on small surfaces from the lower terrace, there appear cambic and degraded chernozems.

### MATERIAL AND METHODS

The work method has consisted in field trips, at regular time intervals, for observing the modifications induced by people and domestic animals in the semi-natural ecosystems from the researched territory. Previously, it has been achieved a bibliographic documentation regarding the existing data about this zone.

There have been noted all the modifications appeared in the studied phytocoenosis with the purpose of being compared with the phytocoenosis in which the influence of the zoo-anthropogenous factor is absent or insignificant.

### RESULTS AND DISCUSSIONS

The effects of the anthropogenic impact upon the natural forest ecosystems are manifested under several aspects to a local level, where they still remain hard to quantify, predict and control.



Through his direct or indirect activities, man has caused changes in the structure of phytocoenoses by land clearing in order to extend the agricultural areas or to use wood as fuel, the irrational grazing, all these having serious consequences in the structure and dynamics of phytocoenoses.

Forest exploitation has to rely on limited-impact technologies in order to serve the aims of sustainable development (BĂDESCU, 1972).

If from the theoretical point of view these aspects are clarified, putting into practice, in the researched territory, becomes extremely complex due to various factors of influence among which the most important ones are the poor education of the labour force in the ecologic spirit. Unfortunately, the continuous wish to minimize the exploiting costs leads to anti-ecological methods, like collecting the trees put down by dragging, without any previous method to fragment the trunk. This phenomenon can be observed in the coppice within the Danube's floodplain.

The repeated visits of the tourists into the forests. From a simple transit and up to camping, tourists leave evident "marks" in the highly frequented forests (deep paths, fire camps, wastes and so on). These contribute to the modification of the floral composition of the forest phytocoenosis.

To the human impact, it is also added the premature drying phenomenon of the poplars due to drought, pollution, ecological catastrophes and thunderstorms, which by their violence provoked great damages. Although these falls down are often considered natural catastrophes, in fact they remain the consequence of some anthropogenic impacts, which lead to equinizing of the structures of some forest plantations. Of all types of forests met by now, the meadow forest is the most strongly influenced by the zoo-anthropogenous factor. It is partly recovered in certain areas by measures that respect the structure of the few fragments which are left along the Danube.

To a large scale, the effects of the zoo-anthropogenous impact upon the forest phytocoenosis from the investigated area is translated by their synatropization. This one is defined by replacing the characteristic species with the cosmopolitan ones, of the autochthonous species by the allochthonous ones, of the stenotopic ones by the eurytopic ones, meaning that at last, by the substitution of the primary forest phytocoenosis, which have a high level of homeostasis, with secondary phytocoenosis with low stability.

In the presents the meadows from the investigated areas occupy the lands from the Danube's riverside or places which were fallow lands a few years ago.

The important issue is not grazing itself but infringing certain rules in its organization. Excessive grazing associated with prolonged drought have modified the physiognomy and the continuity of the grass and have weakened the capacity of the meadows to support feeding the herbivorous animals. This fact can be noticed on certain fields from the investigated areas, where grazing the meadows on certain areas for a long time lead to evident modifications in the floral composition and indirectly to their fauna. The valuable plants from nutritional point of view have been replaced by plants with a low nutritional value and which are rejected by the animals. Through the abusive grazing the plants' resistance to frost weakens and consequently, the vegetative cover degrades, becoming fewer, which favours the erosional action exerted by wind and water upon the soil.

Most of the cases, in the investigated area, the herbs are grazed up to the soil's level, these ones becoming weak and less resistant to drought. That is why the meadows that are irrationally grazed, become more vulnerable to drought in comparison to the ones grazed rationally.

On the other side, the repeated grass cutting in certain areas leads to the elimination of the plants with late flourishing, to the modification of the floral composition of the grasslands and in the end to the biodiversity drop.

The biocoenosis of the useful plants is a very anthropized, modified, semi-natural one and it is represented by all agricultural crops and organisms (soil's microorganisms, diseases, and so on), which live in trophic correlations (RESMERIȚĂ & TEXTER 1956). This biocoenosis is simpler than the natural biocoenosis (forest, meadow and so on) due to the fact that it has in its composition a single primary producer (useful plants for the alimentătion). It displays a more reduced stability and complexity than the natural biocoenosis.

Man, through his activities, evaluates and improves the environment conditions in order to establish a permanent concordance with the requests of the useful plants and to avoid the disturbance agroecosystems.

A large part of the cultivated surfaces are left as fallow lands either due to the lack of financial support for growing new crops or to let the soil "rest" because of a low fertility.

Although these lands are left to "rest" they still produce a large quantity of green mass made of weeds.

A part of the plants identified in the investigated area become invasive. There are also included in this category the adventitious plants, which usually grow in anthropogenic habitats (cultivated fields and/or ruderal areas). From the invasive taxa identified in the area, we mention: *Amorpha fruticosa* L. - (Fabaceae), *Ambrosia artemisiifolia* L. (Asteraceae), *Calamagrostis epigejos* ROTH. - Wood Small-reed (Poaceae), *Cardaria draba* (L.) DESV. - Whitetop (Brassicaceae), *Cirsium arvense* (L.) SCOP. - Cursed Thistle (Asteraceae), *Conium maculatum* L. - Poison hemlock (Apiaceae), *Conyza canadensis* (L.) CRONQUIST - Horseweed (Asteraceae), *Hordeum murinum* L. - Wall Barley (Poaceae), *Matricaria perforata* MÉRAT - Scentless Mayweed (Asteraceae), *Onopordum acanthium* L. - (Asteraceae), *Polygonum aviculare* L. s.l. - Common Knotgrass (Polygonaceae), *Sambucus ebulus* L. - Danewort (Caprifoliaceae), *Xanthium italicum* MORETTI - *X. strumarium* (Asteraceae).

The floods registered in the spring of 2006 fully contributed to the modification of the floral and fauna composition from the area, as well as to the change of Rast locality physiognomy. These are the consequences of man's activity upon nature.

The defence barrage near the localities of Rast and Nedeia collapsed and the area was filled with water. The whole locality was flooded (Fig. 1). Over 2000 houses were affected only in Dolj county. A third of these cases was recorded in Rast locality (Figs. 2-4), presently known as Rastu Vechi.



Figure 1. Image from the periphery of Rast locality during the floods.  
Figura 1. Imagine de la periferia localității Rast în timpul inundațiilor.

The deluge started on the 16<sup>th</sup> of April 2006, when Rast and Negoii villages were flooded by the Danube through the breach made by the authorities in the near barrage several days before. Over 100 persons were immediately evacuated, while the houses were collapsing due to the water infiltrated into the walls. Until the second day, 115 houses had collapsed and the water was of 2 meters height in other 700. 800 people were evacuated by the authorities and other 3,000 inhabitants left being afraid of the waters. In a couple of days a real camp of improvised shelters and army tents was founded. The distressed people spent the Resurrection night here to an improvised church, also taking benefit of all the help received as food or clothes.



Figure 2. Image of a house affected by floods in Rast locality.  
Figura 2. Imagine cu casă afectată de inundații din localitatea Rast.

In order to support the distressed people, both private persons and different ONG came there.

Meanwhile the corps of the animals left behind by the withdrawing waters, became a real pest hole, and for a short period the locality was in quarantine.

After the water withdrew, it was decided for the village to be moved on another area with a level quota of around 6 meters higher, 6 km north from the old area.

During the floods of April-December 2006, the population lived in the distressed people camp, first in tents from ISU Dolj and from the Red Cross and after that in the 500 modular houses brought by the Government.

In the summer of 2006, there arrived the first materials in order to re-build the locality. With the help of the state authorities, until December 2006, there were build 300 houses in Rast, 140 of which are founded on wood structures and 160 of carrying capacity masonry.

In 2007, after the floods, 72 people died, most of them due to a stroke or of high blood pressure, in comparison with only 17 births.

Catastrophic floods such as those of 2006 from the Danube's floodplain could be avoided. The Ministry of Environment started a cartography program of river and its riparian areas. The specialists will fly over the area in order



to achieve a digital map on the base of which they shall be able to establish what are the areas vulnerable to floods and what measures should be taken.



Figure 3. A household affected by floods in Rast locality.  
Figura 3. Gospodărie afectată de inundații în localitatea Rast.



Figure 4. A whole image to notice that the entire village is affected by floods.  
Figura 4. Imagine de ansamblu în care se observă că întreg satul este afectat de inundații.

The specialists will transform the images from the plane into a digital dummy of the field, which hydrologists will analyze in order to estimate the floods risk.

The floods from 2006 still show their consequences, the houses, lands and agricultural crops being affected even after the water withdrew.

A special effect from the social point of view is represented by the inhabitants who were physically and morally affected, who found themselves into the situation of moving into a new place after watching how their lifetime fortune or even back-generations one was swallowed by the waters.

### CONCLUSIONS

People have inhabited the investigated territory since old times. Human settlements are generally located at the contact between different landforms, for example the contact area between the floodplain and river terraces.

Most of the inhabitants of this territory have a poor education regarding ecology. The education concerning the environment must develop at the entire level of human kind, and we aim here at the attitude of respect and responsibility towards the natural resources in order to protect them.

During the trips in the area, there has been tried to infuse the people with the concept that man, as a biological species, depends on nature and cannot live without it.

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## ACID PRECIPITATION AND ITS IMPACT ON MONUMENTS

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**Abstract.** *Monitoring the chemical composition of atmospheric precipitation and acid oxides concentrations in the atmosphere in the years 1990-2008 showed the presence of acid rain in Moldova. The value of pH in water samples collected from rainfall varied in limits from 2.65-10.35. During the years 1990-1998 the percentage share of samples showed that acid increased continuously. However, between 1999 and 2001 a change was detected, water samples collected were mostly neutral, but after 2002 to 2008 it was observed an increase in the rate of acid samples. It was found that the Stratus and Stratocumulus clouds, which absorb pollutants from the layer of atmosphere below the clouds, contain less acidic precipitation than Cumulonimbus clouds, which make contact with the upper atmospheric layers and perhaps incorporating pollutants brought by air masses from the front. Analysis of ions content and the pH-value in precipitation was found to be dependent on the direction and structure of the wind at altitude. In the case of descending rainfall the ionic concentration is higher and more acidic. Increasing levels of pollution of the atmosphere with acidic substances increase the aggressiveness to material objects, buildings, monuments of art. Acids and acid gases in the atmosphere cause the chemical and electrochemical corrosion; this sharply reduces the life of inorganic and organic building materials. The effect is stronger in joint action with oxidants, ultraviolet radiation, high temperature and moisture. While studying affected monuments it was established that the corrosion rate of marble in the cities is 3.5 mm in 100 years and in rural areas no larger than 0.5 mm for the same time period. Among the gases responsible for acid rain acidification are sulphur oxides and nitrogen. Sulphur oxides are released in large quantities in the atmosphere together with burning gasses.*

**Keywords:** *acid rain, atmosphere, transboundary transfer, ecological impact, corrosion.*

**Rezumat.** *Ploile acide și impactul lor asupra monumentelor. Monitorizarea compoziției chimice a precipitațiilor atmosferice și a concentrațiilor oxizilor acizi din atmosferă în anii 1990-2008 au arătat prezența ploilor acide în Republica Moldova. Valoarea pH-ului în probele de apă colectate din precipitații a variat în limitele de la 2,65-10,35. În perioada anilor 1990-1998 cota mostrelor acide în procente a crescut continuu, însă pentru anii 1999-2001 s-a detectat o schimbare, probele de apă au fost în cea mai mare parte neutre și după anul 2002 până în anul 2008 se observă o creștere a cotei probelor acide. S-a constatat că precipitațiile provenite din norii Stratus și Stratocumulus, care absorb poluanții acizi din straturile de jos ale atmosferei, sunt mai puțin acide decât mostrele de precipitații colectate din norii Cumulonimbus, care contactează cu partea superioară a atmosferei și care încorporează poluanți transportați de masele frontale de aer. Conținutul ionilor analizați și valoarea pH-ului în precipitații depind și de direcția și structura vântului la înălțime. În cazul vântului descendent concentrațiile ionilor analizați sunt mai mari și mostrele de precipitații mai acide. Creșterea nivelului de poluare a atmosferei cu substanțe acide duce la creșterea agresivității ei față de materiale, obiecte, clădiri, monumente de artă. Gazele acide și acizii din atmosferă provoacă corodarea chimică și electrochimică. Durata de viață a materialelor de construcție de natură anorganică și organică brusc se reduce. Efectul este și mai puternic în cadrul acțiunii comune cu oxidanți, iradiieri ultraviolete, temperaturi înalte și umezeală. Studiind monumentele afectate s-a stabilit că în orașe viteza de corodare a marmurei este de 3,5 mm în 100 de ani, iar în mediul rural nu mai mare de 0,5 mm pentru aceeași perioadă. Dintre gazele acide responsabile pentru acidularea ploilor cele mai importante sunt oxizii de sulf și azot. Oxidul de sulf este degajat în atmosferă în cantități mari împreună cu gazele de ardere.*

**Cuvintele cheie:** *precipitații acide, atmosfera, transfer transfrontier, impact ecologic, coroziune.*

## INTRODUCTION

External baric centres determine climate resources. The atmospheric circulation is predominantly anticyclone, with a relatively reduced activity of the atmospheric processes, expressed by a variety of changes in seasonal movement. Most cyclones cross the territory of Moldova from west and southwest, at an average speed of 20-30 km/hour, the maximum speed reaching 80-90 km/hr. Prevailing winds blow from the West, North, North West, while the South and South-West winds display a lower frequency. The average speed reaches 2.5-4.5 m/sec.

Acid rain became a major problem since the introduction of the Arab oil embargo in 1973, because most of the industrialized countries have started using coal as a result (RODHE et al., 1995, ȘERBAN et al., 1993).

The first mentioned acid rain occurred in Uilling (USA) in 1978 and had a pH = 2.0 (BLANCHER et al., 1992). The average annual pH value is 4.5 in Europe and 4.0 in Northern Europe. The theoretical value of the average annual rainfall pH value for Moldova, calculated by EC UN, is 5.0 (BUBURUZ et al., 1993).

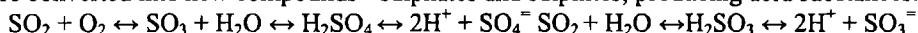
Amongst the most important gases responsible for acid rain acidification we mention sulphur and nitrogen oxides. Sulphur oxide is discharged with exhaust gases in the atmosphere.

Increasing levels of pollution of the atmosphere with acid substances lead to an upward aggressiveness toward the material objects, buildings, art monuments. Acids and acid gases in the atmosphere cause the chemical and electrochemical corrosion; this sharply reduces the life of inorganic and organic building materials. The effect is stronger in joint action with oxidants, ultraviolet radiation, high temperature and moisture. While studying affected monuments, it was established that the corrosion rate of marble is 3.5 mm in 100 years in the cities and no greater than 0.5 mm in rural areas for the same period. Limestone or insoluble marble reacts with carbon oxide (IV) and passes in soluble  $\text{Ca}(\text{HCO}_3)_2$  according to the reaction:  $\text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O} = \text{Ca}(\text{HCO}_3)_2$  (BUBURUZ et al., 1993, 1995, 1997).

In Europe, around 30 million tonnes of sulphur oxides are released per year, in North-Eastern Canada - 40 million tonnes per year, in Japan and southeast China - 10 million tonnes per year. In the Republic of Moldova 230 kt sulphur oxides were discharged in the year 1990 (reference year) and about 10 kt in 2005. The global emission of sulphur oxide (IV) in the atmosphere is valued at around 113 million tonnes/year, 98 million tons of which reach the atmosphere as SO<sub>2</sub>, 3 million tonnes as SO<sub>3</sub>, 9 million tonnes as aerosols of sulphates, and 3 million tonnes as H<sub>2</sub>S (BUBURUZ, 2003, BUBURUZ et al., 1997, RODHE et al., 1995).

NO<sub>x</sub> content in the atmosphere varies from tenths of the thousandths mg/m<sup>3</sup>. Natural sources of production of nitrogen oxides are electric discharges in the atmosphere, large fires and the elimination from the soil. The intensity of emission from natural sources is 0.27 kg/km<sup>2</sup> in 24 hours. The global anthropogenic quantity of NO<sub>x</sub> emissions is estimated at around 40-90 million tonnes/year. Ambiguous sources refer to the transformation of NH<sub>3</sub> to NO<sub>x</sub>. Average concentration of ammonia in the atmosphere is estimated at 2.5-3 mkg/m<sup>3</sup> (BUBURUZ et al., 1993, 1997, RODHE et al., 1995).

Under the action of solar radiation, oxidants and free radicals, always present in the atmosphere, sulphur oxides are converted into new compounds - sulphates and sulphites, producing acid substances:



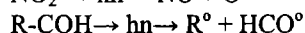
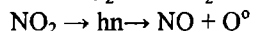
Acid rains are virtually diluted solutions of acids, especially sulphuric and nitric acids. Pollution sources influence the ratio between H<sub>2</sub>SO<sub>4</sub> and HNO<sub>3</sub>, and it changes within the limits of 1:1 to 4:1. The graphical presentation of the concentration change of sulphur and nitrogen compounds and their transformations depending on time show that the maximum concentration of H<sub>2</sub>SO<sub>4</sub> in the atmosphere reaches over 30 hours and that of HNO<sub>3</sub> over 15 hours (BUBURUZ et al., 1993, 1997).

Acids can form not only in the atmosphere, but also in the solution from the sedimentation or absorption surface, lowering the pH and increasing the corrosive aggressiveness degree of the atmosphere.

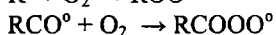
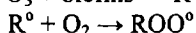
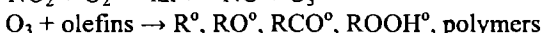
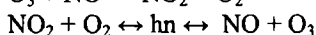
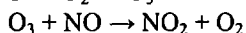
Aggressive corrosion of the atmosphere is also provoked by the photochemical smog formation. Oxides of CO, NO, NO<sub>2</sub>, (CH<sub>2</sub>)<sub>n</sub> under the solar radiation favour the formation of the ozone.

A typical cycle of reactions for the formation of photochemical smog is rendered below:

Primary reactions:  $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$



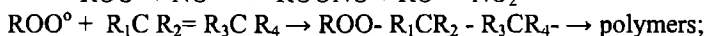
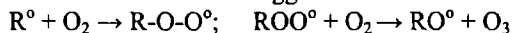
Undesirable secondary:  $\text{O}^\bullet + \text{O}_2 \rightarrow \text{O}_3$



These reactions do not consider many chemical processes in the typical organic chemistry. For example, the release of styrene, halogens, chlorine, bromine, under the influence of photochemical reactions, easily pass in an excited state (BUBURUZ et al., 1993, 1997, NICORICI et al., 2003).

Some reactions lead to the formation of free radicals, to the release of hydrogen from the organic substances in the secondary reactions with O<sup>°</sup> and O<sub>3</sub>. Free radicals are formed in the photochemical decomposition of nitrite and peroxyacetylnitrite in the initial stages.

A source of the formation of free radicals is the aldehydes released with exhaust gas. Radicals form peroxides with the oxygen, which increase the corrosive aggressiveness of the atmosphere (BUBURUZ et al., 1997):



Hydrocarbons under UV irradiation in the atmosphere are oxidized to aldehydes (BUBURUZ et al., 1997). In Fig.1 it is presented the change and transformation of propylene (CH<sub>2</sub> = CH-CH<sub>3</sub>) in the presence of NO<sub>x</sub>.

Ozone concentration in the air due to photochemical transformations can reach 60.10<sup>-8</sup> vs. (3-4).10<sup>-8</sup> normal concentration. Ozone is a strong oxidant and its presence in the ozone layer is beneficial, but in the troposphere, its increased concentration leads to the disturbance of metabolic processes in plants and animals and increases the corrosive aggression of the atmosphere. Ozone action on plastic and construction materials leads to their rapid degradation.

## THE OBJECT OF STUDY AND RESEARCH METHODS

The objective of this research study is the impact exerted by precipitation on the environment and their trends of change during 1993-2008.

Methodology for collecting samples of precipitation (snow, sleet, and rain), their chemical analysis, the monitoring of the acidifier oxides (NO, NO<sub>2</sub>, SO<sub>2</sub>) and SO<sub>4</sub><sup>2-</sup> concentration in the air were performed according to the normative document PD 52.04.186-89. Precipitation samples (time of collection 2-60 min) were collected using polyethylene funnels with a total area of 1.28 m<sup>2</sup>. From a cycle of rainfall, a series of consecutive samples, which were analyzed separately, were collected in the quantity required for the performance of the analysis. It was measured the pH



value, the concentration of the ions  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$ ,  $\text{HCO}_3^-$ ,  $\text{NO}_3^-$ ,  $\text{NH}_4^+$  and the sum  $\text{Ca}^{2+} + \text{Mg}^{2+}$ . At the same time, there was monitored the concentration of the acid oxides ( $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{SO}_2$ ) and  $\text{SO}_4^{=}$  in the atmosphere. When samples were collected, there was also made a complex of standard meteorological observations.

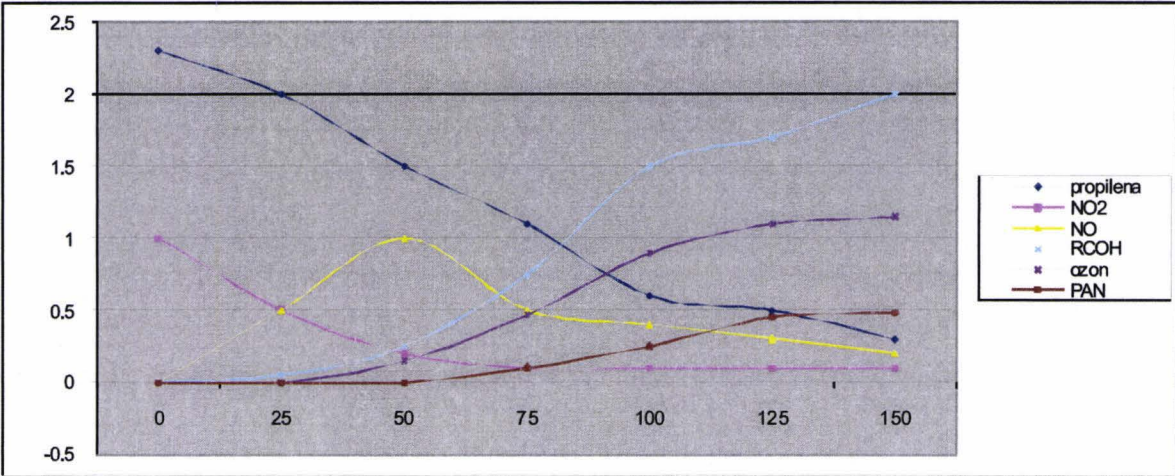


Figure 1. Photochemical smog formation under the irradiation with UV of the polluted air by converting propylene in the aldehyde, ozone and peroxyacetylnitrite in the presence of nitrogen oxides.  
Figura 1. Formarea smogului fotochimic în timp la iradierea cu raze UV a aerului poluat prin transformarea propilenei în prezența oxizilor de azot în aldehydă, ozon și peroxiacetilnitrit.

RESEARCH RESULTS

1. Collection and analysis of rainwater samples

The systematic study of acid precipitation was held at the field station Hincesti of the National Institute of Ecology starting with 1993.

During the research period (1993-2008), samples of precipitation were collected, chemical analysis carried out, and the pH of rainfall water determined. At the same time, we determined the concentration of acid oxides ( $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{SO}_2$ ) and sulphates in the atmosphere. A standard complex of meteorological observations was also made. The number of rainfall events, the number of discrete collected samples, the average annual pH and the variation of pH are rendered in Table 1.

Table 1. Number of precipitation and collected samples and their acidity.  
Tabel 1. Numărul de precipitații și mostre colectate și aciditatea lor.

Year	No. of precipitation	No. collected samples	Average annual pH	Interval pH per year
1993 (August-October)	9	43	-	2.65-7.60
1994	49	152	6.71	3.51-9.13
1995	93	272	6.11	3.80-10.35
1996	65	177	5.97	3.75-9.70
1997	43	174	5.70	4.20-7.85
1998	54	125	5.21	2.55-7.30
1999	60	306	5.45	4.10-7.85
2000	58	148	6.60	4.40-8.22
2001	82	253	5.34	3.00-6.80
2002	69	192	4.89	4.00-6.50
2003	64	183	5.97	5.00-6.50
2004	46	59	5.26	3.8-6.00
2006	88	108	6.53	4.00-8.40
2007	82	124	6.02	4.20-7.20
2008	92	116	5.28	3.90-8.40

The average annual pH of the rainfalls (Table 1) oscillates between 5.21 and 6.71, so it is practically neutral. There is a slow increase of acidity of the average annual rainfall from 1994 to 1999, corresponding to: 6.71; 6.11; 5.97; 5.70; 5.21. In 1999, it was observed an increase in the basic features of the mediated samples at pH = 5.45 and in 2000 the average annual pH is 6.60. In 2001, the pH dropped to 5.34, while in 2002 to 4.89. This reduction of the acidity of the rainfalls can be explained by decreasing emissions of alkaline dust in the atmosphere of the Republic of Moldova due to the economic crisis. The presence of alkaline features between 1999 and 2000 is due to the massive transboundary transfer of basic substances from the area of armed conflicts (Balkans, Chechnya) and this is demonstrated by the sudden change in the chemical composition of rainfalls compared to the previous years (BUBURUZ, 2003, BUBURUZ et al., 1993, 1995, 1997, NICORICI et al., 2003).

During the research (1993-2008), the pH of the solutions of discrete collected rainfall ranged from 2.65 to 10.35 (Table 1, 2). According to the World Meteorological Organization methodology, it is considered acid precipitation if the pH value  $< 6.5$  and alkaline for a pH  $> 7.5$ . In a pure atmosphere, the pH of rain will be equal to 5.6 due to the dissolution of carbon monoxide (IV) in rain water and carbonic acid production. The first sample of strong acid rainfall was recorded on August 11, 1993 with the pH = 2.65. This discrete sample (one from a number of discrete samples collected consecutively during a rainfall, Table 2) was characterized by an unusually high content of anionic sulphate ( $\text{SO}_4^{2-}$ ). Hydrocarbons were absent, the other ion concentrations were within normal. Other discrete samples collected during the same rainfall had a pH = 5.95-6.68. The most alkaline sample was collected in 1995 on July 15, with the pH = 10.35 (Table 2).

Table 2. Characteristics of two acid rains (consecutive discrete samples collected at a rainfall) (mg.ekv/m<sup>2</sup>.hours).  
Tabel 2. Caracteristica a două precipitații (mostre discrete consecutive colectate dintr-o precipitație) (mg.ekv/m<sup>2</sup>.oră).

Date	Time for collection (min)	pH	[ $\text{SO}_4^{2-}$ ]	[ $\text{HCO}_3^-$ ]	[Cl <sup>-</sup> ]	[ $\text{Ca}^{2+} + \text{Mg}^{2+}$ ]	[ $\text{NH}_4^+$ ]
The 11 <sup>th</sup> of August 1993	2	6.68	0.61	0.44	0.10	0.41	0.09
	2	6.17	0.27	0.30	0.09	0.47	0.11
	4	5.95	0.50	0.40	0.10	0.22	0.08
	2	2.65	16.10	0.00	0.10	0.54	0.12
The 15 <sup>th</sup> of July 1995	5	10.35	3.18	1.68	2.45	4.43	0.0
	5	9.62	0.94	1.18	1.76	2.58	0.0
	10	8.73	0.02	0.37	0.64	1.01	0.0
	7	7.12	0.27	0.63	1.05	2.41	0.0

The analysis of the chemical composition of the rainwater samples from the years 1993-1998 show the dominant role of sulphate and carbohydrate ions, each 40 to 20% on average, corresponding to the amount of ions content. Among cations, the sum  $\text{Ca}^{2+} + \text{Mg}^{2+}$  represents about 37%. The content of carbohydrate ions in discrete samples range from 0.0 to 226.9 mg/l, for the sulphate ion from 0.0 to 178.0 mg/l, while the concentration of chlorine ion ranges from 1.06 to 93.7 mg/l. The chemical composition of rainfall in the years 1999-2002 differs from the composition of rainfalls registered in 1993-1998 and 2003-2008. In 1999, we mention the carbohydrate ion, which represented 52% of the total amount of analysed ions. The maximum value was 44.5 mg. ekv/m<sup>2</sup> hour. Increased cation concentrations are registered by the sum  $\text{Ca}^{2+} + \text{Mg}^{2+}$  (33%), the maximum being of 53.4 mg.ekv/m<sup>2</sup>.hours. Higher values compared to the previous years were also registered by the ammonium ion (maximum value - 24.7 mg.ekv/m<sup>2</sup>.hours). Transboundary transfer of alkaline substances can explain such a distribution of the chemical composition of atmospheric precipitation in 1999 and 2000 from the areas of armed conflict.

The chemical content of precipitation and the pH changes over time. The concentration and the ratio of various impurities in precipitation depend on their type, intensity and duration. In the first sample, it is observed an increased content of all analyzed ions, when rainfall duration exceeds 60 min, the concentration of ions in rainwater approached the minimum. In some cases, the variation is chaotic indicating dispersion of pollutants in the atmosphere (Table 2).

The analysis of the rainwater samples from 1994, a dry year, showed a higher chemical content and the pH value ranging between 3.50 and 9.10, although the pH value indicated the decreasing acidity in samples during periods with greater rainfalls.

The chemical analysis of the precipitation samples revealed some features in 1994. From April to July, the poorest in rainfall, there was registered a higher content of fix residuum, reaching, for example,  $[\text{Ca}^{2+} + \text{Mg}^{2+}] = 19.0$  mg.ekv/m<sup>2</sup>.hours,  $[\text{SO}_4^{2-}] = 10.0$ -15.0 mg. ekv/m<sup>2</sup>.hours,  $[\text{Cl}^-] = 15.0$ -20.0 mg.ekv/m<sup>2</sup>.hours. In August, the intensity of rainfall increased and with it, acidity decreased. Insufficient rainfall should lead to lower rainwater pH value.

Comparing with the data analysis of the rainwater for the first half of 1995, which reveals a large number of heavy rains, we find that the pH ranged between 4.01 and 8.35, with an average of 5.86, which means it was predominantly basic, so we do not take into account the contribution of carbon oxide (IV).

The average annual pH in the studied rainfalls ranges between 5.21 and 6.71, which are neutral, but if we analyze discrete samples, we see that in 1998 the rate of acid precipitation samples increased, while in 1999, the rate of neutral and basic samples increased, followed again by acid rain. Between 2000 and 2001, the value of pH  $< 5.60$  oscillated between 35.1% and 60% of the samples; pH values of 5.61-6.50 represented 29.5% and 39.1%, pH  $> 6.50$  had 35.4% and 0.9% corresponding. In 2002, all monitored rainfall are acid (Table 3).

## 2. The dependence of chemical composition of rainwater on meteorological factors.

It has been studied the relation between the chemical constitution of the rain and the movement of the frontal air masses and the presence of acid oxides in these masses. The influence exerted by the movement direction of air masses on the concentrations of nitrogen oxides in the atmosphere is different during the year. In the cold period, they are smaller and almost and do not depend on the movement direction of air masses. From May to September, the highest concentrations were found in air masses coming from the directions N, NW, NE, S, SW (which coincides with the frequency of occurrence of frontal air masses) and they do not depend on the direction of surface wind at all.

Depending on the direction of frontal air masses, there occurs the change of the chemical characteristics of the water samples, as emphasized by tab.4, which illustrates a variation of the analysed indices (BUBURUZ, 2003, BUBURUZ et al., 1993, 1997, NICORICI et al., 2003).

Table 3. Distribution (%) of the samples of precipitation water according to the value of the pH.  
Tabel 3. Repartizarea în (%) a mostrelor de apă din precipitațiile atmosferice după valoarea pH-ului.

pH/year	1976-95	1994	1995	1996	1997	1998	1999
<5.60	34.0	22,4	24,0	70.0	43.7	68.8	33.0
5.61-6.50	35.0	26,0	43,0	25.0	36.8	27.2	50.0
6.51-7.50	21.0	30,0	19,6	3.0	16.6	4.0	16.0
>7.51	10.0	21,3	13,4	2.0	2.9	0.0	1.0
pH/year	2000	2001	2002	2004	2006	2007	2008
<5.60	35.1	60,0	78,15	83	14,8	29	51
5.61-6.50	29.5	39,1	21,85	17	37	49,2	36,1
6.51-7.50	28.4	0,0	0,0	0	25,9	16,2	9,5
>7.51	7.0	0,9	0,0	0	22,3	5,6	3,4

Together with the analysis of atmospheric precipitation, there were analyzed the acidic oxides from the atmosphere and SO<sub>4</sub><sup>-</sup> aerosols. The results showed that from April to July, with the increasing circulation of the air in the Republic of Moldova, there also occurs an increase of the atmospheric concentration of oxides. This increase coincides with the N, NE, SW and W direction of the air masses. Depending on the direction of the air masses, the chemical characteristics of the water samples undergo certain changes as well. The results are rendered in Table 4 (BUBURUZ et al., 1997, IANOVCIUC, 1997). Rainfall acidity increases for SE and SW directions and this allows us to see that the most pollutants in the air is brought by frontal air masses.

Table 4. Changes in average indices analyzed in water samples (mg.ecv/m<sup>2</sup>.hours) depending on the direction of cyclonic air masses.  
Tabel 4. Variația indicilor medii analizați în mostrele de apă (mg.ecv/m<sup>2</sup>.ora) în dependență de direcția maselor de aer ciclonice.

	N	NE	E	SE	S	SW	W	NW
pH	4.80	5.51	5.44	5.43	5.20	5.46	5.53	5.20
SO <sub>2</sub> <sup>-</sup>	1.58	0.16	1.06	0.97	0.19	1.07	0.82	0.70
Cl <sup>-</sup>	0.37	0.16	0.40	0.56	0.12	0.63	1.11	0.36
HCO <sub>3</sub> <sup>-</sup>	1.17	0.48	0.90	2.03	0.32	0.98	3.23	1.24
Ca <sup>2+</sup> +Mg <sup>2+</sup>	0.84	0.51	0.83	1.06	0.29	0.71	2.34	2.07
NH <sub>4</sub> <sup>+</sup>	0.307	0.042	0.193	0.170	0.0	0.140	0.0	0.279

According to the West Center of Meteorological Synthesizing, referring to the average input/output of polluting substances calculated as transboundary aspect, the Republic of Moldova proved to be a net importer of sulphur, nitrogen oxides, and ammonia. Thus, among the pollutants coming from the neighbouring areas, sulphur and nitrogen register very high levels in Moldova, representing 84% of sulphur emissions, 96% of the nitrogen oxidant deposits and 45% of the reducing nitrogen. This analysis confirms that the transboundary transfer of acid substances plays a decisive role in the pollution of air within the basin of the Republic of Moldova.

It is known that atmospheric precipitation is formed and falls from the bottom layer of the atmosphere (up to 2 km). In this layer, there are the three types of clouds: Stratus - St, Stratocumulus - Sc and Nimbostratus - Ns. There are two types of very important clouds: Cumulus - Cu and Cb – Cumulonimbus, characterized by the occurrence heavy rainfalls. Comparing the results of the analysis of rainwater samples to the type of clouds, we see that the Stratus and Stratocumulus clouds, which absorb pollutants from the layer of atmosphere below the clouds, are less acid precipitation than those generated by Cumulonimbus clouds, which make contact with the upper atmospheric layers and, probably, incorporate pollutants brought by frontal air masses.

3. Harmful effect of acid precipitation

Acid precipitations influence the functionality of the ecosystems by altering life conditions (IANOVCIUC, 1997, KULLBERG, 1992, RODHE et al., 1995).

The harmful effect of acid precipitation, as a rule, refers primarily to the acidification of surface water, which, in its turn, leads to essential changes in the composition of plankton, flora and fauna and also to the trophic chain interruption. The analysis of water samples collected from surface waters on the territory of the Republic have shown that the quality of surface water is not practically influenced by acid rainfall due to the chemical composition of the water bed soil, which has an increased content of carbonates and probably to the average pH of the rainfalls, which is within the limits of 5.21-6.71. When clouds were inseminated with anti-hail agents, surface waters displayed lead and silver ions.

However, the present quantity of pollutants in the acid precipitation is sufficient to influence the vegetation and productivity of crops. Performed experiments allowed us to establish an empirical correlation enabling us to calculate

the productivity of crops depending on the precipitation pH value and to estimate the damage induced by the influence of individual or mixed pollutants (IANOVCIUC, 1997). Fogs and acid rain negatively influenced the productivity of crops and positively the development of pests.

### SUMMARY OF RESULTS

The results of our research show that the average annual pH of the collected rainfall samples (at Hincesti) during 1993-2008, oscillates between 5.21 and 6.71, which means slowly acid.

Even more interesting is the information obtained from the analysis of the rainwater samples collected constructively in a cycle of rainfall. If the average annual pH decreases constantly, with the exception of 1999, then the analysis of pH values for discrete samples shows that the pH highly varies during a rainfall. During the research period, with some exceptions, the number of acid samples increases due to the decrease of local emissions of acid substances. More acid rains occur during the warm period of the year, when atmospheric mobility increases and southern air masses became more active, due cyclonic activity.

The analysis of the pH dependence on wind structure shows that acid rain occurs at descending winds. The synthesis of the results shows that the transboundary transfer plays a determining role in the formation of acid precipitation in the Republic of Moldova.

### CONCLUSIONS

Moldova is under the influence of acid rain, pH value in the discrete samples of precipitation during 1993-2008 ranging between 2.65 and 10.35.

Ions concentration and pH value in discrete samples collected consecutively during a rainfall varies substantially.

Acid rain is caused by transboundary transfer of acid substances.

The increase of acid precipitation and of their acidity degree leads to the increase of the corrosive aggressiveness of the atmosphere on constructions, monuments etc.

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## WHEN DID THE DANUBES BECOME THE DANUBE?

ION ANDREESCU

*This paper is dedicated to Professor PETRE COTEȚ,  
an outstanding Romanian Geomorphologist.*

**Abstract.** *In the Middle Dacian (Parscovian) – Early Romanian (Pelendavian) time span at least three major migrational phases of the fresh-water molluscs, coming from the southern Pannonian Basin "Paludonian Beds," have been recorded in the Dacian Basin. In these conditions a direct, even intermittent, fluvial connection between the two realms, is to be supposed. According to the available data, since at that time the Paleo-Danube did not reach yet the central Pannonian Basin, such a connection could possibly be accomplished by the Paleo-Timok River (a southwestern Dacian Basin tributary) through the Serbian Paleo-Morava tectonic corridor. The Upper Valahian (=Uppermost Romanian) morphogenetic movements led, inter alia, to the fluvial connection breaking off through the Timok-Morava corridor. But, meantime, the Paleo-Danube already reached the southern Pannonian Basin area. Consequently one may say the Paleo-Danube became the Danube when it reached the Dacian Basin through the Iron Gates piercing, an event that could take place some 2.0-1.8 Ma ago, i.e. during the Uppermost Romanian (Upper Valahian) – Early Pleistocene.*

**Keywords:** *Danube, Dacian Basin, Pannonian Basin, Paludonian Beds, Paleo-Timok.*

**Rezumat. Când au devenit Dunărea Dunăre?** *Deoarece în intervalul Dacian mediu (Parscovian)-Romanian inferior (Pelendavian) în Bazinul Dacic se înregistrează cel puțin trei faze importante de migrație a faunei de moluște dulcicole, provenite din "Stratele cu Paludine" sud-pannonice, este de presupus o legătură fluvială, posibil intermitentă, între cele două bazine. Conform datelor de care dispunem, în lipsa Paleo-Dunării, care în acest interval nu avansase încă în sectorul central al Bazinului Pannonic, Paleo-Timokul pare să fi realizat o astfel de legătură prin intermediul culoarului tectonic drenat de Paleo-Morava. Mișcările morfogenetice valahiene au determinat întreruperea pasajului Timok-Morava dar, între timp, Paleo-Dunărea ajunsese în zona sudică a Bazinului Pannonic. În consecință este de presupus că pătrunderea Paleo-Dunării în Bazinul Dacic a avut loc cel mai probabil în urmă cu cca. 2,0-1,8 Ma, adică în partea terminală a Romanianului (Valahian) - începutul Pleistocenului (în actuala accepțiune a acestuia).*

**Cuvinte cheie:** *Dunărea, Bazinul Dacic, Bazinul Pannonic, «Stratele cu Paludine», Paleo-Timok.*

The present Danube valley, as a whole, is made of four major segments:

- a) from the source to the entrance in the Pannonian Basin;
- b) the Pannonian segment;
- c) the Iron Gates gorges;
- d) the Valahian - Pontic segment.

The Danube River course can be structured according to other criteria also, as for example, by tacking into account the six gorges it passes through.

Admitting the Danube course is made by several elements, then the questions are when and how these segments put together, resulted in the present course?

In time, a lot of more or less realistic hypotheses regarding these questions have been proposed. The present contribution does not intend a particularly analysis of those hypothesis. However, it is worth mentioning that till recently, most of them were mainly focused on the genesis of the Iron Gates gorges, considered with good reason, the clue in the Danube's evolution course.

Four of those hypotheses, although lasting since the 19<sup>th</sup> century, could be still considered as topical:

1. the gorges installed as a result of *tectonic displacements* that took place in the southwesternmost part of the Southern Carpathians (PETERS, 1876);

2. the *drainage capture* (PETERS, 1876) assumes the western side rivers of the Almașu Mountains have been captured by the eastern side ones. This hypothesis, adopted by de MARTONNE, 1902; MURGOCI, 1908; VÂLSAN, 1918 etc., has been subsequently developed by FICHEUX & TRICOM (1948, apud COTEȚ, 1954); POSEA et al., 1963, 1969) becoming the "successive capture" hypothesis.

3. the *antecedence* hypothesis (PENCK, 1895, apud COTEȚ, 1954) implies that the Danube's valley through the Iron Gates gorges existed already in Pontian, as a heritage of a Miocene or pre-Miocene valley.

CVJIĆ, 1908, adopted this opinion conceiving the gorges as a former marine narrow. In other words, this hypothesis claims the fluvial connection between the Dacian and Pannonian basins has practically been permanent since the Pontian time. Besides most of the Serbian authors, this model is supported by COTEȚ, 1954; 1957; BADEA, 1970; PAULIUC et al., 1988; LEEVER, 2007, as well;

4. the *overflow* of the Pannonian Lake in the Dacian Basin (TOULA, 1896, apud COTEȚ, 1954) has in view the similitude of the mollusc assemblages in the "Paludonian Beds", from the southern Pannonian Basin, with the freshwater mollusc assemblages from Pliocene deposits in the Dacian Basin.



Except the first hypothesis, the others are implicitly, or explicitly, referring to the time span when in the Iron Gates area, or in its upstream or downstream proximities, there took place the events that led to the present Danube configuration.

However, the timing of those supposed events is rather out-of-date, whether one take into account that the meaning of some chronostratigraphic units used that time is quite different by comparison with the actual Neogene chronostratigraphic units. As for example, what did the Miocene or the Pontian mean to CUVIIC, 1908?

Did he use the Pontian in the sense accepted that time by the greatest part of the Austro-Hungarian authors, in TEISSEYRE's, 1907; 1909, sense or in ANDRUSOV's, 1897; 1906 one?

But, beyond those features related to some temporal inaccuracy and inconsistency of several ideas, there is no reason, in any way, to consider those opinions as imputable to our ancestors.

During the last two decades a recrudescence of the items regarding the Paleo-Danube evolution in the Pannonian Basin is to be noted, in contrast with a somewhat slowness concerning the same subject, but in the Dacian Basin realm.

Most authors tried to integrate the various Danube's elements evolution in the tectono-sedimentary regime of the Pannonian and/or the Dacian Basin.

Several authors intending to integrate the paleogeographic evolution of the two basins in the frame of the Upper Miocene circum-Mediterranean events consider that the so-called "Messinian Salinity Crisis" has decisively influenced the Paleo-Danube evolution, either in the Pannonian Basin, or in the Dacian one.

In this respect, a peculiar note concerns the papers of CLAUZON et al., 2005; 2008, in which the authors claim the Paleo - Danube built a Zanclean delta in the Gura Văii - Drobeta Turnu Severin outlet.

The bottom set beds of that so-called Gilbert-type delta would be represented by the Upper Pontian (Bosphorian) silty-sandy clays from Hinova (= Sandy Clays of Valea Boereasca, in MARINESCU, 1978), while the foreset beds would be represented by the Gura Văii Conglomerates and Pebbles (= Gura Văii Formation, ANDREESCU, in ANDREESCU et al., 1992a), thought BY CLAUZON et al., 2005, to be Bosphorian too.

In CLAUZON's et al., 2005 acceptance, those pebbles and conglomerates, exposing a normal bedding, have erroneously been considered to belong to the Badenian Stage by the Romanian authors.

LEEVE, 2007, ENCIU, 2007 etc., adopted without any comment CLAUZON's et al. (2005) opinion.

Our investigations concerning the stratigraphy of the Neogene deposits from Oltenia prove the edifice of CLAUZON et al., 2005, is nothing else but an artifact.

The careful inspection of Fig. 1, in which the relationships among the Neogene deposits from Gura Văii-Drobeta-Turnu Severin area are depicted, is conclusive.

It is enough to see that the Gura Văii Conglomerates and Pebbles are channelized by huge Sarmatian alluvial fans (= Izvoru Bârzii Pebbles, MARINESCU, in MARINESCU et al., 1972; MARINESCU, 1978) which, in their turn, are transgressively invaded by the Lower Pontian deposits of the Ilovăț Formation (ANDREESCU, in ANDREESCU et al., 1992a, 1992b).

Thus, the cross-section (Fig. 1) shows the inconsistency of CLAUZON's et al., 2005, idea as concerns the presumably Upper Pontian age of the Gura Văii Formation and, consequently, the existence of a Bosphorian Gilbert-type delta in the Drobeta-Turnu Severin area as well.

The paleogeographic considerations of CLAUZON et al., 2005; 2008, regarding the Danube evolution follow a strange scenario according to which, during the Pontian, the Danube flowed on a similar course to its modern one, while the Pontian aquatorium of the Dacian Basin remained as a "perched" lake somewhere to the north.

In JIPA, 2008 and JIPA's et al., 2008 opinions, the hypothesis of CLAUZON et al., 2005, regarding the Messinian - Zanclean origin of the Danube in the Dacian Basin seem to be unlikely and in conflict with the stratigraphic data.

The first Proto-Danube delta had been built immediately after entering the Vienna Basin, in the low-stand interval subsequent to the Neo-Paratethys depletion, corresponding to Zone B (PAPP, 1951), of the basal Pannonian (HARZHAUSER et al., 2003, 2007), or to the Upper Bessarabian from the Oriental Paratethys.

That initial delta has been destroyed after about 1.1-1.3 Ma by the transgressive phase, coincident with Zone C (PAPP, 1951) of the Early Pannonian (HARZHAUSER et al., 2003; MAGYAR & SZTANO, 2007; CZICZER et al., 2008).

In the Dacian Basin this transgressive phase took place in the Lowermost Meotian, in a time interval corresponding to *NSM<sub>5a</sub>* - *Congerina neumayri* - *Teissereomya subatava* Subzone (ANDREESCU, 1981; 1983 etc.), paleomagnetically dated at 8.75 - 8.9 Ma (ANDREESCU, 2008, revised).

Against the strong transgression background, the connections between the Pannonian and Dacian basins could be easily re-established through the Cerna - Timis and/ or Iron Gates - Baziaș corridors, already extant in the Early Sarmatian.

The so-called "*Dosinia Level*" (= *NSM<sub>5b</sub>* - *Dosinia maeotica* Subzone) represents the high-stand of the Lower Meotian transgression.

Soon, in the 8.6-8.1 Ma time span (= *NSM<sub>5c</sub>* - *Eolymnium moldavicum* - *Sinzovinaia prahovensis* Subzone), the aquatorium of the Dacian Basin recorded a sudden level fall, leading to the completely freshening, strong erosion and developing of deltaic or even alluvial fan delta environments, as a result of breaking off the connections with the Euxinic and Pannonian basins (ANDREESCU, in ANDREESCU et al., 1992a; 1992b).

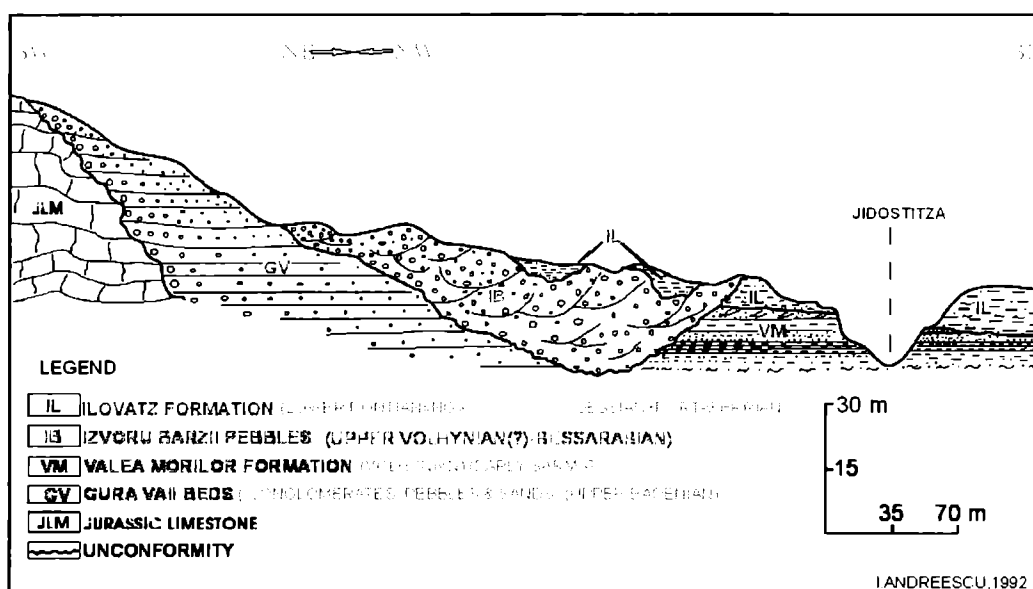


Figure 1. Cross-section in the Jidoștița valley area, NW to Drobeta-Turnu Severin.

Figura 1. Secțiune în zona văii Jidoștița, nord-vest de Drobeta-Turnu Severin.

This low-stand interval (about 0.5 Ma), inducing a real “salinity crisis” in the Dacian Basin, has been experienced by the Pannonian Basin as well, being illustrated by a substantial progradation of the Paleo-Danube and Paleo-Tisa deltaic environments (HARZHAUSER et al., 2003, 2007; MAGYAR & SZTANO, 2007; CSATO et al., 2007 etc.) at a stratigraphic level corresponding to Zone D (PAPP, 1951).

This interval seemingly is coincident with the “Lower Messinian Evaporites” from the marginal Mediterranean basins.

The Upper Meotian transgression in the Dacian Basin (~8.1 Ma), had been less evident in the Pannonian Basin. However, according to MARINESCU, 1978, several facts suggesting some restrictive connections between the two basins through the above-mentioned corridors, could take place.

At the level of ~7.7-7.5 Ma, the connections between the Dacian Basin and the Pannonian Basin were completely restored and, as a result, Lower Pontian retrogradational delta environments, which gain a wide expansion reaching the western Vienna Basin, have destroyed the Pannonian deltas of the Paleo-Danube and Paleo-Tisa.

According to STEININGER & WESSELY, 2000, the Paleo-Danube entered again the Vienna Basin not earlier than about 3.0 Ma ago, i.e. during the Pelendavian.

The second half of Portaferrian Substage (~7.0-6.75 Ma) is affected by a strong regressive tendency of the Paratethys realm. Finally, that regression led to a new and final depletion of the Paratethys.

On this background, the extinction processes of the Pontian brackish water molluscs are severely experienced in the Pannonian Basin. From now on, to the almost complete basin fill in Pleistocene, the Pannonian Basin is biostratigraphically characterized by the exclusive development of the freshwater molluscs of the “Paludinean Beds”.

Concomitantly, a series of quite interesting faunal events took place: tens and tens of freshwater bivalves and gastropods taxa, peculiar for the “Paludinean Beds” are to be found in the Upper Dacian and Romanian deposits from the Dacian Basin, a fact revealed by a lot of authors: BRUSINA, 1874; 1902; NEUMAYR & PAUL, 1875; PORUMBARU, 1881; PENECKE, 1883; FONTANNES, 1886; COBĂLCESCU, 1883; SABBA ȘTEFĂNESCU, 1896; TEISSEYRE, 1907; IONESCU-ARGETOAIA, 1918, 1923; KREJCI-GRAF, 1932; JEKELIUS, 1935, 1943; WENZ, 1942; LUBENESCU, 2008 etc.

Those similarities of the freshwater mollusc assemblages imply a fluvial connection, even intermittent, between the two basins.

As it was already specified, this is the strongest proof of the hypothesis of antecedence of the Danube course through the present Iron Gates area.

The proof is irrefutable indeed, but, in the same time, it is quite insufficient, by itself, to prove the validity of the antecedence hypothesis.

Firstly, it is noteworthy to point out that, during the slice time following the beginning of the Upper Portaferrian regression, the Paleo-Danube was trapped in the Vienna Basin (STEININGER & WESSELY, 2000), or somewhere in the northwestern Pannonian Basin (HARZHAUSER et al., 2003, 2007 etc.).

The amazing capacity of the Pannonian Basin to accommodate huge masses of Upper Neogene sediments, as an effect of a thermal subsidence, led to a relatively slowness in the progradation of the northern tributaries Paleo-Danube and Paleo-Tisa (CSATO et al., 2007 etc.).

Then an essential fact must be kept in mind, namely that those very numerous taxa of the “Paludinian Beds” recorded in the Pliocene deposits of the Dacian Basin, represent the vicariant faunas of the Croatian, Slovenian and south-westernmost Serbian realms, and not of the central or northern Pannonian Basin ones.

Once admitted these evidences, then the natural question is: how could those freshwater molluscs reach and disseminate, starting with the Upper Parscovian, the Dacian Basin?

Partially, the answer is rendered out in the attached charts (Figs. 2-5).

Those charts are based on a series of multidisciplinary investigations: litho-biostratigraphic, morphostructural, magnetostatigraphic, carbogenetic etc.), carried out during 1975-1998 in Oltenia (PANĂ et al., 1981; PAULIUC et al., 1981; ANDREESCU et al., 1984; ANDREESCU et al., 1985; ANDREESCU, 1986; ANDREESCU et al., 1986; ANDREESCU et al., 1992a; 1992b; 1993; 1994; 1995; 1996; 1997; 1998).

From the corroboration of the processed data, regarding mainly the coal bearing sediments in Oltenia, the following observations can be pointed out:

- in the Getian - Pelendavian interval, the Pannonian Paleo-Danube did not reach the Dacian Basin;
- in the Uppermost Bosphorian, lithologically represented by the Cocorova Sands and Vânu Mare Sands, and in the Lowermost Getian Substage, represented by the Lazu Sands, in the south-westernmost Dacian Basin flowed at least 5 important rivers: the Paleo-Motru, the Paleo-Coșuștea and the Paleo-Hușnița-Topolnița, in the north area, as well as the Paleo-Timok and the Paleo-Lom in the south (Fig. 2);
- both Balkan rivers representing major drainage axes, followed the structural dip along the depression corridors of Pătulele-Izvoru Aneștilor-Samarinești (PAS) and Băilești-Terpezița-Filiași (BTF) (Fig. 2);

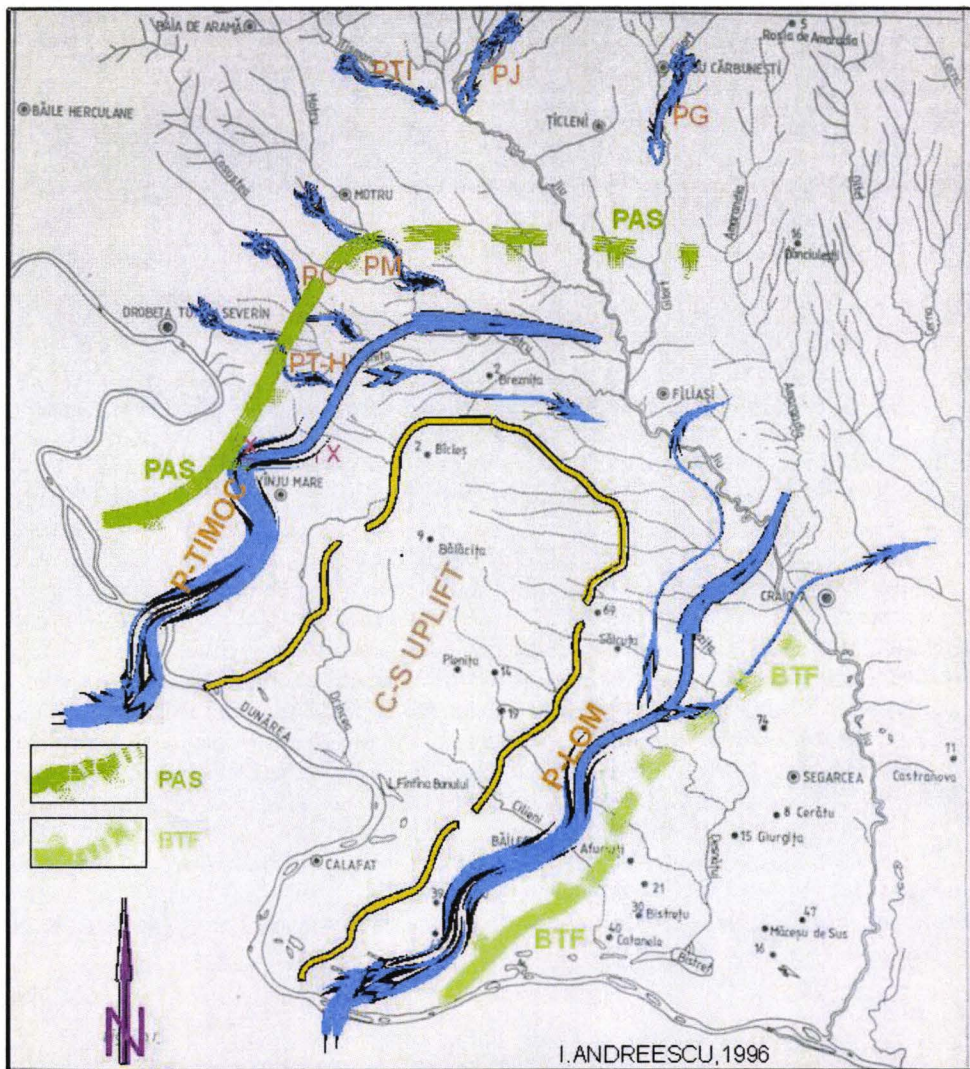


Figure 2. Main drainage axes in the Lower Dacian (Getian) from Western Oltenia.  
Figura 2. Principalele axe de drenaj în Dacianul inferior (Getian) din Oltenia occidentală.

- the lithofacial cross-section, drawn out in the southernmost Livezile sector (= „X – X” in Fig. 2; Fig. 3) reveals an important channel, flowing from south to north, as suggested by the data processed in a number of about 800 wells in the Western Husnicioara, Eastern Husnicioara and Western Prunișor - Izvoru Aneștilor - Livezile sectors;
- the same sediment supplying trend is documented by the Lower Getian sands containing heavy minerals and the bipiramidate and/or hexagonal quartz, originated from the Belogradcik - Boljevac eruptive zones and/or in the eruptive and metamorphic rocks from the south-Danubian areas south of Maidanpek (HADNAGY, in ANDREESCU et al., 1992a; 1992b);
- that channel, which deposited Uppermost Bosphorian - Lower Getian extensive sand sheets and accretionary sand bodies, reaching up to 100-150 m thickness in the corridor Pătulele - Izvorul Aneștilor - Samarinești, represents the Paleo-Timok River (Figs. 2; 3) (ANDREESCU, in ANDREESCU et al., 1992a; 1992b);

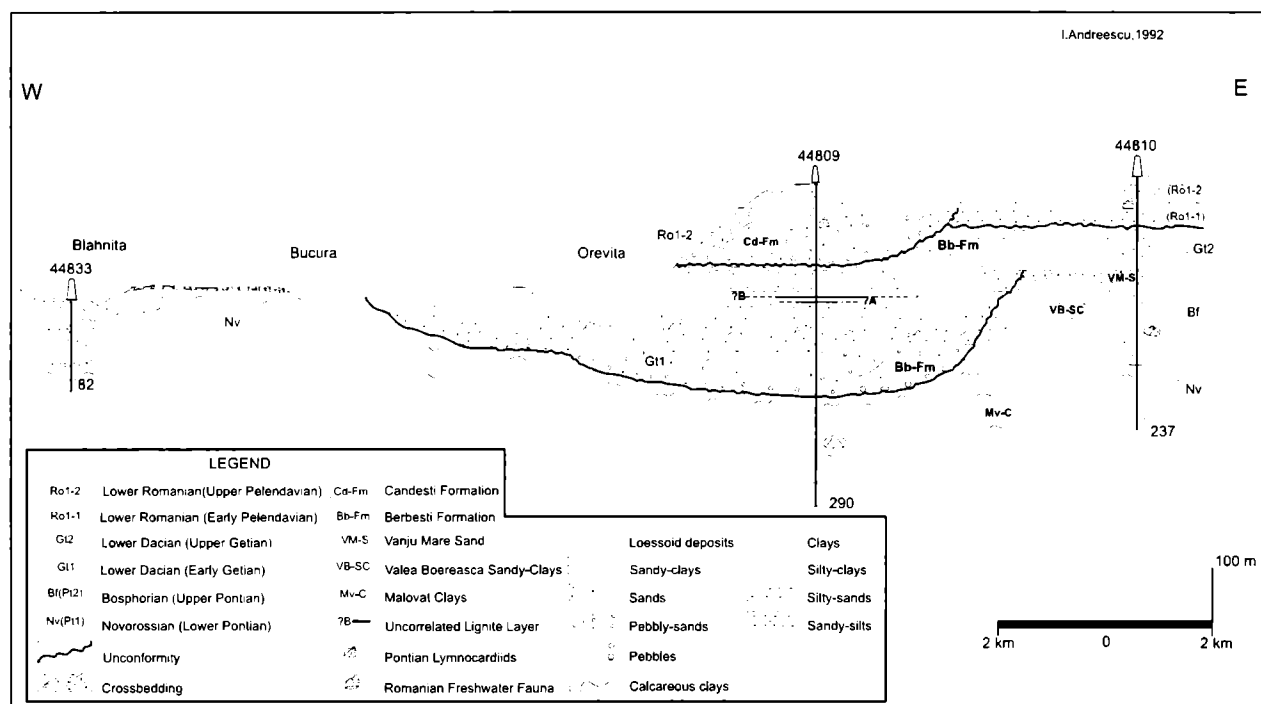


Figure 3. Lithofacial cross-section in southernmost Livezile perimeter.  
 Figura 3. Secțiune litofacială în extremitatea sudică a perimetrului Livezile.

- the greatest part of the extended “sandy platform” (Cocorova and Lazuv Sands), without which the initiation of the peat generating environments leading to the “Viseni Valley Coaly Complex”, could not be possible, has mainly to be put in the account of the Paleo-Timok River (ANDREESCU, TICLEANU, in ANDREESCU et al. 1985).
  - in the second part of the Getian, the sediment supply of the Paleo-Timok suffered a dramatic shortage, which favoured the development of peat generating environments (coal beds I to IV) in the medial-distal fan-delta lobes;
  - in contrast to the Paleo-Timok regime, a cyclic, impetuous activation of the Carpathian rivers, the Paleo-Motru, the Paleo-Coșuștea and the Paleo-Hușnița-Topolnița, which formed extended fan deltas, is to be noted.
  - frequently, the alluvial channels cannibalized their own deposits accumulated either during the former cycles, or in the same cycle, and eroded even the thick (12-21 m) peat sheets, corresponding to the 4<sup>th</sup> lignite bed (4-7 m) (Fig. 4).
  - basinward the medial to distal alluvial fans of the Carpathian rivers (the Paleo-Hușnița-Topolnița etc.) and the Paleo-Timok, built joined, more or less, shared-fan deltas, in the area of Prunișor - Izvoru Aneștilor (Fig. 5).
  - no freshwater molluscs ascending in the “Paludinean Beds” have been recorded in the Getian deposits from this sector of the Dacian Basin.
- The heralds of the “Lower Paludinean Beds” [*Bittneriella bittneri* (BRUS.), *Sibinunio pannonicus* (NEUM.), *S. sibiricus* (PEN.), *Viviparus spurius* (BRUS.), *V. eburneus* (NEUM.), *V. sadleri* (PARTSCH), *Melanopsis decollata* STOL., *Valvata sibiricus* NEUM., *Bulimus croaticus* PILAR, *B. pilari* NEUM., *Pyrgula eugeniae* NEUM., *Prososthenia radmanesti* (FUCHS), *Hydrobia syrmica* NEUM., *Theodoxus slavonicus* (BRUS.) etc.], occurred in Parscovian (*NSM<sub>9b</sub>*-*Prosodacnomya sturi* - *Bittneriella bittneri* Subzone) (ANDREESCU, 1981), whose lower limit is paleomagnetically dated at ~ 4.7 Ma (ANDREESCU, 2008, revised).



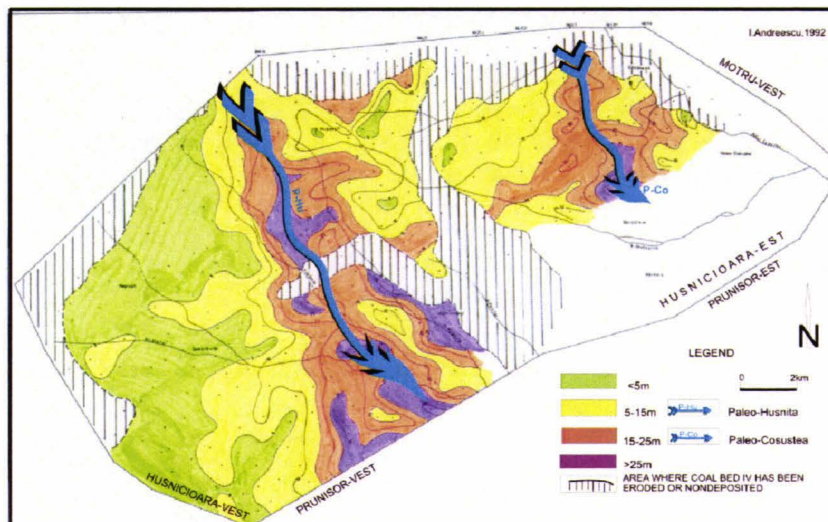


Figure 4. Sands isopach between the 3<sup>rd</sup> and the 4<sup>th</sup> coal beds in Husnicioara perimeters.  
 Figura 4. Izopahitele nisipurilor dintre stratele de lignit III-IV în perimetrele Husnicioara.

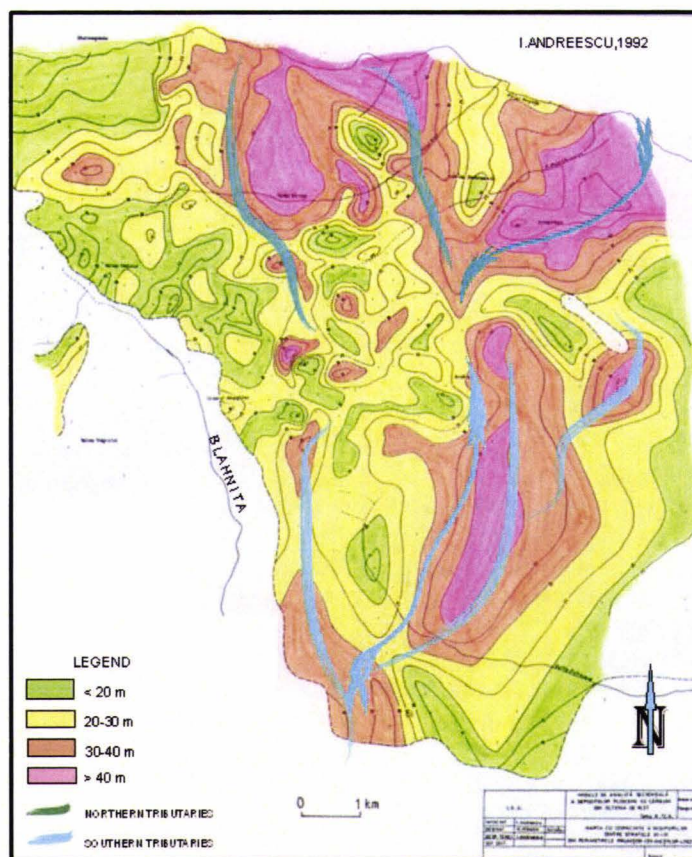


Figure 5. Isopach map of sands between 3<sup>rd</sup> and the 4<sup>th</sup> coal beds  
 in Prunișor-Izvoru Aneștilor-Livezile perimeters.  
 Figura 5. Harta cu izopahitele nisipurilor dintre stratele de lignit III-IV  
 în perimetrele Prunișor-Izvoru Aneștilor-Livezile.

Next south-Pannonian freshwater molluscs migration is a true invasion. Among those immigrants, several taxa must be mentioned: *Bittneriella stoltzskai* (NEUM.), *B. sandbergeri* (NEUM.), *Cyclopotomida zelebori* (HOERN), *Recurvunio hochstetteri* (NEUM), *Unio partschi* PEN., *V. bifarcinatus* (BIELEZ), *V. stricturatus* (NEUM.), *V. woodwardi* (BRUS.) etc.

Many other tens of species of the genera *Dreissena*, *Melanopsis*, *Lithoglyphus*, *Bulimus*, *Valvata*, *Staja*, *Hydrobia*, *Baglivia*, *Stenothyrella*, *Prososthenia*, *Pseudamnicola*, *Pyrgula*, *Micromelania*, *Theodoxus* etc., which concurred to the definition of the Zone NSM<sub>10</sub> - *Malvensinaia psilodonta*-*Viviparus bifarcinatus* (ANDREESCU, 1981) characterizing the Upper Parscovian and Siensian Substages, could be attached.



Paleomagnetically calibrated, the *Zone NSM<sub>10</sub>* extends on ~0.8 Ma (4.5-3.7 Ma) (ANDREESCU, 2008, revised).

The third south-Pannonian migration phase is the most spectacular and it roughly corresponds to the “Middle Paludinic Beds”.

That interval is defined by the Pelendavian Substage (3.7-2.7 Ma), characterized by the luxuriant development of the sculptured unionids and viviparids (*Zone NSM<sub>11</sub>* - *Moldavunio lenticularis*-*Valahunio iconomianus*).

Temporal and areal distribution of the *NSM<sub>11</sub>* Zone, with its 4 subzones: *11a* - *Rytia brandzai*; *11b* - *Pristinunio pristinus*; *11c* - *Pelendunio bielzi*; *11d* - *V. iconomianus*, are expressively reflected by the paleogeographic configuration and major tectono-sedimentary events of the Dacian, Pannonian and Euxino-Caspian Basins (ANDREESCU, 1981, 1983 etc.).

The south-Pannonian faunal elements are still dominant in the *Subzones NSM<sub>11a-c</sub>*, while the *NSM<sub>11d</sub>* - *Subzone* witnesses an accused recession of the Pelendavian fauna and the first occurrence of some oriental, Euxino-Caspian, elements: *Cuneopsidea excentrica* (BOG.), *Moldavunio crispisulcatus* (BOG.), *Valahunio orientalis* ANDR. etc., announcing the last Neogene molluscs zone, *NSM<sub>12</sub>*.

Since during the Parscovian-Pelendavian interval the Paleo-Danube was still trapped somewhere in the northern Pannonian Basin (MULLER et al., 1999; HARZHAUSER et al., 2003; RUSZKICZKAY-RUDIGER et al., 2005; etc.) nothing remains to think but to suspect the Paleo-Timoc River of possible fluvial connections with the southern Pannonian Basin (the Alföld Zone). In that case, the tectonic corridor of the Serbian Morava River could act as a passage-way.

This opinion has already been enounced by GILLET, 1961, which considered a connection between the Dacian Basin and the Pannonian Basin, through the Soljig Strait, as plausible.

As a matter of fact, in the present area of the Morava- the Danube junction, several taxa pertaining to *NSM<sub>11</sub>* Zone: *Margaritifera flabellatiformis* (DUNK.), *M. arca* TSCHEP., *Pristinunio davilai* (PORUMB.) etc., have been recorded (RAKIC & SIMONOVIC, 1997).

The Upper Romanian (Valahian substage) is biochronologically defined by *NSM<sub>12</sub>* - Zone - *Ebersininaia milcoensis*-*Moldavunio crispisulcatus* (2.7-2.0 Ma) and *QM<sub>1</sub>* - Zone-*Unio apscheronicus* (2.0-1.8 Ma) (ANDREESCU, 1981, 1983, ANDREESCU et al., 1981).

Besides the impoverishment of the molluscs fauna, the essential phenomenon is mass extinction of the related Pannonian fauna, replaced by oriental elements: *Ebersininaia geometrica* (BOG.), *Cuneopsidea neustruevi* (BOG.), *Sulcopotomida sudovskyi* (BOG.), *Bogatschevia tamanensis* (EBERS.), *B. bugasica* and by the boreal unionids as well: *Unio kujalnicensis* (IATZ.), *U. tumidus* etc., suggesting the cessation of the fluvial connection with the Pannonian Basin in the interval 2.4-2.0 Ma, as a result of the Valahian morphogenetic movements and climate deterioration.

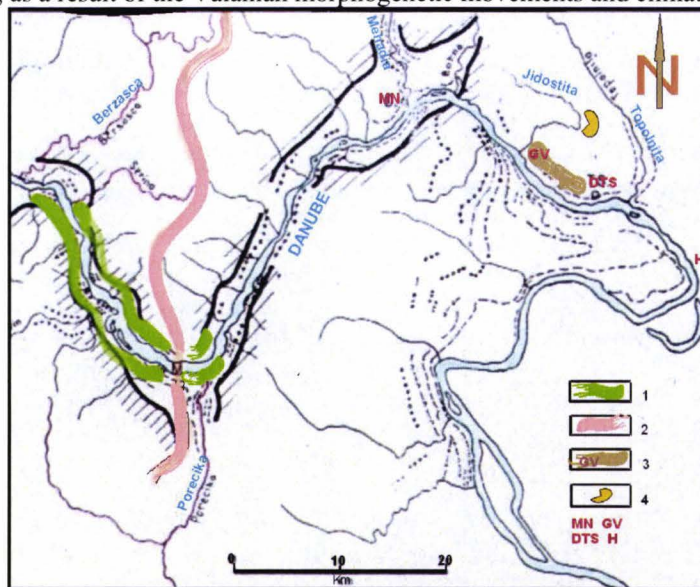


Figure 6. Geomorphologic features of the Danube River in the Iron Gates Area.

1= Area where the eastern “Valahian” River *PORECIȚA* captured the western “Pannonian” River *BERZASCA* (Modified, after Cotet, 1954); 2=The watershed zone in the Almașu Mountains; 3=Gura Văii Formation outcropping area along the Danube; 4=Area of the Jidoștița River capturing; MN=Moldova Nouă; GV=Gura Văii; DTS=Drobeta-Turnu Severin; H=Hinova.

Figura 6. Aspecte geomorfologice ale Dunării în zona Porțile de Fier.

1=Zona unde râul « valah » *PORECIȚA* a captat râul vestic « pannonic » *BERZASCA* (Modificat, după Cotet, 1954); 2=Cumpăna apelor în Munții Almașu; 3=Zona de aflorare a Formațiunii de Gura Văii de-a lungul malului stâng al Dunării; 4=Zona în care s-a produs captarea pârâului Jidoștița; MN=Moldova Nouă; GV=Gura Văii; DTS=Drobeta-Turnu Severin; H=Hinova.

In these circumstances, we think that the Danubes could become the DANUBE, through the Iron Gates piercing, or capturing (Fig. 6), during the Uppermost Valahian - Lowermost Pleistocene.

The strongest proof consists in the presence of the *nominative species* of the Zone  $QM_2$  - *Bogatschevia sturi*, starting in the Earliest Pleistocene deposits (1.8-1.6 Ma), which has been recorded from Pricaspia, Pricernomorie, eastern-central Dacian Basin to the southern Pannonian Basin.

As it is well known, the life and prochoresis of the reophile unionids are strictly dependent on the fish movements.

Paradoxically, one may state that the "Danube's problem" could only be solved by taking into account, simultaneously and/or successively, at least three of the four mentioned hypothesis.

When the Danube reached the Black Sea, this is another intricate question...

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## MAGNETOSTRATIGRAPHY OF THE UPPER NEOGENE DEPOSITS IN THE EASTERN DACIAN BASIN: AN OVERVIEW

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**Abstract.** For the present paper the following 12 sections – Cozieni, Jitia, Trestieni, Berca-Joseni, Beceni, Berca-Plșcoi, Slatina, Râmnicu Sărat, Badislava, Topolog, Bizdidel and Valea Vacii have been taken into account. The first 10 of those sections have been used in the elaboration of a magnetostratigraphic framework (in accordance with ATNTS scale) of the Sarmatian – Uppermost Pliocene deposits from the eastern Dacian Basin. The most significant results refer to the following stage/substage boundaries: Kossovian-Sarmatian = ~12.8 Ma (C5Ar2n); Volhynian-Bessarabian = ~11.6 Ma (C5r1n); Early-Late Bessarabian = ~10 Ma (C5n1r); Bessarabian-Kersonian = ~9.4 Ma (C4Ar1n); Sarmatian-Meotian = ~8.85 Ma (uppermost chron C4An); Lower Meotian (Baguerovian) – Upper Meotian (Akmanian) = ~8.1 Ma (base of subchron C4n2n); Meotian-Pontian = ~7.55 Ma (C3Br3r); Odessian-Portaferrian = ~7.3 Ma (C3Br1n); Early Portaferrian-Late Portaferrian = ~7.0 Ma (mid. chron C3Ar); Portaferrian – Bosphorian = ~6.8 Ma (upper chron C3Ar); Pontian-Dacian = ~5.25-5.3 Ma (= ~ C3r-C3n4n „Tvera” boundary); Getian – Parscovian = ~4.75 Ma (mid subchron C3n2r); Parscovian-Siensian = ~4.2 Ma (basal C2Ar chron, or top C3n1n „Cochiti”); Siensian (Upper Dacian)-Pelendavian (Upper Romanian) = ~3.7 Ma (terminal C2Ar); Pelendavian-Valahian (Upper Romanian) = ~2.7 Ma (uppermost C2An1 = Gauss terminal); Romanian-Pleistocene = 1.8 Ma (top C2n = „Olduvai”).

**Keywords:** Dacian Basin, Upper Neogene, magnetostratigraphy, integrated sections, stratotypes.

**Rezumat.** Magnetostratigrafia depozitelor Neogen superioare din estul Bazinului Dacic: o revizuire. Pentru prezenta lucrare au fost luate în considerare secțiunile Cozieni, Jitia, Trestieni, Berca-Joseni, Beceni, Berca-Plșcoi, Slatina, Râmnicu Sărat, Badislava, Topolog, Bizdidel și Valea Vacii. Dintre aceste secțiuni primele 10 au fost utilizate în elaborarea, revizuită în acord cu scala ATNTS, a cadrului general magnetostratigrafic al depozitelor Sarmatian – Pliocen superioare din estul Bazinului Dacic. Rezultatele mai semnificative se referă la următoarele limite: Kossovian-Sarmatian = ~12,8 Ma (C5Ar2n); Volhynian-Bessarabian = ~11,6 Ma (C5r1n); Bessarabian inferior-Bessarabian superior = ~10 Ma (C5n1r); Bessarabian – Kersonian = ~9,4 Ma (C4Ar1n); Sarmatian-Meotian = ~8,85 Ma (partea terminală a cronei C4An); Meotian inferior (Baguerovian)-Meotian superior (Akmanian) = ~8,1 Ma (baza subcronei C4n2n); Meotian-Pontian = 7,55 Ma (C3Br3r); Odessian-Portaferrian = ~7,3 Ma (C3Br1n); Portaferrian inferior-Portaferrian superior = ~7,0 Ma (partea mediană a cronei C3Ar); Portaferrian-Bosphorian = ~6,8 Ma (partea superioară a cronei C3Ar); Pontian-Dacian = ~5,25-5,3 Ma (= ~limita dintre crona C3r cu subcrona C3n4n „Tvera”); Getian-Parscovian = ~4,75 Ma (partea mediană a subcronei C3n2r); Parscovian-Siensian = ~4,2 Ma (partea bazală a cronei C2Ar, sau top C3n1n „Cochiti”); Dacian (Siensian)-Romanian (Pelendavian) = ~3,7 Ma (partea terminală C2Ar); Pelendavian-Valahian = ~2,7 Ma (partea terminală C2An1 = Gauss terminal); Romanian-Pleistocen = 1,8 Ma (top C2n = „Olduvai”).

**Cuvinte cheie:** Bazinul Dacic, Neogen superior, magnetostratigrafie, secțiuni integrate, stratotipuri.

### INTRODUCTION

Magnetobiostratigraphic investigations in the Dacian Basin started several decades ago (POSPELOVA, ANDREESCU, 1977) and then, our research in the field lasted till the end of 1998.

Preliminary and/or final results of those investigations have been rendered out in a series of papers (ANDREESCU 1981; ANDREESCU et al., 1981; GHENEA et al., 1982; ALEXEEVA et al., 1983; ANDREESCU et al., 1987 etc.).

Many of the preliminary results have subsequently been reconsidered and included in a more comprehensive magnetobiostratigraphic study referring to the Sarmatian-Pliocene deposits from the eastern Dacian Basin (ANDREESCU, 2008), by taking into account the paleomagnetic polarities pointed out by Valerii Trubihin (Moscow) in the following sections:

- Cozieni: Uppermost Badenian (Kossovian) – Early Volhynian – Early Bessarabian;
- Jitia: Upper Volhynian – Bessarabian – Kersonian – Early Meotian (Baguerovian);
- Mânzălești: Upper Bessarabian – Kersonian – Early Meotian (Baguerovian);
- Bisoca: Upper Bessarabian – Kersonian – Lowermost Meotian;
- Trestieni: Uppermost Kersonian – Meotian (Baguerovian-Akmanian) – Early Pontian (Lower Novorossian = Odessian);
- Berca: Meotian – Lowermost Pontian;
- Berca-Joseni: Upper Meotian (Akmanian) – Pontian (Novorossian – Bosphorian) – Lower Dacian (Getian);
- Beceni: Upper Pontian (Bosphorian) – Dacian type-section (Getian – Parscovian – Siensian) – Romanian type-section;
- Vintilă Vodă: Parscovian – Siensian;
- Berca-Plșcoi: Upper Dacian (Siensian) – Romanian (Pelendavian) – Lower Valahian;
- Slatina: Upper Romanian (Valahian) – Lowermost Pleistocene.

For the above named study the GPTS scales of CANDE & KENT, 1992; 1995, have been used.



Meanwhile several sections: Putna, Râmnicu Sărat, Badislava and Topolog (VASILIEV et al., 2004) and Slănicu de Buzău, Valea Vacii, Bizdidei and Badislava (SNEL et al., 2006) have been paleomagnetically investigated in the eastern Dacian Basin.

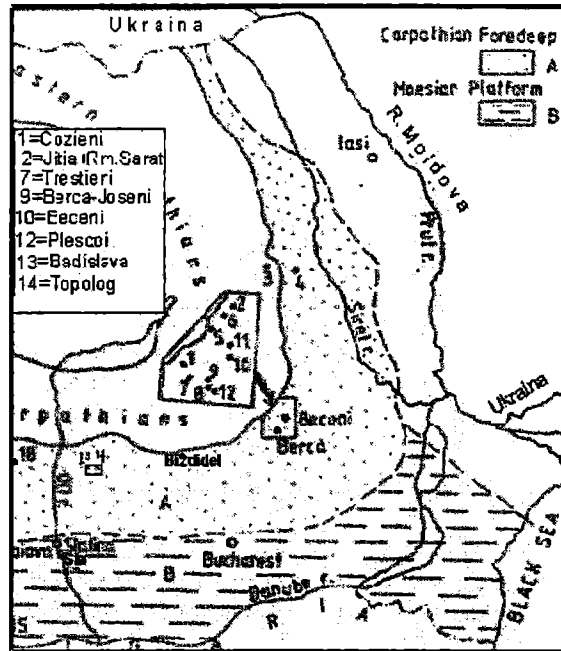


Figure 1. Location of the sections taken into account in the present paper.  
Figura 1. Localizarea secțiunilor prezentate în această lucrare.

In the present contribution Cozieni, Jitia, Trestieni, Berca-Joseni, Beceni, Berca-Pleşcoi and Slatina sections are taken into consideration, together with Râmnicu Sărat, Badislava (13) and Topolog (14) ones (Fig. 1).  
Given interpretations of the above mentioned authors for the last two sections are rendered out in Fig. 2.

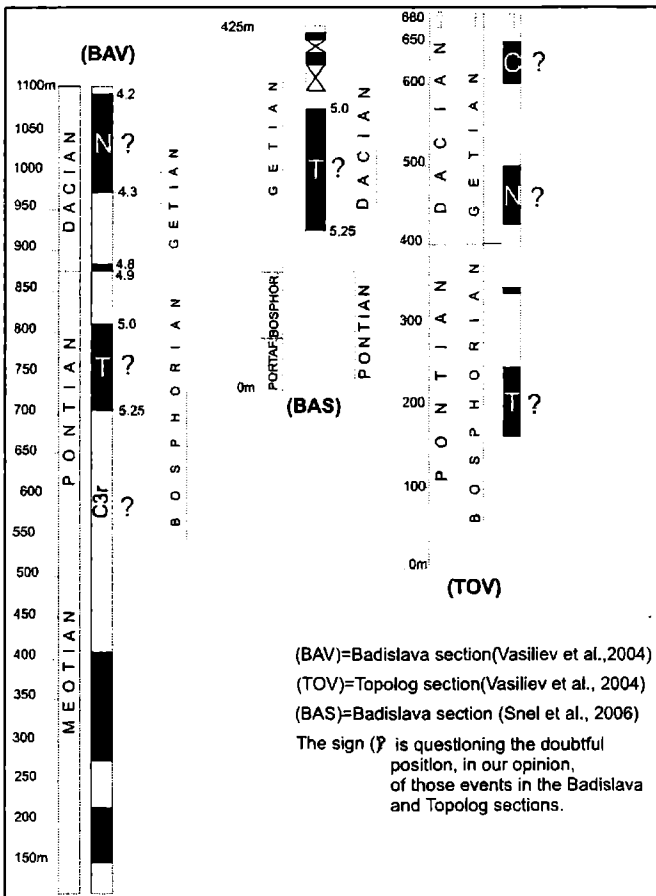


Figure 2. Magnetostratigraphy of the Neogene deposits from Badislava and Topolog sections according to VASILIEV et al., 2004 versus SNEL et al., 2006.

Figura 2. Magnetostratigrafia depozitelor neogene din secțiunile Badislava și Topolog în accepțiunea lui VASILIEV et al., 2004, comparativ cu SNEL et al., 2006.

The Fig. 3 refers to the sections: Badislava, Bizdidel, Valea Vacii and Râmnicu Sărat, in our interpretation, together with the Trestieni section, and Fig. 4 includes the above mentioned 10 revised sections, involved in the present contribution.

In this paper the ATNTS of LOURENS et al., 2004, scale has been used.

Badislava section (VASILIEV et al., 2004; SNEL et al., 2006) refers to the Late Meotian, Late Pontian and Early Dacian, but the paleomagnetic polarity records concerning the Pontian and Dacian deposits is quite different according to each of the two teams (Fig. 2). Thus, VASILIEV et al., 2004, found that the Bosphorian deposits in the Badislava section, and in the Topolog one as well, do include, in the middle-upper part, an important normal event, thought to represent the C3n4n Subchron (=Tvera).

SNEL et al., 2006, found no normal events in the Bosphorian deposits, but the C3n4n Subchron, has been pointed out lasting on about 150 m, in the Getian (Early Dacian) deposits from Badislava section (Fig. 2).

On the other hand, in the stratotypic section of the Dacian Stage (Slănicu de Buzău River, Beceni locality) the “Cochiti” (C3n1n Subchron) and “Nunivak” (C3n2n Subchron) events have undoubtedly been proved to characterize the Parscovian Substage (Middle Dacian) (ANDREESCU, 1981; GHENEA et al., 1982; ALEXEEVA et al., 1983; ANDREESCU, 2008 etc.).

In the same stratotypic section of the Dacian Stage and in the Berca – Joseni section, as well (Fig. 4), the Getian deposits are developed in the time span between the base “Tvera” (C3n4n Subchron) and the middle part of the reverse event (C3n2r subchron) above “Sidufiall” event (C3n3n Subchron).

Taking into account the above mentioned observations and considering the polarity record is accurately identified, we tried to integrate the sections Badislava and Topolog in a more logically assessment of paleomagnetic frame by reporting them to other well dated sections in the Dacian Basin (Figs. 3; 4).

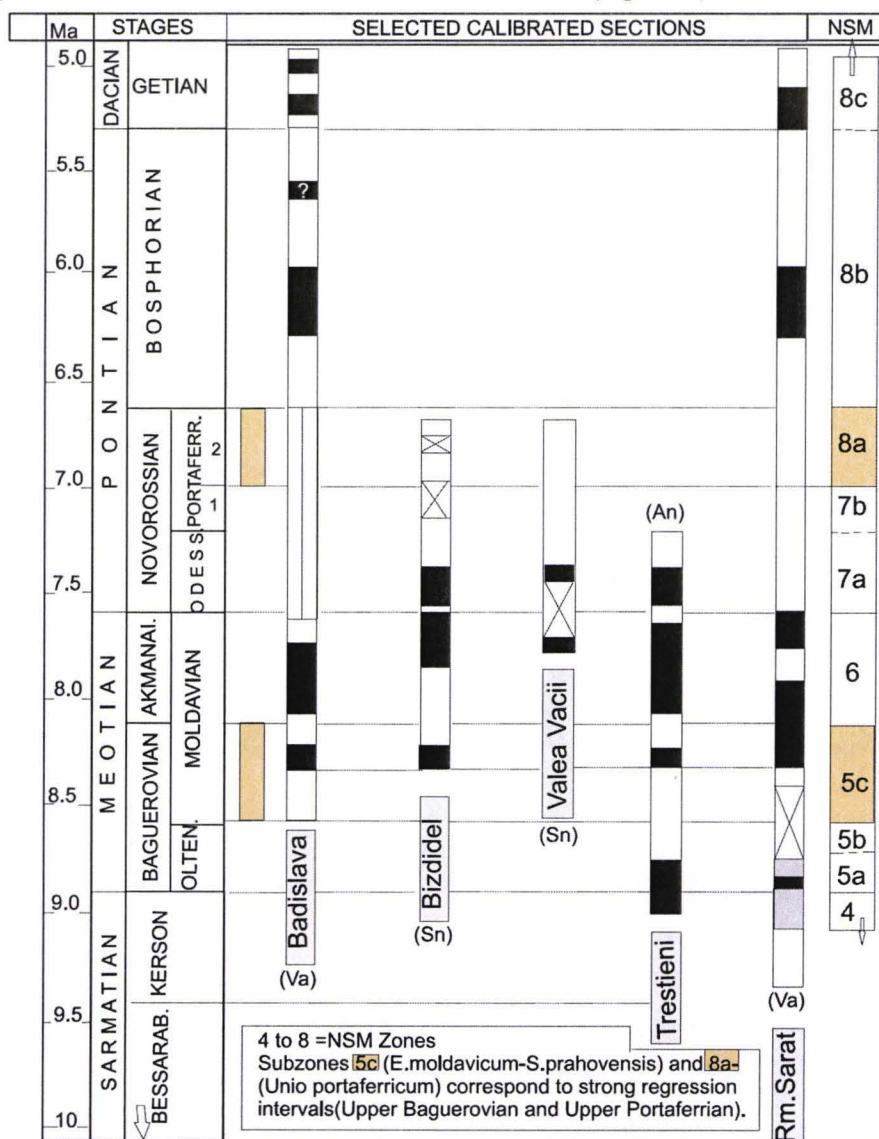


Figure 3. Integrated sections Badislava, Bizdidel, Valea Vacii and Râmnicu Sărat with Trestieni section, in our actual interpretation.

(Va) = VASILIEV et al., 2004; (Sn) = SNEL et al., 2006; (An) = ANDREESCU, 2008.

Figura 3. Secțiunile: Badislava, Bizdidel, Valea Vacii și Râmnicu Sărat integrate cu secțiunea Trestieni, în prezenta interpretare.



As concerns the Râmnicu Sărat and Putna sections, VASILIEV et al., 2004, committed an artificial shifting of sediment piles from a stage/ sub-stage to other neighbour units.

As for example: ~250-300 m of Kersonian deposits, in Putna section, had been transferred to the Early Meotian and ~200 m of lower Pontian deposits passed to the Upper Meotian. In Râmnicu Sărat section the Getian loses ~400 m, transferred to the Bosphorian, but gains ~500 m from the Parscovian.

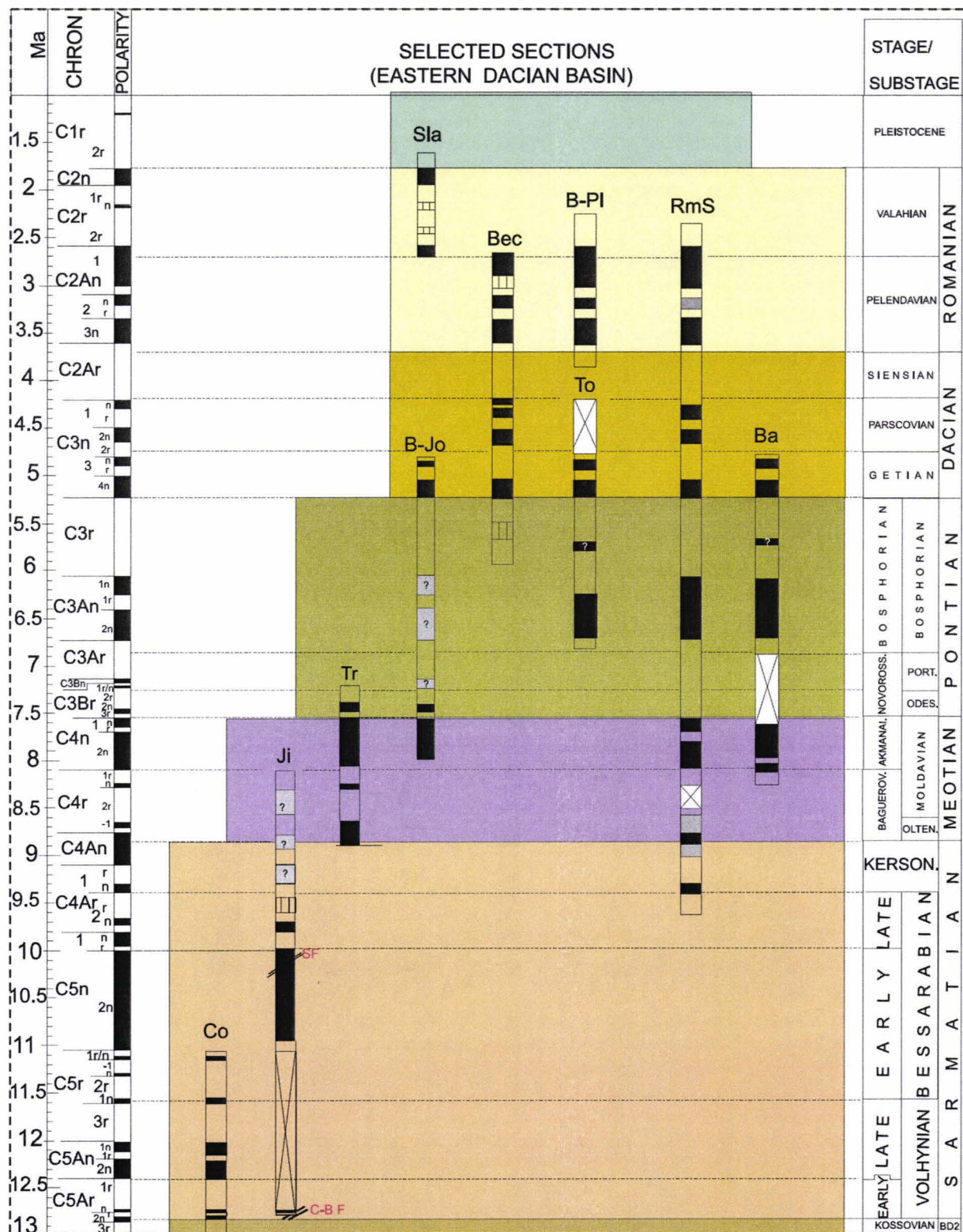


Figure 4. Revised paleomagnetically investigated sections in the eastern Dacian Basin.

Co = Cozieni; J = Jitia (C-BF = Cașin-Bisoca-Fault; SF = Sărule-Fault); Tr = Trestieni; B-Jo = Berca-Joseni; Bec = Beceni; B-Pl = Berca-Pleșcoi; Sla = Slatina; RmS = Râmnicu Sărat; Ba = Badislava; To = Topolog.

Figura 4. Secțiunile revizuite, investigate paleomagnetice, din estul Bazinului Dacic.



In fact, the Parscovian deposits reach up to 675 m, while in the fig. 9 of VASILIEV et al., 2004, the thickness of those deposits does not reach 350 m.

The most spectacular, amazing, transfer concerns the Upper Dacian and Early Romanian deposits: ~1,800 m-2,000 m have been taken away from the Pelendavian Substage for the benefit of the Siensian Substage, which, actually, does not exceed 800 m.

Without any tie-point and reliable biochronologic marker, the paleomagnetic assignment of the Neogene deposits in Putna and Râmnicu Sărat sections, in VASILIEV et al., 2004, manner is, in our opinion, more than questionable.

Whether VASILIEV et al., 2004 would have in view the Uppermost Kersonian - Lowermost Meotian Mammal site from Reghiu (=MN11 Unit, according to STIUȚĂ, 2003), corresponding to the Lower Turolian, whose basal limit is dated at ~9.5 Ma, and if they would take into account the tens and tens of reliable radiometric datings concerning the Sarmatian-Meotian-Pontian or Sarmatian-Pannonian-Pontian interval from Paratethys, and would have in view the magnetostratigraphic investigations carried out by PEVZNER, 1987, PEVZNER & VANGENGIM, 1984; VANGENGIM et al., 2006 etc., on the Sarmatian-Kimmerian deposits from the north-euxinian region, then the calibration of the Sarmatian-Romanian deposits from Putna and Râmnicu Sărat sections could certainly be rendered out in a more appropriate manner.

This assignment we intended to be illustrate in Figs. 3 and 4 which, taken together, do not need additional explanations.

Finally, several words about the approach of CLAUZON et al., 2008, concerning one of the best investigated and best known Neogene area of the Dacian Basin, namely the stratotypical sections of the Dacian and Romanian Stages (Fig. 5).

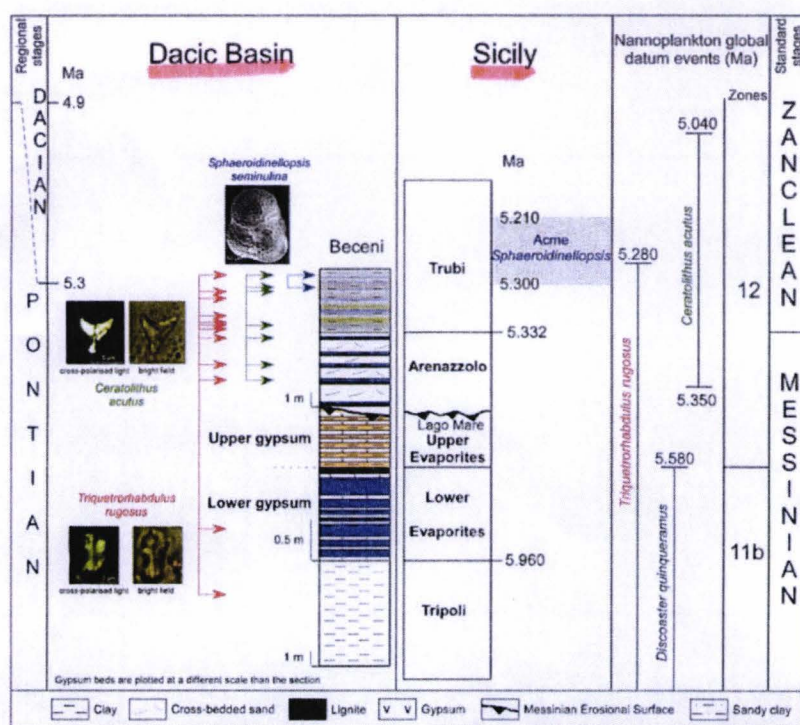


Figure 5. "Beceni Site" of the Messinian and Zanclean according to Clauzon et al., 2008.

Figura 5. „Situl Beceni” cu ocurența Messinianului și Zancleanului în opinia lui Clauzon et al., 2008.

... "We discovered in central-eastern Romania two conformable sequences of gypsum alternating with clays, overlain by an erosional surface and fluvial sands, topped by cyclic clays [...].

This succession, dated using marine calcareous plancton remarkably resembles those of the Mediterranean marginal Messinian - Zanclean series: Sicily, Crete, Spain" (CLAUZON et al., 2008, p. 36).

From the Fig. 5 and subsequent text the reader is informed that the Messinian and Zanclean Stages descended with all their attributes ("Lower gypsum", "Upper gypsum", marine forams ("*Sphaeroidinellopsis seminulina*"), marine calcareous nannoplankton ("*Triquetrorhabdulus rugosus*", "*Ceratolithus acutus*"), from the Mediterranean to the "Beceni Site", in the eastern Dacian Basin.





Figure 6. Geological map of the Berca-Arbănași region (ANDREESCU, 1972; 1977; 1981).

Figura 6. Harta geologică a zonei Berca-Arbănași (ANDREESCU, 1972; 1977; 1981).

A careful inspection of the Figs. 6 and 7 shows the two Mediterranean stages have been intruded in the Uppermost Siensian Substage (Upper Dacian) at a level (red cross) close to the lower boundary of the Pelendavian Substage (=Early Romanian = Ro1-1 in Fig. 6 = Pe1-1 in Fig. 7) whose base is estimated at ~3.7 Ma (Figs. 4; 7).

In addition, several mentions need to be made:

- the so-called "Lower gypsum" and "Upper gypsym" in the "Beceni Site" do represent but thin, up to 1-2 cm, of secondary gypsiferous alteration crusts occurring as a result of sulfides reduction from the clayey-silty-sandy lignite beds (0.1-0.6 m) interbedded with thick (0.4-5.5 m) coarse detritics (sands, small pebbles) and/or fine detritics (silts, silty clays, clays, marls) sequences;
- the macrofaunal content of those deposits, pertaining to the Râmna Formation, is exclusively represented by freshwater molluscs of the *NSM10<sub>b</sub>-Bittneriella mrazeci-Viviparus bifarinatus Subzone* (ANDREESCU, 1981), characterizing the Upper Siensian;
- both lithological and faunal content preclude the presence, at this stratigraphic level (~3.8 Ma), of any marine Messinian and/or Zanclean nannoplankton and forams taxa.

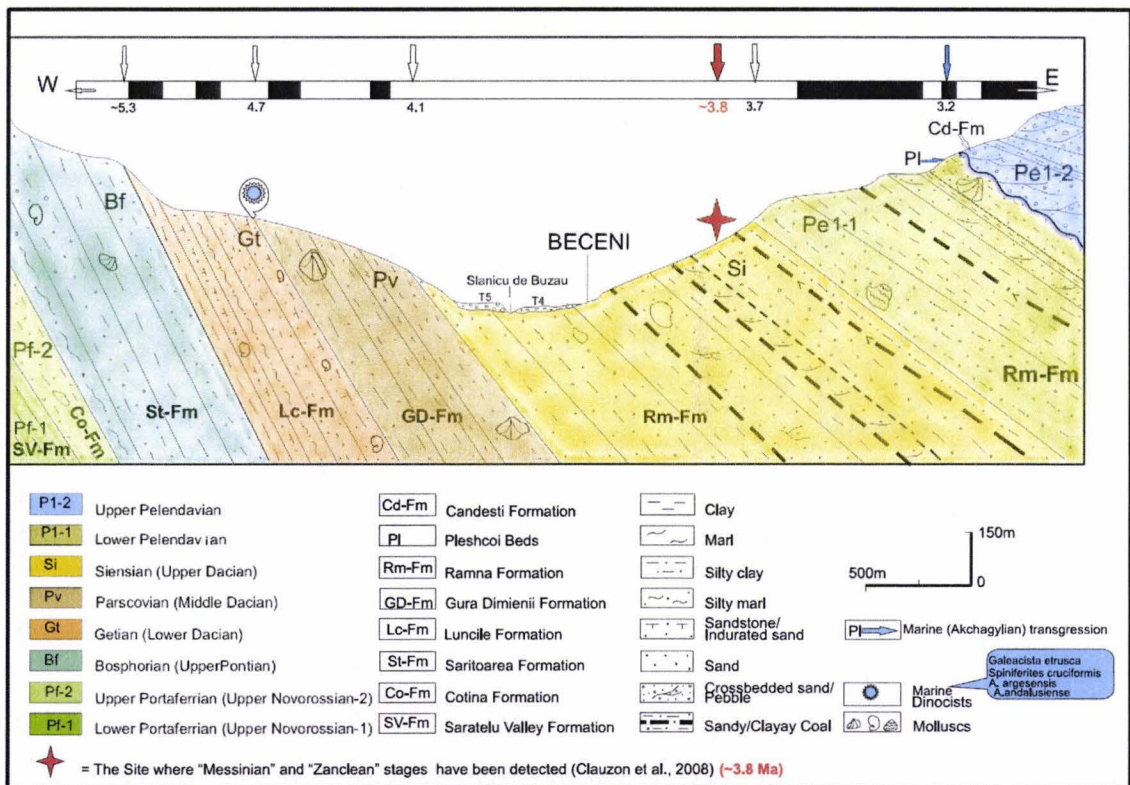


Figure 7. Cross-section in the Dacian and Romanian Stages stratotypic area.

Figura 7. Secțiune în aria stratotipică a etajelor Dacian și Romanian.

Consequently, one may say the CLAUZON et al., 2008 "findings" concerning the "Beceni Site" based on a series of spurious lithological, microfloristic and microfaunistic data are illusive.



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# ESTIMATION OF MEAN ANNUAL TEMPERATURES IN OCNA DEJ FORMATION (MIDDLE BADENIAN) AT PRAID BASED ON COEXISTENCE APPROACH METHOD

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**Abstract.** A line for paleoclimate reconstructions based on quantitative pollen data is the coexistence approach (CA), firstly used by MOSBRUGGER & UTESCHER (1997). For a fossil assemblage and a certain climatic parameter, one looks for the suitable interval inside which all the actual correspondents of the fossil taxa could coexist. We used CA for interpreting the Middle Badanian flora documented by pollen in the salt from Praid (Basin of Transylvania). The results indicate 16.6-17°C mean annual temperature, according with the data already issued from other Central Paratethys Badanian deposits. It also reflects the climate turnover occurred soon after the Mid-Miocene Climatic Optimum event, when the climate worsened.

**Keywords:** Rumania, Basin of Transylvania, Middle Miocene, Badanian, flora, salt, Praid.

**Rezumat.** Estimări ale temperaturilor medii anuale în Formațiunea de Ocna Dej (Badanian mediu) de la Praid pe baza metodei coexistențe approach. O metodă pentru reconstituirile paleoclimatice cantitative o reprezintă metoda Coexistence Approach (CA), aplicată pentru prima oară de MOSBRUGGER & UTESCHER (1997). Pentru o floră fosilă dată și pentru un anumit parametru climatic se caută acel interval pentru care toți corespondenții actuali ai florei fosile pot să coexiste. Am folosit această metodă pentru microflora Badanianului cu sare de la Praid (Formațiunea de Ocna Dej) și am stabilit un interval pentru temperatura medie anuală cuprins între 16,6-17°C. Valorile sunt asemănătoare celor estimate Badanianul altor regiuni corespondente din Paratethys. Datele reflectă o tranziție de la temperaturile mai ridicate din Optimumul Climatic Miocen Mediu, spre temperaturi mai scăzute ce au urmat acestui eveniment, indicând degradări climatice.

**Cuvinte cheie:** România, Bazinul Transilvaniei, Miocen mediu, Badanian, floră, sare, Praid.

## INTRODUCTION

The Miocene means a geologic time span including several geologic and climatic events. Among others, it was also the last really warm episode-Mid-Miocene Climatic Optimum-(BÖHME, 2003; MOSBRUGGER et al., 2005; KOVAČ et al., 2007; ZACHOS et al., 2007) before the Late Miocene, Pliocene and especially Pleistocene cooling.

The pollen studies carried out on Miocene sediments in Central Paratethys, in spite of an apparent abundance, are far to be enough and some of them (e.g. PLANDEROVÁ, 1990; NAGY 1991, 1992, 1999) are now considered as inconclusive, devoid of convenient method (e.g. JIMENEZ-MORENO et al., 2005).

The pollen taxonomy is helpful to better know the ancient plant assemblages, environments, or climate. Rich such data concern the Miocene and Pliocene. Starting with the Eocene, the majority of actual plants is already known in the geological records, thus facilitating a better understanding, through direct comparisons.

Once, for paleoclimate evaluations based on microfloristic data, the ratio between thermophile: intermediary: temperate representatives had been used. In more recent contributions on climate reconstructions based on pollen data, the most used methods are *Coexistence Approach* (CA; MOSBRUGGER & UTESCHER, 1997) and *Climatic Amplitude Method* (CAM; FAQUETTE et al., 1998).

CA is reliable for quantitative Cenozoic non-marine climatic reconstructions. It is based on the presumption that the ancient Cenozoic plants had the same climatic requirements as their actual correspondents. The method's aim is the following: for a Cenozoic fossil flora and for a climate parameter, it had to be found the climate realm where all actual plant taxa could coexist.

For the marine Cenozoic, there are several quantitative estimative methods, the most common being the one based on stable isotopes. But, for the terrestrial environments, the carbon and oxygen isotopes are less useful for the climate reconstructions, due to difficulties rose in interpreting such data.

The method is based on some suppositions: for the fossil taxa one can identify the actual correspondents, with systematic close affinities; the exigencies of a fossil taxon are very similar with the one of the actual correspondent; the climate exigencies and tolerance of an actual plant, as well as the ones of its fossil correspondent, could be deduced from their spreading areas. At the same time, one can presume that the meteorological stations are yielding reliable data for describing the climatic tolerances of an actual taxon.

MOSBRUGGER & UTESCHER (1997) underlined that the basics of this methods are not news, but in its philosophic "classical" approach of the actual correspondent (i.e. NLR= nearest living relative) one used once only few of the fossil taxa, leading to incertitude and gaps in knowledge. For example, a taxon occurrence or extinction is not due to climate changes in all situations, but also to taphonomic, edaphic, paleogeographic etc. reasons. Resuming the interpretations only on some taxa, one cannot reach to a maximum appropriate climate resolution, the results being influenced by the taxa selection.

Another cumulative method is based on plant morphology, i.e. *Climate Leaf Analysis Multivariate Program* (CLAMP). However, MOSBRUGGER & UTESCHER (1997) are considering that CA is more correct than CLAMP. On the Middle Miocene macro-and microflora in Schrotzburg (South Germany), the CA estimations were similar with the

ones issued from Leaf Margin Analysis (LMA) or with another method, ELPA. On the opposite, CLAMP lead to different results (UHL et al., 2006).

CAM was firstly applied in interpreting the Pliocene from the Mediterranean area. Eight hundred actual pollen spectra had been used. For each spectrum, the frequency of pollen grains of a taxon was reported to the total quantum of pollen, excepting for the water plants and spores. Six climatic parameters were considered. The actual climate amplitude allowed by each plant taxon was established by representing the actual pollen frequencies in the actual pollen spectra in relationship with each climatic parameter (FAQUETTE et al., 1998).

Ultimately, another method based on nearest living relatives too is Overlapping Distribution Analysis (ODA). It was applied-besides other methods-in Shanwang Basin (China) and it is based on the explicit local distribution of plants taxa, but also on the associated meteorological stations (YANG et al., 2007).

## INTERPRETATIONS BASED ON POLLEN DATA CONCERNING THE MIDDLE BADENIAN FROM THE TRANSYLVANIAN BASIN

The Miocene pollen data in Europe outlined various floras, which evolved in different climates. The compositions of the flora assemblages were controlled mainly by altitude and latitude. In the Basin of Transylvania, the evaluation of the salt and gypsum Badenian deposits (i.e. Ocna Dej and Cheia formations) is of interest because it coincides with the end of the Mid-Miocene Climate Optimum (MCO) event.

In this basin, several pollen analysis were carried out for the Badenian salt deposits, as in: Sărățel (PETRESCU et al., 2001), Ocna Dej (PETRESCU & MESEȘAN, 1993), Turda (PETRESCU & BICAN-BRIȘAN, 1997), Praid (PETRESCU & BICAN-BRIȘAN, 2005). These studies pointed out the transition condition of the floras in middle Badenian (Wieliczian), between the Moravian ones and the subsequent Kosovian assemblages. Across this time span, one can outline a decreasing tendency of the thermophile representatives and the increase of the temperate taxa.

For the pollen assemblage found into the salt in Praid we used several data issued from the already done analysis (PETRESCU & BICAN-BRIȘAN, 2005), interpreting them by the CA method. In order to establish the actual correspondents (NLR) of the Middle Badenian taxa, as well as for the mean annual temperatures (MAT) optimal for these plants, we used the website [www.palaeoflora.de](http://www.palaeoflora.de)

Table 1. Relationships between the middle Badenian taxa in Praid, their actual correspondents (NLR) and the mean annual temperatures (MAT in °C).

Tabel 1. Relațiile dintre taxonii din Badenianul mediu de la Praid, corespondenții actuali (NRL) și temperaturile medii anuale (TMA în °C).

Badenian taxa	NLR	MAT
<i>Polypodiaceoisporites torosus</i>	<i>Pteris</i> sp.	2.0- 21.7
<i>Abiespollenites</i> sp.	<i>Abies</i> sp.	-6.7- 27.4
<i>Pityosporites microalatus</i> <i>Pityosporites alatus</i>	<i>Cathaya</i> sp.	17.0- 22.2
<i>Pityosporites labdacus pseudocristatus</i>	<i>Pinus silvestris</i>	-9.2- 10.8
<i>Piceapollis</i> sp.	<i>Picea</i>	-8.9- 21.7
<i>Cedripites miocaenicus</i>	<i>Cedrus</i> sp.	11.6- 18.4
<i>Podocarpidites libellus</i>	Podocarpaceae	11.0- 27.7
<i>Zonalapollenites igniculus</i> <i>Zonalapollenites maximus</i>	<i>Tsuga</i> sp.	1.8- 21.9
<i>Sciadopityspollenites</i> sp.	<i>Sciadopitys verticillata</i>	7.4- 16.6
<i>Cupressacites insulapapillatus</i>	Cupressaceae ( <i>Cupressus</i> , <i>Chamaecyparis</i> ) Cupressaceae ( <i>Austrocedrus</i> , <i>Libocedrus</i> , <i>Papuacedrus</i> )	1.8- 21.7 8.2- 26.5
<i>Sequoiapollenites gracilis</i> <i>Sequoiapollenites polymorphosus</i>	Taxodiaceae	9.1- 25.0
<i>Sparganiaceapollenites sparganioides</i>	<i>Typha</i> sp.	8.2- 25.7
<i>Moncolpopollenites</i> sp.	Palmae	13.3- 27.7
<i>Areipites</i> sp.	<i>Arecoideae</i> sp.	13.5- 27.7
<i>Triatriopollenites bituitus</i>	<i>Myrica</i>	-6.9- 28.1
<i>Momipites</i> sp.	<i>Engelhardtia</i> sp.	15.6- 27.0
<i>Caryapollenites simplex</i>	<i>Carya cordiformis</i>	6.6- 21.3
<i>Pterocaryapollenites stellatus</i>	<i>Pterocarya</i> sp.	7.6- 24.2

Ulmaceae	Ulmaceae	3.4- 27.7	
<i>Alnipollenites verus</i>	<i>Alnus</i> sp.	-13.3- 27.4	
<i>Intratriporopollenites instructus</i>	<i>Tilia</i> sp.	2.5- 20.8	
<i>Tricolpopollenites liblarensis</i>	Fagaceae	-1.1-27.9	
<i>Nyssapollenites</i> sp.	<i>Nyssa</i> sp.	-1.1- 23.9	
<i>Cyrillaceapollenites megaexactus</i>	Cyrillaceae	13.6- 25.4	
<i>Ericipites baculatus</i>	<i>Erica arborea</i>	Ericaceae	13.1- 18.6
<i>Ericipites callidus</i>			
<i>Ericipites ericius</i>	<i>Erica tetralix</i>		
<i>Chenopodipollis multiplex</i>	Chenopodiaceae	-7.6-27.7	

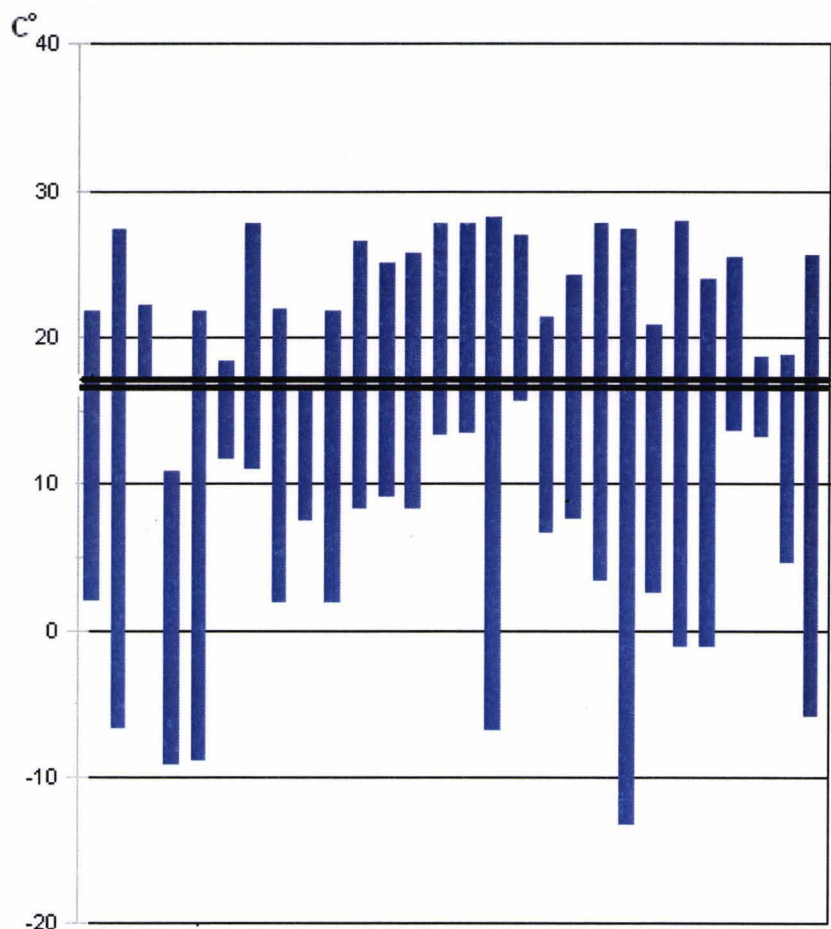


Figure 1. The coexistence interval for the MAT of the actual correspondents of the Badenian plant taxa in Praid. The MAT intervals for each taxon are represented in blue, and the coexistence interval is marked by the two horizontal black lines. The taxa, according Tabel 1, starting with *Polypodiaceoisporites torosus* at left.

Figura 1. Intervalul de coexistență pentru TMA a corespondenților actuali ai taxonilor de plante din Badenian de la Praid. Intervalele TMA pentru fiecare taxon sunt reprezentate cu albastru și intervalul de coexistență este marcat de două linii negre orizontale. Taxonii, conform Tabelului 1, încep cu *Polypodiaceoisporites torosus* de la stânga.

In Fig. 1, there are the MAT for the actual taxa (in blue) and the coexistence interval (two black lines). The coexistence interval for the MAT in the Badenian in Praid is 16.6- 17.0 °C. One can observe an outlier corresponding to the MAT fitting with the actual *Pinus sylvestris*. The taxa which may coexist represent 96% (statistically significant are the calculated coexistence intervals, where 88-100% of taxa could be in coexistence). For comparison, actually, the MAT measured in two meteorological stations (where the climatic measurements cover more than thirty years) located next to Praid, in Odorheiu-Secuiesc and Târgu-Mureș, is of 8.0°C and 8.6°C (1961-2005; \*\*\*).

In Table 2, there is a comparison between the MAT in European Miocene localities, mainly in Badenian. One can observe a decreasing trend of the MAT from the Egerian until the Sarmatian.



Table 2. MAT (in °C) in some Miocene European localities, based on macro- and microflora and various methods.  
Tabel 2. TMA (în °C) în câteva localități europene din Miocen, pe baza macro- și micro-florei și a altor metode.

		Lăpugiu pollen (PETRESCU et al. 1990)	Bozovici pollen (PETRESCU & NICORICI, 1989)	Tebea pollen (PETRESCU & FAZECAS, 1989)	Hungary macroflora (ERDEI et al., 2007) CA	Hungary pollen (JIMENEZ-MORENO et al., 2007) CAM	Germany macroflora (BÖHME et al., 2007) CA
Sarmatian					14.0- 16.5	16.0	
Badenian	upper			16-18.	14.5- 16.5	18.0- 20.0	15.7- 20.8
	midd. lower	17-18					
Karpatian					15.6- 16.6		15.7- 20.5 °C
Ottangian				> 16			22.2- 24.2
Eggenbur-gian			16.-17		16.5- 18.8		
Egerian					13.3- 20.6		

The MAT estimated for Praid resembles the ones reported for the Eastern and Central Paratethys (PETRESCU & NICORICI, 1989, PETRESCU & FAZECAS, 1989, PETRESCU et al., 1990, ERDEI et al., 2007, BÖHME et al., 2007, IVANOV et al., 2002, 2007). Larger values (18-20°C) are reported for the Badenian in Hungary, based on “Climatic Amplitude Method” (JIMENEZ-MORENO, 2006).

From the climate viewpoint, an important feature for the Middle Miocene is the MCO worldwide event. The deep drilling data (based on  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ ) estimated that this warm time lasted between 17-15 My BP and was followed by a gradual cooling and a recovering of the icecap in Antarctica (ZACHOS et al., 2001).

For the Central Europe, the MCO was between 18 and 14.0 My BP (i.e. Ottangian-Early/Middle Badenian). The MAT was between 17.4 °C and 20-22°C. Between 14.0-13.5 My BP an abrupt climate worsening occurred, the MAT being 15.4°C - 14.8°C. In these circumstances, the marine and terrestrial records are decaled (BÖHME, 2003).

For the analysis of the climate evolution in the Central Europe Cenozoic, forty-five floras had been studied, originating from various localities, interpreted through CA (MOSBRUGGER et al., 2005).

The cooling tendency, which followed the MCO is recorded also in the middle Badenian foraminifers from western Transylvania. In these assemblages, the *Candorbulina* representatives are missing, being replaced by planktonic species, which evolved in cooler waters. This cooling tendency reported just in the middle of the salt-bearing formation, corresponds to a regressive episode, to a decreasing of the marine fauna diversity and extinction of subtropical representatives (FILIPESCU, 2001).

In the Wieliczka salt (Poland), Zabłocki made a first description of the flora (SZAFER & KOSTYNIUK, 1952). The climate was estimated as “mild”, with taxa as *Taxodium distichum miocenum*, *Platanus*, *Magnolia*, *Liquidambar*, *Pinus*, *Carya*, *Juglans*, *Libocedrus*, *Engelhardtia*, *Magnolia*, *Castanopsis* etc. A revision of this flora outlined the dominance of arcto-tertiary representatives, only a third of taxa being paleotropical. The flora assemblages from Wieliczka comprised mesophytic forests, leaf trees, and evergreen shrubs, typical for a mastixian flora, including *Juniperus succinifera*. (LAŃCUCKA-ŚRODONIOWA & ZASTAWIAK, 1997).

The pollen data issued from the Carpathian-Sarmatian cores originating from the Tengelic 2 borehole Hungary (Jimenez-Moreno, 2006) pointed out the existence of multi-staged forests, which evolved in a wet warm subtropical climate, illustrative for the MCO. The cooler and drier climate from the Late Badenian and Sarmatian was interpreted as a cool episode, correlative with “Monterey Cool Event”.

## CONCLUSIONS

The Neogene evolution in the Basin of Transylvania interfered with the one of the surrounding mountains. The 15 – 5 My BP time span (including the Middle Miocene salt genesis) is also the one of the erecting Carpathian orogene. For the Eastern Carpathians, 2,500 m maximum height is estimated (SANDERS et al., 2002). Thus, geography may explain the presence of altitude representatives into the Badenian salt pollen spectra (large number of *Picea* pollen grains). The dominance in clay minerals of the illite-chlorite suggests also a source-area controlled by altitude (BICAN-BRIȘAN & HOSU, 2006).

A cool episode in the Central Paratethys can be obviously observed in the marine Late Badenian microfauna, even if the planktonic foraminifers are indicating even an earlier beginning of this event, to the end of Early Badenian. The biogeographical differentiation between the northern, northeastern, and southern basins became sharper in Late Badenian (KOVAČ et al., 2007).

As concerning the climate during the Middle Miocene (13.6-13.4 My BP according BALINTONI & PETRESCU, 2002) salt genesis, it seems that it occurred in the cooler episode (14.0-13.5 My BP), which followed the MCO. On the other hand, this cooler episode may correspond to a change between anti-estuarine water movements with an estuarine one. But, the salt deposition should occur during the anti-estuarine movements, when the Mediterranean shallow waters invaded the Central Paratethys, while the bottom waters flowed to the Mediterranean Sea. This type of water circulation

(implying also a heat mobilization) was dominating the middle Badenian, facilitating the deposition of evaporites (BÁLDI, 2006).

This is the first tentative in interpreting the Middle Badenian climate using the CA method in Rumania. Obviously, these data could be refined by future additional pollen analysis.

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## CENOZOIC MOLASSE BASINS IN KOSOVO AND THEIR GEODYNAMIC EVOLUTION

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**Abstract.** *From the Oligocene to Recent, Kosovo was part of the South Balkan extensional region. Extension began in the eastern and southeastern regions of Kosovo during the Early Oligocene with the formation of Dardane and Morava e Binçes - Gjilan molasse basins. Following a period of crustal shortening at the end of the Late Oligocene to the Early Miocene, a second period of Neogene extension commenced that continues to the present and resulted in the formation of the Fushe-Kosovo, Drenica and Dukagjini molasse basins. Six cycles can be defined during the Oligocene to Recent extension. These basins were closed and slightly deformed into asymmetric syncline structures either at the end of the Late Miocene or at the end of the Pliocene. Subsequently Kosovo formed part of an uplifted continental area that was exposed to denudation processes that led to the development of the current landscape. The neotectonic normal faulting occurred during the Pliocene-Quaternary in eastern regions of Albania and eastwards into Kosovo and Macedonia. This tectonism created well-defined horst and graben structures. The Dukagjini and Fushe-Kosovo basins, which are subdivided into numerous blocks and depressions, provide the evidence for these tectonic events.*

**Keywords:** *Kosovo, Balkans, molasse basins, extensional tectonics.*

**Rezumat.** *Bazinele cenozoice de molasă din Kosovo și evoluția lor geodinamică. Din Oligocen până în prezent, Kosovo a făcut parte din regiunea de extensiune sud-balkanică. Extensiunea a început în părțile de est și sud-est ale regiunii Kosovo în timpul Oligocenului timpuriu când s-au format bazinele de molasă Dardane și Morava e Binçes - Gjilan. După o perioadă de micșorare crustală de la sfârșitul Oligocenului superior până în Miocenul timpuriu, a debutat o nouă extensiune în Neogen, care se continuă și în prezent și a dus la formarea bazinelor de molasă Fushe-Kosovo, Drenica și Dukagjini. Pot fi evindefiate 6 cicluri din oligocen până în prezent. Aceste bazine au fost închise și ușor deformate în structuri sinclinale asimetrice fie la sfârșitul Miocenului superior, fie la sfârșitul Pliocenului. Astfel, Kosovo a făcut parte dintr-o zonă continentală înălțată care a fost expusă proceselor de denudație care au dus la formarea peisajului actual. Falierea neotectonică normală s-a produs în Pliocen - Cuaternar în regiunile estice ale Albaniei și spre est în Kosovo și Macedonia. Această tectonică a creat structuri de horsturi și grabene bine definite. Bazinele Dukagjini și Fushe-Kosovo, care sunt subdivizate în numeroase bloxuri și depresiuni, reprezintă dovezi ale evenimentelor tectonice.*

**Cuvinte cheie:** *Kosovo, Balcani, bazine de molasă, tectonică extensională.*

## 1. INTRODUCTION

Two periods of regional extension, interrupted by a period of compression (Late Oligocene-Early Miocene) occurred in Kosovo from the Early Oligocene to the present.

These extensional events in Kosovo comprise part of the South Balkan extensional region that, in addition to Kosovo, includes Northern Greece, Macedonia, Eastern Albania, Montenegro and Serbia.

This contribution concerns the Oligocene to Recent geodynamic evolution of Kosovo based on the data provided by the Cenozoic molasse basins.

The deep sedimentary sequences of the Cenozoic basins are rarely exposed, as they are covered by Pliocene or Quaternary deposits. Thus, most of the geological data from these basins is from boreholes and occasional exposures.

The basement of the Cenozoic basins in Kosovo had a long and complex tectonic evolution. The pre-Cenozoic basement rocks related to several major tectonic units, from East to West:

- (1) Dardan Massif (part of Serbian-Macedonian Massif),
- (2) Vardar Zone,
- (3) Sharri Zone,
- (4) Ophiolite Zone,
- (5) Durmitori Zone (MALIQI, 2001; ELEZAJ, 2002).

## 2. CENOZOIC BASINS IN KOSOVO

The Cenozoic formations are widespread in Kosovo, covering about 40% of its territory. They include sedimentary and volcano-sedimentary rocks that were deposited in marine and lacustrine environments.

The oldest sediments in Kosovo are Oligocene, but the presence of Eocene sediments in Macedonia and the Presheva regions suggest that they also exist in Kosovo.

The Cenozoic sedimentary basins in Kosovo are, from west to east, as it follows (Fig. 1):

1. Dukagjini Basin, divided into smaller sub-basins: Peja, Gjakova, Prizreni and Bellanica;
2. Drenica (Drenasi) Basin;
3. Fushe-Kosovo Basin, divided into the sub-basins: Besiana (Podujeva) and Morava e Binçes-Gjilan;
4. Dardane (Kamenica) Basin;
5. Besiana (Podujeva) Basin (ELEZAJ, 2002; ELEZAJ and KODRA, 2008).

The Fushe-Kosovo and Drenica basins are filled with Middle and Late Miocene molasse successions, while the Dukagjini Basin with Middle-Late Miocene and Pliocene molasse sequences. Besiana and Prizreni sub-basins are filled

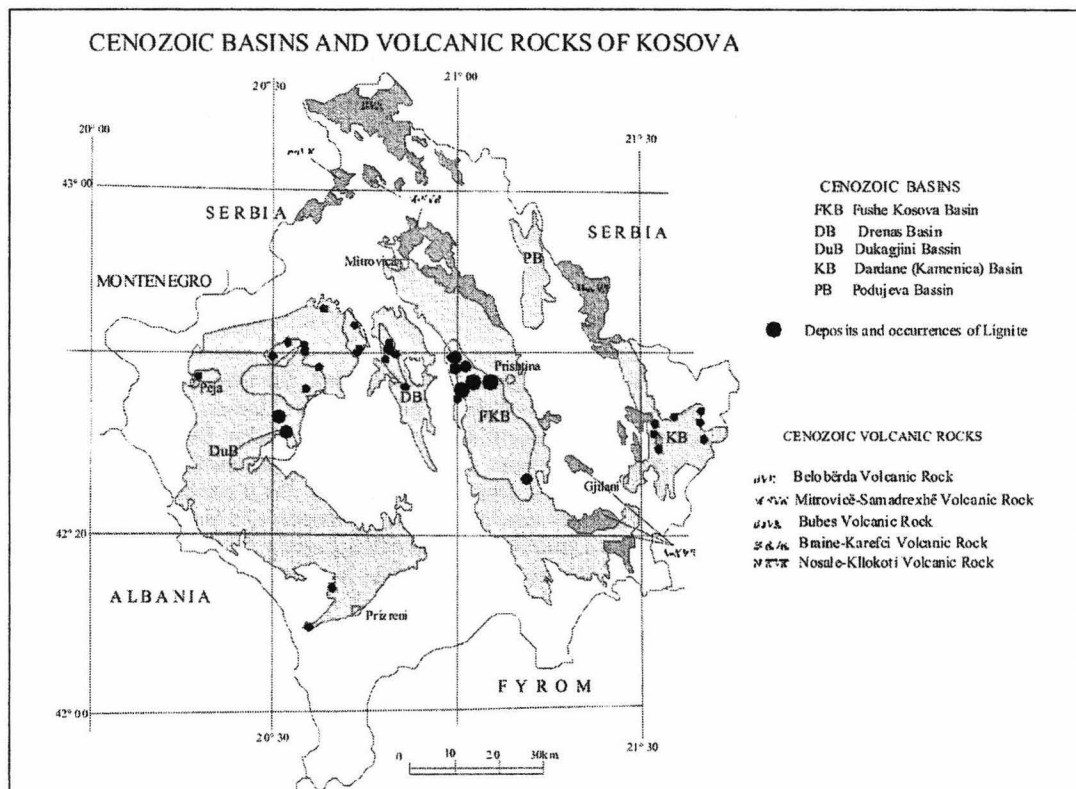


Figure 1. Cenozoic Basins and Volcanic Rocks of Kosova.  
Figura 1. Bazinele cenozoice și rocile vulcanice din Kosovo.

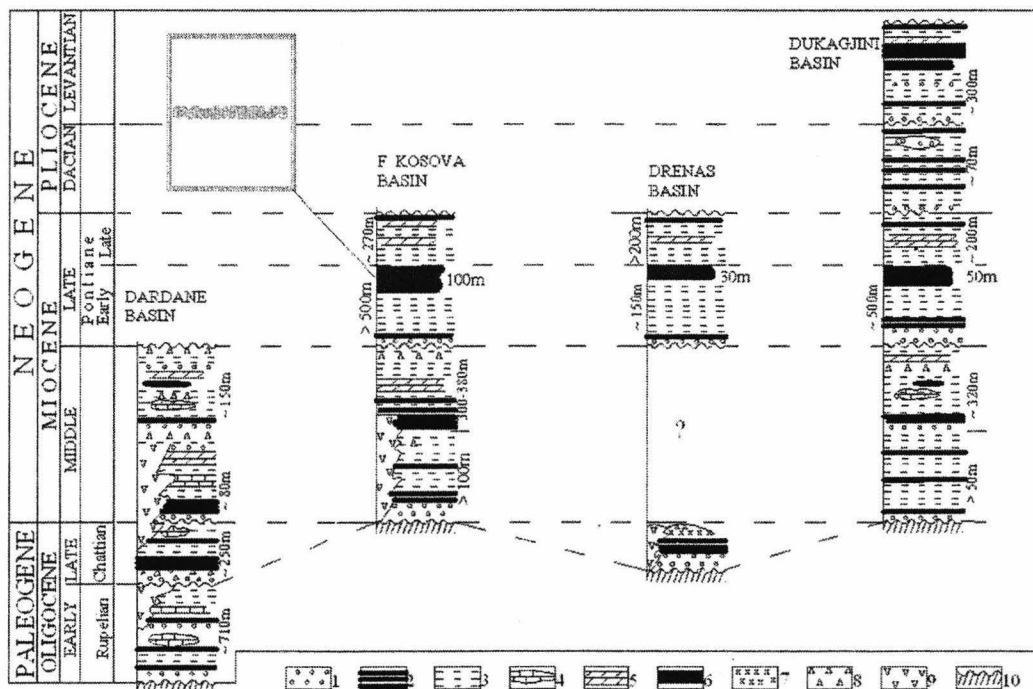


Figura 2. Coloană stratigrafică cenozoică din Kosovo  
1-Conglomerate, 2- Sandstone, 3-Clay, 4- Limestone, 5-Marl, 6-Lignite, 7-Magnesite, 8-Tuff, 9-Eruptive rock, 10-Basement.



The Fushe-Kosovo Basin exposes a low asymmetric depression (into which the bottom of pre-molasse deposits is west-tilting.)

During the Pliocene, the Dukagjini and Fushe-Kosovo basins as well as their surroundings were deformed by strong extensional tectonism that resulted in the subdivision of these terranes by normal faulting (see Fig. 3 and 4). In the Fushe-Kosovo Basin the normal faults also penetrate into the basement rocks that underlie the molasse succession.

## 2.1 Stratigraphy

The stratigraphy of these sedimentary basins is outlined in ELEZAJ & KODRA, 2008.

**PALAEOGENE.** Palaeogene rocks in Kosovo occur in the north (Mitrovica and Besiana), as well as in eastern and south-eastern Kosovo. They transgress older formations and include Early Oligocene marine and volcano-sedimentary as well as Late Oligocene sedimentary and volcano-sedimentary sediments.

**Early Oligocene.** The Early Oligocene sedimentary sequence in the Morava e Binçes - Gjilan Basin begins with conglomerates passing upward into sandstones and claystones with coral and lithotamnic limestone lenses marked by the following marine fauna:

a) gastropods: *Cerithium plicatum*, *C. vivari*, *Diastoma costellatum elongatum*, *Natica (Ampullina) giberosa*, *N. (Ampullina) sigaretina*, *N. (Ampullina) cf. radula*, *N. cf. angustata*, *Strombus* sp.

b) corals: *Stylocoenia taurinensis*, *St. microphthalma*, *St. minuscola*, *Stilophora distans*, *St. cf. conferta*, *Astrocoenia multigrosa*, *Astracopora compressa*, *Phyllocoenia irradiata*, *Ph. (Heliastrea) hebertish (Pheliastrea) lucasiana*, *H. immersa*, *H. colunaris*, *Dimorphostrea iridians*, *Isastrea affinis*, *I. michelottina* etc., and

c) bivalves: *Macrosolen hollowaysii*, *Ostrea gigantica*, *Pecten cf. bucherii*, *Meretrix incrassata*.

**Early Oligocene (Rupelian).** These deposits are widespread in east and southeast Kosovo, from Besiana Basin and eastwards to southeastern part of Fushe-Kosovo Basin, in Ferizaj and Kaçanik. They are represented by a volcano-sedimentary series, transgressing basal conglomerates with clasts of diabase and gabbro as well as Late Cretaceous flysch. The stratigraphic section in the Morava e Binçes - Gjilan Basin begins with conglomerates passing upward into coral limestones, claystones, sandstones and volcanic rocks.

The following faunal assemblages occur:

a) corals: *Stylina suessi*, *Stylocoenia taurinensis*, *Cyathimorpha gregaria*, *Phyllocoenia irradians*, *Thamnastae centrifuga*, *Heliastrea forojuhensis*, *H. cylindrica*, etc.

b) bivalves: *Ostrea (Picnodonta) brougniarti*, *Spondylus cisalpinus* etc., and

c) gastropods: *Megatylotus crassatinus*, numulites: *Nummulites intermedius* and *N. incrassatus*. from that *N. intermedius* e *M. Crassatinus*, markers for the Rupelian stage.

The volcanic rocks are trachytes, latites, tracho-leucite breccias and tuffs.

**Late Oligocene.** These deposits are generally located in eastern Kosovo, in the Dardane region and partly in the Dubovc and Smrekonica regions. They are represented by lacustrine sediments, intruded by volcanic rocks.

In the Dardane Basin the Late Oligocene section is marked by basal conglomerates, passing upwards into clays, marls, sandstones, limestones and tuffites. A macroflora including *Gomtonia* sp. *Quercus neriofolia*, *Driophylum curticelese*, *Sequoia sterbergi*, *Grevilea haerengiana*, *Andromeda protogena*, *Zizyphus zizyphoides*, *Bumelia* sp. etc., documents the Late Oligocene.

The Lece andesitic complex is the same age.

The Late Oligocene deposits are also found on the northeast margin of the Drenica Basin, where it is represented by the Dubovci magnesite series and Smrekonica calc-trachytes.

**NEOGENE.** The Neogene in Kosovo include Miocene and, occasionally, Pliocene sequences that are found in the Fushe-Kosovo, Dukagjini, Drenica and Dardane molasse basins. They include sedimentary sequences developed in lacustrine environments, particularly during the Pontian and Pliocene. These basins are distinguished by their coal-bearing beds (Fig. 2).

**MIOCENE.** The Miocene sequences are represented by the Early Miocene (?), Middle to Late Miocene and Late Miocene.

**Middle Miocene.** The Middle Miocene successions are located in Dardane (Krivareka), Dukagjini and Fushe-Kosovo basins, and include sandstones, marls, and occasional tuffites. The data demonstrate that the Dukagjini and Fushe-Kosovo basins were a single molasse basin during the Middle Miocene.

In Dardane Basin, the Middle Miocene deposits are divided into three clastic levels.

**Middle and Late Miocene (undivided).** These sequences are found in the Dukagjini and Fushe-Kosovo Basins, and transgress over the Late Cretaceous limestones, as well as over magmatic and metamorphic rocks. Three lithofacial horizons are distinguished from bottom to top: basal, carbonate, and sandstone-claystone, the last including coal strata.

**Late Miocene.** The Late Miocene sequences are found in the Fushe-Kosovo, Dukagjini and Drenica Basins.

These Late Miocene lake sediments have an important extension in the fore-mentioned basins, which may have been interconnected. The coal forming environment developed in the Late Pontian and resulted in the formation of thick strata.

**Early Pontian.** The Early Pontian sediments are located within the Fushe-Kosovo, Dukagjini and Drenica basins. There are two main horizons: a Early clastic horizon and a coal-bearing towards the top.

In Fushe-Kosovo Basin the Early Pontian includes terrigenous molasse series that is 50 m thick. The coal-bearing strata range from 40 m to 100 m in thickness.

The claystones within the coal-bearing sequence host a rich microflora: *Verrucatosporites fagus*, *Polypodiaceae*, *Reticuloidosporites secundus*, *Polypodiaceae*, *Monocolpopollenites tranquillus*, *Palme*, *Pityosporites microalatus*, *Pinus naploxyton*.

In the Drenica Basin, the Early Pontian sediments transgress over Palaeogene and Late Cretaceous formations. The coal-bearing horizon is thinner, from only some meters up to 40 m thick. In the Dukagjini Basin the coal bearing horizon belongs to the Middle and Late Miocene succession and is up to 50 m thick.

**Late Pontian.** The Late Pontian deposits occur in the basins mentioned above.

In the Fushe-Kosovo Basin the Late Pontian sediments transgress over the Early Pontian coal-bearing horizon. The following fauna is reported from the northwest of the basin: *Congerina ornithopsis*, *Viviparus viquesneli*, *Kosovia ornata* *dhe Melanopsis decollata*, markers for the Late Pontian.

In the Dukagjini Basin the Late Pontian sediments are developed as a terrigenous sequence, with molluscs and ostracods: *Congerina ornithopsis*, *Viviparus kujarçensis*, *V. tetracarinus*, *V. bicarinatus*, *V. lilianus*, *V. micricus*, *Kosovia ornata*, *K. kompressa*, *K. bouei*, *K. cf. pavlovi*, *Melanopsis decollata*, *Neritodonta veljentinensis*, *Candona stupeli*, *C. marginata*, *krusevoense*, *C. hvosnoica*, *C. cf. Veljae*, *Ilyocypris sp.* The sequence is about 200 m thick.

**PLIOCENE.** Pliocene deposits are found only in the western and southern sectors of the Dukagjini Basin, where they transgress over the Middle and Late Miocene.

The absence of Pliocene sediments in the other basins, such as the Fushe-Kosovo and particularly the Peja sub-basin, demonstrates that sedimentation in these basins was concluded during the Pontian. Pliocene subsidence in the southern part of Dukagjini Basin (Prizreni sub-basin) resulted in the deposition of lacustrine deposits, including clays, sands and gravels interbedded with thin coal strata.

The Pliocene sediments are sub-divided into the Dacian and Levantian. These sediments are flat-lying and 350-400 m thick in the Prizreni sub-basin. The Levantian sediments transgress over Late Cretaceous carbonate rocks, and contain freshwater molluscs: *Dreissensia munsteri hvosnoensis*, *Viviparus dukagjensis*, *V. conica*, *V. dinici*, *V. lomejkoi*, *Lythoglyphus fascus*, *Unio sp.*, *Anodonta sp.*, and ostracods: *Candona sp.*, *C. ex.gr.fabaeformis*, *Paracandona sp. A.B.*, *ilyocypris cf.gibba*, *J.cf. bradyi*, as well as flora: *Quercus pseudocastanea*, *Quercus sp.*, *Monocotyledonae div.gen.sp.indet.*

In the Besiana (Podujeva) sub-basin the Pliocene sediments transgress over the Late Cretaceous limestones, and the sequence includes gravels, sands and clays.

**QUATERNARY. Pleistocene.** Pleistocene sediments, 10-30 m thick, are represented by sands, gravels and sandy clays and found principally in the Dukagjini, Drenica and Fushe-Kosovo basins, where they overlie Miocene or Pliocene sequences, and rarely Late Cretaceous ("Senonian") flysch.

Sedimentation in the Gjakova Lake ceased at the end of Pliocene (Romanian) or at the beginning of Pleistocene. Subsequently the whole Kosovo area gradually developed the present-day landscape: a continental area exposed to erosion processes.

## 2.2 Stratigraphic Setting of Coal Fields in Kosovo

The correlation of stratigraphic logs from the Fushe-Kosovo, Dukagjini (Peja sub-basin) and Drenica molasse basins demonstrate that the coal-bearing sequences formed during the Early Pontian (Late Miocene).

The coal field sequences are composed of the following rocks, from bottom to top:

i) Terrigenous, 500 m thick in Fushe-Kosovo Basin, composed of gravels at the lower part, passing upwards into sandstones, marls and clays.

ii) Coal of lignite type, 100 m thick in Fushe-Kosovo Basin, form a sequence of lignite coal that is some meters up to 10's meters thick, with interbedded clays, marls and carbonatic tuffs that are millimetres or centimetres thick, only rarely decimetres thick.

Multicoloured clays occur at the base of the coal sequence.

The Early Pontian is overlain by Late Pontian carbonate clays.

The absence of the Pliocene in Fushe-Kosovo and Drenica basins demonstrate that sedimentation in these basins ceased at the end of the Late Miocene.

The Fushe-Kosovo lignite field, extending NNW for about 30 km in a syncline structure, is estimated as one among of the biggest in Europe. The Dukagjini lignite field is the second biggest one in Kosovo.

## 3. CENOZOIC GEODYNAMIC EVOLUTION OF KOSOVO

Two principal sedimentary molasse basins were developed in Kosovo from the Early Oligocene to Recent time. The basins were formed on basement and reflect two major periods of extensional deformation interrupted by a short period of compression.

### 3.1 Periods of Extensional Deformations

The main geodynamic evolution events registered during the Cenozoic in Kosovo are the following:

i) Oligocene extensional regime,

- ii) Latest Oligocene - Early Miocene compressional regime,
- iii) Middle Miocene - Pleistocene extensional regime.

#### **i) The Oligocene extensional regime**

After the Illyrian compression phase occurred during the late Eocene to early Oligocene, the so-called Illyrian tectogenesis resulted in westward thrusting of the internal units the Kosovo was part of South Balkan extensional region, as northern part of the Aegean extensional regime.

Extension began in the Early Oligocene in east and southeast Kosovo, establishing the Dardane and Morava e Binces - Gjilan molasse basins.

Similar molasse basins also developed in eastern FYROM, parallel to similar basins in adjacent Bulgaria, as well as in Presheva region.

The oldest period of extension and basin development in FYROM began in the late Eocene and was marked by various types of basins with sedimentary sequences ranging from late Eocene to Oligocene (DUMURDZANOV et al., 2005). Basins of this type are also found in the Presheva region. Based on the data from the adjacent territories around Kosovo, it is presumed that the oldest sediments in the Kosovo Oligocene basins are Late Eocene, but this remains to be checked by future studies.

This extension period can be divided into two sedimentary cycles, as follows:

- Early Oligocene - Cycle I
- Late Oligocene - Cycle II

##### **Early Oligocene: Cycle I**

In the Early Oligocene the typical marine facies had evolved into epicontinental shallow water environments. The presence of Early Oligocene deposits in the deeper parts of the basins demonstrates the existence of a large marine basin connected with the Mediterranean Tethyan Basin.

The lowermost part of the Early Oligocene sedimentary succession in the Dardane Basin is represented by conglomerates, passing upward into sandstones and claystones with coral limestone lenses. This succession is overlain by a volcanic-sedimentary series, containing coral limestones. A large volcanic eruption, marked by trachitic, latitic and leucitic lavas, as well as by breccias and tuffs, occurs in East and Southeast Kosovo.

##### **Late Oligocene: Cycle II**

During the Late Oligocene the first continental lacustrine and fluvial sedimentary facies, with intercalated volcanic and pyroclastics, were deposited within lake basins that developed from the Early Oligocene marine basins. The magnesite deposits in the Dubovci area are connected with this effusive-sedimentary series.

#### **ii) The End of Late Oligocene to Early Miocene period of compression regime**

A period of compression affected the Kosovo area at the end of the Late Oligocene and persisted until the early Miocene in two short Pyrenean and Savian tectonic events.

These short episodes of deformation were followed by erosion, which reduced the landscape to a low relief.

#### **iii) The Middle Miocene to Pleistocene period of extensional regime**

Following a brief period of compression in the Late Oligocene to Early Miocene, a second period of Neogene extension began that has continued up to present. During this period the Fushe-Kosovo, Dukagjini and Drenica molasse basins were established.

The Neogene was characterized by continental conditions similar to those that were established in the late Oligocene.

Following a short period of erosion and the development of a low-relief landscape, a second period of extension began in the late Early Miocene (?) or Middle Miocene time and became the dominant mode of deformation from then to the present. This extensional period can be divided into four sedimentation cycles, as follows:

- Pleistocene - Cycle VI,
- Late Pliocene - Cycle V,
- Late Miocene - Early Pliocene - Cycle IV,
- Middle Miocene - Cycle III,

In eastern Albania, west of Kosovo, the Librazhdi and Mati molasse basins transgressively overlie the Mirdita ophiolite zone, and are filled with Middle-Late Miocene lacustrine deposits (PASHKO, 1976). In FYROM, south of Kosovo, Miocene basins of this age range are also developed (ARSOVSKI, 1997). In Kosovo, sedimentation commenced in the Middle Miocene, and transgressively overlies basement rocks of different tectonic units (ELEZAJ, 2002).

##### **Middle Miocene: Cycle III**

The Middle Miocene lacustrine deposition was characterized by a transgressive sedimentary facies (conglomerates, sandstones, clays, marls and tuffs) of considerable thickness that occurs throughout almost all Kosovo territory. The coal strata within Dukagjini and Dardane Basins were deposited at this time.

##### **Late Miocene – Early Pliocene: Cycle IV**

The Late Miocene (Pontian) sediments transgressively overlie the Middle Miocene sequence and host the very important Early Pontian coal-bearing succession in the Fushe-Kosovo, Drenica and Dukagjini Basins.

The formation of the lignite coal deposits of lignite type during the Early Pontian within lacustrine basins, especially in the Fushe-Kosovo Basin, demonstrate the presence of suitable paleogeographic conditions and optimal climate existed for the coal-formation process.

At the end of the Late Miocene sedimentation in the Fushe-Kosovo and Drenica lacustrine basins ceased and the sequences were slightly deformed. Early Pliocene sedimentation continued only in the Dukagjini Basin with the deposition of sands, clays and marls.

#### Late Pliocene: Cycle V

A Late Pliocene (Levantian) a transgressive succession, represented by sands, clays and marls, with coal strata in its lower part, was deposited.

Sedimentation in the Dukagjini Basin (Gjakova Sub-basin) ceased at the end of the Pliocene (Levantian) or Early Pleistocene, when finally it was also slightly deformed.

Subsequently the Kosovo territory developed its present-day landscape: a continental area with predominance of erosional processes.

#### Pleistocene: Cycle VI

Sedimentary rocks of Pleistocene age (cycle VI) are the most widespread Cenozoic deposits in Kosovo. In many places they cover older Cenozoic deposits. The Pleistocene age (cycle VI) tectonic activity is characterized by a general uplift and development of glacial deposits. Subsidence and formation of the present Aegean Sea, and the simultaneous elevation of the Balkan Peninsula, resulted in the burial of lacustrine deposits by glaciofluvial and proluvial-alluvial material as well as the draining of the lake system.

The Dukagjini and Fushe-Kosovo Basins were the site of subsidence during the Pleistocene that resulted in the deposition of around 30 m of poorly sorted gravels.

### 3.2 Neotectonic (Pliocene-Quaternary) Normal Faulting Tectonics

Strong and progressive uplift occurred throughout the Mediterranean Region, including Greece, Albania, Kosovo, FYROM and many other countries to the east and north-west, during the Pliocene-Quaternary and resulted in normal faulting. This faulting established there a well-defined horst-and-graben structural morphology (ALIAJ, 1998; ELEZAJ, 2002, 2008; MERCIER et al., 1989) in the region.

In Albania and its surroundings the neotectonic orogene is divided into two domains: a coastal domain of compression dominated by northwest to north-northwest striking thrusts and folds, and an interior domain of extension dominated by north-striking normal faults. The commencement of neotectonic activity in the Pliocene was marked by extensional tectonics, which affected the interior domain of the country and created its horst-graben structures (Aliaj, 1998).

The Dukagjini and Fushe-Kosovo Basins and surrounding areas were deformed during the Pliocene-Quaternary by a strong extensional tectonics that resulted in the subdivision of these terranes by normal faulting (see Figs. 3 and 4). In the Fushe-Kosovo Basin the normal faults penetrate not only the complete sedimentary succession, but also the underlying basement rocks.

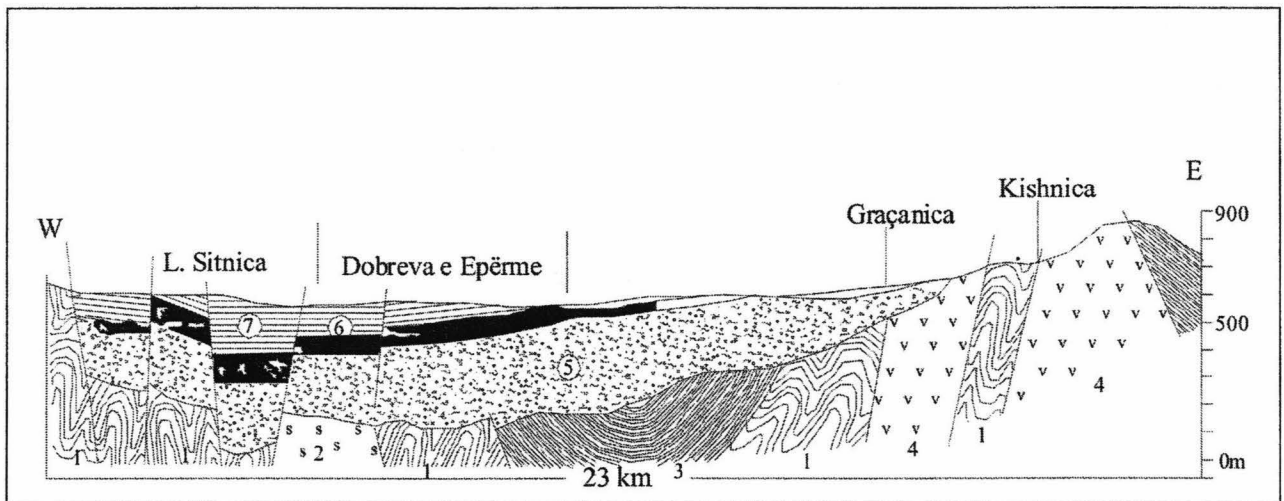


Figure 3. Geological cross – section through Fushë – Kosova Basin

1-Metamorphic Paleozoic rocks, 2-Ophiolite rocks, 3-Upper Cretaceous deposits, 4-Effusive rocks, 5-Upper Miocene sediments, 6-Lower Pontian lignites, 7-Upper Pontian cover.

Figura 3. Secțiune geologică în bazinul Fushë-Kosovo

1-roci metamorfice paleozoice, 2-roci ofiolitice, 3-depozite din Cretacicul Superior, 4-roci efuzive, 5-sedimente din Miocenu Superior, 6-lignit din Pontianul Inferior, 7-strat Pontian Superior.

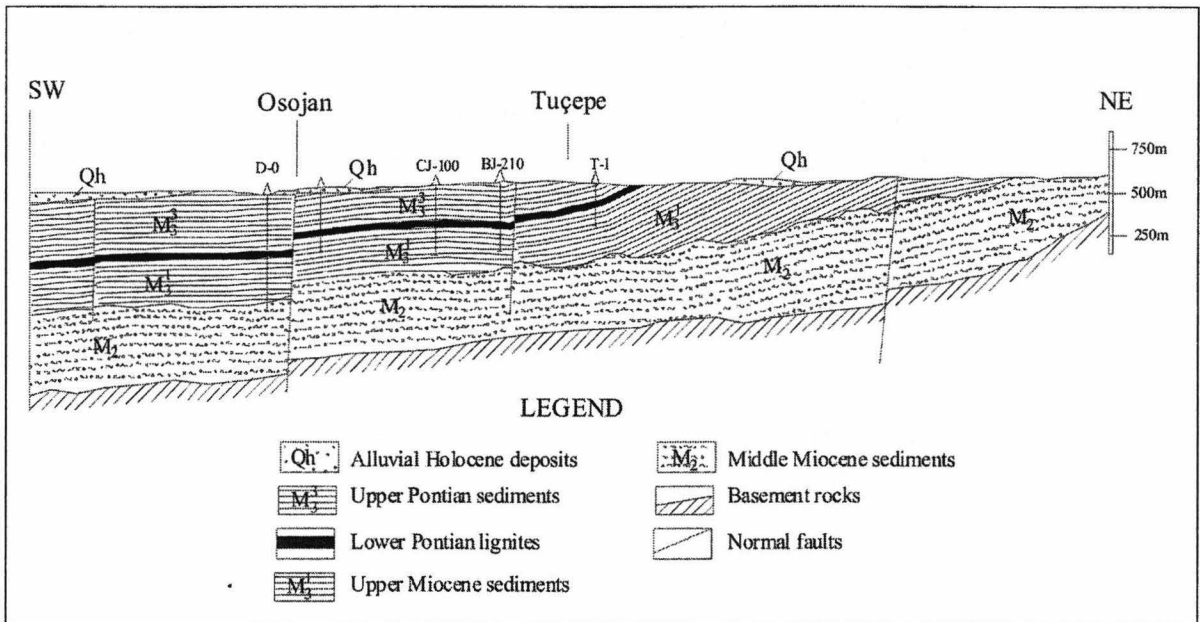


Figure 4. Geologic cross – section through Dukagjin Basin (Osojan-Tuçe).  
 Figura 4. Profil geologic în Bazinul Dukagjin (Osojan-Tuçe).

Due to this strong normal faulting tectonism during the Pliocene-Quaternary Kosovo is characterized by horst and graben structures.

#### 4. CONCLUSIONS

During the Cenozoic, Kosovo experienced two periods of extension separated by two brief periods of compression.

The first period of extension Early to Late Oligocene established the Dardane and Morava e Binçes-Gjilan molasse basins. These basins were deformed by NW-trending thrust faults and folds during the Late Oligocene to Early Miocene time. This period of compression was short-lived and followed by a period of erosion that resulted in a landscape of low relief.

The second period of extension began in the Middle Miocene and has continued to the present, during which the Fushe-Kosovo, Drenica and Dukagjini Basins were established. At the end of the Late Miocene sedimentation ceased in the Fushe-Kosovo and Drenica lacustrine basins and subsequently weakly deformed in asymmetric syncline structures.

Pliocene sedimentation continued only in the Dukagjini Basin, where it ceased at the end of the Pliocene (Levantian) or Pleistocene, when it was slightly deformed into an asymmetric syncline.

Two other small basins: the Prizreni and Besiana (Podujeva) Sub-basins were established during the Pliocene. They were closed and deformed at the end of Pliocene.

Subsequently, the entire Kosovo territory acquired its present-day landscape: a continental area with predominance of erosional processes.

The neotectonic normal faulting period during the Pliocene-Quaternary in the eastern regions of Albania, Kosovo, FYROM and other countries, created there a well-defined horst-and-graben structural morphology.

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# AULACOSTEPHANIDS SPECIES (*AULACOSTEPHANUS*, *RINGSTEDIA*, *SIMOCOSMOCERAS* AND *GRAVESIA* GENERA) FROM “ACANTHICUM BEDS” OF GHILCOȘ (THE EASTERN CARPATHIANS – ROMANIA)

DAN GRIGORE, IULIA MARCU

**Abstract.** In this paper there are described some species of the *Aulacostephanus* TORNQUIST, *Ringstedia* SALFELD, and *Gravesia* SALFELD genera, recently discovered in the Ghilcoș Mountain area (Hășmaș Masiff-Eastern Carpathians) in Upper Jurassic deposits (“acanthicum beds”) and there are also revised the specimens of former authors (NEUMAYR, 1873, HERBICH, 1878 and PREDA, 1973), pertaining to this family group (mentioned before and from *Simocosmoceras* SPATH genus).

**Keywords:** *Aulacostephanidae*, *Palaeontology*, *Hășmaș*, *Ghilcoș*, *Kimmeridgian*.

**Rezumat.** Specii de Aulacostefanide (genurile *Aulacostephanus*, *Ringstedia*, *Simocosmoceras* și *Gravesia*) din „Stratele cu Acanthicum” de la Ghilcoș (Carpații Orientali-România). În lucrare sunt descrise câteva specii din genurile *Aulacostephanus* TORNQUIST, *Ringstedia* SALFELD și *Gravesia* SALFELD, recent descoperite în regiunea muntelui Ghilcoș (Masivul Hășmaș-Carpații Orientali) în depozite jurasice superioare („Stratele cu Acanthicum”) și sunt revizuite exemplarele autorilor anteriori (NEUMAYR, 1873, HERBICH, 1878 și PREDA, 1973), aparținând unor specii atribuite acestei familii (din genurile deja menționate la care se adaugă genul *Simocosmoceras* SPATH).

**Cuvinte cheie:** *Aulacostephanidae*, *Palaeontologie*, *Hășmaș*, *Ghilcoș*, *Kimmeridgian*.

## INTRODUCTION

The Ghilcoș Acanthicum Beds used to be known only four aulacostephanids taxa (with few specimens), pertaining only to *Sutneria* and *Simocosmoceras* genera. This study firstly reveals the presence in this area of the Eastern Carpathians of some other same family species' but pertaining to *Ringstedia* and *Gravesia* genera. The presence here of aulacostephanid representatives is very important from a palaeobiogeographical point of view, regarding the placement of this ammonite fauna between the Mediterranean palaeoprovince and Submediterranean ones.

The outcrops are placed on the western slope and walls of Ghilcoș Massif, a large area with blocks, almost systematically studied in the last 20 years, which yielded one of the richest Kimmeridgian ammonite fauna (GRIGORE, 2000, 2002).

## SYSTEMATICS

Abbreviations for the measurements:

D<sub>max</sub> = maximal diameter

D<sub>ph</sub> = phragmocone diameter

D = measured diameter

U = diameter of umbilicus

H = height

W = width

N<sub>i</sub> = number of inner ribs (over one whorl)

N<sub>e</sub> = number of external ribs (over the same one whorl as N<sub>i</sub>)

Order Ammonoidea ZITTEL, 1884

Family Aulacostephanidae SPATH, 1924

Genus *Aulacostephanus* TORNQUIST, 1896 emended ARKELL, 1935

*Aulacostephanus* cf. *eudoxus* (D'ORBIGNY, 1847)

Pl. I, Fig. 1.

1847 *Ammonites eudoxus*-D'ORBIGNY; p. 252; pl. 213, Figs. 3-6.

non 1973 *Aulacostephanus* aff. *pseudomutabilis* (LORIOLE)-PREDA; pl. 10, fig. 6.

Material: LRk1H12.

Remarks: our specimen represents a 1/6 whorl of a medium sized *Aulacostephanus*, which preserves the specific ornamentation.

The Preda's specimen (preserved in the University of Bucharest), described as *A. eudoxus* (1973) is possible to belong to an opelid individual, for the straight umbilicus and thin ribs, without periumbilicale bullae.

Occurrence: Late Kimmeridgian-Eudoxus Zone in the Acanthicum Beds from Ghilcoș-Hășmaș Mts., Romania; Late Kimmeridgian-Eudoxus Zone in England, France, Germany, Poland, Switzerland.

Genus *Ringstedia* SALFELD, 1913

It is firstly mentioned in this region (in the acanthicum beds from Ghilcoş); the species of Neumayr: *Perisphinctes haliarchus* was revised here as belonging to this genus too.

*Ringstedia* ("Decipia") *helvetica* GEYER, 1961

Pl. I, Fig. 2.

1961 *Ringstedia* (*Decipia*) *Helvetica*-GEYER; p. 129; pl. 21, Fig. 5.

Material: LRk2W4.0.

Measurements:

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	H/W	*Ni	*Ne	N <sub>0</sub> /N <sub>1</sub>
Holotype	215	180	200	86	64	51	0.43	0.32	0.25	1.25	47	174	3.7
LRk2W4.0	180	180	140	60	47	41	0.43	0.33	0.29	1.15	~44	~120	2.72

Remarks: our specimen is a large sized one, representing a phragmocone ventrally deformed, which preserves a small part of the living chamber. The whorl-section is ogivale and its specific ornamentation is well preserved; the morphology and morphometry are comparable with that of type species one.

Occurrence: Early Kimmeridgian-in the top of Strombecki/Hypsilocyclum Zone in the Acanthicum Beds from Ghilcoş-Hăşmaş Mts., Romania; Early Kimmeridgian-Platynota and Hypsilocyclum zones in Switzerland (Melikon).

*Ringstedia* ("Decipia") *haliarchus* (NEUMAYR, 1873)

Pl. I, Fig. 3.

1873 *Perisphinctes haliarchus*-NEUMAYR; p. 177; pl. 35, fig. 1, *non* Fig. 2.

1878 *Perisphinctes haliarchus*-HERBICH; p. 157.

Material: LRk3A1; Neumayr's Holotype: Collection of the Geological Institute of Austria (Bundesanstalt)-Wien; it originates from red nodular limestone from Ciofronca outcrop; Herbich's specimen: Collection of "Babeş Bolyai" University from Cluj Napoca; it originates from the Ghilcoş outcrop.

Measurements:

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	H/W	*Ni	*Ne	N <sub>0</sub> /N <sub>1</sub>
Holotype	198	198	198	97	51	46	0.49	0.26	0.23	1.11	38	-	-
Herbich sp.	106	106	106	53	30	25	0.50	0.28	0.24	1.20	-	-	-
LRk3A1	-	-	-	-	43	41	-	-	-	1.05	-	-	-

Remarks: our specimen represents a phragmocone sector of a large sized individual, with H>43, which preserves the specific ornamentation very well, comparable with the type specimen; also, the other parameters, both morphological and morphometrical are comparable with those of the type specimen (also).

The Herbich's specimen represents a medium sized phragmocone, which is different from the type specimen for an "earliest" smooth band on its venter (from 90 mm diameter not by 150 mm as in type specimen).

Occurrence: Early Kimmeridgian-Divisum Zone in Acanthicum Formation ("A" profile from Ghilcoş and "Ciofronca")-Hăşmaş Mts., Romania; not reported anywhere else in the world.

Genus *Simocoscoceras* SPATH, 1925*Simocoscoceras nitidulum* (NEUMAYR, 1873)

1873 *Coscoceras nitidulum*-NEUMAYR; p. 167; pl. 33, Fig. 6.

1973 *Simocoscoceras nitidulum* (NEUMAYR)-PREDA; pl. 17, Fig. 8.

Material: Neumayr's specimen: Collection of the Geological Institute of Austria (Bundesanstalt)-Wien; it originates from green nodular limestones from Ghilcoş outcrop; Preda's specimen: Collection of Piatra Neamţ Natural Science Museum; originating from red nodular limestones from Ghilcoş outcrop.

Remarks: with this opportunity we have the possibility to analyze Preda's specimen, poorly preserved; some peculiar features as the hexagonal whorl section and a smooth lateral tuberculation remind to us this species.

Occurrence: Kimmeridgian (?) from Acanthicum Beds-Hăşmaş Mts. Romania; this species is reported only in this region all over the world and for that reason it worth to be mentioned here.

Genus *Gravesia* SALFELD, 1913*Gravesia* cf. *gravesiana* (D'ORBIGNY, 1847)

Pl. I, Fig. 4.

1847 *Ammonites Gravesianus*-D'ORBIGNY; p. 271; pl. 219, Fig. 1.

1966 *Gravesia gravesiana* (D'ORBIGNY)-ENAY; p. 7.

Material: LRk4dp.

Remarks: the specimen represents half of a whorl of a medium sized individual, with a very depressed whorl section and preserving the specific features of the ornamental style.

Occurrence: Late Kimmeridgian (?) in the Acanthicum Beds, (from the slope debris of Ghilcoș), Hășmaș Mts., Romania; Early Tithonian-Gravesiana Zone (/Hybonotum) in the franco-suab "biome" (France, Germany).

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## PLATE I

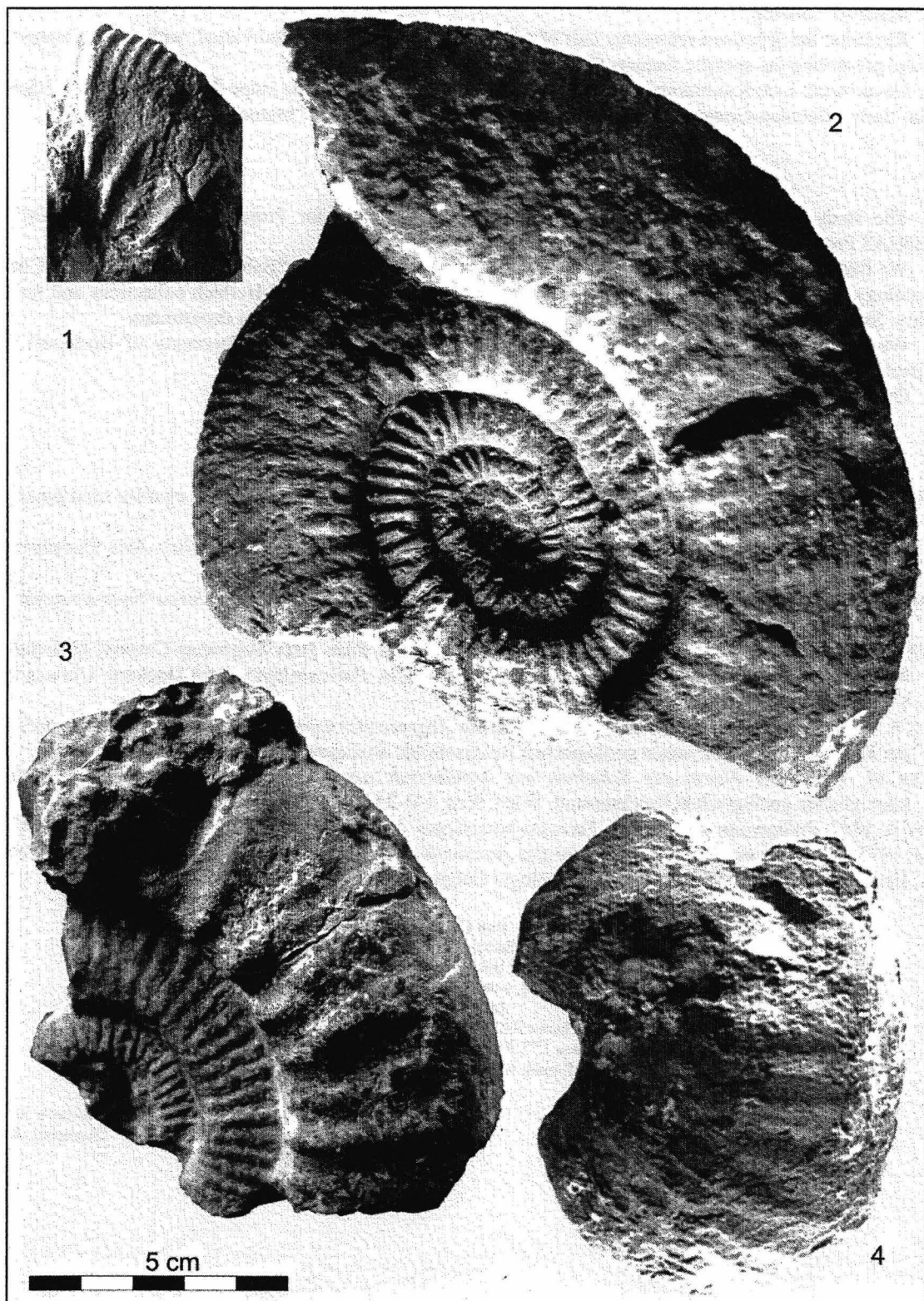


Figure 1. *Aulacostephanus* cf. *eudoxus* (LRk1H12); gray limestones, Late Kimmeridgian-Eudoxus Zone. (x 1) / Figura 1.

*Aulacostephanus* cf. *eudoxus* (LRk1H12); calcare cenușii, Kimmeridgian superior-Zona Eudoxus. (x 1)

Figure 2. *Ringstedia* (*Decipia*) *helvetica* (LRx2W4.0), phragmocone; red or green nodular limestone, Early Kimmeridgian, Hypselocyclum (Strombecki) Zone. (x 1) / Figura 2. *Ringstedia* (*Decipia*) *helvetica* (LRx2W4.0), fragmocon; calcare nodulare roșu/verde, Kimmeridgian inferior-Zona Hypselocyclum (Strombecki). (x 1)

Figure 3. *Ringstedia* (*Decipia*) *haliarchus* (LRx3A1), phragmocone; nodular limestones / green sandstones Late Kimmeridgian-Acanthicum Zone. (x 1) / Figura 3. *Ringstedia* (*Decipia*) *haliarchus* (LRx3A1), fragmocon; calcare nodulare / gresii verzui Kimmeridgian superior-Zona Acanthicum. (x 1)

Figure 4. *Gravesia* cf. *gravesiana* (LRk3dp), ventral view; Kimmeridgian, yellow calcarenite, slope debris. (x 1) / Figura 4. *Gravesia* cf. *gravesiana* (LRk3dp), vedere ventrală; Kimmeridgian calcarenite gălbui, depozite de pantă. (x 1)



## PALAEONTOLOGICAL SITES FROM CHEILE BICAZULUI – HĂȘMAȘ NATIONAL PARK

DAN GRIGORE, IULIANA LAZAR, CONSTANTIN GRASU, ION GHEUCA, DIANA  
CIOBANETE, ADRIANA CONSTANTINESCU, IULIA MARCU

**Abstract.** *This paper is a preliminary form of the Catalogue of palaeontological sites from Hăghimaș Mts., sites found in Cheile Bicazului - Hășmaș National Park (CBHNP) area or bordering it. The first part presents a data sheet pattern for the site and the catalogue structure. In the second part there are summarised the palaeontological sites inventoried during the project GEOBIOHAS, some of these discovered on this occasion. The paper is a partial revision of the natural heritage (palaeontological one) of Hășmaș Massif (i.e. of Cheile Bicazului – Hășmaș National Park).*

**Keywords:** *Sites, Palaeontology, Hășmaș, National Park.*

**Rezumat. Situri paleontologice din Cheile Bicazului – Parcul Național Hășmaș.** *În aceasta lucrare este prezentată o formă preliminară a Catalogului siturilor paleontologice din masivul Hăghimaș, situri din aria Parcului Național Cheile Bicazului – Hășmaș sau limitrofe acestuia. În prima parte este prezentat un model de fișă de sit și structura catalogului. În cea de-a doua parte sunt prezentate pe scurt siturile paleontologice inventariate cu ocazia proiectului GEOBIOHAS, unele descoperite cu acest prilej. Lucrarea reprezintă o revizuire parțială a patrimoniului natural din masivul Hășmaș (i.e. a Parcului Național Cheile Bicazului – Hășmaș).*

**Cuvinte cheie:** *Situri, Paleontologie, Hășmaș, Parc Național.*

### INTRODUCTION

In Romania, one of the best-known zones for the abundance of Mesozoic palaeontological sites, known starting with FRANZ HERBICH (since 1866) is Hăghimaș Massif (the Eastern Carpathians). The geological researches in this area were made, at great periods of time, sometimes ten or more than ten years, in several expeditions. This way, it seems that information is presently dispersed and the scientific literature consists in most cases in published articles. This fact leads, unfortunately, to an ignorance of the sites discovered in time, some of those notified as international ones. More than that, presently, tourists and even people who live there are not informed about the sites' locations or about the geological information.

Starting from this idea, about two years ago, took birth the GEOBIOHAS Project, project gathering several institutions, in order to reevaluate the present situation of the whole natural heritage in this area. The objective is to bring new information about the palaeontological sites from Cheile Bicazului- Hășmaș National Park and to publish papers in scientific journals for a better understanding of the lithology and stratigraphy of these palaeontological sites.

The present paper aims at briefly rendering the terrain research of the team members. It provides an attempt in revealing information concerning the results and presents a method for data processing. The catalogue comprises various information, some of them exceeding the scientific area and suggesting measures for development or/ and maintenance.

Less than two years ago, the members of the this project (involving the authors) analyzed (formally) in situ the existing situation of 14 palaeontological sites, following the information in the scientific literature; we concluded that some of these sites probably vanished in the wake of geomorphologic evolution of the terrain or they are poorly conserved. On this occasion, new locations/sites were found (about 10). At the same time, we did a detailed analyze, for 7 of the most important ones and we are currently taking part at scientific meetings to bring new information about Hăghimaș area and to publish the results.

### THE SITES CATALOGUE STRUCTURE

The catalogue contains several chapters: introduction, sheets of sites, references, index and annexes - graphic drawings, pictures and map. For data sheet pattern of the site we propose the following content:

1. General data (a. Preserved area type; b. IUCN Category; c. Rating rules IGR category; d. Constitutive act; and e. Landowner);
2. Location (a. Locality; b. Longitude; c. Latitude; d. Altitude; e. Surface; f. Geotectonic unit; g. Lithostratigraphic unit; h. Geographical location: (attached drawing); and 2.b "Access to" (as public indications);
3. Description (a. Exposure mode; b. Geological description – lithology, structure and age enclose) and 3.b "Position in the landscape (attached photos)" and/or "Geotourist features" (as public indications);
4. Palaeontological resources/content (a. significant fossils (label – No. /Coll. indication/ Inv. no. /Species /Specimen indication /Special indication /site features); b. More fossils; c. Collections; d. Inventory data sheet (as attachment);

5. Scientific value (includes a. Motifs to protect the area; and b. Measures for preservation);
6. Suggestion for development and maintenance (site development, sketches);
7. Helpful information (localities, tourist zones, distances, etc.);
8. Indications for a. References; b. Graphics; c. Photos and Web addresses (about natural reserve and tourist accommodation).

## SITES DATA SHEET

### **F 1 Ghilcoş 1 Site (“Kimmeridgian of the Ghilcoş Mts. walls”) (Figs. 1, 2)**

Exposures of Upper Jurassic (Kimmeridgian - Lower Tithonian) deposits are located in the base of the western walls of Ghilcoş Massif and were discovered by FRANZ HERBICH in 1866.

Fossils: lumachelle ammonites and other rarer invertebrates: bivalves, brachiopods, gastropods, belemnites, echinoids and plants.

Importance: biostratigraphy, palaeontology, palaeoecology and palaeogeography of Upper Jurassic.

It provides one of the richest Kimmeridgian ammonites' fauna.

Until now, this was not legally notified as a reserve. The effective area of exposures is about 2.5 hectares and is located within the CBHNP area.

References: HERBICH (1866, 1878), NEUMAYR (1873), VADASZ (1915), JEKELIUS (1921), BĂNCILĂ (1941), PATRULIUS (1960), PREDĂ & PELIN (1965), GRASU (1969b), SÂNDULESCU (1969, 1975), PREDĂ (1973), DRAGASTAN (1975, 1980), PREDĂ et al. (1976b), GRASU & TURCULEȚ (1980), TURCULEȚ (1980), NEAGU & NEAGU (1995), GRIGORE (1996, 2000a, 2000b, 2002), TURCULEȚ & GRIGORE (2006).

### **F 2 Ghilcoş 2 Site (“Kimmeridgian blocks of the Ghilcoş slope”) (Figs. 3, 5)**

Exposures of Upper Jurassic (Kimmeridgian - Early Tithonian) deposits are located in a large area with blocks on the northwestern slope of Ghilcoş Massif and discovered by FRANZ HERBICH in 1866.

Fossils: ammonites lumachelle and other rare invertebrates: bivalves, brachiopods, gastropods, belemnites, echinoids and plants.

Importance: biostratigraphy, palaeontology, palaeoecology and palaeogeography of Upper Jurassic and tectonic interpretations.

These exposures were never considered to be palaeontologically or biostratigraphically important and proposed as a reserve until now. The complete area of exposures is about 3.5 hectares and it is located within the CBHNP area.

References: HERBICH (1866, 1878), NEUMAYR (1873), JEKELIUS (1921), PATRULIUS (1960), PATRULIUS et al. (1969), PREDĂ (1973), SÂNDULESCU (1975), GRIGORE (1996, 2000a, 2000b, 2002), TURCULEȚ & GRIGORE (2006).

### **\*F 3 Ghilcoş 3 Site (“Marls with ammonites from western Ghilcoş”) (Fig. 4)**

Exposures of Upper Jurassic deposits located in base of the northwestern walls of Ghilcoş Massif, discovered by the authors in 2008.

Fossils: ammonites, brachiopods and plant debris.

Importance: biostratigraphy, palaeontology and palaeoecology of Upper Jurassic.

The complete area of exposures is about 1.5 hectares and is located within the CBHNP area.

No references.

### **\*F 4 Ghilcoş 4 Site (“Limestones with brachiopods from north Ghilcoş”) (Fig. 6)**

Outcrop of Upper Jurassic deposits located in base of the northwestern walls of Ghilcoş Massif, discovered by the authors in 2008.

Fossils: brachiopods, bivalves, gastropods, echinoids and crabs – perirecific facieses.

Importance: biostratigraphy, palaeontology and palaeoecology of Upper Jurassic.

The effective area of the outcrop is about 0.3 hectares and is located within the CBHNP area.

No references.

### **F 5 “Ghilcoş Valley 1” Site (“Liassic of the Ghilcoş Valley”)**

Exposures of Lower Jurassic (Liassic) deposits located on right side of the Ghilcoş Valley, near the confluence with the Oii Valley (i.e. Hăghimaş Valley).

Fossils: brachiopods, belemnites, bivalves and rare ammonites.

Importance: biostratigraphy, palaeontology and palaeoecology of Lower Jurassic.

The outcrop is about 0.1 hectares and is located outside the CBHNP area.

References: BĂNCILĂ (1941), ATANASIU & RĂILEANU (1952), PREDĂ & PELIN (1963, 1969), GRASU & TURCULEȚ (1967, 1980), PELIN (1967), GRASU (1970a, 1970b), PREDĂ (1976a).

**F 6 “Ghilcoș Valley 2” Site (“Dogger of the Ghilcoș Valley”) (Fig. 7)**

Exposures of Middle Jurassic (Dogger) deposits located in the riverbed and on the right side of the Ghilcoș Valley, at the middle rivulet way.

Fossils: bivalves, belemnites, rare ammonites, and plant debris.

Importance: biostratigraphy, palaeontology and palaeoecology of Upper Jurassic.

The complete area of exposures is about 0.5 hectares and is located outside the CBHNP area.

References: HERBICH (1878), BÂNCILĂ (1941), GRASU (1969a), PREDĂ (1976a), GRASU & TURCULEȚ (1980).

**\*F 7 “Cherecului Valley 1” Site (“Cretaceous Gossau from the Cherecului Valley”) (Fig. 8)**

Exposures of Cretaceous deposits located in the riverbed of the Cherecului Valley, in its spring area. Discovered by the authors in 2008.

Fossils: gastropods (*Nerinea* and other), bivalves and solitary corals.

Importance: biostratigraphy, palaeontology, palaeoecology and Palaeogeography of Cretaceous.

The complete area with river debris and outcrop is about 0.5 hectares and is located within the CBHNP area.

No references (?).

**\*F 8 “Valea Cherecului 2” Site (“Limestones with *Nerinea* from the Cherecului Valley”) (Fig. 7)**

Exposures of Lower Cretaceous deposits are located on the right side of the Cherecului Valley, on the path near its conjunction with the rivulet. Discovered by the authors in 2008.

Fossils: gastropods (*Nerinea*) and rare bivalves, brachiopods, crinoids.

Importance: palaeontology and palaeoecology of Cretaceous.

The area of outcrop is about 0.1 hectares and is located outside the limit of the CBHNP.

No references.

**\*F 9 “Hăghimașul Negru Valley 1” Site (“Triassic reef from the Hăghimașul Negru Valley”) (Fig. 10)**

Exposures of Triassic coral reef located on the slope from the right side of the Hăghimaș Valley (i.e. Oii), near the confluence with the Hăghimașul Negru Valley, on the path towards Poiana Albă. Discovered by the authors in 2008.

Fossils: fossil coral reef.

Importance: palaeontology, palaeoecology and palaeogeography of Triassic.

The complete area of exposures is about 1 hectare and is located outside the CBHNP area.

No references.

**\*F 10 “Hăghimașul Negru Valley 2” Site (“Liassic with cephalopods from the Hăghimașul Negru Valley”) (Fig. 13)**

Exposures of Liassic deposits located on the slope from right side of the Hăghimaș Valley (i.e. Oii), in the path towards Poiana Albă. Discovered by authors in 2008.

Fossils: belemnites, bivalves and rare aptychi.

Importance: biostratigraphy, palaeontology, palaeoecology and palaeogeography of Lower Jurassic.

The complete area of outcrop is about 0.1 hectares and is located within the CBHNP area.

No references.

**\*F 11 “Potcoava Mts. 1” Site (“Kimmeridgian from Potcoava Mts.”)**

Exposures of Upper Jurassic (Kimmeridgian-Tithonian) deposits located on the western slope of Potcoava Mts., in the path towards Poiana Albă, in the spring area of a tributary of the Hăghimașul Negru rivulet. Discovered by the authors in 2008.

Fossils: rare brachiopods, ammonites and belemnites.

Importance: biostratigraphy and palaeogeography of Upper Jurassic.

The complete area of exposures is about 0.3 hectares and is located outside the limit of the CBHNP.

No references.

**\*F 12 “Potcoava Mts. 2” Site (“Recifal limestones from Potcoava Mts.”) (Fig. 11)**

Exposures of Upper Jurassic deposits located on the western slope of Potcoava Mts., on the path towards Poiana Albă, an area with large blocks (debris slope) at the base of walls. Discovered by the authors in 2008.

Fossils: brachiopods, echinoids, gastropods, bivalves and crabs.

Importance: palaeontology, palaeoecology and palaeogeography for Upper Jurassic.

The complete area of exposures is about 0.5 hectares and is located within the CBHNP area.

No references.

**F 13 “Fagu Oltului Valley 1” Site (“Brachiopods from the Fagu Oltului Valley”) (Fig. 12)**

Outcrop of Upper Jurassic (Oxfordian ? Kimmeridgian) deposits located on the left side of the Fagu Oltului Valley, on the river bed and valley walls, in the spring area.

Fossils: brachiopods, crinoids and rare bivalves – lumachelle.

Importance: biostratigraphy, palaeontology, palaeoecology and palaeogeography of Upper Jurassic.  
The effective area of outcrop is about 0.2 hectares and is located within the CBHNP area.  
References: GRASU (1964, 1969a), PELIN (1965), PREDA (1973), GRASU & TURCULEȚ (1980).

**\*F 14 “Fagu Oltului Valley 2” Site (“Limestones with brachiopods from the Fagu Oltului Valley”)**

Outcrop of Upper Jurassic (?Kimmeridgian) deposits located on the right side of the Fagu Oltului Valley (in the walls) in the spring area. Discovered by the authors in 2008.

Fossils: rare brachiopods, crinoids, bivalves and belemnites.

Importance: biostratigraphy, palaeontology and palaeoecology for Upper Jurassic.

The effective area of outcrop is about 0.2 hectares and it is located within the CBHNP area.

No references.

**F 15 “Fagu Oltului Valley 3” Site (“Limestones with *Nerinea* from the Fagu Oltului Valley”) (Fig. 16)**

Outcrop of Upper Jurassic (Tithonian) deposits located on the Fagu Oltului Valley (in the spring area), in the river bed and valley walls; in the southern walls of Piatra Roșie Mts.

Fossils: *Nerinea* sp. – lumachelle.

Importance: palaeontology and palaeoecology for Upper Jurassic.

The effective area of outcrop is about 0.2 hectares and it is located inside the limit of the CBHNP.

References: HERBICH (1870, 1878), GRASU (1964, 1969a), PELIN (1967), DRAGASTAN (1975, 1980), GRASU & TURCULEȚ (1980).

**F 16 “Piatra Unică 1” Site (“Kimmeridgian from Piatra Unică Mts.”) (Fig. 15)**

Exposures of Upper Jurassic deposits located on the western slope of Piatra Unică Mts., near its walls.

Fossils: brachiopods, crinoids and rare ammonites.

Importance: biostratigraphy, palaeontology and palaeoecology of Upper Jurassic.

The complete area of exposures is about 1 hectare and is located inside the limit of the CBHNP.

References: HERBICH (1870, 1878), JEKELIUS (1921), BÂNCILĂ (1941), PELIN (1967), SÂNDULESCU (1969, 1975), PREDA (1973), SÂNDULESCU et al. (1975).

**F 17 “Cheia Valley” Site (“Kimmeridgian with ammonites from the Cheia Valley”) (Fig. 14)**

Exposures of Upper Jurassic (Kimmeridgian) deposits are located in the spring area of the Cheia Valley, on the path towards Bălan locality. We presume this was discovered by HERBICH in the year 1866 (possible corresponding to Ciofronca site).

Fossils: ammonites and rare brachiopods – lumachelle.

Importance: biostratigraphy, palaeontology, palaeoecology and palaeogeography of Upper Jurassic.

The complete area of exposures is about 0.5 hectares and is located outside within the CBHNP area.

References: HERBICH (1866, 1870, 1878), NEUMAYR (1873), VADASZ (1915), JEKELIUS (1921), PREDA (1973), PELIN (1976).

**F 18 “Tunnel of Bicaz Gorges” Site (“Kimmeridgian with ammonites of the tunnel from Bicaz Gorges”)**

Outcrop of Upper Jurassic (Kimmeridgian - Lower Tithonian) deposits located in Bicaz Gorges walls, near to the old tunnel.

Fossils: ammonites.

Importance: biostratigraphy, palaeontology and palaeogeography for Upper Jurassic.

The effective area of exposures is about 0.5 hectares and is located within the CBHNP area.

References: Preda I. (1973).

**F 19 “Curmătura” Site (“The Adneth limestones from Curmătura”)**

Exposure of Lower Jurassic (Liassic) deposits located in the place named “Curmătura”, near the spring area of the “Pârâul Sec”; it was discovered by FRANZ HERBICH in 1866. Not refunded after 1970 (SÂNDULESCU, 1975).

Fossils: ammonites - lumachelle.

Importance: biostratigraphy, palaeontology, palaeoecology and palaeogeography for Lower Jurassic.

References: HERBICH (1866, 1870, 1878), VADASZ (1915), JEKELIUS (1921), BÂNCILĂ (1941), ATANASIU & RĂILEANU (1952), GRASU (1968), PREDA (1976a), GRASU & TURCULEȚ (1980).

**F 20 “Hăghimașul Negru Mts”. Site (“Lower Cretaceous marls with ammonites from Hăghimașul Negru Mts.”)**

Exposures of Lower Cretaceous deposits located on the western slope of Hăghimașul Negru Mts., in the spring area of the Hăghimașul Negru rivulet. Discovered by CONSTANTIN GRASU in 1960.

Fossils: ammonites and other invertebrates more rare.

Importance: biostratigraphy, palaeontology and palaeogeography of Lower Cretaceous.

References: GRASU (1969c).

**F 21 Ghilcoș 5 Site ("Neocomian of the Ghilcoș Mts.")**

Exposures of Lower Cretaceous deposits located on the north-eastern slope of Ghilcoș Massif. Discovered by CONSTANTIN GRASU in 1960.

Fossils: ammonites and other invertebrates more rare.

Importance: biostratigraphy, palaeontology and palaeogeography of Lower Cretaceous.

References: GRASU (1969c).

**\*F 22 Suhard 1 Site ("Limestones with crinoids of Suhard Mts.")**

Outcrop of Upper Jurassic deposits located in the southern walls and slope (as debris) of Suhard Mts. Discovered by the authors in 2008.

Fossils: Crinoids' lumachelle and other invertebrates: bivalves, brachiopods, gastropods, crabs and echinoids.

Importance: palaeontology, palaeoecology and palaeogeography for Upper Jurassic.

No references.

**F 23 Surduc 1 Site ("Kimmeridgian of the wall from Postal Office-Lacu Roșu")**

Exposures of Upper Jurassic (Kimmeridgian - Lower Tithonian) deposits located in base of the western walls of Surduc Massif, near the Postal Office-Lacu Roșu.

Fossils: brachiopods, echinoids.

Importance: biostratigraphy, palaeontology, palaeoecology and palaeogeography for Upper Jurassic.

References: PRÉDA (1973).

**F 24 Surduc 2 Site ("Limestones with *Requenia* of Surduc Mts.")**

Exposures of Lower Cretaceous deposits located on the top of Surduc Massif. Discover by FRANZ HERBICH in 1870.

Fossils: *Requenia* sp. lumachelle and other rarer bivalves and gastropods.

Importance: palaeontology, palaeoecology for Lower Cretaceous.

References: HERBICH (1870, 1878), JEKELIUS (1921), BÂNCILĂ (1941), PATRULIUS (1960), PELIN & PRÉDA (1964), PELIN (1967), GRASU (1969a, 1969b), SÂNDULESCU (1975), DRAGASTAN (1975, 1980).

**F 25 Suhard 2 Site ("Dogger from Suhard Mts.")**

Exposures of Middle Jurassic deposits located on the southern slope of Suhard Massif, near the Bicaz resurgence from the Lacu Roșu. Discovered by FRANZ HERBICH in 1866.

Fossils: bivalves, gastropods and other invertebrates.

Importance: palaeontology, palaeoecology for Middle Jurassic.

References: HERBICH (1866, 1870, 1878), VADASZ (1915), JEKELIUS (1921), BÂNCILĂ (1941), GRASU (1969a), PRÉDA (1976a), GRASU & TURCULEȚ (1980).

**F 26 Site "Piatra Unică 2" ("The Hallstatt limestones from Piatra Unică Mts.")**

Exposures of Triassic deposits located on the southern slope of Piatra Unică Mts, near the path towards Bălan locality. Discovered by FRANZ HERBICH in 1870.

Fossils: bivalves, gastropods and other invertebrates.

Importance: palaeontology, palaeoecology of Triassic.

References: HERBICH (1870, 1878), MOJSISOVICS (1875), BÂNCILĂ (1941), PATRULIUS (1960), PATRULIUS et al. (1969).

## CONCLUSIONS

Many of these natural values of Romania were given to the drawer is thought the best way of protection. But it turned out that it is not the best solution for preserving and in fact, the place is often occupied by other activities and enterprises, instead of sustained not only did we deviate from this value the wealth, which nature has given us one.

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Figures 1-6. 1 and 2) Ghilcoș western walls site (F 1) – Kimmeridgian-Lower Tithonian; 3 and 5) The site Ghilcoș north-western slope (F 2) – blocks with Kimmeridgian-Lower Tithonian deposits; 4) The site F 4 – north-western walls of Ghilcoș; 6) The site F 3 – north-western Ghilcoș side with Kimmeridgian-Lower Tithonian deposits. Fossils: *Taramelliceras compsum* (OPPEL) and *Hybonoticerus beckeri* (NEUMAYR).

Figuri 1-6. 1 and 2) Situl Ghilcoș, pereții vestici (F 1) – Kimmeridgian-Tithonian inferior; 3 and 5) Situl Ghilcoș, versantul nord-vestic (F 2) – blocuri cu depozite din Kimmeridgian-Tithonic Inferior; 4) Situl F 4 – Ghilcoș, pereții nord-vestici; 6) Situl F 3 – Ghilcoș, partea nord-vestică cu depozite din Kimmeridgian-Tithonic Inferior. Fosile: *Taramelliceras compsum* (OPPEL) și *Hybonoticerus beckeri* (NEUMAYR).



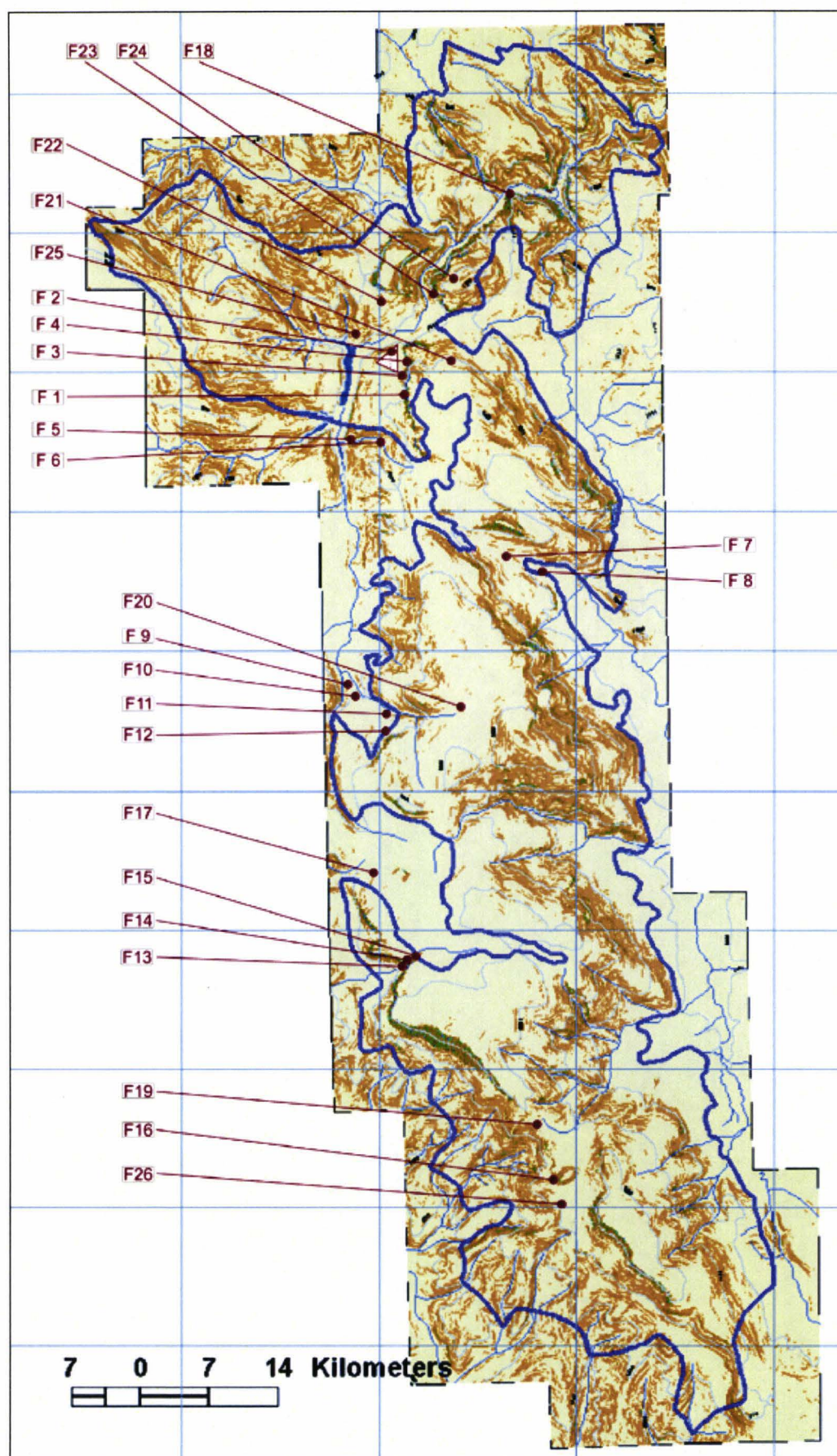


Figure 17. Sites location on Hăghimaș morphological map. Cheile Bicazului – Hășmaș National Park limits in blue line.  
 Figura 17. Localizarea siturilor pe harta morfologică a zonei Hăghimaș. Limitele Parcului Național Cheile Bicazului – Hășmaș sunt marcate cu albastru.





Figures 7-12. 7) Site F 8 – the Cherecului Valley; 8) Site F 7 – the Cherecului Valley; 9) Site F 6 – the Ghilcoş Valley; 10) Site F 9 – the Hăghimaşul Negru Valley (triassic reef); 11) Site F 12 – Potcoava Mts.; 12) Site F 13 – the Fagu Oltului Valley – brahiopodes.

Fossils: *Nerineea* sp., gastropode, *Chlamis* sp., crab, *Lacunosella* sp. (in figs. order).

Figuri 7-12. 7) Situl F 8 – Valea Cherecului; 8) Situl F 7 – Valea Cherecului; 9) Situl F 6 – Valea Ghilcoş; 10) Situl F 9 – Valea Hăghimaşul Negru (recif triasic); 11) Situl F 12 – Munţii Potcoava; 12) Situl F 13 – Valea Fagu Oltului– brahiopode. Fosile: *Nerineea* sp., gastropode, *Chlamis* sp., crab, *Lacunosella* sp. (în ordinea figurilor).





Figures 13-16. 13) Site F 10 – the Hăghimașul Negru Valley (Liassic); 14) Site F 17 – the Cheia Valley (Kimmeridgian); 15) Site F 16 – Piatra Singuratică Mts. (Oxfordian-Kimmeridgian); 16) Site F 15 – the Fagu Oltului Valley (limestones with *Nerineea*). Fossils: belemnites, ammonite, *Nerineea* sp.

Figuri 13-16. 13) Situl F 10 – Valea Hăghimașul Negru (Liasic); 14) Situl F 17 – Valea Cheia (Kimmeridgian); 15) Situl F 16 – Munții Singuratică Mts. (Oxfordian-Kimmeridgian); 16) Situl F 15 – Valea Fagu Oltului (calcare cu *Nerineea*). Fosile: belemniti, amoniți, *Nerineea* sp.

# AULACOSTEFANIDS SPECIES (*SUTNERIA* GENUS) FROM “ACANTHICUM BEDS” OF GHILCOȘ MASSIF (THE EASTERN CARPATHIANS – ROMANIA)

DAN GRIGORE

**Abstract.** The paper describes the species of *Sutneria* ZITTEL genus recently discovered in Ghilcoș Massif (the Hășmaș Mountains-the Eastern Carpathians) in Upper Jurassic deposits (“Acanthicum Beds”) and the authors reviews specimens previously collected by forerunners (NEUMAYR, 1873, HERBICH, 1878 and PREDA, 1973). There are reviewed the groups of the species *S. platynota* (Reinecke) and *S. eumela* (D'Orbigny) and three new species: *Sutneria* (*S.*) *spinata*, *S. (S.) carpathica* and *S. (Enosphinctes) zeissi*.

**Keywords:** *Sutneria*, Palaeontology, Hășmaș, Ghilcoș, Kimmeridgian.

**Rezumat.** Specii de Aulacostefanide (genul *Sutneria* ZITTEL) din „Stratele cu Acanthicum” de la Ghilcoș (Carpații Orientali-România). În lucrare sunt descrise speciile genului *Sutneria* ZITTEL recent descoperite în regiunea muntelui Ghilcoș (Masivul Hășmaș-Carpații Orientali) în depozite jurasic superioare („Stratele cu Acanthicum”) și sunt revizuite exemplarele autorilor anteriori (NEUMAYR, 1873, HERBICH, 1878 și PREDA, 1973). Sunt revizuite aici grupurile speciilor *S. platynota* (REINECKE) și *S. eumela* (D'ORBIGNY) și descrise trei specii noi: *Sutneria* (*S.*) *spinata*, *Sutneria* (*S.*) *carpathica* și *Sutneria* (*Enosphinctes*) *zeissi*.

**Cuvinte cheie:** *Sutneria*, Paleontologie, Hășmaș, Ghilcoș, Kimmeridgian.

## INTRODUCTION

Exposures of Upper Jurassic deposits are located on the upper slopes and walls in the western side of Ghilcoș Massif, a large area with blocks, almost systematically studied in the past 20 years. It provided one of the richest Kimmeridgian ammonite fauna (GRIGORE, 2000a, 2002).

From the “Acanthicum Beds” from Ghilcoș only two *Sutneria* species were known until now by few specimens, pertaining only to *S. platynota* and *S. eumela*. This study reveals for the first time in this region of the Eastern Carpathians the presence of other 11 species of this genus, three of them new for science: *Sutneria* (*S.*) *spinata*, *S. (S.) carpathica* and *S. (E.) zeissi*.

The presence of 13 species (revealed now) of this genus among the other species from the Aulacostephanidae Family and a relatively dense population of *Sutneria* found in this area, are good reasons to re-evaluate the position of Ghilcoș fauna (and region) between the Submediterranean and Mediterranean ones.

## SYSTEMATICS

Abbreviations for the measurements and collections:

Dmax = maximal diameter

D = measured diameter

U = diameter of umbilicus

H = height

W = width

N<sub>i</sub> = number of inner ribs (over one whorl ore a half of this)

N<sub>e</sub> = number of external ribs (over the same one whorl as N<sub>i</sub> ore a half of this)

Geological Institute of Austria (Bundesanstalt)-Vienna = GIA

“Babeș Bolyai” University from Cluj Napoca = BB

Geologic Laboratory of Bucharest University = LGB

Palaeontology Laboratory of Bucharest University = LPB

Natural Science Museum-Piatra Neamț = NSMPN

The “Acanthicum Formation” and location for the studied outcrops and different profiles in GRIGORE (2000a and 2002).

Order Ammonoidea ZITTEL, 1884

Family Aulacostephanidae SPATH, 1924

Genus *Sutneria* ZITTEL, 1884

Type species: *Ammonites platynotus* REINECKE, 1818

Subgenus *Sutneria* (ZITTEL, 1884) emended GEYER, 1961

Small ammonites with irregular coiling and different morphology from inner to outer whorls, the ornamentation changing from ribbed to tuberculated one. Until now this subgenera comprise only three species: *S.*



*platynota* (REINECKE), *S. galar* (OPPEL) and *S. cyclodorsata* (MOESCH); SCHAIRER (1970) and ZEISS (1979) separated some subspecies from *S. platynota* ("A" "B" and "C" morphotypes) and *S. galar thieli* ZEISS. Here is revised once again this group and described other new species: *S. spinata* and *S. carpathica*.

*Sutneria* (*Sutneria*) *platynota* (REINECKE, 1818)

Pl. I, Figs. 1, 2, 5

- 1818 *Nautilus platynotus* - REINECKE in R.C.Moore; p. L327; Figs. 419/ 2 a, b, c  
 1873 *Perisphinctes platynotus* REINECKE-NEUMAYR; p. 184  
 1877 *Ammonites* (*Perisphinctes*) *platynotus* REINECKE-FAVRE; p. 47; pl. 5, Fig. 2  
 1878 *Perisphinctes platynotus* REINECKE-HERBICH; p. 166; pl. 11, Fig. 3  
 1878 *Ammonites* (*Perisphinctes*) *platynotus* REINECKE-LORIOL; p. 91; pl. 15, Figs. 1, 2  
 1888 *Ammonites Reineckianus*-QUENSTEDT; p. 1000; pl. 112, Figs. 8-15 and 18  
 1961 *Sutneria* (*Sutneria*) *platynota* (REINECKE)-GEYER; p. 131; pl. 3, Figs. 11bis, 12  
 1970 *Sutneria* (*Sutneria*) *platynota* (REINECKE) B morphotype-SCHAIRER; p. 155; pl. 1, Figs. 2-12; pl. 2, Figs. 1-13  
 1973 *Perisphinctes platynotus* (REINECKE)-PREDÁ; pl. 10, Figs. 1, 2  
 1975 *Sutneria* cf. *platynota* (REINECKE)-DRAGASTAN; pl. 3, Figs. 1, 2  
 1978 *Sutneria platynota* (REINECKE)-OLORIZ; p. 371; pl. 39, Fig. 2  
 non 1888 *Ammonites platynotus*-QUENSTEDT; p. 999; pl. 112, Fig. 6; (= *S. spinata*)  
 non 1888 *Ammonites Reineckianus*-QUENSTEDT; p. 1002; pl. 112, Figs. 16, 17; aff. (= *S. carpathica*)  
 non 1888 *Ammonites Reineckianus evolutus*-QUENSTEDT; p. 1003; pl. 112, fig. 19  
 non 1970 *Sutneria* (*Sutneria*) *Platynota* (REINECKE) form A-SCHAIRER; p. 158; pl. 1, Fig. 1; (= *S. spinata*)  
 non 1970 *Sutneria* (*Sutneria*) *Platynota* (REINECKE) form C-SCHAIRER; p. 158; pl. 2, Figs. 6-13 (= *S. carpathica*)

Material: LRs1E1, LRs2E1, LRs3F1, LRs4F2, LRs5F5, LRs6F5, LRs7W0.1, LRs8W0.5. Neumayr's specimen: Collection of GIA; it originates from red nodular limestone of Ciofronca outcrop. Herbich's specimen: Collection of BB; it originates from red nodular limestone of Ciofronca outcrop. Preda's specimens: two specimens in the Collection of NSMPN; they originate from the green nodular limestone of Ghilcoş outcrop (Inv. 69A MPN, 69B MPN) and one in the Collection of LGB (inv. 1s LGB); it originates from the reddish nodular limestone of Ghilcoş outcrop. Dragastan's specimen: the Collection of LPB (inv. 3284); it originates from the reddish nodular limestone of Ghilcoş outcrop.

Diagnosis: globular conch-convolute with irregular coiling, straight deep umbilicus ( $U/D = 0.20$ ) and large tabulate venter. Crenate umbilicus wall. Depressed whorl-section, with the maximum width in the external third of the flanks on the body chamber. Ornamentation with polyplote and falcoid ribs in the inner whorls and simple rare and more powerful ribs, ending in small tubercles tangent to the venter on the body chamber.

Discussion: the large amount of specimens known until now, reported by former authors (QUENSTEDT, SCHAIRER) included more aberrant individuals, which are exceeding an intraspecific variability. For that reason, Schairer in 1970 divided this species in three groups, named morphotypes "A" "B" and "C" each one based on morphological, morphometrical and biostratigraphic features. This was the base for this new revision on the *S. platynota* species.

Remarks: only seven of my specimens are complete, the last one representing a body chamber. All specimens have morphological and morphometrical parameters comparable with those of the type species; the density of ornamentation on the body chambers is the only different feature, the LRs4F2 being the most ornamented one.

Occurrence: Early Kimmeridgian-Platynota Zone in the Acanthicum Formation ("E" "F" "W" profiles), from the Ghilcoş and Ciofronca-Hăşmaş Mts., Romania; Early Kimmeridgian-Platynota Zone in Europe (Spain, France, Germany) and East Africa (Ethiopia).

*Sutneria* (*Sutneria*) *spinata* nov. sp.

Pl. I, Fig. 3 (Holotype)

- 1888 *Ammonites platynotus*-QUENSTEDT; p. 999; pl. 112, Fig. 6  
 1970 *Sutneria* (*Sutneria*) *platynota* (REINECKE) A morphotype-SCHAIRER; p. 158; pl. 1, Fig. 1  
 Holotypus: specimen LRs9F1 exemplified in pl. I, Fig. 3

*Derivatio nominis*: "*spinatus*" = with spines (in Latin)-after its ornamentation with external spines on the last whorl.

*Locus typicus*: Haghimas Massif-Acanthicum Beds-Lacu Roşu, outcrop Ghilcoş.

*Stratum typicum*: F1 level-in the base of Platynota Zone

Material: LRs9F1 and LRs10X1

Description: globular conch - convolute with irregular coiling, straight deep umbilicus ( $U/D = 0.25$ ) and normal round venter. The whorl section is isometric, round with maximum width on the 1/3 of flanks height and slowly depressed on the body chamber. The umbilical wall is high and oblique. The Holotype preserves half of a whorl from the body chamber, devoid of the aperture region. The ornamentation well preserved is makeup in the inner whorls of fine dense ribs, bifurcated and trifurcated ones (divided at 2/3 of flanks), slowly falcoid. On the body chamber, the ribs

transformed in bullae knee like, more rare and ended in large spines on the imaginary limit with the venter. The spines have an elliptic base and are oblique with the venter.

Comparison: *S. (S.) platynota* has the ornamentation on body chamber with more prominent ribs (bullae), knee like, grate spines (spatulate) periventrally and a less larger venter; the new species has more affinities with that figured by Schairer in 1970 (pl. 1, Fig. 1).

Discussion: the specimens presented by Schairer (1970) as *S. platynota* form "A" have a grate variations over the features (whorl section, ornamentation) of the body chamber and they can be put in isomorphic series type with *S. spinata* and *S. platynota* as extreme ones. I remind that the specimen here discussed was only figured by QUENSTEDT (1888 pl. 112, Fig. 6), for the first time. As long as we have two specimens in our region, it could give a possible biostratigraphic value fore this species (as a subzone one).

Occurrence: Early Kimmeridgian-in the base of Platynota Zone (Spinata Subzone nov.sz.) in the Acanthicum Formation ("F" and "X" profiles) from the Ghilcos-Hasmas Mts., Romania; Early Kimmeridgian-Platynota Zone (Polygyratus Subzone) in Germany (Francoia) and France.

*Sutneria (Sutneria) carpathica* nov.sp

Pl. I, Fig. 4 (Holotype)

aff 1888 *Ammonites Reineckianus*-QUENSTEDT; p.1002; pl.112 , Figs. 16,17

1970 *Sutneria (Sutneria) Platynota* (REINECKE) C morphotype-SCHAIRER; p. 159; pl. 2, Figs. 6-13

*Holotypus*: specimen LRs11F4 figured in pl. I, Fig. 4

*Derivatio nominis*: "*carpathicus*" = carpathian (from Latin); which are meaning "specific to Carpathian Mts".

*Locus typicus*: Haghimas Masiff -, „*Acanthicum Beds*” - Lacu Rosu, outcrop Ghilcos

*Stratum typicum*: level E<sub>3</sub>-in the top of Platynota Zone

Material: LRs11F4, LRs12F5

Description: globular conch - convolute with irregular coiling, straight umbilicus (U/D= 0.23) and large round venter. The whorl section is isometric, round with maximum width on the middle flanks. Ornamentation with fine dense ribbing which are bifurcated and trifurcated on the inner coiling; the ribs' profile is slowly flexuous and divided from the 2/3 of its height (radiate secondary); on the body chamber the ornament became more rare, with rectiradiate lateral ribs thin tuberculation (periventral) and a thin ribbing on the venter (which are specific).

Comparison: this taxon has many affinities with *S. platynota*, differing by its round venter and less powered ornamentation on the body chamber only.

Discussion: this taxon was separate as *S. platynota* form C by SCHAIRER (1970; pl. 1, Fig. 1) in its revision. The specimens figured by QUENSTEDT (1888, pl. 112, Fig. 16, 17) can also be attached to this species, the differences being small ones.

Occurrence: Early Kimmeridgian-top of Platynota Zone (Guilherandense Subzone) in the Acanthicum Formation from the Ghilcoș-Hășmaș Mts., Romania; Early Kimmeridgian-top of Platynota Zone (Guilherandense Subzone) in Germany (Franconia) and France.

*Sutneria (Sutneria) cyclodorsata* (MOESCH, 1867)

Pl. I, Figs. 13, 18, 23

1867 *Ammonites cyclodorsatus*-MOESCH; p. 292; pl. 1, Fig. 1

1878 *Ammonites (Perisphinctes) cyclodorsatus* MOESCH-LORIOL; p. 93; pl. 15; Fig. 3 (*non* Fig. 4)

1929 *Sutneria* cf. *cyclodorsata* (MOESCH)-WEGELE; p. 94

1958 *Sutneria cyclodorsata* (MOESCH)-ZIEGLER; p. 188

Material: LRs13D2, LRs14D2; *S. cf. cyclodorsata*: LRs15W4

Remarks: the two specimens (LRs13D2, LRs14D2) preserve well the specific peristome with apophysis and partly the ornamentation with short, geniculate primary ribs (polyplote).

Occurrence: Late Kimmeridgian-Acanthicum Zone in the Acanthicum Formation („D” profile) from the Ghilcos - Hasmas Mts., Romania; Early Kimmeridgian-in Germany, Switzerland, Spain and France.

**Subgenus *Enosphinctes* (SCHINDERWOLF, 1925)**

Type species: *Ammonites eumelus* D'ORBIGNY

*Sutneria (Enosphinctes) pedinopleura* SEEGER, 1961

Pl. I, Fig. 7

1979 *Sutneria pedinopleura* SEEGER-ZEISS; p. 262; pl. 2, Figs. 6, 14

Material: LRs16E2

Remarks: my specimen is a small-sized one, more compressed and dense ribbed than the specimen figured by Zeiss in 1979 (fig. 6).

Occurrence: Early Kimmeridgian-Hypslocyclum Zone in the Acanthicum Formation ("E" profile) from the Ghilcoş-Hăşmaş Mts., Romania; Late Kimmeridgian-Eudoxus Zone in France and Germany.

*Sutneria (Enosphinctes) eumela* (D'ORBIGNY, 1847) emended ZEISS, 1979

Pl. I, Figs. 12, 14, 16, 20

1847 *Ammonites Eumelus*-D'ORBIGNY; p. 554; pl. 216, Figs. 1, 2, 3

1873 *Perisphinctes Eumelus* D'ORBIGNY-NEUMAYR; p. 184

1878 *Perisphinctes Eumelus* D'ORBIGNY-HERBICH; p. 166; pl. 11, Figs. 3 a, b

1971 *Sutneria eumela* (D'ORBIGNY)-CALLOMON & COPE; p. 161; pl. 10, Figs. 4, 5

1975 *Sutneria eumela* (D'ORBIGNY)-CONTINI & HANTZPERGUE; p. 11; pl. 4, Figs. 1, 2

\*1979 *Sutneria eumela* (D'ORBIGNY)-ZEISS; p. 263; pl. 3, figs. 1-13 non Figs. 16, 17 (= *S. zeisii*)

Material: LRs17T3,0, LRs18T5,0, LRs19D3, LRs20D3, LRs21D3, LRs22D4, LRs23D4, LRs24D10, LRs25K10, LRs26K18, LRs27A7, LRs28A9, LRs29A9; Neumayr's specimens: two in the Collection of GIA; they originate from green sandstones of Ghilcoş outcrop; Herbich's specimen: Collection of BB; it originates from red nodular limestone of Ciofronca outcrop.

Remarks: all specimens are comparable with the type species emended by Zeiss, with a variable ribbing alternant of the bi- or triplicates (intraspecific spectra). Only one specimen preserves the aperture lappets.

Occurrence: Kimmeridgian-the interval of Uhlandi to Eudoxus zones/subzones in the Acanthicum Formation ("A" "D" "K" and "T" profiles) from the Ghilcoş-Hăşmaş Mts., Romania; Late Kimmeridgian-Acanthicum and Eudoxus zones in Europe (France, England, Spain, Switzerland, Poland, Bulgaria, Germany).

*Sutneria (Enosphinctes) lorioli* ZEISS, 1979

Pl. I, Figs. 8, 17, 22

1872 *Ammonites eumelus* D'ORBIGNY-LORIOU in Zeiss; p. 272, Fig. 5

1979 *Sutneria lorioli* nov. nom.-ZEISS; p. 272; pl. 2, Fig. 1

Material: LRs30D14, LRs31D18, LRs32H11; *S. cf. lorioli* ZEISS: LRs33D3

Remarks: damaged specimens: the LRs30D14 - the peristome and the ornamentation; the LRs31D18 and LRs32H11-are more or less fragmentary, but all these have preserved some specific features in the ornamentation or the aperture lappets. In the measurements, only LRs30D14 specimen have a more closed umbilicus than the type one. The specimen LRs33D3 is comparable with that of Zeiss figured in 1979 (Fig. 6), with a thin secondary ribbing stile.

Occurrence: Late Kimmeridgian-Eudoxus and Beckeri zones in the Acanthicum Formation ("D" and "H" profiles) from the Ghilcoş - Hăşmaş Mts., Romania; Late Kimmeridgian-Eudoxus Zone in Poland and Germany.

*Sutneria (Enosphinctes) hoelderi* ZEISS, 1979

Pl. I, Figs. 10, 15

1959 *Sutneria cyclodorsata* (MOESCH)-HOLDER & ZIEGLER; p. 186; pl. 21, Fig. 4

1961 *Sutneria (S.) cyclodorsata* (MOESCH)-GEYER; p. 132

1979 *Sutneria hoelderi* nov. nom.-ZEISS; p. 268; pl. 2, Fig. 3

Material: LRs34A6, LRs35A8, LRs36A9

Remarks: specimen LRs34A6 has its morphological features and measurements close to those of the type species. The other specimens have the umbilicus more closed and the secondary ribs powerful on the LRs36A9.

Occurrence: Kimmeridgian-Divisum and Acanthicum zones in the Acanthicum Formation ("A" profile) from the Ghilcoş-Hăşmaş Mts., Romania; Kimmeridgian-on the interval of Hypselocyclum to Acanthicum zones in Ethiopia, Germany, and France.

*Sutneria (Enosphinctes) weidmanni* ZEISS, 1979

Pl. I, Fig. 19

1979 *Sutneria weidmanni* n. sp.- ZEISS; p. 271; pl. 3, Figs. 19, 20, text Fig. 4

Material: LRs37A7

Remarks: all the features of my specimen are comparable with those of the type species, the final sector with bifurcated start at 6 mm diameter; my specimen does not preserve the peristome and a part of the outer whorl.

Occurrence: Early Kimmeridgian-Divisum Zone in the Acanthicum Formation ("A" profile) from the Ghilcoş-Hăşmaş Mts., Romania; Kimmeridgian-Divisum and Acanthicum zones in Djibuti Republic and Yemen (East Africa and South Arabia).

*Sutneria (Enosphinctes) cf. batalleri* GEYER, 1963

Pl. I, Fig. 6



cf 1963 *Sutneria (Enosphinctes) batalleri* n. sp.-GEYER; p. 189; pl. 18, Figs. 2, 3

Material: LRs38G6, LRs39A7

Remarks: the specimens' features are comparable with the type species one, for the **stile** of ribbing but more powerful and rigid one. From the biostratigraphic point of view, they are founded in the same level.

Occurrence: Early Kimmeridgian-in the base of Divisum Zone in the Acanthicum Formation ("A" and "G" profiles) from the Hășmaș Mts., Romania; Early Kimmeridgian-at the limit of Hypselocyclum / Divisum zones in France.

*Sutneria (Enosphinctes) zeissi* nov. nom.

Pl. I, Figs. 9, 11

\*1878 *Ammonites cyclodorsatus* MOESCH-LORIOL; p. 93; pl. 15, Fig. 4

1979 *Sutneria* cf. *lorioli* n. nom.-ZEISS; p. 273; pl. 2, Figs. 4, 5, 6

*Holotypus*: specimen LRs40D2 figured in pl. I, Fig. 9

*Derivatio nominis*: "zeissi" = dedicated to Prof. Arnold Zeiss

*Locus typicus*: Hășmaș Masiff-Acanthicum Beds-Lacu Roșu, outcrop Ghilcoș.

*Stratum typicum*: D 2 level-in the base of Acanthicum Zone.

Material: LRs40D2, LRs41D3; *S. cf. zeissi*: LRs42K10

Description: medium-sized species convolute with a round whorl section. Ornamental features: with bifurcated and simple ribs (by the ending) and slow flexure of middle flanks-with the most rigid ribbing from this group (with equal power of the secondary and primary too). The peristome and suture are unknown.

Discussion: the features are compellable with that of *S. lorioli* ZEISS and *S. eumela* D'ORBIGNY; the first has a pronounced flexure of the ribs, while in the second case, the ribs are powerful and some trifurcate are present. The third specimen (LRs42K10) is ventrally compressed and preserves a similar ribbing **stile** on a half of the whorl.

Occurrence: Late Kimmeridgian-Acanthicum Zone in the Acanthicum Formation ("D" profile) from the Ghilcoș - Hășmaș Mts., Romania; Kimmeridgian-Divisum and Acanthicum zones in Ethiopia.

*Sutneria (Enosphinctes) subeumela* SCHNEID, 1915

Pl. I, Fig. 21

1915 *Sutneria subeumela*-SCHNEID; p. 124; pl. 6, Figs. 7, 7 a

1959 *Sutneria subeumela* SCHNEID-BARTHEL & ZIEGLER; p. 139; pl. 21, Figs. 6, 7

1978 *Sutneria subeumela* SCHNEID-SAPUNOV; p. 74; pl. 6, Fig. 1

Material: LRs43D30

Remarks: the single specimen available represents 2/3 of a whorl originating from a small individual, well preserving the specific ornamentation; compared with the type specimen, its ribbing is more powerful on the venter and the siphonal groove less evident, on its smaller diameter.

Occurrence: Late Kimmeridgian-Beckeri Zone in the Acanthicum Formation ("D" profile) from the Ghilcoș-Hășmaș Mts., Romania; Late Kimmeridgian-Beckeri Zone (Subeumela Subzone) in France, Germany, Bulgaria and Ethiopia.

*Sutneria (Enosphinctes) hararina* (VENZO, 1959)

Pl. I, Fig. 24

1959 *Enosphinctes hararinus* VENZO-VENZO; p. 38; pl. 4, Figs. 4 a, b

1979 *Sutneria* aff. *hararina* (VENZO, 1959)-ZEISS; p. 264; pl. 2, Figs. 13, 15

Material: LRs44T7.0

Remarks: my specimen is broken of 1/5 on the last coiling but it preserves the peristome with its long lappets. The ribbing **stile** on the last quarter of whorl is less flexuous than in the type specimen; the other features-morphologically and morphometrically-are comparable with that of the type species.

Occurrence: Late Kimmeridgian-Beckeri Zone in the Acanthicum Formation ("T" profile) from the Ghilcoș-Hășmaș Mts., Romania; Late Kimmeridgian-Eudoxus and Beckeri zones (-Pedinopleura Subzone) in Germany and Tanzania.

## Measurements

Species	Specimen	Dmax	D	U	H	W	O/D	H/D	W/D	H/W	*Ni	*Ne	N <sub>e</sub> /N <sub>i</sub>
<i>Sutneria (Sutneria) spinata</i> nov. sp.	Holotype (LRs9F1)	>16	14	3.5	6	6	0.25	0.43	0.43	1	7 Ni/2	7 Ne/2	-
<i>Sutneria (Sutneria) carpathica</i> nov. sp.	Holotype (LRs11F4)	20	17	4	6.5	6	0.23	0.38	0.35	1.08	6	10	1.7
<i>Sutneria (Sutneria) cyclodorsata</i>	sp. Lorient	-	17	4.3	7	9	0.25	0.41	0.53	0.78	18	47	2.6
	LRs13D2	-	16.2	4.2	7	8	0.26	0.43	0.49	0.87	7	~20	~2.8
<i>Sutneria (Enosphinctes) pedinopleura</i>	sp. Zeiss	-	30	7.5	12	9	0.25	0.40	0.30	1.33	12	24	2
	LRs16E2	-	18	4.3	8	5.2	0.24	0.44	0.29	1.54	8	17	2.1
<i>Sutneria (Enosphinctes) eumela</i>	Lectotype	-	15	4.2	6.2	5.3	0.28	0.41	0.35	1.17	10	25	2.5
	LRs17T3,0	-	15	3.8	6.5	6.3	0.25	0.43	0.42	1.03	10	27	2.7
	LRs19D3	-	15	3.8	5.9	5.9	0.25	0.39	0.39	1	4	10	2.5
	LRs29A9	-	14	3.5	5.5	5.9	0.25	0.39	0.42	0.93	10	25	2.5
	LRs27A7	-	14	3.9	6	5.5	0.28	0.43	0.39	1.09	7	16	2.3
	LRs20D3	-	16	4.5	6.2	6.7	0.28	0.39	0.42	0.92	6	14	2.3
<i>Sutneria (Enosphinctes) lorioli</i>	Holotype	-	20	6.6	7.6	7.6	0.33	0.38	0.38	1	7	16	2.3
	LRs30D14	-	15.5	4.8	5.5	5.5	0.34	0.35	0.35	1	9	-	-
	LRs31D18	-	15.5	5	6	6	0.37	0.39	0.39	1	7	15	2.1
<i>Sutneria (Enosphinctes) hoelderi</i>	Holotype	-	15	5.3	6.2	5.6	0.35	0.41	0.37	1.11	12	41	3.4
	LRs34A6	-	14	4.8	5.9	5.5	0.34	0.42	0.39	1.07	10	34	3.4
	LRs35A8	-	16	5.2	6.4	5.5	0.32	0.40	0.34	1.16	8	29	3.6
	LRs36A9	-	18	5.6	7.5	6.5	0.32	0.42	0.36	1.15	9	30	3.3
<i>Sutneria (Enosphinctes) weidmanni</i>	Holotype	-	18	5.4	8.5	8.3	0.30	0.47	0.46	1.02	12	26	2.1
	LRs37A7	-	15	4.5	6.7	6.5	0.30	0.45	0.43	1.03	9	18	2
<i>Sutneria (Enosphinctes) zeissi</i> nov. nom.	Zeiss ( <i>S. cf. lorioli</i> )	-	19	7.4	6.7	7.4	0.37	0.36	0.37	0.90	10	19	1.9
	Holotype (LRs40D2)	-	17	6	6	6.5	0.35	0.35	0.38	0.92	9	17	1.9
	LRs41D3	-	16	6	5.5	6	0.37	0.34	0.37	0.92	10	19	1.9
<i>Sutneria (Enosphinctes) subeumela</i>	Holotype	-	22	8	8	7	0.35	0.35	0.32	1.14	10	18	1.80
	LRs43D30	-	13.5	5	5.5	4.5	0.37	0.41	0.33	1.08	9	17	1.89
<i>Sutneria (Enosphinctes) hararina</i>	Holotype	-	36	13	13	12	0.36	0.36	0.33	1.08	10	20	2
	LRs44T7,0	-	15	5.5	5.5	5	0.37	0.37	0.33	1.10	10	21	2.1

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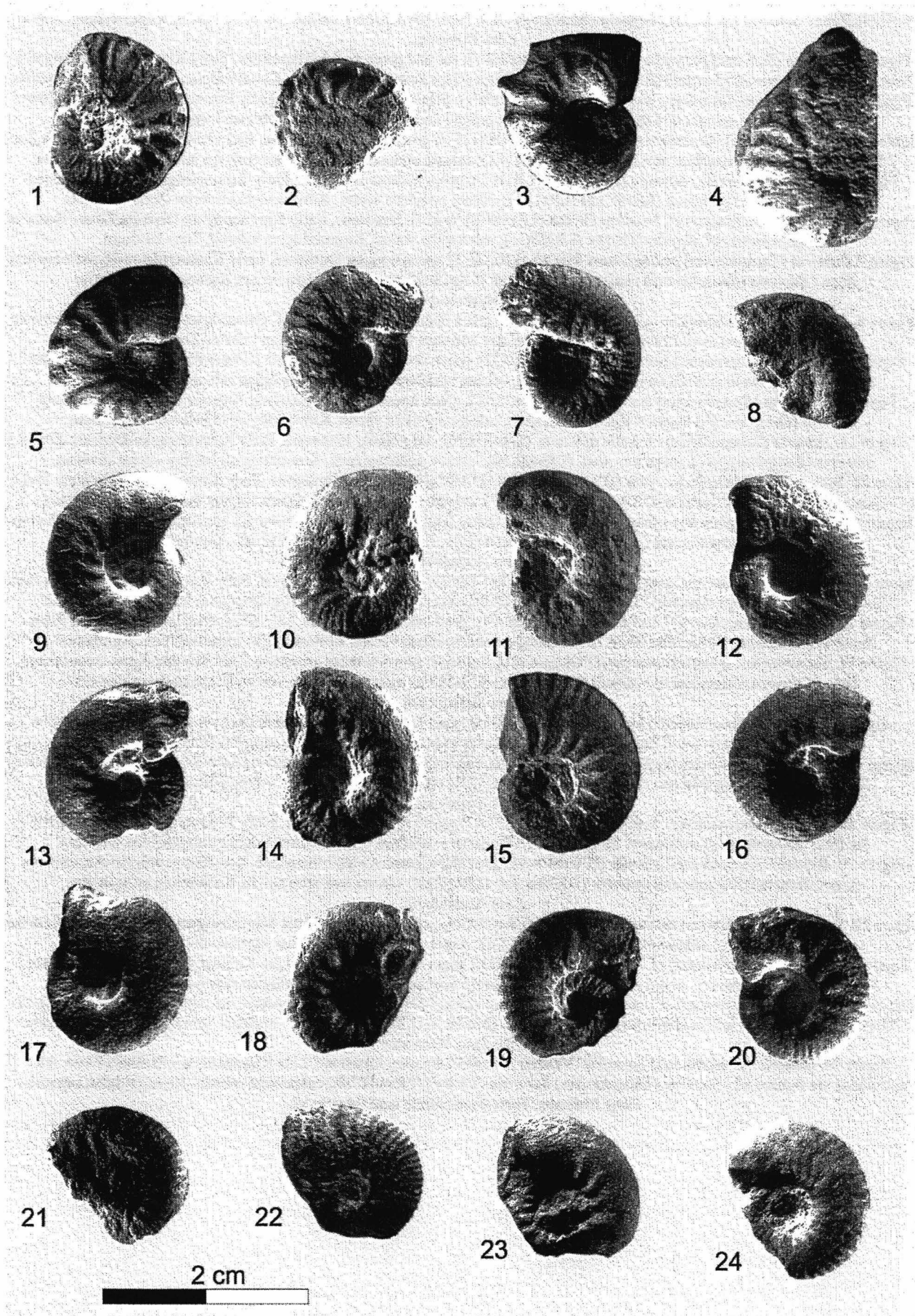
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PLATE I



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- Figure 1. *Sutneria (Sutneria) platynota* (REINECKE) Preda's specimen (69A MPN); green nodular limestone, Early Kimmeridgian-Platynota Zone / *Sutneria (Sutneria) platynota* (REINECKE) expl. Preda (69A MPN); calcare nodulare verzui, Kimmeridgian inferior-Zona Platynota.
- Figure 2. *Sutneria (Sutneria) platynota* (REINECKE) (LRs8W0.5); red and green nodular limestone, Early Kimmeridgian-Platynota Zone / *Sutneria (Sutneria) platynota* (REINECKE) (LRs8W0.5); calcare nodulare rosu/verde, Kimmeridgian inferior-Zona Platynota.
- Figure 3. *Sutneria (Sutneria) spinata* nov.sp. (Holotype; LRs9F1); green nodular limestone, Early Kimmeridgian-Platynota Zone / *Sutneria (Sutneria) spinata* nov.sp. (holotip; LRs9F1); calcare nodulare verzui, Kimmeridgian inferior-Zona Platynota.
- Figure 4. *Sutneria (Sutneria) carpathica* nov.sp. (Holotype; LRs11F1); green nodular limestone, Early Kimmeridgian-Platynota Zone / *Sutneria (Sutneria) carpathica* nov.sp. (holotip; LRs11F1); calcare nodulare verzui, Kimmeridgian inferior-Zona Platynota;
- Figure 5. *Sutneria (Sutneria) platynota* (REINECKE) (LRs1E1); green nodular limestone, Early Kimmeridgian-Platynota Zone / *Sutneria (Sutneria) platynota* (REINECKE) (LRs1E1); calcare nodulare verzui, Kimmeridgian inferior-Zona Platynota.
- Figure 6. *Sutneria (Enosphinctes) cf. batalleri* GEYER (LRs38G6); reddish limestone, Early Kimmeridgian-Divisum Zone / *Sutneria (Enosphinctes) cf. batalleri* GEYER (LRs38G6); calcarenite visinii, Kimmeridgian inferior-Zona Divisum.
- Figure 7. *Sutneria (Enosphinctes) pedinopleura* SEEGER (LRs16E2); green nodular limestone, Early Kimmeridgian-Hypselocyclum Zone / *Sutneria (Enosphinctes) pedinopleura* SEEGER (LRs16E2); calcare nodulare verzui, Kimmeridgian inferior-Zona Hypselocyclum.
- Figure 8. *Sutneria (Enosphinctes) lorioli* ZEISS (LRs31D18); green nodular limestone, Late Kimmeridgian-Beckeri Zone / *Sutneria (Enosphinctes) lorioli* ZEISS (LRs31D18); calcare nodulare verzui, Kimmeridgian inferior-Zona Beckeri.
- Figure 9. *Sutneria (Enosphinctes) zeissi* nov.nom. (LRs40D2); green nodular limestone, Late Kimmeridgian-Acanthicum Zone / *Sutneria (Enosphinctes) zeissi* nov.nom. (LRs40D2); calcare nodulare verzui, Kimmeridgian inferior-Zona Acanthicum.
- Figure 10. *Sutneria (Enosphinctes) hoelderi* ZEISS (LRs35A8); green nodular limestone, Early Kimmeridgian-Divisum Zone / *Sutneria (Enosphinctes) hoelderi* ZEISS (LRs35A8); calcare nodulare verzui, Kimmeridgian inferior-Zona Divisum.
- Figure 11. *Sutneria (Enosphinctes) cf. zeissi* nov.nom. (LRs42K10); red nodular limestone, Early Kimmeridgian-Divisum Zone / *Sutneria (Enosphinctes) cf. zeissi* nov.nom. (LRs42K10); calcare nodulare rosii, Kimmeridgian inferior -Zona Divisum.
- Figure 12. *Sutneria (Enosphinctes) eumela* (D'ORBIGNY) (LRs27A7); green nodular limestone, Early Kimmeridgian-Divisum Zone / *Sutneria (Enosphinctes) eumela* (D'ORBIGNY) (LRs27A7); calcare nodulare verzui, Kimmeridgian inferior-Zona Divisum.
- Figure 13. *Sutneria (Enosphinctes) cyclodorsata* (MOESCH) (LRs13D2); green nodular limestone, Late Kimmeridgian-Acanthicum Zone / *Sutneria (Enosphinctes) cyclodorsata* (MOESCH) (LRs13D2); calcare nodulare verzui, Kimmeridgian superior-Zona Acanthicum.
- Figure 14. *Sutneria (Enosphinctes) eumela* (D'ORBIGNY) (LRs17T3.0); green nodular limestone, Early Kimmeridgian-Divisum Zone / *Sutneria (Enosphinctes) eumela* (D'ORBIGNY) (LRs17T3.0); calcare nodulare verzui, Kimmeridgian inferior-Zona Divisum.
- Figure 15. *Sutneria (Enosphinctes) hoelderi* ZEISS (LRs36A9); green nodular limestone, Late Kimmeridgian-Acanthicum Zone / *Sutneria (Enosphinctes) hoelderi* ZEISS (LRs36A9); calcare nodulare verzui, Kimmeridgian superior-Zona Acanthicum.
- Figure 16. *Sutneria (Enosphinctes) eumela* (D'ORBIGNY) (LRs29A9); green nodular limestone, Late Kimmeridgian-Acanthicum Zone / *Sutneria (Enosphinctes) eumela* (D'ORBIGNY) (LRs29A9); calcare nodulare verzui, Kimmeridgian superior-Zona Acanthicum.
- Figure 17. *Sutneria (Enosphinctes) lorioli* ZEISS (LRs30D14); grey limestone, Late Kimmeridgian-Eudoxus Zone / *Sutneria (Enosphinctes) lorioli* ZEISS (LRs30D14); calcarenite censusii, Kimmeridgian superior-Zona Eudoxus.
- Figure 18. *Sutneria (Enosphinctes) cyclodorsata* (MOESCH) (LRs14D2); green nodular limestone, Late Kimmeridgian-Acanthicum Zone / *Sutneria (Enosphinctes) cyclodorsata* (MOESCH) (LRs14D2); calcare nodulare verzui, Kimmeridgian superior-Zona Acanthicum.
- Figure 19. *Sutneria (Enosphinctes) weidmanni* ZEISS (LRs37A7); green nodular limestone, Early Kimmeridgian-Divisum Zone / *Sutneria (Enosphinctes) weidmanni* ZEISS (LRs37A7); calcare nodulare verzui, Kimmeridgian inferior-Zona Divisum.
- Figure 20. *Sutneria (Enosphinctes) eumela* (D'ORBIGNY) (LRs20D3); green nodular limestone, Late Kimmeridgian-Acanthicum Zone / *Sutneria (Enosphinctes) eumela* (D'ORBIGNY) (LRs20D3); calcare nodulare verzui, Kimmeridgian superior-Zona Acanthicum.
- Figure 21. *Sutneria (Enosphinctes) subeumela* SCHNEID (LRs43D30); green sandstones, Late Kimmeridgian-Beckeri Zone / *Sutneria (Enosphinctes) subeumela* SCHNEID (LRs43D30); gresii verzui, Kimmeridgian superior-Zona Beckeri.
- Figure 22. *Sutneria (Enosphinctes) cf. lorioli* ZEISS (LRs33D3); green nodular limestone, Late Kimmeridgian-Acanthicum Zone / *Sutneria (Enosphinctes) cf. lorioli* ZEISS (LRs33D3); calcare nodulare verzui, Kimmeridgian superior-Zona Acanthicum.
- Figure 23. *Sutneria (Enosphinctes) cf. cyclodorsata* (MOESCH) (LRs15W4); red and green nodular limestone, Early Kimmeridgian-?Divisum Zone / *Sutneria (Enosphinctes) cf. cyclodorsata* (MOESCH) (LRs15W4); calcare nodulare verzui/rosii, Kimmeridgian inferior-Zona ?Divisum.
- Figure 24. *Sutneria (Enosphinctes) hararina* (VENZO) (LRs44T7.0); grey limestone, Late Kimmeridgian-Eudoxus Zone. All specimens are figured x2 / *Sutneria (Enosphinctes) hararina* (VENZO) (LRs44T7.0); calcarenite censusii, Kimmeridgian superior-Zona Eudoxus. Toate exemplarele sunt figurate x2.



## SYSTEMATICAL POSITION AND EVOLUTION OF THE GENUS *ARVERNOCEROS* (CERVIDAE, MAMMALIA) FROM PLIO-PLEISTOCENE OF EURASIA

ROMAN CROITOR

**Abstract.** The article presents a description of new fossils of *Arvernoceros ardei* from the Pliocene of Southern Moldova, followed by an overview on the important data regarding the representatives of the genus *Arvernoceros* from Plio-Pleistocene of Europe and their relationship with Asian fossil cervids. The comparative study of antler morphology suggests a close relationship of *Arvernoceros* with modern genus *Rucervus*.

**Keywords:** *Arvernoceros*, Cervidae, Plio-Pleistocene, Eurasia, systematics, evolution.

**Rezumat.** Poziția sistematică și evoluția genului *Arvernoceros* (Cervidae, Mammalia) din Plio-Pleistocenul Eurasiei. Articolul prezintă descrierea materialului nou al cerbului *Arvernoceros ardei* din Pliocenul Moldovei Meridionale și sinteza datelor relevante privitoare la genul *Arvernoceros* din Pliocenul și Pleistocenul Europei, precum și relațiile cu formele fosile asiatice. Analiza comparativă a morfologiei coarnelor sugerează o relație filogenetică apropiată între *Arvernoceros* și genul actual *Rucervus*.

**Cuvinte cheie:** *Arvernoceros*, Cervidae, Plio-Pleistocen, Eurasia, sistematică, evoluție.

### INTRODUCTION

HEINTZ (1970) created the genus *Arvernoceros* with a single species *Cervus ardei* CROIZET & JOBERT from the Lower Villafranchian site Perrier-Etouaires (France), with unusual traits in antler morphology, such as a generally simple antler pattern with two axes, and a well developed distal palmation of antler. HEINTZ (1970) associated some isolated upper molars with cyngulum, claiming the hypothetical ancestral relationship of *Arvernoceros* with *Megaloceros*.

For a long time, the genus *Arvernoceros* was considered to be a peculiar Lower Villafranchian element of restricted geographical value. However, the later publications significantly broadened the geographical and stratigraphic distribution of the genus. VISLOBOKOVA & CHANGKANG (1990) mentioned the presence of the genus in Early Pliocene of Mongolia. BAJGUSHEVA (1994) reported *Arvernoceros* sp. from Livenzovka (South Russia, Azov Sea shore). In 1992, DAVID established the new large sized species *Arvernoceros verestchagini* (Fig. 2) based on a shed antler from the upper deposits of a quarry near the village of Salcia (Moldavia). The Salcia deposits have yielded a fauna of Middle-Upper Villafranchian type (ABBAZZI et al. 1999), indicating the presence of the genus *Arvernoceros* in younger biostratigraphic levels than previously suggested. The giant *Arvernoceros verestchagini* from Salcia apparently is very close to a large deer from Apollonia (Latest Villafranchian, Greece; CROITOR & KOSTOPOULOS, 2004) and possibly is a junior synonym of *Pseudalces mirandus* FLEROW 1962 (CROITOR, 2005a, b) from the mixed Villafranchian fauna from the Kosiakinskij quarry (Northern Caucasus foothills). *P. mirandus*, according to International Zoological Code, are still available species and genus names and cannot be regarded as a *nomen oblitum*. The taxonomical difficulty comes from the poor preservation of the type specimen of *Pseudalces mirandus*, which is represented by an orbito-frontal cranial fragment with right upper molar series, which did not preserve the diagnostic characters used in description of *Arvernoceros*.

CROITOR & KOSTOPOULOS (2004) proposed a revision of the genus with emended definition and enlarged genus composition. According to the new definition, cingulum in upper molars is not considered as a diagnostic character for the genus. Beside the type species *A. ardei* and giant *A. verestchagini*, CROITOR & KOSTOPOULOS (2004) also included in this genus KAHLKE's (1997) *Eucladoceros giulii*, which is characterized by remarkably long and slender limbs, simple teeth patterns without cingulum, and the typical for *Arvernoceros* pattern of antler construction, which can be noted in a single well-preserved juvenile antler.

The systematic position of *Arvernoceros* is still unclear. TEILHARD DE CHARDIN & PIVETEAU (1930) assumed that *Cervus ardeus* is rather close to modern *Elaphurus*. LISTER (1987) considered *Arvernoceros* as a tribe *incertae sedis* genus. VISLOBOKOVA (1990), following the HEINTZ's (1970) hypothesis on phylogenetic relationship between *Arvernoceros* and *Megaloceros*, included the former genus in the tribe Megacerini. DI STEFANO & PETRONIO (2000-2002) suggested that *Arvernoceros ardei* is closely related to *Axis shansius*, and therefore they regarded *Arvernoceros* as a junior synonym of *Axis*.

In the present article, a description of the first find of *Arvernoceros ardei* in Moldova and Eastern Europe is presented, as well as a discussion of the systematic position, radiation and evolution of the genus.

## MATERIAL AND METHOD

The new fossil cervid antler fragments described in the present study were collected from the close vicinity of Slobozia Mare village, Cahul District, Southern Moldova (Fig. 1). The fossils had been discovered by Vasile Constantin BRÎNZĂ in the outcrops situated southeast of Slobozia Mare, in the place called "Rîpa de la Ganu". The unlabeled fossils are curate at the Village Museum of Slobozia Mare. The sample from Rîpa de la Ganu includes also few poor remains (two basal antler fragments and a calcaneus with damaged surface) of a smaller deer. The systematic attribution of those poorly preserved bones is undeterminable, since the outcrops near Slobozia Mare has yielded another cervid form *Dama* sp. (CROITOR, 2006). An advanced and rather small-sized *Anancus arvernensis* is also recorded in the neighbourhoods of Slobozia Mare, which, according to Theodor OBADĂ (*personal communication*) may indicate that these deposits belong to Middle Villafranchian (MN17). However, the exact stratigraphic position of many finds stored in the Museum of Slobozia Mare is unknown, therefore one cannot assume that the taxa discovered in the outcrops near Slobozia Mare represent a genuine mammalian assemblage.

The fossil sample of *Arvernoceros ardei* from the type locality Perrier-Etouaires (France) is used in the present study as a comparative material. The material from Perrier-Etouaires had been revised and described in details by HEINTZ in 1970 and at present, a part of material is stored in the National Museum of Natural History in Paris, and another part in the Palaeontological Museum of the University of Lyon (France). The osteological material of modern deer used in the comparative study is stored in the Zoological Museum "La Specola" of the University of Florence (Italy). The proposed body mass estimations are based on the cranio-dental measurements according to the method of JANIS (1990).

**Description**

Family Cervidae GOLDFUSS, 1820

Subfamily Cervinae GOLDFUSS, 1820

Genus *Arvernoceros* HEINTZ, 1970

*Arvernoceros ardei* (CROIZET & JOBERT, 1828)

The studied specimen is a right shed antler with a damaged distal part and a broken off basal tine (Fig. 2). The length of the preserved part of the beam amounts to 25 cm. The antler beam is cylindrical, set obliquely on the burr and directed sideward and backward. The antler slightly turns back at the level of first ramification then the antler beam is gently curved upward and becomes almost straight, with slight undulation. The first ramification is situated high above the burr. The basal tine is flattened and set obliquely with respect to the antler beam. The antler beam generally is cylinder-shaped; however, there is a longitudinal blurred keel on the anterior side of the proximal portion of the beam. The transversal cross-section of the beam is oval above the first tine and regular circular (anteroposterior diameter amounts to 27.0 mm; lateromedial diameter, 28.0 mm) at the level of breakage. The rest of measurements are indicated in the table. The beam surface is covered with longitudinal ridge-and-furrow ornament. The antler from Slobozia Mare is somewhat smaller than the neotype of *Arvernoceros ardei* from Perrier-Etouaires, however, the shapes of antler base and of antler beam, as well as the flattened set obliquely basal tine in the antler from Moldova are characteristic of *Arvernoceros ardei*.

The distal fragment of the right antler represents a bifurcation with two tines situated in the parasagittal plane. The length of the fragment amounts to 176 mm. The antler is strongly compressed from the sides in the area of the ramification. The cross-section of the posterior tine is regularly circular. The angle of ramification amounts to 47°.

## DISCUSSION

***Arvernoceros ardei*.** The species was firstly described by CROIZET & JOBERT (1828) as *Cervus ardeus* from the Early Villafranchian of Perrier-Etouaires. Later, HEINTZ (1970) placed it in the separate monotypic genus *Arvernoceros*. This is a rather large deer with estimated body mass amounting to 180 kg (the body mass estimation is based on the mixed *perrieri-ardei* sample described by HEINTZ, 1970). This deer is interesting by its mixture of some primitive characters (long parallel pedicles trended backwards; simple antler plan corresponding to three-pointed evolutionary stage; primitive dentition with simple P<sub>4</sub> and relatively long premolar series) and such advanced characters as large body size and distal antler palmation that appears in mature males (Fig. 3, C). The shape of distal palmation of the type specimen with three tines pointed forwards, possibly, is not typical and the reconstruction of two distal tines may not be exact. The distal fragment of the antler PET1024 from Perrier (the National Museum of Natural History, Paris) suggests that the palmation was bilobed, with two prongs on the one of the preserved lobe of palmation, and apparently, evolved from a simple distal fork. A similar shape of palmation is found on the antler fragment from the Upper Pliocene site of Valea Graunceanului (Fig. 3, D, Institute of Speleology, Bucharest), which belongs to somewhat larger form similar to *A. ardei* (CROITOR & POPESCU, work in progress). The basal tine is often supplemented with an accessory prong in fully grown large antlers (Fig. 3, C1). *A. ardei* is peculiar since it represents for the first time in cervid history an ecomorphological large-sized form with palmed antlers. Somewhat later, by the end of Pliocene this ecological space will be conquest by *Cervalces gallicus*, and then, in Pleistocene, a large variety of large cervids with palmed antlers belonging to various unrelated evolutionary lineages (genera *Praemegaceros*, *Megaloceros*, *Sinomegaceros*, *Alces*, *Dama*) will occur in Northern Eurasia. The ecomorphological significance of palmed antlers is a

matter of debates, but generally their important social function is assumed (GEIST, 1998). In my opinion, the thermoregular function of growing antlers suggested by STONEHOUSE (1968) may be another important factor favouring the development of palmations in large-sized deer inhabiting open landscapes with continental and seasonal climate with hot summers. Growing antlers are rich in blood vessels and represent an effective organ of thermoregulation. Apparently, palmed antlers are characterized by an increased surface of hit radiation. It is important to note that all large-sized deer with palmed antlers appeared in high latitudes with continental climate. There are no cervids with palmed antlers that evolved in tropical or subtropical environments<sup>1</sup>. One can assume that *A. ardei* was a first Cervinae that evolved some adaptations to more open landscape, most probably an open woodland or wooded savannah, since its teeth are still quite primitive. The earliest record of *Arvernoceros* in Europe was reported from Late Ruscinian (Early Pleistocene) of Weże-1 (Poland); this is a frontal part of skull, which shows similarity with the frontal shape of *A. ardei* from Perrier-Etouaires (CROITOR & STEFANIAK, 2009). A few remains from Pliocene site Weże-2 (Poland) ascribed to *Arvernoceros* (STEFANIAK, 1995), in fact, are poor and their systematic determination is not possible. *A. ardei* was reported by HEINTZ (1970) from several Lower Villafranchian sites of France and Spain. The antler from Slobozia Mare is the first specimen originating from Pliocene of Eastern Europe that can be ascribed to *A. ardei* with a certain confidence.

***Arvernoceros ubensis*.** This deer from Upper Pliocene of Altai, South of Western Siberia, was originally described by VISLOBOKOVA (1977) as *Cervus ubensus* (Fig. 3, A). Later, she placed this species in the genus *Axis* (VISLOBOKOVA, 1990). Actually, the antler shape of the deer from Altai suggests a close relationship with *Arvernoceros ardei*. This is a rather large deer (140 kg) with primitive dentition ( $P_4$  simple, premolar series relatively long, devoid of cingulum and additional enamel folds in upper molars). Antler morphology is very remarkable and strikingly reminds some of the morphological variants of *A. ardei*. Antlers are three-pointed, with one basal tine forming an obtuse angle with the beam ( $102^\circ$ ), and a distal fork. The basal tine is flattened and supplemented with an accessory prong on its upper side. The antler beam is cylindrical, with a faint keel on the anterior side above the first ramification, and flattened distal portion preceding the distal fork. The antler morphology of *Arvernoceros ubensis* reminds the specimen from Slobozia Mare, however, unlike the antler from Moldova, the basal tine in *A. ubensis* is situated close to the burr and it forms an obtuse angle. Unlike *A. ardei*, pedicles of *A. ubensis* are quite short (pedicle transversal diameter exceeds pedicle length); however, their parallel orientation and close position on the skull are the same as in *A. ardei*.

***Arvernoceros giulii*.** This is a large-sized deer from Untermassfeld (Lower Pleistocene, Germany) originally described by KAHLKE (1997) as *Eucladoceros giulii*. This is a large-sized deer with body mass attaining 400 kg. Unusually long metapodials are the most peculiar character of this species (KAHLKE, 1997). The dentition, as in previous species, is quite primitive, with simple  $P_4$ , relatively long lower premolar series and upper molars without cingulum. The complete adult antlers of *A. giulii* are not known. The hypothetical reconstruction of the antler proposed by KAHLKE (1997: fig. 28) is based on scant fossil fragments belonging to individuals of different ontogenetic ages and probably different species, therefore the eucladocerine comb-like structure provided is not fully supported (CROITOR & KOSTOPOULOS, 2004). The juvenile antler from Untermassfeld figured by KAHLKE (1997: fig. 26, p. 229) represents a typical for *Arvernoceros* antler shape with flattened first tine ended with a fork and a distal dichotomous branching. Apparently, to this species it should be ascribed a lower mandible from Early Pleistocene of Cismichioi (Moldova) reported earlier as *Arvernoceros* sp. (CROITOR, 2005 b). Lower mandibles from Rosieres (France) of a large-sized deer described by STEHLIN (1912) as *Cervus (Megaceros) dupuisi* (now should be regarded as *nomen oblitum*) also belong to the species under discussion. Most probably, the frontlet of a large deer from Early Pleistocene of Saint-Prest (France) reported by GUERIN et al. (2003) as *Praemegaceros verticornis*, in fact, belongs to *A. giulii*.

*A. giulii* was a large-bodied long-legged open-landscape runner that inhabited wooded savannah. Unlike *Praemegaceros*, which also appears in Europe in Early Pleistocene, *A. giulii* maintains a primitive morphology of dentition suggesting that this deer was a browser.

***Arvernoceros verestchagini*.** This is an extremely large species (body mass ca. 700 kg), probably, the largest among Cervinae, with rather simple shape of antlers (Fig. 3, B). The holotype, a single known antler from Villafranchian of Salcia (Moldova), is similar to *A. ardei*, but it is larger and lacks distal palmation (DAVID, 1992). The antler ends with a simple distal fork. The basal tine is strong, extended into a small palmation with three prongs. The remains of similar large cervids from Villafranchian of Kosiakinskij Quarry (Russia) and Latest Villafranchian of Apollonia (Greece) provide us with some information about the ecomorphology of this species. The giant *Arvernoceros* maintains rather long pedicles, well-developed preorbital fossae, primitive dentition with simple  $P_4$ , however, the lower premolar series is quite short (CROITOR & KOSTOPOULOS, 2004). Limb bones are quite long for such a heavy animal, but also the proportions of limbs are unusual. The length of metacarpals approaches that of metatarsus and radius reminding the postcranial proportions of some browsing giraffids. Perhaps, the extremely long limb bones of *A. cf. verestchagini* from Apollonia in combination with primitive morphology of dentition portray this deer as a high-lever browser that feed on the tree-crown leaves, occupying an ecological niche similar to that of modern giraffes (CROITOR & KOSTOPOULOS, 2004).

<sup>1</sup> The natural area of distribution of modern rather small-sized fallow deer with palmed antlers *Dama dama* and *D. mesopotamica* is restricted to rather warm lands of Anatolia and Persia; however, the palmed antlers first appeared in large-bodied Middle Pleistocene *D. clactoniana* from Western Europe.

***Arvernoceros bifurcatus*.** TEILHARD DE CHARDIN & PIVETEAU (1930, pl. VIII, Fig. 10) described their species *Cervus (Elaphurus) bifurcatus* from the Early Pleistocene of Nihowan (China). According to these French authors, the antler morphology of the deer from Nihowan is close to modern *Elaphurus*, but also reminds "*Cervus*" *ardeus* (= *Arvernoceros ardei*). The antler of *Arvernoceros bifurcatus* is characterized by a high position of first tine which is terminated by a fork. The antler beam bends toward posterior in the area of the first ramification, then it curves forward and forms a distal bifurcation. Teeth, skull and postcranial bones are unknown.

**Remarks on systematics and evolution.** The deer of the genus *Arvernoceros* display quite conservative little varying morphology of antlers, but also very conservative morphology of dentition. The antlers generally remain simple tree-pointed, with high position of basal tine and a distal fork. The basal tine often tends to be flat and is supplemented by an additional prong. The advanced condition of first tine shape is found in *A. bifurcatus* (fork-shaped) and *A. verestchagini* (palmed with three prongs). Distal portion of antler is usually terminated by a simple fork, but in some European forms (*A. ardei*) the distal part of antler is extended into a small palmation. The pattern of antler construction of *Arvernoceros* corresponds to modern *Rucervus duvauselli* (Fig. 3, E), which evolves antlers with dichotomous pattern of distal crown ramification and basal tine with additional prong occasionally present. According to genetic studies carried out by PITRA et al. (2004), the modern genus *Rucervus* together with *Axis* is a Late Miocene off-shoot of Cervinae phylogenetical stock. Therefore, the appearance of *Rucervus*, likely, is a part of the first radiation of Cervinae that produced Early Pliocene *Arvernoceros ardei* and "*Cervus*" *warthae* in Europe (CROITOR & STEFANIAK, 2009). The earliest fossil record of *Rucervus* known so far was reported from Late Pliocene of Siwalik Hills (AZZAROLI, 1954). Apparently, the extinct genus *Arvernoceros* is phylogenetically close to modern *Rucervus*. At the present state of knowledge, it is difficult to assume if *Arvernoceros* and *Rucervus* are synonymous or not, since the shape of antlers is a rather unsafe criterion at the genus level. The definitive conclusion may be obtained from the detailed comparative study of cranial morphology of *Arvernoceros* and *Rucervus*.

According to modern genetic studies, the origin of *Elaphurus davidianus* is related with a hybridization process that took place in Late Pleistocene between *Cervus canadensis* and *Panolia eldi*. Therefore, TEILHARD DE CHARDIN & PIVETEAU's (1930) hypothesis on close relationship between *Elaphurus davidianus* and *Arvernoceros ardei* is not supported. The synonymy between *Arvernoceros* and *Axis* as suggested DI STEFANO & PETRONIO (2000-2002) has a weak support since the Italian authors based their conclusion on a general primitive three-pointed plane of antler construction, which is characteristic of many deer forms that represent early evolutionary stages of all evolutionary lineages. Some antler characters typical for *Arvernoceros* (flattened and branched basal tine, distal part of beam compressed from the sides under the distal ramification) are never recorded in *Axis*.

The radiation of *Arvernoceros*, probably, was caused by temporary geographical isolation of early population with very vast area of distribution across northern part of Eurasia. This fragmentation, probably, was caused by Paratethys transgression in Late Pliocene (VISLOBOKOVA, 1990) that separated Western lineage with *A. ardei* and *A. verestchagini*, and Eastern lineage with *A. ubensis*, *A. bifurcatus*, and *A. giulii*. The evolution of *A. verestchagini* took place, most probably, in the area of the Azov Sea and North Caucasus foothills where numerous remains of *Arvernoceros* of various sizes were recorded (BAIGUSHEVA, 1994). *A. giulii*, probably, is a descent of *A. ubensis* that evolved in the conditions of open woodlands of Asian heartland. *A. giulii* penetrated in Europe somewhat later, by the end of Villafranchian. *Arvernoceros* became extinct in Europe during the End-Villafranchian faunal turnover when climate became colder and more seasonal.

## CONCLUSIONS

Presently, the genus *Arvernoceros* includes five large to very large-sized species with area of distribution from Western Europe to Eastern Asia: *A. ardei* (Early-Late Pliocene, Europe), *A. verestchagini* (Latest Pliocene-Early Pleistocene, Eastern Europe), *A. ubensis* (Late Pliocene, South of Western Siberia), *A. giulii* (Early Pleistocene, Europe), and *A. bifurcatus* (Latest Pliocene-Earliest Pleistocene, China). The genus is characterized by rather conservative specific variability of antler shape and primitive morphology of dentition. *Arvernoceros* belongs to the earliest radiation of Cervinae stock and is phylogenetically very close to, or even synonymous with modern genus *Rucervus*.

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Table. Measurements of the antler of *Arvernoceros ardei* from Slobozia Mare (Moldova) and the neotype of *A. ardei* from Perrier-Etoudaires (France).

Tabel. Măsurători ale coarnelor de *Arvernoceros ardei* de la Slobozia Mare (Moldova) și ale neotipului *A. ardei* de la Perrier-Etoudaires (Franța).

Measurements	Slobozia Mare	Etoudaires (neotype)
Antero-posterior diameter of antler base (mm)	27.3	42.7
Latero-medial diameter of antler base (mm)	28.6	39.0
Height of basal ramification (mm)	71.0	93.0
Maximal diameter of first tine base (mm)	37.5	37.8
Minimal diameter of first tine base (mm)	22.5	26.5
Angle of basal ramification	70°	80°

FIGURES

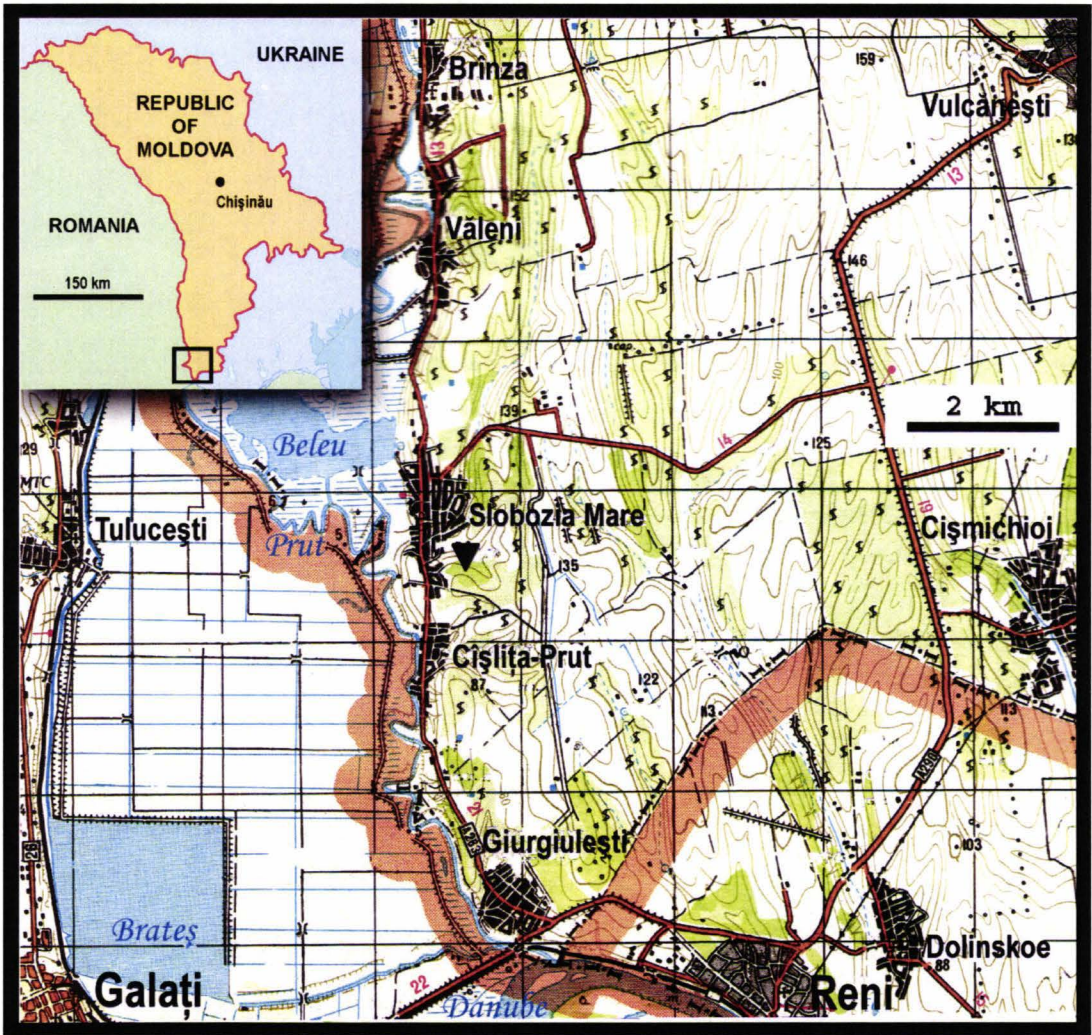


Figure 1. Location map: the black triangle indicates the geographical situation of Rîpa de la Ganu near Slobozia Mare where the fossil material was collected.

Figura 1. Harta. Localizarea Râpei de la Ganu în apropierea satului Slobozia Mare, unde au fost găsite rămășițele fosile, este indicată cu triunghiul negru.

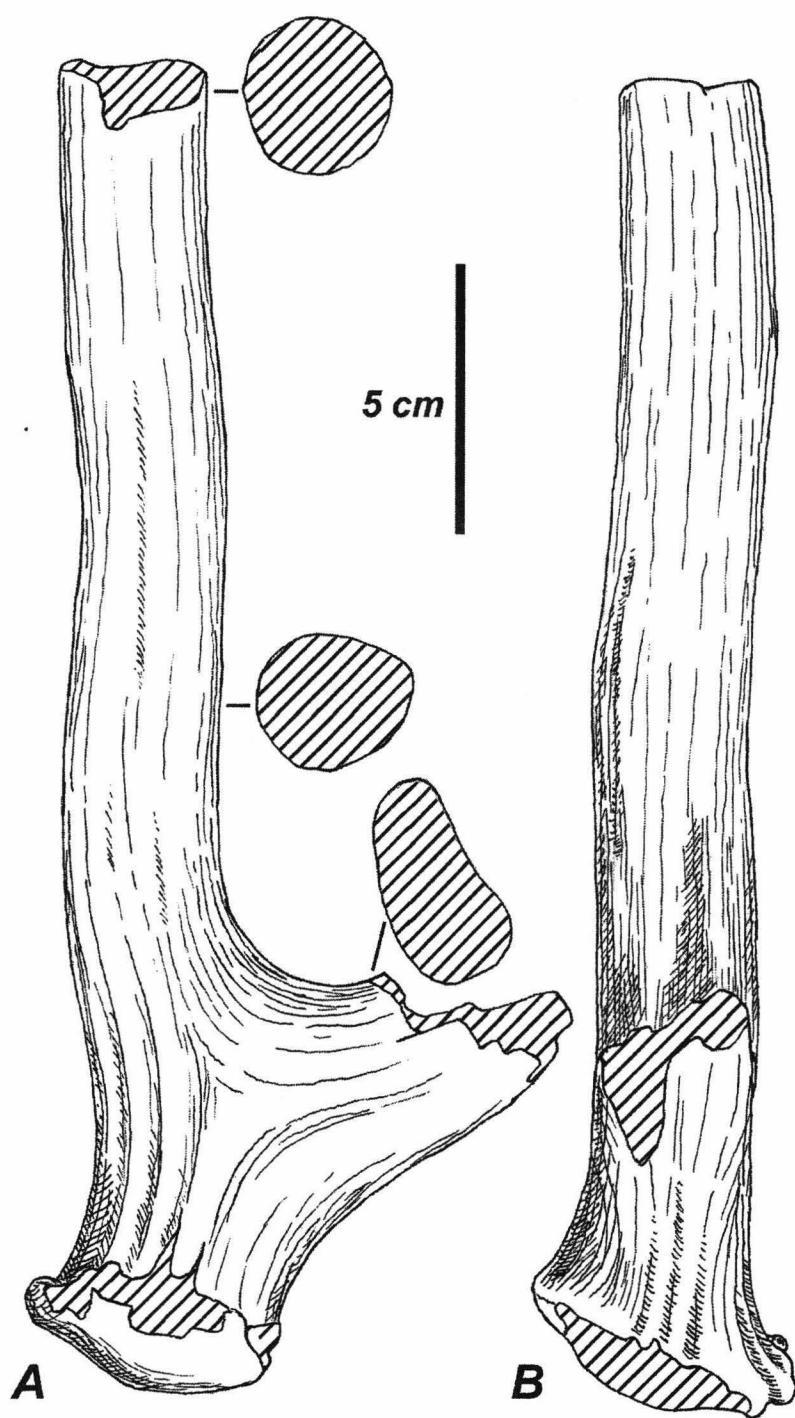


Figure 2. Right shed antler of *Arvernoceros ardei* from Slobozia Mare (Moldova R.): A, lateral view of antler with transverse cross-sections outlines; B, anterior view of the antler.

Figura 2. Corn de cădere drept al *Arvernoceros ardei* de la Slobozia Mare (R. Moldova): A-vedere laterală și secțiunile transversale; B-vedere anterioară.

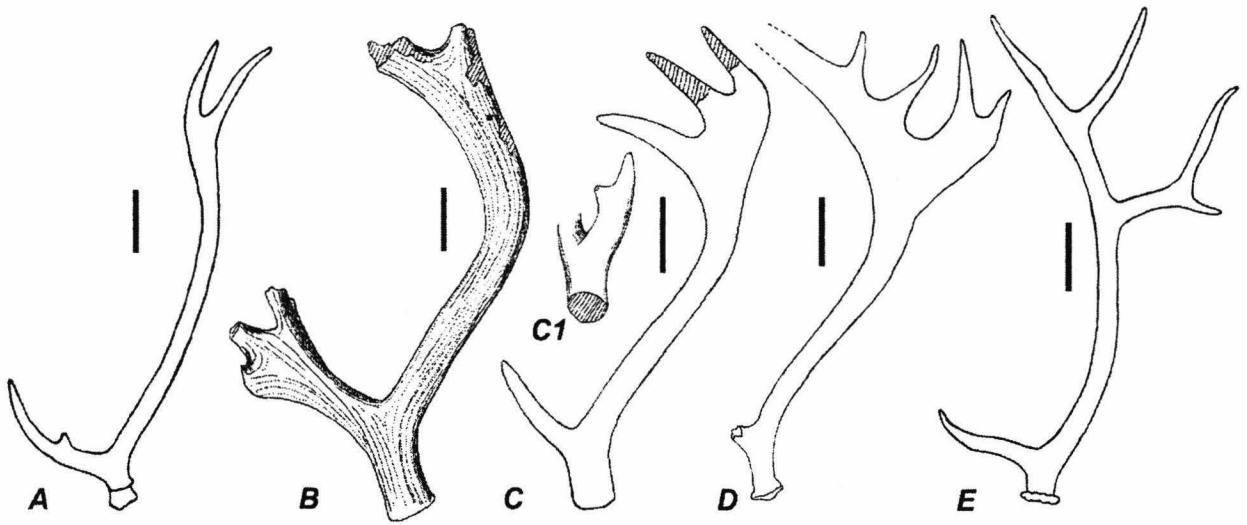


Figure 3. Antler shape of *Arvernoceros* and *Rucervus*: A, *Arvernoceros ubensis*, Altay (adapted from VISLOBOKOVA, 1977); B, *Arvernoceros verestchagini*, Salcia (adapted from DAVID, 1992); C, *Arvernoceros ardei*, Perrier-Etouaires (neotype); C1, proximal view of basal antler tine of *A. ardei*; *Arvernoceros* from Valea Grăunceanului (reconstruction); *Rucervus duvaucelli*, modern.

Scale bar: 10 cm.

Figura 3. Morfologia coarnelor cerbilor *Arvernoceros* și *Rucervus*: A, *Arvernoceros ubensis*, Altay (din VISLOBOKOVA, 1977); B, *Arvernoceros verestchagini*, Salcia (din DAVID, 1992); C, *Arvernoceros ardei*, Perrier-Etouaires (neotipul); C1, aspectul proximal al razei bazale speciei *A. ardei*; *Arvernoceros* de la Valea Grăunceanului (reconstituire); *Rucervus duvaucelli*, modern. Scara: 10 cm.

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# A BRIEF CHARACTERISATION OF THE LOWER PONTIAN ENVIRONMENTS FROM THE MOLDAVIAN PLATFORM

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**Abstract.** *The present paper makes an analysis of the Lower Pontian land biocoenoses from the Moldavian Platform. The reconstruction of the Lower Pontian palaeoenvironments from this region is based on mammal assemblages and pollen data.*

**Keywords:** *Early Pontian, palaeoenvironments, mammals, pollen.*

**Rezumat.** *Scurtă caracterizare a paleomediilor Ponțianului timpuriu din Platforma Moldovenească. În lucrare sunt menționate biocenozele de uscat ponțian inferioare din Platforma Moldovenească. În limitele teritoriului studiat au fost delimitate paleomedii pe baza analizei mamiferelor fosile și a palinocomplexelor determinate din depozitele Ponțianului inferior.*

**Cuvinte cheie:** *Ponțianul timpuriu, paleomedii, mamifere, polen.*

## INTRODUCTION

This work refers to the study of new finds of fossil mammals originating from the neighbourhoods of the villages of Leordoia, Veverița, Bahmut and Bălănești, all located in the central part of the Codru Rands. The systematic analysis of the fossil remains evidences the presence of the Early Pontian (unit MN13). These data, issued from mammal assemblages, as well as from pollen and macroflora analysis, are now interpreted in accordance with previous results from the southern regions of Republic of Moldova and Odessa region in Ukraine (NESIN, 1995).

## RESULTS AND DISCUSSION

The studied deposits of the central part of Codru Rands are known as the Stolniceni Formation (BUKATCHUK et al., 1968). The deposits are represented by two or three alluvial cycles embedded with wash-out erosion on the alluvio-lacustrine beds of the Balta Formation, showing the sharp difference from the latter, both in mineralogy and granulometry. The lithological peculiarities of the Stolniceni Formation mainly refer to the presence of pebbles of Carpathian origin, as well as to the coarse arenite forming these deposits and the cross-bedded sedimentation. The features of these deposits suggest their fluvial genesis. The mineralogical composition of the Stolniceni Formation is identical to the deposits from the lower terraces of the Dnestr and the Prut rivers (BUKATCHUK et al., 1968).

Facies analysis revealed the hydrological regime of the river system that generated these deposits. The presence of coarse clasts and clay indicates a turnover in intensity of water streams, seemingly due to the base level lowering. This process probably evolved under tectonic control.

The well-preserved fossils provide detailed information on chronology of deposits and character of space differentiation of the terrain (NICOARA & LUNGU, 2008). The analysis of oryctocoenosis of the terrestrial faunas from Leordoia, Veverița-2, and Bălănești revealed the occurrence of mammals belonging to various ecosystems:

- Wetlands
- Floodplain meadows
- Floodplain (gallery) forests
- Watershed forests
- Savannah

Wetland ecosystems are represented by taxa as *Euroxenomys*, *Castor*, *Microstonyx*, *Mygalinia* and others, which lived on floodplain environments with swamp tendencies, covered by grasses. The presence of such biotopes is supported also by pollen documenting plants as *Podocarpus*, *Salvinia*, *Sphagnum*, *Osmunda*, *Sparganiaceae*, *Typhaceae*, *Tiperaciae*, *Myriophyllum*, etc.

Evidences for the floodplain meadow environment are *Keramidomys*, *Anamolospalax tordosi* KORDOS, 1989, and *Crusafontina kormosi* (BACHMAYER & WILSON, 1970), while large-sized mammals were represented by *Zygodontomys turicensis* (SCHINZ, 1824). According to the lithological and carpological data (fossil seeds and imprint of plants), the river valleys borders were covered by broad-leaved forests composed by *Ulmus*, *Quercus*, *Betula*, *Carpinus*, *Salix*, as well as by subtropical representatives as *Liquidambar*, *Taxodium* etc (MEDEANIK, 2007).

The watershed forests were composed by coniferous trees like *Cedrus*, *Sequoia*, *Picea*, *Eupicea*, *Pinus haploxydon*, *Pinus strobus*, *Tsuga*, *Glyptostrobus*, *Abies* etc. (NEGRU, 1986). The fauna of watershed forests included *Miopetaurista*, *Spermophilinus*, *Pliopetaurista*, *Hylopetes*, *Blackia* etc.

The open landscapes were covered by shrubs and high grasses. This ecosystem was inhabited by reptiles as *Ophisaurus* and *Protestudo*, as well as by mammals: *Proochotona*, *Prolagus*, *Parapodemus*, *Lophocricetus*, *Miocricetodon*, *Hipparion*, *Metailurus* etc.

The mammal fauna originating from the ecosystems of forests mixed with meadows was represented by *Glis*, *Myomimus*, *Cervavitus*, *Procapreolus* etc., which lived in forests dominated by: *Ulmus*, *Quercus*, *Betula*, *Carpinus* and *Salix*.

## CONCLUSION

According to the Lower Pontian vertebrate oryctocoenoses and pollen data, this region of the Moldavian Platform was a wide uneven plain. In this area, several environments developed: swampy meadows, floodplain forests, watershed forests, and expansive open spaces of savannah-steppe type.

The recorded changes in lithology and granulometry compositions were caused by a sedimentary turnover, which also suggest a significant landscape differentiation. Those changes are clearly marked by the occurrence of pebbles originating from Carpathian source areas in the deposits of the Stolniceni Formation. Their presence could be related to the intensification of the tectonic movements and involvement of jasper-bearing beds in the fluvial erosion (BILINKIS, 1992).

Altogether, in the Early Pontian, on the Moldavian Platform, there developed wood and savannah vegetations on the plain that took shape after the regression of the Sarmatian and Meotian seas. The plain was dismembered by the river erosion with the development of wetland, floodplain meadows and floodplain (gallery) forests, watershed forests and savannah landscape.

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## THE ENVIRONMENTS OF THE UPPERMOST MIOCENE VERTEBRATES FROM DERȘIDA (NORTHWESTERN ROMANIA, SĂLAJ COUNTY)

VLAD CODREA, CLAUDIU MARGIN

**Abstract.** Few are known about the Uppermost Miocene vertebrate faunas in Romania. Such discoveries are very scarce in our country. An exception is Derșida, locality situated in northwestern Romania, in Sălaj County. An extended section is exposed on the Peșterii Valley, north to the village. The Miocene assemblage refers mainly to large herbivores (deinotheri, mastodon, tridactyl horses, rhino, cervidae), but also to a small sized hyena (*Ictitherium*). The small fauna is restricted just to a single representative, the beaver *Dipoides*. Only a large, probably terrestrial turtle documents the reptiles. This assemblage is considered here as Late Pontian (MN 13). The fossils originated from representatives of at least two habitats: a forested habitat and an open grassy one, interleaved. Probably the forests bordered the rivers, while the grassy environment was located somewhat further.

**Keywords:** Uppermost Miocene, NW Romania, mammals, reptile, environments.

**Rezumat.** Habitatele faunei de vertebrate Miocen terminale de la Derșida (NV României, jud. Sălaj). Asociațiile de vertebrate Miocen terminale sunt puțin cunoscute în România, în principal din cauza rarității unor astfel de descoperiri. O excepție o constituie fauna de la Derșida, localitate situată în NV țării, în jud. Sălaj. Aflorimente relevante pot fi observate pe Valea Peșterii, la nord de sat. Asociația de vertebrate se referă îndeosebi la o serie de mamifere ierbivore mari (deinotheri, mastodonți, cai tridactili, rinoceri, cervide), dar și la un reprezentant al carnivorelor, o hienă de mici dimensiuni (*Ictitherium*). Fauna mică este reprezentată exclusiv de câteva resturi de castor (*Dipoides*). Doar câteva fragmente de carapace dovedesc prezența unei făune de talie considerabilă, probabil terestră. Această asociație o interpretăm ca revenind Pontianului superior (MN 13). Fosilele dovedesc existența a cel puțin două habitate: un habitat împădurit, însoțit la o oarecare distanță de întinderi deschise acoperite de ierburi. Probabil pădurile bordau cursurile de apă ale unui sistem fluvial, iar întinderile ierboase se găseau la o oarecare distanță de acestea.

**Cuvinte cheie:** Miocen terminal, NV României, mamifere, reptile, paleomedii.

### INTRODUCTION

Uppermost Miocene vertebrates are extremely scarce in our country, mainly because convenient taphonomic environments for preserving such teeth and bones did not frequently occur. However, among the few localities of this kind from our country one can notice Derșida (Bobota commune) in northwestern Romania, in Sălaj County (Fig. 1). This village is located nearby the road E81, connecting Zalău to Satu Mare.

### GEOLOGICAL SETTING

At Derșida Uppermost Miocene deposits are exposed, the most extended sections being located on the Peșterii Valley, north to the village (marked F on Fig. 1).

PAUCĂ (1954) was the first to report these deposits and their fossil mollusks, followed soon by MAXIM & GHIURCĂ's (1960, 1963, 1964) contributions on same topics. Some few vertebrate remains collected from the same levels were studied only several years after (MACAROVICI & JURCSÁK, 1968; JURCSÁK, 1973, 1983). After 1980's, there was no any additional study on these faunas. Two decades after CODREA et al. (2002) retrieved the fossil-bearing sites, adding some new vertebrate taxa as well as sedimentological data, pointing out an Uppermost Miocene fluvial system environment in a distal-plain setting, with lakes or ponds within the floodplain. Its lithology consists of fine-grained clastic deposits interleaved with detrital complexes, with thicknesses of ten of meters (Fig. 2), dominated by sandstone and sand. These arenite sheets are forming hilly heights. Among them, on Balotă's Hill a Neolithic settlement was unearthed, bearing interesting artefacts made among others on fossil mollusks (JURCSÁK, 1984).

The geological age of Derșida deposits was a rather vexed question. Some geologists as MACAROVICI & JURCSÁK (op. cit.) considered them as Pontian, while TERZEA (1983) as Dacian. However, TERZEA's opinion was questioned by RĂDULESCU & SAMSON (1995) who estimated the vertebrate samples originating from this locality too scarce for indicating a clear MN unit. On the other hand, some others, as PAUCĂ (op. cit.) or MAXIM & GHIURCĂ (op. cit.) elected a less definite solution, indicating only the "Pliocene".

### THE MIOCENE VERTEBRATES FROM DERȘIDA

Beside the data issued from sedimentology and invertebrate faunas, the vertebrates from this locality yield interesting data on the environments.

The majority of fossils belong to the large mammals. The smaller ones are rather rare and the micromammals are for instance missing at all from the fossil record. This situation is a result of a peculiar taphonomic frame: most of the teeth and bones collected by us accumulated in a small sized channel fill (lateral extension on less than four meters, half meter maximum thickness), rather in its basal lag, mixed with broken mollusk shells and quartzite clasts (Fig. 3, 4). A lot of these fossils were broken while they were carried by the water streams. In such circumstances, one can presume

a hydrodynamic grading before their burial and therefore, a selected composition of the oryctocoenosis. In this manner, representatives originating from various terrestrial environments mixed into the same deposit.

Some other remains, mainly the ones belonging to the large mammal representatives, were unearthed by our forerunners from an upper level on the same valley, just few meters above the mentioned channel. There, one can still observe sandstone and gray clay interleave, the last bearing numerous mollusk shells belonging mainly to *Unio wetzleri flabellatiformis* MIK. (Fig. 5).

Among proboscideans, there is the large-sized deinother *Deinotherium proavum* EICHWALD, 1835 (= *D. gigantisimum* ȘTEFĂNESCU, 1892; for the species' name priority see CODREA, 1994), documented by an atlas and a lower jaw fragment. A fragmentary skull was also collected by MAXIM and GHÎURCĂ, but it was completely broken while the preparation works at Cluj-Napoca University in 1960's. The large atlas is indicating an evolved specimen. The size-increasing tendency along deinotheres' Miocene evolution was remarked since long time ago (e.g. GRÄF, 1957).

Concerning the Middle Miocene – (?) Pliocene deinotheres, there are opinions either to join *D. proavum* with *D. giganteum* KAUP, 1828 in a single species (e.g. ROGER, 1896; ATHANASIU, 1907; HARRIS, 1978; HUTTUNEN, 2002), or to consider them as separate species (GÖHLICH, 1999). In our viewpoint, the last approach seems to be more credible.

The number of *D. proavum* finds in our country is rather low. One can mention here Ștefănescu's "*D. gigantissimum*" finds from Găiceana or Mânzați (1891, 1895, 1899, 1910). Both localities had been reported as Meotian ones, but in our opinion – as well in others (BACHMAYER & ZAPFE, 1972) – this age would need more arguments. As one of us pointed out (CODREA, 1994), other finds as the ones from Vernești (ATHANASIU, op. cit.) or on the Elan Valley in Moldova, refer to localities practically devoid of accurate stratigraphy.

An overview on the *D. proavum* finds from Hungary (KRETZOI, 1982) reveals exclusively Upper Miocene ("Baltavarium") localities, more exactly the Pontian s.s. (*sensu* STEVANOVIĆ, 1951) and not older ones. In these circumstances, one doubts once more the stratigraphic data originating from Moldova. But, on the other hand *D. thraceiensis* KOVACHEV & NIKOLOV, 2006 (in our opinion, a junior synonym of *D. proavum*), is reported to originate from "Meotian" deposits from Ezerovo, in Bulgaria (KOVACHEV & NIKOLOV, 2006), where the deinother is reported in association with *Gomphotherium angustidens* (CUVIER, 1817).

Another remains concern a mastodont, reported by JURCSÁK (op. cit.) to *Anancus arvernensis* (CROIZET & JOBERT, 1828). Surprisingly, from the same locality he mentioned also "*Mastodon (Bunolophodon) longirostris* Kaup", based only on an apical tusk fragment. The presence of this species would be unlikely in Derșida, because it was extinct earlier in Europe, i.e. MN 11 (GAZIRY, 1997). In fact, the fossil that JURCSÁK used is irrelevant for a species determination.

These proboscideans are peculiar for environments where the forested areas were alternating with open forest, or even grassy areas (ATHANASSIOU, 2004). Probably the forested areas bordered the river courses, where marshy places occurred too (preferred by deinotheres; HARRIS, 1978; TSOUKALA & MELENTIS, 1994), while the open ones were situated somewhere further. This kind of environment is in agreement with the sedimentological data too.

The most numerous fossils collected until now belong to hipparions. However, nearly all available data refer to isolated teeth, and not to cranial or postcranial bones. In these circumstances, the physiognomy of the animal can be hardly sketched. One can only estimate middle-sized hipparions, probably belonging to a single species. It could be related to *Cremohipparion mediterraneum* (ROTH & WAGNER, 1855), but a clearer systematic position would need further more detailed studies, based on more fossils. If the Derșida hipparion is close to the mentioned species, one can relate it rather to open habitat (SCOTT et al., 2005). Perhaps, it could deal also with intermediate habitats.

In spite of several successive diggings on this site, rhinoceros remains could not be retrieved. Therefore, one can mention only the presence of these large herbivores in the assemblage.

The artiodactyls are also scarce. The presence of *Procapreolus* is rather sure, as well as the one of unnamed bovidae. *Procapreolus* could be interpreted as a forest dweller, as the modern representatives of *Capreolus* are.

The carnivores are documented by few *Ictitherium* teeth, assigned to *I. pannonicum* KRETZOI, 1952 (KRETZOI, 1952). This small hyena probably lived on open habitats, covered by grasses. Obviously, the carnivore diversity should be higher – if we are thinking to some other late Miocene localities, but for instance no other representatives had been found in Derșida.

The scarcest fossils in Derșida belong to rodents. Only the beaver *Dipoides* can be documented until now in this assemblage. Smaller taxa are completely missing, probably because of taphonomic reasons. *Dipoides* was mentioned only from Oradea - Dealul Viilor (JURCSÁK, 1983a), a Dacian locality according to TERZEA (op. cit.). However, RĂDULESCU & SAMSON (op. cit.) appreciated as doubtful this geological age considering the faunal evidence less indicative.

Non-mammal vertebrates are extremely rare. We can mention only some fragmentary carapace bones originating from a large, probably terrestrial turtle.

## CONCLUSIONS

The vertebrates from Derșida document the latest Miocene (MN 13) in this region of our country. In Rumania, these assemblages are extremely rare, mainly due to the low number of localities, which yielded such faunas. Even

scarce, the faunal list point out at least two main habitats: forested areas, probably bordering the water streams (where deinotheres, mastodonts, cervids and beavers were the dwellers) and open grassy areas, probably located somewhat further (documented by hipparions, bovids, hyaenas). The teeth and bones of both representatives were mixed together, carried by water streams. Sometimes, this mobilization was aggressive, as many of these remains had been broken before their burial.

### ACKNOWLEDGEMENTS

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Figure captions:



Figure 1. Satellite view on Derșida and Valea Peșterii (marked F).  
Figura 1. Imagine satelitară – Derșida și Valea Peșterii (marcată cu F).



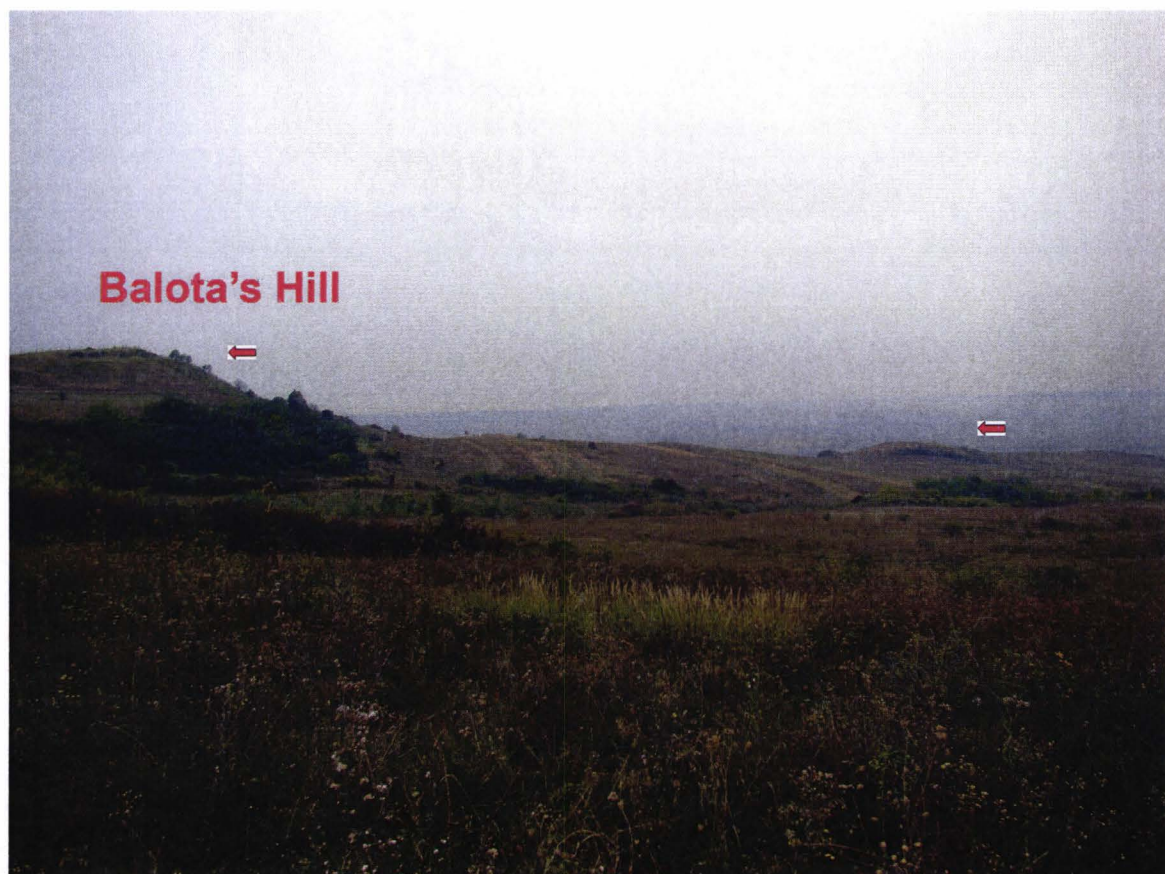


Figure 2. Some of the detrital complexes (marked with arrows) from Derșida, including Balotă's Hill.  
Figura 2. Câteva complexe detritice (marcate cu săgeți) de la Derșida, inclusive Dealul lui Balotă.



Figure 3. Late Pontian channel filled with mollusk fragments, teeth and bones in Valea Peșterii.  
Figura 3. Canal din Ponțianul Superior umplut cu fragmente de moluște, dinți și oase în Valea Peșterii.





Figure 4. Detail on the Late Pontian channel filled with mollusk fragments, teeth and bones in Valea Peșterii (hammer as scale). The arrow marks a *Hipparion* tooth.  
 Figura 4. Detaliu din canalul pontianul superior umplut cu fragmente de moluște, dinți și oase în Valea Peșterii (ciocanul geologic, ca scară). Săgeata marchează un dinte de *Hipparion*.



Figure 5. *Unio wetzleri flabellatiformis* MİK. in the Late Pontian from Derșida (hammer as scale).  
 Figura 5. *Unio wetzleri flabellatiformis* MİK. din Pontianul Superior de la Derșida (ciocanul geologic ca scară).

# CONTRIBUTION TO THE STUDY OF MAEOTIAN HIPPARION FAUNAS FROM THE REPUBLIC OF MOLDOVA

ANDRIAN DELINSCHI

**Abstract.** *The present work deals with the faunal structure and taphonomy of several Meotian faunas with Hipparion from the Upper Miocene of the Republic of Moldova. According to the local stratigraphic scale of continental formations, these Meotian faunal associations can be correlated with the Lower and Middle Turolian (MN11-12 biozones) of European Land Mammal Ages.*

**Keywords:** *Hipparion fauna, Upper Miocene, Republic of Moldova.*

**Rezumat.** *Unele studii cu privire la siturile faunei meotiene cu Hipparion din Republica Moldova. În această lucrare sunt specificate unele informații cu privire la componența sistematică a asociațiilor faunistice și tafonomia siturilor faunei cu Hipparion din Miocenul superior, care sunt atribuite diferitor nivele stratigrafice ale Meoțianului din Republica Moldova. Conform scării stratigrafice a formațiunilor geologice continentale, vârstele asociațiilor faunistice din Meoțian sunt atribuite Turolianului inferior și mediu (biozonele MN11-12).*

**Cuvinte cheie:** *Fauna cu Hipparion, Miocenul superior, Republica Moldova.*

According to ROSCA & HUBKA (1986), Meotian continental formations are represented by strata (up to 290 m thick) of continental unstratified clay with aleurite prolayers and fine-grained sands, which are known as the Cahul Formation. Deposits ascribed to this formation include important sites of *Hipparion* fauna such as: Ciobruciu, Tudora, Taraclia, Cimislia, Gura-Galbenei.

**Ciobruciu**, Stefan-Voda district. The site is located on the right bank of the Dniester River, at the western borders of Ciobruciu village.

Stratigraphic position, taphonomy, faunal determinations and descriptions have been already studied by PAVLOW (1913, 1914), GABUNJA (1959), LUNGU (2001), and LUNGU & DELINSCHI (2006).

In Ciobruciu section, marine sediments of the Khersonian substage are overlain by 40 to 45 m thick sandy-argillaceous sediments referred to as the Balta Formation. According to the stratigraphic data and lithology, these continental sediments, represent lacustrine, fluvial, and deltaic facies.

Gabunija (1959) listed the following terrestrial vertebrates from this site:

**Reptilia:** *Protestudo bessarabica* RJABININ, 1918;

**Mammalia. Edentata:** *Orycteropus gaudryi* F. MAJOR, 1888;

**Carnivora:** *Mustela palaeatica* WEITHOFER, 1888, *Ictitherium viverinum* ROTH & WAGNER, 1854, *Adcrocuta eximia* (ROTH et WAGNER, 1854), *Machairodus schlosseri* WEITHOFER, 1888, *Machairodus cultridens* CUVIER, 1824, *Simocyon primigenius* WAGNER, 1832;

**Proboscidae:** *Choerolophodon pentelici* (GAUDRY & LARTET, 1856), *Mastodon* sp., *Deinotherium giganteum* KAUP, 1829;

**Perissodactyla:** *Hipparion* cf. *verae* GABUNJA, 1979, *Hipparion* cf. *moldavicum* GROMOVA, 1952, *Aceratherium incisivum* KAUP, 1832, *Dihoplus schleiermacheri* (KAUP, 1832);

**Artiodactyla:** *Cervus* sp., *Palaeotragus rouenii* GAUDRY, 1861, *Palaeotragus* sp., *Helladotherium duvernovi* GAUDRY et LARTET, 1856, *Tragoportax frolovi* PAVLOW, 1913, ?*Palaeoryx stutzeri* SCHLOSSER, 1905, *Gazella desperdita* GERVAIS, 1847.

Gabunija (1959) defines the age of Ciobruciu fauna as Lower Meotian, an opinion shared by LUNGU & DELINSCHI (2006), and DELINSCHI (2008). KOROTKEVICH (1988) considered this site as Upper Khersonian.

Since 1987-2006, new excavations in Ciobruciu site unearthed very interesting palaeontological material of small terrestrial vertebrates (LUNGU, 1990, 2001, LUNGU & DELINSCHI, 2006, DELINSCHI, 2008).

Taphonomy. Remains of vertebrates were collected from argillaceous sands underlying Quaternary fluvial terraces of the Dniester. Bone remains are homogeneously distributed within the deposits and they do not form accumulations. They show different degrees of rolling, fossilization, and colour. Gabunija (1959) thought that fossil remains of Ciobruciu were brought by water in swampy river bank conditions, covered by willow and alder, while some specimens originate from more remote steppe and semi-steppe sites. Judging by lithology, bedding pattern, and fossilization, the burial area should represent a deltaic region of a Meotian river.

This site yielded remains of the following taxa of terrestrial vertebrates (LUNGU & DELINSCHI, 2006):

**Amphibia:** *Mioproteus* cf. *caucasicus* ESTES & DAREVSKI, 1977, *Rana* sp.;

**Reptilia:** *Cheledropsis* sp., *Melanochelis* sp., *Sakya* sp., *Protestudo* sp., *Lacerta* sp., *Ophisaurus* sp., *Natrix* sp., *Elaphe* sp., *Vipera* sp.;

**Aves:** *Struthio* sp., *Anas* sp.;

**Mammalia. Insectivora:** *Desmana* sp., *Soriciculus* sp., *Amblyopterus* sp.;



**Lagomorpha:** *Proochotona eximia* CHOMENKO, 1914;

**Rodentia:** *Spermophilinus cf. bredai-turolensis* DAXNER-HÖCK, 1975, *Myomimus dehmi* (DE BRUIJN, 1966), *Vasseuromys cf. thenii* DAXNER-HÖCK & DE BRUIJN, *Hansdebruijnina neutrum*, (DE BRUIJN, 1976), *Valerimys* sp., *Neocricetodon (Kowalskia) cf. lavocati* (HUGUENEY & MEIN, 1965);

**Carnivora:** *Ictitherium* sp.;

**Perissodactyla:** *Hipparion* sp., *Aceratherium* sp.;

**Artiodactyla:** *Cervavitus* sp., *Tragoportax amaltheus* GAUDRY, 1861.

The fauna of Ciobruciu indicates the presence of different biocoenoses. The occurrence of *Proochotona cf. eximia*, *Vasseuromys cf. thenii*, *Hansdebruijnina cf. neutrum*, *Valerimys* sp., *Neocricetodon cf. lavocati*, *Hipparion cf. moldavicum* etc. confirms a lower Meotian age that can be attributed to the Early Turolian (biozone MN11).

**Taraclia**, Causeni district. The site is located at the northwestern margin of Taraclia village, 25 km South of Tighina city. It is one of the largest sites of *Hipparion* fauna from Meotian (Turolian) in the Eastern Europe.

Lithology and stratigraphy indicate alluvial-lacustrine deposits of the Cahul Formation overlying marine sediments of Kersonian (Upper Sarmatian) age.

**Taphonomy.** In this section CHOMENKO (1913) distinguished seven bone lenses (I-VII), up to two meters wide, and 0.3-0.5 m thick, interrupted by 0.2-0.3 m thick unfossiliferous beds. The lithological features of the bone lenses, the absence of a coarse-grained material, the uniform orientation of bones into the layers, indicate their accumulation by a slowly flowing river. The burial zone possibly represented the delta of a Meotian river.

The distribution pattern of bones and their arrangement in lenses indicates variable water energy in streams transporting the animal remains.

The presence of articulated postcranial bones, skulls and mandibles and rounded bone fragments evidences the transportation of bones from sites at different distance from the burial. Turbulent streams could rumple and shatter the bones.

Large bone fragments indicate a considerable initial speed of water streams. It is probable that smaller bones were transported from more distant locations. When water speed decreased, only small bones fragments could be transported to the burial.

The presence of seven bone lenses in the section points to a long duration of the locality formation. Seasonal severe rainfalls could produce strong water streams that transported and deposited bone remains in the delta and floodplain of a Meotian river.

Non-uniform distribution of atmospheric precipitation might be responsible for the formation of the Taraclia vertebrate locality; droughts or catastrophic rainfalls could be among the causes of animals' deaths.

The fauna of Taraclia was studied by CHOMENKO (1913, 1914). Some forms of this faunal association are also described by RYABININ (1929), GROMOVA (1952), TROFIMOV (1954), and GODINA (1979).

The list of the Taraclia fauna includes:

**Reptilia:** *Protestudo bessarabica* RJABININ, 1918;

**Mammalia. Lagomorpha:** *Proochotona exima*, CHOMENKO 1914; *Alilepus lascarevi* (CHOMENKO, 1914)

**Rodentia:** *Castor cf. praefiber* LINNE, 1902; *Hystrix bessarabica* RJABININ, 1918;

**Carnivora:** *Martes leporinum* (CHOMENKO, 1914); *Hyaenictitherium venator* SEMENOV, 1989; *Ictitherium viverinum* ROTH et WAGNER, 1854; *Lycyaena choereticis* (GAUDRY, 1862); *Thalassictis parvum* (CHOMENKO, 1914); *Adcrocuta exima* (ROTH et WAGNER, 1854); *Felis attica* WAGNER, 1857; *Paramachairodus orientalis* GAUDRY, 1862; *Metailurus parvulus* (HENSEL, 1862); *Machairodus giganteus* (WAGNER, 1857).

**Proboscidea:** *Deinotherium giganteum* KAUP., 1829; *Tetralophodon longirostris* (KAUP, 1832), *Zygolophodon turicensis* (SCHINZ, 1824)

**Perissodactyla:** *Hipparion moldavicum* GROMOVA, 1952; *Hipparion platygenis* GROMOVA, 1952; *Aceratherium incisivum* KAUP, 1832; *Diceros pachygnathus* (WAGNER, 1848); *Dihlopus orientalis* (SCHLOSSER, 1921);

**Artiodactyla:** *Microstonyx major* (GERVAIS, 1848-1852); *Cervavitus novorossiae* CHOMENKO, 1913; *Palaeotragus rouenii* GAUDRY, 1881; *Samotherium boissieri* F. MAJOR, 1888; *Helladotherium duvernovi* (GAUDRY & LARTET, 1856); *?Camelopardalis* sp.; *Tragoportax amalthea* (ROTH & WAGNER, 1854); *Tragoportax amalthea* var *parvidens* (SCHLOSSER, 1904); *Tragoportax rugosiformis* (SCHLOSSER, 1904); *?Tragoportax validus* (CHOMENKO, 1913); *Palaeorix majori* SCHLOSSER, 1904; *Palaeorix stutzeri* SCHLOSSER, 1904; *Tragoreas oryxoides* SCHLOSSER, 1904; *Protragelaphus skouzesi* DAMES, 1883; *Procapra rodleri* (PILGRIM & HOPWOOD, 1928); *Pseudotragus capricornis* SCHLOSSER, 1904; *Gazella deperdita* GERSVAIS, 1848; *Gazella capricornis* WAGNER, 1854; *Criotherium argalioides* F. MAJOR, 1891; *Procobus brauneri* CHOMENKO, 1913; *Procobus melania* CHOMENKO, 1913;

The distinctive feature of the Taraclia fauna is the presence of diverse antelopes, widespread in the Turolian in the eastern Mediterranean.

GABUNJA (1959) and DELINSCHI (2008) correlated the fauna with Middle Meotian. The fauna from Taraclia has a Turolian aspect. It can be attributed to the Middle Turolian (zone MN 12) of the European continental stratigraphic scale.

**Cimislia.** The site is located on the right banks of the Kogylnik River, near the town of Cimislia. A dense ravine network covers an area of about 100 hectares. The ravines expose (at about 90 m a.s.l.) bone-bearing beds. There are altogether 11 fossiliferous sites in the fluvial-lacustrine deposits of the Balta Formation.

**Taphonomy.** Bone remains of terrestrial vertebrates occur in sands and clays of channel and floodplain alluvial facies. Bone concentrations of 1.0 by 1.5 m form local bone breccia lenses. A rapid burial is indicated by the chaotic bone arrangement. The material includes articulated bones, vertebrae, skulls with mandibles, and sporadic rolled bone fragments. It is possible that strong temporary water currents transported floating, not decomposed corpses, and as separate parts. Bones were buried in channel and floodplain settings of a Meotian river. Animals could have died as a result of flooding or drought.

The Cimislia fauna (BARBU, 1959, BELJAEVA, 1948, LUNGU & TARABUKIN, 1966, TARABUKIN, 1968, LUNGU & DELINSCHI, 2008, DELINSCHI, 2005, 2008) includes:

**Reptilia:** *Protestudo bessarabica* (RJABININ, 1918);

**Aves:** *Struthio* sp.;

**Mammalia. Insectivora:** *Erinaceus* sp.;

**Logomorpha:** *Alilepus lascarevi* (CHOMENKO, 1914).;

**Rodentia:** *Hystrix* sp.;

**Carnivora:** *Promeles palaeattica* (WEITHOFER, 1888), *Eomellivora rumana* Simionescu, 1938, *Miochyaenotherium bessarabicum* (SIMIONESCU 1938), *Thalassictis parvum* (CHOMENKO, 1914), *Adcrocuta eximia* (ROTH et WAGNER, 1854), *Machairodus giganteus* (WAGNER, 1857), *Paramachoirodus orientalis* GAUDRY, 1862, *Acinonyx* sp., *Felis* sp.;

**Proboscidea:** *Tetralophodon* aff. *atticus* (WAGNER, 1857), *Zygodontophodon turicensis* (SCHINZ, 1824), *Deinotherium giganteum* KAUP, 1829;

**Perissodactyla:** *Hipparion praegiganteum* TARABUKIN, 1968, *Hipparion moldavicum*, GROMOVA, 1952, *Hipparion matthewi* ABEL, 1926, *Aceratherium incisivum* KAUP, 1832, *Dihoplus* aff. *pikermiensis* TOULA, 1906, *Chilotherium schosseri* (WEBER, 1905), *Acerorhinus* sp.;

**Artiodactyla:** *Microstonyx major* (GERVAIS, 1848-1852), *Cervavitus variabilis* ALEXEJEW 1915, *Cervavitus novorossiae* CHOMENKO 1913, *Palaeotragus rouenii* GAUDRY, 1861, *Helladotherium suchovi* (GODINA, 1977), *Miogazella pilgrimi* (BOHLIN, 1935), *Vetaprocampa capricornis* (PILGRIM, HOPWOOD, 1928) *Tragoportax frolovi* (PAVLOW, 1913), *Palaeoryx* aff. *pallasi* WAGNER, 1857, *Palaeoreas lindermayeri* WAGNER, 1848.

The fauna from Cimislia is one of the richest *Hipparion* faunas from Eastern Europe, but systematics of many taxa need a revision. Forms of open, savannah-like biotopes dominate in this fauna.

Recently, a new locality of terrestrial vertebrates was discovered in the quarry at the northern margin of Cimislia city (at the absolute elevation of 80 m). Bones occur in alluvial sediments of the Balta Formations (Delinschi 2005, 2008).

The bed of coarse-grained sand is exposed at the basis of the section. This bed contains intercalations of marl gravel and microconglomerate, which contains bones of small terrestrial vertebrates. They are overlain by clayey cross-bedded sands grading to compact clay.

These sediments account for a uniform alluvial sedimentation cycle, combining channel and meadow river facies. The following forms have been recorded from this site (DELINSCHI, 2008):

**Reptilia:** *Protestudo* sp., *Ophisaurus* sp., *Lacerta* sp., *Vipera* sp.;

**Mammalia. Chiroptera:** gen. et sp. inden.;

**Insectivora:** *Parasorex socialis* (VON MEYER, 1865), ?*Erinaceus* sp., *Ruemkelia* sp.

**Logomorpha:** *Alilepus lascarevi* (CHOMENKO, 1914).;

**Rodentia:** *Tamias atsali* DE BRUIJN, 1995, *Euroxenomys minutum rhenanum* (FRAZEN & STORCH, 1975), *Myomimus maritsensis* DE BRUIJN, DAWSON & MEIN, 1970, *Vasseuromys* sp., *Lophocricetus minusculus* SAVINOV, 1977, *Neocricetodon* (*Kowalskia*) *browni* DAXNER-HOCK, 1992, *Neocricetodon* (*Kowalskia*) sp., *Pseudocricetus orienteuropaeus* TOPACEVSKI et SCORIK, 1992, *Hansdebruijnina* aff. *neutrum* (DE BRUIJN, 1976), *Apodemus* aff. *barbarae* (VAN DE WEERD, 1976);

Remains of murids and cricetids (*Muridae* and *Cricetidae*) dominate in the fauna.

Cimislia fauna is correlated with the Upper Meotian, but its taxonomic composition evidences a younger age than that of Cioburciu and probably Taraclia sites.

Cimislia fauna is dated to the later part of the Meotian (Middle Turolian, upper part of MN12 or MN12-13 boundary).

**Gura-Galbenei,** Cimislia district.

The site is situated in the Kogylnik River valley, at the eastern margin of Gura-Galbenei village, 20 km N of Cimislia city.

The outcrop exposes a 50 m thick member of grey-green compact clay alternating with fine-grained quartz-micaceous sand of lacustrine-alluvial origin. These sediments, referred to as Balta Formations, show a rhythmic structure with several alluvial cycles. Each cycle begins with medium-grained quartz-micaceous sands grading upwards to fine-grained sands, covered by compact clays.

The geological age of the locality is under discussion. By stratigraphic position and taphonomic features, Gura-Galbenei should be quite similar to the Cimislia site.

According to SUHOV (1945), KONIKOV (1957), and DELINSCHI (2008) the faunal association from Gura-Galbenei includes the following forms:

**Mammalia. Lagomorpha:** *Alilepus* sp.

**Carnivora:** *Machairodus* sp.

**Proboscidea:** *Mammuth borsoni* (HAYS, 1834)

**Perissodactyla:** *Hipparion* sp., *Chilotherium schlosseri* (WEBER, 1905), *Aceratherium incisivum* KAUP, 1832.

**Artiodactyla:** *Microstonyx major* (GERVAIS, 1848-1852), *Cervavitus variabilis* ALEXEJEW, 1915, *Helladotherium duvernoyi* GAUDRY & LARTET, 1856, *Gazella deperdita* GERSHMAN, 1847

**Tudora**, Stefan Voda district

The site is located on the right bank of the Dniester River, at the northwestern margin of Tudora village.

**Taphonomy.** As shown by bones occurrence in compact clays and fine-grained clayey sandstones, and in humus clays, the burial is associated with a shallow water basin of lacustrine or estuary type. Sands intercalations and sporadic pebbles indicate temporary currents as the accumulation agent of the animal remains.

Krokos (1914) noted the presence in the bone bed of a leaf flora including *Salix*, *Ulmus*, *Populus* and other forms that evidence a damp temperate climate.

Tudora fauna was described by PAWLOV (1913, 1914), KROKOS (1916), and GABUNJA (1959).

According to BELJAEVA (1948) and DELINSCHI (2008), the faunal association from Tudora includes the following forms:

**Reptila:** *Protestudo bessarabica* (RJABININ, 1918),

**Mammalia Carnivora:** *Adcrocuta exima* (ROTH & WAGNER, 1854);

**Perissodactyla:** *Hipparion tudorovense* GABUNJA, 1959,

*Aceratherium incisivum* KAUP, 1932, *Aceratherium simplex* (KROKOS, 1914)

**Artiodactyla:** *Microstonyx* aff. *major* GERSHMAN (1848-1852), *Tragoportax amaltheus* (GAUDRY, 1861) *Palaeoryx majori* SCHLOSSER, 1904, *Gazella deperdita* GERSHMAN, 1848.

The majority of the forms of Tudora fauna are common in the Meotian faunal associations from Moldova and Ukraine. The fauna also includes a new form of *Hipparion* (*H. tudorovense*) and a rhinoceros (*Aceratherium simplex*). Based on these data, Gabunja (1959) dated Tudora fauna at the Upper Meotian. This is in agreement with the local geology as continental fossiliferous formations overlain by marine sediments of the Lower Pontian.

The fauna from the Tudora locality is poorly studied. Until recently, it was considered younger than those from Cimislia, and it was correlated with the upper part of MN12 or lower part of MN13. In this case, faunas of Cimislia and Tudora are synchronous or the Tudora fauna may have Early Pontian age.

## CONCLUSIONS

□ Fossil *Hipparion* fauna of the Meotian age occur in Moldova in deltaic and lacustrine-alluvial facies frequently forming large lense-like concentrations.

□ Meotian faunal associations have a Turolian aspect possibly attributable to mammal zones MN11-MN13.

□ In the Late Miocene, the area of the modern Moldova was situated at the boundary between different palaeobiogeographic provinces that influenced the formation and evolution of the local theriofauna.

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## CHARLES DARWIN'S BICENTENARY (THE 12<sup>th</sup> OF FEBRUARY 1809 - THE 19<sup>th</sup> OF APRIL 1882). THE MAN AND WORK

**ȘTEFAN NEGREA, ALEXANDRINA NEGREA**

**Abstract.** *Celebrating two centuries since the birth of the famous naturalist Charles Darwin, the first part of this paper presents briefly his origin, his childhood, his adolescence and his studies followed by an even shorter description of his journey around the world on the brig-sloop "Beagle" (the 27<sup>th</sup> of December 1831-the 2<sup>nd</sup> of October 1836) and the ulterior activity until his death. This continues with the summary of Darwin's evolutionary conception, the origin of the species, the natural and sexual selection and the concept of species.*

**Keywords:** *Darwin's life, the voyage on the "Beagle", the origin of the species, the natural and sexual selection, the evolutionary theory.*

**Rezumat.** *Bicentenarul nașterii lui Charles Darwin (12 febr. 1809-19 apr. 1882). Omul și opera. La două sute de ani de la nașterea marelui naturalist Charles Darwin (12 febr. 1809-19 apr. 1882), autorii prezintă pe scurt originea, copilăria, adolescența și studiile și foarte pe scurt călătoria în jurul lumii la bordul bricului „Beagle” (27 Dec. 1831-2 Oct. 1836) și activitatea sa de la revenirea din călătorie până la moarte. În continuare este prezentată sumar opera sa științifică: concepția sa evoluționistă, originea speciilor, selecția naturală și sexuală, conceptul de specie.*

**Cuvinte cheie:** *viața lui Darwin, călătoria cu „Beagle”, originea speciilor, selecția naturală și sexuală, teoria evoluționistă.*

### INTRODUCTION

In the year 2009 two centuries have come to pass since Jean-Baptiste de Monet Lamarck (1744-1829) published his work "Zoological philosophy" in which the author of the first evolution theory offered a scientific explanation for evolution with insufficient arguments. At the same time, two centuries ago, Charles Robert Darwin was born (1809-1882), founder of a scientific theory on the evolution of animal and plant species through natural selection. The works of these two all time titans of Biology had, however, a different fate. If Lamarck's work lacked an echo in his own time-it could not be understood because, following the opinion of MOTAȘ (1973), "it had been brought into the world too soon" - Darwin's works enjoyed a far greater outlet seeing as he managed to place his evolutionary conception on a sturdier foundation. This foundation was possible due to mankind's considerable progress in the age in various natural science disciplines: Geology, Palaeontology, Physiology, Embryology, Agronomy as well as others. As one will easily come across further on, although he was a mediocre student, with barely any natural sciences bases, coming from a wealthy family and later accumulating enough data in his long journey around the world, he did manage to put together the "Theory of Evolution". A theory that, after having shocked his contemporaries, made Darwin immortal- known to all of mediocre education, known as the savant that proved "man comes from the ape" (in fact Darwin said that man and the ape have a common ancestry). According to MOTAȘ (1973) in his Magnum Opus "The origin of species", Darwin enunciated the natural selection concept - "the pivot for the entirety of the Darwinist evolutionary doctrine". "Discovering this principle - Motaș writes - is not in any manner surpassed by the discovery the principle of universal gravitation, of the transformation and preservation of energy. It can be compared - Motaș furthers - as the influence on scientific development in later ages, with the discovery of atomic energy and the recent nuclear physics discoveries". Along the same line, we further add for comparison, the computer science revolution brought about by the birth of the Internet.

### DARWIN'S BIRTH, CHILDHOOD, ADOLESCENCE AND STUDIES

Charles Darwin was born on the 12<sup>th</sup> of February 1809 in Shrewsbury, from an old Scottish yeomen family. Before the 1600's, his ancestors spelled their name differently-all of them derivatives from Derwent, the name of a river from the Lincolnshire district, close to Yorkshire: Darwen, Darwynne, Darwyn and Darwin (MOTAȘ, 1973, p.11).

The grandfather, Erasmus Darwin (1731-1802), was a physician, philosopher, natural scientist and poet. His Magnum Opus "Zoonomia" (1794) served, as some say, as a source of inspiration for Lamarck. Charles Darwin inherited from his grandfather, his athletic frame, lively imagination, propensity for sports, his kindness and modesty so rarely encountered. His grandfather's "Zoonomia" contains medical psychological and physiological information on animals, comments concerning how exterior stimuli affect such considerations and the common traits to all animals-whereupon the conclusion that they all have the same origin - the diversity being a later phenomena, achieved through crossbreeding between species. In other words, the grandfather was a true precursor of the grandson soon to become a celebrity.

The father, Waring Darwin (1766-1848), was likewise a physician; after he got his PhD, at the age of 19 at Leyda (Today, Leiden) in Holland, he practiced medicine in Shrewsbury to his dying day. The mother, Susannah

Wedgwood (1763-1817), having left Charles Darwin an orphan at the age of 8, was the daughter of a ceramic worker that created a new kind of porcelain. With such well trained relatives and parenthood, Charles found within the bosom of his family the perfect environment for his intellectual superior formative project.

Charles Darwin commenced his studies in 1817, the year of the unfortunate loss of his mother. Disliking scholarly activity he was a poorer student than his sister Catherine. He was impassioned, however, by collecting minerals, coins, medals, stamps, shells, birds' eggs and was trying to find out the names of all the plants he had gathered. One year later he moved on to Preacher Butler's school where he studied for 7 years Latin, Greek, something of the works of ancient thinkers and poets, as well as some notions of history and geography. This scholastic education made him write in his autobiography that: "Nothing could have been more harmful for the development of my intelligence than Preacher Butler's school (DARWIN, 1962).

In those years of study, Darwin liked to wander alone and fish with a pole. He was 10 years old when, finding a book on bird watching, he proceeded to take notes on the lives of birds, and at the age of 15, having received a hunting rifle, he became a skilful hunter. Through these activities he came closer to nature. Reaching a point where he would understand it, in time he would give up hunting, because of his inborn love for animals. Although he had a keen capacity for analysis and interpretation of nature, Darwin was not suited with a matching memory. He could learn by heart hundreds of Homer's and Virgil lyrics but within a matter of days he would forever forget them. Further on, he was never able to seriously study any foreign languages (MOTAȘ, 1973, p. 16). I found out this biographical detail when during the "History of Biology" class of 1953, the 9<sup>th</sup> of November, Professor N. Botnariuc told us that Darwin, never having trusted the soundness of memory in general, and of his own in particular, during his great journeys he would always care to note down and collect as many study materials as he could before he would depart. Although written ad-hoc, his notes were rich in detail because he was convinced "rushed notes" leave gaps that later require adages of "vague and superficial hypotheses". He wrote: "Never rely on memory, because memory becomes an uncertain holder when an interesting object is followed by and even more interesting one" (DARWIN, 1958, p.32). Consequently, throughout his life, Darwin made concrete, exact notes, so that he may insure his memory. This explains the density and accuracy of his works, based from exact field observations, on his readings and consulting of other trust-worthy sources. (The same habit is still found, to this day, with the authors of this article, practiced diligently after professor N. Botnariuc spoke in the aforementioned class of Darwin's method. Today, students and researchers make use of a computer's memory, which basically is also based on a filling system). Darwin was extremely honest with himself and held no prejudices. He believed only in facts that he apprehended and sought to find a scientific explanation. It was only natural that upon returning from his great journey he studied his notes and collected materials – an occasion for hard work and meditation throughout the rest of his life (details to be found in NEGREA, 1953-1954, BOTNARIUC, 1961, MOTAȘ, 1972).

Upon graduating from school, both Butler and the other teachers tagged Charles as a "very regular boy, rather beneath a mediocre intelligence" (DARWIN, 1962, p.36), and his father scolded him bitterly: "Outside of hunting and catching rats you have no other interest in life; you will be a disgrace for this family and for yourself" (DARWIN, 1957, p. 4). It is clear the father did not understand his son and would in further times, further fail to do so. The son however, kept his eye on his passions as a collector and hunter. Chancing to read "The Wonders of the World", the yearning to travel arose in him and he read it several times.

In October 1825, Charles and his elder brother Erasmus (1804-1881), were sent by their father to Edinburgh in Scotland to study medicine. Soon, in order to escape the boring classes, the horror of assisting surgical interventions without anaesthesia and dissecting cadavers, he started allocating more time for meetings with natural scientists in town, growing closer most to Robert Grant, a pupil of Lamarck. From him he got word of Lamarck's zoological theory, but was not impressed by it; he was not interested in speculative theoretical ideas. He preferred to study nature without a proxy. In later years he would regret as a zoologist, his initial disgust for anatomy and his lack of talent for drawing.

In 1826 he became a member of the Edinburgh Natural Scientists Association, called "Plinius", wherein he presented his first scientific work about the *Flustra bryozoan* and the *Pontobdella muricata* hirudin. His mentor, Doctor Grant, made possible Darwin's taking part in the Royal Medicine Society meetings and those of the Wemerian Geological Society, thus becoming a true self-taught natural scientist. During his vacation he preferred to walk (up to 50 kilometres within one day), travel and hunt.

After Erasmus left the Medical College for the one in Cambridge, the father of the boys, seeing that his dream to leave Charles as his successor in his cabinet practice was in shambles, moved him to Christ's College in Cambridge, where he studied Theology for 3 years (1828-1831). At first he liked the idea of becoming a country Chaplin, being able as such to study nature, insects and birds, and hunt at ease. But, the more his passion for science grew the less time he had to study theology. He chose to follow the elective courses at the Cambridge University for Natural Sciences in spite of those at the Theological College. As such he took Sedgwick's Geology and J.S. Henslow's Botany—a young professor, but knowledgeable in all biological disciplines. He did not miss one student trip, collecting plants and studying them. Noticed as a professor, a lasting friendship formed between them. Being invited to the get-togethers at his house, Darwin met and spoke with numerous men of science and culture. By this way, Darwin completed his self-taught natural scientist education. Worth mentioning is that in his 3 Cambridge years he managed to bring together a rich coleopterans collection—insects that he was well acquainted with and that allowed him to befriend known entomologists and got him his first researcher satisfaction. No poet - wrote Darwin in "Autobiography" - has ever felt a

more wondrous happiness that the one I am have experienced reading "Illustration of British Insects", the magical words "collected by Ch. Darwin Esq.". After he finished the Theological College in August 1831, Sedgwick, the geologist, took Darwin for a research in North Wales. With this opportunity, he learned to interpret the tectonic and geological structure of a region. Worth mentioning in addition is the fact that his reading of Alexander von Humboldt's "Journey to America", reignited his interest for expeditions that would allow him to know nature around the world. Enthused, he used to read to his friends entire passages from that book, promising them he will without a doubt see himself those wonderful places described in Humboldt's book. That promise came true occasioned by his trip around the world.

### **DARWIN'S TRIP AROUND THE WORLD (the 27<sup>th</sup> OF DECEMBER 1831-the 2<sup>nd</sup> OF OCTOBER 1836)**

It is practically impossible to summarize, within the limits imposed on this commemorative article, the content of the second edition "corrected, with additions" from 1845, the only one translated into Romanian, titled in the original: "Journal of Researches into the Natural History and Geology of the Countries visited during the voyage of H.M.S. Beagle around the world under the command of Capt. Fitz Roy R. by Charles Darwin, M.A., F.R.S.". We will however, try to dot down some of the relevant data, taken from the Romanian edition (see DARWIN, 1985), accompanied by our comments. In spite of having more than 500 pages, Darwin's book stands to this day as a captivating, non-fiction novel.

**Day 24 August 1831.** It was the happiest day in Darwin's life: his protector, professor Henslow, gave Darwin notice that he was to be recommended as the natural scientist of the brig-sloop H.M.S. Beagle, that was getting ready for a round the world trip. Captain Fitz Roy, an energetic "sea wolf", good sailor, cartographer, hydrologist, geographer and meteorologist, was just about to deny Darwin passage on account of the shape of his nose, that, to the captain, betrayed a man without energy and endurance necessary for a long span trip (Fig. 1, 2).

**Departure of the H.M.S. Beagle from Devonport.** The young self-taught natural scientist boarded on the 24<sup>th</sup> of October 1831 but, due to some heavy storms, the ship only departed from Devonport on the 27<sup>th</sup> of December, heading for South America. The purpose was to map out Patagonia and Tierra del Fuego (started by captain King during 1826-1830), as well as mapping the topography of the Chilean and Peruvian coastlines, including of some islands in the Indian, Pacific and Atlantic Oceans. Likewise, it was also meant to make chronometric measures during the journey around the Terra. The H.M.S. Beagle was a robust ship, of 235 tones, with three masts and 6 cannons but, because of some manufacturing defects, it was classed as a "floating coffin". In spite of all these, it held together through all the storms and difficult seas of the Southern Hemisphere.

**The H.M.S. Beagle Journey:** Devonport (England)-Santiago Island (Capo Verde Arch.)-San Paolo Isl. (Atlantic Ocean)-Fernando de Noronha Isl.-Bahia (or San Salvador, Brazil)-Rio de Janeiro-Montevideo (Uruguay)-Maldonado-Rio Negro-Bahia Blanca-Buenos Aires (Argentina)-Santa Fe-Puerto Deseado (Patagonia)-Rio Santa Cruz-Tierra del Fuego-Falkland Islands-Magellan's Strait-Valparaiso (Central Chile)-Trip to the Andes Mountains-Santiago de Chile-Chiloé Isl.-Chonos Isl.-Tres Montes Peninsula-Conception-Valparaiso (traversing the Andes to Mendoza)-Copiapo (North Chile)-Iquique (Peru)-Lima-Galapagos Arch.-Tahiti Isl.-Eimeo Island-New Zealand-Sydney (Australia)-Tasmania (Van Diemen Country)-King George Golf (Australia)-Keeling or Cocos Island (Indian Oc.)-Mauritius Isl.-Cape Town (South Africa)-St. Elena Island (St. Helena)-Ascension Island-Bahia (Brazil)-Pernambuco-Sao Tiago Island (Capo Verde Arch.)-Azores Islands-Falmouth (SE England). From the 5 years of the journey, mapping out the South American coast line took 3 years of hard work (this being the main purpose of the journey). This mapping proved however, beneficent for the development of maritime ports.

**Darwin, the natural scientist *modus operandi* regarding field work.** The extended station in Montevideo, Maldonado, and other South American ports was benign for Darwin as well, this allowed him to take trips around the continent, of over hundreds perhaps thousands of kilometres. While reading his field files, one is amazed at the precision of his descriptions, the logic of his interpretations and the depth of his conclusions. One is left to wonder what to appreciate more: his unusually keen sense of observation, his talent for clearly expressing his ideas, or the pages in which he describes the surrounding nature in a pure literary style. But he did not limit himself only to description and contemplation of natural phenomena and various discoveries. He compared, sought for causes, the scientific explanations of those that he observed, writing his ideas, hypotheses and certainties on the spot. He had no trust for memory. And he was perfectly right to do so. We know from our own experience that memory can deceive, deform, synthesize or erase any information old or new, if it is not recorded immediately. Although young, Darwin did not hesitate to advise naturalists to do as he did: to keep in mind that gathering collections is the least important side of field-work; that materials collected gain a "considerable" value (read as "scientific") only if they are tagged (correctly and completely, we add), if sketches and drawings are made and if a careful and patient research of all that needs comparing seen or read is industriously performed. It follows that Darwin was gifted with an exquisite methodical spirit, his thoroughness extending to pedantry. His results were as such to match the efforts. It was worth it, as much for him, giving him the satisfaction of being an accomplished natural scientist and allowing him to move from the "fixist" conception (fashionable at the time due to Cuvier's authority) to an evolutionist conception (whose precursor was Lamarck), as well as for mankind, determining its belief in facts only and not in unscientific based speculations.

**Darwin's discoveries during his journey around the world.** We will be referring herein only to some of the discoveries that led Darwin's thoughts, chiefly to a scientific argumentation of the origin of species through natural selection and the propounding of the evolutionary theory.

1. In Rio de Janeiro he noticed that the cultivated cabbage is not attacked by insects as it was in the home regions of England. Why? Darwin asked: isn't it possible that there are particular relations between species inhabiting the same region and that with time a reciprocal adjustment occurs? In this case, regarding the cabbage brought from Europe quite recently, is it possible that the local pests did not have enough time to adapt for attacking the plant?

2. Also in South America, in Maldonado, close the La Plata estuary, Darwin noticed the swollen, sick, practically sightless eyes of a small tucutuco rodent (*Ctenomys brasiliensis*) that digs galleries underground and vocalizes in a manner similar to his colloquial name. If we take into account his strictly subterranean life-style-Darwin writes (1958, p. 90-91) - the lack of sight cannot be a great disadvantage; nevertheless it is strange that an animal has organs so often exposed to harm. If Lamarck had known this fact, he would have been of course quite happy with his own speculations (probably more truthful than he was used to) on the gradually acquired blindness of the *Aspalax* rodent (*Spalax*, NN) or by the *Proteus* reptile (amphibian, NN)[...]. Without a doubt Lamarck would have said that the tucutuco is at present moving from the state of the *Aspalax* to that of the *Proteus*".

3. Journeying on land from Bahia Blanca towards Buenos Aires, Darwin discovered in the diggings of Punta Alta a fossil deposit made of primitive mammal bones, especially edentates, deposited in the estuary of a long gone river. "This discovery is very interesting-he noted-both on account of the large number as well as the extraordinary variety of the gigantic land animals buried here" (Darwin 1958, p. 115). There were bones of *Megatherium*, *Magalonyx*, *Scelidotherium*, *Myiodon* that in later times was to be dedicated to him (*M. darwini*) and several other skeletons, some nearly complete. Out of all the fossils, he was most impressed by the *Toxodon* ones, that was "one of the strangest animals ever discovered thus far: as big as an elephant or a *Megatherium* but the teeth formation, as Mr. Owen establishes, proves beyond any doubt that it was a close kin of the rodents [...]. How amazing it was that *Toxodon*'s constitution reflected the traits of different animal orders, presently so different from one another!" (DARWIN, 1958, p.118). Today, *Megatherium* and the other "gigantic animals" from Punta Alta are considered as the ancestry to the actual South-American forest sloths, likewise lacking the canines and incisors (wherefrom the edentate name). *Toxodon* is classified into a separate order of the South American ungulates; although their teeth resemble that of rodents, they are not related. What is important is that the Punta Alta fossils played a crucial role in Darwin's mind when forming the evolutionary ideas. Far from considering them "acts of creation", he advanced the hypothesis that it is more logical to consider the present edentates the descendant of the fossil ones.

4. Reaching South America at the end of a long drought (1827-1832) known as "Gran Seco", Darwin saw destroyed vegetation and barren land, dead wild animals, flocks migrating towards the Varana river, carcasses being carried by the water towards its estuary, piles of bones. If Cuvier would have seen them, Darwin noted, he had interpreted them as a proof of creation! His natural scientist eye did not overlook neither the crop plants nor the domestic animals brought by the Europeans, and the modifications brought on by the former to the structure of the local fauna and flora, bringing some plants to extinction and some animals to turn feral, etc. Analyzing these observations the idea of the interdependence of species that populate a certain region came to him.

5. Researching the flora and fauna from the Galapagos volcanic islands, situated in the Pacific Ocean, almost 1,000 km from the Ecuadorian coast, led Darwin to believe that species indeed evolve. He observed that, although the fauna and flora is similar to the South American one, it has its particulars, that each island has its particular species. One example: while the aqua-endemic lizard *Amblyrhynchus cristatus* populates the rocky shores of all the islands within the archipelago, the land kind, *A. demarllii* (that do not have the flat-sided tail as well as palmed feet and does not feed on algae as the first species) inhabits only the interior of 4 islands from the central part of the archipelago (details in DARWIN, 1958, p. 378-383). In terms of Natural History the distinct characteristic of this archipelago - Darwin affirms (1958, p. 386) is to be found in the fact that each island is inhabited by living things with particular traits. He noticed that the natives can distinguish between the different turtles on the different islands, because of their various sizes and characteristics. Consequently, Darwin concludes, it is probable that every different island has a race of lizards or turtles particular to itself. Based on the numerous observations, Darwin deduced that the islands' flora and fauna come from ancestors brought on by oceanic currents and other ways and means of passive spread from South America that eventually adapted to the features of the environment special to each island. Thus Darwin contributed to solving the problem of common ancestry, of the environment's influence and adaptability to it. Also in the Galapagos islands, Darwin studied the behaviour of the birds that allowed men to come close to them and even posed on their hands. The given explanation was logical: on the uninhabited islands, birds did not have a self-defence instinct for their lives that is itself fixed in the nature of the organism and transmitted through the genes.

6. Until the beginning of the 18<sup>th</sup> century, Saint Helen's Island was covered with vast forests, among which the Great Forest. If in 1716 there were still trees, mostly dry, until 1724 all of them collapsed from old age. The cause? The goats that had been brought to the island in 1502, in the absence of any carnivores, had multiplied to such levels and, being left to wander everywhere, they destroyed the entire sylvan youth. As a result, the forests including the Great Forest, got smaller and smaller until they were extinct, their place being taken by a large field of spiky grass that with time engulfed everything. To no avail in 1731, it was ordered that all the pigs and goats without a master be slaughtered: without young trees the forests could not recover. Together with the trees, floor plants became extinct, as



well as birds and invertebrates. DARWIN (1958, p. 467) made the following note: "Such a considerable modification within the vegetation has not only affected the terrestrial mollusc population, provoking the extinction of 8 species, but in the same fashion it has touched a multitude of insects". From this example one can deduce how serious can man's reckless intervention be, through introducing species in an ecosystem without conducting a previous study and how complicated food chain interspecific relations can be.

In the last pages of his travel journal, Darwin analyses the "damages and gains, pains and pleasures of sailing around the world". According to him, the journey's satisfactions were not outweighed by the pains. If not for the scientific scope, it would not have been worth it, and he who, like Darwin, is pained by sea sickness, should himself dwell on the matter well before departing, because this affliction is without cure. It was a hard extenuating journey and it undermined his health so much that, when he returned home, he was constantly ill to his dying day. It remained however, the most significant event of his natural scientist life, being the occurrence that led to writing his immortal work. In the 23 years of hard work during which he processed the collected material and field notes and also edited his famous writ-piece "*On the origin of the species*" (DARWIN 1859), he would always remember the images and events that impressed him most: "The Southern Cross, Magellan's Cloud and all the other constellations of the Southern Hemisphere; the maritime waterspout; the blue ice glacier river, hanging over the sea more ominous than any gorge; the lagoon-island made by the coral reef; an erupting volcano, the terrible disaster of an earthquake" (DARWIN, 1958, p. 479).

### AFTER THE VOYAGE (1836-1882)

After his journey, Darwin had a period of intense scientific activity in Cambridge and in London. On the 29<sup>th</sup> of January 1839 he wedded his cousin Emma Wedgwood and settled in London. His first child, Francis, as well as the girls and boys that followed, were equally the object of his affection and of his study. The outcome of those studies was included in the paper "*The expression of emotions*", translated in Romanian (DARWIN, 1969). His precarious health determined Darwin, in 1842, to isolate in the village of Down, found somewhere at a 20 mile distance from London (Fig. 3-7). But even here, although he would lead a modest life, care-free, in the bosom of his ever-growing family, tended to by his devoted wife, he was tortured by an affliction of the stomach, conducive of insomnia and nausea. He read very much, he studied and edited scientific papers, he conducted laboratory experiments, he walked and rode, but did not hunt anymore. As the head of the family he was good and kind, loved and respected, and as a host he was polite and pleasant, often telling stories from his childhood and from his journey around the world. He was not an able man when it came to disturbing or offending, he would patiently listen to anyone. His total lack of envy and quick tempers, his polite behavior and delicacy onto all, betrayed the equilibrium of a perfect soul, entirely opposed to his bodily suffering. It was only when his scientific convictions were at stake, they sometimes praised sometimes critiqued, that Darwin stood his ground firmly based on facts and scientific experiences.

Right in the year of his departure (1842), in the quietude of Down, Darwin found the necessary respite to draft for the first time his theory of evolution-a draft that would only be discovered 14 years after his death. Two years later (1844) he also brought together a larger draft, better prepared, that he, however, hesitated to publish even with the support of the geologist Charles Lyell and of other friends, because it seemed to him that the material on which his theory was grounded was still insufficient. After another dozen years, in 1858, Darwin received from Alfred Wallace (natural scientist) an article entitled: "On the Tendency of Varieties to Depart Indefinitely from the Original Type", in which Wallace asked Darwin to publish it. A great surprise: in said article, A Wallace formulated precisely Darwin's construal of the origin of species, including the particulars of Darwin's theory as to a principle of struggle for existence and of natural selection! Kind-hearted and modest, Darwin was about to give up on the priority of his theory but, upon Lyell's insistence, he presented in that same year (1858), in front of the 'Linnaean Society', Wallace's article, together with a short summary of his own theory. Upon the push of that same friend, Darwin edited his famous work: "The Origin of Species" that was made public on the 24<sup>th</sup> of November 1859, in 1250 copies, all of them sold that very day. Encouraged by his success, he went on to edit a series of works, apparently with no connection between themselves, but all aimed at the same scope: to prove the verity of his conceptions in various fields. BOTNARIUC (1961, p 315) gives a list of these papers, a total of 8 titles in 17 editions, with the publishing year and for some the printing serials. MOTAȘ, 1972, p. 109, estimates the number of these papers somewhere around 5000 pages.

- *On the origin of species* (Edition II 1860, III 1861, IV 1866; V 1869; VI 1862 greatly added to, the last edition within Darwin's life time)
- *On the various contrivances by which British and foreign orchids are fertilized by insects* (Edition I 1862, II 1877)
- *Variation of Plants and Animals Under Domestication* (Edition I 1868, II 1875)
- *The Descent of Man, and Selection in Relation to Sex* (Edition I 1871, II 1874)
- *The Expression of Emotions in Man and Animals* (1872)
- *Insectivorous Plants* (1875)
- *The Effects of Cross and Self Fertilization in the Vegetable Kingdom* (Edition I 1876, II 1878)
- *Cross-breeding in plants* (1880)

After Motaș's appreciation (1972), Darwin thought well when "receiving all the praise and acknowledgements without getting drunk on his successes and attacks, taking all with the utmost serenity and tranquillity". He was equally

overwhelmed by critics and honours. He received numerous medals, decorations, prizes and membership titles for over 69 associations from all around the world including from the "Transylvanian Natural Science Society in Sibiu".

In July 1881, at the age of 72, Darwin wrote to A. Wallace of his hardships; that he has it a loss as to what to do in the few years of his life that are left to him: "I have everything I need to be happy and content, but life for me is now terribly tiresome". He continued however, to work on a problem regarding plant physiology that preoccupied him: Ammonium carbonate's effects on roots and leaves. He was unaware that death was already stalking his affairs. Early in February 1882, his cardiac seizure, arrhythmia, atrial fibrillations came at a faster pace, so much that Friday, on the 19<sup>th</sup> of April, at 4 p.m. his heart stopped beating. He had just celebrated his 73<sup>rd</sup> anniversary. The illustrious naturalist was buried in Westminster Abbey with the representatives of France, Germany, Russia, and Spain present as well as numerous university and scientific society members, colleagues and friends. His tomb is situated in nave of the Abbey, close to Isaac Newton's, another giant of universal science.

## DARWIN'S EVOLUTIONARY CONCEPTION

In the following lines we will attempt to offer a sketch, as brief as possible, of Darwin's evolutionary concept. For a more exhaustive briefing one must consult, chiefly, the following works: DARWIN (1957, 1958, 1962, 1967, 1969), RACOVITĂ (1929, 1993), BOTNARIUC (1961, 1967, 1992, 2003), MOTAȘ (1972), STUGREN (1965), HASAN (1998), GOULD (2002), MUSTĂȚĂ (2003), MUSTĂȚĂ & MUSTĂȚĂ (2006). In what we are concerned, MUSTĂȚĂ's paper (2003) contains the clearest and most concise presentation of Darwin's evolutionary conception, including post-Darwinist theories, and that in the author's attractive and characteristic style.

J. B. Lamarck was the first naturalist to reach the conclusion that the living world was not always the same, that species transform under the influence of the environment and that man is a descendent of "singes quadrumanes" (four handed apes). These ideas he exposed two centuries ago in his work "Philosophie Zoologique", published in 1809. He is considered the founder of the **transformist theory**, upon which God created the world which, through successive transformations, has become what it is today. Lamarck's theory is based on two laws: the law of use and of non-use, as stated by G. L. Buffon, and the law of acquired characters inheritance, the latter refused by modern genetics. What is incomprehensible is that Lamarck did not recognize the category of species on the grounds that, being in a continual transformation, it does not have an ontological status. The transformation theory was not accepted by his contemporaries, although it was heartily defended by Etienne Geoffroy de Saint-Hilaire against Georges Cuvier's attacks. Without being able to sell his book, he died forsaken, blind and poor at the age of 85. He was buried in common burial grounds.

The groundwork for the **theory of evolution** was done by Charles Darwin in his famous work on the "*Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*" in 1859, held a century after Lamarck's Zoological Philosophy. It is considered the birth act of Evolutionary Theory. As we have seen, the direct contact with nature during his Voyage around the world, furnished enough material to favour this conception. Working on this material, he managed to decipher the mechanisms that determine the evolution of species. In the series of lectures given at the Biology Faculty in Bucharest (NEGREA, 1953-1954), Professor N. Botnariuc drew on the blackboard a guiding schemata of Darwin's thought, schemata that he further used in his book "From the History of General Biology" (BOTNARIUC, 1961, p. 319):

### VARIANCE AND HEREDITY:

- OVERPOPULATION–FIGHT FOR SURVIVAL–NATURAL SELECTION–WILD SPECIES TRANSFORMATION
- ARTIFICIAL SELECTION–DOMESTIC SPECIES TRANSFORMATION

Professor Botnariuc drew our attention to the interspersed dashes that indicate chronology and not derivatives: *variance* furnishes material for evolution; *heredity* is the factor that establishes variation, it leads to an accumulation in time; *overpopulation* generates or intensifies the *struggle for survival*, and *natural selection* ("survival of the fittest" with A. Wallace) leads to the transformation of wild species. The schemata for domestic species is grossly simplified due to man that selects with a view to his own interest. As it is well put by MUSTĂȚĂ (2003, p. 27), natural selection stands for the factor as well as the engine of evolution; it represents the natural mechanism through which the evolution of species is channelled in one direction.

### Evolution Factors

**1. Variance** is organism's character to respond differently, from one individual to another, to environmental factors, giving birth to so called variations. There are several types of variance: *defined*, it occurs within all the individuals of a population in the aftermath of environment modifications; *indefinite*, this affects the individuals of a populations differently when that population's environment factors change; *corresponding*, this is derived from the two types stated above and unfolds according to the law of correspondence (ex: an organ's transformation affects the other organs with which it corresponds-but there are unexplained phenomena: white coloured cats with blue eyes are deaf etc); *extended*, this manifests over several generations (if the conditions that provoked the variance are maintained); *saltatory* (that does not consist of small modifications accumulated by degree), such as with some sheep or cattle races

(ex. Ancona sheep race with short legs, etc.) - the latter variance was considered by Darwin as insignificant for the evolution of species.

**2. Heredity** is just as important as a factor of evolution, because it fixes the small variations that occur and it transmits them to the future generations. This refers to the new character transmission from ancestors to descendents. Darwin makes a precision point on that matter that not all variation is transmitted by way of heredity (ex. extended variance can impede hereditary fixation if, with each generation, that particular character is affected). Darwin explains hereditary characters transmission through the theory of pangenesis. Following Democritus, he admitted the existence of material particles with a hereditary role, called *gemules*, located in the reproductive cells, which can circulate through the organism, where they can be influenced by the environment. Darwin holds that there is a *simple type of heredity*, which occurs when the traits of a single parent are inherited, achieved thusly through vegetative reproduction (autogamous) and there is also a *combined type of heredity* that occurs when two partners are involved, this being the case of sexual reproduction (allogamous).

**3. Overpopulation** is an important factor that can determine or intensify the fight for survival. Darwin was inspired by Thomas Malthus' principle of overpopulation from his paper "*An essay on the principle of population*". In fact he had noticed a tendency with organisms to multiply indefinitely as a means of survival of their species long before he became acquainted with Malthus' book. Darwin brought irrefutable proof that the high number of individuals does not depend with necessity on the number of laid eggs (e.g. the ostrich lays up to 20 eggs and the condor 2 at most but there is still a greater number of condors than of ostriches; the explanation is simple: the condor eggs are not destroyed by predators). Exaggerate reproduction with some organisms occurs in special situations, as a result of the powerful influence of some environmental factors or when man intervenes and destroys natural equilibrium within the species of the ecosystem (we have mentioned the consequences of introducing goats on St. Helen's Island). Some of Darwin's examples prove the impossibility of overpopulation in a natural, virgin environment. The great number of "germs" is not and cannot be the cause for overpopulation.

**4. The struggle for survival** is a factor of the utmost importance in Darwin's theory. This struggle can only be of 3 kinds: *the struggle with the environment* (drought, frost, floods etc.); *the intraspecific struggle* (between the individuals of the same species, for the same food, space, breeding grounds etc.) *the interspecific struggle* (considered by Darwin to be the biological engine of evolution). The interspecific struggle for survival has as its effect the limitation of territory extensions of that species and exaggerated breeding; also it influences the development of the species. In other words, this refers to the fight between predator and prey, to what we among us, ecologists, call food chain relations between carnivores and herbivores; referring to food chains and cycles made up of a considerable number of strains after the following schemata: nutritional resources → primary producers (especially plants) → primary consumers (animals that feed on producers) → secondary consumers of different degrees (animals that feed on primary producers and/or primary consumers) → decomposers (that close the respective cycle) (details in NEGREA, NEGREA, ARDELEAN, 2004).

**5. Natural selection** is the most important factor of evolution, titled as aforementioned, "the engine of evolution". This is the factor that maintains the equilibrium in nature, eliminating or promoting the increase in some happenstance variance or another. Resorting to natural selection, Darwin excluded the necessity of an intervening force from outside the surrounding nature. In other words, he discovered that nature acts as a unique selector. Any of the environmental factors that determine modifications, can act accordingly. The variations resulted from this action can be positive, favouring the individuals that bear them, some though could prove negative, disfavours their carriers. It follows with logic that only the individuals fitted for the modifying environment will survive. The more these conditions are maintained, the more accentuated positive variations will enhance, making possible, through organ correspondence, that new traits will be genetically transmitted to descendents. Natural selection sorts out variations that occur in individuals, in no case it induces the apparition of new variations the evolution of species. It results that the natural selection insures both the adaptation and the evolution of the species, that it has a creative role. The phenomenon of homochromia, for instance, is created by natural selection. One could therefore state that in light of Darwin's conception that "evolution is adaptable and adaptation is, in its own turn, evolutive" (MUSTAȚĂ, 2003).

**6. Sexual selection.** Darwin noticed that it does not always happen that secondary sexual characters are useful to the individual that carries them for his struggle to survive: that some do not give it an advantage, and others can place him at peril's end. Likewise, there are habits such as singing or mating ritual dances with birds that, by attracting attention to carnivores, can be attacked by surprise. However, why are these morphological traits and behaviours not eliminated but fortified? Darwin explained this through sexual selection that promotes and insures the mating of the fittest, capable of yielding the most enduring of descendants, the best genetically endowed, and therefore being a benign selection. "This manner of selection, Darwin emphasized (1967), depends not only on the struggle for survival but on the connection with other organisms and external conditions, but on the fight between same-sex individuals, mostly males, for possession of the opposite sex". Darwin was convinced that all secondary sexual characters are of a real use in the attempt to possess the female. Better endowed, bolder and more attractive males will prevail in this competition, that is less hard than for survival: "A hornless elk or a spurless rooster, writes DARWIN (1967, p. 179), will have a lesser chance to leave a more numerous lineage".

**7. The origin of domestic organisms and artificial selection.** Based on an in-depth study of morphological, ecological, palaeontological and historical data, as well as on the results yielded by comparing domestic species with

wild similar species, Darwin managed to prove the common monophyletic origin of many grown plants and domesticated animals. Among others, he proved beyond a reasonable doubt that all races of house pigeons are descending from *Columba livia*. Using the same procedure with domesticated races of poultry, he proved without a doubt that they descended from *Gallus bankiva*, which lives to this day in the wilderness of forests in India, Indonesia, the Philippines and the Malay Archipelago. By the same way it was proved that domesticated species of hares come from *Oryctolagus cuniculus* from South-East Europe, and domesticated races of donkeys come from *Equus taeniopus* etc. Once more, in the same fashion, Darwin solved the problem of the origin of domestic plants, by proving that the numerous kinds of corn, cabbage, beans, peas, potatoes, apricots etc. have a common monophyletic origin (details in BOTNARIUC, 1961, p. 338-340). Both in animals and in plants there are cases of a common polyphyletic origin, meaning that one entire group of domestic races comes from a wild species, another from another species, each of these groups having therefore a common monophyletic origin as well. Solving the matter of the origin of home-grown plants and of domestic animals was of a great importance because if the existence of polyphyletic common origins would have provided grounds for rigid interpretations, while proving common monophyletic origins was alone the proof for evolution (BOTNARIUC, 1961, p. 338).

All sorts of homegrown plants as well as domesticated animal species have been created by men with precise goals, concretely anchored in economic necessities, esthetical taste or fantasies. They have reached desired results through artificial selection. For Darwin this is of two kinds: unconscious and methodical.

7.1. *Unconscious artificial selection* was practiced by man ever since he started to hunt and grow plants. He did not propose to create a race or a kind in particular, having in his perview the sole satisfaction of the immediate household or collective needs of his life. Practically, he kept only the individuals that served his interests: productive birds, the best cattle for milk or meat, the best productive plant seeds etc. In fact this sort of selection has been and is to this day continuously practiced.

7.2. *Methodical or conscious artificial selection*. A selector proposes a specific scope, the creation of a new race of animals with particular qualities or with modifications in a singular direction. These goals are achieved through selecting appropriate individual variants, by way of cross-breeding, disparaging unfit individuals without hesitation. Methodical selection lasts for several generations until it reaches its set goal. Obtaining new sorts of plants is reached by the same way. For details regarding artificial selection see BOTNARIUC (1961, p. 340-344).

### Darwin's conception of the species

Is species a reality that sits at the basis of evolution or is it an artificial category, invented by taxonomists, like all supraindividual traditions? If it is a reality, how was it formed and how did it evolve? Darwin retorted adequately and well documented by elaborating "The scheme of diverging characters" (BOTNARIUC, 1961, p. 383), which, given its length, cannot be reproduced or commented upon here. We can however reproduce the conclusions reached by the author at the end of the diagram, summarized by BOTNARIUC (op. cit., p. 385): "From this diagram it is clear that the evolutionary process, therefore the process of descendency of forms, can be presented through a phylogenetic tree, within which the thinnest more numerous branches stand for the diverging character superlatively diversified of the forms. The forms' divergence and diversification appear as necessary consequences of natural selection, they are advantageous to the evolving forms. During this process, its continuance (although irregular, some species remaining unchanged over prolonged periods of time) leads with necessity to a discontinuity of the forms at every moment, due to a struggle to survive that usually eliminates the intermediary forms. This way, through the application of the principle of divergence, Darwin solved the contradiction between a continuity of the evolutionary process and the discontinuity of the species from nature and thus he explained why *species are real groups*, generally well framed, that have a constant relative in time and space".

Following BOTNARIUC (op. cit., p. 385), Darwin errs when he explains the character divergence as a result of interspecific struggle. He also did not bring proof for this type of struggle, and therefore, it cannot be invoked as a necessary and permanent factor of the evolutionary process. According to N. Botnariuc, "this role can be successfully performed by the fight between species closer to one another or distanced from one another, the fight at the outset of which the intermediary forms, the lesser adapted as they are to some precise conditions, will generally be eliminated".

Darwin did not give a definition for the species. Furthermore, like Lamarck, he did not recognise that the species is real, as an evolutionary stage but as an ever-changing entity. "I look at the term species - Darwin writes - as being arbitrarily given, for reasons of comfort, to a group of individuals that are very much alike; the term species is not at all different from what is essentially called variety, that is given to forms less distinct and more variable. Also, the term variety, in comparison with simple individual differences, is applied arbitrarily and for comfort, so much that at this time species are divided one from the other by large or small hiatuses, and some of them are found at the threshold between species and sub-species". Although he did not recognize the species as a reality, Darwin contributed greatly to knowledge of the species in its dynamics.

Related to the problem of the species, of divergent evolution, we need to mention that Darwin was the one who scientifically fundamented **man's descendance from humanoid apes**, setting forth in his paper (DARWIN, 1967) far more arguments than Lamarck.

## CONCLUSION

Furthermore opposed to Lamarck, Darwin enjoyed great success with his evolutionary theory that spread quickly throughout the scientific world and beyond, changing equally philosophical and biological thought. This immense success is due, without a doubt, to the ardent defence and support on the part of 2 great scientists. It is Thomas Huxley that defended Darwinism against an accusing church and Ernst Haeckel that enriched the evolutionary conceptions with his own personal achievements in the field. What is important is that Darwinism has lasted over decades well into our times, cleansed of its outdated aspects and enriched with new ideas, achieved from accumulated data coming from different disciplines of modern biology.

We could further our brief exhortation about Darwin and Darwinism by presenting Neo-Darwinist theories: micelar theory of heredity as formulated by NÄGELI (1884); mutational theory founded by HUGO DE VRIES (1901-1903); August Weismann's Neo-Darwinism (weismannism) that developed Nägeli's ideas; hereditary factors theory fundamented by Gregor Mendel; chromosome heredity theory based on Mendel's laws and launched by Th. Morgan; geographical isolation theory fundamented by M. Wagner. In the end we dwelled on the Synthetic Evolution Theory (TSE) based, itself, on the theory of natural selection – "the spine" of Darwin's theory, and we would conclude with the most recent of evolutionary theory: M. Kimura's and T. Ohta's neutralist theory; antisynthetic theory (leapist, of marked equilibrium); Lima de Faria's autoevolution theory and we would conclude with modern Neolamarckism. However, presenting these theories, however in brief, we would occupy tens of pages, therefore we send the reader three referential works: BOTNARIUC (1992), GOULD (2002), MUSTAȚĂ (2003) - the latter of the works being benefited by a final attractive and accessible edition.

## EPILOGUE

Fate, willed paradoxically, that a theology doctor (as willed by the father) and self-taught naturalist (through his calling and passion) would scientifically build the evolution theory? How did Darwin solve this problem of consciousness? His discussion with L. Büchner and dr. Aveling, relayed in N. Leon's "Memories" (1925, p. 16) is most edifying and is taken further by MOTAȘ (1972, p. 137). At a luncheon offered by Darwin in his Down household, wherein his two brethren had come to speak of Büchner's book on animal intelligence, Darwin asked them: "Why do you call yourselves atheists?" Aveling answered: "Because we do not have any proof of God's existence [...], because man's science does not know anything but the natural order of things, or an uninterrupted chain of causes and effects, and because invoking supernatural causes will barricade the road of science [...]. We do not admit God's existence because His existence is not proved and therefore our hopes have to be oriented towards this world and not the next".

"Well why don't you call yourselves agnostics instead of atheists?" Darwin replied. Afterwards, laughing, he asked if it just so happened that such ideas are fitted only for superior cultured and thinking men, but not for the masses, not yet sufficiently trained to fully understand such matters. From this discussion it follows that Darwin, in his modesty and prudence, strived spare all from the harm done by his personal convictions. He was a self-declared "agnostic" and not an "atheist", and he respected any sincere opinion irrespective of who was the holder of that opinion. "He was interested, as he confesses himself in many places, in evolution of any kind, even that of man's conceptions", concludes C. Motaș the story in his book dedicated to Darwin.

## ACKNOWLEDGEMENTS

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## ILLUSTRATION EXPLANATION

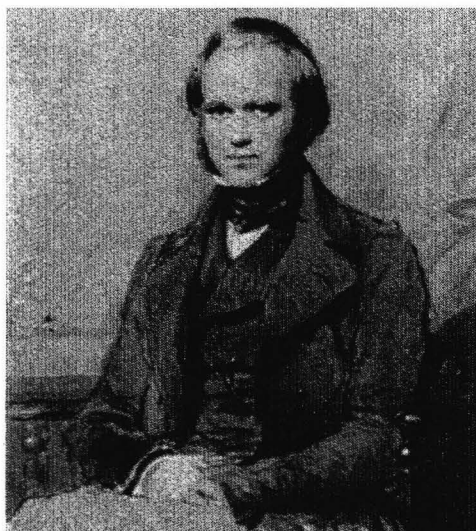


Figure 1. Charles Darwin at 22 years old (1831) before his departure with HMS "Beagle" in the great five years journey around the world (DARWIN, 1958).

Figura 1. Charles Darwin la 22 ani (1831) înainte de plecarea cu bricul "Beagle" în marea călătorie de cinci ani în jurul lumii (DARWIN, 1958).



Figure 2. Robert Fitz Roy, captain of the „Beagle” (DARWIN, 1958)

Figura 2. Robert Fitz Roy, căpitanul vasului „Beagle” (DARWIN, 1958)

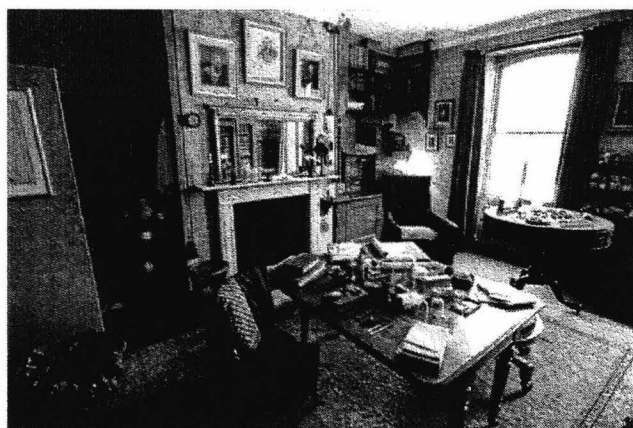


Figure 3. Charles Darwin's office in Down ([www.englishheritageimages.com](http://www.englishheritageimages.com))

Figura 3. Cabinetul de lucru al lui Charles Darwin din casa de la Down ([www.englishheritageimages.com](http://www.englishheritageimages.com))

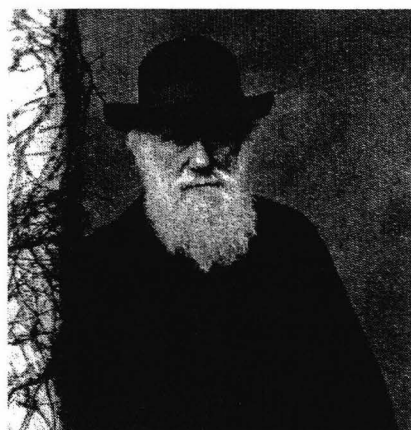


Figure 4. Charles Darwin at the end of his life in his garden in Down (LEROY, 1966).

Figura 4. Charles Darwin la vârsta senectuții în grădina casei sale din Down (LEROY, 1966).



Figure 5. Ch. Darwin' bust at the Botanical Institute of Bucharest (photo Șt. Negrea, at the request of C. Motaș for his book, „Charles Darwin”, published in 1973).

Figura 5. Bustul lui Ch. Darwin de la Institutul Botanic din București (foto Șt. Negrea făcută la solicitarea lui C. Motaș pentru cartea „Charles Darwin”, publicată în 1973).

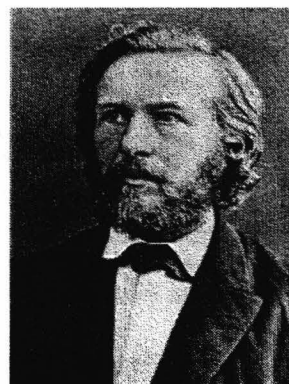


Figure 6. Ernst Haeckel (1834-1919), the most fervent disciple of Charles Darwin, tireless preacher of the Darwinism (MOTAȘ, 1973).

Figura 6. Ernst Haeckel (1834-1919), cel mai înflăcărat adept al lui Charles Darwin, propagator neobosit al darwinismului (MOTAȘ, 1973).

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## THE CONCEPT OF EVOLUTION AFTER 150 YEARS SINCE THE PUBLICATION OF THE "ORIGIN OF SPECIES"

DUMITRU MURARIU

**Abstract.** Continuing the ideas of evolutionists (Georges-Louis Leclerc, Comte de Buffon) and of heredity theory (Jean Baptiste Lamarck), Charles Darwin succeeded in enriching causality phenomenon. He observed and demonstrated that all plant and animal species evolved along the time from common ancestors, under the pressure of the natural selection. His observations made in his journey around the world, of 57 months, allowed him not only the definition of the evolution theory but also of the movement of the Earth's mantle, of the coral reef barrier formation or of the volcanic islands. Basing on the palaeontological data, he established the gradual evolution of beings and not by a leaping one. After discovering of the genetic laws and especially after discovering the population genetics in 1920 it was demonstrated that the mutations do not transform species. They offer basic elements on which natural selection works. Within 1930-1940 anatomists, geneticists, palaeontologists, ecologists and ethologists created the modern synthetic theory of evolutionism after which the new species appear due to the action of the natural selection on the gradual accumulations of mutations in isolated populations. After 1950, molecular genetic appeared, which studies the protean sequences and points out the gene importance in evolution. In 1977 the phylogenetic tree is redefined based on the genetic similarities and not only on the morphological features. Therefore by DNA sequencing and establishing molecular phylogenies, life tree includes three sections: Eubacteria, Archaea and Eukariota. By the sequencing of the human genome it was established that man and chimpanzee had a common ancestor. Synthesis led to the restriction of the numerous currents in the evolutionary thinking and the concept of panselection appeared - as an acceptable evolutionary mechanism in which macroevolution is considered only the result of the extensive microevolution. By the approaching of the cybernetic systems to those of the structuralist evolutionism the importance of the self-organisation processes revealed as factors which directed the evolution way. Today, for understanding the mechanism of the biological evolution history, Darwin's inferences are no more necessary; it has been read in the genetic code. DNA confirms the evolution reality and shows the level where mutations develop. The gene is recognized as the unit of selection.

**Keywords:** transmutation, evolution, Darwinism, neo-Lamarckism, Mendelism, evolutionary synthesis, panselection, structuralist evolutionism, sociobiology, ultra-Darwinism.

**Rezumat.** Conceptul de evoluție la 150 ani de la publicarea „Originei speciilor”. Precadat de părintele evoluționismului (Georges-Louis Leclerc, Comte de Buffon) și de părintele teoriei eredității (Jean Baptiste Lamarck), Charles Darwin a mers la cauzalitatea fenomenului evolutiv. El a observat și a demonstrat că toate speciile de plante și animale au evoluat de-a lungul timpului din strămoși comuni, sub influența selecției naturale. Observațiile și reflecțiile sale în călătoria în jurul lumii, timp de 57 de luni, la bordul navei Beagle i-au permis nu numai formularea teoriei evoluționiste, ci și a altor teorii, privind mișcarea scoarței terestre, formarea recifelor-barieră și atolilor de corali, formarea insulelor vulcanice etc. Pe baza datelor de paleontologie a constatat evoluția graduală a viețuitoarelor și nu prin salturi. După descoperirea legilor geneticii și mai ales după apariția geneticii populațiilor în 1920 s-a arătat că mutațiile nu transformă speciile. Ele oferă materialele de bază (variațiile) asupra cărora lucrează selecția naturală, favorizând răspândirea celor favorabile, în toate populațiile speciilor. În decada 1930-1940, anumiști, geneticienii, paleontologii, ecologii și etologii au formulat teoria sintetică modernă a evoluționismului, după care noile specii apar sub acțiunea selecției naturale, asupra acumulărilor gradate a mutațiilor, în populații izolate. După anul 1950 a apărut genetica moleculară, care studiază secvențele proteice și pune bază pe importanța genelor în evoluție. În 1977 se redefinește arborele filogenetic, pe baza similarităților genetice și nu pe baza trăsăturilor morfologice. Astfel, prin secvențierea ADN-ului și stabilirea de filogenii moleculare, arborele vieții cuprinde trei domenii: Bacteria, Archaea și Eucariota. Prin secvențierea genomului uman la început de secol XXI s-a stabilit că omul și cimpanzeul au avut un strămoș comun. Sintezele au condus spre restrângerea numeroaselor curente din gândirea evoluționistă și a apărut conceptul de panselecționism – drept mecanism evolutiv acceptabil, în care macroevoluția este considerată doar rezultatul microevoluției extensive. Prin apropierea sistemelor cibernetice de cele ale evoluționismului structuralist s-a dezvoltat importanța proceselor de autoorganizare, ca factori care au direcționat cursul evoluției. Astăzi, pentru a înțelege mecanismul istoriei evoluției biologice nu mai sunt necesare inferențele lui Darwin (de altfel corecte), cu 150 de ani în urmă (ex., explicarea formei diferite a ciocului cîntezelor din insule diferite în Galapagos), ci trebuie citită „scriptura” genetică. ADN-ul confirmă realitatea evoluției și arată nivelul (genelor) la care se produc mutațiile. Gena, mai curând decât întregul organism este unitatea asupra căreia acționează selecția.

**Cuvinte cheie:** transformism, evoluție, darwinism, neo-lamarckism, mendelism, evoluția sintetică, panselecție, evoluționism structuralist, sociobiologie, ultra-darwinism.

Defining the base idea according to which the creatures evolve from a species to another and revising the entire title of the most important work published by Charles Darwin, 150 years ago (*On the Origin of Species by means of natural Selection, or Preservation of favoured races in the Struggle for Life*), we realise that the author was convinced that the better adapted descendants of a common ancestor will multiply and rule a territory, while the weaker ones have less chances to evolve in time, to a new species. After him, the species have a common ancestor and evolve, under the pressure of the natural selection, for surviving to the environmental conditions. The evolution is not the result of an inner tendency to perfection, but the result of a permanent contradiction between the tendency of the organisms of having a maximum reproduction and the limiting factors of the environment.

Even if the biological thinking was dominated by the fixity of creatures till the 18<sup>th</sup> century, yet the idea of their modification along time arose in humans' mind since the Antiquity. Greeks', Romans', Chinesees', Muslims' ideas

remained unanswered till the 17<sup>th</sup> century, when Galileo Galilei, father of modern physics and the discoverer of Venus (in 1610) laid the bases of the replacement of the geocentric theory, Ptolemaeus' legacy, with Isaac Newton's heliocentric theory (in 1687). After the new cosmological knowledge was spread, naturalists asked themselves on the species variability more and more. The birth of palaeontology pointed out the new concept of species disappearance and raised new questions on the static conception on nature. Thus we can distinguish a pre-evolutionary worldview.

At the beginning of the 19<sup>th</sup> century, Jean-Baptiste Lamarck proposed the species transmutation/transformation theory (transformism) which later became the scientific theory of evolution. According to Lamarck, the creatures did not have a common ancestor, and the simple life forms were always created by spontaneous generations. His theory marked first transmutationist ideas followed by principle of uniformity.

The term of evolution was used by Robert Jameson for the first time in pre-Darwinian evolutionary ideas (in 1826 - DESMOND, 1992), when he admired Lamarck's theory, on how the larger beings "evolved" from the simplest worms. Those ideas played an important role in reform-minded a politically charged early in the 19<sup>th</sup> century in London. In 1844, the Robert Chambers published the book *Vestiges of the Natural History of Creation*, proposing an evolutionary scenario, as a progressive process of the origin of the solar system and of life on Earth. Fossils indicated the progressive growth of the animal kingdom, relatives of the extinct species among the present ones and the evolutionary line which led to Hominidae. Cuvier contradicted Lamarck's idea and of the anatomist Étienne Geoffroy de Saint-Hilaire, supporting Aristotle's conception according to which the species were immutable. Louis Agassiz and Richard Owen, and the geologists Charles Lyell were fixity partisans and anti-Lamarck, eliminating the idea of the species transformations for decades.

BOTNARIUC (1992, page 34) mentioned that evolution concept was introduced by SPENCER (1864-1867) meaning the phylogenetic development but today the term is very complexly used: evolution of a disease, evolution stars, of a football match, of a political situation, social evolution etc.

In 1859, Charles Darwin published *On the Origin of Species, or the Preservation of favoured races in the Struggle for Life*, basing on the ideas of natural selection theory, on the conclusions of the synthetic study of the complex collections present in his time and, especially, on the study of his own collections, gathered along 57 months (1831-1836), the period when he travelled at the board of the ship "Beagle". Biogeographical, geological data (from which he understood that the Earth changed in time), then the palaeontological, anatomical, embryological data made him to understand that the creatures had a common ancestor, from which the phylogenetic tree resulted. This theory was convincing for most of the biologists, which, in their turn, understood the presence of the biological evolution, but they were not convinced that the natural selection was its primary mechanism.

Among the fundamental ideas of the evolutionist theory distinguishes the gradual transformation of the species (some of them evolving from others), by the variability interaction, heredity, overpopulation, fight for surviving and natural selection. Variability, as a result of the correlation between organism and environment, offers material for the selection activity. Even if he was inconsistent, since then Darwin admitted heredity of the given features, heredity having to fix variations and to gather them along generations. Natural selection had to stimulate the development of the well adapted forms, by which the adaptive features improve from a generation to another.

Also, HUXLEY (1868) was not totally convinced by the key role of the natural selection; he was not convinced by the gradualism invoked by Darwin, too. But, he was a well known English anatomist and he was the first who understood that birds descended from carnivorous dinosaurs. He did not adopt Darwin's ideas but in 1860 he became an enthusiastic supporter of the evolutionist theory, reason why he was called "Darwin's bulldog". He recognized and publicly asserted that, in comparison with Lamarck's transformism, Darwin's theory explained the evolution mechanism without the intervention of a supernatural force.

DARWIN (1859) not knowing yet about heredity wrote: "...As many more individuals are produced than can possibly survive, there must in every case be a struggle for existence, either one individual with another of the same species, or with the individuals of distinct species, or with the physical conditions of life.... Can it, then, be thought improbable, seeing that variations useful to man have undoubtedly occurred, that other variations, useful in some way to each being in the great and complex battle of life, should sometimes occur in the course of thousands of generations? If such do occur, can we doubt (remembering that many more individuals are born than can possibly survive) that individuals having any advantage, however slight, over others, would have the best chance of surviving and of procreating their kind? On the other hand, we may feel sure that any variation in the least degree injurious would be rigidly destroyed. This preservation of favourable variations and the rejection of injurious variations, I call Natural Selection." His argument was that natural selection emerges as a necessary conclusion from two premises: a) - the assumption that hereditary variations useful to organisms occur; b) - the observation that more individuals are produced than can possibly survive. The most serious difficulty facing Darwin's evolutionary theory was the lack of an adequate theory of inheritance that would account for the preservation through the generations of the variations on which natural selection was supposed to act. Theories then current of "blending inheritance" proposed that offspring merely struck an average between the characteristics of their parents.

In his letter to J. D. Hooker, in 1869, Darwin himself wrote: "If I live another 20 years and I am able to work, how much I should modify the SPECIES ORIGIN and how much I should modify my perspective on all ideas! Yet, this is a beginning and this means something ..."

HUXLEY (1868) contributed to the foundation of Darwinism followed by the eclipse of this theory between 1875 and 1925.

Most of the naturalists, named neo-Lamarckians, explained the evolution by the inheritance of the given features, an inborn tendency of progressive change (orthogenesis) or by sudden mutations (evolution by leaps).

After Mendel's studies (1866) about the inheritance, his work contributed to the foundation of the modern science of genetics and mutation theory. Even first rejected, Mendel's ideas were rediscovered in the early of the 20<sup>th</sup> century and in 1930 and 1940 the modern synthesis combined Mendelian genetics with Darwin's theory of natural selection. This was based on the new field opened by the genetic laws elaborated by Gregor Mendel – population genetics which appeared in 1920 and in 1930. Later, population genetics was included in other branches of biology and the synthetic theory of evolution resulted.

Following the laws of the biologic evolution, studying the mutations and variations of natural population, combined with the biogeographical and systematic data, a complicated mathematic and causal pattern of evolution was created. Palaeontology and comparative anatomy permitted the detailed reconstruction of life history. After 1950, molecular genetics appeared, which developed the molecular evolution, basing on the protean sequences and on immunologic tests, then including the studies on RNA and DNA. The conception based on the importance of genes in evolution reached its apogee in 1960, and it was followed by the theory of the molecular evolution, raising passionate discussions on adaptations, selection units and the relative importance of the genetic drift in comparison with the natural selection. At the end of the 20<sup>th</sup> century, DNA sequence permitted the establishing of molecular phylogenesis and the reorganization of life tree in three fields: Bacteria, Archaea and Eukariota. In addition, the newly recognized factors of the symbiogenesis and of the horizontal transfer of genes made the evolutionism history much complicated.

That is why, in the 20<sup>th</sup> century, there were several naturalists who considered the Lamarckian mechanisms of the orthogenetic evolution offered the best explanations on the complexity of the present living world. Just the genetics development and the genetic diversity emphasized by the Russian specialist CHETVERIKOV (1927) and by DOBZANSKY (1937) diminished the supporting of Lamarckism and founded the development of micro- and macroevolution.

In his work, MAYR (1942) took into account the German specialist Bernhard Rensch's papers, on the influence of the environmental local factors on the species distribution and on closely related species. This kind of speciation occur within the conditions of the geographical isolation of a subpopulation, accompanied by the mechanism developing of the of reproduction isolation. Mayr (op. cit.) laid the foundation of the biological species concept – as a population group with compatible or potentially compatible individuals to breed and which is isolated from other populations, from the reproductive point of view.

SIMPSON (1944) demonstrated that the fossil study did not indicate a directional pattern of evolution and that the linear tendencies, supported by the palaeontologists and by neo-Lamarckians, were repealed by the subsequent specialized studies. Simpson (op. cit.) integrated the facts of palaeontology with those of genetics and natural selection.

Synthetic theory of evolution provided the conceptual principle of natural selection and of population genetics (belonging to Mendel), which, in fact, includes all biological fields. This theory offered legitimacy to the evolutionist biology and allowed a scientific climate, which promoted the experimental methods instead of those of science history. Syntheses led to the restriction of the numerous currents of the evolutionist thinking, phenomenon which GOULD (1977) called "*strengthening of syntheses*", according to which natural selection actions on the genetic variation, generating the new concept of "*panselectionism*" – an acceptable evolutionary mechanism, in which the macroevolution is considered only the result of the extensive microevolution. The concept of synthetic theory was invented and used by HUXLEY (1942), in his book "*Evolution: the modern synthesis*" and represents the present paradigm of the evolutionist biology. By this concept the difficulties and the confusions, appeared because of the strict specialization of some specialists and the lack of communication between the biologists of the first half of the 20<sup>th</sup> century, were solved. Huxley's modern synthesis gathered ideas of different branches of biology: genetics, cytology, systematics, botany, morphology, ecology, palaeontology.

After the appearance of molecular biology, at the half of the 20<sup>th</sup> century, the chemical nature of genes as DNA sequences and their relations with the protean sequences was better understood by the genetic code. Meanwhile, the biochemical phenomena were also included in the synthetic theory of evolution due to the huge development of the analyzing technics of proteins (electrophoresis, sequencing). ZUCKERKANDL & PAULING (1962) proposed the hypothesis of the "*molecular clock*", according to which the differences of the sequences from the homologous proteins can be used in calculating the time difference between two divergent species. KIMURA (1969, 1983) and CROW (1972) demonstrated that, at least at the molecular level, most of the genetic mutations are neither injurious nor useful, and the genetic drift is responsible for a large part of the genetic exchange (according to them, more than the natural selection). This conception (obviously non-Darwinian) got the name of neutralist theory of the molecular evolution. The studies on the intraspecific protean differences also provided molecular information on the population genetics, by the estimation of the heterozygosity level in natural populations.

BORNARIUC (1992) mentioned that neo-Darwinians reject the neutralist theory, because they consider high genetic polymorphism as an advantage in the natural populations and the selection used different mechanism to determine a high genetic variation in populations.

Thus, after the '60s, molecular biology was received as a threat to the traditional content of the evolutionist biology. The three architects of the modern theory (the synthetic one of evolution), Ernst Mayr, Theodosius Dobzhansky



and G. G. Simpson (all Darwinists) were extremely skeptical with the molecular approach, especially when it referred to the new content of natural selection or even ignored it. Hypotheses of the “*molecular clock*” (species detachment from a common ancestor based on the differences of the protean structure or DNA) and the neutralist theory of evolution were passionately discussed, invoking the relative importance of the genetic drift, but also of natural selection, debates which also continued in the ‘80s, practically without clear conclusions from neutralists and selectionists.

Also, after the ‘60s, George C. Williams severely criticized the term of adaptation with the sense of “species surviving”, as an argument of the group of the “selectionist” specialists. The explanations on the adaptation and species surviving were replaced by a new concept on evolution which focused on gene. It reduced itself to the similar arguments of selection, introduced by W. D. Hamilton, George R. Price and John Maynard Smith, resumed by DAWKINS (1976) in his book “*The Selfish Gene*”. But, those evolution patterns were too limited and did not allow the explanation of selection at different organization levels of the living matter. By applying the concept of the selfish gene to the origin of social instincts, the new Darwinism opened up a revolutionary approach which became known as socio-biology and ultra-Darwinism which recognize the gene as the unit of selection.

VAN VALEN (1973) proposed the term “*Red Queen*” for describing a scenario according to which an implied species in one or several evolutionary directions should change continuously in order to be in harmony with the co-evolutional species.

Hamilton, Williams and others suggested that this idea can explain the evolution of the sexed reproduction, in which the growth of the genetic diversity determined by the sexed reproduction might help the resistance against the rapid evolution of parasites. Thus, in spite of the huge cost from the point of view of the central importance of gene, only half of an organism genome can transfer by the sexed reproduction. The supporting of the central part of gene within the evolution process brought to light again the importance of Darwin’s idea on sexual selection and lately, the theme of the sexual conflict and of the intragenomic conflict.

Studying different kinds of selection, HAMILTON (1964) created a new discipline – sociobiology, which presumed the presence of the altruistic habits, a dilemma of the evolutionary theorists, since the 19<sup>th</sup> century. Hamilton (op. cit.) demonstrated the inequality of the selection ways, giving example the social organization in insects (with sterile workers). WILSON (1975) published the book “*Sociobiology: New Synthesis*”, in which he supported that the evolutionist theory can explain many aspects of the animal world, including human habits. The critics of the “new synthesis” (GOULD & LEWONTIN, 1970) considered that sociobiology exaggerated the degree in which the complex human habits can be influenced by genetic factors. They also supported that the sociobiologists’ theories seldom reflect their ideological conceptions. But, in spite of these critics, papers continued both in sociobiology field and in related fields of evolutionist psychology, including also other aspects of altruism.

After ‘70s, serious debates on the punctual equilibrium theory appeared. Niels Eldredge and Stephen Jay GOULD (1972) considered that in the existence of the fossil species there was a pattern which, broadly remained unchanged (*stasis*) for a very long period of time, scattered with short periods of rapid changes within the speciation duration. This is a sending to the intermittent equilibrium theory (ELDRIDGE, 1972), after which the evolutionary process (appearance of new taxa) manifest once in a while, alternating with long periods of relative stability/equilibrium. He criticized the supporting of the central role of gene within biological evolution and pointed out the importance of the evolutionary and ecological systems.

The improving of the sequence technics of DNA and the growth of the sequential genomes permitted the testing and redefining the evolutionist theories, basing on the information on genome. The comparisons between these genomes permitted the understanding of the deep molecular mechanism of the speciation and adaptation. Genomic analyses generated fundamental changes in the understanding of the evolutionary history of life, as the creation of the system with three fields (Bacteria, Archaea and Eukariota) made by WOESE (2000, 2001, 2002, 2004). The improvement of the informational technics (hard and soft) permitted tests and extrapolation of the advanced evolutionary patterns and the development of the field of the biological systems. One of the results was the exchange of ideas between the biological evolution theories and the data processing fields, known as computerized evolution, which tries to simulate the biological evolution for the developing of the new computerized algorithms. Present discoveries of biotechnology allow the genome modifications, leading the evolutionary studies up to the level in which the future experiments will be implied in the creation of synthetic complex organisms.

Because of the lack of some clear morphological features and of a concept on species in microbiology, this field was neglected by the evolutionist theory. Today, by the comparison of the microbial genomes, amazing progresses in the understanding of the physiology and ecology of these organisms were made and their taxonomy and evolution could be explored. Such kind of studies pointed out unthinkable levels of the microbe diversity and demonstrated that they represent the prevalent form of life on Earth.

A very important result of the study of the microbial evolution was the discovering of the horizontal transfer of genes, in Japan, in 1959. This transfer of genetic material between different bacterial species played an important party in the resistance spread against antibiotics. Then, continuing the study and the understanding of genomes it was suggested that the lateral transfer of genetic material was very important in the evolution of all organisms. As a part of the endosymbiotic theory for the origin of organs, horizontal gene transfer was a critical moment in the evolution of eukaryotes: fungi, plants and animals.

In 1980 and 1990, the principles of the modern evolutionist theory (synthetic) were minutely investigated and the themes of the structuralist evolutionist biology (GOODWIN, 1994, KAUFFMAN, 1993) were resumed. Goodwin comes to the conclusion that biological complexity has arisen through the ordering of dynamic systems independently of the action of genes. The ideas of cybernetics were put together with those of the theory of systems and it was underlined the importance of the development of the self-organization processes, as factors which directed the evolution course. Evolutionist biologist Stephen Jay Gould updated the older ideas of the heterochrony – alternations in the relative rhythm of the developing processes during evolution course, explaining the new forms of generations. GOULD & LEWONTIN (1970) published a paper in which they suggested that a change in any biological structure or even a structural novelty can appear incidentally as an accidental result of selection on another structure, most probable than by the direct selection for a certain adaptation. These incidental structural changes were named “*sprandeli*”, after the architectural term – the space between the arches bases in constructions. Then, GOULD & VRBA (1982) brought under discussion the acquisition of some new functions of the new structures, appeared this way, and named “*exaptations*”.

Molecular data underlined that the development of the animal morphology was not the result of different kits of regulator proteins of the development of different animals but the changes of the development of a small kit of proteins, which were common to all animals. These proteins were known as “kits of developing”. From this perspective, phylogeny, palaeontology and the biology of comparative development were influenced later, generating a new discipline – “*evo-devo*”.

Recently, the papers of this field pointed out the phenotypical and developing plasticity. Rapid appearance of the base plans in the structuration of the animal bodies from the Cambrian “explosion” was mostly due to the environmental changes which action on the properties of the inborn material of the cellular colonies, by the differentiate adhesion of cells and by biochemical oscillations. Resulted forms were later stabilized by natural selection. Experimental and theoretical studies on these and other related ideas were gathered in a volume, “The Origin of Organism forms”, signed by several authors.

Among the non-conventional evolutionist theories we mention Pierre Teilhard de Chardin’s “omega point”: (unscientific), according to which the gradual development of the Universe, from the level of the subatomic particles to human society, would be the final stage and purpose – ideas linked by James Lovelock’s *Gaya* theory, which proposed that the living and non-living parts of the Earth to be considered a complex systems of interactions, similar to the organ systems with all types of tissues which make a living organism. Considered an extension of the endosymbiosis and exosymbiosis, this hypothesis establishes that all creatures have a regulator effect on the Earth environment which spreads life everywhere. Futurists see in the scientific and technologic progress a continuation of the biologic evolution, technologic evolution being the purpose of their philosophy.

Starting with a pre-evolutionary worldview, in 1809 there appeared first transmutationists followed by foundation of Darwinism. The period between 1875 and 1925 can be considered the eclipse of Darwinism and defence of neo-Lamarckism. Mendelism and mutation theory preceded the evolutionary synthesis theory. In the last decades, socio-biology and ultra-Darwinism debate how natural selection operates as a crucial mechanism in evolution. Ultra-Darwinism focused on the gene recognizing that these (rather than the whole organism) could be treated as the unit of selection.

Today, after 150 years since the printing of Charles Darwin’s masterpiece, the biological evolution is considered by most biologists as a result of the natural selection, by the action of the environmental factors on some populations of creatures in competition for getting resources, necessary to surviving and reproduction. In other words, in the evolutionary race, each species has to improve itself constantly or it will be outstripped by its rivals.

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## TWO HUNDRED YEARS SINCE THE PUBLICATION OF *PHILOSOPHIA ZOOLOGICA*: JEAN-BAPTISTE LAMARCK'S VISIONARISM

ORIANA IRIMIA-HURDUGAN

**Abstract.** In 1809, Jean-Baptiste Lamarck (1744-1829) was publishing his *Philosophia zoologica*. It was the fruit of a mature reflection on the natural history as it was known by his contemporaries, as well as of the acquiescence of the necessity for a new theory that would explain the increasing complexity of the organisation of the living matter as well as the speciation. Father of the evolutionism, than called transformism, and of the term of "biology", Lamarck was time after time noticed, discarded and ignored for two hundred years. Never the less, some aspects of his theory are making a comeback, more fashionable than ever, highlighted by a new current in natural sciences and by breakthrough in epigenetics. An evolutionist ahead of his time and, most of all, before Darwin (*The Origin of the Species* will be published only in 1859), the man that was Lamarck deserves to be acknowledged for his assiduous and hard work, his discerning genius as well as for his survival as a scientist during the murky times of the French revolution.

**Keywords:** history of evolutionism, lamarckism, invertebrate taxonomy, epigenetic.

**Rezumat.** Două sute de ani de la publicarea *Philosophiei zoologice*: vizionarismul lui Jean-Baptiste Lamarck. Jean-Baptiste Lamarck (1744-1829) publică în 1809 *Philosophia Zoologica*. Aceasta era fructul unei mature chibzuințe asupra istoriei naturale, așa cum era ea cunoscută de contemporanii săi, precum și al conștientizării necesității unei teorii noi, care să explice complexitatea crescândă a organizării materiei vii și speciația. Părinte al teoriei evoluționiste, numită de el transformistă și al cuvântului «biologie», Lamarck a fost pe rând remarcat, refuzat și ignorat timp de două sute de ani. Cu toate acestea, aspecte ale teoriei sale devin mai actuale ca oricând, în lumina unui nou curent în științele naturii și de noile descoperiri ale epigeneticii. Evoluționist «avant la lettre» și, mai ales, înaintea lui Darwin (*Originea speciilor* apărea abia în 1859), omul Lamarck merită să i se recunoască activitatea asiduă și aplicată, geniul pătrunzător precum și supraviețuirea ca om de știință în perioada tulbură a revoluției franceze.

**Cuvinte cheie:** istoria evoluționismului, lamarckism, clasificarea nevertebratelor, epigenetică.

### SHORT BIOGRAPHY OF THE SCIENTIST

Jean-Baptiste Pierre Antoine de Monet, knight of Lamarck was born at the 1<sup>st</sup> of August 1744 in an old noble family. He studies from 1755 to 1759 at the Jesuite School of Amiens and engages, between 1761 and 1765, in a short military career that would bring him, following the battle of Villinghausen, the title of filed officer and knight of Saint-Martin. Following the accident that would end his military career in 1765, he will work as accountant for a while and then he will dedicate to his studies of medicine and botany, for which he develops a particular interest.

In 1778 he publishes *The French Flora* at the Royal Printings, using the dichotomic identification keys (Linnaeus' model) in an accessible and user friendly way. This work will make him notorious and will get him elected, in 1779, member of the French Academy of Sciences, with the help of Georges-Louis Leclerc, count of Buffon.

The Academy will receive him in full membership in 1783 and he will retire in 1790. That year, at the age of 46, he reconverts successfully from botany to invertebrate zoology, becoming the Insects and Worms Natural History professor at Jardin du Roi, in Paris. He will be involved, in 1793, in the conversion of the Royal Gardens to the Natural History National Museum, at Lakanal's proposal. In the new establishment he will teach the invertebrate zoology and he will innovate in the study of invertebrate palaeontology and general systematic biology.

His works on invertebrates represent a great advance over existing classifications; he was the first to separate the Crustacea, Arachnida, and Annelida from the "Insecta." His classification of the mollusks was far in advance of anything proposed previously; Lamarck broke with tradition in removing the tunicates and the barnacles from the Mollusca. In 1809 he publishes *Philosophia zoologica* and from 1815 to 1822, he publishes *Histoire naturelle des Animaux sans vertèbres*. These two works made him the founder of the transformism, latter known as Lamarckism, the early versions of the evolutionism.

He died in Paris, the 18<sup>th</sup> of December 1829, at 85 years old, after being blind for the last ten years. For more than a century several authors, quoted by HUMBERT, 1946, and later by JAUSSAUD & BRYGOO, 2004, considered that Lamarck died in extreme poverty at his residence at the Museum, after he had to sell his plant collection to the German botanist Johannes August Christian Roeper. Michel Guédès' study on Lamarck's incomes (1982) is though proving a comfortable lifestyle as he cumulated several incomes: his professor salary at the Museum, his Academy pension, incomes from the sale of his different works etc., up to 9500 old francs, a very reasonable and sustainable sum at the time. Nevertheless, his human remains were buried in a rented grave, having a very poor and modest ceremony, and three years later they were exhumed and reburied in a common grave at the Montparnasse cemetery. This fact seems to be due not to the lack of money, but mostly to the "lack of filial piety" of his son, Auguste (LAURENT, 2001).

## LAMARCK AND THE SCIENTIFIC CONTEXT OF HIS TIME

Since the Antiquity it was considered that the simplest forms of life appear directly from the inanimate matter and one form of life can transform into another. This idea was still part of the popular belief in the 19<sup>th</sup> century. Only at the end of the 18<sup>th</sup> century several scientists as Erasmus Darwin (*Zoonomia or Laws of the Organic Life*, 1794-1796) in England, Alberto Fortis (*Viaggio in Dalmazia*, 1774) in Italy, Jean-Claude de la Méthérie, Philippe Bertrand (*Théorie de la Terre*, 1797), Eugène-Melchior-Louis Patrin (*Histoire Naturelle des Minéraux*, 1801), and Bernard-Germain-Etienne de Lacepède in France were formulating the hypothesis of the gradual transformation of the life forms accompanying the successive transformations of the Earth's crust. At the same period there were undertaken the first rigorous scientific studies of palaeontology, bringing proof of some species evolution in geological eras.

Besides the theoretical discoveries, New Zealand was being discovered and the South America's geography, fauna and flora were being systematically researched by Humboldt and Bonpland (HUMBOLDT, 1968). Brisson had published the birds systematic, Linnaeus' binomial taxonomy was being adopted by every naturalist and Fabre was inspired describing the insects' behavior.

Studying the mollusk fossils at the National Museum of Natural History, Lamarck noticed that during the geological eras, their external morphology changed and he was the first scientist to wonder about the reasons for these modifications. He hypothesized that the individuals are adapting all the long of their existence mostly by using more or less certain organic functions that develop or decrease according to organ's use or disuse. Lamarck is also the one who gave the first modern definition of biology, in 1802, in *Système des animaux sans vertèbres*: « all that is generally common to plants and animals as well as all the characteristics of each of these beings with no exception, must form the only and vast object of a special science, not yet founded nor named, that I will call Biology ».

Carefully studying the differences between living beings and inanimate objects studied by Physics, Lamarck was the first to understand that the evolution is a theoretical necessity in the explanation of the complexity of the living beings, which are not only the product of a temporary conjecture of some physical and chemical phenomena (as the theory of the spontaneous generation, embraced by most of his contemporans, stated), but also the product of a historical elaboration and construction of these phenomena in more and more complex and differentiated organizations.

Nevertheless, the inheritance of acquired characters theory or the soft inheritance theory was already being hypothesized, in other forms, even in Aristotle's' work, but it was Lamarck that integrated and adapted the principles of this theory in his own evolution theory: the transformism. The latter had many supporters, as Geoffroy de Saint-Hilaire for example, until the experiments of the German evolutionist August Weismann in 1868-1876 (CHURCHILL, 1968) when the transformism was discarded. On the contraire, Lamarck was not able to prove his theory by experiments. Although considered the main detractor of soft inheritance, Darwin wrote, in the *Origin of Species*, that the vestigial eyes of moles and of cave-dwelling animals are "probably because of a gradual reduction from disuse, although aided perhaps by the natural selection."

200 years ago, in 1809, Lamarck expressed in a systematized and logical fashion, in *Philosophia zoologica*, his theory, the transformism, according to which the organisms are evolving over long periods of time. This would have not been possible in the scientific context of 1700-1750, but 1789 brings the French Revolution and, with it, the extreme secularization of the society as well as science's liberation from the restrictions in its expression. Although longtime considered a certain fact, the French Revolution was not atheist but merely anticlerical, and this conjecture contributed, 20 years later, to the freedom of expression necessary for Lamarck in order to elaborate his theory.

## PHILOSOPHIA ZOOLOGICA

*Philosophia zoologica* is the reviewed and much developed and enlarged version of an earlier lamarckian work: *Recherches sur les corps vivans*. It is structured in three main parts, each subdivided in seven to nine chapters. Fortunately for us, his modern readers, Lamarck's vast opera was written entirely in French, one more thing that we probably owe to the French Revolution, as the hermetic Latin of the scholars was replaced by the national language, thus allowing any citizen who could read access to knowledge.

Following the title and the short description of the contents, the author begins, as that period's customs imposed it, with a *Warning* and a *Preliminary Speech*, each near four pages long.

In the first part, presenting "essential observed facts and the general principles of the natural sciences", he first describes the terms employed by "the mentioned sciences, the importance of considering the ratios and the idea we must have on what is called species amongst the living beings". He then develops the generalities regarding the animals and presents on one hand "the proof of degradation in organisation from one extremity to an other of the animal scale, the most perfect animals being placed on the anterior extremity of this scale", and on the other hand he demonstrates "the influence of circumstances and habits on animal organs, as a source of the causes favouring or stopping their development". He ends this first part by presenting the "natural order of animals", their distribution and reviewed classification.

In the second part the author proposes his ideas on the order and on the state of things composing the essence of the animal life and presents the essential conditions for life existing in nature while the third part theorises on intelligence and senses as engine of action in animals.



From his own observations of the individual anatomical parameters within the same species, Lamarck deduced that the individuals adapt themselves to the environmental conditions of their habitat. If the climatic and geological conditions change for a sufficiently long period of time, the living beings are changing their morphology but not in a controlled manner. An organ may change in order to answer a necessity or need, as the author calls it, and this change can be inherited by that animal's descendents (the soft inheritance). For Lamarck, these changes take place gradually, over long periods of time, and are inaccessible to the human perception scale.

"Dimensions, both in space and time, are relative: if one would indulge to represent this truth, one will see that one must be circumspect regarding the *stability* [Tr.N.: As immobility] that one will attribute, in nature, to the state of the object of his observation. [...] I will have the chance to prove with the help of some well known facts the changing power of circumstances in granting animals new needs and pushing them into new actions; of repeated new action in becoming new habits and new tendencies; finally the power of the more or less frequent use of an organ to modify that organ, either by strengthening it, developing it and enlarging it, or by weakening it, shrinking it and attenuating it to the point of disappearance."

„Regarding life, nature made everything little by little and successively, there is no doubt about it. In deed, [...] I will try to prove, citing only well known facts, by composing and complicating more and more the animal organisation, nature progressively differently specialized organs as well as the faculties the animals posses.

The author largely theorises on the animal systematics, adopting the binomial taxonomy of Linnaeus and demonstrating his evolution theory *in spe* with zoomorphological and systematic arguments. "Long time it was considered that there is a scale or gradual chain of life bearing bodies. Bonnet developed this opinion but did not prove it with facts extracted from the organisation itself, although this was necessary, especially concerning the animals. He could not have done it since in his time the necessary means were not yet present.

By studying animals of all classes, there are more things to notice in the increasing composition of the animal organisation. The result of circumstances as cause of new needs, the result of needs that engender actions, that of the repeated actions that create habits and tendencies, the results of the increased or decreased use of one organ or an other, the means of nature to perfect what it was achieved by organisation etc., etc., are objects of main importance for the rational philosophy".

The author presents the second and the third parts of this work as particularly dear to him, as he speaks of the apparition of irritability, sense and intelligence in animals with different degrees of complexity, as the nervous system follows the general complication of the animal morphology in phylogeny.

Most certainly, *Philosophia zoologica* would have not ever been published unless its author had not studied so arduously the invertebrates and their fossils. In this paraphyletic group the speciation reaches its maximum and the phylogeny is easily traceable, step by step, due to the organisms' great diversity.

"Thus, this *Zoological Philosophy* presents the results of my studies on animals, their general and particular characteristics, their organisation, the causes of their development and diversity and of the characteristics they achieve from it; in order to put it together I used the main materials I gathered for a projected work on the living bodies, under the name of *Biology*, that will remain, as far as I am concerned, unfinished. [...]"

## REDESCOVERING LAMARCK IN THE PRESENT SCIENTIFIC CONTEXT

The soft inheritance makes a comeback in fashion among the scientists of our time, under the weight of the logical and experimental arguments as well as under the irrefutability of the present epigenetically studies.

A study made by the research team of the University of Umea, Sweden, published in the *European Journal of Human Genetics* (VAN DER LUGT, 2006) on the inhabitants for several generations of a small village in Sweden (320 individuals), stressed out the fact that a predecessor that suffered from malnutrition (during famine episodes) in his teenage years will provide his descendents with an increased protection against cardiovascular disease and against diabetes. The vice versa is also valid, a grandfather having a rich alimentation during adolescence would have a descendence four times more exposed to mortality causes related to diabetes than the population average. The unusual discovery was that this inheritance was made on paternal line, thus excluding any pregnancy related environmental factors that would have affected the individual *in utero*.

As an explanation, the Swedish team prudently advances an analogy to the epigenetic soft inheritance theorized by Lamarck, but the international scientific community demands further proof in the replication of the Swedish results by other studies. Voices of the medical community are already rising, stating that the epigenetic phenomena could serve as rheostat in the rapid adaptation of the species to a given environment, unlike the Darwinian like natural selection (Junien Claudine, Genetics professor at Necker Hospital, Paris, France, in an interview to *Le Monde* journal).

As other tendencies in science before this, the new opening on Lamarck's soft inheritance was appropriated by the pompously named «Intelligent Design» current, a sort of creationism in evolutionist clothes, supported by some self proclaimed "Christian" circles in the United States, whose pseudoscientific speaker is the Discovery Institute, thus discrediting any new related findings and contaminating them with ridicule by mere association with the name of these circles.

As the climate changes faster and faster, we are about to witness the veracity of the acquired characteristics inheritance during our lifetime. If this phenomenon is real at least some species will survive the global warming...

## CONCLUSIONS

An avanguardist evolutionist, armed with irrefutable logical reasoning and common sense showing a scientist responsible for his allegations, Lamarck leaves us, in his extended work, the modern invertebrate systematics principles, the taxonomy, applying the principles of the compared anatomy, as well as an innovating analysis of the influence of environmental changes on the physiology and morphology.

Jean-Baptiste Lamarck's writings are visionary for their time, setting the theoretical bases for an evolutionary step in the history of the biological sciences. Although logically argued and exemplified, the theory of the achieved characters inheritance was discredited by some, rejected by Lamarck's fixist contemporans as well as by his Darwinist successors due to the lack of experimental proof. But in the end the history gives him justice, geneticists bringing new evidence and arguments, sometimes against their will, in favour of the scientist's statements of 200 years ago. Certainly, in the light of the actual state of the biological research, Lamarck's original thesis will not be embraced by the scientific community, but the principles he stated at that time are valid and most likely provable.

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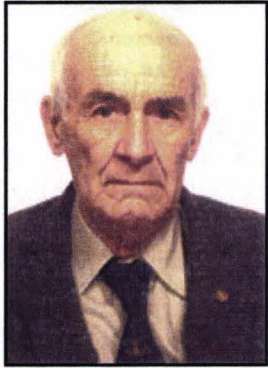
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## IN MEMORIAM

ACAD. BĂNĂRESCU PETRU MIHAI

(the 15<sup>th</sup> of September 1921, Craiova – the 12<sup>th</sup> of May 2009, Bucharest)

VICTORIA TATOLE



This spring, on the 12<sup>th</sup> of May, Acad. Petre Mihai Bănărescu, renowned ichthyologist, fulfilled zoologist, zoogeographer of international importance and as well a special character, full of humbleness, kindness, understanding, tolerance, humour and high spirits died after a long and hard illness.

Acad. Petre Mihai Bănărescu was born on September 15, 1921, in a family of intellectuals, his father, Marin Bănărescu being a university teacher at the Mechanic Faculty of the Polytechnics University of Timișoara, well known as the founder of the Romanian School of Thermal Engines.

Early in his childhood, Petre Mihai Bănărescu has shown a sustained interest for the life of aquatic ecosystems. As he confessed to me, he was not 11 years old yet and he was already enjoying himself by starrng at what was happening in the garden pool of his family. Latter he started to collect, observe and identify fishes from the neighbourhood of the city of Timișoara.

In 1940, when he graduated from high-school, he was able to identify all the fish species described in Grigore Antipa's monograph.

Petre-Mihai Bănărescu attended the classes of the Science Faculty, the Department for Natural Sciences of the "King Ferdinand I" University, in Cluj.

His university career begun as a tutor at the Zoology Chair of the Faculty of Sciences in Cluj, at that time situated in Timisoara, later becoming an assistant at the same Faculty Chair, and locum tenens lecturer at the Biogeography Chair.

In 1949, he obtains the PhD. in natural sciences with a thesis on the comparative anatomy of the encephalon of the telosteen fishes.

After one year spent in a political prison he returns home, is still unemployed for over a year, but succeeds to elaborate and publish seven papers.

Beginning with 1953 he works as a researcher at the Pisciculture Research Institute in Bucharest and later as a scientific researcher at the Biology Institute of the Romanian Academy, where he works until the end of his career. In 1962 he receives the Docent PhD. title.

PhD. Petru Mihai Bănărescu distinguishes himself in the zoology domain both at a national and international level. Concentrating in the beginning on the research of taxonomy, systematics and biology for the fresh and salt water fish found in Romania, in time he diversifies the frame of his research domains, approaching in details:

- the systematics of the Cyprinidae and Cobitidae families in Europe and Asia;
- the problematic of biogeography, zoogeography in general and of zoogeography of fresh water fish and invertebrates, in special;
- the complex problematic of taxonomical principles;
- the complex problematic of the speciation;
- problems concerning the nature protection.

Among the special results obtained, the following must be enumerated:

▪ the description, alone or in cooperation, of certain new taxa in Romania's and the entire world's ichthyofauna, for example: a genus, two subgenera, one species and two new fish subspecies from Romania, a subfamily, 10 genera, 38 subspecies and 26 fish subspecies from China, Korea, Vietnam, Thailand, Myanmar, India, Pakistan, Afghanistan, Israel, Turkey etc.

▪ studies of taxonomical revision, as: the synonymisation of 6 genera from the Cyprinidae family; the revalidation of two generic names for Cyprinidae and four for Cobitidae and the reviewing of a subfamily;

▪ the first quotation in the Romanian fauna, by himself or/and in cooperation of eight fish species and six copepod species;

▪ the elaboration of the first and only zoogeography for fresh waters, on a worldwide level;

▪ the involvement in the problematic of the nature protection, through the elaboration of the scientific documentation for declaring new protected areas;

▪ elaboration of the Pisces chapter from the Romanian Red Book of Vertebrates.

As a PhD. coordinator he played a part in the formation, advancement and promotion of over 25 Biology PhDs.

As for the original scientific papers of Acad. P. M. Bănărescu<sup>1</sup>, these include 327 titles, 316 of them being articles written in periodicals, collections or chapters from books, and 12 books.

Six of these were published in Romania, two being already translated: "Principles and Problems of Zoogeography" and "Biogeographie. Fauna und Flora der Erde und ihre geschichtliche Entwicklung", and six were published abroad, as "Zoogeography of Fresh Waters" (three volumes) and "Freshwater Fishes of Europe" (three volumes). Most of his papers (over 60%) have been written in important foreign languages as: English, German, French, Russian. The works of Petre-Mihai Bănărescu are, have been and will be quoted in important national and international papers from all the continents.

Spanning his entire important career amongst the Animal Taxonomy Board from the Romanian Academy, Petre-Mihai Bănărescu established almost religiously a big collection of fresh water fishes, especially Cyprinidae and Cobititidae. This extremely wide and valuable collection contains personally collected or offered through exchange specimens from Romania, Greece, Macedonia, Bulgaria, Spain, Israel, Ukraine, Turkey, Korea, etc., in fact from the big majority of aquatic basins from Eurasia, North America and partially from Africa.

The Collection *Bănărescu-Nalbant* can be found at the *Grigore Antipa* National Museum of Natural History since 1999.

Petre-Mihai Bănărescu was a fervent catalyst of knowledge exchanges, crossing over the iron curtain even in historical moments when such a step seemed quite impossible. He kept open and tempting the scientific dialogue with specialists from the country and from abroad, well known remaining the meeting and the correspondence with the Emperor of Japan himself, an accomplished ichthyologist. He was engaged in a great number of study journeys in Austria, Belgium, Bosnia, Bulgaria, Czech Republic, Korea, France, Germany, Greece, Israel, Macedonia, Holland, Spain, Russia, Ukraine, Hungary etc.

For special accomplishments, Petre-Mihai Bănărescu received the following awards:

- "Emil Racoviță" – the Romanian Academy (1964);
- Honorary foreign member of the American Ichthyologic and Herpetological Society (since 1975);
- Honorary member of the European Ichthyologic Society (since 1988);
- Honoris Causa Doctor of the "Al. I. Cuza" University in Iași (since 1999);
- Full member of the Romanian Academy (since 2000).

We worked together more than 25 years and all these years Petre-Mihai Bănărescu kept taxonomy as an independent domain. I honoured, respected and loved him as an elite colleague, funny, warm and accessible.

As many of my colleagues and friends I regret and already miss him.

Victoria Tatole

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<sup>1</sup>In Trav. Mus. natl. Hist. nat. "Grigore Antipa", 36: 497-510, 1996, has been published the list of papers until 1997.



RECOMMENDATIONS  
regarding the elaboration of the papers for the scientific journal  
“*Oltenia. Studies and communications. Nature sciences*”

The journal is edited by the Oltenia Museum Craiova and it publishes original papers in the fields of vegetal and animal biology, ecology-environment protection, paleontology, as well as scientific reports, reviews, anniversary or commemoration papers. It appears annually, it is ISI indexed and accredited by CNC SIS as a B+ Journal.

I. Structure, format:

A. *Original papers* will be structured according to information rendered in the next table.

Table.

STRUCTURE OF THE PAPER	CHARACTERISTICS	OBSERVATIONS
TITLE	Capital letters, 12 pt., bold, centered	
<i>two free lines (12 pt.) between the title and the name of the author/s</i>		
Author/Authors	name, capital letters, first name, non capital, 11 pt., bold, aligned right	between two or many authors, use comma
<i>a free line, 10 pt.</i>		
Abstract (English)	from the beginning of the line, without tab, 9 pt., bold	<i>the abstract will be written with 9 pt., italic, non-bold, maximum 300 words</i>
<i>a free line, 9 pt.</i>		
Keywords (English)	from the beginning of the line, without tab, maximum 5 words, 9 pt., italic	
<i>a free line, 9 pt.</i>		
Rezumat (Romanian)	from the beginning of the line, without tab, 9 pt., bold	<b>Complete translation of the title in Romanian</b> (no capital letters, except for the first letter of the title; 10 pt., bold). <i>The content of the abstract – 9 pt., italic, non-bold, maximum 300 words</i>
<i>a free line, 9 pt.</i>		
Cuvinte cheie (Romanian)	from the beginning of the line, without tab, maximum 5 words, 9 pt., italic	
<i>a free line, 14 pt.</i>		
INTRODUCTION	10 pt. (capital letters, bold)	content – 10 pt., normal
<i>a free line, 10 pt.</i>		
MATERIAL AND METHODS	10 pt. (capital letter, bold)	content – 10 pt., normal
<i>a free line, 10 pt.</i>		
RESULTS AND DISCUSSIONS	10 pt. (capital letter, bold)	content – 10 pt., normal
<i>a free line, 10 pt.</i>		
CONCLUSIONS	10 pt. (capital letter, bold)	content – 10 pt., normal
<i>a free line, 10 pt.</i>		
ACKNOWLEDGEMENTS	10 pt. (capital letter, bold)	content – 10 pt., normal
<i>a free line, 10 pt.</i>		
REFERENCES	10 pt. (capital letter, bold)	content – see bibliographical references
<i>a free line, 10 pt.</i>		
Bibliography enumeration	see the detailed explanations at the references heading	

B. *Scientific reports* will be structured according to the author’s (authors’) preferences, but it has to include abstract and key words, both in English and Romanian.

C. *As for reviews*, there will be mentioned: author (authors) of the book (name and first name – SMALL CAPS), comma, the title of the book, non capitals (*Italic*), publishing house, publishing location, year, number of pages. Use a free space and then render the text of the review with as fewer paragraphs as possible and the same characters as in the case of original papers.

- the materials sent for publication (printed and in electronic format) has to be between 2 and 8 pages (the number of pages must be even).
- publishing language: English.
- page format - A<sub>4</sub> (21x 29.7 cm), margins: top – 2.5 cm; bottom – 2.0 cm; left – 2.0 cm; right – 2.0 cm; gutter – 0 cm; header, footer – 1.27 cm. The papers will be elaborated in Microsoft Word, justified; font: Times New Roman, 10 pt., normal; single space.
- Latin names (genus, subgenus, species, subspecies) will be written with *italic characters*; suprageneric names **are not written** with italic characters. The same procedure is used when they are mentioned within figures.
- you have to use the English punctuation signs, namely comma instead of dot and dot instead of comma at numbers in the text, figures, and tables. For example: 54,30 m (in Romanian) = 54.30 m (in English); 2.500 m (in Romanian) = 2,500 m (in English).
- the first mention of a taxon in the text will be followed by the taxon author’s name and the publishing year of the description, according to the zoological nomenclature code (e.g.: *Cossus cossus* (LINNAEUS 1758)).
- the names of the authors quoted in the text, at references, as well as the authors of the scientific names will be written in SMALL CAPS; if you do not know this option, write normally, non capital letters!

II. References

- References in the text (quotation) includes only the author’s/authors’ names (SMALL CAPS) and publishing year.  
Example: IONESCU (1965) or (IONESCU 1965), when it is a single author; IONESCU & WEINBERG (1970) or (IONESCU & WEINBERG 1970), when there are two authors; IONESCU et al., (1992) or (IONESCU et al. 1992), when there are more than two authors;  
- in case there are many papers written by the same author/authors, published in the same year, use the letters a, b, c, etc. after the year (e.g.: IONESCU 2000; IONESCU 2000a, ..., 2000g).
- References will include **only** the papers quoted in the text (10 pt.), alphabetically rendered, without numbers, as it follows: author (SMALL CAPS), publishing year (normal), (**do not use** comma between the author and the publishing year or between



the name and first name of the same author; use comma between different authors, when there are more than two), *the title of the paper (italic)*, name of the journal, publishing house, volume number (bold), number of pages (normal). When there are two authors, use "&"; if there are many authors, mention **all** of them. The ladies' first name is completely written; for gentlemen, use only the first letter. The reference titles will be aligned as it follows: the first line from the beginning (no tab), the second at 1.27. Example:

**Book reference:**

BOȘCAIU N. 1971. *Flora și vegetația Munților Țarcu, Godeanu și Cernei*. Edit. Academiei R.S.R. București: 30-35.

**Paper published in a journal:**

STAN M. & BACAL S. 2006. *New contributions to knowledge of Staphylinidae (Coleoptera: Staphylinidae) of the landscape reserve "Codrii Tigheci" (Moldova)*. Muzeul Olteniei Craiova. *Oltenia. Studii și comunicări. Științele Naturii*. 22: 155-159.

**Reference to a part of a collective paper; volume (with editors):**

IFTIME AL. 2005. *Amfibieni și Reptile*. In: Botnariuc & Tatole (Eds.) *Cartea Roșie a Vertebratelor din România*. Edit. Academiei. Române: 1-325.

**Papers presented at scientific manifestations and published in a volume without editors:**

CIOCHIA V. & STANCĂ-MOISE CRISTINA. 2001. *Contributions to the knowledge of the Macrolepidoptera from natural complex "Dumbrava Sibiului"*. Sesiunea Științifică dedicată împlinirii a 75 de ani de la înființarea Stațiunii Biologice Marine „Prof. dr. I. Borcea” Agigea-Constanța. 19-20 octombrie 2001: 125-131.

**Official publications (laws, decrees, official reports):**

\*\*\* România. *Legea nr. 13 / 1993 pentru aderarea României la Convenția privind conservarea vieții sălbatice și a habitatelor naturale din Europa, adoptată la Berna la 19 septembrie 1979*. Monitorul Oficial al României, An. V, nr. 62/ 25 martie 1993. București: 1-20.

**PhD thesis:**

COSTACHE I. 2005. *Flora and vegetation Motru River Lower Basin*. Ph.D. Thesis, University of Bucharest: Romania.

**Web page:**

Muzeul Olteniei Craiova. Secția Științele Naturii. *Oltenia. Studii și comunicări. Științele Naturii* (online). 2008. Publisher: Museum of Oltenia Craiova, Romania. (accessed on May 8, 2009). [www.olteniastudii.3x.ro](http://www.olteniastudii.3x.ro)

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Fauna Europaea: *Chironomidae*. In Fauna Europaea: Chironomidae, Diptera, Nematocera (ed. H. de Jong). Fauna Europaea version 1.5, <http://www.faunaeur.org>. (accessed on June 23, 2009).

**For e-book:**

CARROLL L. 1994. *Alice's Adventures in Wonderland* (online). Texinfo ed.2.1. (Dortmund, Germany): WindSpiel, November 1994 (cited 30 March 1995). Chapter VII: A Mad Tea-Party. Available from the World Wide Web: [http://www.germany.eu.net/books/caroll/alice\\_10.html#SEC\\_13](http://www.germany.eu.net/books/caroll/alice_10.html#SEC_13)

**Electronic publication (papers):**

DANILEVSKY M. L. 2007. *A check-list of Longicorn Beetles (Coleoptera, Cerambycoidea) of Europe*. Available online at: [http://www.coleoptera-literatura.ic.cz/literatura/checklist\\_cerambycidae\\_2007.doc](http://www.coleoptera-literatura.ic.cz/literatura/checklist_cerambycidae_2007.doc). (accessed 20 May 2009).

**Note:** The papers published with other characters than the Latin ones, will be re-written with Latin characters, both in text and at references.

**Example:**

ALEXANDROVICH O. R. 1995. *Reconstruction of the ways of the ground beetles (Coleoptera, Carabidae) fauna forming at the West of the Russian plain*. In: I.K. Lopatin, Pisanenko A.D., Shklyarov L.P. (Editors), *Fauna and taxonomy: Proceed. Zool. Museum Byel. Univ. Minsk: Nauka i Tekhnika*. 1: 52-68. [In Russian with English abstract]

### III. Illustration

Images (white/black or colour) are inserted into the manuscript, but the original versions have to be also sent separately: original drawing made in ink, good contrast photographs, electronic images in TIFF format at a minimum resolution of 300 dpi.

➤ Tables and graphs will be inserted into the manuscript, but original versions will be sent separately, as well. Tables have to be achieved using the same text editor mentioned above, 8 pt. Graphs must be achieved in Microsoft Word or Microsoft Excel.

➤ Illustrations references (tables, images) will be made in the text as it follows: (Fig. 1), (Fig. 1a, b), (Figs. 3; 5); (Table 1)

➤ The title of a figure (both in English and Romanian), will be centered below the figure; as for tables, put it above (aligned right), both 9 pt., normal. Examples:

a) Table 1. List of the identified staphylinids from the Lower Dniester. / Tabel 1. Lista faunistică a stafilinidelor identificate în pădurile Nistrului Inferior;

b) Figure 1. Distribution of the butterfly *Papilio machaon* L. / Figura 1. Distribuția fluturelui *Papilio machaon* L.

➤ For diagrams, use white, black, grey, different tones and textures. They will not be published in colours.

**The paper will be accepted for publishing if:**

➤ it acquires a favourable review from the scientific reviewers of the journal;

➤ it respects the aforementioned requirements;

➤ it is sustained within the framework of the International Conference "Museum and scientific research", organized annually in September;

➤ the publication fee is paid;

➤ it is respected the deadline, **May 1** of the current year.

**The editorial board** has the right to reduce the number of figures and photos (if there are too many as compared to the text of the paper or if they do not correspond to the requirements) and not to accept papers sent after deadline, **May 1**.

➤ **With all the respect for the authors, papers that do not correspond to the recommendations will be sent back.**

➤ **The responsibility of the scientific content of the papers depends entirely on the authors.** Authors must revise the papers reviewed by the reviewers.

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