# THE TOPONYMY OF THE LOCALITIES WITH UKRAINIAN MINORITY POPULATION IN THE LOWER VALLEY OF THE VIŞEU RIVER AND THE RUSCOVA RIVER – HUTZULIA MARAMUREŞEANĂ VIŞEVŞCENA (MARAMUREŞ, ROMANIA)

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**KEYWORDS**: toponymic localities, Vişeu and Ruscova valleys.

**ABSTRACT**

The toponymy of Ukrainian minority localities on the lower Vișeu and Ruscova rivers "Hutzulia maramureşeană Vişevşcena" (Maramureş, Romania).

The present paper introduces a research method for the toponymy of the cross-border areas using the lexical-semantic process. Toponyms used in the area of the Ukrainian settlements in the lower catchment areas of the Vișeu and Ruscova rivers (Maramureș County) were collected and studied. These toponyms were named by the Ukrainian population, starting in the 16th century. A toponymic interaction of Romanian and Ukrainian can be observed, yet it is not substantial. In the clarification of toponyms, one must prioritize those versions corresponding at the most to the natural environment and to the nominating culture. These toponyms have deep roots and are true monuments of culture and language. 12 toponym classes were elaborated and 126 toponyms were explained. The study of the toponymy has informative and geographical importance and it is applicable in the field orientation and environmental reconstruction.

**REZUMAT**: Toponimia localităţilor cu minoritate ucraineană din valea inferioră a râului Vişeu şi a râului Ruscova „Hutzulia maramureşeană Vişevşcena" (Maramureş, România).

Lucrarea de faţă prezintă o modalitate de cercetare a toponimiei în zone transfrontaliere, cu ajutorul procedeului lexico-semantic. Au fost culese şi studiate toponime de pe teritoriul localităţilor ucrainene al bazinului inferior al râului Vişeu şi al râului Ruscova din judeţul Maramureş. Acestea au fost nominalizate de ucraineni şi datează încă din secolul al 16-lea. Se remarcă o interferenţă româno-ucraineană a toponimiei, dar puţin substanţială. În desluşirea toponimelor trebuie să acordăm prioritate acelor versiuni care corespund mai mult mediului natural şi acelei culturi care le-a nominalizat. Toponimele au rădăcini adânci şi sunt un adevărat monument al culturii şi limbii. Au fost elaborate 12 clase de toponime şi explicate un număr de 126 toponime. Studiul toponimiei are importanţă informativ-geografică şi aplicabilitate în ceea ce priveşte orientarea în teren şi în reconstrucţia mediului.

**RÉSUMÉ**: Les toponymes des minorités ukrainiennes localisées dans le bassin inférieure des rivières de Vișeu et de Ruscova "Hutzulia maramureşeană Vişevşcena" (Maramureş, Roumanie).

L'article ci-dessus présente une méthode de recherche de la toponymie des zones transfrontalières à l'aide du procédé lexico-sémantique. Des toponymes utilisées dans les localités ukrainiennes du bassin inférieur des rivières de Vișeu et the Ruscova, département de Maramureș, ont été recueillies et étudiées. Celles-ci ont été nominalisées par les ukrainiens dès le 16-ème siècle. On remarque une interférence roumano-ukrainienne de la toponymie quoi que peu substantielle. Dans la clarification des toponymes, on doit accorder la priorité aux versions correspondant le plus au milieu naturel et à la culture les ayant nominalisés. Les toponymes ont des racines profondes et constituent de vrai monuments de la culture et de la langue. 12 classes de toponymes ont été élaborées et 126 toponymes ont été expliquées. L'étude de la toponymie présent une importance informative et géographique ainsi qu'une applicabilité concernant l'orientation dans le terrain et la reconstruction de l'environnement.

## INTRODUCTION

Toponymy is considered an interdisciplinary science which includes scientific branches such as philology, history, geography and ethnography. Each of these sciences tries to explain and analyse toponymy through methodology and specific concepts, of the scientific branch. Historians think that this science is auxiliary to history where the chronological methods are being used. Any phenomenon or process has a history, more exactly an origin. (Lyaşciuk, 1993)

Philologists consider that the history of a phenomenon can be studied only after its main elements have been characterized through linguistic methods. The essential criterion of toponymy as a linguistic branch is functional and not semantic (Oros, 1996).

As a science, geography largely uses toponymy, as the geographical names are closely related to the territory and give the possibility of studying the relations between the elements of the relief, the plants, the animals and the people.

Toponyms gathered from some places on the inferior valleys of the Vişeu and Ruscova rivers (Bistra, Ruscova, Repedea and Poienile de sub Munte villages) have been named by the local Ukrainian minority. If a certain territory had been populated earlier, this would have been characterized by a presence of toponymy. Socio-political elements and the level of the spiritual culture had a remarkable influence in naming the geographical objects. In order to be able to orientate themselves on the territory, in the past, people were using as clues the relief features (mountain tops, ridges, peaks, rivers, lakes and others). The similarities between features and their great number require the individualization of this geographical objects with the aid of nominalization (Lyaşciuk, 1993). The origin of toponyms is motivated, bearing addressing functions which hide informations about geographical objects, their purpose and meaning. Each toponym in its way bears an important geographical historical, linguistic, ethnographical and cultural information.

Geographical objects' nominalization is a popular creation in which the dialectal meaning of words plays a special role, taking a hard task to discover the meaning of toponyms in its absence (Hudash, 1991). We need to offer a great priority to those versions corresponding more to the natural background and to the culture which had nominalized them, in order to discern toponyms. We can see that the collected toponyms have deep roots and represent a real monument of the Ukrainian culture and language, having a semantic loading and a specific information.

The diversity of the toponyms collected from the Ukrainian places in the inferior valley of the Vişeu River and of the Ruscova River in the Maramureş County assert the very old presence of this ethnic community in the area. In his work called *Maramureşean Diplomas*, the well-known Romanian historian Ioan Mihali de Apsa mentions the fact that most of the Ukrainian and Romanian places in Maramureş County have been dated from the 14th century. These places had been populated much earlier. The historical facts and the semantic analysis of the toponymy give us the possibility to include a great part of the geographical names as part of an old Ukrainian period. During the centuries many toponyms have met linguistic influences, due to the existing interrelations from the specific area.

Of course the majority Romanian population let numerous toponyms along the history, ex. Brebeneskul-Brebenescu, Bretskul-Breţcu, Turkul-Turcu, Trufanets-Trufăneţ, Urda, Steryshora-Stânişoara, Petros, Scherban-Şerban, Hropshora-Gropşoara, etc., (Drăgulescu et al., 1999) but this is not the subject of this paper.

**RESULTS AND DISCUSSION**

During his field research the author of this study collected and classified 360 toponyms from all the Ukrainian places situated in the inferior valley of the Vişeu and Ruscova rivers in Maramureş County. Their classification was accomplished, based on the lexical-semantic principle (Cureleac, 1999). Not all toponyms have been included in the article.

Toponyms categories:

1. Toponyms which are derived from the **representatives of the animal world**:

a) **wild animals: Bilka/Білка** (squirrel) – toponym with an Ukrainian origin – Bistra Village; **Vovcia/Vovchya/ Вовчя** (wolf) – Ruscova Village; **Medvejei/Medvejiy/Медмежий** (bear) and **Sokolov/Sokil/Сокіл** (eagle) – Poienile de sub Munte Village; **Svennei/Свинний** – (the place where the wild boars hide) and **Suldac/Shuldak/Шулдак** – wild boar – Repedea Village;

b) **domestic animals: Korovli/Коровлі** (cow) – Poienile de sub Munte Commune;

2. Toponyms deriving from the **vegetal world representatives** (vegetal elements, trees, bushes and herbs): **Berezneac/Bereznyak/Березник** (birch tree forest), **Cosiv/Косів** (mowed land), **Ceretiv/Черетів** (bulrush, cane), **Cesnekiv/Часників** (garlic, the place where garlic grows), **Dibrova/Діброва** (grove, oak tree forest), **Dubruci/Дубрівки** (oakery), **Hreskiv/Гришків** (buckwheat), **Ialenca/Yalynka/Ялинка** (fir, fir tree forest), **Ialivnek/Ялівник** (spruce fir forest), **Iasinac/Yasinnyk/Ясінник** (ash tree, ash tree forest), **Iavoriv/Яворів** (sycamore maple tree forest), **Luh/Lunca/ Луг** (pasture), **Malannac/Малинник** (raspberry, raspberry bush), **Plai/Плай** (Romanian toponym – hill area with grass), **Tisa/Тис** (resinous essence tree), **Topoliv/Тополів** (poplar, poplar tree forest) – Bistra village (the belonging villages, Valea Vişeului, Bistra and Crasna Vişeului) (***); **Dubrova/Діброва** and **Dubovet/Дубовец** (grove, oak tree forest), **Ialynca/Yalynka/Ялинка** (fir, fir tree forest), **Ialovet/Yalovet/Ялівец** (spruce fir forest), **Bokovenka/Bocovinca/Буковинка** (beech, beech tree forest) – Ruscova village; **Dolyna Iasenunska/Yasenunsca/Долина Ясенунська** (Ash Tree Valley); **Ceretu/ Очерет** (the grass lawn); **Dibrova/Діброва** (grove, oak tree forest); **Smereceanei/ Смеречяний** (spruce fir tree forest); **Suharasce/Сухарище** (dry wood forest), **Ceresenica/Черешенька** (sweet cherry tree) – Repedea Village; **Ruska Polyna** (the old name given to Poienile de sub Munte – The Meadow Below The Mountain – comes from Poiana Rusului – The Meadow of the Russian), **Polyna/Поляна/Полонина** (meadow, grassland, mountain), **Zarub/ Заруб** (cleared forest); **Iasenunskiy/ Yasenunskiy/Ясенунський** (ash tree forest).

3. Toponyms which derive from different **landscape's characteristic** features such as:

a) toponyms deriving from **mountain and hill forms**: **Dil/Діл** (rivers' sweep), **Hora/Гора** (mountain), **Makovita/Маковиця** (Ukrainian – Makivka, the upper part of a mountain), **Măgura/Мигура-Височина** (mountain), **Obcina/Обчина** (peak, a prolonged ridge of a hill or mountain which joins two peaks), **Picuiata/Пікуята/Пік** (top, peak), **Megla/ Мигла** (a small hill in the middle of the plain, evidence of erosion in Valea Vişeului Village) – Bistra Maramureş Village;

b) toponyms denoting **valleys, depressions and terraces**: **Pereslup/ Переслуп** (depression), **Gruninky/** Груньки (hill, hillock) – Ruscova Village; **Jolob/Жолоб** (sewer, deep valley); **Iama/ Яма** (hollow), **Zarinok/Зарінок** (meadow area), **Cotel/Котел** (small depression), **Berdo/Бердо** (steep slope), **Poderei/ Подерей** (terrace shaped territory) – Bistra Village; the toponym **Zarika/Zarica/Заріка** (beyond the river territory) is met in all four villages.

c) toponyms derived from **slopes**: **Osui/Осуй** (sunny slope); **Repky/Rypky/ Репки** (uneven steep slope) – Repedea Village; **Osovnya/Осовня** (slope with

sunny steep, southern position) – Bistra Village; **Oblaz/Облаз** (road at the foot of a mountain) – Ruscova and Bistra communes.

d) toponyms deriving from **passes and canyons**: **Rostoca/Ростока** (the place where rivers separate themselves); **Perehrestea/Перехрестя** (the intersection of the mountainous paths) – Bistra Commune; **Pereslup/Переслуп** (saddle-shaped pass, highly situated) – Repedea and Poienile de sub Munte communes.

e) toponyms deriving from the **agricultural lands**: **Lazy/Лази** (common), **Lujana/Лужана** (everglade), **Tarina/ Царина** (arable lands), **Levadcyna/ Левадчина** (orchard) – Repedea Commune; **Luh/Луг** (everglade), **Pasovnea/Пасовня** (grazing place), **Poderei/Подерей** (terrace shaped territory), **Poloninca/Полонинка** (meadow, mountainous pasture), **Preluca/Прелука** (small glade), **Poleanche/Полянки** (meadow, lawn), **Stuilasce/Стуйлище** (the place where sheep graze in spring time – spring like), **Toloca/Толока** (common), **Sadoc/Садок** (orchard) – Bistra Commune.

f) toponyms deriving from some **geological layers**: **Kaminceane/ Кам'янчаний** (Ukr. – stone), **Pud Kamenem/Під каменем** (under the stone) – Repedea Commune; **Cameanca/ Кам'янка** (stone, boulder) and **Cremenasce/Кременище** (flint) – Bistra Commune, **Grehit/Грегіт** (detritus) – Bistra and Poienile de sub Munte communes; **Soloteanei/Солотяний** (territory rich in mineral salts – salt) – Poienile de sub Munte Commune; **Vapnarke/Вапнярки** (the place with kilns where they burn the lime) – Bistra and Repedea communes.

**Hydronimy**: **Mlaciky/Млачки** (swampy territory) – Repedea Commune; **Rica/Ріка** (river) – Poienile de sub Munte Commune; **Bolota/Болота** (swamp, puddle), **Bolotin/Болотин** (swamp, puddle), **Carnacica/Кринички** (stream), **Potic/Потік** (stream, torrent, spring) – Bistra Commune.

5. Toponyms deriving from the **old landowners: Denkova/Denkiv/Денків** (Denko's territory), **Keresove/Керешове** (Keres's land), **Serbanskiy/Шербанський** (Romanian toponym Serban's land) – Bistra Commune; **Dancul/Данкул, Денків** (Dancul's land) – Repedea Commune; **Drahmirov/Драгмиров** (Drahmir's estate) – Ruscova Commune; **Maxemniuc/ Максемнюк** (Maxemniuc's land) – Poienile de sub Munte, the largest commune in the county.

6. Toponyms which come from the **given names of the old landowners: Hora Hali/Гора Галі** (Halea's Mountain – Ruscova Commune); **Mihailyk/ Михайло** (Michael's land), **Mihailusky/Михайлуський** (Michael's land) and **Miclusa/Micklush –** Nicolae from Hungarian (Miclush's estate) – Repedea Commune; **Ivancikov/Іванчіков** (Ivan's land) and **Paulik/Павлик** (Pavlo's land), **Iurcescu/Юрческу** (the toponym with a Ukrainian origin with a Romanian termination – the given name Yura in the Romanian language *Gheorghe* – the Iurcescu field) – Poienile de sub Munte Commune; **Pip Ivan/Піп Іван** (river and mountain having the same name) – Bistra and Repedea communes.

7. Toponyms deriving from **household objects: Bardeu/Bardau/ Барда/Бардій** (axe, hatchet) – Poienile de sub Munte Commune; **Vorotet/Ворота** (gate) – Bistra Commune.

8. Toponyms deriving from the **exterior aspect of people**: **Voloseanka/ Волосянка** (the toponym comes from Ukrainian, **volosea** in Romanian hair – very thick forest), **Holovaci/Головач** (thick – headed); **Tovstei/Товстий** (thick, fat, big hill) – Bistra Commune; **Ciolar/Чолар** (forehead) – Repedea Commune.

9. Toponyms which derive from **people's profession**: **Cusnirca/Кушнірка** (Ukr. – furrier, the furrier's estate), **Pasicinyi/Пасічний/Пасіка** (apiary), **Tokarnea/Токарня** (the turner's estate) – Bistra Commune.

10. Toponyms formed by **adjectives and nouns combination: Crasna Vișeului/ Красна Вішеулуй** (in Slavonic transcription and in the Ukrainian language, crasna, means beautiful). **The upper/lower/**

**Grigoretz/Григорець Вирхній, Нижній** (the inferior and superior part of the landowner Hryhoriy).

11. **Adjectives-formed toponyms: Billy/Білий** (Ukr. – white), **Plavniy/ Плавний** (Ukr. – slowly), **Seredni/ Середний** (Ukr. – middle) – Ruscova Commune; **Bilyanskii/Білянський** (Ukr. – albino), **Mohnatey/Мохнатий** (Ukr. – hairy, moss-covered soil), **Ciornii/Чорний** (Ukr. – black) – Bistra Commune.

12. Toponyms with a **mystical-religious meaning: Hluhei/Глухий** (Ukr. – deaf), **Poklykovysce/ Покликовище/Покликати** (Ukr. – to call), **Neviru/Невіру** (Ukr. – do not believe in facts and phenomena which don't make sense) – Bistra Commune; **Valea Neagră – Black Valley** (after the building of the monastery it was changed into Valea Luminata – The Lighted Valley) – at the bourne of the communes Rona de Sus, Petrova and Bistra; **Bludniak/Блудняк** (the place where people loose their orientation; derived from the Ukrainean **bludyty** – to loose oneself), **Zaklyana Dolyna/Закляна Долина** (Ukr. – the cursed valley), **Hamonanka/Гамованка** (Ukr. **Halmuvaty** – to brake, the place where something stops you; areal explanation – the place which confuses you) – Repedea Commune; **Lyhey Potik/Лихий Потік** (Ukr. – The Bad Valley), **Reveaka/Рев'яка** (Ukr. **Revty, Plakaty** – to cry, the crying place), **Ustekliy/Устеклий** (Ukr. **Ustekliy –** mad, the place where people loose their minds) – Poienile de Sub Munte Commune.

The detailed analysis of the areal spreading of the Ukrainian toponymy of this mystical-religious group of toponyms shows itself almost regularly in the studied territory, at a certain distance (Cureleac, 1999). The nominalization of the toponyms is related to some forms of the relief, hydrographical objects, the vegetal and animal world features.

The nominalization of the geographical objects took place in a sudden connexion of man and nature. In the past, at the subconscious level, some people would comprehend the mystical character of a certain territory, which used to have an influence upon their psychic. This is how the origin of the religious-mystical toponyms is explained. In the specialised literature these places are called geopathogenic areas. In order to investigate and study them we shall suggest the classification and the analysis of the toponymy, which has an important, informative and applicative influence. The discovery of the geopathogenic areas has an applicative relevance. In these relaxing areas, habitable objectives, churches, roads, schools and others were built. With an applicative purpose we recommend the mapping of these toponyms on largely-used maps: topographic, touristic and many more.

In the Ruscova River valley, the following homonyms-toponyms are specific: **Poloninka, Polyana**, **Bukovynka, Yalynka**. The geographical name **Scorodniy** is familiar in Repedea and Bistra communes. **Yalynka** toponym is located in the following villages: Valea Vişeului, Bistra, Crasna Vişeului, Ruskova and the toponym **Uloha** is familiar in Bistra and Poienile de Sub Munte communes.

Toponyms have been formed and named by the Ukrainians allowed to settled on these territories by Romanians, beginning with the 14th century. If a territory has been populated from old times, this will bear a rich and interesting toponymy and their semantic and explanation must be looked for in the language where these true linguistic monuments have been formed.

In many Ukrainian places from Hutzulia Maramureşană Vişevşcena the history placed its fingerprints upon toponymy. Here we can find Romanian origin names (**Big Little, Little Big, The Sleeking, Intense Heat –** in Repedea commune, **Podina, Plai, Furghiu**, **Runcul –** Bistra Commune) Hungarian (**Micluşa** – Repedea Commune, **Portos –** woods storehouse – Bistra Commune). We can notice a Ukrainian-Romanian collision of toponymy, though somewhat significant.

## CONCLUSIONS

The study of toponymy of the trans-frontier area in Maramureș can be accomplished on the basis of a bilateral complex Romanian-Ukrainean and Ukrainian-Romanian linguistic, historic, geographic and ethnographic studies.

The study of toponymy in the villages of Hutzulia Maramureșană – Vișevșcena proves that during the history, this area has met different cultural and linguistic influences, around the Romanian majority population. The minoritary Ukrainian population was remarkable through its steadiness concerning the preservation of mother's tongue, the toponymy, customs, rites and culture. The ethno-cultural values which have been created in the past, especially the old toponyms represent a living evidence of the continuation of this ethnic community in the area had been assimilated among the Ukrainian population and shared respectfully from generation to generation.

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# INFLUENCE OF HUMUS ON THE BIOACCUMULATION OF A NORWAY SPRUCE STAND FROM CINDREL MOUNTAINS

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**KEYWORDS**: *Picea abies*, bioaccumulation, Cindrel Mountains, humus.

**ABSTRACT**

This study examines biomass accumulation in a spruce stand in the Cindrel Mountains under the influence of soil type. The research has been carried out in the Cindrel Mountains, Onceşti District. Two surfaces were analized, located at similar altitude, with similar climatic conditions and vegetation, but developed on different soils. The aim of the research was to establish a link between humus type and amount of biomass accumulated by forest species. In experimental plots soil samples were collected on which were made measurements of the morphological, physical and chemical properties, and an inventory of the forest vegetation to which it was integral. We aimed to characterize the soil in terms of pH, degree of base saturation, nitrogen, type of humus and edaphic useful volume. The determinations of the trees covered the height, diameter and some quality indicators. Other observation focused on the replicability of the forest site and indicator flora. The results obtained allowed us to draw conclusions based on statistical processing.

**REZUMAT**: Influența humusului asupra acumulării de biomasă.

Acest studiu analizează acumularea biomasei în arboretele de molid din Munții Cindrel sub influența tipului de humus. Experimentele s-au desfășurat în Munții Cindrel, masivul Onceşti. S-au analizat două suprafețe amplasate la aceeași altitudine, în aceleași condiții climatice și de vegetație, dar dezvoltate pe soluri diferite. Cercetarea are ca scop stabilirea legăturii dintre tipul de humus și cantitatea de biomasă acumulată de către speciile lemnoase. În suprafețele experimentale s-au recoltat probe de sol asupra cărora s-au efectuat determinări în ceea ce privește proprietățile morfologice, fizice și chimice, iar vegetația lemnoasă s-a inventariat în întregime. S-a urmărit caracterizarea solului din punct de vedere al gradului de saturație în baze, pH, aprovizionare cu azot, tipul de humus, conținutul de schelet, volumul edafic util. Determinările asupra arborilor au vizat măsurarea diametrelor, înălțimilor, indicilor de calitate. Alte observații au vizat bonitatea stațiunii forestiere și flora indicatoare. Rezultatele obținute au permis formularea concluziilor bazate pe prelucrarea statistică.

**ZUSAMMENFASSUNG**: Der Einfluss von Humus auf die Biomasseakkumulation.

Die vorliegende Arbeit analysiert die Anhäufung von Biomasse in den Fichtenwäldern des Cindrel-Gebirges unter dem Einfluss des Humustyps. Die Versuche wurden im Cindrel-Gebirge und zwar im Onceşti-Massiv durchgeführt. Dabei wurden zwei Flächen analysiert, die auf gleicher Höhe liegen, dieselben klimatischen und Vegetationsbedingungen, jedoch unterschiedliche Böden aufweisen. Die Untersuchung hat zum Ziel eine Beziehung zwischen Humustyp und der von den Bäumen angehäuften Menge an Biomasse zu ermitteln. Auf den Untersuchungsflächen wurden Bodenproben entnommen, wobei dann eine Bestimmung der morphologischen, physikalischen und chemischen Eigenschaften durchgeführt sowie die Vegetation insgesamt aufgenommen wurde. Außerdem wurde eine Beschreibung und Bewertung des Bodens bezüglich Sättigungsgrad an Basen, pH-Wert, Stickstoffversorgung, Humustyp, Gehalt an Skelettmaterial und edaphisch nutzbarem Volumen vorgenommen. Die Bewertung der Bäume wurde mittels der Messung ihres Durchmessers, ihrer Höhe und ihres Qualitätskennwerts vorgenommen. Andere Beobachtungen betrafen die Bonität des Forststandortes und seine floristischen Zeigerarten. Die erzielten Ergebnisse ermöglichten Folgerungen, die auf einer statistischen Bearbeitung der Erhebungsdaten beruhen.

## INTRODUCTION

Spruce forest productivity is largely limited by the rate of nutrient release from decomposing organic matter (Van Cleve et al., 1981), which often increases with higher soil temperatures (Van Cleve et al., 1990) and varies with landscape position (Van Cleve and Yarie, 1986; Van Cleve et al., 1991).

Soil structure, porosity, and nutrient capital are attributes of ecosystems least tolerant of actions during or after timber harvest. Harvest can initiate sudden shifts in forest ecosystem dynamics.

Distribution of moisture and solar energy may change radically, altering soil and air temperatures and evapotranspiration rates at the soil surface and within the remaining canopy (Harvey et al., 1994).

In addition to affecting local soil temperatures, relatively small-scale changes in topography can impact the lateral and vertical movements of water, which affect soil nutrient transformations and uptake in black spruce forests (Yarie and Van Cleve, 1983; Grant, 2004).

The bioavailability of surface organics decreases during humification, resulting in compounds that decay by orders of magnitude more slowly than fresh litter (Aber et al., 1990; Berg and Meentemeyer, 2002).

## MATERIAL AND METHODS

This study was conducted in the Cindrel Mountains, Onceşti District, presenting two experimental variants: landscape unit 107C and 114B (Fig. 1). For each variant three repetitions were made. Also, the experiment was monofactorial and was organized after randomized blocks method.

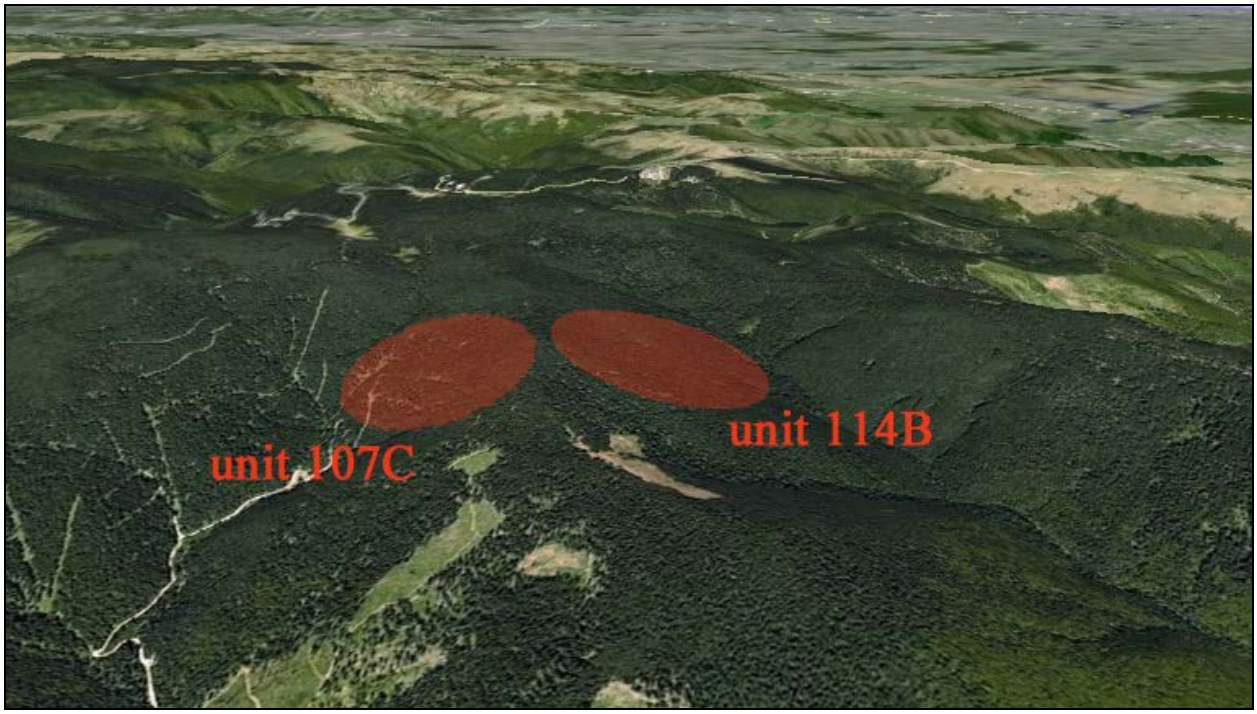


Figure 1: Map of experimental area.

Soil determinations were made on the main features and vegetation observations were made on trees' quality, trunk diameter at 1.30 m height above the ground, and trees height. Experimental surfaces were between one and three hectares. Total tree inventory was 3,234.

Quality grades were assessed visually, using four quality classes of standing trees as specialized methodology, the heights were measured using an electronic dendrometer and diameters were measured using a forest caliper.

We determined average height, average diameter, diameter of the base area, average unit volume, and average tree volume.

The analysis of soil samples were carried out in compliance with specific methodology for soil analysis.

For statistical data processing we used the Mann-Whitney (U test), the non-parametric analysis (Ardelean, 2006). Statistical analysis was done using the program IBM SPSS Statistics 20.

## RESULTS AND DISCUSSION

Geomorphological, unit 107C shows southern exposure and a slope of $20^g$; unit 114B shows northen exposure and a $22^g$ slope.

Altitudinal, the two units are located between 1,220 m and 1,475 m high. Unit 107C presented podzolic brown soil type, with very strong acid reaction (pH 3.5-4), oligobasic (V%, 12-37%), the edaphic medium volume, skeletal soil middle edaphic volume, with mull-moder type of humus. In the 114B unit acid brown soil type is present, with less acid reaction than the podzolic brown soil from landscape unit 107C, (pH 4.1-5), that is oligomesobasic (38-51%), with edaphic medium volume, and with mull-moder type of humus. The type of station is mountain spruce stands, average bonity, acid brown soil, edaphic in middle, with *Oxalis-Dentaria*, and type of forest Spruce with *Oxalis acetosella* on skeletal soils.

During the growing season temperatures of over 10°C during the study period were present in 175 days.

The average annual temperature is 6-7°C. The first frosts were reported around September 21 – October 2011, while the last frosts were felt on April 21 – May 1 2012. Rainfall regime is characterized by an annual average of approximately 850 mm variable between 650-900 mm.

The aridity index value is 62.7.

Forest vegetation inventory results are graphically presented below (Figs. 2 and 3; Tabs. 1 and 2).

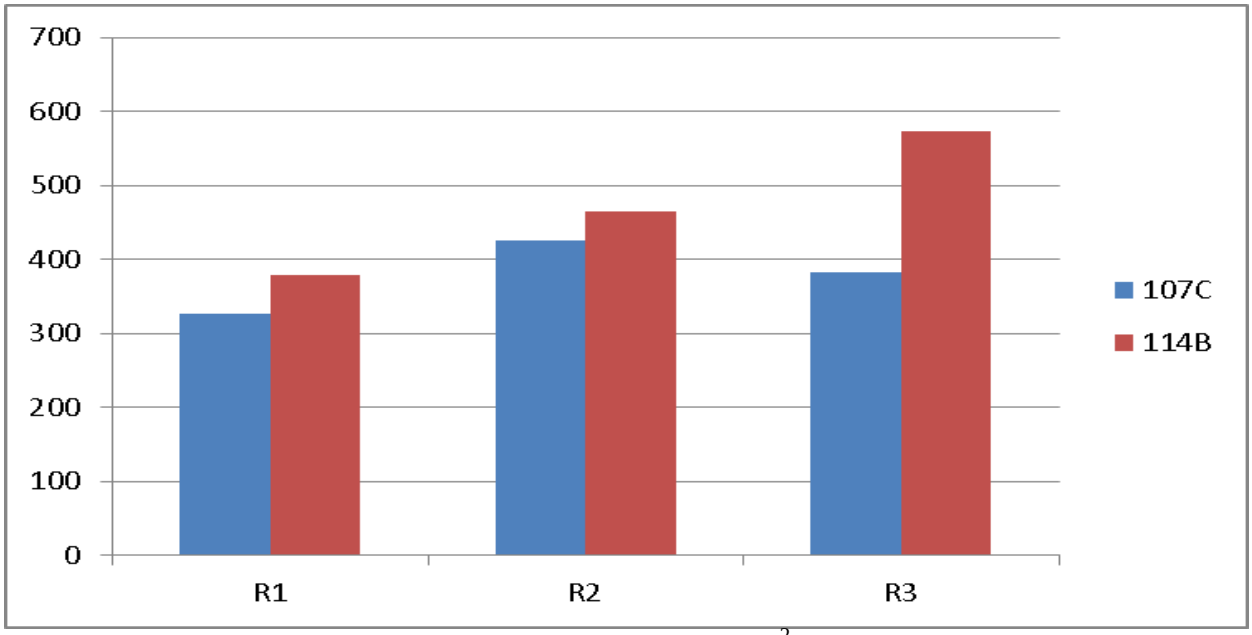


Figure 2: Volume per unit ($m^2$/ha).

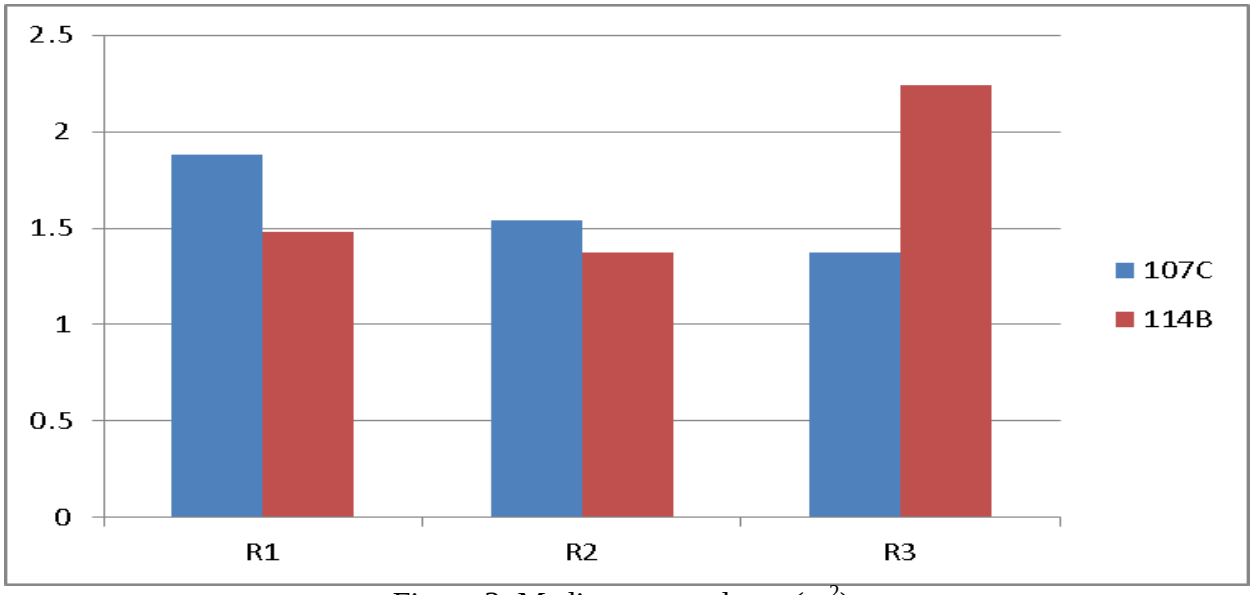


Figure 3: Medium tree volume ($m^2$).

Table 1: Vegetation inventories results for unit 107C.

| No. | Sample's surface | Surface (ha) | Number of trees | Total volume ($m^2$) | Number of trees per ha |
|---|---|---|---|---|---|
| 0 | 1 | 1 | 2 | 3 | 6 |
| 1 | R1 | 3 | 521 | 981 | 174 |
| 2 | R2 | 1 | 276 | 425 | 276 |
| 3 | R3 | 2.5 | 644 | 958 | 278 |

Table 2: Vegetation inventories results for unit 114B.

| No. | Sample's surface | Surface (ha) | Number of trees | Total volume ($m^2$) | Number of trees per ha |
|---|---|---|---|---|---|
| 0 | 1 | 1 | 2 | 3 | 6 |
| 1 | R1 | 2.5 | 638 | 944 | 255 |
| 2 | R2 | 1 | 339 | 465 | 339 |
| 3 | R3 | 2.5 | 639 | 1,432 | 256 |

Regarding the influence of the type of humus on the process of accumulation of biomass, the analysis is nonparametric, the data are from two independent groups of measurement (Tabs. 3 and 4), using the Mann-Whitney (U test) with the independent variable type of humus and unitary volume ($m^3$/ha) the dependent variable.

Table 3: Mann-Whitney Test.

| | Humus | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| Unitary volume | 1.00 | 3 | 2.67 | 8.00 |
| | 2.00 | 3 | 4.33 | 13.00 |
| | Total | 6 | | |

Table 4: Test Statistics[a].

| | Unitary volume |
|---|---|
| Mann-Whitney U | 2.000 |
| Wilcoxon W | 8.000 |
| Z | -1.091 |
| Asymp. Sig. (2-tailed) | 275 |
| Exact Sig. [2*(1-tailed Sig.)] | 400[b] |

Ranks

a. Grouping Variable: Humus.

b. Not corrected for ties.

The value of t is -1.091. This compares with $t_{teor}$ for $P_{5\%}$, $P_{1\%}$, $P_{0.1\%}$ at GL = ∞. It follows that $t_{calc}$ (1.091) < $t_{teor}$ for $P_{5\%}$ (1.96), therefore, the difference between the two types of humus is insignificant.

## CONCLUSIONS

Following research that unitary volume (m³/ha) is not directly influenced by the type of humus, differences between the two types of humus (mull-moder humus crude) are insignificant.

Differences in bioaccumulation, growth in diameter and height are due to other factors: exposition, pH, degree of base saturation or nitrogen supply (Bratu, 2012).

In the two type of soil, podzolic brown soil and acid brown soil, forest formations represented by pure spruce stands or mixed with beech and silver fir of medium productivity can develop.

These types of humus mull-moderr or raw humus, did not lead to differences in terms of biomass accumulation.

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# DIPLOIDY INDICES IN THE PLANT ASSOCIATIONS FROM THE NATURA 2000 SITE SIGHIŞOARA – TÂRNAVA MARE (TRANSYLVANIA, ROMANIA)

*Silvia OROIAN* [1]

**KEYWORDS**: diploidy indices, Sighişoara – Târnava Mare site, plant associations.

**ABSTRACT**

The habitats identified in the Sighişoara-Târnava Mare Natura 2000 site are outstanding for their rich flora and are important for the conservation of plant and animal diversity, some being recognised as key habitats for the preservation of European biodiversity. Following the present study, 43 vegetal associations were identified; grouped in 30 alliances, one sub-alliance, 18 orders and 13 classes. The authors present the distribution of diploids and polyploids in order to estimate diploidy indices, calculated according to the Pignatti equation and based on the ratio established between the sum of diploid species and the sum of polyploid species. From the total 897 vegetal taxa identified within the Sighişoara – Târnava Mare site, 51.32% are diploid, 46.29% are polyploid, and 2.40% are diplo-polyploid. For the remaining 2.01%, the authors lack caryological information. The diploid-polyploid species ratio calculated for the overall vascular flora is 1.11. The highest frequencies of polyploids were encountered in unbalanced biotopes and the most reduced polyploid frequences were encountered in climactic associations. Generally, the diploidy indices for the associations present in the studied territory have similar values to the indices for Central Europe. These values remain similar to those of the associations identified in other Transylvanian areas, Mureş Gorges and Gurghiului Valley, as well as to those found in the wetlands of north-western Romania.

**REZUMAT**: Indici de diploidie în asociaţiile vegetale din situl Natura 2000 Sighişoara – Târnava Mare (Transilvania, România).

Habitatele identificate în situl Natura 2000, Sighişoara-Târnava Mare se remarcă printr-o mare bogăţie floristică, importante pentru conservarea diversităţii plantelor şi animalelor, unele dintre ele fiind recunoscute ca habitate cheie pentru menţinerea biodiversităţii la nivel european. În urma studiului efectuat, au fost identificate 43 de asociaţii vegetale, grupate în 30 alianţe, o subalianţă, 18 ordine şi 13 clase. Am redat distribuţia diploizilor şi poliploizilor, în vederea estimării indicilor de diploidie, calculaţi după formula lui Pignatti, bazaţi pe stabilirea raportului dintre suma prezenţei speciilor diploide şi a celor poliploide. Din totalul celor 897 taxoni vegetali, identificaţi în situl Sighişoara – Târnava Mare, 51,32% sunt diploizi, 46,29% sunt poliploizi, 2,40% sunt diplo-poliploizi, iar pentru 2,01% nu am dispus de informaţii cariologice. Valoarea raportului dintre speciile diploide şi cele poliploide calculat pentru ansamblul florei vasculare este de 1,11. Cele mai ridicate frecvenţe ale poliploizilor au fost întâlnite în cazul biotopurilor destabilizate, iar cele mai reduse frecvenţe în cazul asociaţiilor aflate în stadiu de climax. În ansamblul lor, indicii de diploidie ai asociaţiilor din teritoriul cercetat corespund cu valorile indicilor similare din Europa centrală. Valorile acestor indici rămân similare cu cele ale asociaţiilor identificate în alte zone ale Transilvaniei: Defileul Mureşului, Valea Gurghiului, dar şi cele din zonele umede din nord-vestul României.

**ZUSAMMENFASSUNG**: Diploidie-Indices der Pflanzengesellschaften im Natura 2000-Gebiet “Sighişoara/Schässburg-Târnava Mare/Große Kokel”.

Die im Natura 2000-Gebiet “Sighişoara/Schässburg-Târnava Mare/ Große Kokel” festgestellten Habitate zeichnen sich durch einen hohen Reichtum an Pflanzenarten aus, die für die Bewahrung der Diversität der Pflanzen und Tiere von großer Bedeutung sind. Einige dieser Lebensraumtypen sind als Schlüsselhabitate für die Bewahrung der Biodiversität auf europäischer Ebene anerkannt worden. Auf Grund der durchgeführten Untersuchungen wurden 43 Pflanzengesellschaften aus 30 Verbänden, einem Unterverband, 18 Ordnungen und 13 Klassen identifiziert. Dabei wird im Hinblick auf die Auswertung der Diploidie-Indices, auf die Verteilung der diploiden und der polyploiden Arten eingegangen, die nach der Formel von Pignatti, berechnet wurden. Diese nimmt Bezug auf das Verhältnis zwischen der Summe der vorhandenen diploiden und der polyploiden Arten. Von der Gesamtzahl von 897 Pflanzentaxa, die im Gebiet Sighişoara – Târnava Mare festgestellt wurden, sind 51,32% diploid, 46,29% polyploid und 2,40% diplo-polyploid, während für 2,01% der Taxa keine karyologischen Informationen zur Verfügung standen. Der Wert des Verhältnisses zwischen den diploiden und den polyploiden Arten, der für die gesamte Gefässpflanzenflora errechnet wurde, beläuft sich auf 1,11. Die höchsten Vorkommen der Polyploiden wurden in den gestörten Biotopen bzw. Gesellschaften festgestellt, die geringsten Vorkommen jedoch im Falle der Klimax-Gesellschaften. In ihrer Gesamtheit entsprechen die Diploidie-Indices der Pflanzengesellschaften im untersuchten Gebiet den Werten ähnlicher Indices im zentraleuropäischen Raum. Die Werte der Indices sind jenen in anderen Gebieten Siebenbürgens untersuchten Pflanzengesellschaften ähnlich, wie jenen in der Mureş/Mieresch-Enge und im Gurghiu-Tal, aber auch jenen der Feuchtgebiete im Nordwesten Rumäniens.

## INTRODUCTION

Sighişoara – Târnava Mare (Fig. 1) is located in the geographical center of the country, in Southern Transylvania and contains 27 cities and towns that belong to three counties: Braşov, Mureş and Sibiu (Tab. 1). This site has a surface area of 97,000 hectares, making it the largest site in the continental region (of Romania).

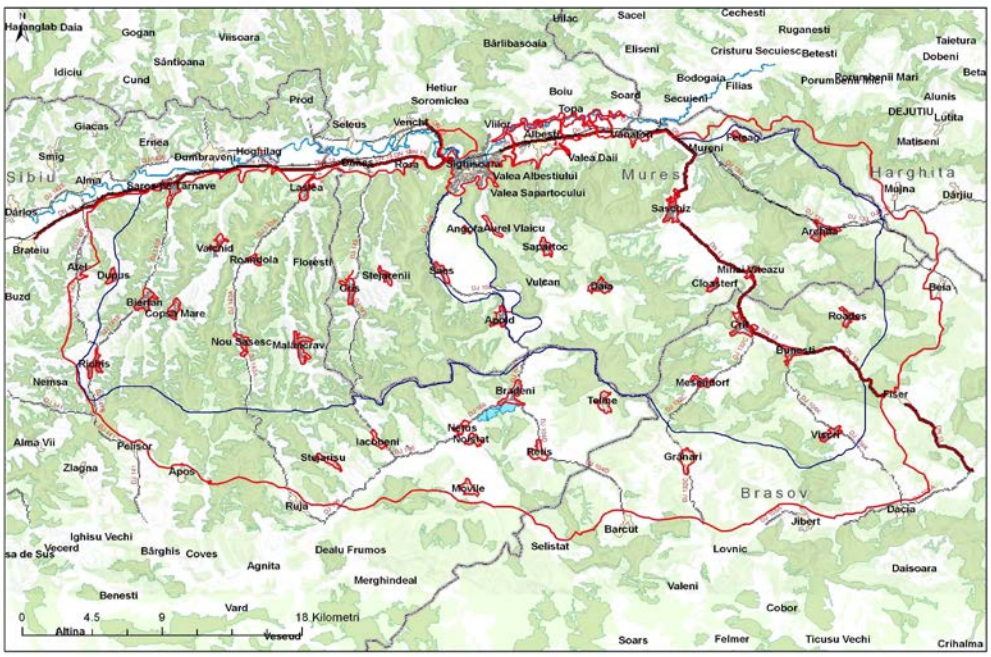


Figure 1: Map of the Sighişoara – Târnava Mare Natura 2000 site.

Table: 1 Sighişoara – Târnava Mare site localities where the research was conducted.

| County | Communes | Villages |
|---|---|---|
| Braşov | Buneşti | Criţ<br>Meşendorf<br>Roadeş<br>Viscri |
| | Rupea | Fişer |
| Mureş | Albeşti | Valea Albeştiului<br>Şapartoc |
| | Apold | Daia<br>Şaeş<br>Vulcan |
| | Daneş | Criş<br>Stejăreni |
| | Saschiz | Cloaşterf<br>Mihai Viteazu |
| | Vânători | Mureni |
| Sibiu | Biertan | Richiş<br>Copşa Mare |
| | Brădeni | Retiş<br>Ţeline |
| | Iacobeni | Movile<br>Netuş<br>Noiştat<br>Stejăriş |
| | Laslea | Floreşti<br>Mălâncrav<br>Nou Săsesc<br>Roandola |

The flora found in the Natura 2000 Sighişoara – Târnava Mare site is characteristic of the hilly regions in our country with diversity correlated to the height of the hills, the narrow valleys, wavy land, asymmetrical sides due to land slides, and terraced valleys and riversides. A part of this area is Podişul Vânătorilor, a flat area with slightly unleveled terrain reaching about 550 m in height, only rarely reaching 700 m, the region actually being part of Podişul Hârtibaciului from the south. The terrain of the Podişul Hârtibaciului region is also dominated by asymmetrical, tall hills, and wide valleys, marshy at the bottom. There are two large rivers passing through the Sighişoara – Târnava Mare site: Hârtibaciu in the middle and Târnava Mare to the North.

This area is remarkable due to the large number of plant species, many of these species are protected nationally and internationally, due to the numerous habitat types that are included in the Natura 2000. The floristic inventory includes 858 plant taxa, 839 plant species, 15 subspecies, and four varieties. We want to mention that the area of this research project is approximatelly 24.51% of the Romanian flora (3,500 species, as presented in RPR and RSR Romanian Flora). Considering the number of the plant taxa present on this land surface that is only about 0.04% of the Romania's entire land surface; this area has aproximately a quarter of the plant species found in our country, which allows us to consider this Sighişoara – Târnava Mare site, a site of great floristic diversity (Oroian, 2009).

## MATERIALS AND METHODS

For this research we used phytosocial research methods according to the Central-European School, based on the principles developed by J. Braun-Blanquet (1926) and modified by Borza (1934) to the special properties of the plant cover in our country. The method of naming the plant associations was done in accordance with the regulations established by the Phytosocial Code of Nomenclature (Barkman et al., 1981). While for describing the plant associations we used the methods suggested by Borza and Boşcaiu (1965) and Cristea et al. (2004), as well as the basic knowledge of phytosiology according to Gehu J. M. and Rivas-Martinez S. (1981). Syntaxonomic identification was carried out on the basis of the most recent works on vegetation classification at the European level (Grabherr et al., 1993; Mucina et al., 1993). For the detailed inventory of the plant associations floristics research was performed (ecological behaviour was analyzed by using ecological indicators U, T, R, biomorphology, floristics, karyotype, etc.). For describing the plant make-up we used hydroseries criteria, starting with the Lemnetea Class, and continuing with the riverside (palustrine) and marshy plant associations, followed by hydrophytic meadows, and then xerophitic meadows.

## RESULTS AND DISCUSSION

As a result of this study we identified 43 plant associations, included in 30 alliances, one suballiance, 18 orders and 13 classes (Oroian, 2009). The plant associations were analyzed from an ecological and corological level (regarding the geographical distribution of plants), the floristical composition, as well as cytotaxonomically. We assessed the distribution of the diploid and the polyploid species, in order to estimate the indices of diploidy as calculated by the Pignatti's formula; by calculating the proportion of diploid versus the polyploid species.

The general make-up of the Sighişoara-Târnava Mare site's vegetation is determined by the past and present physical and geographical conditions, the origin of the diverse floristics elements, and the modifications induced by the presence of the anthropogenic and zoogenic factors that had a strong influence on the vegetation make-up by changing natural habitats inhabited by the native flora with cultivated agricultural species. The area included in this study has a variety of habitats, spread from 375 to 700 m altitude, with well preserved forests and diverse herbaceous vegetation.

The karyotype information regarding the components of the various plant associations are of interest both from a phytogeographical causation stand point, as well as for phytohistorical interpretations. For the purpose of this research the chromosomal numbers of the various species was considered according to many authors (Tarnavschi, 1948; Fedorov, 1969; Löve and Löve, 1961, 1974; Májovsky et al., 1987; Kuzmanov, 1993).

From the total 897 plant taxons identified in the Sighişoara – Târnava Mare site, 51.32% are diploid, 46.29% are polyploid, 2.4% are diplo-polyploid, and for 2.01% we have no karyotype information. The proportion between the diploid versus polypoid species as calculated for the vascular flora is 1.11. In the cases where we did not have that information for the Romanian native flora, as much as possible, we refered to the number of chromosomes as established for a territory as close as possible to our country. While calculating the Pignatti's diploidy index, we excluded the diplopolypoid species, as these have a variable karyological status, sometimes in the same population one can find together the diploid as well as tetra- and polyploid species.

The flora in the studied site includes the representative number of old, diploid species. These species ensure the genetic potential for a favorable future plant evolution. The increased frequency of the polypoids is due to their increased ability of

phytosocial competition. The diploid species ensure an increased resistence of the species to the ecological extremes, because they are the pioneer species that populated this area during the postglacial period. The highest proportions of polypoids were found in unbalanced biomes, while the lowest were located in associations that were in the ecological climax.

The cytological studies show that, the frequency of polypoids increases with the altitude. For this reason, it is of particular importance to calculate Pignatti's diploidy index (Pignatti, 1960, 1961, 1966, 1982), starting with the ratio between the diploid species (ΣD) and the polyploid species (ΣP) from the flora of a particular region (Boşcaiu, 1971; Voik, 1975).

By comparing the diploidy indexes of the analyzed plant associations [Sig-T-M.], with the ones from the Mureş River valley between Toplița and Deda (Oroian, 1998) [Def.], Valea Gurghiului (Sămărghiţan, 2005) [V. Gur.] and the hydrophytic areas in north-western Romania (Burescu, 2003) [N-V Ro], we conclude that our data have comparable values.

In the case of the plant associations of stagnant waters with short vegetation at the edge of the ponds, depleted of nutrients that is even more intense during the periods of periodical drying up of these ponds, the indexes remain below one (Tab. 2).

Table 2: Diploidy indexes of the plant associations from the class *ISOETO-NANOJUNCETEA* Br.-Bl. et Tx. 1943.

| Association | Total no. of sp. | Know karyotype (%) | Diploids | | Polyploids | | D. I. | |
|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M. | N-V Ro |
| *Cyperetum flavescenti* | 18 | 94.45 | 4 | 22.22 | 13 | 72.22 | 0.307 | 0.798 |

The index values remain below one also in the case of the aquatic and palustrine wetland vegetation (Tabs. 3 and 4).

Table 3: Diploidy indexes of the plant associations from the class *LEMNETEA* de Bolós and Masclans 1955.

| Association | Total no. of sp. | Know karyotype (%) | Diploids | | Polyploids | | D. I. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | Def. | V. Gur. | N-V Ro |
| *Lemnetum minoris* | 14 | 92.85 | 6 | 42.85 | 7 | 50 | 0.857 | 0.749 | 0.85 | 0.562 |

Table 4: Diploidy indexes of the plant associations from the class *POTAMETEA* R.Tx. ex Prsg. 1942.

| Association | Total no. of sp. | Know karyotype (%) | Diploids | | Polyploids | | D. I. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | V. Gur. | N-V Ro |
| *Ranunculo trichophylli-Callitrichetum cophocarpae* | 25 | 92 | 9 | 36 | 14 | 56 | 0.642 | 0.857 | - |

Table 4 (continuing): Diploidy indexes of the plant associations from the class *POTAMETEA* R.Tx. ex Prsg. 1942.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Potametum natantis* | 20 | 100 | 7 | 35 | 13 | 65 | 0.538 | - | 0.162 |
| *Potamo perfoliati-Ranun-culetum circinati* | 14 | 92.84 | 3 | 21.42 | 10 | 71.42 | 0.299 | - | - |

The smallest diploidy index numbers were found in the newest associations, due to the increased phytosocial competition advantage of the polypoid species (Tab. 5).

Table 5: Diploidy indexes of the plant associations from the class *PHRAGMITETEA* Tx. et Prsg. 1942.

| Association | Total no. of sp. | Know karyo-type (%) | Diploids | | Polyploids | | D. I. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | Def. | V. Gur. | N-V Ro |
| *Scirpo-Phragmitetum vulgaris* | 129 | 93.74 | 54 | 42.18 | 66 | 51.56 | 0.818 | 0.591 | 0.528 | 0.545 |
| *Typhetum latifoliae* | 37 | 91.89 | 13 | 35.13 | 21 | 56.75 | 0.619 | 0.486 | 0.683 | 0.374 |
| *Glycerietum aquaticae* | 47 | 89.35 | 14 | 29.78 | 28 | 59.57 | 0.499 | 0.406 | 0.38 | 0.483 |
| *Sparganietum erecti* | 23 | 86.94 | 5 | 21.73 | 15 | 65.21 | 0.333 | - | - | 0.333 |
| *Eleocharitetum palustris* | 24 | 91.66 | 7 | 29.16 | 15 | 62.5 | 0.466 | - | - | 0.431 |

The diploidy index is below one in the case of the associations from the ***Molinio-Arrhenatheretea*** class R.Tx. 1937 em R.Tx. 1970 that have also recently developed secondary succesion associations (Tab. 6).

Table 6: Diploidy indexes of the plant associations from the class *MOLINIO-ARRHENATHERETEA* R. Tx. 1937 em. R. Tx. 1970.

| Association | Total no. of sp. | Know karyo-type (%) | Diploids | | Polyploids | | D. I. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | Def. | V. Gur. | N-V Ro |
| *Angelico-Cirsietum oleracei* | 19 | 94.73 | 8 | 42.10 | 10 | 52.63 | 0.799 | - | - | - |
| *Scirpetum sylvatici* | 50 | 88 | 13 | 26 | 31 | 62 | 0.419 | 0.408 | 0.450 | 0.399 |
| *Ranunculeto strigulosi-Equisetetum palustris* | 32 | 90.62 | 11 | 34.37 | 18 | 56.25 | 0.611 | - | - | 0.590 |

Table 6 (continuing): Diploidy indexes of the plant associations from the class *MOLINIO-ARRHENATHERETEA* R. Tx. 1937 em. R. Tx. 1970.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Junco inflexi-menthetum longifoliae* | 21 | 85.71 | 6 | 28.57 | 12 | 57.14 | 0.5 | 0.738 | 0.270 | 0.703 |
| *Epilobio palustri-Juncetum effusi* | 83 | 92.77 | 27 | 32.53 | 50 | 60.24 | 0.540 | - | - | 0.695 |
| *Holcetum lanati* | 66 | 90.9 | 25 | 37.87 | 35 | 53.03 | 0.714 | - | - | - |
| *Agrostetum stoloniferae* | 202 | 85.15 | 99 | 36.15 | 73 | 49 | 0.737 | 0.735 | - | 0.631 |
| *Filipendulo-Geranietum palustris* | 33 | 90.9 | 9 | 27.27 | 21 | 63.63 | 0.428 | - | 0.597 | - |
| *Agrostio-Deschampsietum caespitosae* | 121 | 84.3 | 47 | 38.84 | 55 | 45.46 | 0.854 | - | 0.513 | - |
| *Cirsio cani-Festucetum pratensis* | 124 | 89.76 | 61 | 48.03 | 53 | 41.73 | 1.150 | - | 0.789 | - |
| *Arrhenatheretum elatioris* | 212 | 92.45 | - | 44.81 | - | 47.64 | 0.940 | - | 0.817 | - |
| *Trisetetum flavescentis* | 101 | 96.03 | 50 | 49.50 | 47 | 46.53 | 1.063 | - | - | - |
| *Anthoxantho-Agrostetum tenuis* | 94 | 86.16 | 39 | 41.48 | 42 | 44.68 | 0.928 | - | - | - |
| *Festuco rubrae-Agrostietum capillaris* | 164 | 87.19 | 78 | 47.56 | 65 | 39.63 | 1.200 | 1.082 | 0.962 | - |

The associations from the ***Festuco-Brometea*** class Br.-Bl. et R. Tx. ex Klika and Hadač 1944, that are in balance for a longer period of time, have diploidy indexes higher than one (Tab. 7).

Table 7: Diploidy indexes of the plant associations from the class *FESTUCO-BROMETEA* Br.-Bl. et R.Tx. ex Klika and Hadač 1944.

| Association | Total no. of sp. | Know karyotype (%) | Diploids | | Polyploids | | D. I. | |
|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | V. Gur. |
| *Rhinantho rumelici-Brometum erecti* | 196 | 8.98 | 91 | 46.43 | 85 | 43.37 | 1.070 | - |
| *Brachypodio pinnati-Festucetum rupicolae* | 195 | 83.08 | 87 | 44.62 | 75 | 38.46 | 1.160 | - |

Table 7 (continuing): Diploidy indexes of the plant associations from the class *FESTUCO-BROMETEA* Br.-Bl. et R.Tx. ex Klika and Hadač 1944.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Danthonio-Brachypodietum pinnati* | 151 | 88.73 | 72 | 47.68 | 62 | 41.05 | 1.161 | 1.238 |
| *Polygalo majoris-Brachypodietum pinnati* | 164 | 85.48 | 86 | 52.55 | 54 | 32.93 | 1.59 | 0.898 |
| *Medicagini minimae-Festucetum valesiacae* | 199 | 86.93 | 96 | 48.24 | 77 | 38.69 | 1.246 | 1.075 |
| *Elytrigetum hispidi* | 119 | 84.88 | 55 | 46.22 | 46 | 38.66 | 1.195 | - |
| *Thymio pannonici-Chrysopogonetum grylli* | 97 | 94.84 | 45 | 46.39 | 47 | 48.45 | 0.957 | - |
| *Festuco rupicolae-Caricetum humilis* | 105 | 80.95 | 49 | 46.66 | 36 | 34.29 | 1.360 | - |
| *Botriochloetum ischaemi* | 107 | 86.92 | 54 | 50.47 | 39 | 36.45 | 1.384 | - |
| *Carici humilis-Stipetum joannis* | 58 | 87.93 | 29 | 50 | 22 | 37.93 | 1.318 | - |
| *Stipetum capillatae* | 126 | 75.4 | 50 | 39.68 | 45 | 35.71 | 1.111 | - |

The anthropic associations from the ***Bidentetea*** class Tx., Lohm., and Prsg., 1950, on muddy shores, as well as the ones in the ***Artemisietea*** Lohmeyer et al. in R. Tx. 1950 and ***Secalietea*** Br.-Bl. 1951 classes, also have the diploidy indexes below one (Tabs. 8, 9 and 10).

Table 8: Diploidy indexes of the plant associations from the class *BIDENTETEA TRIPARTITI* Tx., Lohm., et Prsg. 1950.

| Association | Total no. of sp. | Know karyo-type (%) | Diploids | | Polyploids | | D. I. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | V. Gur. | N-V Ro |
| *Bidenti-Polygonetum hydropiperis* | 15 | 86.66 | 4 | 26.66 | 9 | 60 | 0.444 | 0.490 | 0.612 |

Table 9: Diploidy indexes of the plant associations from the class *ARTEMISIETEA* Lohmeyer et al. in R. Tx. 1950.

| Association | Total no. of sp. | Know karyo-type (%) | Diploids | | Polyploids | | D. I. | |
|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | V. Gur. |
| *Conietum maculati* | 37 | 97.29 | 12 | 32.43 | 24 | 64.86 | 0.5 | 0.494 |

Tabel 10: Diploidy indexes of the plant associations from the class *SECALIETEA* Br.-Bl. 1951.

| Association | Total no. of sp. | Know karyo-type (%) | Diploids | | Polyploids | | D. I. |
|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M |
| *Spergulo-Aperetum spica-venti* | 29 | 96.54 | 16 | 55.17 | 12 | 41.37 | 1.333 |

The associations with *Salix alba* have the diploidy index of 1.270 due to the consistent presence of more diploids (Tab. 11).

Table 11: Diploidy indexes of the plant associations from the class *SALICETEA PURPUREAE* Moor 1958.

| Association | Total no. of sp. | Know karyotype (%) | Diploids | | Polyploids | | D. I. | |
|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | V. Gur. |
| *Salicetum albae* | 90 | 93.33 | 47 | 52.22 | 37 | 41.11 | 1.270 | 0.849 |

The diploidy indexes for the association from the ***Alnetea glutinosae*** class Br.-Bl. et R. Tx. ex Westhoff et al., 1946 as well as for the ones from the ***Rhamno-Prunetea*** class Rivas Goday and Borja Carbonell, 1961, that contains shrubby associations, are values that are under one (Tabs. 12 and 13).

Table 12: Diploidy indexes of the plant associations from the class *ALNETEA GLUTINOSAE* Br.-Bl. et R. Tx. ex Westhoff et al. 1946.

| Association | Total no. of sp. | Know karyotype (%) | Diploids | | Polyploids | | D. I. | |
|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | V. Gur. |
| *Calamagrostio-Salicetum cinereae* | 69 | 92.74 | 30 | 43.47 | 34 | 49.27 | 0.882 | 0.812 |

Table 13: Diploidy indexes of the plant associations from the class *RHAMNO-PRUNETEA* Rivas Goday and Borja Carbonell 1961.

| Association | Total no. of sp. | Know karyotype (%) | Diploids | | Polyploids | | D. I. | |
|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | V. Gur. |
| *Pruno spinosae-Crataegetum* | 150 | 88.67 | 83 | 55.34 | 50 | 33.33 | 1.660 | 1.333 |
| *Euonymo-Prunetum spinosae* | 20 | 95 | 9 | 45 | 10 | 50 | 0.9 | - |

The most important forests, from the ***Querco-Fagetea*** class Br.-Bl. and Vlieger 1937 are found in the ecological climax, are well balanced and their indexes of diploidy are above one (Tab. 14).

Table 14: Diploidy indexes of the plant associations from the class *QUERCO-FAGETEA* Br.-Bl. and Vlieger 1937.

| Association | Total no. of sp. | Know karyotype (%) | Diploids | | Polyploids | | D. I. | |
|---|---|---|---|---|---|---|---|---|
| | | | No. of sp. | % | No. of sp. | % | Sig-T-M | V. Gur. |
| *Dentario bulbiferae-Quercetum petraeae* | 86 | 98.83 | 48 | 55.81 | 37 | 43.02 | 1.297 | 1.373 |
| *Corno-Quercetum pubescentis* | 41 | 95 | 24 | 58.53 | 15 | 36.58 | 1.6 | - |

## CONCLUSIONS

Overall, the diploidy indexes of the analyzed plant associations are very similar with diploidy indexes found in Central Europe. These values are also similar to the diploidy indexes values found in other areas of Transylvania (Mureş River gorge, Gurghiul River valley, as well as the ones calculated for plant associations in other hydrophytic regions of the north-western Romania).

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# THE MAPPING OF THE BABADAG PLATEAU VEGETATION USING FREE GIS DATA

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**KEYWORDS**: Romania, Dobrogea, Babadag Plateau, vegetation mapping.

**ABSTRACT**

This paper examined elements related to the mapping of the main vegetation types based on free GIS data, which is a long-held ambition of mine. For this, we considered several types of raster data (satellite imagery, scanned maps, satellite maps, etc.) and vector (CORINE Land Cover, Contour maps by D. E. M. and ETOPO2 processing, Relief units map, European Union soil map according to SOTER, etc.). All of these are georeferenced in the Stereographic system 1970 (Stereo 70). All these data were correlated against each other in order to obtain an image as close as possible to the real spatial distribution of the different types of vegetation, especially of plant communities. But, to achieve a clear image of the real situation of the spatial distribution of vegetation, and of the limits of this approach to vegetation mapping, the GIS data were compared with data obtained through field studies.

**REZUMAT**: Cartarea vegetaţiei din cadrul Podişului Babadag folosind date SIG gratuite.

Elementele, ce vizează cartarea vegetaţiei, abordate în acestă lucrare, reprezintă o dorinţă mai veche de a mea, de a utiliza date GIS/SIG disponibile gratuit pentru delimitarea suprafeţelor de teren ocupate de diferite tipuri principale de vegetaţie. Pentru acesta, am avut în vedere mai multe tipuri de date raster (imagini satelitare, hărţi scanate, hărţi satelitare, etc.) şi vectoriale (CORINE Land Cover, Harta curbelor de nivel – prelucrare după D. E. M. și ETOPO2, Harta unităţilor de relief, Harta solurilor Uniunii Europene cf. SOTER, etc.), toate fiind georeferenţiate în sistem Stereografic 1970 (Stereo 70). Toate aceste date au fost corelate între ele, pentru a genera o imagine cât mai apropiată de cea reală a distribuţiei spaţiale a diferitelor tipuri de vegetaţie în general şi a asociaţiilor vegetale în special. Aceste date au fost comparate cu cele obţinute, prin studii de teren, astfel să trasăm o imagine clară asupra situaţiei reale a distribuţiei spaţiale a vegetaţiei, cât şi a limitelor acestui mod de a aborda cartarea vegetaţiei.

**RÉSUMÉ**: Cartographie de la végétation du plateau Babadag à l'aide de données SIG libres.

Ce document aborde la cartographie des principaux types de végétation avec l'utilisation des données SIG disponibles gratuitement, un projet ambitieux et souhaités depuis longtemps. Pour cela, nous avons considéré plusieurs types de données raster (images satellites, cartes numérisées, des cartes satellites, etc.) et vecteurs (CORINE Land Cover, la carte des courbes de niveau – traitement après D. E. M. et ETOPO2, la carte des unités de relief, la carte des sols de l'UE selon SOTER, etc.), qui sont toutes géoréférencées dans le système stéréographique 1970 (Stereo 70). Toutes ces données sont corrélées entre elles pour générer une image proche de la distribution spatiale réelle des différents types de végétation et des associations végétales en particulier. Afin d'obtenir une image clair de la situation réelle de la répartition spatiale de la végétation ainsi que les limites de ce mode de représentation de la végétation, les données SIG ont été comparées à celles obtenues par le biais des études sur le terrain.

## INTRODUCTION

The goal of this paper was to show how to achieve an updated vegetation map based on the vectorial thematic layer of the CORINE Land Cover (CLC) map and other types of thematic maps (geologic maps, hypsometric maps, soil maps, etc.) that could be used to define the distribution of vegetation, as well as plant communities on the Babadag Plateau. The objective of the analysis of the spatial distribution of vegetation is to produce standardized maps and associated data sets of vegetation and other land-cover occurring within the studied area. In order to achieve all of these objectives, the data resulting from analysis of digital spatial distribution of vegetation will be correlated with those obtained by studies in the field.

Finally, the importance of this approach is justified by the ability to use data obtained from analysis of the spatial distribution of vegetation in the landscape planning and habitats conservation.

## MATERIAL AND METHODS

The necessary stages to achieve this paper were as follows:

- obtaining the thematic cartographic materials and satellite imagery in digital format;
- obtaining data from field studies in different points of Babadag Plateau;
- correlation of GIS data with those obtained from field studies.

Within this paper, a large amount of digital data obtained from different sources has been used in order to achieve a clearer image of the real spatial distribution of the different types of vegetation.

The digital data (these are not available for commercial purposes in many cases) came from different sources, as follows:

- Romanian Geological Map scale 1:200000, sheets: Focșani (L-35-XXII), Brăila (L-35-XXVIII), Tulcea (L-35-XXIX), Sulina (L-35-XXX), Călărași (L-35-XXXIV), Constanța (L-35-XXXV), Mangalia (K-35-V), published by the Geological Institute of Romania and provided in digital format by geo-spatial.org (earth.unibuc.ro);
- ASTER GDEM Ver2 produced by METI and NASA in cooperation with the Japan-US ASTER Science Team and available in several tiles on the website of the last ones (www.gdem.aster.ersdac.or.jp);
- Relief Map Units (shapefiles format) provided by geo-spatial.org (earth.unibuc.ro);
- Attribute maps (scale 1:1000000) derived from the European Soil Database v2 (Google Earth files format) made by European Soil Data Centre (ESDAC) and provided through European Soil Portal (eusoils.jrc.ec.europa.eu);
- CORINE Land Cover maps (shapefiles format) accomplished by European Environment Agency at scale 1:100000 in 2006 (www.eea.europa.eu).

Firstly, the data processing was achieved by converting the data from the WGS84 at Stereo 70 projection system. Then, the data was loaded as thematic layers in Quantum GIS application and analyzed afterwards.

The field studies were performed by Marcela Tone in the year 2009, in order to achieve the data for her diploma paper. Sites were positioned in the woods near localities Cârjelari, Fântâna Mare, Ciucurova, Slava Rusă, Visterna, Enisala, Babadag, Slava Cercheză, Atmagea, Nicolae Bălcescu, Horia, General Praporgescu, as well as in the following protected areas: Pădurea Babadag – Codru, Uspenia, Dealul Bujorilor, Vârful Secaru, Muchiile Cernei – Iaila and Valea Ostrovului.

The plant associations were identified by the study on itinerary method.

## RESULTS AND DISCUSSION

Babadag Plateau is located in the south-western part of the northern Dobrogea. This is situated between Dobrogea Central Massif (Casimcei Plateau) in south-west, the Măcin Unity (along the river Taiţa) in the north and the Niculiţel and Tulcea units in the east. This area has a hilly relief with small heights. (Ionesi, 1994)

In the first stage, we achieved a correlation between geological aspects and CORINE Land Cover classes (Fig. 1). Within this area are predominantly Turonian calcareous sandstones and limestones, Coniacian marls and limestone, as well as Quaternary loess deposits, which are the parent soil cover material.

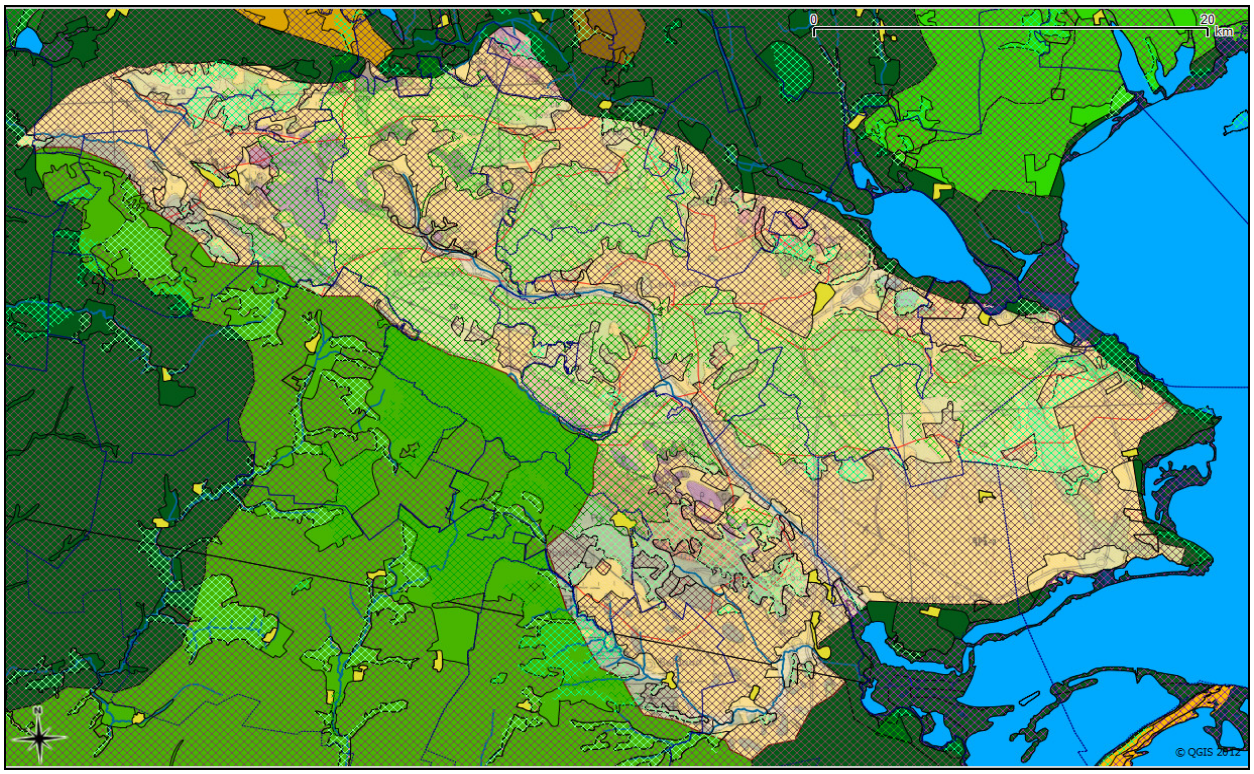


Figure 1: Overlapping of the land coverage classes over geological map (the vegetation classes appear hatched).

In the next stage, the CORINE Land classes were laid over a modeling relief map (according to ASTER GDEM Ver2) to which the contour lines were added of ten to ten meters (Fig. 2).

Finally, was followed way in which land cover classes are correlated with soil classes (Figs. 3 and 4) that have been determined in accordance with World Reference Base for Soil Resources – 1998 (WRB-SR, 1998).

Within Babadag Plateau the forest areas are common, because of this the data mapping was analyzed using data collected in these areas. Within the sites used for the study (Fig. 5) the most common plant associations identified were the following: *Cotino – Quercetum pubescentis, Galantho plicatae – Tilietum tomentosae, Nectaroscordo – Tilietum tomentosae, Fraxino orni – Quercetum dalechampii, Fraxino orni – Quercetum dalechampii, Paeonio peregrinae – Carpinetum orientalis, Galio dasypodi – Quercetum pubescentis, Querco pedunculiflorae – Tilietum tomentosae, Violo suavis – Quercetum pedunculiflorae, Carici – Quercetum frainetto, Tilio tomentosae – Carpinetum betuli*.

All these data were gathered in a synthetic table (Tab. 1) designed to correlate these data with the Romanian Soil Taxonomy System (Florea and Munteanu, 2003) and data related to plant associations of the study "The habitats of Romania" (Doniţă et al., 2005).

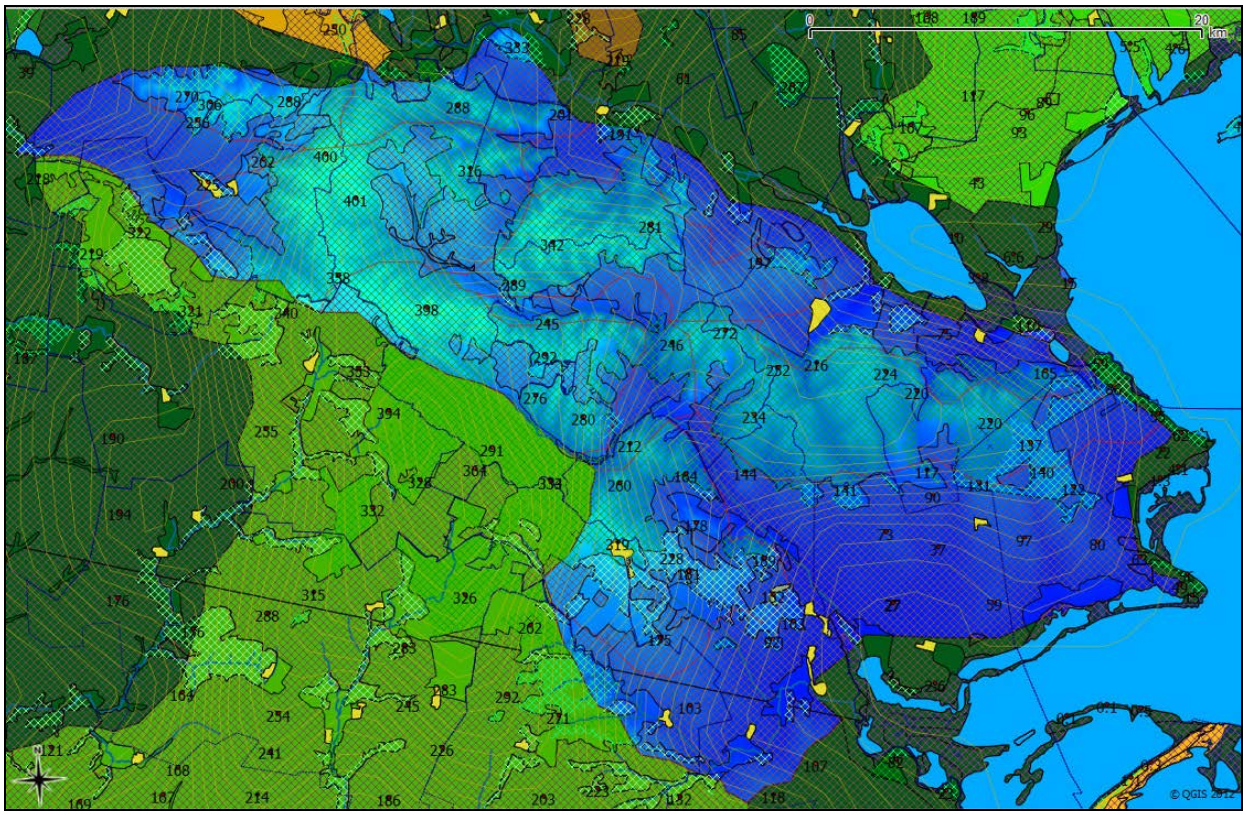

Figure 2: Overlapping of the land coverage classes over modeling relief map (with pseudo colors) and the contour lines of ten to ten meters on top (the vegetation classes appear hatched).

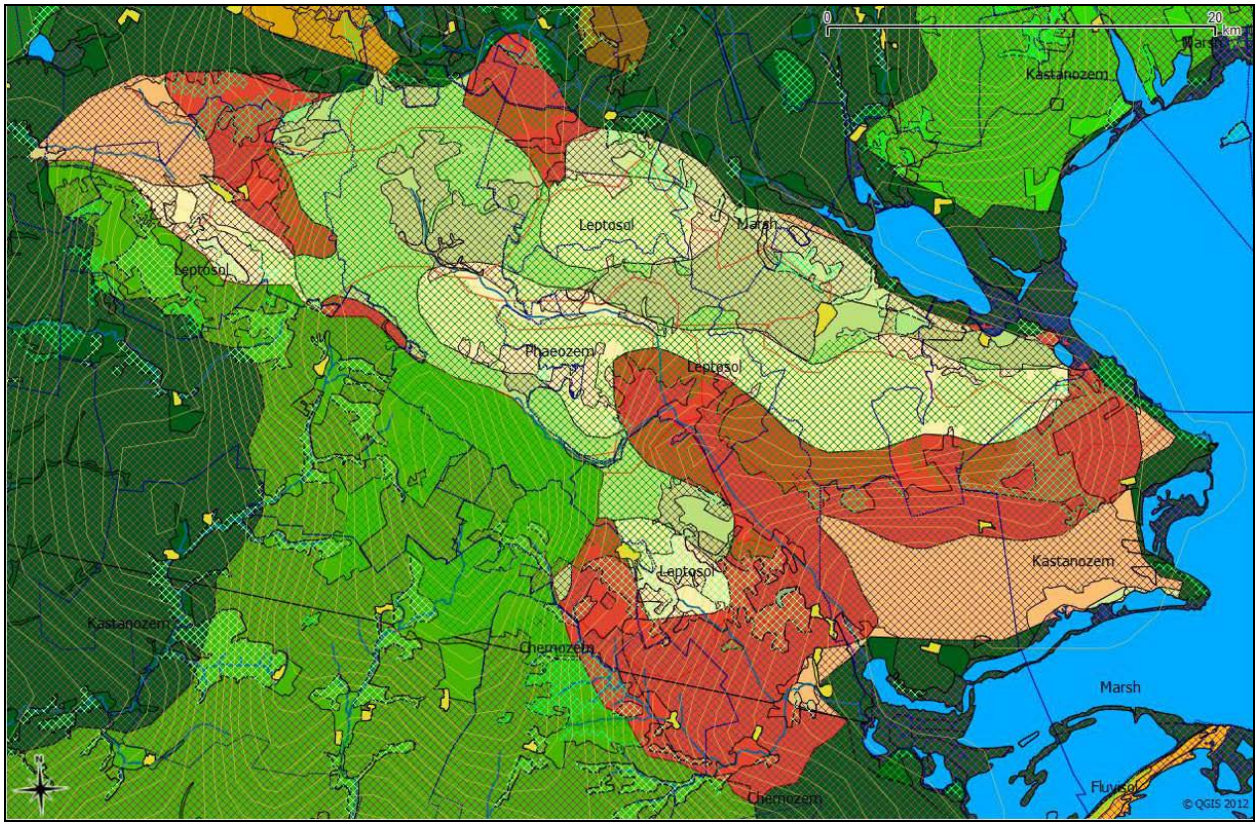


Figure 3: Overlapping of the land coverage classes over soils map (with soil WRB-SR type: Chernozem, Kastanozem, Phaeozem, Leptosol) and the contour lines of ten to ten meters on top (the vegetation classes appear hatched).

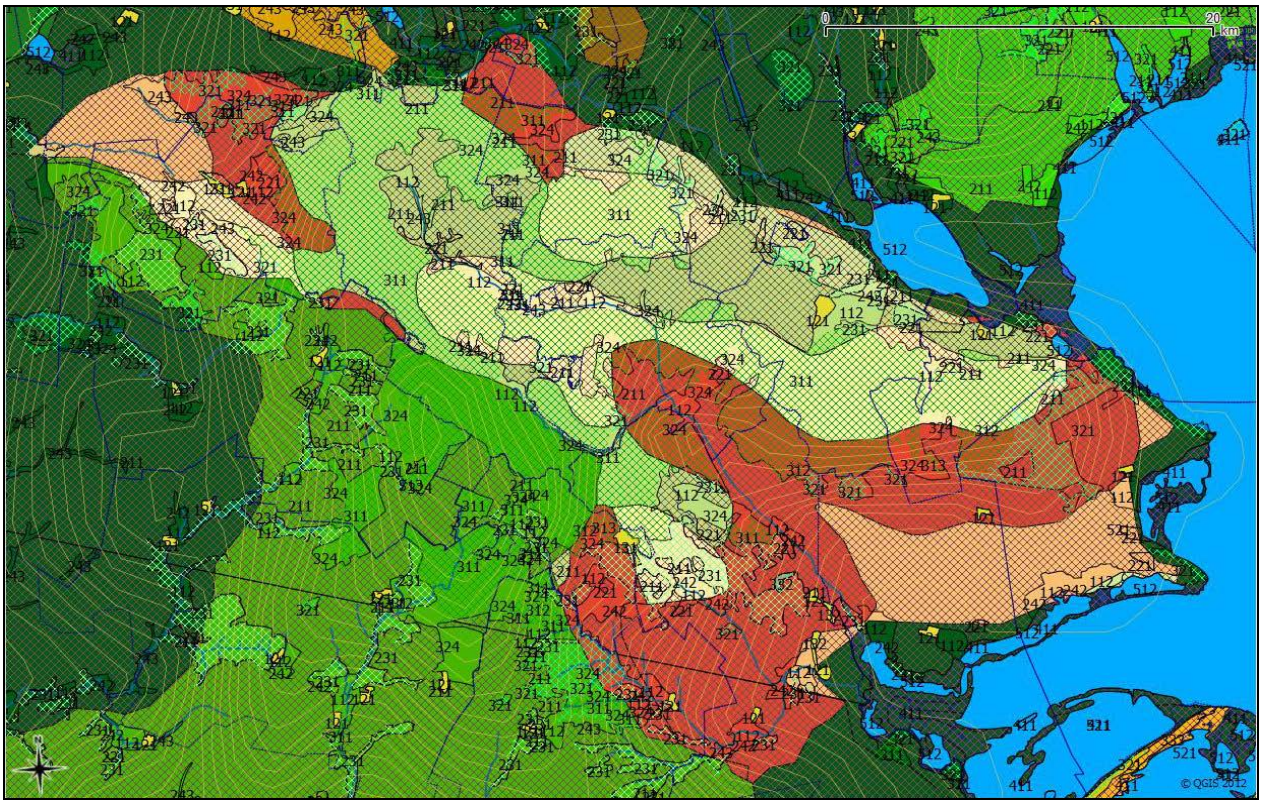

Figure 4: Overlapping of the land coverage classes with CORINE Land Cover codes over soils map (with soil WRB-SR type: Chernozem, Kastanozem, Phaeozem and Leptosol) and the contour lines of ten to ten meters on top (the vegetation classes appear hatched).

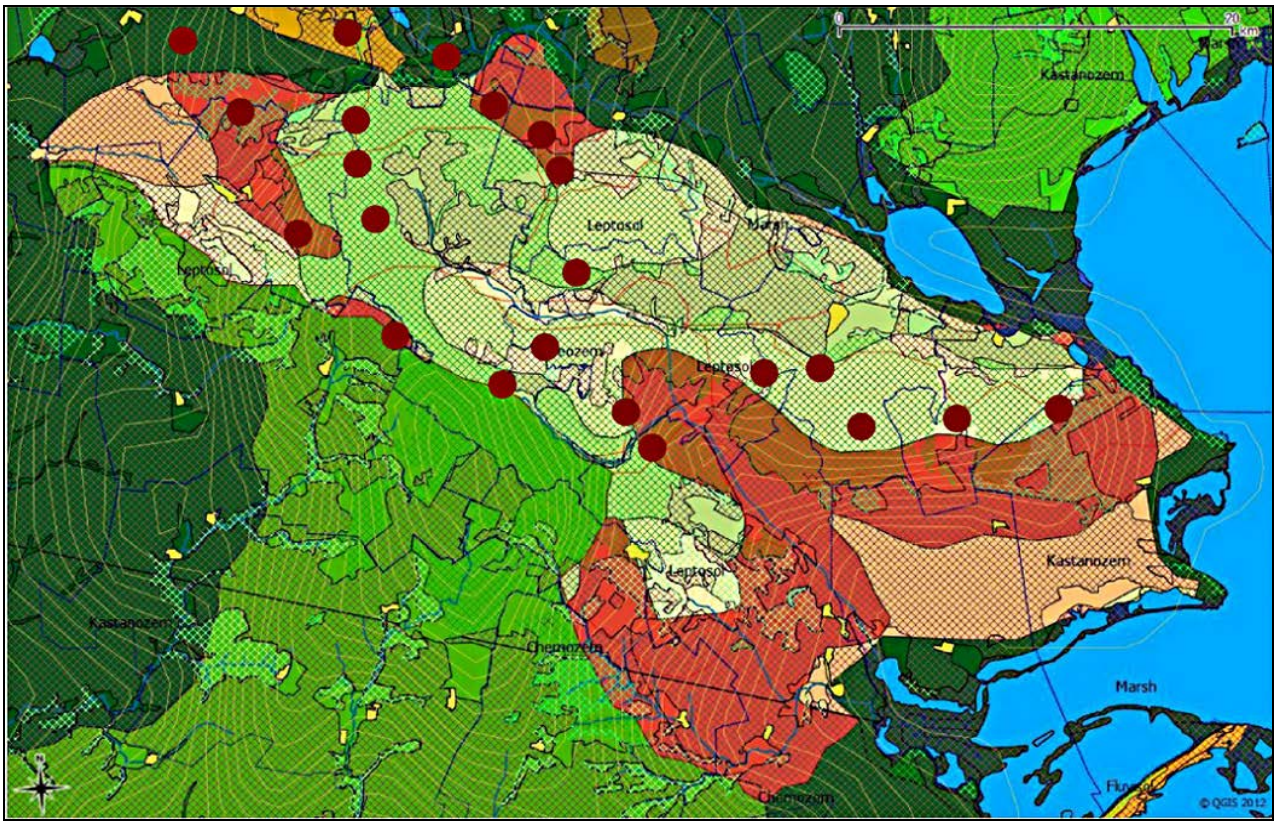


Figure 5: Overlapping of the land coverage classes over soils map (with soil WRB-SR type: Chernozem, Kastanozem, Phaeozem and Leptosol), as well as the contour lines (ten to ten meters) and the studied sites on top (the vegetation classes appear hatched).

Table 1: Correlation of the environmental factors with CORINE Land Cover classes and types of plant associations from the studied areas.

| Lithology | Relief | Soil (WRB-SR 1998) | Soil (SRTS – 2003) | CORINE Land Cover (code) | CORINE Land Cover (label 3) | Plant associations studied |
|---|---|---|---|---|---|---|
| limestone | sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 231 | Pastures | |
| limestone | sloping land | Leptosol, Chernozem | Rendzin | 242 | Complex cultivation patterns | |
| loess | slightly sloping land, level ground | Chernozem | Cernoziom | 242 | Complex cultivation patterns | |
| limestone | sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 243 | Land principally occupied by agriculture, with significant areas of natural vegetation | |
| limestone, loess | sloping land, level ground | Chernozem, Kastanozem | Cernoziom, Kastanoziom | 243 | Land principally occupied by agriculture, with significant areas of natural vegetation | |
| limestone | steep terrain | Leptosol | Rendzin, Litosol | 311 | Broad-leaved forest | *Cotino – Quercetum pubescentis* |
| limestone | steep terrain | Leptosol | Rendzin | 311 | Broad-leaved forest | *Galantho plicatae – Tilietum tomentosae* |
| limestone | sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 311 | Broad-leaved forest | *Nectaroscordo – Tilietum tomentosae* |
| limestone, loess | sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 311 | Broad-leaved forest | *Fraxino orni – Quercetum dalechampii* |
| limestone | tableland | Phaeozem, Chernozem | Cernoziom, Faeoziom | 311 | Broad-leaved forest | *Fraxino orni – Quercetum dalechampii* |
| limestone, loess | slightly sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 311 | Broad-leaved forest | *Paeonio peregrinae – Carpinetum orientalis* |

Table 1 (continuing): Correlation of the environmental factors with CORINE Land Cover classes and types of plant associations from the studied areas.

| | | | | | | |
|---|---|---|---|---|---|---|
| limestone | sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 311 | Broad-leaved forest | *Galio dasypodi – Quercetum pubescentis* |
| loess | slightly sloping land | Phaeozem | Faeoziom | 311 | Broad-leaved forest | *Querco pedunculiflorae – Tilietum tomentosae* |
| loess | slightly sloping land | Phaeozem | Rendzin, Faeoziom | 311 | Broad-leaved forest | *Violo suavis – Quercetum pedunculiflorae* |
| loess | slightly sloping land, | Luvisol | Luvosol | 311 | Broad-leaved forest | *Carici – Quercetum frainetto* |
| loess | slightly sloping land | | Eutricambosol | 311 | Broad-leaved forest | *Tilio tomentosae – Carpinetum betuli* |
| green schists | sloping land | Chernozem | Cernoziom | 312 | Coniferous forest | |
| green schists | sloping land | Chernozem | Cernoziom | 313 | Mixed forest | |
| limestone | sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 321 | Natural grasslands | |
| loess | slightly sloping land | Chernozem, Phaeozem | Cernoziom, Faeoziom | 321 | Natural grasslands | |
| loess | level ground | Chernozem | Cernoziom | 321 | Natural grasslands | |
| limestone | sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 324 | Transitional woodland-shrub | |
| limestone, loess | slightly sloping land | Leptosol, Phaeozem | Rendzin, Faeoziom | 324 | Transitional woodland-shrub | |
| loess | slightly sloping land | Phaeozem | Rendzin, Faeoziom | 324 | Transitional woodland-shrub | |
| loess | slightly sloping land | Chernozem, Phaeozem | Cernoziom, Faeoziom | 324 | Transitional woodland-shrub | |
| limestone, green schists | steep terrain | Leptosol | Litosol | 332 | Bare rocks | |

Within this study is easy to observe that only two associations (*Carici – Quercetum frainetto, Tilio tomentosae – Carpinetum betuli*) are not correlated, most likely due to the scale 1:100000 used in this study.

## CONCLUSIONS

Although this study revealed a good correlation between the data used, a reconsideration of the scale that can be worked (lower than 1:100000) is necessary.

Of course those data can be brought to many others at a large scale that can increase resolution of the map. And the fastest and most effective method is to intersect three vectors maps, as follows: CORINE Land Cover maps, slope aspect map in azimuth degrees (cardinal points expressed in degrees) and slope angle map in tilt degrees. The raster maps obtained on ASTER GDEM Ver2 were used to trace the last two thematic vectors maps. The small polygons (included in a particular type of plant association) that contain information about one type of vegetation are obtained by intersecting CORINE Land Cover maps with the two vector maps of land slope. Within the field studies on stationary (established based on the GPS coordinates) the data about vegetation type will finally be obtained.

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# PHYTOSOCIOLOGIC AND ECOLOGIC STUDY OF ŢARA LĂPUŞULUI AREA (ROMANIA)

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**KEYWORDS**: vegetal species, phytocoenosis, ecological indices, bioforms, floristic elements, vegetal association, dynamics, endangered plants, Ţara Lăpuşului.

**ABSTRACT**

Ţara Lăpuşului is outstanding through a complex geological composition that has contributed to the development of some varied relief forms and is particularly picturesque, comprising three relief units: depression area, dominated by the Lăpuşului Depression, hilly and mountainous areas.

The scientific novelty of the research consists of drawing up the cenotaxonomic synopsis for the studied area.

The research on flora and vegetation from the field and the interpretation of observations and results have been accomplished from the perspective of phytosociological study requirements. The paper hereby presents the results of our own research carried out in Ţara Lăpuşului in 2006-2012.

To attain the proposed targets, we have focused the study both on the evaluation of existing literature, and especially on documentation and research undertaken on the field. Hence, the exhaustive studies have provided various data regarding the evolution of phytocenoses, in diverse woodland and grassland ecosystems of primary and secondary origin.

**REZUMAT**: Studiu fitosociologic şi ecologic al zonei Ţara Lăpuşului (România).

Ţara Lăpuşului se remarcă printr-o alcătuire geologică complexă care a contribuit la dezvoltarea unor forme de relief variate şi deosebit de pitoreşti, cuprinzând trei unităţi de relief: zona depresionară, dominată de Depresiunea Lăpuşului, zona deluroasă şi zona montană.

Noutatea ştiinţifică a investigaţiilor constă în realizarea conspectului cenotaxonomic pentru regiunea luată în studiu.

Cercetarea florei şi vegetaţiei din teren şi interpretarea observaţiilor şi a rezultatelor obţinute au fost realizate din perspectiva cerinţelor studiului fitosociologic. Lucrarea de faţă prezintă rezultatele propriilor cercetări efectuate în zona Ţara Lăpuşului, între anii 2006-2012.

Pentru atingerea obiectivelor propuse, am axat studiul atât pe evaluarea literaturii existente, cât mai ales pe documentarea şi cercetările întreprinse în teren. Astfel, studiile exhaustive au furnizat numeroase date asupra evoluţiei fitocenozelor, diverselor ecosisteme nemorale şi praticole de origine primară şi secundară.

**ZUSAMMENFASSUNG**: Phytozönologische und ökologische Untersuchungen im Lăpuş-Gebiet/Ţara Lăpuşului (Rumänien).

Das Gebiet der "Ţara Lăpuşului" zeichnet sich durch die Komplexität seines geologischen Untergrunds aus, was zur Entwicklung vielfältiger und besonders malerischer Reliefformen geführt hat, die sich in drei Gruppen aufteilen: das Senkengebiet, dominiert durch die Lăpuş-Senke, das hügelig-bergige sowie das montane Gebiet.

Neu für die wissenschaftlichen Untersuchungen des Gebietes ist die von den Autoren ausgearbeitete Liste der coenotaxonomischen Einheiten.

Die Geländeuntersuchungen zur Flora und Vegetation wurden im Hinblick auf die Auswertung der Daten aus phytoconologischer Sicht durchgeführt. Die vorgestellten Ergebnisse beruhen auf eigenen im Lăpuş-Gebiet zwischen 2006-2012 durchgeführten Untersuchungen.

Zur Erreichung des Zieles unserer Arbeit wurde sowohl die vorhandene Fachliteratur ausgewertet, als auch die eigenen Geländeuntersuchungen entsprechend aufbereitet. Die umfassenden Untersuchungen lieferten sowohl Daten zur Entwicklung der Phytozönosen, der unterschiedlichen nemoralen und Grünland-Ökosysteme primären und sekundären Ursprungs.

## INTRODUCTION

Ţara Lăpuşului geographic area is administratively integrated in Maramureş County, occupying the south-eastern part of this county. It mostly corresponds to the depression with the same name and valleys that flow from all over towards it.

The complex of geological units from Lăpuşului area comprises four geographical fields: crystalline, Eocretacic flysch, Transcarpatic or Maramureşean-Panonic area and Intercarpatic depression of Transylvania.

The soils from Ţara Lăpuşului present a vertical flooring. By the spreading area we can distinguish mountain area soils, compact, depressionary area soils as well as azonal soils in limited areas.

Ţara Lăpuşului falls under the temperate continental-moderated climate, fairly cold, with mountain areas very rich in rain falls.

## MATERIAL AND METHODS

### Study Methods of Flora

Two work stages have been covered: the field stage and the laboratory stage. In the first work stage we have carried out field research, within different periods of the year, in order to observe plant species in varied phenological phases. The laboratory stage has involved the determination of collected plants that could not be identified in field.

The botanic material collected in the field has been analyzed based on the information comprised within the specialty bibliography and on our own research. Each species has been systematically classified on gender and family observing the actual system of phylogenetic classification of plants, consistent with the International Code of Botanic Nomenclature.

For the interpretation of floristic diversity we have made a description of taxons taking into account the following aspects: the scientific denomination of species and author, local popular denomination based on the literature, values of ecological indices, life span, cariotype, floristic element, economic category where they belong, the spreading of the species within the studied areas, frequency, and area corology.

### Study Methods of Vegetal Groups

Our phytocenologic and ecologic research has started with the delimitation of the territory that was about to be investigated. Between March 2007 and July 2011 we have performed a series of surveys within the studied area for the completion of a spontaneous vegetal association list.

The work method used in the phytosociologic and ecologic study of Ţara Lăpuşului is based on the method of J. Braun-Blanquet (1964), adapted by A. Borza and N. Boşcaiu (1965) at the particularities of the vegetal cover from our country. The technique of phytocenological elevations and notations is done according to the Central European phytocenological school.

For the cenotaxonomic classification of the vegetal associations identified in the area of Ţara Lăpuşului, we have used works elaborated by Doniţă et al. (2005), Sanda et al. (2007) and Sanda et al. (2008).

A synthetic table corresponds to each association, table that reunites surveys from the same type of phytocenosis. The choice and grouping of surveys into diverse taxonomic units has been carried out after the accession to specific literature and by comparing the floristic and ecologic structure of surveys with the synthetic tables from these works. For ordering the species in tables, we have taken into account the cenotaxonomic units where they belong and listed them in alphabetic order.

The analysis renders the floristic composition, composition in bioforms, geoelements, genetic types of phytocenosis and their economic value.

In order to emphasize the similitude between surveys of the same phytocenosis, we have calculated Sorensen similarity index, the results being expressed under dendogram forms.

## RESULTS

### Phytotaxonomic considerations

The systematic epitomy of the vascular plants comprises the listing of plant families and species, concurrently mentioning the station and their spreading in Ţara Lăpuşului. In a series of vegetal species we have mentioned the author and the year of field observation, the rest of the species being mentioned in “Flora R. S. R.”.

The floristic list totalizes 1212 vegetal taxons belonging to cormophytes. The identified taxons belong to 411 genders and 92 families. We grouped them based on species (943), subspecies (200), variety (43), form (17) and hybrids (9).

### Spectre of Main Ecological Indices

The identified species have been analysed based on their behavior towards the main ecologic factors. These ecologic factors render, by their numeric, spectral interpretation, the weight of species with certain ecological valences against U, T, R, and we have made the values interpretation according to the information regarding the natural environment, the history of vegetation and the anthropic influence.

### Analysis of Bioforms and Floristic Elements

From the analysis of bioforms spectre (Tab. 1, Fig. 1) it is ascertained that the most increased percentage is owned by hemycryptophytes – 53.61%. These bioforms are followed by terophytes – 22.61%, phanerophytes – 8.38%, geophytes – 9.55%, camephytes – 4.45% and helohydatophytes – 1.38%.

Table 1: Bioforms Statistics.

| Bioforms | Ph | Ch | H | G | T | | Hh |
|---|---|---|---|---|---|---|---|
| | | | | | Th | TH | |
| No. of sp. | 79 | 42 | 505 | 90 | 170 | 43 | 13 |
| **%** | 8.38 | 4.45 | 53.61 | 9.55 | 18.05 | 4.56 | 1.38 |

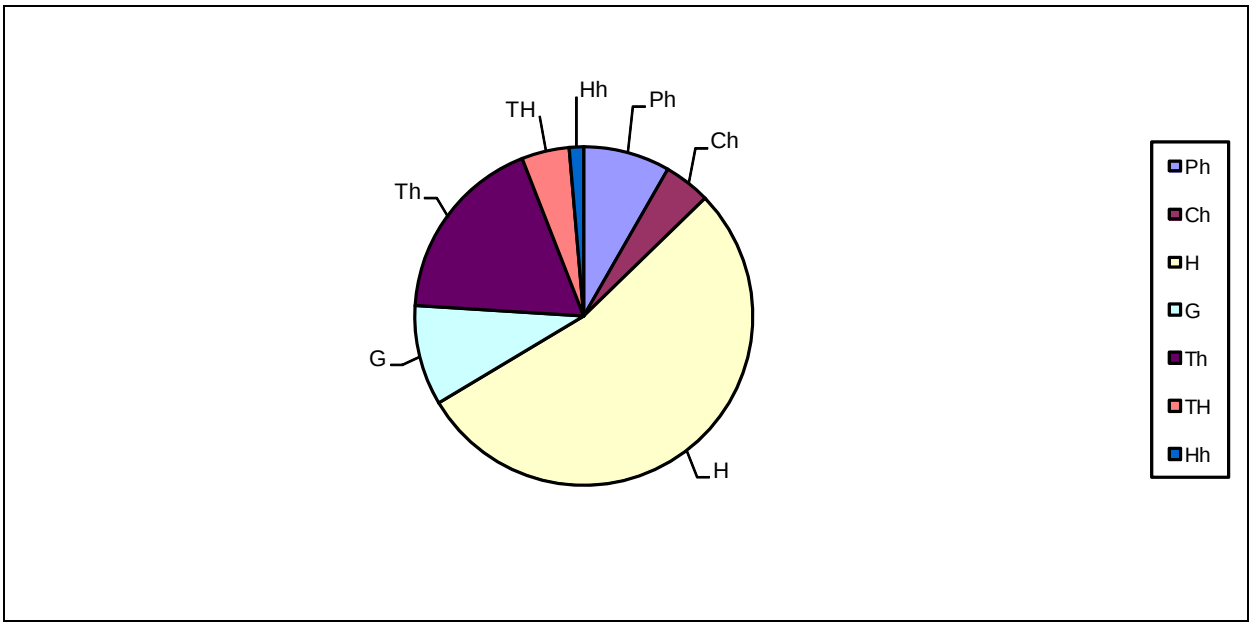


Figure 1: Specter of bioforms charted for the assembly of vascular flora from Ţara Lăpuşului.

Altitudinal indices was calculated with the formula: Ka (%) = T/H x 100, elaborated by Pop I. and Drăgulescu C. in 1983, is 42.18%.

From the spectra of geoelement categories (Tab. 2, Fig. 2) results that the Eurasian floristic element (34.91%) is dominant in the herbaceous vegetation from lawns and in the herbaceous layer of forests.

Table 2: Categories of geoelements for vascular flora from Ţara Lăpuşului.

| Geoelements | No. sp. | % |
|---|---|---|
| Cosm | 54 | 5.73 |
| Cp | 104 | 11.04 |
| Eua | 329 | 34.92 |
| Eua-Cont | 26 | 2.76 |
| E | 132 | 14.02 |
| Ec | 107 | 11.36 |
| P | 5 | 0.53 |
| Pp | 7 | 0.74 |
| M | 10 | 1.06 |
| sM | 19 | 2.02 |
| Atl-Med | 9 | 0.96 |
| Mp | 17 | 1.80 |
| B | 5 | 0.53 |
| DB | 26 | 2.76 |
| D | 1 | 0.10 |
| End-Carp | 19 | 2.01 |
| Alp-Carp | 58 | 6.15 |
| Adv | 14 | 1.48 |

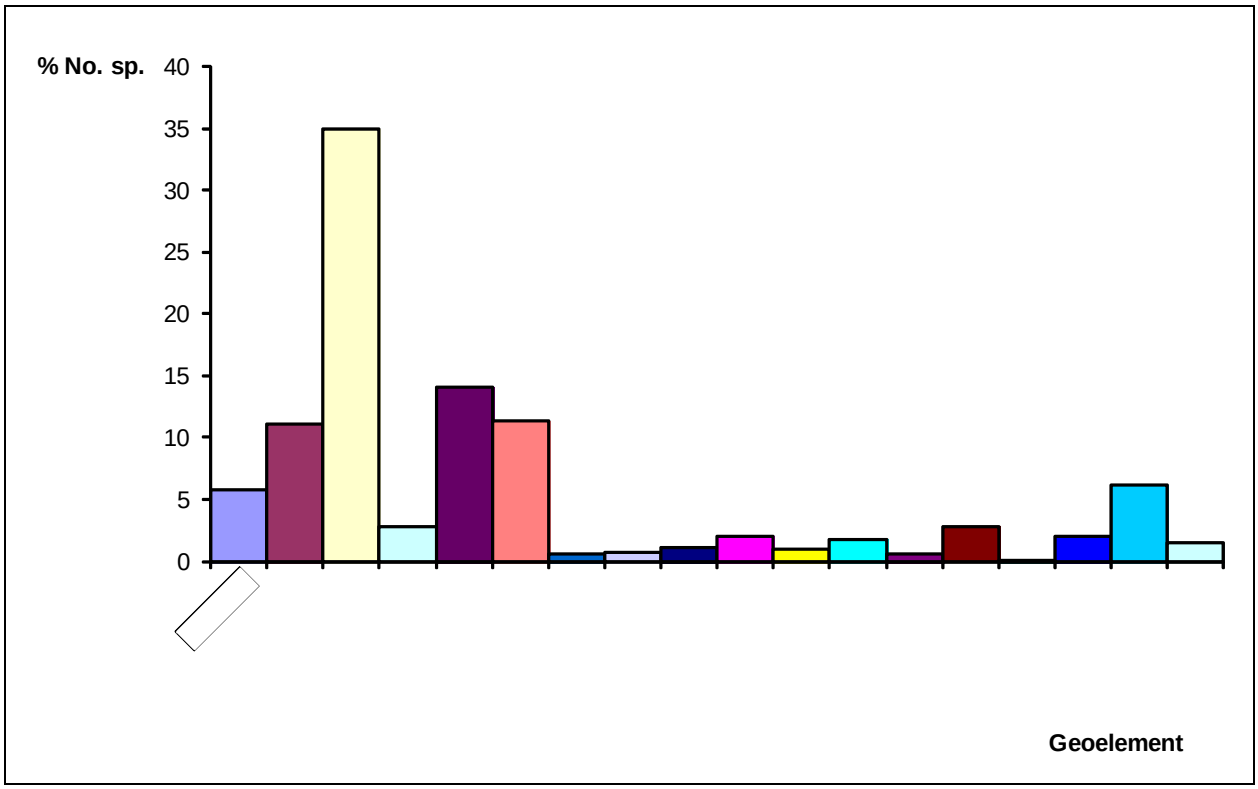


Figure 2: Spectrum of geoelements
from Ţara Lăpuşului.

**Composition in genetic types**

In order to establish the composition in genetic types we have taken into consideration the karyological aspects of the study area. With the support of bibliographical information we have identified as being present in the region: 409 diploid species, 391 polyploid species, 89 diplo-polyploid and 54 species for which karyological data are not known.

**List of rare, protected, endangered and endemic species from the flora of the area**

From the total number of 1212 taxons inventoried in the study area, the rare and endangered plants represent 4.95%.

Compared to the number of taxons from the flora of Romania – 3,795 (Ciocârlan, 2000), the floristic rarities represent 1.58%. From the point of view of their belonging to the sozological categories established by IUCN, from which the rare plant has disappeared (Dihoru and Negrean, 2009) the situation is the following:

– 8 species are critically endangered of disappearance;

– 5 species endangered of extinction;

– 3 species are vulnerable;

– 3 species at low risk of disappearance.

For the sozological stages: extinct in spontaneous flora, deficient information and non-assessed we have not identified vegetal species.

**Vegetation of Ţara Lăpuşului**

Following the performed study, we have summarized a number of 55 vegetal associations, from which 17 associations have been previously debated by other authors, and 38 are associations we have described for the first time as being present in Ţara Lăpuşului.

By the description of the vegetation, we have pursued the knowledge of the climatic and edaphic factors, of their interrelation with the community of plants. Also, we have pursued the distribution of the vegetation, both in the depression area, where due to the presence of localities, the anthropic impact is greater, as well as in the lower and mountainous area, where the natural aspect of the vegetation is more abundant.

**Dynamics of vegetation**

The first information regarding the stages of the evolution of the vegetal carpet, in Ţara Lăpuşului, have been provided by Pop E., Diaconeasa B. and Boşcaiu N., in 1965. The pollen analysis of the peat from Tăul Negru, carried out by Pop (1960) has highlighted a greater quantity of pollen for the *Pinus*, which has experienced a greater development in the Post-glacial, Pre-boreal age. For the Boreal and Atlantic age there was a reduced number of pollen grains from the gender *Picea*, *Ulmus*, *Corylus*, *Betula* and *Fagus*.

In order to present the dynamics of the vegetation we have analysed the spatial distribution of the vegetation in different echotopes, as well as structural transformations occurred in various vegetal cenosis, starting with the pioneer ones and ending with the mature ones, in the climax stage.

**DISCUSSION**

The performed research resulted in a complex data of the flora and vegetation in Ţara Lăpuşului.

1. Our research, first of this kind and extent in the territory, comes to complete the research in the field, having as fundamental objective the phyto-sociological and ecological knowledge of the plants from the territory of Ţara Lăpuşului, in view of their efficient and rational valorisation, and as the conservation of some species of interest.

2. Our scientific approach demarche has an exhaustive character, concluding with the inventory of all species of cormophythes, ecological, corological and phyto-sociological characterisation thereof in order to preserve the biodiversity of this territory.

3. The floristic investigation has finalized with the identification and inventory of the species of vascular plants on the territory of Ţara Lăpuşului. This inventory comprises 943 species belonging to 92 families and 411 genders. The floristic list contains 1212 vegetal taxons belonging to cormophyths.

4. Each listed species is followed by the scientific denomination, synonyms, the most used popular denomination, the genome structure, some ecological features, bioform, geo-element and corology of the studied area.

5. From the 943 species of plants, 117 are species encountered by us for the first time in the territory of Ţara Lăpuşului: *Asplenium trichomanes-ramosum, Athyrium distentifolium, Cystopteris fragilis, Aconitum tauricum* ssp. *nanum*, ssp. *tauricum, Isopyrum thalictroides, Pulsatilla alba, Ranunculus repens, Thalictrum flavum, Cerastium brachypetalum* ssp. *brachypetalum, Holosteum umbellatum, Minuartia setacea, Moehringia muscosa, Silene bupleuroides* ssp. *bupleuroides, Halimione verrucifera, Polygonum bistorta, Rumex kerneri, Sedum acre, Alchemilla xanthochlora, Potentilla leucopolitana, P. pusilla, Rosa gallica, Rubus caesius* var. *arvalis, R. sulcatus, Sanguisorba officinalis, Spiraea chamaedryfolia, Chamaecytisus albus* var. *microphyllus, Lathyrus laevigatus, Lotus pedunculatus, Robinia pseudacacia, Trifolium arvense, T. campestre* f. *pseudoprocumbens, T. medium* ssp. *medium*, ssp. *banaticum, T. spadiceum, Epilobium parviflorum, E. roseum, Erodium cicutarium, Geranium lucidum, G. palustre, Chaerophyllum hirsutum, Eryngium planum, Torilis japonica, Viola alba* ssp. *alba, V. odorata, V. suavis, Tamarix ramosissima, Brassica nigra, Lepidium campestre, Thlaspi arvense, Populus alba, P. nigra, Salix elaeagnos, Vaccinium microcarpum, Moneses uniflora, Pyrola rotundifolia, Cortusa matthioli, Soldanella montana, Gentiana punctata, Menyanthes trifoliata, Verbena officinalis, Glechoma hirsuta, Phlomis tuberosa, Thymus serpyllum, Digitalis lanata, Euphrasia salisburgensis, Gratiola officinalis, Linaria alpina, Tozzia alpina* ssp. *carpathica, Veronica longifolia, V. montana, V. verna, Campanula abietina, C. latifolia, Galium rubioides* ssp. *rubioides, Viburnum lantana, Valeriana simplicifolia, V. tripteris, Achillea crithmifolia, Aster alpinus, Carlina acaulis* ssp. *simplex, Centaurea mollis* f. *maramarosiensis, C. pannonica, C. trinervia, Cirsium helenioides, C. pannonicum, C. waldsteinii, Hieracium lactucella, H. murorum, Lactuca serriola, Petasites kablikianus, Scorzonera laciniata, Senecio nemorensis* ssp. *nemorensis*, ssp. *fuchsii, Sonchus arvensis, Tanacetum corymbosum* ssp. *corymbosum, Telekia speciosa, Colchicum autumnale, Veratrum nigrum, Narcissus poeticus* ssp. *radiiflorus, Iris pseudacorus, Dactylorhiza incarnata* ssp. *ochroleuca, D. sambucina, Nigritella nigra, N. rubra, Orchis laxiflora* ssp. *elegans, O. maculata* ssp. *signifera, O. pallens, O. purpurea, Juncus minutulus, Carex dioica, C. pauciflora, Eriophorum latifolium, Calamagrostis villosa, Cleistogenes serotina, Dactylis polygama, Lolium multiflorum, Phleum alpinum* ssp. *alpinum, Arum maculatum.*

6. From the species mentioned for the first time by us, for the studied area, a number of seven species are relictary, rare, endemic plants or obsolescent: *Dryopteris*

*cristata*, *Aconitum tauricum* glaciary relicts, *Potentilla pusilla*, *Juncus minutulus* species critically endangered, *Centaurea mollis* f. *maramarosiensis* endemic species, *Nigritella nigra*, *N. rubra* in danger of extinction.

7. In the ecological analysis we have considered as characterisation criteria three indices: humidity, temperature and soil reaction.

Compared to the requirements of the species against the soil humidity we have registered the following spectre: a dominance of the mesophyle species – 41.66%, followed by xero-mezophytes – 28.02% and mezohigrophytes – 17.85%. Of reduced percentage are the higrophytes species – 4.75%, xerophytes – 3.35%, amphyitolerant – 3.24% and hydrophytes – 1.08%.

According to the temperature the majority of the species belong to the micro-mesotherm category – 58.21%, followed at a greater difference by the microtherm species – 14.39% and amphytolerant one – 15.80%.

The spectre of the echoforms compared to the reaction of the soil proved to be the following: dominant are the plants slightly acid-neutrophiles – 34.30%, to which are added with significant values the species acid-neutrophil – 27.04% and eurionic – 26.19%.

Therefore, it can be said that the flora from Ţara Lăpuşului has a mesophyle character, micro-mesotherm, slightly acid-neutrophil toward acid-neutrophil.

8. The spectre of the bioforms highlights the fact that the greater percentage is comprised of hemicryptophytes 53.61%, indicating an abundance of herbal formations, many of them of secondary origin due to human intervention. To these are added 22.61% terophytes species, which indicate the succession of some dry periods, especially due to the anthropic influence. The percentage of 8.38% belonging to the fanerophytes indicate the presence of the forests on the northern, western and eastern versant from the lower and mountainous area. The geophytes 9.55% and camephytes 4.45% are identified in forests, but also in meadows. The existence of a very reduced number of slopes and lakes explain the diminished presence of the helohidatophytes 1.38%.

The percentage and the proportion of the categories of bioforms present in the regional flora confirms the presence in the region of the forests and lawns, zonal vegetal formations, also the existence of some azonal phytocenosis.

9. The value of latitudinal index is of 42.18% thus placing, the study area, in the category of the regions from the mountain floor, with moderate anthropic climate and influences. This value confirms the fact that the studied area presents diversified vegetation corresponding to the upper and sub-alpine floor, also as the high piedmonts.

10. The spectre of floristic elements highlights the prevalence of the Eurasian species (34.92%) in the herbal vegetation of the lawns and in the herbal layer of the forests. The Eurasian element is of 20.90% greater than the European element and of 23.56% than the Central-European element, which participates to the composition of vegetation. These three categories of geo-elements represent the expression of the temperate-continental climate. The circumpolar species, present in percentage of 11.04%, correspond to the microclimate of the colder and more humid, on the versants of northern and western exposure, like the micro-climate from the steep and shaded valleys. The percentage corresponding to the vegetation of the mountainous area of Ţara Lăpuşului is 6.15%, indicating the alpine element.

In the area we found less southern species, thermophile in the hilly floor, which belong to the Mediterranean, Atlantic-Mediteranean, Pontic-Mediteranean and Sub-Mediteranean, Adventive, Panonic, Pontic-Panonic geo-elements, found in the lawns and forests on the southern, sunny versants.

According to the distribution of geo-elements and the geo-botanic distribution of the territory of Romania and taking into

account the floristic criterion, the soil-geographical criterion, climatic criterion, geo-morphologic criterion and ecologic criterion, the territory of Ţara Lăpuşului belongs to the Central-European floristic region, Carpathian Province, Carpathian Sub-province, district of Northern-Central Mountains.

11. With regard to the composition of genetic types we have identified as present in the study region: 409 diploid species, 391 polyploid species, 89 diplo-polyploid and 54 species of whose karyological data is unknown.

For the hereby paper we can say that the variation in frequency in the altitude of the polyploid species (41.46%) is inscribed within the limits corresponding also to other mountainous area from the country (43.5%).

12. Of the total number of 1212 taxa inventoried in the study area, the rare and endangered plants represent 4.95%. If we report the floristic rarities from Ţara Lăpuşului to the number of rare taxons from the Romanian flora, we obtain a percentage of 1.58%, percentage which imposes upon us the taking of some measures to protect them along with the biotypes which shelter thereof and their proposal for Natura 2000 site.

13. According to UNEP-WCMC 1997 − IUCN Red List, updated in 2004, in Ţara Lăpuşului, we have identified the following taxons threatened at global, European and national level:

– 8 species are critically (seriously) endangered of disappearance (CR): *Aethionema saxatile*, *Alyssum wierzbickii* ssp. *transsilvanicum*, *Centaurea trinervia*, *Juncus minutulus*, *Potentilla pusilla*, *Ranunculus millefoliatus*, *Rumex thyrsiflorus*, *Salix daphnoides*;

– 5 species are endangered of extinction (EN): *Festuca filiformis*, *Glyceria declinata*, *Lotus pedunculatus*, *Nigritella nigra*, *N. rubra*;

– 3 species are vulnerable (VU): *Carex biharica*, *Linaria alpina*, *Narcissus poeticus* ssp. *radiiflorus*;

– 3 species are at low risk of disappearance (LR): *Carduus lobulatiformis*, *Poa stiriaca*, *Veronica catenata.*

14. Following the identification in the field and the inventory of vegetal species corresponding to Ţara Lăpuşului, we have encountered for the first time in the study area:

– 3 species critically endangered of disappearance (CR): *Centaurea trinervia* in lawns and at the edge of the forests from Cheile Babei/Gorges *Juncus minutulus* in humid pastures near the locality of Suciu de Sus, *Potentilla pusilla* in lawns, on calcareous rocks at Cheile Babei/Babei Gorge;

– 2 vulnerable species (VU): *Linaria alpina* on rocks and detritus, on calcareous soils in the area of Valea Mare/Valley of Ţibleş Mountains, *Narcissus poeticus* ssp. *radiiflorus* through humid lawns at the border of locality Suciu de Sus, Troian and Lacul Ţuli.

15. From the reliquary species identified in the area: five species belong to the glacial relicts (*Allium victorialis*, *Dryopteris cristata*, *Carex dioica*, *C. pauciflora*, *Oxycoccus palustris*) and nine species belong to the tertiary relicts (*Aconitum tauricum* ssp. *tauricum*, *Blechnum spicant*, *Drosera rotundifolia*, *Empetrum nigrum* ssp. *nigrum*, *Eriophorum vaginatum*, *Melanpyrum saxosum*, *Sanicula europaea*, *Viola alpina*, *V. biflora*). The expansive, post-glacial relicts found in the study area belong to the gender: *Acer*, *Crataegus*, *Carpinus*, *Fraxinus*, *Quercus*, *Ulmus*, *Tilia*.

16. Following the study of the spontaneous vegetation performed on 246 surveys, we have identified 55 vegetal associations, from which 38 associations have been described for the first time in the area of research: As. *Saponario-Salicetum purpureae*, As. *Alno-Salicetum cinereae*, As. *Stellario nemori-Alnetum glutinosae*, As. *Aegopodio podagrarie-Alunetum glutinosae*, As. *Symphyto cordati-Fagetum*,

As. *Leucanthemo waldsteinii-Fagetum*, As. *Hieracio rotundati-Fagetum*, As. *Luzulo albidae-Fagetum sylvaticae*, As. *Hieracio transsilvanico-Piceetum*, As. *Doronico columnae-Piceetum*, As. *Hieracio transsilvanico-Abietetum*, As. *Sphagno girgensohnii-Piceetum*, As. *Piceeto-Juniperetum sibiricae*, As. *Poo compressae-Tussilaginetum*, As. *Telekio-Petasitetum hybridi*, As. *Petasitetum kablikiani*, As. *Telekietum speciosae*, As. *Sambucetum racemosae*, As. *Agrosti capillaris-Betuletum pendulae*, As. *Coryletum avellanae*, As. *Pruno spinosae-Crataegetum*, As. *Calamagrostio villosae-Pinetum mugo*, As. *Campanulo abietinae-Vaccinietum myrtilli*, As. *Vaccinio-Juniperetum communis*, As. *Philonotido-Calthetum laetae*, As. *Adenostylo-Doronicetum asutriaci*, As. *Agrostetum stoloniferae*, As. *Cirsio cani-Festucetum pratensis*, As. *Agrostetum caninae*, As. *Poëtum trivialis*, As. *Caricetum brizoidis*, As. *Festucetum rupicolae*, As. *Ranunculetum arvensis*, As. *Cirsio waldsteinii-Heracleetum transilvanici*, As. *Arrhenatheretum elatioris*, As. *Sambucetum ebului*, As. *Urtico dioicae-Rumicetum alpini*, As. *Urtico-Convolvuletum.*

17. From all these, the association *Telekio-Petasitetum hybridi* which the authors have identified on Valea Minghetului/Minghetului Valley, Valea Ţibleşului/Ţibleşului Valley, Izvorul Alb, Lăpuşului Valley is an endemic association for Carpathian Mountains.

18. The studied vegetal association are distributed as follows: five vegetal associations for swamps and marshy areas, six vegetal associations for water meadows and riverside coppices, 12 vegetal association for forests, 11 vegetal associations for shrubs and forests edges, 13 vegetal associations for lawns and eight ruderal vegetal associations**.**

The vegetal associations have been analysed and characterised from ceno-taxonomic, corrologic, physionomic-structural, ecologic and bio-economic point of view.

19. Based on findings in the field, regarding the actual modifications of the forestry and practical formations of the perimeter of the studied regions, we have presented the dynamic of the vegetation and we have drafted up the chart of the vegetal successions

20. Following the floristic phyto-cenologic study, we propose for protection four new areas: the secular forest from Izvorul Rău, the secular forest from Izvorul Arcer, the peat bog from mountains Văratec and the Glade with *Narcissus poeticus* ssp. *radiiflorus* from the locality of Suciu de Sus.

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# MANAGEMENT OF THE ALIEN SPECIES *IMPATIENS GLANDULIFERA* IN ROŞIA MONTANĂ AREA (TRANSYLVANIA, ROMANIA)

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**KEYWORDS**: invasive alien species, management measures, river banks.

**ABSTRACT**

*Impatiens glandulifera* (Himalayan balsam) is originally from the Himalaya (1,800-4,000 m). It was introduced in the mid-19th century into England (Kew Gardens) as a decorative species, then in the last half a century it has spread in temperate parts of Europe and Asia. In Romania, in 1959, the species was identified as present in ten localities in Transylvania; today the situation is different, with its distribution being more extensive, especially on river banks.

Due to the large number of seeds, effective seed dispersal and short life cycle, *Impatiens glandulifera* quickly became an invasive alien species at a European level, being listed by IUCN among the world's 100 worst invasive alien species. In this study we have set out to establish the inventory and mapping of surfaces with *Impatiens glandulifera* in the Roșia Montană area and also to elaborate a set of management measures, in order to limit the distribution of this species.

**REZUMAT**: Managementul speciei invazive *Impatiens glandulifera* în zona Roșia Montană (Transilvania, România).

*Impatiens glandulifera*, slăbănogul himalaian (Himalayan balsam), este originară din Himalaya (1.800-4.000 m). A fost introdusă la jumătatea secolului XIX ca specie decorativă în Anglia (Kew Gardens), ca apoi în jumătate de secol aceasta să se răspândească în zonele temperate din Europa și Asia. În România, în 1959, această specie era identificată ca fiind prezentă în doar zece localități transilvănene, în prezent situația este diferită, distribuția ei la nivel național fiind mult mai amplă. Datorită numărului mare de semințe, dispersarea eficientă a semințelor și a ciclului de viață scurt, *Impatiens glandulifera* a devenit în scurt timp o specie invazivă la nivel european, fiind listată de către IUCN printre cele mai invazive 100 de specii la nivel mondial.

Prin intermediul acestui studiu ne-am propus inventarierea și cartarea suprafețelor cu *Impatiens glandulifera* din zona localității Roșia Montană și elaborarea unui set de măsuri de management pentru limitarea distribuției acestei specii.

**ZUSAMMENFASSUNG**: Management des invasiven Indischen Springkrauts *Impatiens glandulifera* im Gebiet von Roșia Montana (Transylvanien, Rumänien).

*Impatiens glandulifera*, das Indische Springkraut, stammt aus dem Himalaya-Gebirge (1.800-4.000 m). Es wurde um die Mitte des 19. Jahrhunderts als Zierpflanze in England (Garten von Kew) eingeführt und verbreitete sich in einem halben Jahrhundert in den gemäßigten Breiten Europas und Asiens. In Rumänien wurde die Art 1959 lediglich an zehn Fundorten festgestellt, wobei sich die Situation gegenwärtig jedoch ganz anders darstellt, da sie landesweit viel häufiger vorkommt.

Bedingt durch die große Zahl ihrer Samen und ihren kurzen Lebenszyklus, wurde *Impatiens glandulifera* in kurzer Zeit zu einer europaweit invasiven Art, die von der IUCN auf die Liste der hundert weltweit am stärksten invasiven Arten aufgenommen wurde.

Die vorliegende Arbeit hat zum Ziel, die im Gebiet von Roșia Montana von *Impatiens glandulifera* eingenommenen Flächen zu erfassen und zu kartieren, sowie eine Reihe von Managementmaßnahmen vorzuschlagen, die eine Begrenzung der Verbreitung der Art im Gebiet gewährleisten.

## INTRODUCTION

The impact of human activities on the environment is more and more pronounced. One of the traces of human activities is the invasion of alien species in places that did not belong to their habitat in the past.

At European and global level the problem of invasive alien species is considered critical, International Union for Conservation of Nature (IUCN) even created a list of the 100 world's worst invasive alien species occurring in 35 countries.

At a national level, in Romania, Atanasiu and Negrean (2006) listed 39 species as invasive alien species and the Global Invasive Species Database inventory of invasive alien plant species includes 73 species, the remarkable difference may be issued from the different approaches and the lack of a national database of invasive alien species.

One of the species included in the databases analyzed is *Impatiens glandulifera* (syn. *Impatiens roylei* Walpers) (Himalayan balsam), distributed in 34 countries (Pyšek et al., 2009). In 1959 the species was identified in Romania within ten of Transylvanian localities, at present the situation is different, it's distribution is more widespread (Atanasiu and Negrean, 2006).

*Impatiens glandulifera* is a tall annual plant with a smooth, usually hollow and jointed stem, which is easily broken. The stem can reach a height of three meters and its diameter can be up to several centimetres. The leaves are opposite or in whorls of three, glabrous, lanceolate to elliptical, 5-18 cm long and 2.5-7 cm wide. The inflorescences are racemes of 2-14 flowers that are 25-40 mm long. The flowers are zygomorphic, their lowest sepal forming a sac that ends in a straight spur. The flower colour varies from white to pink and purple and flowering takes place from June to October. The seed capsules are 1.5-3.5 cm long and up to 1.5 cm wide. A capsule contains up to 16 seeds, each four-seven milimeters long and two-four milimeters wide with a mean air dry mass of 2.35 mg (Beerling and Perrins, 1993, in Helmisaari, 2010).

*Impatiens glandulifera* was introduced in Europe (Kew Gardens) in 1839 (Coombe, 1956; Valentine, 1971). It began spreading in continental Europe around 1900, almost half a century later than in England. In the 1920's it was already present hroughout locations in south-west Germany, spreading from a Swiss population (first naturalisation in 1904) via the Rhine.

The main pathway of introduction is by escape to nature from private gardens and by beekeepers. In Finland, distribution has been mainly done by the introduction of seeds from abroad and private exchange of seed material. It is also often spread to the surroundings of settlements by the transport of garden refuse or soil (Helmisaari, 2010).

## MATERIALS AND METHODS

The study area of this paper is Roșia Montană (villages Roșia Montană, Corna, Cărpiniș), in Alba County, Transylvania, Romania. These villages represent the perfect territory for invasive alien species accommodation due to the historical environmental perturbations related to mining activities.

We conducted this survey in July-August 2011, in the area mentioned above. The method we used requires an elaborate data collecting fact sheet, identification of the species on site using Ciocârlan field guide (2009), mapping using a GPS Garmin Dakota 10, measuring the surfaces, noting additional information regarding the vegetation structure and other environmental problems. The data collected in the field was analysed in the office using an open source GIS programme and a distribution map of invasive alien species *Impatiens glandulifera* was designed.

After data interpretation and impact assessment of the species were established, general and specific management measures were recommended.

## RESULTS AND DISCUSSION

### Species ecology

*Impatiens glandulifera* occurs in many different habitats, but grows best in riverine areas, on moist and nutrient rich habitats, especially on lakes and seashores and along rivers and brooks (Kurtto, 1992, in Helmisaari, 2010) (Fig. 3). It is also often found in human influenced and man-made habitats, such as grasslands, shrubbery, ditches, roadsides and hedges (Kurtto 1996; Helmisaari, 2010). Research by Garkāje (2006) has shown the biotopes that are most suitable for *I. glandulifera* are those that have been affected by humans. The studies of species dynamics in Latvia suggest that in the initial phases of invasion the species prefers human-affected weedy sites and dump sites. While during later invasion stages it appears to be successful and frequent invader in riparian habitats (Priede, 2008). In these biotopes *I. glandulifera* most commonly grows with species of plants that need nitrogen in the soil, like *Aegopodium podagraria*, *Urtica dioica*, *Calystegia sepium*, *Deschampsia cespitosa*, *Stellaria nemorum* and *Galium aparine.* The species invades the herbaceous perennial vegetation of river banks, light floodplain forests and wet meadows and is found on a variety of soil types (Kowarik, 2003; Helmisaari, 2010).

In Europe, *I. glandulifera* plants of all ages are frost intolerant. Usually, all adult plants are killed by the first frost in the autumn and seedlings are killed by late frosts in spring. In Karelia region (in the northern European part of Russia), seedlings are tolerant to late frosts in May-beginning of June (Antipina and Briukhanchikova, 2003, in Helmisaari, 2010). The species is also drought-intolerant and quickly wilts, and plants can survive only if the drought period is short (Beerling and Perrins, 1993, in Helmisaari, 2010). The species is relatively shade tolerant (Beerling and Perrins, 1993, in Helmisaari, 2010). *I. glandulifera* is an annual plant and is reported to be without any persistent seed bank. However, from England there are reports that the seeds can occasionally survive up to 18 months. When the species is not exposed to frost, most seedlings appear over a period of four weeks (Beerling and Perrins, 1993, in Helmisaari, 2010). There are no observations from the region of seed survival for more than one year.

*I. glandulifera* has a good regenerative ability and on stems that have been cut down, new branches and flowers are formed. Also small individuals can develop flowers and seeds.

The time from germination to the onset of flowering is 13 weeks in Germany and the flowering continues for a further 12 weeks (Sebald et al., 1998). *I. glandulifera* spreads only by seeds (Figs. 1 and 2). When the mature fruit capsule is touched, it explodes and ejects the seeds. The seeds have been reported to disperse up to seven meters from the mother plant. A single plant can produce more than 4,000 seeds, and in pure stands the production of 32,000 seeds/m² has been reported (Koenies and Glavac, 1979). The expansion of the species in river systems is due to the dispersal of seeds by water currents since they can be transported both by flowing water (in the sediment) and the dry seeds, which are buoyant. Plant parts containing seeds have to be handled carefully since the small seeds are easily transported with soil and in crevices of shoes to new habitats. The seeds are probably also spread by ants (myrmecochory). Fruiting specimens or their fragments are also transported with soil or floating in water (Kurtto, 1993). For Great Britain, a dispersal ability of 2.6-5 km per year has been calculated (NeoFlora, 2006).

The reproductive strategy is based on active spreading of seeds and on rich seed-setting. The seeds have a high germination rate (80%) according to Grime (1987). The plant competes on river banks by synchronous germination of a large amount of seeds to achieve sufficient biomass to suppress the performance of neighbouring species. It grows fairly fast and forms dense stands.

Figure 1: *I. glandulifera* flower and polinators.

Figure 2: *I. glandulifera* flower and capsules.

Figure 3: Riparian vegetation aspect in Roșia Montană (Danci, 2011).

**Location**

Geographical data was collected in the field and centralized. For every spot where *Impatiens glandulifera* was found in the field we marked a GPS point and also noted additional information. We underline the necessity of creating a national data base with invasive alien species and their distribution. In order to make this paper more useful on a national level, all the data collected in the field is presented in table 1 and figures 4 and 5. We collected data from 73 locations distributed especially in Roșia Valley, of a surface area between four to 300 $m^2$.

Table 1: Geographical data coordinates for *Impatiens glandulifera* spots in Roșia Montană area.

| Object ID | X | Y |
|---|---|---|
| 1 | 355446 | 533735 |
| 2 | 353458 | 531676 |
| 3 | 353082 | 530954 |
| 4 | 356019 | 535754 |
| 5 | 356014 | 535724 |
| 6 | 356002 | 535708 |
| 7 | 355794 | 535724 |
| 8 | 355963 | 535698 |
| 9 | 355775 | 535518 |
| 10 | 355724 | 535514 |
| 11 | 355653 | 535500 |
| 12 | 355656 | 535489 |
| 13 | 355589 | 535424 |
| 14 | 355368 | 535436 |
| 15 | 355529 | 535445 |
| 16 | 355493 | 535444 |
| 17 | 355472 | 535425 |
| 18 | 355457 | 535429 |
| 19 | 355438 | 535411 |
| 20 | 355376 | 535449 |
| 21 | 355400 | 535491 |
| 22 | 355353 | 535478 |
| 23 | 355352 | 535458 |
| 24 | 355338 | 535463 |
| 25 | 355261 | 535422 |
| 26 | 355236 | 535424 |
| 27 | 355233 | 535445 |
| 28 | 355124 | 535432 |
| 29 | 355072 | 535412 |
| 30 | 355046 | 535410 |
| 31 | 355034 | 535359 |
| 32 | 354907 | 535615 |
| 33 | 354761 | 535582 |
| 34 | 354717 | 535592 |
| 35 | 354693 | 535617 |

Table 2 (continuing): Geographical data coordinates for *Impatiens glandulifera* spots in Roșia Montană area.

| Object ID | X | Y |
|---|---|---|
| 36 | 354668 | 535640 |
| 37 | 354651 | 535653 |
| 38 | 354073 | 535498 |
| 39 | 353866 | 535627 |
| 40 | 353733 | 535698 |
| 41 | 353551 | 535727 |
| 42 | 353398 | 535694 |
| 43 | 353131 | 535637 |
| 44 | 352882 | 535782 |
| 45 | 352525 | 535867 |
| 46 | 352487 | 535894 |
| 47 | 352420 | 535888 |
| 48 | 352391 | 535879 |
| 49 | 352294 | 535861 |
| 50 | 352259 | 535850 |
| 51 | 352195 | 535795 |
| 52 | 352083 | 535779 |
| 53 | 352027 | 535770 |
| 54 | 351929 | 535786 |
| 55 | 351676 | 535828 |
| 56 | 351609 | 535820 |
| 57 | 351566 | 535842 |
| 58 | 351489 | 535907 |
| 59 | 351460 | 535930 |
| 60 | 351405 | 535957 |
| 61 | 351213 | 536015 |
| 62 | 351195 | 536025 |
| 63 | 350953 | 536017 |
| 64 | 350900 | 536018 |
| 65 | 350745 | 535972 |
| 66 | 350612 | 535979 |
| 67 | 350516 | 535975 |
| 68 | 350540 | 535978 |
| 69 | 350514 | 535950 |
| 70 | 350338 | 536018 |
| 71 | 353607 | 535710 |
| 72 | 354687 | 534978 |
| 73 | 354889 | 535215 |

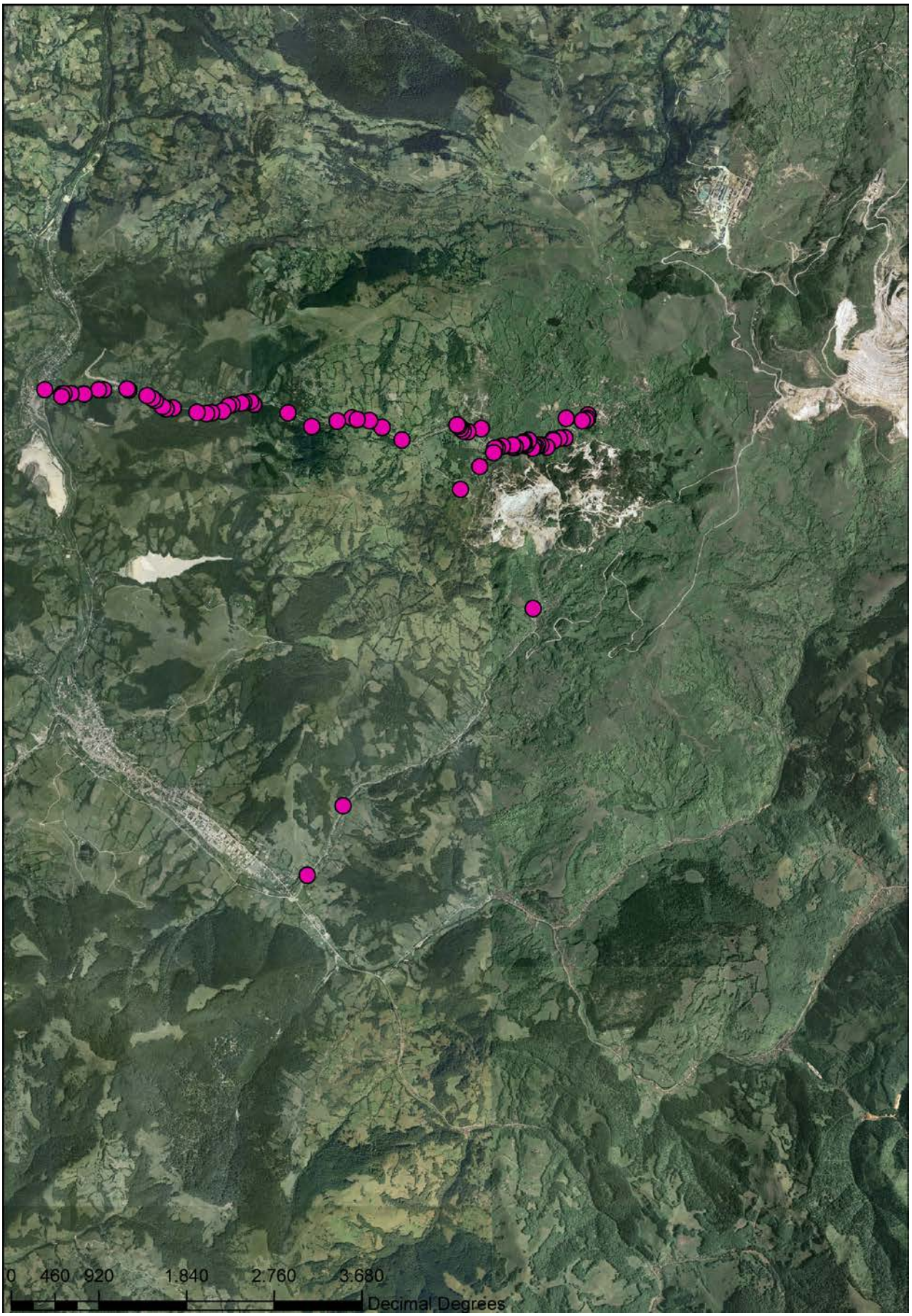


Figure 4: *Impatiens glandulifera* (●) distribution map
in Roșia Montană area.

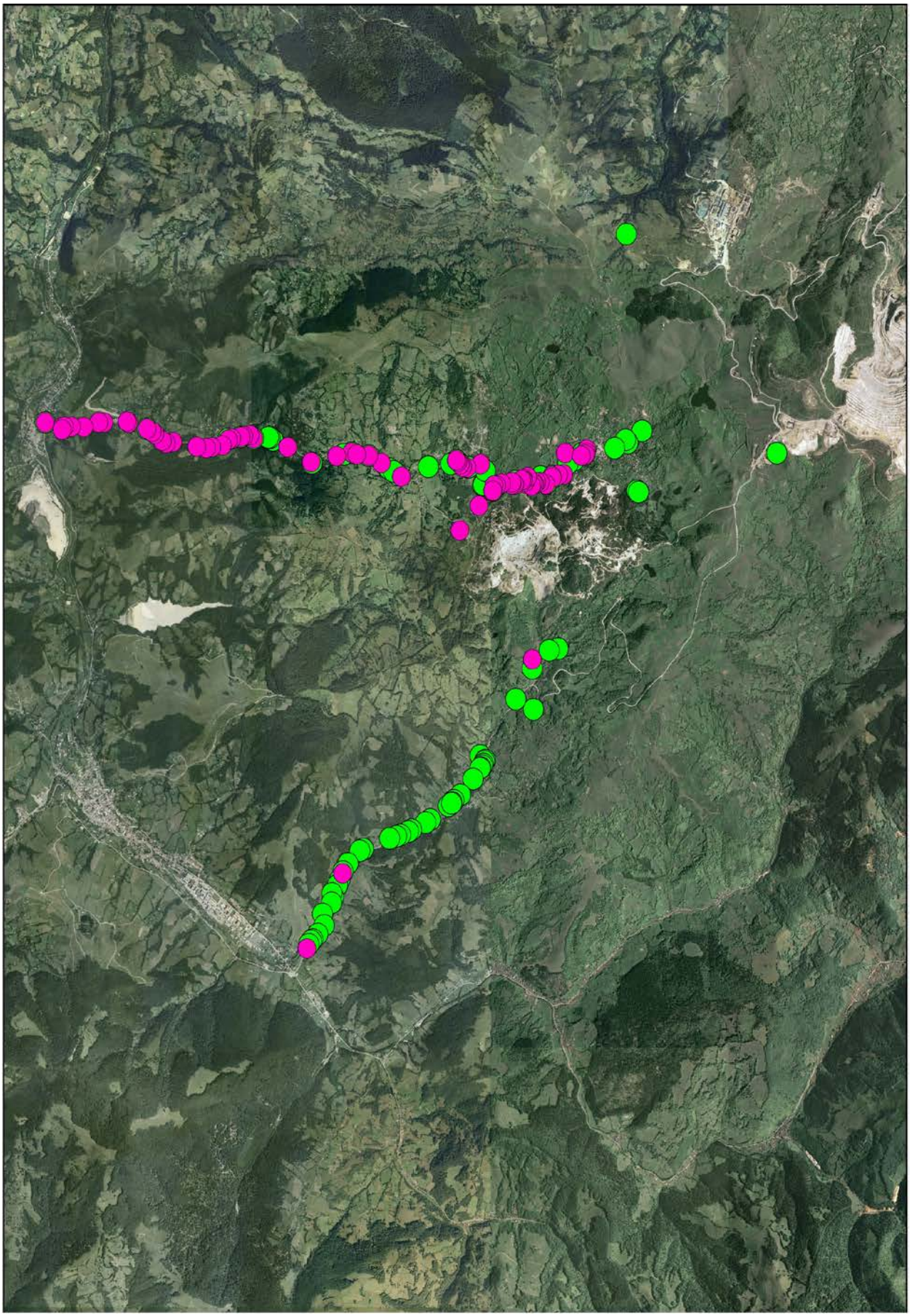

Figure 5: Correlated distribution of *Impatiens glandulifera* (●)
and *Fallopia japonica* (●) in Roșia Montană area.

**Impact**

Wetland invasive plants have substantial and persistent effects on habitat structure, biodiversity and food web functioning. Studies developed in Central Europe showed that wetlands are less prone to invasions, at least in terms of dramatic impacts (Pyšek et al., 2004).

Alien plant species exert ecological and economical impacts, both direct and indirect, at multiple levels. Of the 22 impact types defined by Binimelis et al. (2007), plants included in the 100 worst alien species are attributed, on average, with more than four types of impacts per species, which makes them the group with the second most diverse impact following terrestrial mammals (Pyšek et al., 2009).

Alien plants are reported to reduce availability of pollinators to native species as documented for Himalayan balsam *Impatiens glandulifera* (Chittka and Schürkens, 2001).

These invasive plants are managing to replace the natural species, already adapted to the local soil and climatic conditions, through many means, but all are correlated with the anthropic factor, by the wrong methods of exploitation of these ecosystems (Talmaciu and Huma, 2009).

*Impatiens glandulifera* invasion does not necessarily result in loss of the diversity of the invaded communities, but it shifts in species composition a ruderal, nitrogen demanding species.

Since there is a close correlation between the total number of naturalised species and that of pests, more species mean more impact (Rejmánek and Randall, 2004). That's why we elaborated the distribution map of *Impatiens glandulifera* (Fig. 4) and the correlated distribution map of *Impatiens glandulifera* and *Fallopia japonica* (Fig. 5). The distribution map shows that in the area of Roșia Montană, *Impatiens glandulifera* occurs in riparian areas, along Roșia Valley and it is almost absent on Corna Valley. The correlated distribution maps (Fig. 5) shows that in more than 80%, *Impatiens glandulifera* was found with *Fallopia japonica*, so we may conclude that the invasion of one alien species create the adequate habitat for the invasive alien species to colonise.

The role of ecosystem's disturbances in promotion of invasive plant species is essential. From the natural agents that determine ecosystem's disturbance and the increase of invasion incidence, most important are: fire, overgrazing and undergrazing. Biological features of invasive plant species determine their ability to occupy a surface, respectively they make an invasion to succeed (Sărățeanu et al., 2008).

**Management measures**

There is a considerable body of information on major plant invaders in Europe (Weber, 2003), the situation is much less satisfactory as far as complete national inventories of alien plants are concerned (Pyšek, 2009).

The problem of alien plants needs to be addressed at the European scale. Dispersed and disconnected knowledge cannot easily be marshaled to deliver the information to politicians, but improving information exchange can build regional capacity to identify and manage invasive alien species threats. This implies that coordination of action against invasive species is crucial; so a cross-European regulatory framework is needed. This holds true for plants in particular, as plants spread very easily and are more difficult to monitor and control, compared to some other taxa, such as vertebrates where substantial proportion of introductions is due to intentional releases (Pyšek, 2009).

Biological invasions by alien species are widely recognized as a significant component of human-caused global environmental change, often resulting in a significant loss of the economic value, biological diversity and function of invaded ecosystems. They are large-scale phenomena of widespread importance and represent one of the major threats to European biodiversity (Lambdon, 2008).

National and local measures are needed in order to eradicate, control and monitor *Impatiens glandulifera* invasion. Eradication and control measures include removal and prevention of the formation and spreading of seeds. The timing of the eradication effort is most important. If the removal is too early the plants will regenerate, and if it's made too late the seeds formed will be able to germinate. The right time is when the first flowers occur, mostly at the end of July. Due to its strong regeneration ability, it is extremely important to remove all plant material and to dispose of it appropriately. Sheep and cattle may also be used to graze the plant. Since *Impatiens glandulifera* is sensitive to grazing and grazing animals eat it, grazing is a good method to eradicate the species (Larsson and Martinsson, 1998). The use of herbicides should be avoided and they are often not permitted, especially along waterways.

## CONCLUSIONS

*Impatiens glandulifera* is an invasive alien species whose management measures should be taken on at a national and local level at the same time. Due to its rapid invasive potential, high capacity to regenerate and spread and it's ecological amplitude, it has an increased negative ecological and economical impact.

Main water courses in Roșia Montană, were affected by the invasive alien species *Impatiens glandulifera.* 73 locations with *Impatiens glandulifera* were mapped in the area in 2011, more than 80% of them were found together with *Fallopia japonica*, so we may conclude that the invasion of one alien species creates the adequate habitat for other invasive alien species to colonise.

Measures of prevention, eradication, control, monitoring and public awareness should be taken at the same time.

A national database with invasive alien species and their distribution and a national action plan will help authorities' institutions and local communities to act appropriately in order to face the problem of invasive alien species.

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# PARTICULARITIES OF THE "PARASITE-HOST" SYSTEM CREATED BY MERMETIDS AND HETEROTOPIC INSECTS

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**KEYWORDS**: Mermithidae, Chironomidae, "parasite-host" system, metabolism, interrelations, transcuticular nutrition, invasion intensity, invasion extent, biochemical modifications, morphological modifications.

**ABSTRACT**

The paper presents the results of a study on the biochemistry of the relationships taking place in an invertebrate "parasite-host" system, comprising species of Nematoda, Mermithidae, as parasites, and species of Diptera (Chironomidae) as hosts. The results demonstrate a significant influence of the parasitic mermithids on the host metabolism by inducing profound biochemical alterations of the insect's organization. These alterations include the significant drop in free essential amino acid ratio in the parasitized host. Discrete parasite populations can present various extents of invasion, some being sufficient for the complete annihilation of host populations.

**REZUMAT**: Particularităţi ale sistemului „parazit-gazdă" constituit de mermitide şi insectele heterotope.

Lucrarea prezintă rezultatele studiului privind aspectele biochimice ale interrelaţiilor în cadrul sistemului „parazit-gazdă" constituit din parteneri nevertebrate (Nematoda: Mermithidae – parazit şi Diptera: Chironomidae – gazdă). Rezultatele cercetărilor demonstrează existenţa unei influenţe semnificative a mermitidelor parazitare asupra metabolismului gazdei sale, prin inducerea unor modificări biochimice profunde în organismul acesteia. Aceste modificări se manifestă inclusiv prin diminuarea semnificativă a ponderii aminoacizilor liberi esenţiali în corpul gazdei parazitate. Populaţiile discrete ale parazitului pot prezenta grade de extensivitate a invaziei, suficiente pentru eliminarea completă a unor populaţii ale gazdei.

**RÉSUMÉ** Particularités du système "parasite-hôte" formé par des Mermithidae et des insectes hétérotopiques.

L'article présente les résultats d'une étude concernant les aspects biochimiques des relations se déroulant dans le système "parasite-hôte" formé entre partenaires invertébrés (nématode: mermithidé (parasite) et diptère: chironomidé (hôte)). Les résultats des recherches prouvent l'influence significative des mermitidés parasites sur le métabolisme de leurs hôtes, par le biais des modifications biochimiques profondes dans l'organisme de ces derniers. Ces modifications sont percevables y compris au travers de la baisse significative de la proportion en aminoacides libres essentiels dans le corps de l'hôte parasitée. Les populations discrètes des parasites peuvent présenter différents degrés d'invasion, quelques-uns étant suffisants pour éliminer complètement des populations hôtes.

## INTRODUCTION

Mermithids represent a large and important group of nematodes. Usually, they are typical only for some species or one-two insect families, and are almost always lethal for their hosts. They draw the attention due to the fact that they possess the following characteristics of an ideal biological regulating agent: they are specific for one or a few host species; they are relatively easy to handle in the laboratory; they can be easily disseminated in their environment using the standard technology of pesticide spraying; they have a high potential of mass distribution, which allows reaching a high level of extensiveness of the initial invasion and a subsequent installation of a partial control of the size of the host population for an indefinite period; they are safe to the environment; they are harmless to beneficial organisms because of their vital cycle.

Mermithids are a difficult group, with only a few measurable morphologic characteristics. Most early descriptions, highly incomplete, became inadequate for the majority of known species, and require a detailed study of mermithids.

## MATERIAL AND METHODS

The material was submitted for chemical analysis by freeze drying in liquid nitrogen. The content of chemical e was determined by emission spectral analysis as Eriomenko method (1969). Assessing the amount of total nitrogen was established by the Kjeldahl method, after which recalculation was determined the quantity of proteins. The lipid content was determined by Soxhlet method. The carbohydrate contents was determinated by calculating the difference between 100% and proteins, lipids and mineral substances quantities, in percent. Aminoacids analysis was performed in the laboratory of automated centre of Academy of Science at Moldova Republic, with automatic aminoacids analyzer.

## RESULTS AND DISCUSSION

Mermithids, which attack the aquatic stages of their hosts, are highly similar, mostly varying by the length of time necessary to complete their life cycle. Invasive nematodes hatch the larval stage at age two and, for most species, it swims freely in the aquatic environment of stagnant waters. For species that grow in running waters, the preparasite attaches to the substrate surface. The preparasite is tigmotactic positive and geotactic negative, which allows the nematode to have an easy contact with its host. Mermithids' usual way to attack the host's body is percussion penetration, a fact established through lab experiments on *Hydromermis contorta*.

During penetration and a few minutes after, the host seems to be paralyzed. Gradually, normal mobility and the nutrition of the infested host are being restored. It is assumed that the carbon dioxide exuded/liberated by the host larva represents an important sign for the host to be found by the entomopathogenic nematodes. *H. contorta* females go to the post-parasite stage, having its generative prosucts sufficiently matured, since the last mould already took place in the host's body. This is a distinctive characteristic from other mermithids species for which maturing the post-parasite larvae and their last mould takes place outside their host. Mermithids leave the parasitic organisms forming a hole in the host cuticle, by applying simple mechanical pressure in between the segment sectors. The moment the parasite leaves, the death of the host occurs.

Founding methods to use mermithids as efficient biological regulators requires the study of the influence of environmental factors into their population and vitality. According to experimental data, the most favorable temperature for the development of eggs and larvae, invasive larvae life and post-parasitic nematodes is in the range of 10°C to 25°C. Low temperatures (-2$^{o}$C) and high ones (+30$^{o}$C) are lethal for all life stages of the parasites.

An important factor for the aquatic mermithids can be water movement. Attempts to infect chironomid larvae with pre-parasites in the running waters have been found to be ineffective. The optimum pH for the process of infection is 6.7 to 7.2. Pre-parasites become immobile after eight hours of being in water with high organic content and low concentrations of oxygen. The most common infection occurs at chironomid larvae at ages two-three. In laboratory conditions, the post-parasitic mermitides can be massively affected by pathogenic fungi. The impact of these organisms on mermitides under natural conditions is still unclear.

The mermithids parasitism causes almost complete degeneration of the fat-tissue of the host's body. All backup metabolites of the host, including glycogen, can be mobilized directly or indirectly in the metabolism of the parasite mermithids. Mermithids acquire their dietary amino-acids through the stimulation of the protein catabolism of the fat body of the host. Catabolism products – amino-acids, glycogen, etc. – represent the nutrient environment that is found and on which the parasite feeds. Parasite mermithids larvae's nutrition is trans-cuticular. The cuticle of the zooparasite nematodes is characterized by complexity and high metabolic activity. Major changes to the metabolism of the host caused by the mermithid parasite manifests by suppressing the development of oocytes. In this way, the growth of the hosts to adult stage is jeopardized, making them unable to reproduce. Mermithids lower the fertile insect females up to 7.9% and they may condition the intersexuality of chironomids. The most acute morphological changes that take place under the influence of mermithids incur in males: their antennae shorten up and the structure of the eight abdominal sternit becomes similar to that of the female. Female's external aspect changes more moderately, but, instead of ovaries, sperm ducts and male genitals grow, and sometimes gonads. So, the parasites infection decreases the competitiveness of the individual regarding sexual selection.

Chironomid larvae parasitized by mermithids can be distinguished from the uninfected ones by reduced mobility and transparency of coatings, which allows the long parasites to be seen. Parasite's presence conditions the pronounced decrease of the host's body mass.

In this way, the dry mass of parasitized females of *Chironomus plumosus* decreases compared to the one of the unparasitized ones with around 29%. The dry mass of parasitized males of *Chironomus plumosus* diminishes compared to the one of the unparasitized ones with around 34%. It was found that the mass of the *H. contorta* mermithids depends on the sex of the host in which the parasite develops. So, the mermithids extracted from the body of *C. plumosus* males are 55% lighter than the ones extracted from the body of females.

Mermithids have a focused, discrete distribution. This phenomenon is characteristic for parasites that develop in the larval stages of the hosts. The explanation is that the hosts are killed before leaving the habitat, thus reducing much the mermithids' ability to disperse. Discrete populations of the parasite may have a degree of invasion extension sufficient for complete elimination of some host populations. The extension of the mermitids invasion varies in different geographical points and in different years, varying in the range of 0-100% for different "host-parasite" systems. The extension of the invasion with *H. contorta of C. piger* larvae in October 1992, in Sestra River was 23.5%, and the intensity value of the invasion of 1.21. The intensity of invasion of the host, in most cases, is represented by one parasite, more rarely two and in extremely rare cases three or four parasites on a single host. According to our data, singular invasion was present in 83% of the infected larvae, 13% of the hosts contain two mermithids, and in 4% of cases three parasites were found in a single host. The predominance of the singular invasion is explained by the mass death of hosts with multiple invasions. The extensiveness and intensity of invasion are

influenced by the time until the pre-parasite mermithids meets the host. For example, after 30 minutes of keeping the pre-parasite larvae, a significant decrease is registered, from 1.3 in the intensity and 97% for the extensiveness, to 1.1 and 76%, respectively.

Mermithids get their food trans-cuticular, thereby causing particular difficulties for the in vitro propagation method. Researchers' efforts are directed primarily to the development of effective methods of cultivating mermithids in vivo. *H. contorta* was maintained in laboratory conditions because one of its hosts – *C. thummi* – can easily be grown in these conditions. However, *H. contorta* was not mass produced and applied in natural conditions because of difficulties in obtaining sufficient quantities of material in the laboratory. One possible solution in this case would be the collection of hosts from aquatic habitats with its populations show high values of the extensiveness of the invasion (85-90%), and their subsequent release in habitats with low incidence of the parasite in question.

Mass production of the parasite requires solving the theoretical problems connected with (one) parasite's reproduction depending on its density (sex ratio, fertility, nutritional stress and post-parasites' density), (two) the intensity of the invasion, (three) host population's density, (four) parasites' pathogens, (five) the reproduction of parasites and of their host's and (six) predators and pathogen organisms.

Research results show a significant influence of the metabolism of parasitic mermithids on their host, causing profound biochemical changes in its body (Tab. 1). These changes are manifested through a significant reduction of free amino-acids essential in the body of the parasitized host.

Table 1: Statistical parameters of the correlation between the set of essential free amino-acids and the partners of the "host-parasite" system.

| x, essential free amino-acids, mg% from the amino-acid sum | y, essential free amino-acids, mg% from the amino-acid sum | Regression equation | R (correlation coefficient) |
|---|---|---|---|
| *Ch. piger*, Uninfested larvae | *Ch. piger*, Infested larvae | $y = -(0.431 \pm 0.520) + (0.917 \pm 0.215)\cdot x$ | 0.867 |
| *Ch. piger*, Uninfested pupae | *Ch. piger*, Infested pupae | $y = (0.606 \pm 1.121) + (0.740 \pm 0.316)\cdot x$ | 0.723 |
| *Ch. piger*, Uninfested larvae | *Ch. piger*, Uninfested pupae | $y = (0.956 \pm 0.885) + (0.957 \pm 0.342)\cdot x$ | 0.782 |
| *Ch. piger*, Uninfested females | *Ch. piger*, Uninfested males | $y = (0.181 \pm 0.479) + (0.314 \pm 0.145)\cdot x$ | 0.661 |

During the life cycle, the rapid increase and anatomical restructuring of the helminthes occurs, in addition to providing an increased rate of egg production, requiring high notes of amino-acids and protein metabolism. However, systematic research in the field of parasitology was performed in small numbers, and the issue of the role of amino-acids in the exchange of substances at helminthes and their ability to synthesize amino-acids later are insufficiently clarified. Such studies may be useful for diagnosing problems in human and veterinary medicine, as well as for the detection of specific antigens of helminthes. Proteins specific only to parasites could serve as links in the body metabolism in the parasite's organism, links that may be subject to the action of chemotherapeutic means that only affect the parasite and not cause harm to the host.

The following figures (Figs. 1-4) present the regression equations that indicate, through high values of the correlation coefficient (r), the significant influence of the parasite on measurable biochemical parameters of the host. These regression equations allow the quantification of the influence of the parasite, depending on the stage of growth of the host.

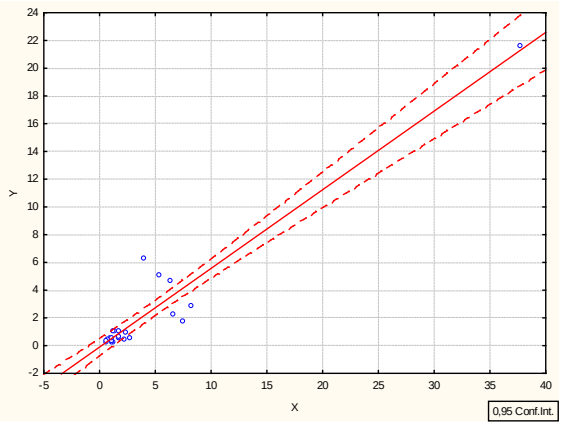


Figure 1: Correlation between the free amino-acids content in *H. contorta*, parasite (X) and post-parasite females (Y)
n=24, $r_{xy}$=0.959
∑x=100.010; ∑y=54.190; $\sum x^2$=1723.068.
$\sum y^2$=579,502; ∑xy=966,688
Curve according to the regression equation:
Y=-(0,105 ± 0,304) + (0,567 ± 0,036)

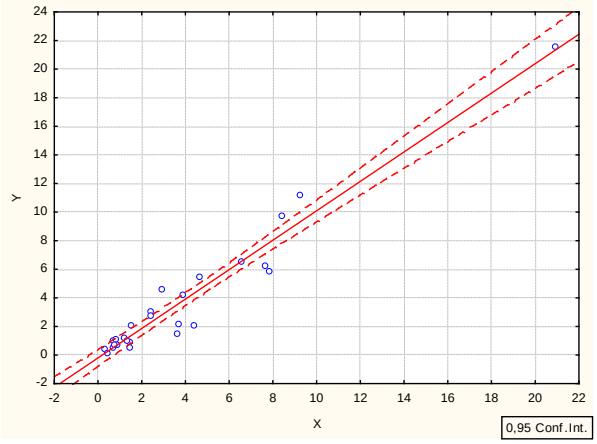


Figure 2: Correlation between the free amino-acids content in *C. piger*, uninfested (X) and infested pupae (Y)
n=26, $r_{xy}$=0.973
∑x=100.010; ∑y=97.650; $\sum x^2$=872.392.
$\sum y^2$=912,361; ∑xy=877,536
Curve according to the regression equation:
Y=(0,203 ± 0,289) + (1,029 ± 0,050)·X

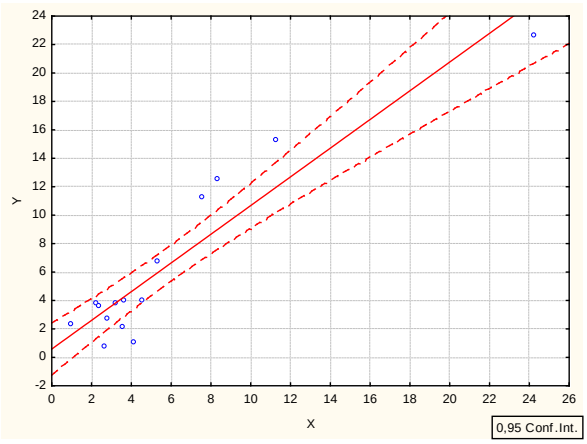


Figure 3: Correlation between the free amino-acids content in *Ch. plumosus*, uninfested (X) and infested females (Y) n = 15, $r_{xy}$ = 0.936
∑x = 87.030; ∑y = 95.590; $\sum x^2$ = 973.524;
$\sum y^2$ = 1166.882; ∑xy = 1033.326
Curve according to the regression equation:
Y = (0.584 ± 0.849) + (1.009 ± 0.105)·X.

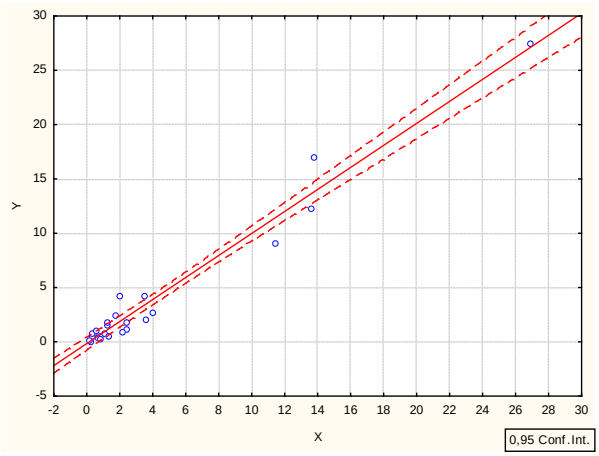


Figure 4: Correlation between the free amino-acids content in *Ch. piger*, uninfested (X) and infested females (Y) n = 25, $r_{xy}$ = 0.983
∑x = 97.260; ∑y = 94,200; $\sum x^2$ = 1306.894;
$\sum y^2$ = 1342.150; ∑xy = 1307.678
Curve according to the regression equation:
Y = -(0.176 ± 0.285) + (1.014 ± 0.039)·X.

According to this information, the infected hosts' share of free amino acid decreases, fact that can be explained both by their use by the parasite and by the intensifying of the protein biosynthesis in the organisms of partners of the system. In favor of this assumption we have data showing that parasitic forms of *H. contorta* contain protein up to 65% of the dry mass, and the post-parasite, only 49% of this mass.

Thus, the post-parasite mermithids have significant differences in the biochemical status in relation to parasitic larvae. These changes are influenced by the different strategies of mermithids at different stages of growth. It has been shown that in the tissue of the chironomids parasited by mermithids the contents of lipids and glucides drop, attesting the increase of protein. Loss of carbohydrates and lipids in parasitized chironomids tissues and the toxic influence of the parasite condition the increased proteic metabolism and protein mobilization of the host.

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# SPECIES OF THE GENUS *PSEUDOSINELLA* (COLLEMBOLA: ENTOMOBRYIDAE) IN THE ROMANIAN FAUNA

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**KEYWORDS**: springtails, distribution, ecology, *Pseudosinella moldavica*.

**ABSTRACT**

This paper presents the distribution of the genus *Pseudosinella* in Romania, based on literature and original field data. The check-list of the genus *Pseudosinella* from Romania is given, together with some critical remarks, data on systematic and ecological features, and distribution in Europe and in Romania. Up until now 24 species of the genus *Pseudosinella* have been recorded in Romania.

*P. sollaudi* Denis 1924 and *P. denisi* (Gisin 1954) were added to the *Pseudosinella* checklist discovered in some other two Romanian works. *Pseudosinella moldavica* Gama and Buşmachiu, 2002 is cited in the present paper for the first time for the Romanian fauna. *P. problematica* Gisin and Gama, 1971 was excluded from the present paper because the species was placed in synonymy with *Lepidocyrtus serbicus* Denis 1933 in Gruia and Popa (2004–2005). Until now six species of *Pseudosinella* appear to be endemic in Romania.

**REZUMAT**: Speciile genului *Pseudosinella* (Collembola: Entomobryidae) în fauna României.

Lucrarea prezintă distribuţia genului *Pseudosinella* în România pe baza datelor din literatură şi a celor originale de teren. Această lucrare cuprinde informaţii despre lista actualizată a speciilor genului *Pseudosinella* în România, precum şi date privind sistematica şi ecologia speciilor, distribuţia lor în Europa şi în ţara noastră. Până în prezent au fost semnalate 24 de specii ale genului *Pseudosinella* în România. *P. sollaudi* Denis 1924 şi *P. denisi* (Gisin 1954) au fost adăugate actualei liste de specii, fiind descoperite în alte două lucrări româneşti. *Pseudosinella moldavica* Gama and Buşmachiu, 2002 este la prima semnalare pentru fauna României în lucrarea de faţă.

*P. problematica* Gisin and Gama, 1971 a fost exclusă din prezenta lucrare fiind sinonimizată cu *Lepidocyrtus serbicus* Denis 1933, conform Gruia şi Popa (2004-2005). Până în prezent, se pare că şase specii aparţinând genului *Pseudosinella* ar fi endemice pentru fauna României.

**RÉZUMÉ**: Les espèces du genre *Pseudosinella* (Collembola: Entomobryidae) dans la faune de Roumanie.

Cet article présente la distribution du genre *Pseudosinella* en Roumanie basée sur des données de la littérature et des données de terrain. La liste mise à jour des espèces du genre *Pseudosinella* en Roumanie est présentée, ainsi que des données concernant la systèmatique et l'écologie des espèces, leur distribution en Europe ainsi qu'en Roumanie. Actuellement, 24 espèces du genre *Pseudosinella* ont été signalées en Roumanie. *P. sollaudi* (Denis 1924) et *P. denisi* (Gisin 1954) ont été ajoutées à cette présente liste des espèces, étant découvertes dans deux autres articles à auteurs roumains. A l'occasion de la publication de cet article, *Pseudosinella moldavica* (Gama et Buşmachiu, 2002) est signalée pour la premiere fois dans la faune Roumaine.

*P. problematica* (Gisin et Gama, 1971) a été exclue de l'article, étant un synonyme de *Lepidocyrtus serbicus* (Denis, 1933) selon Gruia et Popa (2004-2005). Jusqu'à présent, six espèces appartenant au genre *Pseudosinella* seraient endémiques de Roumanie.

## INTRODUCTION

Genus *Pseudosinella* Schäffer, 1897 is the first as largest within the family Entomobryidae (Bellinger et al., 2013) and includes 341 species in the world (Bellinger et al., 2013). In Europe 204 species have been described until now (Ulrich and Fiera, 2010 – in GEB 565 sm Appendix S1; Arbea, 2013). However, some of the species are difficult to identify correctly, due to the fact that their original descriptions are incomplete and do not correspond with the modern taxonomy. Among the most important papers concerning *Pseudosinella* species from Romania are the chaetotaxic studies of Gruia (1974, 1977, 1998a) and Gisin and Gama (1971).

*Pseudosinella*, a very well-studied genus thanks to Gisin's discovery of useful taxonomical features in the chaetotaxy and his development of formulas for reporting these characters (Gisin, 1964a, b; Gisin, 1967) has led to a great increase in the number of species in the last years. Following adaptive characters such as eye number, antennal length, foot structure, head diagonal and non-adaptive characters such as morphology and disposition seta on labial, thoracal and abdominal segments are useful for determination of species of this genus. Christiansen et al. (1983) made a revision of the species studying the specimens cited from Europe and other countries and set up the code of species macrochaetotaxy.

According to the checklist of Romanian springtails, 22 species of *Pseudosinella* were known from Romania (Fiera, 2007). Other two species (*P. sollaudi* Denis 1924 and *P. denisi* Gisin 1954) were added to the Romanian *Pseudosinella* species discovered in the works of Dumitrescu et al. (1955) and Botoşăneanu (1971), which were not available when the checklist of Romanian springtails was published. *P. problematica* Gisin and Gama, 1971 was excluded from the present paper because the species was synonymised with *Lepidocyrtus serbicus* Denis 1933 in Gruia and Popa (2004-2005). Six species of *Pseudosinella* seem to be endemic in Romania until now.

## MATERIAL AND METHODS

The present work represents a synthesis of all present-day available data concerning the genus *Pseudosinella* from Romania; all available references and original sampled material were considered. The systematical and chorological check-list of all species of *Pseudosinella* from Romania is given, together with some critical remarks, data on systematical and ecological features, distribution in Europe and in Romania. Unpublished data, gathered between 2006 and 2013 are also considered.

The *Pseudosinella* species were sampled within several projects conducted by the Department of Ecology, Taxonomy and Nature conservation, Institute of Biology Bucharest, Romanian Academy.

Specimens were separately mounted on permanent slides in Swann medium, following procedure after Rusek (1975) and studied with Axio Scope A1 Zeiss phase contrast microscope.

The nomenclatorial system of body setal pattern is given in accordance to Gisin (1964a, b) and Gisin (1967). In the genus *Pseudosinella* the used system (e.g. Christiansen and Bellinger, 1998, etc.) was incorporated in an inter-active version of *Pseudosinella* key elaborated by Christiansen et al. (2009) to assist in species identification. Nomenclature system of the complete setal pattern of abdominal terga in Lepidocyrtinae (sensu Szeptycki 1979) was developed by Szeptycki (1979) and applied by Mari Mutt (1986), Mateos (2008), Zhang et al. (2009) and Soto-Adames (2010).

### Abbreviations used in the paper

**European countries:** Albania – Al; Andorra – Ad; Austria – At; Azore – Az; Balearic – Bl; Belarus – By; Belgium – Be; Bosnia and Herzegovina – Ba; Britain – Br; Bulgaria – Bg; Corsica – Co; Crete – Ct; Croatia – Hr; Cyprus – Cy; Danemarka – Dk; Dodecanese – Do; Estonia – Ee; Finland

– Fi; France – Fr; Germany – De; Greece – Gr; Hungary – Hu; Islanda – Is; Irlanda – Ie; Italia – It; Kaliningrad – Ka; Letonia – Lv; Lithuania – Lt; Luxemburg – Lu; Macedonia – Mk; Malta – Mt; Moldova – Md; Norvegia – No; Novaya Zemlya – Nz; Polonia – Pl; Portugalia – Pt; Romania – Ro; Sicily – Sc; Slovacia – Sk; Slovenia – Sl; Spain – Es; Svalbard and Jan Mayen – Sj; Sweden – Se; Switzerland – Ch; The Netherlands – Nl; Ukraine – Ua; Yugoslavia – Yu.

**The territorial administrative units of Romania: AB** – Alba; **AG** – Argeş; **AR** – Arad; **B** – Bucharest; **BC** – Bacău; **BH** – Bihor; **BN** – Bistriţa-Năsăud; **BR** – Brăila; **BT** – Botoşani; **BV** – Braşov; **BZ** – Buzău; **CJ** – Cluj; **CL** – Călăraşi; **CS** – Caraş-Severin; **CT** – Constanţa; **CV** – Covasna; **DB** – Dâmboviţa; **DJ** – Dolj; **GJ** – Gorj; **GL** – Galaţi; **GR** – Giurgiu; **HD** – Hunedoara; **HR** – Harghita; **IF** – Ilfov; **IL** – Ialomiţa; **IS** – Iaşi; **MH** – Mehedinţi; **MM** – Maramureş; **MS** – Mureş; **NT** – Neamţ; **OT** – Olt; **PH** – Prahova; **SB** – Sibiu; **SJ** – Sălaj; **SM** – Satu Mare; **SV** – Suceava; **TL** – Tulcea; **TM** – Timiş; **TR** – Teleorman; **VL** – Vâlcea; **VN** – Vrancea; **VS** – Vaslui.

## RESULTS

The systematical and chorological annotated check-list of the species of *Pseudosinella* found up to the present in Romania is given below:

1. ***Pseudosinella aggtelekiensis* (Stach, 1929)**

**First reference in Romania**: Bulimar, 1982.

**Ecology**: *P. aggtelekiensis*, collected from caves is endemic to the Slovak-Aggtelek Karst region in Slovakia and Hungary (Kováč and Rusek, 2012).

**Distribution in Europe**: Hu, Ro, Sk.

**Distribution in Romania**:

**Slătioara Secular Forest, SV,** Stulpicani, ass. *Hieracio transsilvanici-Abietum* (Borhidi 1971) Coldea (1991), moss, soil and decaying trunk, 960 m altitude, 47°27’29”N/25°45’60”E (Bulimar, 1982).

**The Plain and Central Plateau of Moldavia, IS,** Podu Iloaiei, wheat crop and maize, soil, 47°12’45”N/27°16’38”E (Călugăr et al., 1987a).

**IS**, Scobâlteni (Podu Iloaiei Village), maize, soil, 47°11’40”N/27°15’50”E (Călugăr et al., 1987a).

**NT**, Podoleni, meadow, soil, 46°47’54”N/26°35’38”E; Săvineşti-Roznov, rye, soil, 46°50’34”N/26°27’45”E (Călugăr et al., 1983).

**SV**, Bălăceana (Ciprian Porumbescu Village), meadow, ass. *Festuceto-Agrostetum tenuis montanum* Csürös and Kaptalan, 1964, soil, 47°38’26”N/26°2’31”E (Bulimar and Huţu, 1984); Bălăceana (Ciprian Porumbescu Village), meadow with *Agrostis capillaris* L. and *Festuca rubra* L., soil, 47°38’26”N/26°2’31”E (Călugăr et al., 1989a).

**2. *Pseudosinella alba* (Packard, 1873)**

**First reference in Romania**: Stan and Coroiu, 1978.

**Ecology**: lives under stones, in ant hills, debris, being common in various types of habitats (Fjellberg, 2007); reported from cultivated soils – Mediterranean vineyards (Renaud et al., 2004), later stage of succession, acidointolerant (Ponge et al., 2003), edaphic-troglophile species (Stomp et al., 1982).

**Distribution in Europe**: Al, At, Bl, Be, Ba, Bg, Co, Hr, Cz, Dk, Ee, Fi, Fr, De, Br, Hu, Is, Ie, It, Lv, Mt, Md, Nl, No, Pl, Pt, Ro, Yu, Sk, Es, Se, Ch, Ua.

**Distribution in Romania**:

**Apuseni Mountains – Zarandului**, **AR**, Corbeşti (Petriş Village), ass. *Carpino-Quercetum petraeae* Borza, 1941, soil, 280 m altitude, 46°4’16”N/22°22’59”E; **BH**, Tărcăiţa (Tărcaia Village), ass. *Carpino-Făgetum* Paucă, 1941, brown soil, 530 m altitude, 46°35’4”N/22°19’51”E (Harşia, 1995); **Trascăului Mountains, HD**, Buceş – Vulcan (Buceş Village), beech wood, brown mezobasic soil, 550 m altitude, 46°12’55”N/22°58’11”E (Harşia, 1995).

**Slătioara Secular Forest-Rarău**, **SV**, Gemenea (Stulpicani Village), Bâtca Leşii, ass. *Hieracio transilvanico-Piceetum* Pawlowschi et Br.-Bl. 1939, fermentation layer, 1,300 m altitude, 47°26'22"N/25°42'3"E (Bulimar, 1983).

**Dobrogea, Danube Delta**, **TL**, Cocoş Monastery, oakwood, soil, 45°12'25"N/28°24'46"E (Harşia, 1997).

**The Plain and Central Plateau of Moldavia**, **IS**, Podu Iloaiei (Podu Iloaiei Village), oak and holm woods, soil, 160-270 m altitude, 47°13'17"N/27°17'26"E (Bulimar, 1991a); Podu Iloaiei (Podu Iloaiei Village), 47°12'45"N/27°16'38"E, wheat and maize (fertilized/unfertilized), soil; meadow with *Bromus inermis* Leyss. and *Medicago sativa* L., soil, 47°12'45"N/27°16'38"E (Călugăr et al., 1987a); meadow, ass. *Botriochloetum ischaemi* Pop, 1977, soil, 47°12'45"N/27°16'38"E (Călugăr et al., 1987b).

**CJ**, crop, soil, 46°49'56"N/23°36'30"E (Stan and Coroiu, 1978).

**IS**, Popricani (Vulturi), plum orchard, soil, 47°17'1"N/27°30'56"E (Călugăr et al., 1989b); Scobâlteni (Podu Iloaiei Village), vegetables, maize and meadows, soil, 47°11'40"N/27°15'50"E (Călugăr et al., 1987a).

**HR**, Băile Seke and Odorheiu Secuiesc, soil (Fiera, unpublished data).

**MS**, Sovata, 502 m altitude, mixed forest with *Quercus robur* L., *Q. petraea* (Mattuschka) Liebl., *Fagus sylvatica* L. and *Carpinus betulus* L., soil, 46°36'14"N/25°05'07"E (Fiera, unpublished data).

**SV**, Bălăceana (Ciprian Porumbescu Village), meadow with *Agrostis capillaris* L. and *Festuca rubra* L., soil, 47°38'26"N/26°2'31"E (Călugăr et al., 1989a); Bălăceana (Ciprian Porumbescu Village), meadow, ass. *Festuceto-Agrostetum tenuis montanum* Csürös and Kaptalan, 1964, soil, 47°38'26"N/26°2'31"E (Bulimar and Huţu, 1984).

**3. *Pseudosinella annemariae* Stomp, 1972**

**First reference in Romania**: Gruia, 2000.

**Ecology**: muscicolous (Stomp, 1972).

**Distribution in Europe**: Gr, Ro.

**Distribution in Romania**:

(Gruia, 2000) – without locality.

**4. *Pseudosinella crenelata* Gruia, 1974**

**First reference in Romania**: Gruia, 1974.

**Ecology**: lives in caves (Gruia, 2003).

**Distribution in Europe**: Ro.

**Distribution in Romania**:

**CT**, Mangalia, Kara Orban and Obanul Mare from Movile (Gruia and Ilie, 2000-2001); Mangalia: Casian Cave (Gruia, 1974; Gruia and Ilie, 2000-2001; Gruia, 2003); Negru Vodă: Limanu Cave (Gruia, 1974; Gruia and Ilie, 2000-2001); Mangalia: Movile Cave (Gruia, 1998a; Gruia, 1998b); Băneasa: cave from Canaraua de pe Graniţă (Gruia and Ilie, 2000-2001); Gura Dobrogei (Cogealac Village): Liliecilor Cave from Gura Dobrogei (Gruia, 1974; Gruia and Ilie, 2000-2001; Gruia, 2003).

The species is endemic for Romania.

**5. *Pseudosinella horaki* Rusek, 1985**

**First reference in Romania**: Dányi et al., 2006.

**Ecology**: lives in forests; oak woods and *Pinus nigra* plantation (Kováč et al., 2005).

**Distribution in Europe**: Cz, Hu, Md, Pl, Ro, Sk, Ua.

**Distribution in Romania**:

**Igniş Mountains**, **MM**, Izvoarele (Cerneşti Village), Tătarului Gorges, moss, peat bogs, 738 m altitude, 47°35'26"N/23°52'19"E (Dányi et al., 2006).

**Piatra-Maramureş Mountains**, **MM**, Ocna Şugatag, Poiana Brazilor, peat bogs, moss, 900 m altitude, 47°46'40"N/23°56'8"E; Brazilor Valley, soil, 841 m altitude, 47°50'15"N/23°42'42"E (Dányi et al., 2006).

**GR**, Căscioarele (Găiseni Village), forest ecosystem with *Quercus robur* L., soil (Fiera, unpublished data).

**6. *Pseudosinella huetheri* Stomp, 1971**

**First reference in Romania**: Dányi et al., 2006.

**Ecology**: live in forest (Stomp, 1971); interstitial (Bretschko and Christian, 1989).

**Distribution in Europe**: At, De, Lu, Ro, Sk, Ch.

**Distribution in Romania**:

**Igniş Mountains, MM,** Izvoarele (Cerneşti Village), nearby Tăul of Dumitru, turf bog, moss, 1,143 m altitude, 47°35'26"N/23°52'19"E (Dányi et al., 2006).

**Piatra Maramureş Mountains, MM,** Ocna Şugatag, Poiana Brazilor, turf bog, moss, 900 m altitude, 47°46'40"N/23°56'8"E (Dányi et al., 2006); Brazilor Valley, soil, 841 m altitude, 47°50'15"N/23°42'42"E (Dányi et al., 2006).

**7. *Pseudosinella decipiens* Denis, 1924**

**First reference in Romania**: Gruia, 1969a.

**Ecology**: hemiedaphic-troglophile (Stomp et al., 1982), hardwood forest, in soil (Fjellberg, 2007).

**Distribution in Europe**: At, Be, Ba, Ct, Hr, Fi, Fr, De, Br, Hu, Ie, Ro, Yu, Es, Se, Ch.

**Distribution in Romania**:

**Dobrogea and the Carpathians** (Gruia, 1970).

**Dobrogea, CT,** Gura Dobrogei (Cogealac Village): Liliecilor Cave from Gura Dobrogei, 44°28'36"N/28°31'15"E (Gruia, 1969); **CT,** Băneasa: the second cave from Canaraua de pe Graniţă, 44°4'14"N/27°41'56"E (Gruia, 1969); Casian (Târguşor Village): Casian Cave, 44°29'43"N/28°29'15"E (Gruia, 1969); Negru Vodă: Limanu Cave (Dumitrescu et al., 1965; Gruia, 1969a).

**Sebeşului Mountains, HD,** Ohaba-Ponor (Pui Village), the insurgence at Ohaba Ponorului, 45°31'10"N/23°8'15"E (Gruia, 1969); Şura Mare from Ohaba Ponorului, lithoclasis (Dumitrescu et al., 1967); Ohaba-Ponor (Pui Commune): Şura Mare Cave, 45°31'10"N/23°8'15"E (Dumitrescu and Orghidan, 1969); Peştera (Petroşani): Gura Cetăţii Cave, 45°27'11"N/23°18'50"E (Dumitrescu and Orghidan, 1969).

**8. *Pseudosinella denisi*** Gisin, 1954

**First reference in Romania**: Botoşăneanu, 1971.

**Ecology**: lives in caves (Gama, 1991) and also in forests (Kopeszki and Meyer, 1994).

**Distribution in Europe**: De, Fr, Ro.

**Distribution in Romania**:

**Banatului Mountains**, CS, Zamoniţa Cave (Botoşăneanu, 1971).

**9. *Pseudosinella duodecimocellata* Handchin, 1926**

**First reference in Romania**: Bulimar, 1980.

**Ecology**: lives in spruce, fir and beech, forests (Bulimar, 1980) and caves (Gama, 1973).

**Distribution in Europe**: At, Be, Bg, Cz, Fr, De, Br, Ro, Yu, Sk, Sl, Es, Ch.

**Distribution in Romania**:

**Călimani Mountains – Răţitiş Peak, SV,** ass. *Calamagrostio villosae-Pinetum mugi* Sanda and Popescu, 2002, litter, fermentation layer and humus, 1,780 m altitude; ass. *Cembreto-Piceetum abietis* Chifu et al., 1984, litter and fermentation layer, 1,460-1,750 m altitude (Bulimar, 1987).

**Slătioara-Rarău Secular Forest, SV,** Slătioara (Stulpicani Village): Bâtca cu Plai, ass. *Hieracio transilvanico-Piceetum* Pawlowschi et Br. – Bl., 1939, soil, 47°27'57"N/25°39'37"E (Bulimar, 1980); Slătioara (Stulpicani Village), Ion Valley, mixt forest with spruce, fir and beach, soil, 960 m altitude, 47°27'57"N/25°39'37"E (Bulimar, 1980).

**10. *Pseudosinella edax* Gisin, 1967**

**First reference in Romania**: Gruia, 1977.

**Ecology**: edaphic species (Gruia, 1977).

**Distribution in Europe**: At, It, Ro.

**Distribution in Romania**:

(Gruia, 2000) – without localities;

**Mehedinţi Mountains – Motrului Valley**, Izvorul Albiilor and Sohodoale Valley, humus, 600-650 m altitude (Gruia, 1977).

**11. *Pseudosinella fallax* (Börner, 1903)**

**First reference in Romania**: Gruia, 2000.

**Ecology**: caves, agricultural soil, rodent nests, beech forests, steppe region. More information at: http://collembole.free.fr/collembola/publicat/bellingr/indexx.htm (01.11.2013).

**Distribution in Europe**: Al, At, Bg, Ct, Fr, Br, Gr, Hu, Ie, It, Pt, Ro, Sc, Sk, Sl, Es, Ch, Ua.

**Distribution in Romania**:
(Gruia, 2000) – without localities.

**12. *Pseudosinella imparipunctata* Gisin, 1953**

**First reference in Romania**: Călugăr et al., 1987b.

**Ecology**: the species have been recorded from different types of habitas: vineyard, agricultural soil, meadows, stepe region, litoral soil, but also found in caves. More information at: http://collembole.free.fr/collembola/publicat/bellingr/indexx.htm (accessed on 1 November 2013).

**Distribution in Europe**: At, Ct, Fr, Md, Pt, Ro, Yu, Sk, Es, Ch, Ua.

**Distribution in Romania**:
(Gruia, 2000) – without localities.

**The Plain and Central Plateau of Moldavia**, **IS**, Podu Iloaiei, fertilized/unfertilized maize, soil, 47°12’45”N/27°16’38”E (Călugăr et al., 1987a).

**Dobrogea** (Skolka, 2005); **CT**, Mangalia: the cave from Movile, 43°49’9”N/28°33’58”E (Gruia, 1998a; Gruia, 1998b).

B, Izvor Park, soil (Fiera, unpublished data).

**IS**, Popricani (Vulturi), plum orchard, soil, 47°17’1”N/27°30’56”E (Călugăr et al., 1989b).

**PH**, Băicoi, maize, soil (Fiera, 2011).

**13. *Pseudosinella binoculata* Kseneman, 1935**

**First reference in Romania**: Harşia, 1995.

**Ecology**: lives on dry areas under stones and in plant detritus under clusters of grasses (Nosek and Vysotskaia, 1973).

**Distribution in Europe**: At, Be, Cz, Hu, Ro, Es, Ua.

**Distribution in Romania**:

**Apuseni Mountains – Zarandului, AR,** Bârzava, oakwood, ass. *Genisto tinctoriae-Quercetum petraeae* Klika, 1932, brown podzolic soil, 400 m altitude, 46°6’8”N/21°58’12”E (Harşia, 1995).

**14. *Pseudosinella manuelae* Gruia, 1974**

**First Romanian ref.**: Gruia, 1974.

**Ecology**: lives in caves (Gruia, 2003).

**Distribution in Europe**: Ro.

**Distribution in Romania**:
(Gruia, 2000) – without localities.

**Banatului Mountains,** Vraşka Cave (Gruia, 1974; Negrea and Negrea, 1977; Gruia and Ilie, 2000-2001; Gruia, 2003).

**The National Park Semenic, CS,** Cuptorul Porcului Cave (Gruia and Ilie, 2000-2001; Gruia, 2003).

**Basin of Caraş Valley**, **CS**, Liliecilor Cave (Gruia, 1975).

**Mehedinţi Mountains, MH,** Topolniţa Cave (Gruia, 1974; Gruia and Ilie, 2000-2001; Gruia, 2003).

The species is endemic for Romania.

**15. *Pseudosinella moldavica* Da Gama and Busmachiu, 2002**

**Ecology**: corn and alfalfa fields in Moldavia (Buşmachiu and Bacal, 2012); deciduous forests (Buşmachiu, 2008).

**European Distribution**: Md, Ro, Ua.

**BZ**, Merei, Sărata-Monteoru, 45°9’8”N/26°40’56”E; dead trunk.

**DB**, Cobia, forest ecosystem with *Quercus petraea* L., 44°47’23”N/25°20’41”E, soil.

**IF,** Cernica Forest, 44°25’18”N/26°17’3”E, soil, 06.11.2008; Pustnicu Forest, soil; 06.11.2008.

**GR**, Căscioarele (Găiseni Village), 44°30’57”N/25°44’32”E, litter and soil, 06.11.2008.

**16. *Pseudosinella obanae* Gruia, 1998**

**First reference in Romania**: Gruia, 1998a.

**Ecology**: in caves (Gruia, 1998a).

**Distribution in Europe**: Ro.

**Distribution in Romania**: (Gruia, 2000) – without localities.

**Dobrogea, CT,** Mangalia: the cave from Movile (Gruia, 1998b; Gruia, 1998a).

The species is endemic in Romania.

**17. *Pseudosinella octopunctata* Börner**, **1901**

**First reference in Romania**: Călugăr et al., 1987a.

**Ecology**: the species is characteristic to warm meadow habitats (Fjellberg, 2007); reported from dry open environments, Mediterranean shrub lands and vineyard (Detsis et al., 2000; Renaud et al., 2004).

**Distribution in Europe**: At, Az, Be, Ba, Bg, Canary Is., Ct, Cz, Dk, Fi, Fr, De, Br, Hu, Ir, It, Lv, Md, No, Pl, Pt, Ro, Yu, Sc, Sk, Sl, Se, Ch, Ua.

**Distribution in Romania**:

(Gruia, 2000) – without localities.

**Dobrogea**, **CT**, Mangalia: the cave from Movile, 43°49’9”N/28°33’58”E (Gruia, 1998a; Gruia, 1998b; Gruia, 2003).

**The Plain and Central Plateau of Moldavia**, **IS**, Podu Iloaiei, meadow, ass. *Botriochloetum ischaemi* Pop, 1977, soil, 47°12’45”N/27°16’38”E; Podu Iloaiei, 47°12’45”N/27°16’38”E, wheat, maize, soil (Călugăr et al., 1987a); Podu Iloaiei, meadow with *Bromus inermis* Leyss., *Medicago sativa* L., soil, 47°12’45”N/27°16’38”E (Călugăr et al., 1987b).

**IS**, Popricani (Vulturi), plum trees, soil, 47°17’1”N/27°30’56”E (Călugăr et al., 1989b); Scobâlteni (Podu Iloaiei), legumes, meadow, maize, soil, 47°11’40”N/27°15’50”E (Călugăr et al., 1987a).

**PH**, Băicoi, maize, soil (Fiera, 2011).

**SV**, Bălăceana (Ciprian Porumbescu Village), meadow with *Agrostis capillaris* L. and *Festuca rubra* L., soil, 47°38’26”N/26°2’31”E (Călugăr and al., 1989a); Rădăuţi, 47°50’15”N/25°56’41”E (Cârdeiu, 1949).

**8. *Pseudosinella pallida* Gruia, 1977**

**First reference in Romania**: Gruia, 1977.

**Ecology**: edaphic species (Gruia, 1977).

**Distribution in Europe**: Ro.

**Distribution in Romania**:

**Mehedinţi Mountains, Motrului Valley,** Izvorul Albiilor and Sohodoale Valley (Gruia, 1977).

(Gruia, 2000) – without localities.

The species is endemic for Romanian fauna.

**19. *Pseudosinella picta* (Börner**, **1903)**

**First reference in Romania**: Gruia, 2000.

**Ecology**: lives in caves, decidous and conifer forests, meadows, in soil, litter and moss on rocks. More information at: http://collembole.free.fr/collembola/publicat /bellingr/indexx.htm (accessed on 1 November 2013).

**Distribution in Europe**: Ct, Do, It, Pt, Ro, Sc, Es.

**Distribution in Romania**:

(Gruia, 2000) – without localities.

**BR**, Insula Mare a Brăilei, meadow, ass. *Hordeetum murini* Libbert 1932 em. Passarge, 1964 – *Agropyretum pectiniformae* (Prodan, 1939) Dihoru, 1970, soil (Fiera, 2006).

**GR**: Călugăreni, ass. *Querco robori–Carpinetum* Borza, 1937, soil; Căscioarele (Găiseni Village), forest ecosystem with *Quercus robur* L., soil (Sanda et al., 2006a).

**20. *Pseudosinella racovitzai* Gisin and da Gama, 1971**

**First reference in Romania**: Gruia, 2000.

**Ecology**: lives only in caves (Gruia, 2003).

**Distribution in Europe**: Ro.

**Distribution in Romania**:

(Gruia, 2000) – without localities.

**Şureanu Mountains, HD,** Luncani: Cioclovina Uscată Cave (Ponorici Cave) (Gisin and da Gama, 1971; Gruia, 1975; Gruia and Ilie, 2000-2001; Gruia, 2003).

The species is endemic in Romania.

**21. *Pseudosinella sandelsorum* Gruia, 1977**

**First reference in Romania**: Gruia, 1977.

**Ecology**: edaphic species (Gruia, 1977).

**Distribution in Europe**: Ro.

**Distribution in Romania**:

(Gruia, 2000) – without localities.

**Perşani Mountains, HR,** Mereşti, Vârghişului Gorges (Nitzu et al., 2006-2007).

**Mehedinţi Mountains – Motrului Valley,** Izvorul Albiilor and Sohodoale Valley, humus, 600-650 m altitude (Gruia, 1977).

The species is endemic for Romania.

**22. *Pseudosinella sexoculata* Schött, 1902**

**First reference in Romania**: Gruia, 1965b.

**Ecology**: lives in different types of habitats caves, agricultural lands, mine rock dump, coal mines, forests, meadows, in soil, litter, rodent nests and mushrooms. More information at: http://collembole.free.fr/collembola/publicat/bellingr/indexx.htm (accessed on 1 November 2013); compost and other organic deposits (Fjellberg, 2007).

**Distribution in Europe**: At, Ba, Bg, Cn, Hr, Cz, Ee, Fi, Fr, De, Br, Hu, It, Md, Nl, No, Pl, Pt, Ro, Yu, Sc, Sk, Es, Se, Ch, Ua.

**Distribution in Romania**:

(Gruia, 2000) – without localities.

**Dobrogea and the Carpathians** (Gruia, 1970).

**The Plain and Central Plateau of Moldavia**, **IS**, Podu Iloaiei (Podu Iloaiei Village), oak and holm woods, soil, 160-270 m altitude, 47°13’17”N/27°17’26”E (Bulimar, 1991a); Podu Iloaiei, meadow with *Bromus inermis* Leyss., *Medicago sativa* L., soil; Podu Iloaiei, fertilized maize crop, soil, 47°12’45”N/27°16’38”E (Călugăr et al., 1987a).

**Dobrogea, Danube Delta**, **TL**, Cocoş Monastery, oakwood, soil, 45°12’25”N/28°24’46”E (Harşia, 1997); **CT**, Mangalia: the Movile Cave, 43°49’9”N/28°33’58”E (Gruia, 1998a; Gruia, 1998b; Gruia and Ilie, 2000-2001; Gruia, 2003); Gura Dobrogei (Cogealac Village), the cave from Gura Dobrogei, 44°28’36”N/28°31’15”E (Gruia, 1965a); Limanu, lapidicolous, 43°48’5”N/28°32’27”E (Gruia, 1965a); Limanu Cave, in guano (Dumitrescu et al., 1965); Limanu Peninsula, epigeous, (Gruia and Ilie, 2000-2001); Negru Vodă: the cave from Limanu, 43°48’52”N/28°12’20”E (Gruia, 1969; Gruia and Ilie, 2000-2001; Gruia, 2003).

**Bucegi Massif**, **PH**, Buşteni, ass. *Pulmonario rubrae-Fagetum* (Soo, 1964) Taber, 1987, soil, 910 m altitude; Poiana Stânii, *Fagetum dacicum* Beldie, 1951, soil, 1,290 m altitude; Sinaia, *Pulmonario rubrae-Fagetum* (Soo, 1964) Taber, 1987, soil, 800 m altitude (Falcă, 1984).

**BR**, Insula Mare a Brăilei, maize, soil (Fiera, 2006).

**IF**, Pustnicu Forest, soil (Fiera, unpublished data).

**IS**, Scobâlteni (Podu Iloaiei Village), vegetables and maize, soil, 47°11’40”N/27°15’50”E (Călugăr et al., 1987a).

**NT**, Dumbrava Roşie, barley, soil, 46°53’16”N/26°26’56”E; Podoleni, meadow, soil, 46°47’54”N/26°35’38”E; Săvineşti, meadow, soil, 46°50’34”N/26°27’45”E (Călugăr et al., 1983).

**PH**, Băicoi, maize, soil (Fiera, 2011).

**23. *Pseudosinella sollaudi* Denis 1924 First reference in Romania**: Dumitrescu et al., 1955.

**Ecology**: the species has been found only in caves, in France (Gisin, 1960) and Romania (Dancău and Tăbăcaru, 1964).

**Distribution in Europe**: Fr, De.

**Distribution in Romania**:

**Stogu Vânturariţa Massif**, **VL**, Sfântul Grigore Decapolitu Cave (Dumitrescu et al., 1955; Dancău and Tăbăcaru, 1964).

**24. *Pseudosinella wahlgreni* (Börner in Voeltzkow, 1907)**

**First reference in Romania**: Bulimar, 1982.

**Ecology**: eurytopic and hemiedaphic-troglophile species (Stomp et al., 1982).

**Distribution in Europe**: At, Ba, Bg, Cz, Fr, Br, Gr, Hu, It, Lt, Nl, Pl, Ro, Sk, Es, Ch, Ua.

**Distribution in Romania**: (Gruia, 2000) – without localities.

**Călimani Mountains – Pietricelul Mountain, SV,** Răţiţiş Peak, ass. *Cembreto-Piceetum abietis* (Chifu et al., 1984), litter, fermentation layer, humus, 1,460-1,750 m altitude; ass. *Calamagrostio villosae-Pinetum mugi* (Sanda and Popescu, 2002), litter, fermentation layer, humus, 1,780 m altitude (Bulimar, 1987).

**The Plain and Central Plateau of Moldavia, IS,** Podu Iloaiei (Podu Iloaiei Village), oak and holm woods, soil, 160-270 m altitude, 47°13'17"N/27°17'26"E (Bulimar, 1991a).

**Slătioara Secular Forest, SV,** Stulpicani, ass. *Hieracio transsilvanici-Abietum* (Borhidi 1971) Coldea 1991, litter, moss, soil, decaying trunk, 960 m altitude, 47°27'29"N/25°45'60"E (Bulimar, 1982); Stulpicani, mixt forest with spruce, fir and beach, litter, moss, soil, decaying trunk (Bulimar, 1982).

**Suceava, Neamţ, Vrancea,** fir forest, soil, 440-970 m altitude (Bulimar, 1991b).

**Retezat Mountains, Zlătuii Valley, HD,** Râu de Mori, ass. *Festuco drymejae-Fagetum* (Morariu et al., 1968), soil, 850 m altitude (Falcă, 1984); **HD,** ass. *Hieracio transilvanico-Piceetum* Pawlowschi et Br. – Bl., 1939, soil, 1,250 m altitude (Falcă, 1984).

**Slătioara-Rarău Forest area, SV,** Gemenea (Stulpicani Village), Măgura Hill, ass. *Hieracio transsilvanici-Abietum* (Borhidi, 1971) Coldea, 1991, litter, fermentation layer, 890 m altitude, 47°26'22"N/25°42'3"E; Gemenea (Stulpicani Village), Măgura Hill, mixt forest with spruce, fir and beach, litter, fermentation layer (Bulimar, 1983).

**The Central Plateau of Moldavia, IS,** Strunga, ass. *Aro orientalis-Carpinetum* (Dobrescu and Kovács, 1973) Täuber, 1992, fermentation layer, litter, 890 m altitude, 47°9'32"N/26°57'38"E (Bulimar, 1992); **IS,** Sineşti, mixt forest with spruce, fir and beach, fermentation layer, litter (Bulimar, 1992).

## CONCLUSIONS

24 species of *Pseudosinella* genus (Collembola: Entomobryidae) have been recorded in Romania until now.

*Pseudosinella moldavica* Gama and Buşmachiu, 2002 is reported for the first time for Romanian fauna.

Six species of *Pseudosinella* are endemic in the fauna of Romania: *P. crenelata* Gruia, 1974, *P. manuelae* Gruia, 1974, *P. obanae* Gruia, 1998, *P. pallida* Gruia, 1977, *P. racovitzai* Gisin and da Gama, 1971, *P. sandelsorum* Gruia, 1977.

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# THE STRUCTURAL DYNAMICS OF THE COLLEMBOLAN COMMUNITIES (HEXAPODA: COLLEMBOLA) FROM TWO FOREST ECOSYSTEMS LOCATED IN DOFTANA VALLEY (ROMANIA)

*Cristina FIERA* [1]

**KEYWORDS**: springtails, beech and oak forests, abundance, species richness.

**ABSTRACT**

The present paper presents a comparative analysis regarding the structure and dynamics of collembolan communities from two forests located in Doftana Valley, Romania. 37 species of springtails were identified in 100 soil samples: 25 species in Șotriile Forest and 19 species in Voila Forest. Soil collembolan communities of both forest sites were clearly delimited on both qualitative (presence/absence) and quantitative (in density of individual species) levels as well as in terms of total collembolan density. Mean collembolan density reached 238.85 – 23487.26 ind./$m^2$ in the beech forest from Șotriile compared to 159.24 – 16,799.36 ind/$m^2$ found in the beech-oak mixed forest from Voila. In the first one, from Voila, *Parisotoma notabilis*, *Protaphorura* cf. *quadriocellata*, *Protaphorura armata*, *Pseudachorutes parvulus* and *Isotomiella minor* were the most abundant species. *Superodontella ruta* Kaprus' and Weiner 2007 is reported as a new record for Romanian fauna. In the second one, from Voila, *Protaphorura armata*, *Parisotoma notabilis*, *Folsomia spinosa*, *Pseudachorutes parvulus* and *Protaphorura* cf. *quadriocellata* were the most abundant species. The occurrence of some Carpathian endemics at very low density and frequency in both the forests studied was random.

**REZUMAT**: Dinamica structurală a comunităţilor de colembole din două ecosisteme forestiere situate în Valea Doftanei (România).

Lucrarea prezintă o analiză comparativă a structurii şi dinamicii comunităţilor de colembole, din două păduri situate în Valea Doftanei, România. Au fost identificate 37 specii de colembole din 100 de probe de sol: 25 de specii în pădurea de la Șotriile şi 19 specii în pădurea de la Voila. Comunităţile de colembole din solurile celor două ecosisteme forestiere au fost clar delimitate atât din punct de vedere calitativ (prezenţă/absenţă), cât şi din punct de vedere cantitativ (densitate numerică a fiecărei specii şi densitate numerică totală). Densitatea medie a înregistrat valori cuprinse între 238.85 – 23487.26 ind./$m^2$ în pădurea de fag de la Șotriile comparativ cu 159,24 – 16.799,36 indivizi/$m^2$ în pădurea de amestec, fag cu gorun de la Voila. În pădurea de la Șotriile cele mai abundente specii au fost: *Parisotoma notabilis*, *Protaphorura armata*, *P.* cf. *quadriocellata*, *Xenylla boerneri*, *Ceratophysella silvatica* şi *Folsomia inoculata*. În cealaltă pădure de la Voila, *Parisotoma notabilis*, *Protaphorura* cf. *quadriocellata*, *Protaphorura armata*, *Pseudachorutes parvulus* şi *Isotomiella minor* au fost speciile cele mai abundente. *Superodontella ruta* Kaprus' şi Weiner 2007 este la prima semnalare în fauna României. Apariţia unor endemite carpatice cu densitate numerică şi frecvenţă foarte scăzute în ambele păduri studiate a fost aleatorie.

**ZUSAMMENFASSUNG**: Strukturelle Dynamik der Colembolen-Gemeinschaften in zwei Forstökosystemen des Doftana Tales (Rumänien).

Die Arbeit stellt eine vergleichende Analyse der Struktur und Dynamik von Colembolen-Gemeinschaften aus zwei im Doftana-Tal (Rumänien) gelegenen Wäldern vor. In 100 Bodenproben wurden 37 Arten von Colembolen festgestellt: 25 Arten im

Șotriile-Wald und 19 Arten im Wald von Voila. Die Colembolen-Gemeinschaften aus den Böden der beiden Forstökosysteme unterschieden sich deutlich sowohl qualitativ (Präsenz/Absenz), als auch quantitativ (numerische Dichte der einzelnen Arten und der gesamtnumerischen Dichte). Die mittlere Dichte verzeichnete Werte zwischen 238.85-23487.26 ind./$m^2$ im Buchenwald von Șotriile und zwischen 159.24-16799.36 ind./$m^2$ im Buchen-Traubeneichenmischwald von Voila. Im Wald von Șotriile waren *Parisotoma notabilis*, *Protaphorura armata*, *P.* cf. *quadriocellata*, *Xenylla boerneri*, *Ceratophysella silvatica* und *Folsomia inoculata* die häufigsten Arten, während im Wald von Voila *Parisotoma notabilis*, *Protaphorura* cf. *quadriocellata*, *Protaphorura armata*, *Pseudachorutes parvulus* und *Isotomiella minor* die höchsten Abundanzwerte aufwiesen. *Superodontella ruta* Kaprus' und Weiner 2007 wird erstmals für die Fauna Rumäniens erwähnt. Das Auftreten einiger Karpatenendemiten mit niedriger numerischer Dichte und Frequenz in beiden untersuchten Wäldern war zufallsbedingt.

## INTRODUCTION

The hill beech forests cover most of the woody area in the Doftana Valley of Romania, covering up to 80% of the forest surface. Their diversity is high, both as mixture of tree species (oak-beech forests, dominant hill and mountain beech forests, mixtures of beech and fir trees, monodominant high altitude beech forests) and as association with different herbaceous species (Paucă-Comănescu et al., 2009).

The present study was a part of a more complex project finished in 2007. This study examined spatial and temporal distribution of invertebrate communities from beech and sessile oak forests in Doftana Valley (see also Vasiliu-Oromulu et al., 2008). The following groups of invertebrate were studied in the above mentioned forests: leaf beetles (Coleoptera: Chrysomelidae) (Maican, 2009), Chilopoda, Nematoda, Enchytreidae, Lumbricidae, Acari-Oribatida (Vasiliu-Oromulu et al., 2008), Acari-Gamasida (Manu, 2009; Manu et al., 2013) and Collembola (this paper).

Collembola, a well represented group of soil mesofauna, has a wide distribution, occurring in many types of ecosystems throughout the world. In forests, collembolan fauna plays a major role in the decomposition of fresh organic matter and in the formation of humus profiles (Ponge et al., 1986). Functionally Collembola is an important component of forests, but their community structure remains poorly known, being influenced by many factors. Among the factors (e.g. moisture, temperature, light, depth, food resources), which determine the distribution of soil fauna, humus form (Brêthes et al., 1995) and soil pH have a marked influence on Collembolan communities (Klironomos and Kendrick, 1995; Salmon and Ponge, 1999). While these factors are not direct attributes of plant communities, they are, all correlated with vegetation. Hågvar (1982) concluded that vegetation has a certain, but not determining effect on horizontal distribution of collembolan communities. The impact of vegetation on Collembola seems to be an indirect factor, likely exerted through its effect on the soil environment (soil type, microfloral composition or soil moisture), which in turn determines the composition of collembolan communities (Usher et al., 1982).

Collembolan communities are often found to contain several similar species of similar requirements, but with the species differing widely in their abundances. (Petersen, 1995). Low abundances could be explained by the fact that Collembola is an important prey of forest-living spiders (Rusek, 1998; Lawrence and Wise, 2000) and may even occupy microhabitats with less suitable environmental conditions to avoid areas with high spider activity density (Birkhofer et al., 2010).

The present study aimed: (1) to compare structure and species diversity of Collembola assemblages of two beech

forests: one is mixed with *Quercus petraea* (Mattuschka) Liebl. and the second has association *Hieracio rotundati-Fagetum* (Vida, 1983; Täuber, 1987); (2) to assess the effect of *Fagus sylvatica* L. on the structural and functional parameters of collembolan communities; (3) to analyse the presence of rare and endemic species at the studied forests, the most valuable and vulnerable components of native forest ecosystems.

## MATERIALS AND METHODS

The study was done in two forest ecosystems located in Doftana Valley, (Teleajen Subcarpathians, included in Curvature Subcarpathians). The first forest is at the onset of the road to Şotriile Village (45°13'39"N/25°43'44"E) and the second forest belongs to Câmpina Forestry Department, which is a state-owned forest, located near Voila Village (45°09'58"N/ 25°45'10"E). Both forests are located close to each other on the mountainside above the Doftana River.

Site 1: R4106 South-Carpathian beech forests (*Fagus sylvatica*) and fir forests (*Abies alba*) with *Hieracium rotundatum* (syn. *Hieracium transsylvanicum*); mountain beech forest with *Luzula luzuloides* (Lam.) Dandy and Wilmott, altitude 600 m, low productivity and moderate humus. According to Natura 2000, the habitat type is 9110 *Luzulo-Fagetum* beech forest (Doniţă et al., 2005). This ecosystem is situated on a slope of 30°. Soil districambosol (brown acid), oligobasic, moderate and poorly humiferous, median – deep, clay-sandy texture, variable edaphic volume, small-median, (pH 4.0-5.5); low trophicity and little available water (Paucă-Comănescu et al., 2009). Soil samples were collected in 2007 (from April till October) and 2010 (November).

Site 2: *Quercus petraea* (Mattuschka) Liebl. and *Fagus sylvatica* L. mixed forests, growing on the versants that usually have high slopes, face the east or south-east, where the processes of humus build up from litter decomposition are slower, especially because it is removed by the much more active torrents on these sloped areas. Phytocenological, the studied forest is included in association *Petraeo – Fagetum* Scam. 1956, 1959, 500 m altitude, on sloped land, facing east, 25º inclination, microrelief fragmented by deep and medium torrents. The soil is alluvial stratified, moderately humiferous on the first 25 cm, deep, poorly semiskeletal, with gravel at the basis. Medium trophycity. Water is permanently available. The forest, which is over 100 years old, grows on the shadowed, steep versants with deep valleys and processes of surface of erosion. The soils are more superficial, with little humus coming from litter decomposition, which generally accumulates with difficulty due to the erosion and steeper versants. The western orientation and higher moisture of the *Quercus petraea* (Mattuschka) Liebl. and *Fagus sylvatica* L. forest determined the massive presence in the grass synusia of the Fagetalia elements such as: *Festuca drymeja*, *Lathyrus vernus*, *Mercurialis perennis*, *Oxalis acetosella*, *Carex sylvatica*, *Galium odoratum* (Vasiliu-Oromulu et al., 2008). Soil samples were collected in 2006 (from April till September) and in 2010 (November).

Climatically, the area is temperate-continental, with limited valley influences. The multiannual average temperature (Câmpina weather station) is 9°C and the annual rainfall is 850 mm (Armaş, 1999).

The soil samples were collected randomly, being at least ten meters from the edge of the wood growth. From each site ten soil samples/cores were taken in four sampling occasions (Tab. 1) with a MacFadyen corer four centimeters in diameter and seven to ten centimeters deep. In total, 100 soil core samples were collected. The extraction was performed with a modified Berlese-Tullgren. Springtail specimens were separately mounted on permanent slides in Swann medium, following procedure after Rusek (1975), and studied in Axio Scope A1 Zeiss phase contrast microscope. In total 998 specimens of Collembola were examined.

Table 1: The structural and functional indices of Collembola fauna.

| Şotriile | **Σ** | x | density ($x/m^2$) | $s^2$ | STDEV | CV | biomass ($mg/m^2$) |
|---|---|---|---|---|---|---|---|
| April | 295 | 29.5 | 23487.26 | 308.06 | 17.55 | 59.50 | 63.42 |
| May | 121 | 12.1 | 9633.76 | 60.32 | 7.77 | 64.19 | 26.01 |
| July | 3 | 0.3 | 238.85 | 0.46 | 0.67 | 224.98 | 0.64 |
| September | 70 | 7 | 5573.25 | 76.89 | 8.77 | 125.27 | 15.05 |
| November | 78 | 7.8 | 6210.19 | 65.29 | 8.08 | 103.59 | 16.77 |
| Σ | **567** | 56.7 | 45143.31 | 351.57 | 18.75 | 33.07 | **121.89** |
| Voila | **Σ** | x | $x/m^2$ | $s^2$ | STDEV | CV | $mg/m^2$ |
| April | 14 | 1.4 | 1114.65 | 2.71 | 1.65 | 117.61 | 3.01 |
| June | 211 | 21.1 | 16799.36 | 478.10 | 21.87 | 103.63 | 45.36 |
| August | 2 | 0.2 | 159.24 | 0.40 | 0.63 | 316.23 | 0.43 |
| October | 68 | 6.8 | 5414.01 | 14.62 | 3.82 | 56.23 | 14.62 |
| November | 136 | 13.6 | 10828.03 | 297.38 | 17.24 | 126.80 | 232.77 |
| Σ | **431** | 43.1 | 34315.29 | 1374.54 | 37.07 | 86.02 | **92.65** |

## RESULTS AND DISCUSSION

37 springtails species from 26 genera and seven families were recorded. The species richness of springtail fauna from the investigated sites is presented in table 2. The best represented families were: Onychiuridae (eight species), Isotomidae (seven species), Neanuridae, Entomobryidae and Hypogastruridae – each family with six species. The other families have a low number of species Tullbergiidae (three species) and Odontellidae (only one species). Six species were shared across both forest sites. Two new species for science from *Deuteraphorura* genus were discovered and described from both studied forests (Weiner and Fiera, in press). *Neotullbergia ramicuspis* (Stach, 1953) was reported as new record for Romanian fauna and was previously published (Fiera, 2008). *Hymenaphorura* cf. *valdegranulata*, *Superodontella ruta* and *Neotullbergia ramicuspis* were newly identified for Romania and may be "a priori" considered to be endemic for Romanian fauna. *Superodontella ruta* was described from Ukraine. In our study this species represents the second record from Europe. The new species for science from *Deuteraphorura* genus were detected in very low abundance in both forests and were considered to be very rare in the present study.

Importance of endemic species presence as biodiversity indicators was pointed out by Deharveng (1996). He noted evidently higher number and abundance of endemic Collembola in native beech forests comparative with the present study.

The number of species (Tab. 2) recorded in both forest sites of the current study either corresponds to similar small-scale studies. Wolters (1998) reported 48 collembolan species from the soil of a beech forest on limestone in Germany. Kopeszki and Jandl (1994) recorded 38 species from a beech wood in Austria. In a field experiment established in a mixed beech-oak forest in France, Auclerc et al. (2009) identified 57 species of Collembola from 120 soil blocks (15 cm diameter x 10 cm depth). But the number of recorded species depends on sample units, number of sampling occasion and duration of the study as well as selection, size and heterogeneity of studied forest sites.

Collembola group was better represented in the forest from Şotriile than in mixed *Quercus petraea* and *Fagus sylvatica* from Voila (Tab. 1). Mean collembolan density reached 238.85-

23487.26 ind./$m^2$ in the beech forest from Şotriile compared to 159.24-16,799.36 ind./$m^2$ found in the beech-oak mixed forest from Voila (Fig. 1). The highest values of numerical densities were recorded in April (Şotriile) and June (Voila), while this parameter decreased significantly in summer (July – Şotriile; August – Voila) (Fig. 2).

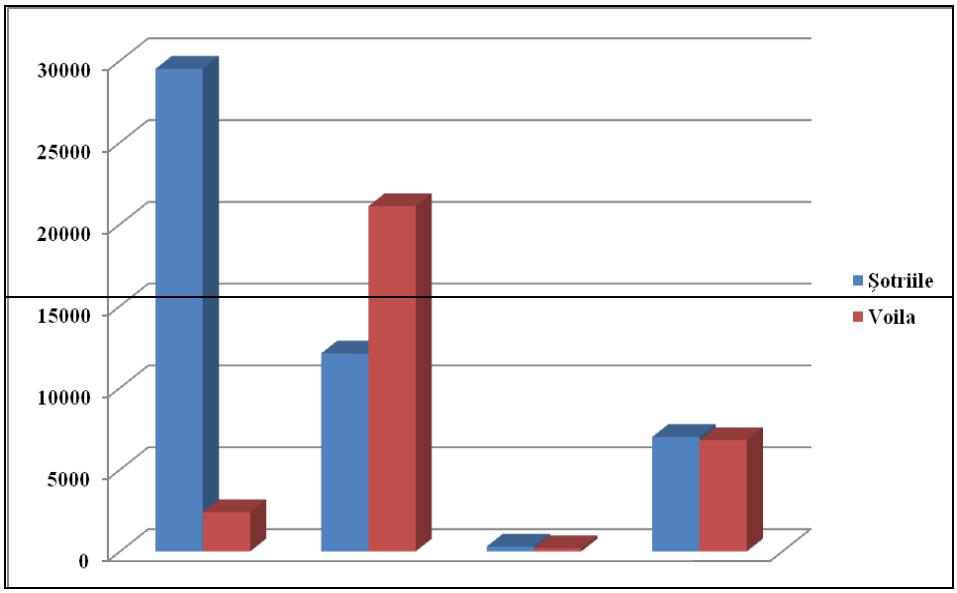


Figure 1: Numerical densities of Collembola at investigated sites in Doftana Valley.

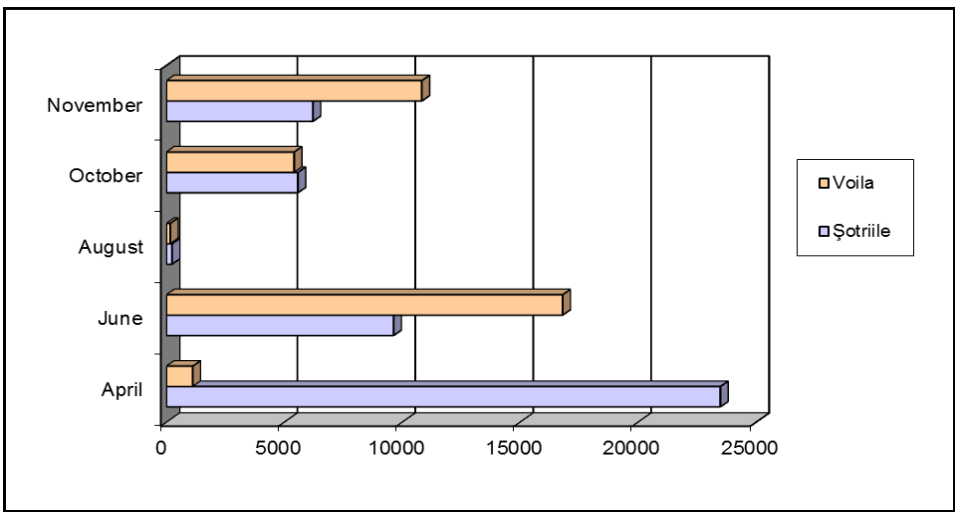


Figure 2: Seasonal mean numerical densities of Collembola at sampling sites in Doftana Valley.

Table 2: The species richness and abundance of Collembola in Doftana Valley.

| | **Taxa** | | | **Şotriile** | **Voila** |
|---|---|---|---|---|---|
| | **Hypogastruridae** | | | | |
| 1. | *Ceratophysella* | *silvatica* | Rusek, 1964 | 36 | |
| 2. | *Ceratophysella* | *armata* | (Nicolet, 1842) | | 19 |
| 3. | *Hypogastrura* | *manubrialis* | (Tullberg, 1869) | | 6 |
| 4. | *Willemia* | *anophtalma* | Borner, 1901 | | 29 |
| 5. | *Willemia* | *scandinavica* | Stach, 1949 | 29 | |
| 6. | *Xenylla* | *boerneri* | Axelson, 1905 | 38 | |

Table 2 (continuing): The species richness and abundance of Collembola in Doftana Valley.

| | **Taxa** | | | **Şotriile** | **Voila** |
|---|---|---|---|---|---|
| | **Onychiuridae** | | | | |
| 7. | *Protaphorura* | *armata* | (Tullberg, 1869) | 45 | 39 |
| 8. | *Protaphorura* | cf. *quadriocellata* | (Gisin, 1947) | 36 | 40 |
| 9. | *Protaphorura* | cf. *fimata* group | (Gisin, 1952) | 13 | |
| 10. | *Orthonychiurus* | *rectopapilatus* | (Stach, 1933) | 27 | |
| 11. | *Deuteraphorura* | species nova one | Weiner and Fiera, in press | 8 | 4 |
| 12. | *Deuteraphorura* | species nova two | Weiner and Fiera, in press | 2 | |
| 13. | *Heteraphorura* | *variotuberculata* | (Stach, 1934) | 15 | |
| 14. | *Hymenaphorura* | cf. *valdegranulata* | (Stach, 1954) | 4 | |
| | **Neanuridae** | | | | |
| 15. | *Friesea* | *mirabilis* | (Tullberg, 1871) | | 8 |
| 16. | *Friesea* | *claviseta* | Axelson, 1900 | 17 | |
| 17. | *Deutonura* | *conjuncta* | (Stach, 1926) | | 18 |
| 18. | *Neanura* | *minuta* | Gisin, 1963 | 14 | |
| 19. | *Pseudachorutes* | *parvulus* | | 19 | 34 |
| 20 | *Thaumanura* | *carolii* | (Stach, 1920) | 16 | 24 |
| | **Entomobryidae** | | | | |
| 21. | *Entomobrya* | sp. | | 7 | |
| 22. | *Entomobrya* | *lanuginosa* | (Nicolet,1842) | | 15 |
| 23. | *Pseudosinella* | *alba* | (Packard, 1873) | | 18 |
| 24. | *Seira* | *domestica* | (Nicolet, 1842) | 17 | |
| 25. | *Heteromurus* | *nitidus* | (Templeton, 1835) | | 17 |
| 26. | *Lepidocyrtus* | *cyaneus* | Tullberg, 1871 | | 16 |
| | **Isotomidae** | | | | |
| 27. | *Parisotoma* | *notabilis* | (Schäffer, 1896) | 56 | 47 |
| 28. | *Folsomia* | *spinosa* | Kseneman, 1936 | | 29 |
| 29. | *Folsomia* | *inoculata* | Stach, 1946 | 37 | 21 |
| 30. | *Folsomia* | *manolachei* | Bagnal, 1939 | 29 | |
| 31. | *Folsomia* | *ksenemani* | Stach, 1947 | 19 | |
| 32. | *Isotoma* | *anglicana* | Lubbock, 1862 | 28 | |
| 33. | *Isotomiella* | *minor* | (Schäffer, 1896) | | 30 |
| | **Tullbergiidae** | | | | |
| 34. | *Mesaphorura* | *hylophila* | Rusek, 1982 | 17 | |
| 35. | *Mesaphorura* | *critica* | Ellis, 1976 | 23 | |
| 36. | *Neotullbergia* | *ramicuspis* | (Gisin, 1953) | | 17 |
| | **Odontellidae** | | | | |
| 37. | *Superodontella* | *ruta* | Kaprus and Weiner, 2007 | 25 | |
| **Specimens sp.** | | | | **567** | **431** |

The highest values for the numerical density and the index of biomass were recorded in the beech forest from Șotriile, where the humus, by its structure (rich in organic matter, a good trophic substrate), provided favourable conditions for development of springtails populations (Tab. 1). Six species (*Parisotoma notabilis*, *Protaphorura armata*, *P.* cf. *quadriocellata*, *Xenylla boerneri*, *Ceratophysella silvatica*, *Folsomia inoculata*) were the most abundant in the beech forest from Șotriile. In the other forest, *Parisotoma notabilis*, *Protaphorura* cf. *quadriocellata Protaphorura armata*, *Folsomia spinosa*, *Pseudachorutes parvulus* and *Isotomiella minor* were the most abundant species.

The soil collembolan communities seem to be both qualitatively (presence-absence) and quantitatively delimited as well as in terms of total collembolan density. The densities in the beech forest from Șotriile correspond to values reported by Wolters (1998) from a German beech wood with mull humus (mean annual density in this site varied between 18,600 and 46,800 ind./$m^2$ recorded over ten years).

The values from the present paper are slightly lower than values reported by Schaefer and Schauermann (1990) from another German beech wood with humus (mean annual collembolan density in their locality reached 63,000 ind./$m^2$).

Litter quality and the rate of decomposition are most likely attributed to the pronounced differences in total collembolan density (Materna, 2004). Pinto et al. (1997) suggests that leaf chemistry (nitrogen and polyphenolic content) may be an important factor controlling the structure of collembolan communities as well as total collembolan densities.

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# FACTORS AFFECTING *HELIX POMATIA* EDIBLE LANDSNAIL'S POPULATIONS IN SOUTHERN TRANSYLVANIA (ROMANIA)

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**KEYWORDS**: Romania, Transylvania, *Helix pomatia*, edible land snail, density, conservation.

**ABSTRACT**

This paper presents the results of a study carried out in the year 2012, aiming at the analysis of 20 *Helix pomatia* populations from southern Transylvania, in similar habitats, namely those which are most likely to preserve the species in the hilly zones of this region. The correspondence between the values of population parameters (density and biomass) and the factors likely to influence them (variations in habitat characteristics and the distance to the nearest settlement) was tested.

The populations analyzed exhibit very different densities, ranging between 0.5 ind./$m^2$ and 7.05 ind./$m^2$, and a biomass of between 8.31 g/$m^2$ and 93.03 g/$m^2$. Both the Kruskal-Wallis test and correspondence analysis show that both population parameters are influenced by the land use of adjacent terrains, the size of the considered habitat, the occurrence of fires, and the distance to the nearest settlement. Thus, even in apparently well preserved habitats, there might be some habitat variables which have a significant influence on the terrestrial gastropods. Other anthropogenic factors compound these natural characteristics. In the sampling stations close to settlements lower values were calculated, both for density and for biomass, probably as an effect of the pressure of snail collecting. The fires that are set in some areas have disturbance effects on *Helix pomatia* populations. The cumulative effect of these factors may lead to serious disequilibria of this species' populations.

**REZUMAT**: Factori care afectează populațiile speciei comestibile *Helix pomatia* în sudul Transilvaniei (România).

Lucrarea prezintă rezultatele studiul derulat în 2012 și care analizează un număr de 20 de populații ale speciei *Helix pomatia* localizate în sudul Transilvaniei, în habitate similare, cele mai susceptibile să conserve specia în zona de podiș, din această regiune. Este testată corespondența dintre valorile parametrilor populaționali (densitate și biomasă) și factori susceptibili să influențeze starea acestora (variații în natura habitatului și distanța până la cea mai apropiată localitate).

Populațiile analizate prezintă o variație foarte amplă, atât în ceea ce privește densitatea cât și biomasa. Densitatea variază între 0,5 ind./$m^2$ și 7,05 ind./$m^2$, iar biomasa este cuprisă între 8,31 g/$m^2$ și 93,03 g/$m^2$. Aplicarea testului Kruskal-Wallis și analiza de corespondență demonstrează că ambii parametrii populaționali considerați sunt influențați de tipul de utilizare al terenurilor limitrofe, de dimensiunea fragmentului de habitat considerat, de practicarea incendierilor și de distanța până la cea mai apropiată localitate.

Astfel, chiar și în habitate aparent conservate, pot exista variabile de biotop care influențează semnificativ gastropodele terestre, la care se adaugă factori perturbatori de natură antropică. În stațiile apropiate de localități, se înregistrează valori mai mici de densitate și biomasă, cel mai probabil ca urmare a presiunii generată de colectare. Practicarea incendierilor are efecte perturbatoare asupra populațiilor de *Helix pomatia*. Cumularea acestor factori poate duce la dezechilibre grave în populațiile acestei specii.

**RÉZUMÉ**: Facteurs affectant les populations d'espèce comestible d'*Helix pomatia* dans la partie Sud de la Transylvanie (Roumanie).

Cet article présente les résultats de l'étude menée en 2012 sur 20 populations de l'espèce *Helix pomatia* dans le sud de la Transylvanie dans des habitats similaires, les plus susceptibles de préserver l'espèce dans cette région. La correspondance entre les paramètres se rapportant aux populations (densité et biomasse) et les facteurs susceptibles de les influencer (variations de la nature de l'habitat, et la distance à la ville la plus proche) sont testés. Les populations analysées présentent une très grande variation en termes de densité et de biomasse. La densité varie entre 0,5 et 7,05 ind/m$^2$. Les valeurs de la biomasse sont répartie entre 8,31 et 93,03 g/m$^2$. Le test de Kruskal-Wallis et l'analyse de corrélation montre que les deux paramètres sont influencés par le mode d'utilisation des terres adjacentes, la dimension de l'habitat considéré, la pratique du brûlage et la distance au village le plus proche.

Par conséquent, même dans des habitats apparemment préservés, des variations au sein de ces habitats ainsi que des perturbations d'origine anthropique peuvent influencer significativement les populations de gastéropodes terrestres. Dans les sites de prélèvement situés à la proximité des habitations, des valeurs plus faibles de la densité et de la biomasse ont été enregistrées, probablement en raison de la pression générée par le ramassage. Le feu a pour effet des perturbations sur les populations d'*Helix pomatia*. La combinaison de ces facteurs peut conduire à des déséquilibres graves dans les populations de cette espèce.

## INTRODUCTION

*Helix pomatia* is one of the most appreciated edible species of snail, which consequently generated, in the second half of the 20th century, a drastic reduction of its population sizes in West Europe. Thus some legal measures were adopted in order to preserve this species. *H. pomatia* is included in some annexes comprising vulnerable animal species whose exploitation needs to be subject of management measures (Annex III of the Bern Convention list and Annex V of 92/43/EEC Directive, known as Habitats Directive). At the same time, national and regional regulations ban the commercial collection of the species from the wild in western European countries. Along with commercial collecting, a series of other factors are also considered responsible for the species' decline in West Europe. Among them, the most important are the destruction and fragmentation of habitats and the development of intensive agriculture (Fortier, 1991). As a consequence, commercial collecting has moved towards East Europe and at this moment the European snail market is supplied mostly from east European countries, Turkey and North Africa. A small amount, evaluated in 2010 as representing about 12% of the total, comes from heliciculture (according to the data from the Cherasco International Institute for Heliciculture, Italy). Despite the increasing interest raised by the pressure of the commercial collecting pressure on this species, there are relatively few studies in this field and little is known about the conservation status of the species in Eastern Europe (Andreev, 2007). The existence of characteristic habitats, which are more and more reduced, represents a limitative condition for the species' development. The present study aims to initiate an evaluation of *Helix pomatia* populations in central Romania and to assess to what degree, in its characteristic habitats, other disturbance factors may lead to disequilibrium in these edible land snail populations.

## MATERIALS AND METHODS

For the status evaluation of *Helix pomatia* natural populations, 20 sampling stations were researched in Sibiu and Brașov counties (Fig. 1a, b), in the same habitat type, namely river valleys, where fragments of riverine coppice are preserved.

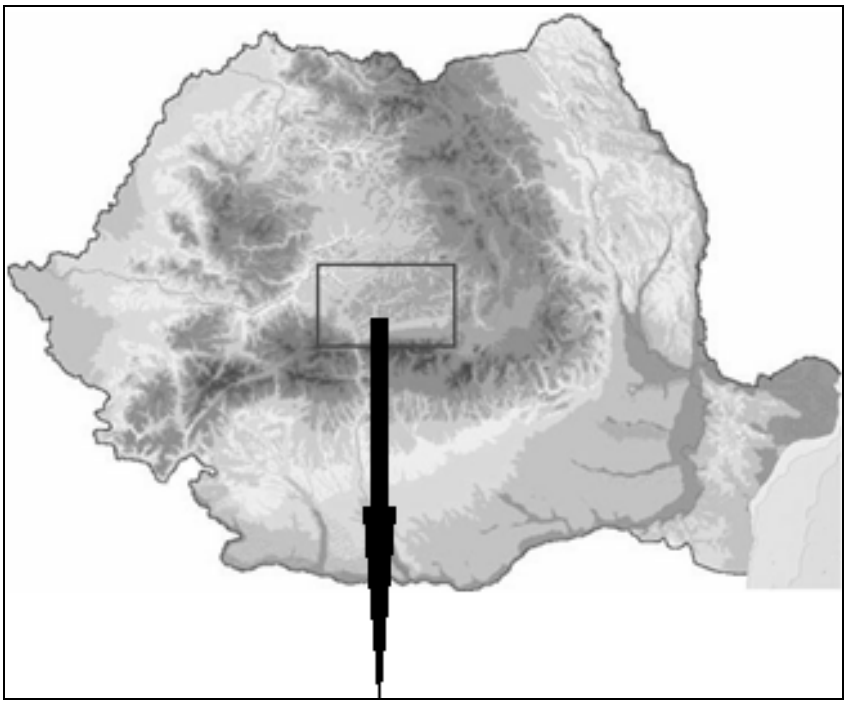

Figure 1a: Location of the sampling stations.

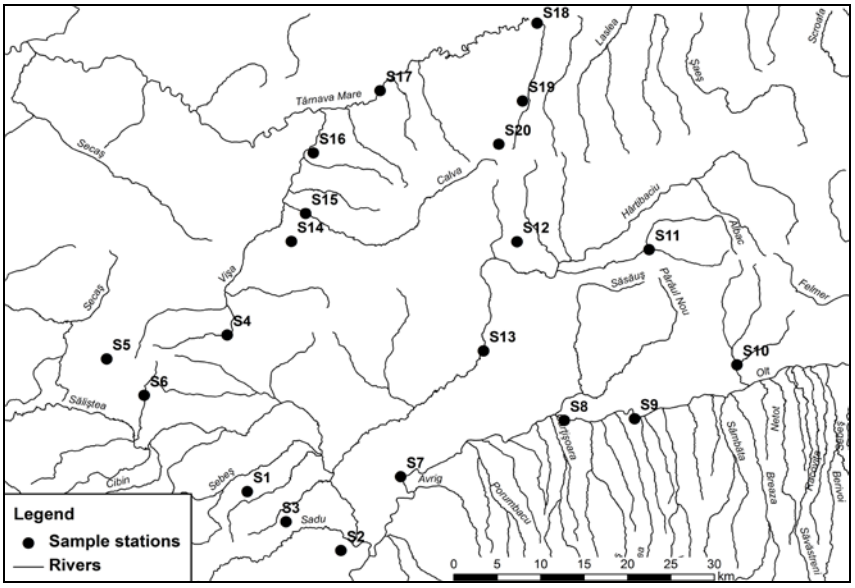


Figure 1b: Location of the sampling stations.

In all the stations, snails were collected from one $m^2$ plots resulting in 20 quantitative samples. The data obtained were used for the calculation of density and biomass, parameters essential for the description of a population. In order to test the correspondence between the population parameters (density and biomass) and habitat variables (use of neighbouring terrains, habitat size-expressed as the width of the river coppice and the distance to the nearest locality), the Kruskal-Wallis test and the correspondence analysis were performed.

**RESULTS AND DISCUSSION**

Concerning the *Helix pomatia* population densities, a wide range of values were calculated for the sampling stations. The densities range between 0.5 ind./$m^2$ and 7.05 ind./$m^2$ (Fig. 2). The highest values were recorded in Avrig (7.05), Cisnădioara (5.05), Amnaș (3.55) and Veseud (3). Five populations have densities lower than one ind./$m^2$, namely Cârța (0.9), (Ucea 0.5), Marpod (0.7), Șaroșu pe Târnave (0.85) and Richiș (0.8).

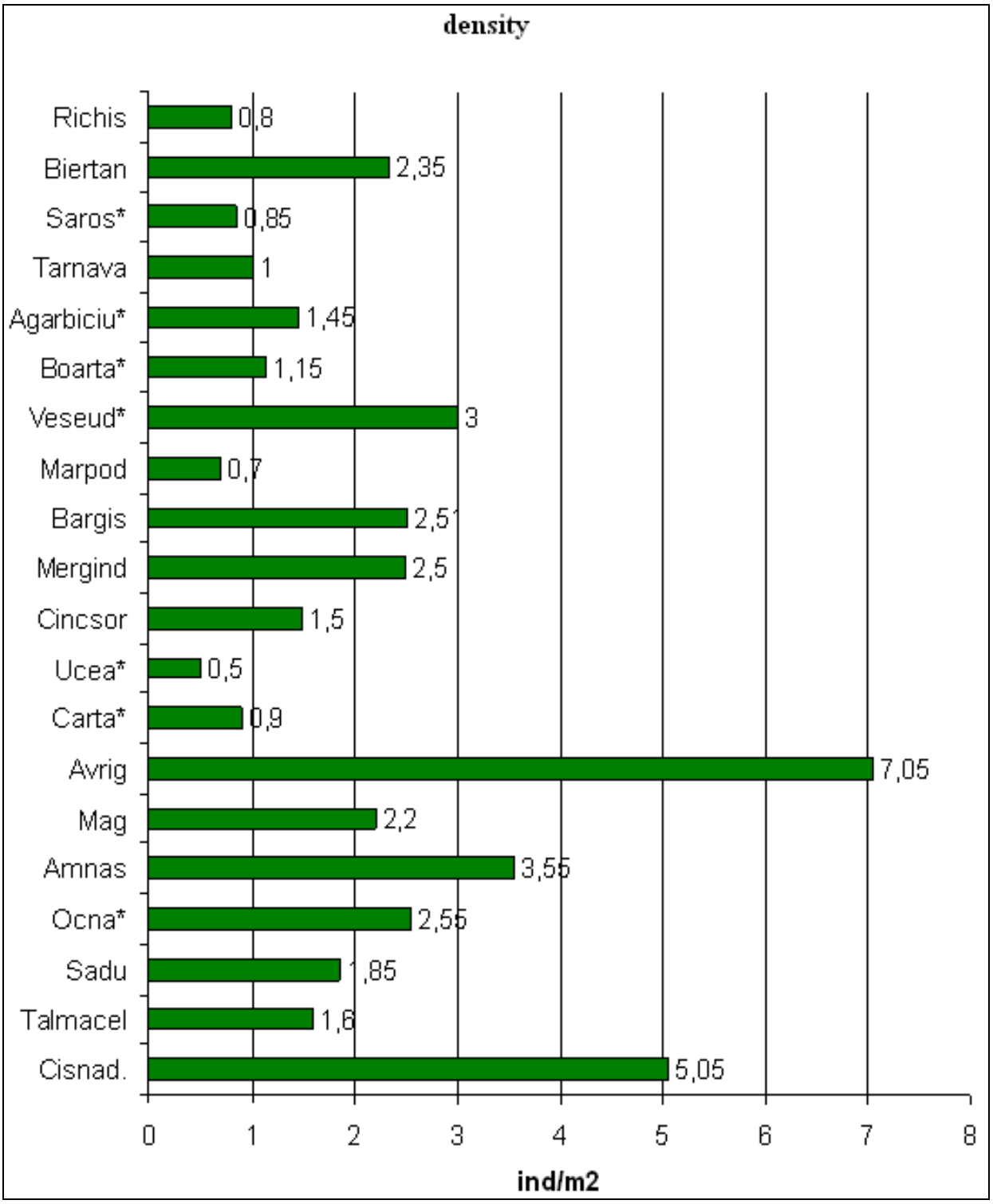


Figure 2: Density values for the 20 populations (S1 – Cisnădioara to S20 – Richiş).

These values were calculated based on samplings made at the end of May, after three weeks of rain, in conditions extremely favourable for the activity of these animals. On the other hand, the biomass ranges between 93.03 g/m$^2$ and 8.31 g/m$^2$ (Fig. 3), the large difference between these two parameters in the stations studied may be due to the great differences among the size of adults measured in the various sampling stations. There might be multiple causes of this variation. We aimed at the exclusion of the differences caused by habitat conditions, and we selected for the sampling the same habitat type, namely river coppices where the high humidity is favourable for the presence of snails and the specific diversity within this taxon is maximum in the hilly

zone (Gheoca, 2005, 2007). However, there were some differences among the sampling stations where the human impact is concerned. Difficult to assess at first sight, in the research sites the anthropic impact is the result of fires set to remove the dry vegetation, reflected in the presence of carbonized plant remains and snail shells, as well as of the land use of neighbouring terrains. In the sampling stations these terrains were grouped into three categories, depending on their use: namely abandoned agricultural fields with a high degree of ruderalization, cultivated fields and pastures or hayfields. In the last two categories case, the human impact is higher, due to frequent access of landowners and/or animals, and potentially, due to pesticides use.

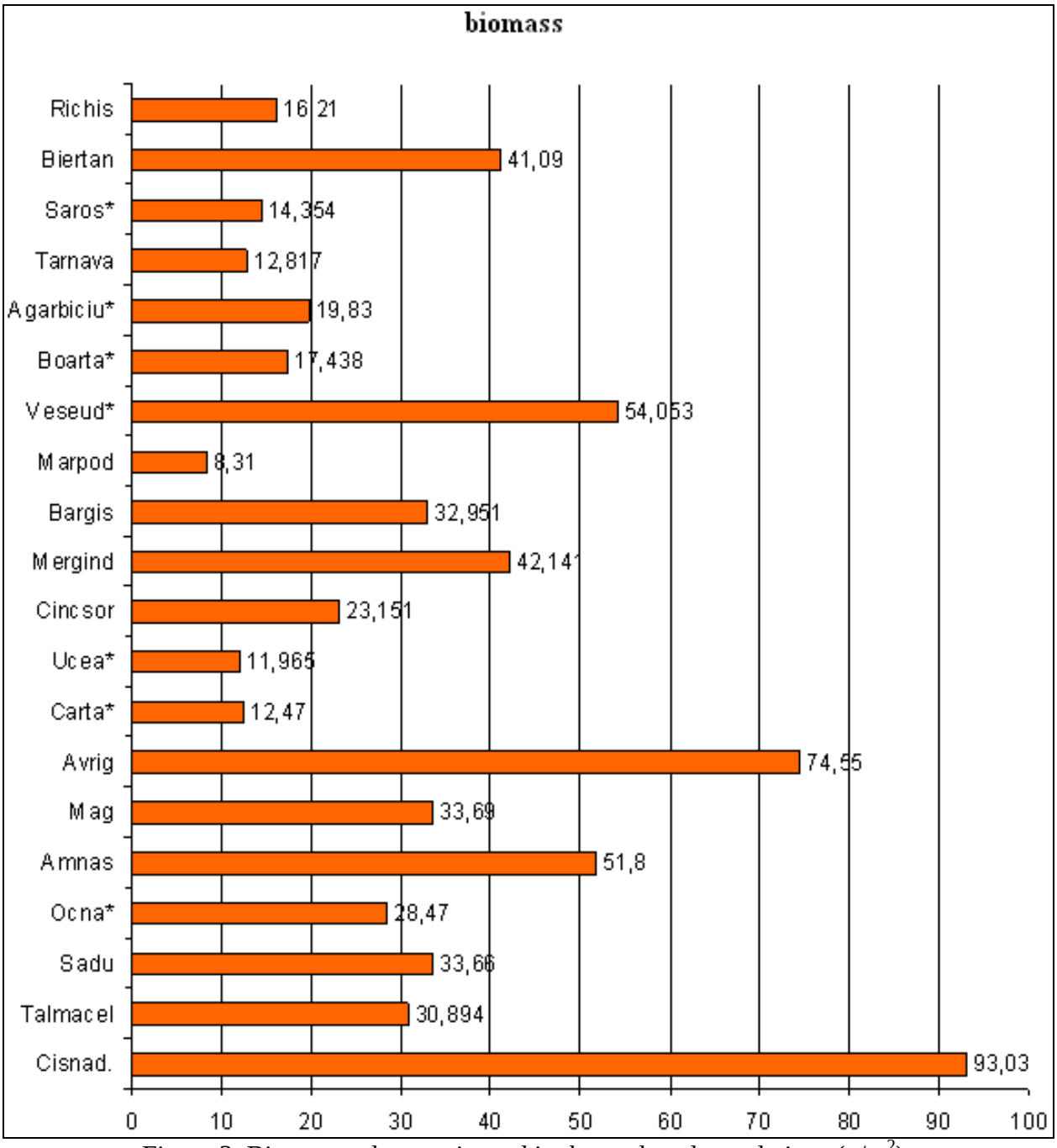


Figure 3: Biomass values registered in the analyzed populations ($g/m^2$).

Another cause of the differences between the population densities among the sampling sites may be induced by the different commercial collecting pressure. This may cause differences among the *H. pomatia* populations, as has been demonstrated in a previous study (Andreev, 2007).

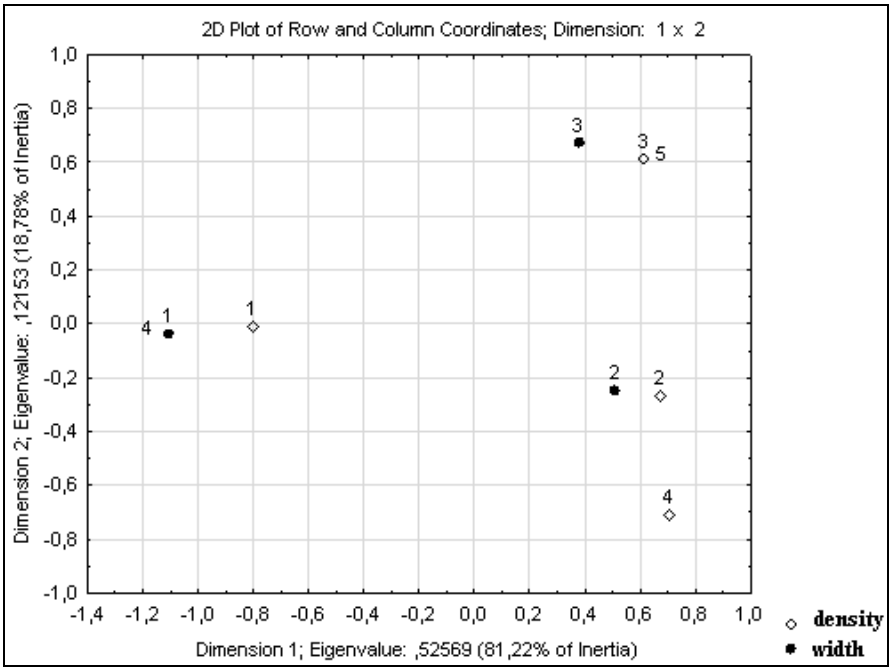


Figure 4: Correspondence analysis between density and riverside coppice width.
The populations are joined in five groups marked with circles
and the coppice width in fur groups using five meters intervals.

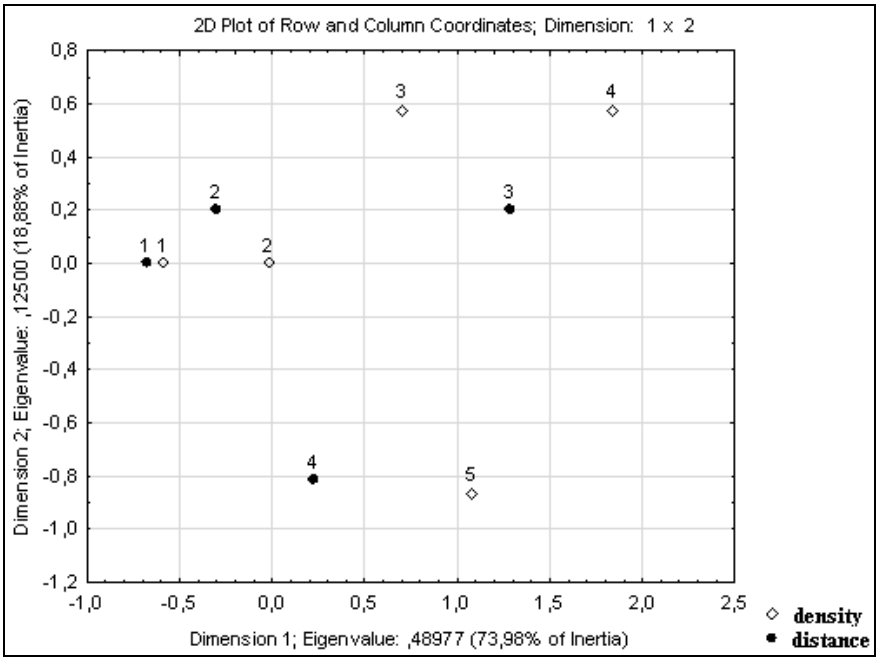


Figure 5: Correspondence analysis between the population density
and the distance to the nearest locality.
The populations were grouped in five classes marked with rhombs
and the distance, in four classes marked with filled circles.
For both variables the grouping was done ascending.

Figure 6: Carbonized vegetation and shells
in Ucea and Șaroșu pe Târnave sampling points.

In order to test the differences induced by the land use of marginal terrains, the Kruskal-Wallis test was performed for the three categories of use, mentioned above. The results show that the land use of neighbouring terrains significantly influences the density and biomass ($p < 0.05$). The highest values were calculated for the stations where the marginal terrains are abandoned fields with a high degree of ruderalization. The stations situated in river coppices next to cultivated fields and pastures/hayfields are similar, there is no significant difference between the parameters of the populations in habitats from these two categories.

In order to assess the relation between habitat size (expressed as intervals of five meters width) and population density, the correspondence analysis was performed also. The results show a relation between snail population density and riverside coppice width only in case of the lower values of the latter. Thus, at less than ten m, the breadth of the coppice may be a limitative factor, while in broader habitats other factors influence the *H. pomatia* population's density. A good example is Ucea, where the coppice is broadest, but with clear evidence of fires.

Habitat size is a major defining element for species conservation and for terrestrial gastropods, small mobile animals, habitat fragmentation may have very serious effects. A series of studies show that the specific diversity decreases with the habitat size and this is true even for larger fragments (Badano et al., 2005; Kappes et al., 2009a; Kappes et al., 2009b; Horsak et al., 2012).

There is a significant influence ($p < 0.1$) of fires on the density and biomass of snail populations, lower values being characteristic for areas affected by fires. Thus, even if this does not have the impact of the natural fires that are characteristic for the Mediterranean region (Kiss and Magnin, 2003), this practice of burning the dry vegetation may have a major effect on the state of these populations, especially if fires are set after the animals' emergence. Their effect might be aggravated by the practice of annual burns, which prevents recolonization.

## CONCLUSIONS

The density and biomass were both very variable in the 20 populations analyzed, despite the fact that similar and undisturbed habitats were selected. The habitat variables considered (distance from the nearest locality, habitat size, land use of marginal terrains) have a significant influence on the density and biomass of *Helix pomatia* populations.

These results emphasize the species' vulnerability, especially the populations from the already extremely fragmented habitats and which, due to their location, are the most likely to be harvested. Other natural or anthropic factors, especially if they act repeatedly, may have disastrous effects on local scale. The use of fires for the management of some agricultural or public terrains, even if usually only on small areas (less than one ha), may have very serious effects both on terrestrial gastropods and on other groups of terrestrial invertebrates with low mobility, which do not live in the soil or are not caught during the buried phase.

Terrestrial gastropods are also affected by climatic extremes, such as extreme temperatures, which can cause a high mortality (Gheoca and Costea, 2012).

All these factors are likely to generate effects, which cumulatively can lead in time to serious disequilibrium in populations of *H. pomatia*.

## AKNOWLEDGEMENTS

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# ENHANCING THE WISE USE OF FRESHWATER BIVALVES IN ORGANIC WASTE WATER TREATMENT

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**KEYWORDS**: freshwater bivalves, native, invasive, water purification, filtration, organic waste water treatment.

**ABSTRACT**

The role of bivalves in aquatic ecosystems is crucial due to the fact that these species can filter out a significant amount of organic matter. This paper underlines the role of "ecosystem engineers" regarding native and invasive bivalves. Further, the paper gives an overview of the current state of knowledge about native and invasive bivalves used in water purifications installations. Species such as *Dreissena polymorpha* have a greater capacity in purifying water than native species. For this reason Dutch researchers have developed a method for increasing water quality by using *Dreissena polymorpha* on artificial substrates in blocks. These blocks are used as biological filters and proved to have a significant impact on water quality. The Danish researchers also developed a method of using bivalves in water purification. However, further research needs to be performed in order to establish the efficiency of bivalves in organic waste water treatment plants and the cost implications for these specific kind of installations.

**REZUMAT**: Utilizarea bivalvelor de apă dulce în epurarea apelor uzate.

Rolul bivalvelor în ecosistemele acvatice este crucial datorită faptului că aceste specii pot filtra o cantitate semnificativă de materie organică. Lucrarea de față își propune să scoată în evidență rolul speciilor de bivalve native și invazive în procesele de epurare naturală a apei. De asemenea, lucrarea oferă o imagine de ansamblu al stadiului actual al cunoașterii cu privire la bivalvele native și invazive utilizate în epurarea apei. În concluzie, specii precum *Dreissena polymorpha* au o capacitate mai mare în epurarea apei decât speciile native. Din acest motiv, cercetătorii olandezi au dezvoltat o metodă de creștere a calității apei prin folosirea *Dreissena polymorpha* pe substraturi artificiale în blocuri. Aceste blocuri sunt utilizate ca filtre biologice și s-au dovedit a avea un impact semnificativ asupra calității apei. Cercetătorii danezi au dezvoltat o metodă prin care utilizează bivalve în epurarea apei. Cu toate acestea, cercetări suplimentare trebuie să fie efectuate pentru a stabili eficiența bivalvelor în stații de epurare a apelor uzate cu substanțe organice și costurile pentru aceste tipuri specific de instalații.

**ZUSAMMENFASSUNG**: Verwendung der Süßwassermuscheln für die Reinigung von Abwässern.

Die Rolle der Muscheln ist für die Gewässserökosysteme von großer Bedeutung, da diese eine beträchtliche Menge organischer Stoffe filtern können. Die vorliegende Arbeit hat zum Ziel, die Rolle der einheimischen und fremdländischen, invasiven Muscheln als "Ingenieure der Ökosysteme" darzustellen. Gleichzeitig wird der Stand der Kenntnisse bezüglich der Verwendung der einheimischen und fremdländischen Muscheln in Kläranlagen vorgestellt. Fazit ist, dass Muschelarten wie *Dreissena polymorpha* im Vergleich zu einheimischen Muscheln eine größere Wasserreinigungskapazität haben. Aus diesem Grund haben holländische Forscher eine Methode zur Verbesserung der Wasserqualität durch Anwendung von *Dreissena polymorpha* auf künstlichen Blocksubstraten entwickelt. Diese Blockschichten werden als biologische Filter

verwendet, wobei sich zeigt, dass sie einen beachtlichen Einfluss auf die Wasserqualität haben. Dänische Forscher haben ebenfalls eine Methode zur Wasserreinigung mit Hilfe von Muscheln entwickelt. Dennoch ist es erforderlich durch zukünftige Forschungen die Effizienz der Anwendung von Muscheln in Kläranlagen mit organischen Stoffen genauer belegt und die Kosten für derartige Anlagen herausgefunden werden.

## INTRODUCTION

Freshwater bivalves (native and invasive) are known as excellent water filters. The filter-feeding bivalves have a significant role in the matter and energy flow of freshwater systems (Bodis et al., 2008). A high density of bivalves does not only remove the particulate material from the water column, but they also excrete a large amount of inorganic nutrients back into the water column (Kohata et al., 2003). However, the water filtration capacity of freshwater bivalves is not sufficiently "exploited" in waste water treatment plants (Strayer et al., 1994). Moreover, the freshwater bivalve's capacity to improve water quality has also been assessed as a mean to restore degraded environments (Gottlieb et al., 1996). In this regard the main objective of this paper is to give the reader an unbiased view of the state of the current knowledge when it comes to freshwater bivales (native and invasive) and their capacity of organic waste water treatment. The research questions that arise from this paper can be summarised as follows: the natural water purification capacity of bivalves can be tested in organic waste water treatment plans? Or are freshwater bivalves (native or invasive) "engineers" in polluted aquatic systems? Furthermore, the filtration capacity of bivalves can increase cost efficency over traditional waste water treatment plants?

## MATERIALS AND METHODS

In order to achieve the objective, a systematic scientific literature review has been performed. To minimize the risk of bias, the author attempts to identify papers and articles and use the research with least amount ofbias (Glasziou, 2013). A number articles have been searched and 25 have been included in the paper.

## RESULTS AND DISCUSSION

Freshwater bivalves consitiute 90% of the benthic biomass of a river (Mann, 1964) and yet are rarely mentioned in modern textbooks on freshwater ecology (Strayer et al., 1999). Bivalves can filter out a significant amount of organic matter through their filtering activity (Kohat et al., 2003). Filtration behavior of freshwater bivalves can play a very important role in the riparian ecosystem by reducing phytoplankton, increasing water clarity and generating benefits for plants, invertebrates, fish and bird populations (McIvor, 2004). Understanding the role of bivalves in freshwater ecosystems is vital for their successful management, especially because bivalve populations are declining worldwide (Bogan, 1993).

In aquatic ecosystems, invasive bivalves species such as *Corbicula fluminea*, *Dreissena polymorpha* etc., have very high filtration rates (Strayer et al., 1994), compared to native species (*Unio crassus*, *Unio pictorum*). Moreover, invasive bivalve species have colonized freshwater systems around the world, and in some cases have caused significant impact on the local economy. By analyzing the ecology of some of the invasive species of bivalves, it has been concluded that they modify, maintain and/or create a new habitat. This can significantly alter the structure and function of an ecosystem (Sousa et al., 2009).

Invasive bivalves filter and remove a wide variety of particles in the water column, resulting in a decrease in phytoplankton and zooplankton and changes in the plankton community. Bivalves filtrating activity has consequences on the physical environment and they act as "ecosystem engineers". An example in this respect is the increase in clarity of the water and thereby the penetration of light into the water column. By reducing the concentration of plankton and other particulate matter. Increased water clarity was observed, especially after the introduction of different species of invasive bivalves such as *Dreissena polymorpha* or *Corbicula fluminea* (Sousa et al., 2009).

There are bivalves species that provide ecosystem services, that can be used by humans, such as: in waste water treatment for small communities, sand filters, biomanipulation (Tab. 1).

Table 1: Ecosystem services provided by bivalves and their applications.

| Ecosystem | Service offered by ecosystem | Application |
|---|---|---|
| Ecosystem | | |
| Wetlands | Retention of sediment and flood control (Moss, 1998) | Wastewater treatment for small communities (Merlin et al., 2002) and wastewater from dairy factories (Fey et al., 1999) |
| Substrate | | |
| Sandy substrate<br><br>Biofilm over substrate | Filtration and purification through physicochemical and biological processes (Wotton, 2002)<br>Removal of organic and inorganic matter in river water (Sabater et al., 2002) | Equivalent of sand filters in water treatment plants, they remove fine suspensions and provides oxygen organic compounds in water (Gruntzmacher et al., 2002) |
| Flora | | |
| Macrophites | Sorting and retention of organic particles in suspension (Horvath, 2004) | Used in waste water treatment as described above (Merli et al., 2002) |
| Fauna | | |
| Pelagic and benthic organisms<br><br>Bivalves | Reducing/controlling phytoplankton (McIvor, 2004) | Biomanipulation of eutrophic waters (Perrow et al., 1997). |

Filtering activity of bivalves, as ecosystem engineers can interact with certain economic activities. For example, a species of invasive bivalves had a positive impact on shrimp farms by removing particulates. However, too high of a density prevented invasive species of shrimp to feed efficiently. The increased water clarity intensified the activity of predatory birds, and has led to reduced pigmentation shrimp which has reduced their market value (Aldrige et al., 2008). Moreover, individual shells of bivalves in high density can affect the flow of water and sediment infiltration affecting particle transport (Gutierrez et al., 2003).

Local increase of sediment is another common feature of invasive bivalve species aggregates with important consequences for other organisms (Escapa et al., 2004). Invasive bivalves can change the physical characteristics of the sludge in the processing, therefore also influence the ecosystem processes and functions, as well as the density and performance of other organisms (Vaugh and Hakenkamp, 2001). Bivalves activity give rise to physical alteration of sediments. These include changes in particle size, the content of organic matter, aggregation, which can affect the porosity characteristics of the interstitial water the redox potential and distribution, and the survival of other organisms (Vaugh and Hakenkamp, 2001).

An interesting relationship was found between filtration rate of bivalve populations and river flow. According to McIvor (2004), bivalves can filter large amounts of organic matter in small rivers.

Filtration rate of bivalve populations increases linearly with the density of bivalves and bivalve population increases linearly with the size of the river. This is understandable because large rivers are wider, and thus provide higher substrate, where bivalves may work. However, the relationship between the filtration rate and the width of the river is less strong than the relationship between the filter rate and the flow of the river, and is non-linear (Strayer et al., 1994; Welker and Walz, 1998).

Invasive bivalves are being used in some countries for the process of filtering freshwater. For instance, Dutch researchers have developed a method for increasing water quality by using *Dreissena polymorpha* as biological filter. Currently this method is tested in the southern Netherlands.

**Explanation behind choosing *Dreissena polymorpha***

*D. polymorpha* filter water in order to feed. The invasive bivalve removes algae from the medium and particles, which are deposited through excretion. In sufficient quantities, these bivalves can prevent flowering water and reduce turbidity. This can improve the conditions for growth of aquatic plants and also contribute to water quality.

The process consists of growing *D. polymorpha* on artificial substrates in blocks and these blocks can be used as a biological filter. In this sense, low quality water can be improved by using these biological filters. This method was patented by Bureau Waardenburg, Netherlands (Waardenburg, 2012).

On the other hand, the Danish researchers are experimenting with another method by using bivalves as filters. The Danish believe that dissolved oxygen and the problem of algae in water bodies can be solved in a natural way by using bivalves.

**Explanation for choosing bivalves**

The use of bivalves has been shown to be a simple and inexpensive way to reduce the nutrients in the water. Many bodies of water are full of algae and a cheap method to clean and filter these waters would be with bivalves.

The benefit of using bivalves is that the results are visible immediately in water. More than that, bivalves used in water purification can be used for human consumption, animal consumption as well as for making biogas.

Danish Shellfish Center (DSC) began in 2010 using bivalves to clean Limfjord water. An “installation” consists of ribbons, ropes and hanging strips where bivalves are attached. These “installations” of bivalves may be used as filter in the waters, thereby eliminating the nutrient substances. Freshwater bivalve organisms are feeding on the microalgae and therefore naturally purifying waters. Each of the individual species of the bivalve used by DSC, filter 50 to 300 liters of water/day, depending on the size of bivalves and other factors (Stenkjaer, 2010).

## CONCLUSIONS

Freshwater bivalves, invasive and native, proved to have a good capacity in filtering and purifying water, thus performing an "auto-adjustment" of aquatic ecosystem. Moreover, it appears that invasive species of bivalves have greater capacity in purifying water than the native species because, of their filtering process. Furthermore, bivalves have recently been used as filters in organic waste water treatment, in countries such as Denmark. However, further research needs to be performed in order to establish the efficiency of bivalves in organic waste water treatment plants and the cost implications for these kinds of installations.

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# BENTHIC MACROINVERTEBRATES COMMUNITIES FROM THE SOUTHERN PART OF THE APUSENI NATURE PARK (TRANSYLVANIA, ROMANIA)

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**KEYWORDS**: Arieş upper river basin, Plecoptera, Ephemeroptera, Trichoptera, Chironomidae, Oligochaeta, community structure, spatial dynamics, human impact.

**ABSTRACT**

The benthic macroinvertebrate communities from the southern part of the Apuseni Nature Park were surveyed in August-September 2005. Samples were collected from 18 stations established along the Arieş River and three of its tributaries. The structure of benthic communities was characterized in terms of mean density and relative abundance of the invertebrate groups. The investigated rivers shelter typical rhithron communities, numerically dominated by Plecoptera, Ephemeroptera, and Trichoptera, which represent up to 79% of total numbers. However, a certain degree of water quality debasement even in the upstream stations is revealed by the high density and ratio of Chironomidae. The human impact (in the form of organic pollution by wastewater discharges from villages, hotels and villas, and sawdust from sawmills) becomes evident in the lower stations on the Arieş River, downstream from Scărişoara, where Oligochaeta have a high density, and are prevalent in the community.

**REZUMAT**: Comunităţi de macronevertebrate bentonice din partea sudică a Parcului Natural Apuseni (Transilvania, România).

Comunităţile de macronevertebrate bentonice din partea sudică a Parcului Natural Apuseni au fost studiate în august-septembrie 2005. Au fost colectate probe din 18 staţii de prelevare stabilite de-a lungul Arieşului şi a trei dintre afluenţii săi. Structura comunităţilor bentonice a fost caracterizată în termeni de densitate medie şi abundenţă relativă a grupelor de nevertebrate. Râurile investigate adăpostesc comunităţi tipice de rithron, dominate numeric de Plecoptera, Ephemeroptera şi Trichoptera, care reprezintă până la 79% din numărul de indivizi. Totuşi, o oarecare scădere a calităţii apei, chiar şi în staţiile din amonte, este indicată de densitatea şi proporţia ridicată a chironomidelor. Impactul antropic (sub forma poluării organice cu apele menajere deversate de către gospodăriile din sate, hoteluri şi vile, dar şi cu rumeguşul provenit de la gatere) devine evident în staţiile inferioare de pe Arieş, în aval de Scărişoara, unde oligochetele au o densitate ridicată, predominând în cadrul comunităţii.

**RÉSUMÉ**: Communautés des macroinvertébrés benthiques de la partie méridionale du Parc Naturel Apuseni (Transylvanie, Roumanie).

Les communautés benthiques de la partie méridionale du Parc Naturel Apuseni ont été étudiées en Août-Septembre 2005. Les échantillons ont été prélevés dans 18 stations établies le long de la rivière Arieş et trois de ses affluents. La structure des communautés benthiques a été caractérisée en termes de densité et d'abondance relative. Les stations étudiées abritent des communautés typiques pour la course montagneuse de rivières, numériquement dominé par les plécoptères, éphéméroptères, trichoptères. Toutefois, l'impact humain (sous forme de pollution organique par les rejets d'eaux usées et de sciure de bois) devient évident dans les stations inférieures du Arieş, où les oligochètes prévalent dans la communauté avec une densité élevée.

## INTRODUCTION

According to their ecological demands living organisms can be used as indicators of different environment characteristics. In case of freshwaters, and especially rivers, the benthic macro-invertebrates are frequently used for monitoring the water quality and other habitat traits, as a measure of the human impact. Although there are differences among the species within a superior taxa concerning their ecological demands, several benthic systematic groups can be used as indicators. For instance Plecoptera are characteristic for the upper sectors of rivers, with high oxygen concentration, low temperatures and organic load, and hard substratum, while most Oligochaeta indicate low oxygen concentration, high temperatures and organic load, their increasing density showing organic water pollution (Szitó and Mózes, 1997). However, the heavy pollution has a limiting effect on specimen density (Szitó and Mózes, 1997).

Several papers were published on the benthic invertebrates communities from rivers surrounding the Apuseni Mountains: Mureş River (Szitó, 1995), Criş rivers (Szitó, 1997a, b; Csia and Sárkány-Kiss, 1997; Buzan and Sárkány-Kiss, 1997; Szitó and Mózes, 1997; Găldean et al., 1997; Sárkány-Kiss et al., 1997), and Someş rivers (Szállassy, 1999; Sárkány-Kiss et al., 1999). In the volume dedicated to the Arieş River basin of the "Transylvanian Review of Systematical and Ecological Research" (Curtean-Bănăduc et al., 2009) several papers concerned some benthic taxa, like the Oligochaeta (Cupşa, 2009), aquatic and semiaquatic Heteroptera (Ilie and Olosutean, 2009), Trichoptera (Ciubuc, 2009), the hyporeic invertebrates communities and their relation with heavy metals (Iepure and Selescu, 2009), and a more complex study concerning algae, macroinvertebrates and fish from the Arieş River basin (Momeu et al., 2009), containing qualitative samples and data on the benthic fauna. The dynamics of the whole benthic macroinvertebrates communities, with a special emphasis on mayflies, related to pollution, was published by Váncsa and Sárkány-Kiss (2007). However, the Arieş River's sector covered by this last study is situated downstream the area of the Apuseni Nature Park (below the confluence with the Arieşul Mic River). Thus, the aim of the present paper is to cover an area of knowledge which is still blank, to bring a contribution to the knowledge of the whole benthic macroinverebrates communities, on supraspecific level, from the upper Arieş River Basin, concerning the river's sector placed in the Apuseni Nature Park, as well as some of its tributaries, and to relate these data on sources and effects of human impact.

## STUDY AREA AND METHODS

The Apuseni Nature Park is situated in western Romania, in the central-north-western side of the Apuseni Mountains, comprising a part of the Bihor and Vlădeasa massifs. The hydrological network of the park belongs to Someşul Mic, Crişul Negru and Arieşul Mare River basins. The present paper is based on samples collected from the last basin in August-September 2005.

The Arieş River is the largest right hand tributary of Mureş River, with a surface of 2,970 km$^2$ and 164 km in lenght (Ujvári, 1972). It springs from 1,195 m a.s.l. in the Vârtop Pass area and borders the southern part of the park. First order thalwegs in the mountain area have a temporary drainage system, depending on the regime of precipitations and snowmelt (Costea, 2009). Its main tributaries within the park are: Cobleş, Gârda Seacă and Albac. Deep waters, represented mostly by those of the endokarst, represent an important reserve supplying the surface water system. Gârda Seacă drains the abundant undergound waters coming from Padiş Plateau, its main tributary being Ordâncuşa. In the Gârda-Ordâncuşa basin, is a mainly karstic area with 25 discovered caves (Ujvári, 1972). Among these, Poarta lui Ionele Cave is located in Ordâncuşa Gorges. It is an active

cave, with a creek flowing through its entrance. The south-eastern limit of the park is represented by the lower course of Albac River, and the confluence with Arieş marks the point where this river exits the park.

The mean slope of Arieş River down to Scărişoara is 13 m/km, while the slopes of its tributaries are steeper, up to 30-35 m/km (Ujvári, 1972).

In the researched area 18 sampling stations (Fig. 1) were established: along Arieş River (6), Gârda (3), Ordâncuşa (4) and the creek exiting Poarta lui Ionele Cave, Albac (4) and its tributary Bulz Creek.

Sampling sites were chosen along the mentioned rivers, from the source area downstream to the confluence, according to the characteristics of waterflow, habitat heterogeneity and the sources of human impact. From each station three samples were collected, from different types of substrate, depth and waterflow velocity zones, usually in cross-section.

Samples were collected using a 625 $cm^2$ functional surface Surber benthometer and fixed in 4% formaldehide solution. Benthic invertebrates were sorted out using a stereobinocular and conserved in 70% ethanol. The results are expressed in terms of mean density (ind./$m^2$) and relative abundance (%).

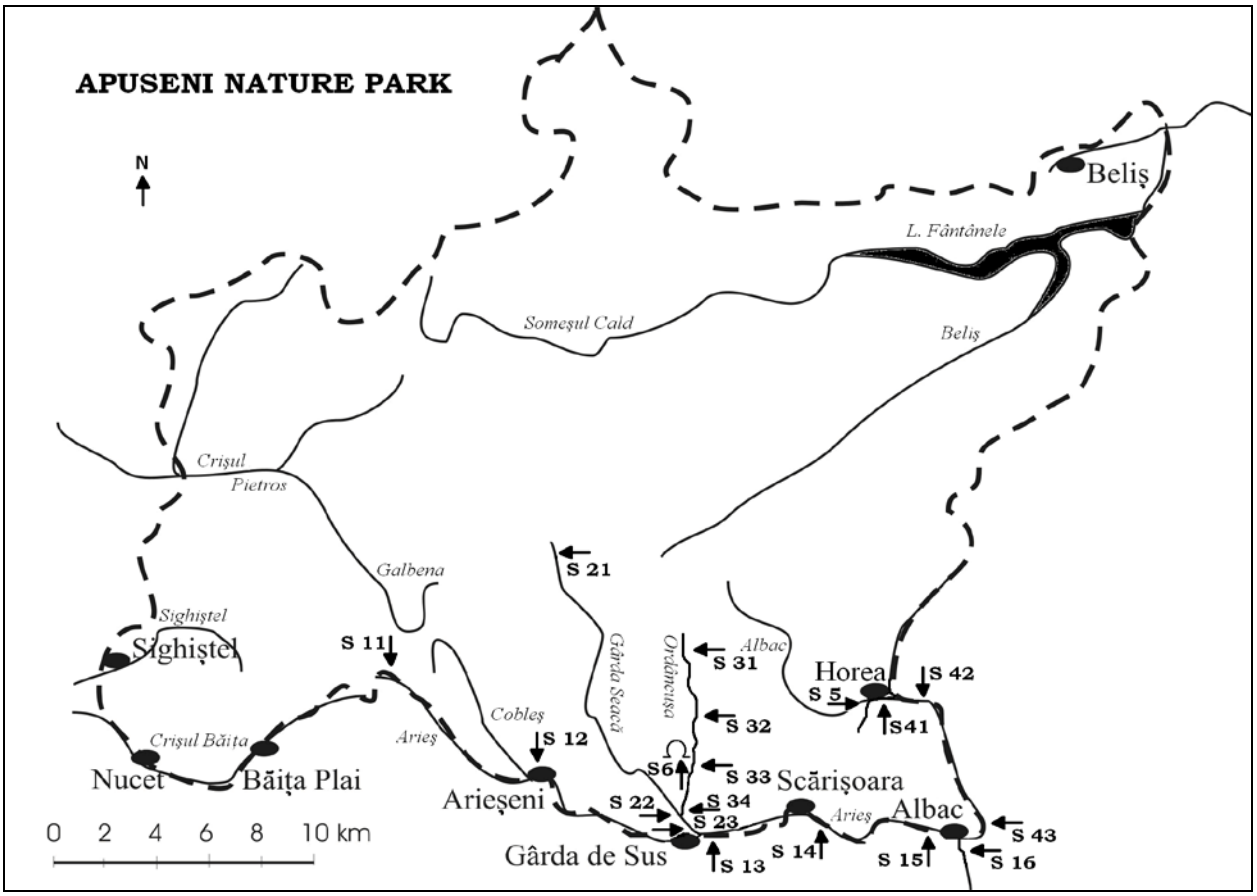


Figure 2: Map and codes of the sampling stations from the Arieş River basin on Apuseni Nature Park.

**RESULTS AND DISCUSSION**

The identified structure of the sampled benthic communities in the total of six sampling stations along Arieş River, expressed in terms of densities, is illustrated in figure 2.

At Vârtop Pass (S11) the Arieş River is a small creek flowing through a swampy thinned out spruce forest. Although in its source area, here the river is already degraded by pollution with organic matter

from the wastewaters discharged by the pensions, villas, and other buildings from the area. Besides, on the banks but also in the riverbed, piles of rubbish from different sources can be found. The water organic load is indicated by the presence of many fibrous algae, the colour and presence of foam, but also by the benthic community structure. Among the invertebrate taxa, Plecoptera (1,864 ind./$m^2$), followed by Chironomidae (400 ind./$m^2$) prevail.

In the second sampling station, at Arieşeni (S12), the river has a typical aspect of mountain creek, with hard substratum, made of boulders, fragments of rocks and gravel. In consequence, the community structure changes significantly. The total abundance of the community is lower, especially due to the decrease in the density of Plecoptera, to 437 ind./$m^2$. However, the other two groups of rheophilous invertebrates, Trichoptera and especially Ephemeroptera have increased densities, the latter reaching 189 ind./$m^2$. Two new groups appear in the longitudinal profile for the first time, namely Mollusca and Diptera.

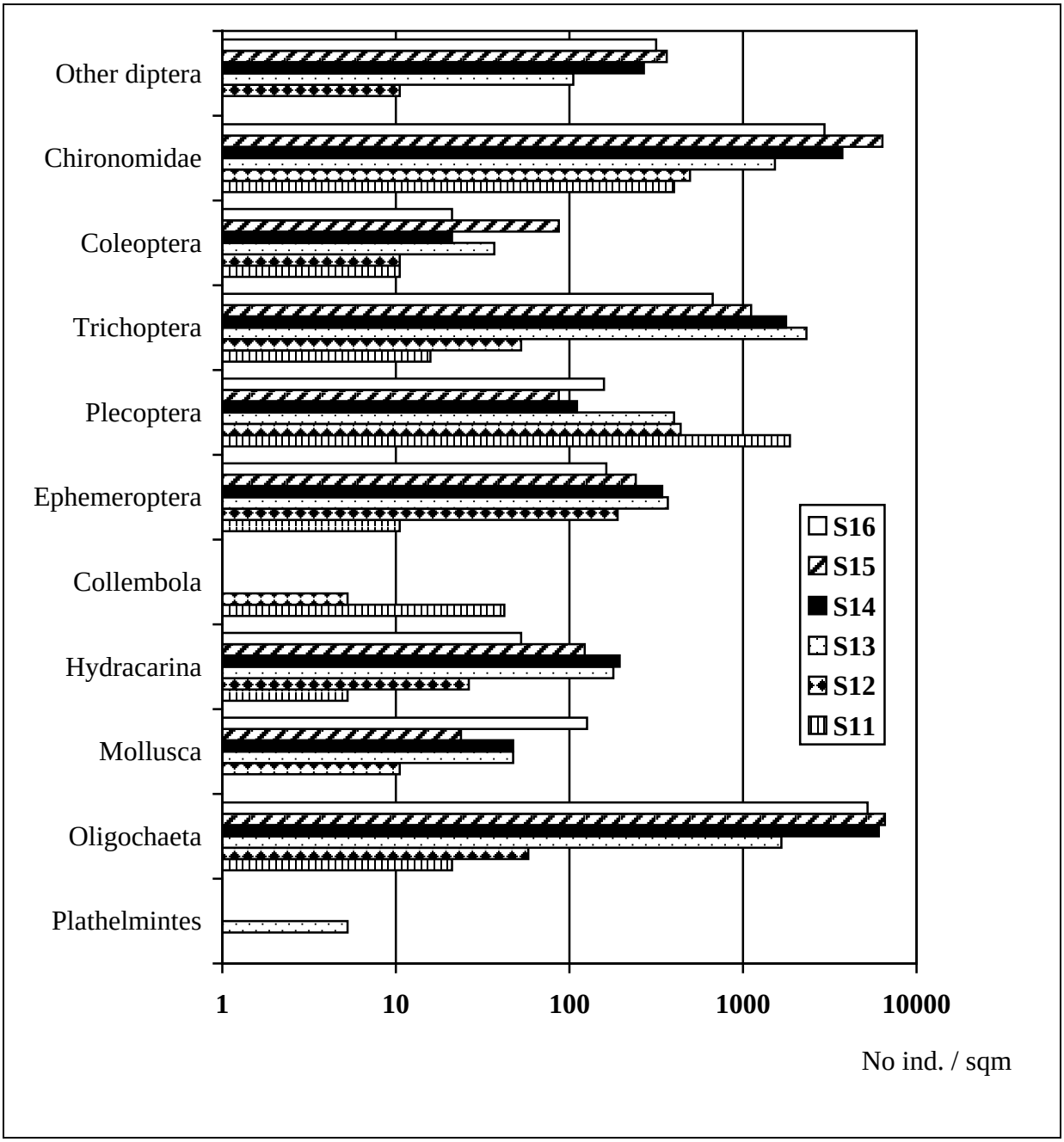


Figure 2: Densities of benthic invertebrates taxa in the six sampling stations along Arieş River.

Downstream Gârda (S13) the river resembles the previous sector, but biotecton is present. Many specimens of the limpet snail *Ancylus fluviatilis* O. F. Müller, 1774 are present, especially next to the banks. The benthic community is more abundant than in the previous sector, all the groups have increased densities, except for Plecoptera, which records a slight decrease and Collembola, which disappears, being replaced by Plathelminthes. Downstream Gârda is the only sector from Arieş where this taxon was identified, with a low density (5.2 ind./$m^2$). Thus, the number of groups (10) remains constant, at its maximum value. The prevailing taxa are Trichoptera (2,322 ind./$m^2$), Chironomidae (1,527 ind./$m^2$), and Oligochaeta (1,664 ind./$m^2$).

Downstream Scărişoara (S14) the boulders are covered with a lot of sediment, especially anorganic, less with biotecton. On the banks there is much waste left behind by the past high waters. The total density of the benthic community increases. It is dominated by Oligochaeta (6,067 ind./$m^2$) and Chironomidae (3,734 ind./$m^2$), which have a singnificanly higher abundance, indicating a decrease in water quality, due to organic pollution caused by the waste waters discharged along its course through Scărişoara locality, but also by the sawdust thrown in the river from the numerous sawmills processing the trees cut from the neighbouring area. However, at this point Arieş River still preserves some of its mountain characteristics, with a high density of Trichoptera (1,769 ind./$m^2$), and a density of Ephemeroptera similar with the previous sampling station (342 ind./$m^2$).

Upstream Albac (S15) the river exits a narrow pass with rocky walls, deep and fast flowing water, whirls, numerous fragments of rock, large and rugged boulders, with lot of biotecton. The structure of benthic community is similar to the previous station, with an increased density of Chironomidae, reaching the highest value among the investigated stations. Thus, the community is dominated by Oligochaeta (6,568 ind./$m^2$) and Chironomidae (6,355 ind./$m^2$), while the three oxyphilic groups (Trichoptera, Ephemeroptera, and Plecoptera) are in a slow and constant decrease. Among the other taxa, beetles (Coleoptera) have the highest density along the whole researched river course.

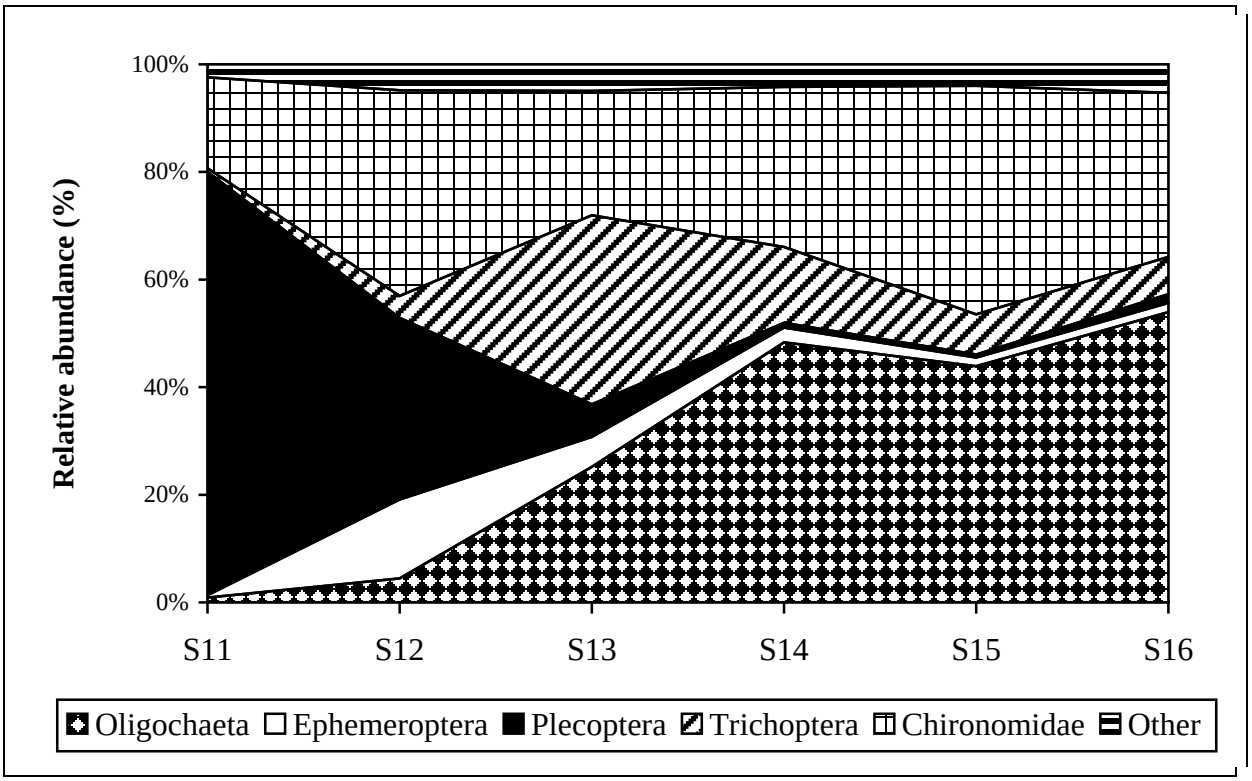


Figure 3: Space dynamics of benthic macroinvertebrates taxa in the six sampling stations along the Arieş River, expressed as relative abundance (RA%).

In the last sampling station, downstream Albac (S16) the river has a smooth flow, on a bed of boulders covered with anorganic sediments, but also detritus and biotecton, and sedimented sawdust along the banks. The total abundance of the benthic community decreases, due to the decrease in most of the taxa, except Plecoptera and Mollusca (126 ind./$m^2$). The prevailing groups remain the same, Oligochaeta (5,219 ind./$m^2$) and Chironomidae (2,949 ind./$m^2$), the last one with a significantly reduced density compared to the previous station.

Considering the longitudinal dynamics of the benthic community structure, illustrated by means of taxa's relative abundances (Fig. 3), the model is typical for a mountain river. The ratios of Oligochaeta and EPT groups (Ephemeroptera, Plecoptera, Trichoptera) are negatively correlated, while the Chironomidae have a relative constant ratio, varying between 41% (upstream Albac) and 17% (Vârtop Pass). In the upper sector (from Vârtop to Gârda) the EPT group prevails in the community (reaching 78.6% of the collected individuals). However, there is a replacement of the taxa within this group, from the springs downstream. In the source area it is represented almost exclusively by Plecoptera, which have a strong and constant decrease from this point downstream. In the second station, at Arieşeni, Ephemeroptera records its maximum ratio, while at Gârda, Trichoptera is the prevailing taxa within EPT group. In the lower sector (Scărişoara and downstream) the community is made up mainly of organisms tolerant to high loads of organic matter and low concentrations of oxygen, belonging to Oligochaeta (up to 56% downstream Albac) and Chironomidae. The ratio of Oligochaeta records a constant increase from the source area (where it represents less than 1% of the community) downstream, more pronounced from Arieşeni, indicating a degrading water quality in what the organic load is concerned. The single exception is the sector downstream Scărişoara – upstream Albac, where the absence of a major pollution source (no locality in between) is reflected by the constant ratio of Oligochaeta.

The ratios of the other taxa are less than 5%, so they are considered together.

The Gârda Seacă River, tributary of the Arieş, is characterized by an important human impact, represented by discharges of household wastewaters, but especially by numerous deposits of sawdust along its course and other direct effects of forest exploitation and wood processing in the sawmills along its valley. Thus, in the benthic community the Chironomidae prevail in all the investigated stations, both as density (ranging between 490 ind./$m^2$ downstream Casa de Piatră and 3,017 ind./$m^2$ at the confluence with Ordâncuşa) and relative abundance (between 52% and 55% in the same stations) (Figs. 4 and 5). However, the river is a typical mountain creek, with shallow, fast flowing, oxygen-rich water. Thus, in the upper sector Ephemeroptera (216 ind./$m^2$ − 23%) and Plecoptera (179 ind./$m^2$ − 20%) are also well represented. In the middle and lower station the next abundant group is Trichoptera (with more than 1,000 ind./$m^2$). Oligochaeta has low densities (less than 100 ind./$m^2$) and the taxonomic diversity of the river is high. Gârda Seacă is the only researched river where all the 13 taxa encountered during the study were identified. The most diverse community (11 taxa) was found at the confluence with Ordâncuşa (S22).

The longitudinal profile of Gârda River is characterized by a relative high homogenity of the benthic communities' structure, with almost constant ratios of Chironomidae, EPT, and Oligochaeta. Only within the EPT group there is a gradual replacement of Ephemeroptera and Plecoptera, co-dominant at Casa de Piatră (S21) by Trichoptera, monodominant at the confluence with Arieş (S23).

Among the other sampled taxa, best represented are Acarina (present in all stations), Collembola (missing at the confluence with Arieş), and Plathelminthes (only at the confluence with Ordâncuşa).

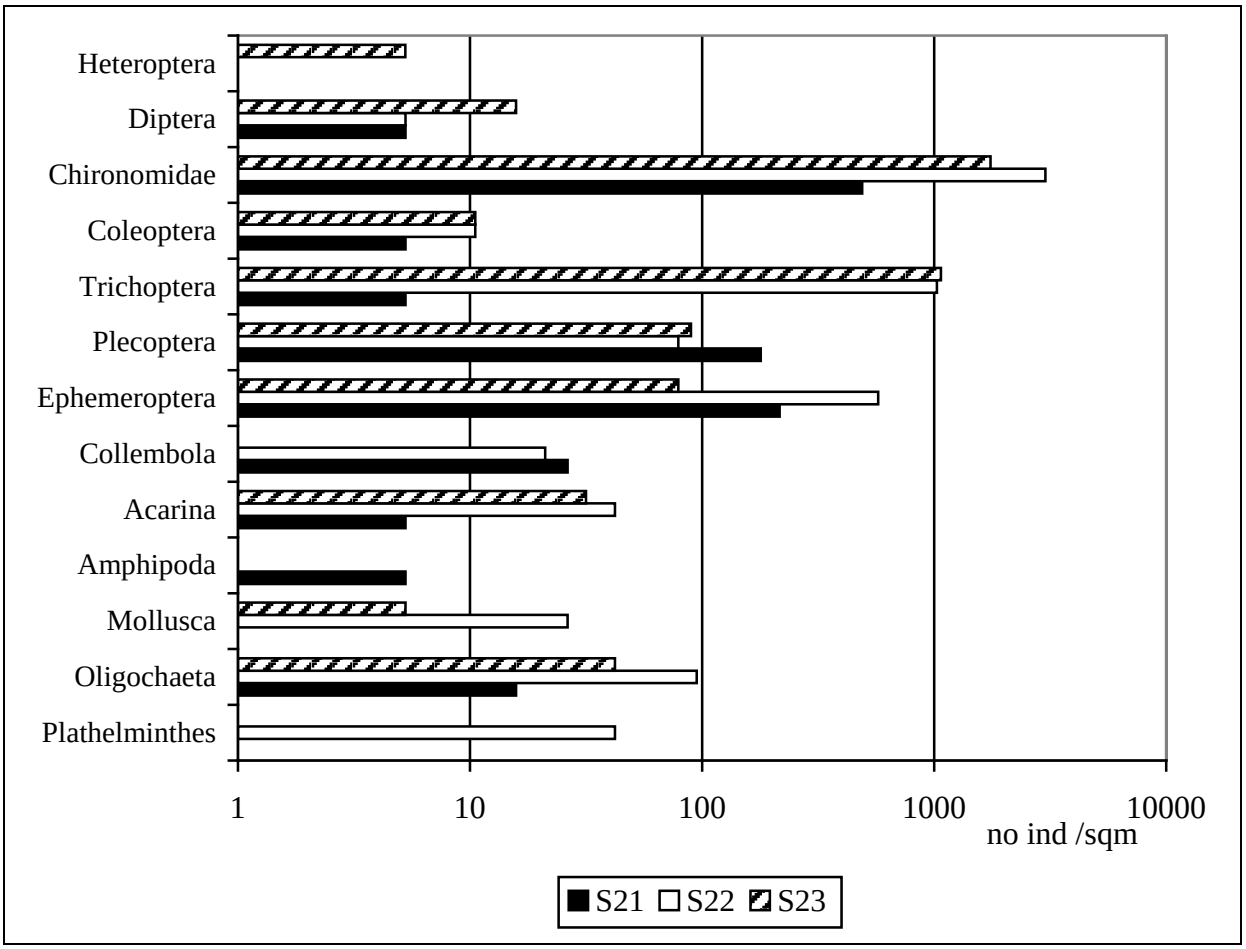


Figure 4: Mean densities of the benthic taxa along the Gârda River (logarithmic scale).

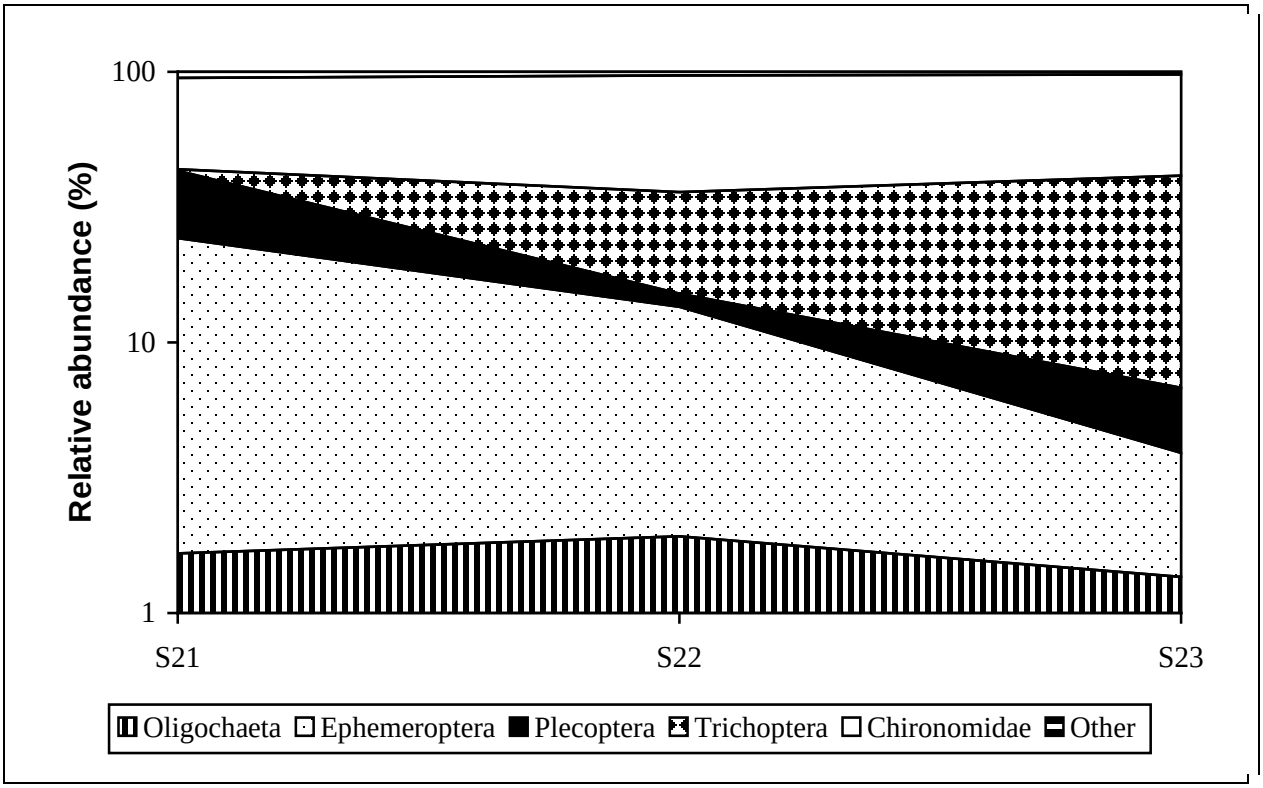


Figure 5: Spatial dynamics of benthic communities along Gârda River (illustrated in terms of relative abundance %, on logarithmic scale).

In Ordâncuşa River (tributary of the Gârda River), the benthic community from the source area (S31) is numerically dominated by Plecoptera (1,801 ind./$m^2$) and Chironomidae (1,016 ind./$m^2$), followed by Ephemeroptera and Trichoptera (Fig. 6).

Upstream Ordâncuşa Gorges (S32) there is a significant decrease of density in Trichoptera (from 568 to 342 ind./$m^2$), and especially Plecoptera (to 1,332 ind./$m^2$) in favour of Ephemeroptera (from 616 to 1,311 ind./$m^2$). More interestingly, a significant decrease in density (from 231 to 68 ind./$m^2$) was found for Oligochaeta.

In Ordâncuşa Gorges, in the vicinity of Poarta lui Ionele Cave (S33), the density of Chironomidae remains constantly high, but due to the decrease in EPT groups, there is a significant shift in the community structure (Fig. 7). In comparison to the benthic communities from other gorges, namely the Cibin Gorges (Curtean-Bănăduc, 2005), there is a significant difference. Chironomidae have a higher ratio (49.8%), while Trichoptera, prevailing in Cibin, have a low relative abundance (6.7%).

In the last station, upstream the confluence with Gârda (S34), significant are the increases in density of Trichoptera and Ephemeroptera, but especially Oligochaeta (from 42 to 452 ind./$m^2$).

In longitudinal profile, the ratio of Chironomidae varies despite its constant density along the river, due to the important changes in the abundance of EPT groups (Fig. 7).

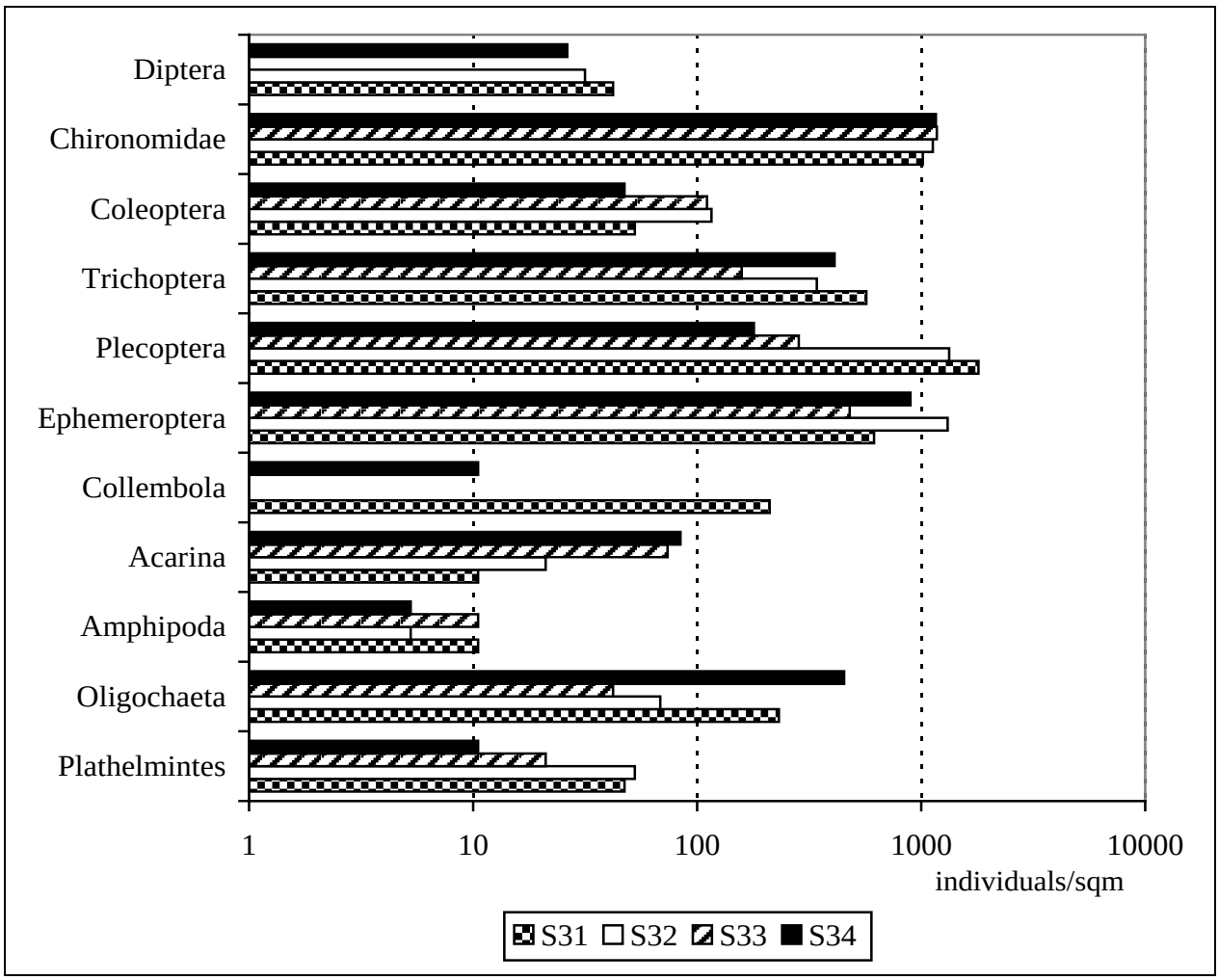


Figure 6: Mean densities of benthic macroinvertebrates in the three sampling stations along Ordâncuşa River.

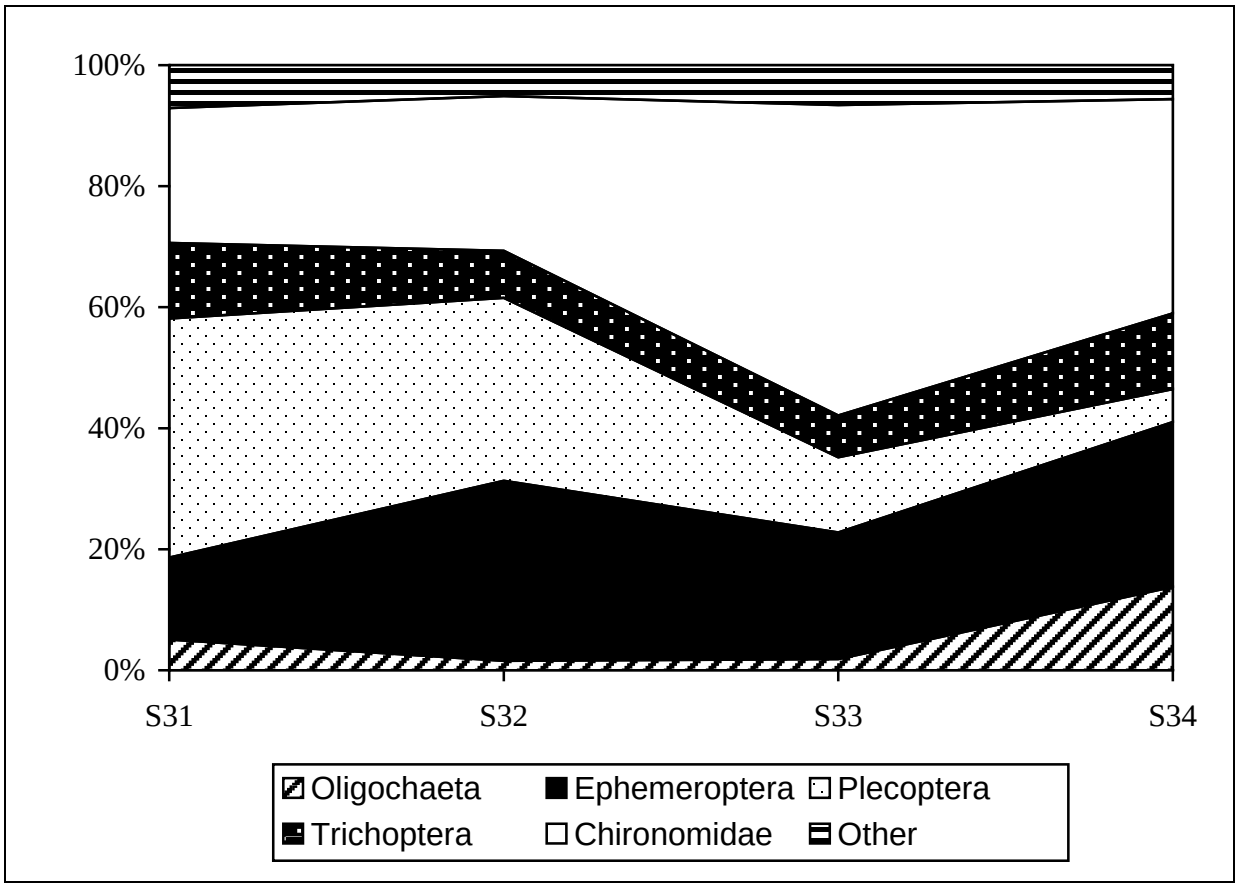


Figure 7: Spatial dynamics of benthic communities on Ordâncuşa River relative abundance (%).

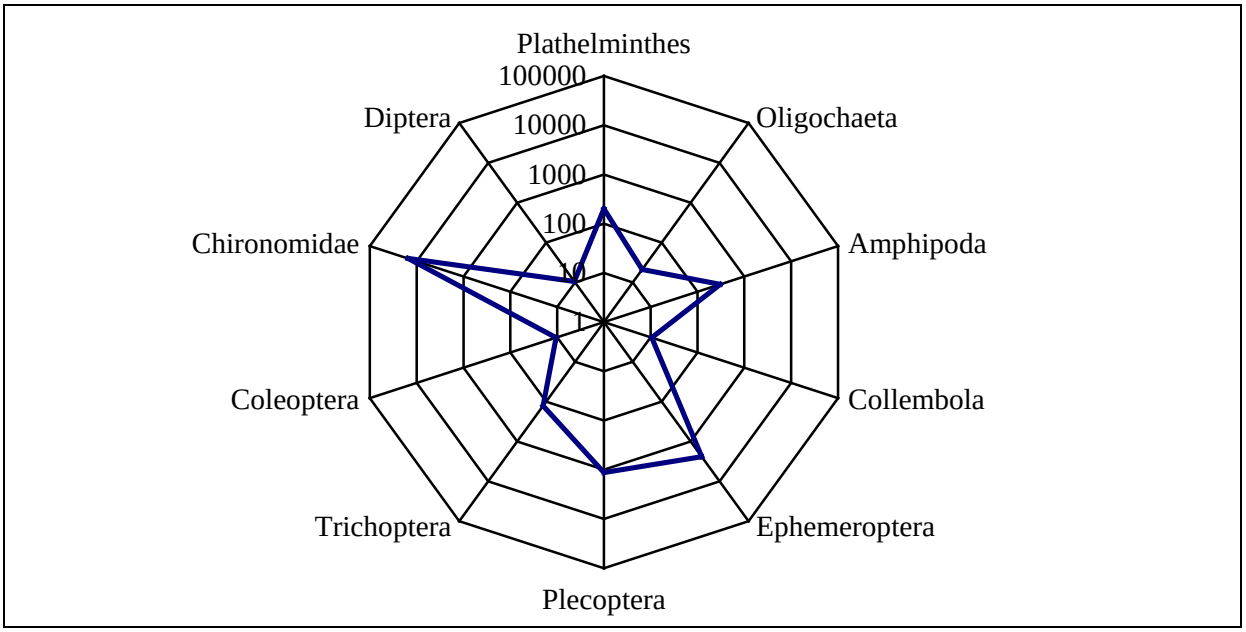


Figure 8: Structure of benthic macroinvertebrate community from the creek exiting Poarta lui Ionele Cave (S6) (mean no. individuals/$m^2$; logarithmic scale).

The benthic community from the creek that leaves Poarta lui Ionele Cave (Fig. 8), and flows into Ordâncuşa River, presents a characteristic structure for this habitat type. The main feature is given by the high density of Amphipoda (305 ind./$m^2$) and Plathelminthes (200 ind./$m^2$), which have here the highest abundance among all the researched stations. The community is dominated by Chironomidae (15,257 ind./$m^2$), followed by Ephemeroptera and Plecoptera. Another characteristic is the absence of Acarina. This is the only station where this taxon was not encountered.

Another studied river is the Albac, a tributary of Arieş River, which marks the south-eastern border of the Apuseni Nature Park. Albac riverbed, like others in the area, is affected by forest exploitation and sawmills, but also by an evident pollution with domestic waste products. The most evident characteristic of the benthic community is the clear and continuous decrease in density of all the taxa along the river, from Horea locality (S41) to upstream Albac (S43), except for Chironomidae, which has the maximum density downstream Horea (S42) (Fig. 9). Along with the numerical impoverishment of the community, a diversity decrease is also noticed, in terms of heterogeneity, but also in terms of number of identified taxa. In the upper station the community is balanced in what the ratio of the codominant groups is concerned (Fig. 10). Trichoptera, Plecoptera, Chironomidae, Coleoptera, and Ephemeroptera have densities of the same magnitude. In the lower sector (downstream Horea and upstream Albac) one single group prevails, namely Chironomidae. The number of taxa decreases from ten at Horea, to seven upstream Albac, the lowest number among all the researched stations. Here, the only taxon among those with low densities is Acarina, with a strongly diminished density (26 ind./$m^2$ compared with 463 ind./$m^2$ in the station from Horea).

Although the density of Oligochaeta also decreases from upstream to downstream (from 579 to 100 ind./$m^2$), its ratio increases slightly in the last two stations, from 3.9 to 5.6 and, respectively 7.7%, on the background of the community's total impoverishment.

Another characteristic of the river is the presence of an important population of the limpet *Ancylus fluviatilis* in its upper sector, reaching a density of 747 ind./$m^2$, in Horea locality.

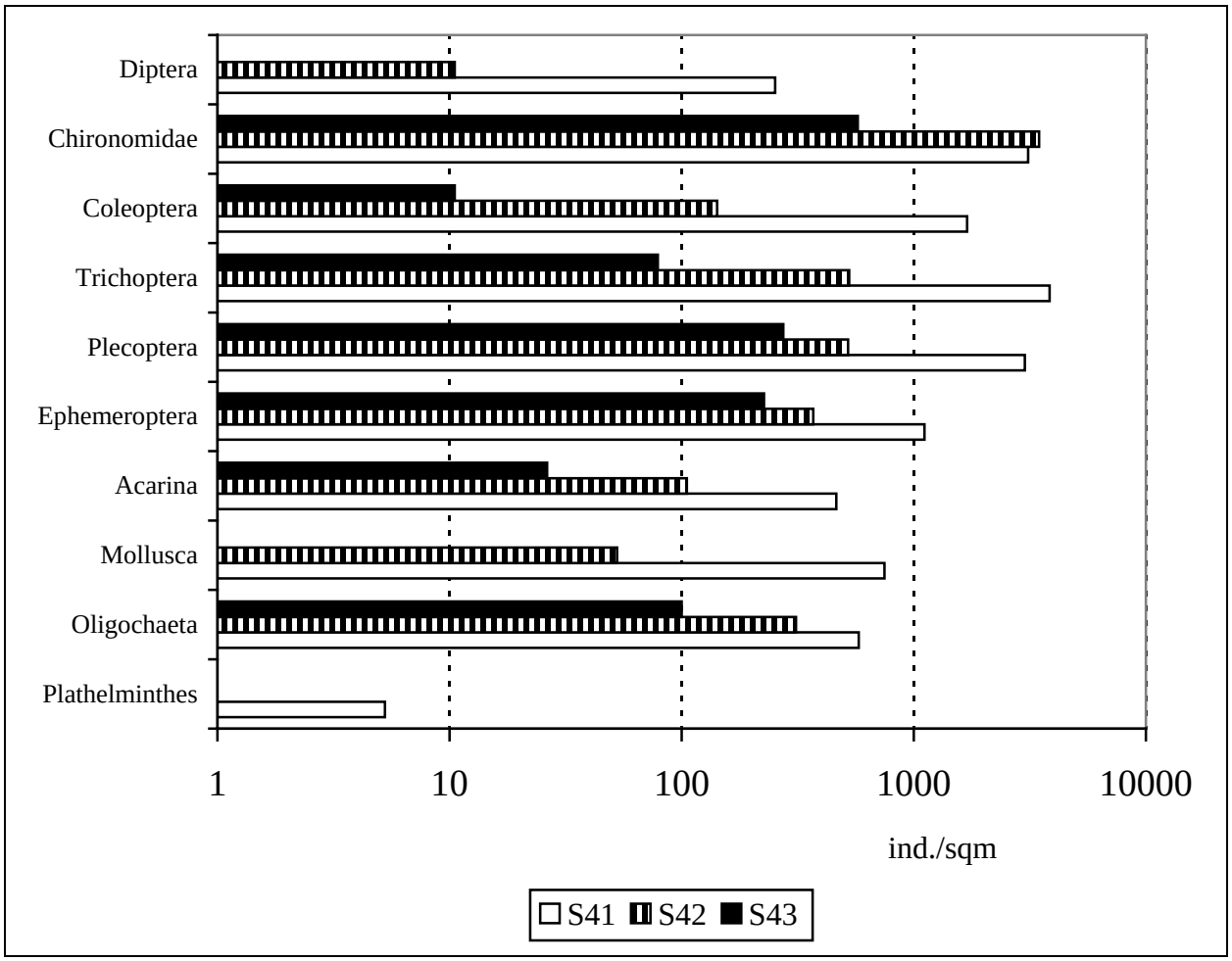


Figure 9: Mean densities of the benthic taxa from Albac River (logarithmic scale).

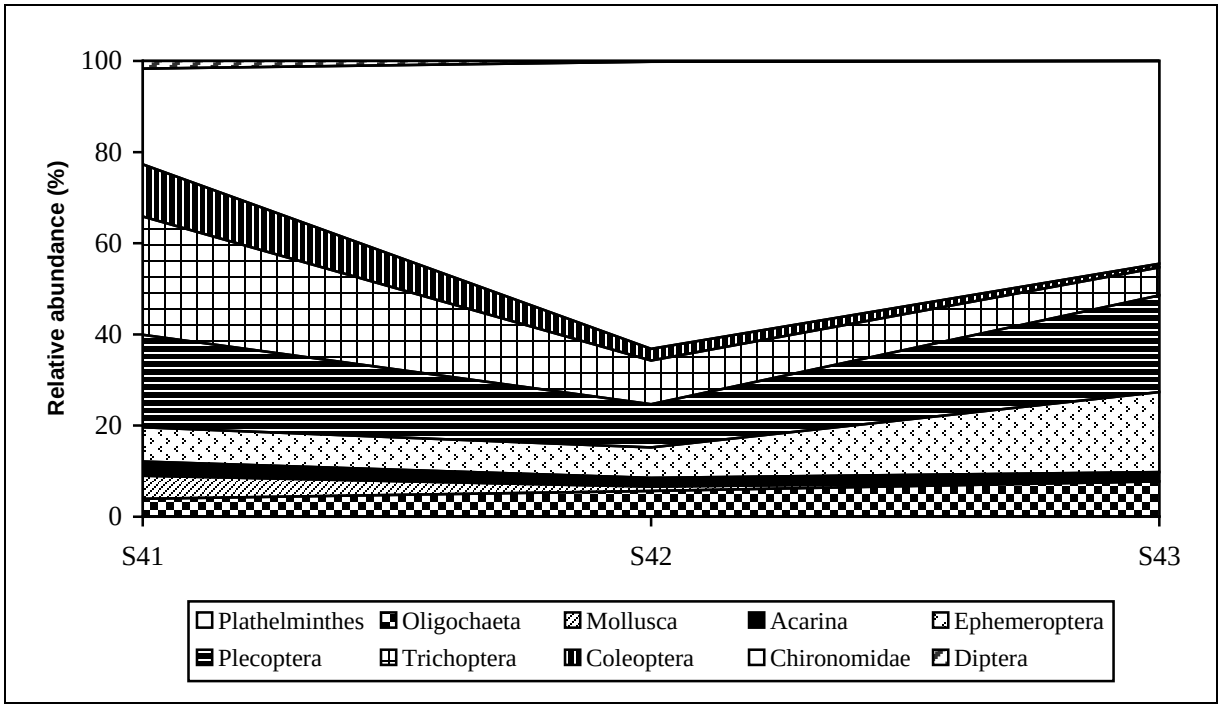


Figure 10: Spatial dynamics of benthic communities along Albac River (in terms of relative abundance %).

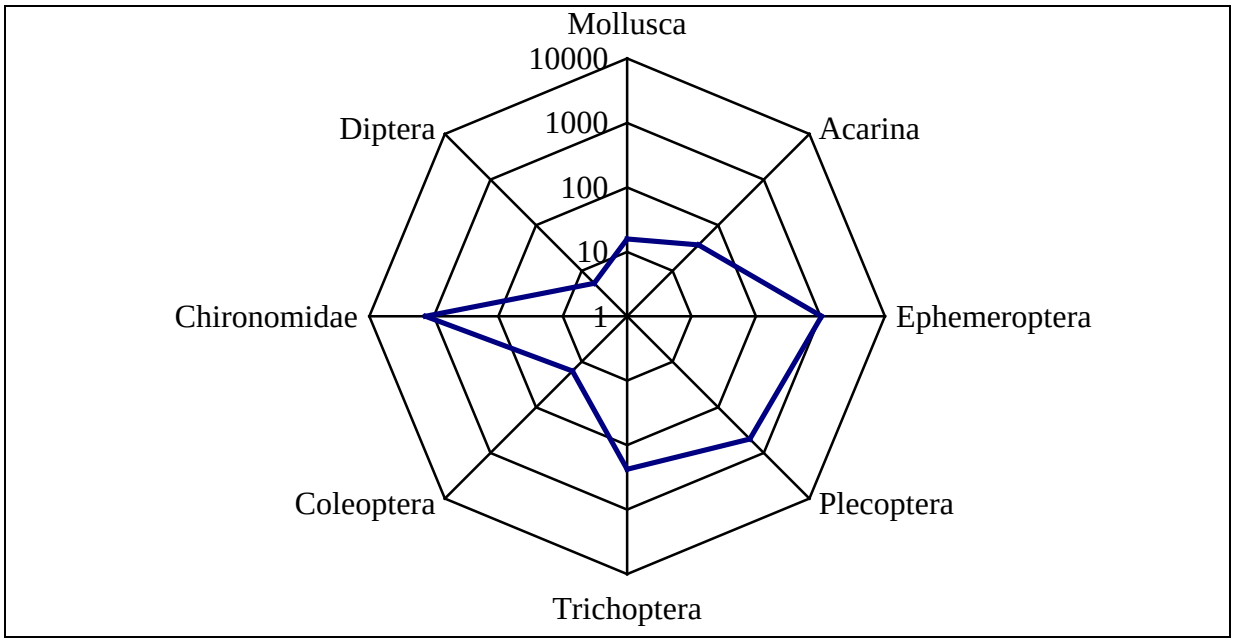


Figure 11: Structure of benthic macroinvertebrate community from Bulz Creek (S5) at Horea (mean no. of individuals/$m^2$; logarithmic scale).

In Bulz Creek, a tributary of Albac River, the benthic community is dominated by Chironomidae and Ephemeroptera, followed by Plecoptera and Trichoptera (Fig. 11). The other identified taxa are poorly represented in the community.

The total density of the benthic communities varies significantly among the investigated stations (Fig. 12), the calculated values ranging between 949 (at Casa de Piatră) and 19,488 ind./$m^2$ (in the creek exiting Poarta lui Ionele Cave). Lowest number of taxa (seven) encountered at Vârtop Pass (S11) and upstream Albac (S43) is correlated with low densities, while the highest number of the groups (11) are correlated with medium densities.

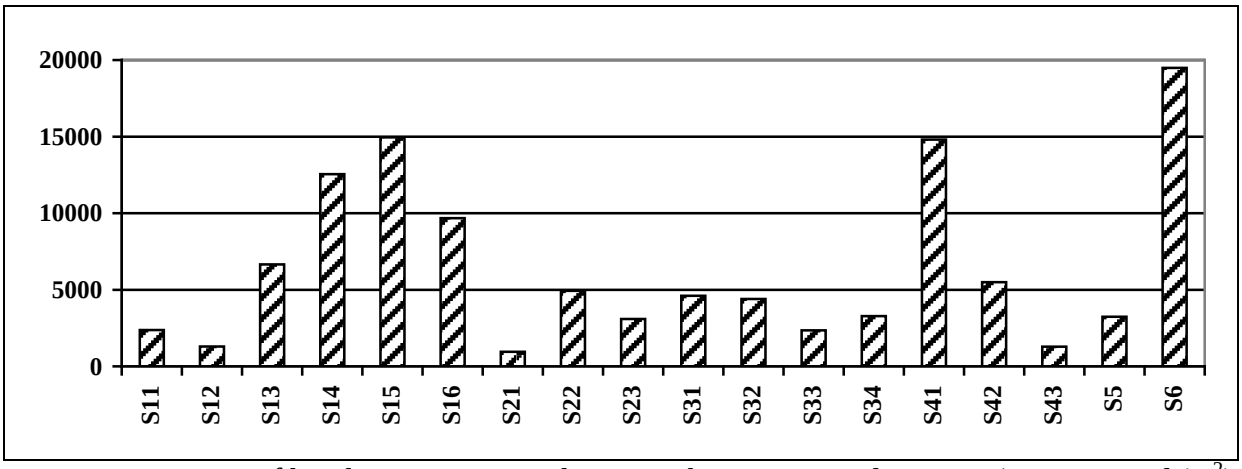


Figure 12: Densitiy of benthic macroinvertebrates in the investigated stations (mean no. ind./$m^2$).

The pattern of longitudinal dynamics of benthic communities' density along the rivers, consists of an unimodal curve, with increasing density from the source area to the middle sector, followed by a decrease in the lower course. This model is well expressed along Arieş and Gârda (here at a lesser scale). Along Albac the model is only half represented, as information from the source area are missing (S41 corresponds to the middle sector). This pattern is determined both by the changes in the natural environment and by human impact, especially the organic pollution. These results are consistent with other studies (Szitó and Mózes, 1997), which show that a mild pollution (i.e. organic) has a stimulative effect on the density of benthic community, contributing to the numerical increase in Chironomidae and especially Oligochaeta, but a heavy pollution causes a decrease in density as well as in taxonomic diversity, at species and superior taxa level.

The absence of localities or other pollution sources along Ordâncuşa, a short river, causes the lack of an obvious model, the benthic community's density remains relatively constant along its course. The most important factor influencing the structure, as well as the community's total density, are the Ordâncuşa Gorges.

Considering the entire research area, the benthic communities are numerically dominated by Chironomidae, representing 42.4% of the collected specimens, followed by Oligochaeta, with 18.7% (Fig. 13), a much higher value than those characteristic for mountain areas, indicating the presence of organic pollution sources along the rivers. The EPT group is still well represented, consisting of 32.4%. Most abundant is Trichoptera, followed by Plecoptera. The differences between their ratios are small.

Other taxa are poorly represented, the most abundant are Coleoptera, Acarina, and Diptera (other than Chironomidae).

Considering their densities in the sampling stations, the benthic taxa with a low frequency and abundance (Amphipoda, Plathelminthes, Heteroptera, Collembola, Diptera (other than Chironomidae), Acarina, and Mollusca) form a compact group at a small distance (Fig. 14A). The dendrogram based on Jaccard index (Fig. 14B) illustrates the relations within this group. Heteroptera (not a proper benthic group) is the most distinct taxon, being collected only in one station, namely in Gârda River at the confluence with Arieş (S23). Collembola, Amphipoda and Plathelminthes, with low frequencies, form a distinct group, characteristic for the upstream stations. Among them, Amphipoda and Plathelminthes present a higher resemblance, being present together in five stations. In the other group the most distinct taxon is Mollusca. Six taxa (Chironomidae, Trichoptera, Ephemeroptera, Oligochaeta, Plecoptera and Coleoptera) are present in all the researched stations, forming a homogenous group, joined at a small distance by Acarina, which is absent only from the creek exiting Poarta lui Ionele Cave.

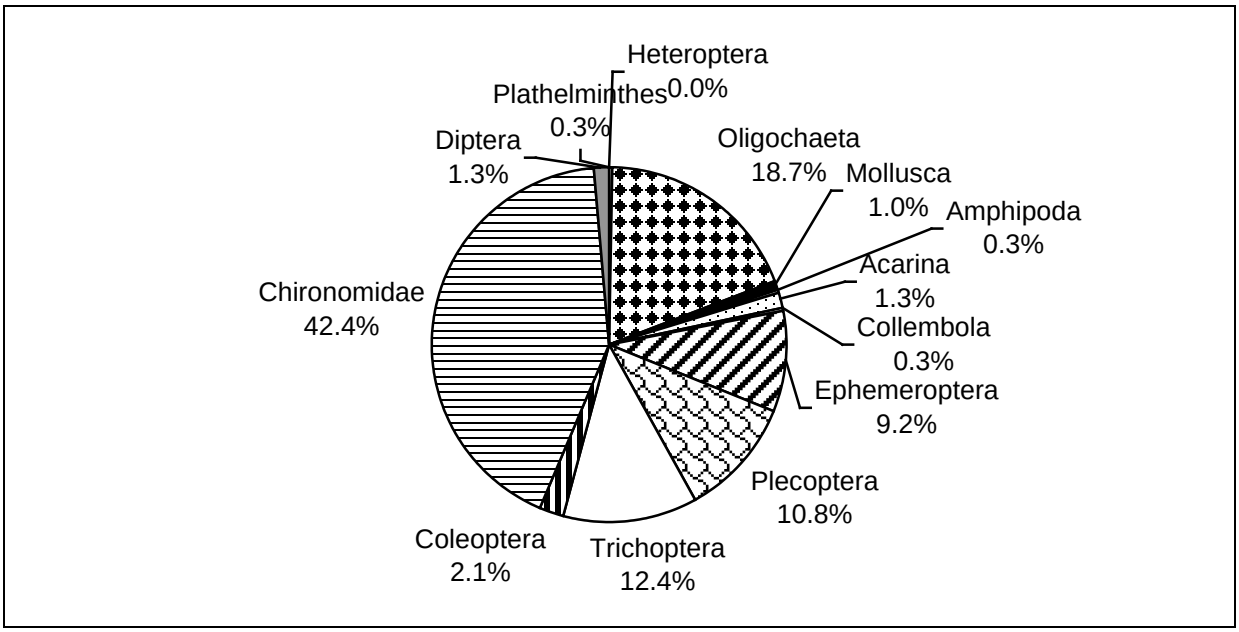


Figure 13: The structure of benthic macroinvertebrates communities (abundance proportion %).

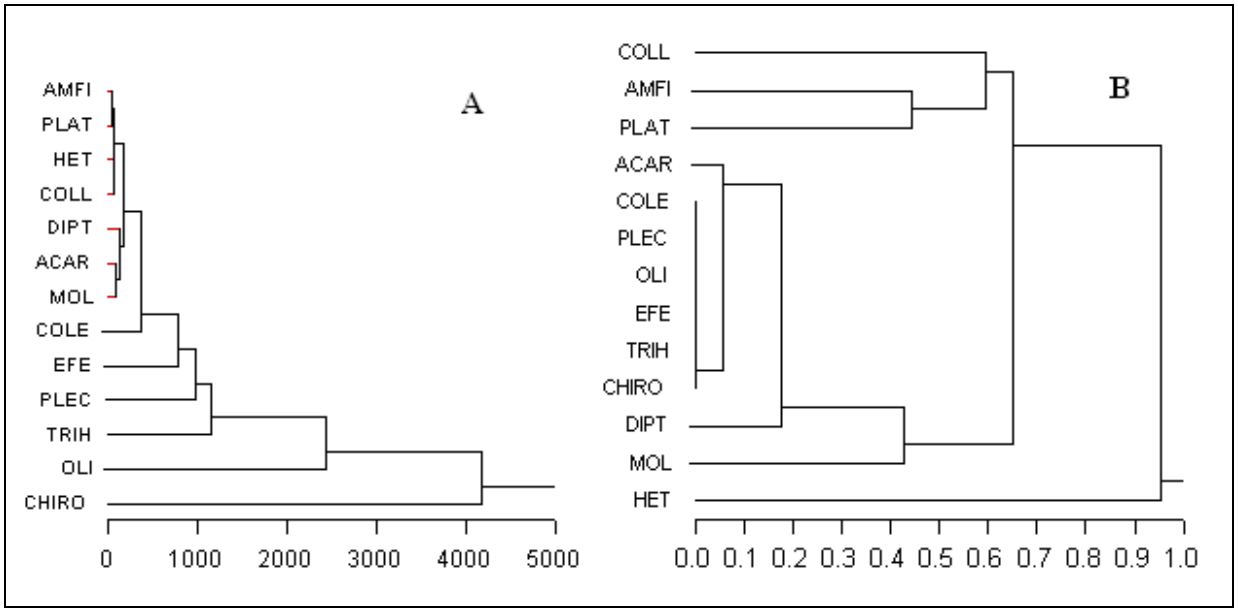


Figure 14: Hierarchical clustering of benthic taxa based on mean densities (euclidean distances, average linkage method) – A, the presence-absence in the sampling stations (Jaccard index) – B.

Densities of benthic taxa are often correlated. Considering the mean densities from the sampling sites, significant ($p < 0.05$) positive correlations were found for 18 pairs of taxa, the strongest correlations were between Mollusca – Coleoptera ($r = 0.978$) and Acarina – Trichoptera ($r = 0.926$), which reach their maximum density in the same station (S43). All the correlations between these four taxa were found to be significant. Other strong direct correlations are between Plathelminthes – Amphipoda ($r = 0.939$), reaching the maximum density in the creek from Poarta lui Ionele Cave, and Oligochaeta – Diptera ($r = 0.901$), having high densities in the lower course of Arieş.

None negative correlations between the densities of benthic taxa was found to be significant. However, if relative abundance is considered, between the ratio of EPT group and some other taxa there is a significant negative correlation, the highest correlation coefficient being calculated for EPT – Oligochaeta ($r = - 0.643$). The relation between these two taxa is much stronger if we consider only the stations along Arieş River ($r = - 0.947$).

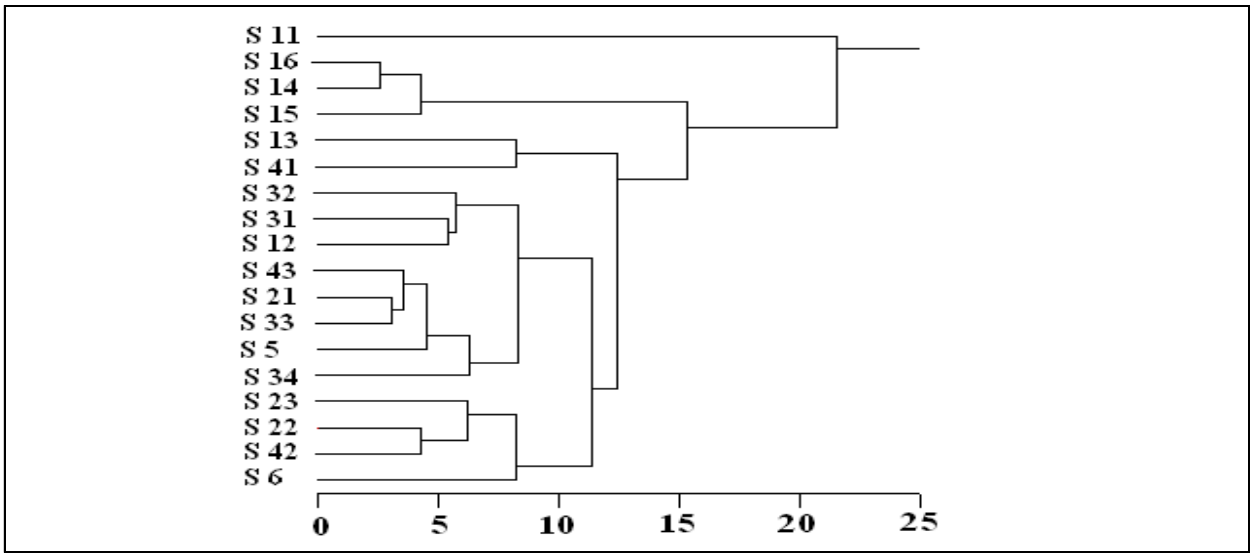


Figure 15: Classification of sampling stations based on the ratio (%) of benthic macroinvertebrates taxa (Euclidean distances, average linkage method).

The total density of the benthic communities correlates significantly and positively only with the density of Chironomidae (r = 0.833). Thus, in the research area, the spatial dynamics of benthic communities is impregnated by the dynamics of Chironomidae populations.

Considering the structure of the benthic macroinvertebrate communities (in terms of relative abundance %; Fig. 15), the most distinctive research station is S11 (Arieş at Vârtop Pass), due to the unequalled high ratio of Plecoptera. A second distinct group is formed by the last three stations along Arieş (S14, S15 and S16). Here, the distinctive element is represented by the high ratio of Oligochaeta, effect of the organic pollution from the localities Scărişoara and Albac. A balanced structure of the community is characteristic for stations S13 and S41, which form a distinct group, but the prevailing taxa are partially different, so they join at greater distance. At the same distance other two groups are formed. One of them comprises the communities numerically dominated by Chironomidae (S6, S42, S22 and S23), the other joins the stations where the EPT group is prevailing, either by itself (S31, S32 and S12), or together with Chironomidae (S43, S21, S33, S5 and S34).

## CONCLUSIONS

The benthic macroinvertebrate communities from the upper Arieş River Basin is numerically dominated by Chironomidae, representing 42.4% of the collected specimens, followed by Oligochaeta, with 18.7%, a much higher value than those characteristic for mountain areas, indicating the presence of organic pollution sources (in form of waste water discharges from localities, hotels and villas in the valleys, as well as sawdust from the sawmills processing the wood extracted from the area) along the rivers. The density and ratio of Oligochaeta increases from the source area downstream, the highest values being calculated for downstream Albac, the lowest station from Arieş River.

The spatial dynamics of benthic communities along the river is also characterized by the decrease in density and ratio of EPT group (Ephemeroptera, Plecoptera and Trichoptera). Within EPT group there is a replacement of taxa along the river. This is especially obvious along Arieş River.

Between the ratios of Oligochaeta and EPT there is a negative and significant correlation, which is stronger if we consider only the sampling stations along Arieş River (r = - 0.947 compared to r = - 0.634).

For some taxa, in the station of highest abundance, the density is significantly higher than in the other stations (up to 30 times in case of Amphipoda). In some cases this outlyer maximum is reached by different taxa in the same station (at Horea by Mollusca, Coleoptera, Acarina, Trichoptera, in the creek from Poarta lui Ionele Cave by Amphipoda, Plathelminthes and Chironomidae). Between the abundance of these taxa there is a significant and positive correlation.

The total density of the benthic communities varies significantly among the investigated stations, the lowest number of taxa (seven) being correlated with low densities, and the highest (11) with medium densities.

A general pattern of longitudinal dynamics of benthic communities' density along the rivers in the investigated area consists of a unimodal curve, with increasing density from the source area to the middle sector, followed by a decrease in the lower researched river's course. This model is well expressed along Arieş and less along Gârda River.

**ACKNOWLEDGEMENTS**

The present study was accomplished in the frame of the PHARE CBC RO 2003/005-702.01 "Romanian-Hungarian Corridor for Biodiversity Conservation" coordinated by the Oradea Forestry Directorate. Special gratitude for those who lead this project, namely Mr. Moş A. and Ms. Petrovici M.

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# INVERTEBRATE SPECIES NEW TO SCIENCE AND NEW TO THE ROMANIAN FAUNA BASED ON RECENT (1994-2009) RESEARCH IN MARAMUREŞ (ROMANIA)

*Iosif BÉRES* [1]

**KEYWORDS**: invertebrates, new species, Maramureș.

**ABSTRACT**

In the present paper we enumerate invertebrate species new to science and to the Romanian fauna, with recorded place and date of collection. These species have been found by several zoologists in Maramureș (România), over the period 1994-2009.

Data presented here indicate and describe 12 species new for science and 141 species new for Romania's invertebrate species list.

These results show the high biodiversity of the area and lack of systematic investigation of invertebrates in Maramureș.

**REZUMAT**: Specii de nevertebrate noi pentru știință și pentru fauna României, pe baza cercetărilor recente (1994-2009) din Maramureș (România).

În prezenta lucrare am enumerat specii de nevertebrate, noi pentru știință și pentru fauna României, menționând locul și data colectării, specii care au fost descoperite de diverși zoologi în Maramureș (România), între anii 1994 și 2009.

Noile date obținute enumeră și descriu 12 specii noi pentru știință și 141 de specii noi pentru inventarul faunistic de nevertebrate al României.

Rezultatele obținute indică o biodiversitate crescută a zonei analizate și lipsa de investigații sistematice a nevertebratelor din Maramureș.

**ZUSAMMENFASSUNG**: Für die Wissenschaft und die Fauna Rumäniens neue Arten auf Grund: rezenter Forschungen (1994-2009) im Gebiet der Maramuresch (Rumänien).

In vorliegender Arbeit werden für die Wissenschaft und für die Fauna Rumäniens neue Arten von Wirbellosen aufgelistet und beschrieben, wobei Sammelort und Datum aufgeführt werden. Dabei handelt es sich um Arten, die im Verlauf mehrerer Jahre, zwischen 1994 und 2009 von verschiedenen Zoologen in der Maramuresch entdeckt wurden.

Es geht um insgesamt 12 für die Wissenschaft neu beschriebene Arten sowie 141 für die Fauna der Wirbellosen Rumäniens neue Arten.

Die Ergebnisse weisen auf eine hohe Biodiversität des Untersuchungsgebietes hin und auf einen Mangel an systematischen Forschungen der Wirbellosen der Maramuresch hin.

## INTRODUCTION

The area of Historical Maramureș is situated in the north – north-west of Romania, in the county of Maramureș, being made up of a depression having the same name and the surrounding mountains down to the watersheds. In the north, the limit of Maramureș coincides with the state border between Romania and the Ukraine – the River Tisa (Fig. 1) and the Maramureș Mountains (Figs. 4 and 5).

The surface of this territory is 3.375 km².

Figure 1: Tisa River next to the Sighetu-Marmaţiei locality.

From the bio-geographical point of view, we speak about a well-defined area with high bio-diversity. This is mainly because of the great variety of habitats, with a range of altitude of over 2000 meters, and vegetation levels well outlined starting from the alluvial fields of the Tisa up the alpine levels of the Rodnei Mountains (Figs. 2 and 3). In Maramureș we have isolated areas, difficult to reach, with almost natural habitats with minimal anthropogenic pressures (Figs. 6 and 7).

Figure 2: Rodnei Mountains.

Figure 3: Rodnei Mountains.

Systematic research on invertebrate fauna began in 1994, when specialists from the "Grigore Antipa" Museum of Natural History of Bucharest made trips to Maramureș. Between 2004-2009, research teams from Budapest Museum of Nature had carried out research on invertebrate fauna in Maramureș under research contracts with the "Vasile Goldiş" Western University of Arad, who succeeded in making three-four study expeditions annually. During this period, Maramureș was also been visited by other foreign zoologists (Polish, Austrian, Hungarian), who have found species new to science and to the Romanian fauna.

Figure 4: Maramureşului Mountains.

Figure 5: Maramureşului Mountains.

In this paper, we enumerate the species new to science and to the Romanian fauna, with recorded place and date of collection. These species are published in various papers, in Travaux XXVII-LII and Studia Universitatis "Vasile Goldiş" Life Sciences Series Vol. supp. 2006 and XVIII, supp. 2008 and other publications.

However, we note the fact that the material collected within the mentioned interval of time has not been completely processed. There are indications that in the near future, other new species may be mentioned that are new to the fauna of Romania and of Maramureş.

Figure 6: Volcanic Plateau.

Figure 7: Volcanic Plateau.

**RESULTS AND DISCUSSION**

The list of species that are new to science, collected in Maramureș by several researchers and published in various scientific papers is presented below.

COLLEMBOLA

*Orychiuridae*

1. *Protophorura ionescui.* n. sp.

Rodnei Mountains in Orientali Carpathias, Borşa, N stope of Pietrosul Rodnei (2,303) aprox. 1,200 m, 27.07.2004

Radwanski et al., 2006 – 31

*Isotomidae*

2. *Tetracanthella borsa* n. sp.

Rodnei Mountains, Borşa, Gura Fântânii, spring area of the Bistriţa Aurie River under the Gărgălau Peak, pine scrub and alpine grassland, 1,668-1,711 m, 29.06.2005

Dany L., Traser G., – 7

3. *Tetracanthella ignisiana* n. sp.

Igniş Mountains, Deseşti, Staţiunea Izvoare, Tătarului Gorge, Brazi Stream, altitude 738 m, 01.09.2004

Dany L., Traser G., – 7

PLECOPTERA

4. *Leuctra dalmoni* n. sp.

Lăpuşului (Văratec) Mountains, Văleni, Zermilor Lake, 23.05.2006;

Ţibleş Mountains, Dragomireşti, Baicu Stream, 24.05.2006;

Maramureşului Mountains, Poieni Valley, Petrova, Tomnatic Stream, 950 m, 25.05.2006;

Vinçon G., Muranyi D. – 37

ACARI – MESOSTIGMATID

*Trachytidae*

5. *Trachytes carpaticus* n. sp.

Igniş Mountains Piatra, Vadul Izei, Bârlan, 700 m, 20.09.2005

Kontschan J. – 11

*Veigaiaidae*

6. *Veigaia transilvanyca* n. sp.

Maramureşului Mountains, Borşa, Baia Borşa, sphagnum moss, 1,046 m, 26.09.2006

Kontschan J., Ujvari Zs. – 12

ORIBATIDS – RIBATIDA

*Galumnidae*

7. *Pergalumna seminervosus* n. sp.

Rodnei Mountains, Borşa, Staţiunea Borşa, spring rook of the Bistriţa Aurie River under the Gărgălău Peak, 26.09.2006

Igniş Mountains, Deseşti, Tătarului Gorges, 750 m, 27.09.2006

Rodnei Mountains, Săcel, Iza Gorges, 946 m, 20.05.2008

Mahunka S., Mahunka L. – 15

*Gustaviidae*

8. *Gustavia transilvanyca* n. sp.

Rodnei Mountains, Borşa, Staţiunea Borşa, 878-1,022 m, 28.06.2005

Igniş Mountains, Sighetu-Marmaţiei, Piatra Mountains, 1,200 m, 21.09.2005

Mahunka S. – 14

*Oppiidae*

9. *Neotrichoppia (Confinoppia) calugarae* n. sp.

Rodnei Mountains, Săcel, near Iza Izvor, 1,000 m, 22.09.2005

Rodnei Mountains, Săcel, near Iza, 22.09.2005

Mahunka S. – 14

10. *Neotrichoppia (Confinoppia) beresi* n. sp.

Igniş Mountains, Deseşti, Tătarului Gorges, 750 m, 27.09.2006

Mahunka S., Mahunka L. – 15

*Punctoribatidae*

11. *Schweizerzeles anoporosus* n. sp.

Igniş Mountains, Giuleşti, Poiana Brazilor, 900 m, bog decaying woods, some peat-moss, 31.08.2004

Mahunka S. – 14

HOMOPTERA – AUCHENORRHYNCHA

C*icadellidae*

12. *Diplocolenus (Erdianus) beresi* n. sp.

Rodnei Mountains, Borşa Resort, Gărgălau Peak, 2,100 m, 01.08.2002

Rodnei Mountains, Borşa, Ştiol and Prislop, 1,500 m, 29.08.2005

Next, we present the list of species that are new to the Romanian fauna, collected in Maramureș by several researchers and published in various scientific papers.

OLIGOCHAETA

**Lumbricidae**

1. *Allolobophora sturanvi* (Rosa, 1895) Records: Igniş Mountains, Piatra Ţiganului meadow, 1,200 m, 21.09.2005, Sighetu Marmaţiei – Igniş Mountains, Vadul Izei, Piatra, 850 m, 21.09.2005. (3)
2. *Aporrectodea carpathica* Cognetti, 1927 Records: Igniş Mountains, Săpânţa Stream, 500 m, 30.06.2005; Lăpuş Mountains, Băiuţ 860 m, 27.05.1996; Rodna Mountains, Borşa, Prislop, 160 m, 19.09.1974. (3)
3. *Dendrobaena alpina alteclitellata* Pop, 1938 Records: Rodnei Mountains, Borşa, 1,665-1,710 m, 29.06.2005; Rodnei Mountains, Săcel, Muced Lake, 1,400 m, 22.09.2005. (3)
4. *Octodrilus robustus* (Pop, 1973) Records: Rodna Mountains, Moisei, Măgura Peak, 1,000 m, 18.06.1997; Gutâi Mountains, Breb, 450 m, 23.09.2005. (3)

TARDIGRADA

**Eutardigrada**

5. *Diphascon oculatum* Murray, 1906 Records: Maramureş Mountains, Vişeu de Sus, Vaser, spring pin forest in the Mihoaia Valley, 683 m, 22.05.2008. (13)
6. *Isohypsibus prosostomus* Thulin, 1928 Records: Maramureş Mountains, Vişeu de Sus, Vaser, spring pin forest in the Mihoaia Valley, 683 m, 22.05.2008. (13)
7. *Mesocrista spitsbergense* Richters, 1903 Records: Rodna Mountains, Săcel, Iza spring pin forest, sphagnum bog, 1,037 m, 20.05.2008; Rodna Mountains, Săcel, Muced Lake, 1,450 m, 20.05.2008. (13)

CRUSTACEA

**Copepoda**

8. *Heterocope saliens* (Lilljeborg, 1863) Records: Gutâi Mountains (Breb), Creasta Cocoşului, 1,050 m, 23.09.2005; Maramureş Mountains Borşa-Băila Borşa, Stanchi Spring, 1,600 m, 26.06.2007. (9)

**Malacostraca**

9. *Gammarus leopoliensis* Jazdzewksi et Konopacka, 1989 Records: Maramureş Mountains, Borşa, Baia Borşa, Vinişor Valley, 1,032 m, 22.05.2007; Maramureş Mountains, Poienile de sub Munte, Lutoasa Valley, 868 m, 24.05.2007; Maramureş Mountains, Poienile de sub Munte, Socolău Valley, 825 m, 24.05.2007; Rodnei Mountains, Săcel, Iza River, 20.05.2008; Maramureş Mountains, Vişeu de Sus, Vaser Valley, Şuligu, 862 m, 21.05.2008. (21)

CHILOPODA

**Geophilomorpha**

10. *Strigamia pusilla* (Sseliwanoff, 1884) Records: Rodna Mountains, Borşa spering area of the Bistriţa Aurie beneath Gărgălău, 1,688-1,711 m, 03.09.2004. (4)

**Myriapoda**

11. *Geophilus oligopus* (Attems, 1895) Records: Igniş Mountains, Piatra Săpânţa, Cabana Colibi, 832 m, 31.08.2004. (5)

COLLEMBOLA

**Neanuridae**

12. *Deutonura stachi* (Gisin, 1952) Records: Igniş Mountains, Piatra, Săpânţa Valea Brazi, 02.09.2004. (6)
13. *Pseudachorutes corticicolus* (Schaffer, 1897) Records: Rodna Mountains, Borşa piemont, 1,200 m, 27.07.2004. (6)

**Hypogastruridae**

14. *Ceratophysella borealis* Martynova, 1977 Records: Rodna Mountains, Borşa piemont, 700 m, 26.07.2004. (6)
15. *Ceratophysella granulata* Stach, 1949 Records: Rodna Mountains, Borşa, Iezer, 1,780 m, 26.07.2004. (6)
16. *Xenylla schillei* Borner, 1903 Records: Rodna Mountains, Borşa piemont, 1,200 m, 27.07.2004. (6)

**Onychiuridae**

17. *Hymenaphorus nova* Pomorski, 1990 Records: Rodna Mountains, Borşa piemont, 1,200 m, 27.07.2004. (6)
18. *Protaphorura subarmata* (Gisin, 1957) Records: Rodna Mountains, Borşa, Iezer, 1,780 m, 26.07.2004. (6)
19. *Protaphorura bicampata* (Gisin, 1956) Records: Igniş Mountains, Brazilor bog peat bog with pine, 800 m, 31.08.2004. (**7**)

**Istomidae**

20. *Desoria duodecemaculata* (Denis, 1927) Records: Rodna Mountains, Borşa, Iezer, 1,780 m, 26.07.2004. (6)

**Katiannidae**

21. *Sminthurinus bimaculutus* Axelson, 1902 Records: Rodna Mountains, Borşa, Iezer, 1,780 m, 26.07.2004. (6)

EPHEMEROPTERA

**Chironomidae**

22. *Rhithrogena carpatoalpina* Klonowska, Olechowska, Sartori, Weichselbaumer, 1987, Records: Maramureş Basin, Rona de Sus, Hera brooh below the pass, Igniş Mountains, Săpînţa, Runcul, 31.08.2004; Deseşti, Staţiunea Izvoare and Poarta Roşie, 937 m and Mara River, 650 m, 01.09.2004. (10)
23. *Rhithrogena gorganica* Klapalek, 1907 Records: Rodna Mountains, Borşa, Staţiunea Borşa, Ştiol Mountains and Prislop Pass, 1,544 m, 29.06.2005. Rodna Mountains, Borşa, spring brooh of the Bistriţa Aurie, Gărgălău Peak, 1,688 m, 29.06.2005; Borşa, Cimpoieş Valley 1,023 m, 23.05.2007. Maramureş Mountains, Petrova Tomnatic Stream, 802 m, 25.05.2006. Maramureş Mountains, Petrova Tomnatic, 25.05.2006; Baia Borşa Vinişor Valley, 870 m, 22-24.05.2007; Baia Borşa, Bălăsâna Stream, 1,360 m, 22.05.2007; Poienile de sub Munte, Budescu Valley, 821 m, 24.05.2007 and Lutoasa Valley, 868 m, 24.0.2007, Socolău Valley, 825 m, 24.05.2007. Igniş Mountains, Deseşti, Staţiunea Izvoare, 1,020 m, 24.09.2005 and three places, volcanic Plateau. Gutâi Mountains, Breb, Creasta Cocoşului, 900 m, 23.09.2005 and two places Maramureş Basin, Sighetu Marmaţiei, Mociar, 369 m, 27.06.2005; Bârsana, Morii Stream, 384 m, 24.05.2006. Ţibleş Mountains, Dragomireşti, Baicu Stream, 718 m, 24.05.2006 and Poeni Valley, 901 m, 24.05.2006. (10)
24. *Ecdyonurus stramachi* Sowa, 1971 Records: Igniş Mountains, Giuleşti, Brazi Valley, 841 m, 02.09.2004. (10)
25. *Caenis pseudorivulorum* Keffermüller, 1960 Records: Igniş Mountains, Deseşti, Mara River, 706 m, 02.09.2004. (10)

ORTHOPTERA

**Phaneropteridae**

26. *Isophya posthumoidalis* (Bazyluk, 1971) Records: Maramureşului Basin, Sighetu Marmaţiei, Mociar, 369 m, 27.05.2005; Crăciuneşti, Mohelca, 299 m, 28.06.2005; Câmpulung la Tisa, Tisa River, 235 m, 30.06.2005. (36)

PSOCOPTERA

**Caeciliusidae**

27. V*alenzuela despaxi* (Badonell, 1936) Records: Rodna Mountains, Borşa, Staţiunea Borşa, 1,377 m, 03.09.2004; Igniş Mountains, Deseşti (Staţiunea Izvoare), 24.09.2005; Maramureş Basin, Rona de Sus, 504 m, 28.06.2005; Rodna Mountains, Săcel (Iza Spring), 900 m, 22.09.2005. (35)

**Elipsocidae**

28. *Elipsocus annulatus* Roesler, 1954 Records: Rodna Mountains, Borşa, Staţiunea Borşa, 878 m, 28.06.2005. (35)

COLEOPTERA

**Curculionoidea**

29. *Smicronyx brevicornis* F. Sol – Wpal, Records: Maramureşului Basin, Bârsana, 8.09.1995. (30)
30. *Rhynchaenus horioni* Dieckm, Records: Maramureşului Basin, Moisei, six km downstream, 21.08.1997. (30)

**Staphylinidae**

31. *Atheta malleus* Joy, 1913, Records: Maramureşului Mountains, Poienile de Munte, Rica Valley, 600 m, 16.07.2004. (17)

32. *Atheta volans* (Scriba, 1859), Records: Maramureş Basin, Sighetu Marmaţiei confluence of Tisa and Iza, 250 m, 11.06.2003. (17)
33. *Atheta tenuissima* Eppelsheim, 1892, Records: Vişeu River. (17)
34. *Eusphalerum alpinum obenbergeri* Zanetti, 1982, Records: Rodna Mountains, Borşa, Izvorul Bistriţei, 1,665-1,710 m, 29.06.2005. (17)
35. *Omalium strigicolle* Wankowicz, 1869, Rodna Mountains, Borşa between Ştiol and Prislop Pass, 1,544 m, 29.06.2005. (17)
36. *Philonthus micantoides* Berick Lohse, Records: Maramureş Basin, Bârsana, 02-09.07.1995, Săpânţa, Colibi, 880 m, 5-14.07.1996. (33)

**Elateridae**

37. *Adrastus kryshtali* Dolin, 1988, Records: Maramureş Basin, Valea Vişeului, 360 m, 11.06.2007; Remeţi, Piatra, bank of Tisa, 210 m, 28.06.2007; Săpânţa, Livada, 400 m, 04.06.2008. (17)

**Dasytidae**

38. *Dasytes hickeri* Kaszab, 1955, Records: Săpînţa, Livada, Peri closter, 400 m, 04.06.2008. (17)

**Cerambycidae**

39. *Leiopus femoratus* Fairmaire, 1859, Records: Maramureş Basin, Sighetu Marmaţiei, Dobăieş, 400 m, 13.06.2006; from fruit trees, 07.06.2008. (17)

**Apionidae**

40. *Perapion lemoroi* (Brisout, 1880), Records: Maramureş Basin, Sighetu Marmaţiei, Dobăieş, 400 m, 03.06.2008. (17)

**Curculionidae**

41. *Acalles petryszaki* Dieckman, 1982, Records: Igniş Mountains, Sighetu Marmaţiei (Piatra) Şorompău, 1,000 m, 14.06.2006. (17)
42. *Brachiodontus reitteri* Weise, 1878, Records: Maramureş Mountains, Borşa, Fântâna Stanchi, 1,600 m, 26.07.2007. (17)
43. *Otiorhynchus repletus* Boheman, 1843, Records: Gutâi Mountains, Breb, mineral water spring, 700 m. (17)
44. *Rhinomias austriacus* (Reitter, 1894), Records: Maramureş Basin, Sighetu Marmaţiei, Dobăieş, 400 m. (17)
45. *Rhyncolus sculpturatus* Waltl, 1839, Records: Rodna Mountains, Săcel, Iza Valley, 05.06.2008. (17)

DIPTERA

**Dolichopodidae**

46. *Rhaphium quadrispinosum* (Strobl), Records: Maramureş Basin, Ieud, 4.07.1995. (22)
47. *Diaphorus deliquescens* Loew, Records: Maramureş Basin, Bârsana, 3.07.1995, Năneşti, 10.07.1995. (22)
48. *Hercostomus separatus* d'Assis Fonseca, Records: Maramureş Basin, Strâmtura (Berşota Rivulet), 3-9.07.1995. (22)
49. *Dolichopus lepidus* Staeger, 1842, Records: Rodnei Mountains, Săcel (Iza Spring), 6.07.1995. (22)
50. *Dolichopus subpennatus* d'Assis Fonseca 1976, Records: Maramureş Basin, Strâmtura (Berşota Rivulet) 6.07.1995, Rodnei Mountains, Săcel (Iza Spring), 6.07.1995. (22)
51. *Tachytrechus hamatus* Loew, Records: Igniş Mountains, Tăul lui Dumitru, altitude 1,100 m., 7.07.1976. (23)
52. *Hercostomus angustifrons* (Staeger), Records: Igniş Mountains, forest range Colibi, 8.07.1996, Poiana Brustan, 6-13.07.1996. (23)
53. *Dolichopus flavipes* Stannius, 1831, Records: Igniş Mountains, Săpânţa, Colibi Valley, forest range, 5-12.07.1996. (23)
54. *Dolichopus signatus* Meingen 1824, Records: Igniş Mountains, Săpânţa, Nireş, 12.07.1996. (23)
55. *Rhaphium ensicorne* (Meigen, 1824), Records: Maramureşului Mountains, Repedea – Smereceni, 22.09.1997. (24)
56. *Rhaphium rivale* (Loew, 1869), Records: Maramureşului Mountains, Repedea-Smereceni, 22.06.1997. (24)
57. *Argyra spoliata* (Kowarz, 1878), Records: Maramureşului Mountains, Repedea – Cârligătura, 26.06.1997. (24)
58. *Diaphorus halteralis* (Loew, 1869), Records: Maramureşului Mountains, Repedea, 2.07.1997. (24)

59. *Rhaphium fasciatum* Meigen, 1824 Records: 19.07.1998. (28)
60. *Rhaphium longicorne* (Fallen, 1823), Records: Igniş Mountains, Săpânţa, Colibia (forest range), 06-12.07.1996. (28)
61. *Melanostolus melancholicus* (Loew, 1896), Records: Igniş Mountains, 15.07.1998; 17.07.1998. (28)
62. *Chrysotus obscuripes* Zettersted, 1838, Records: Igniş Mountains, Giuleşti (Poiana Brazi, Tăul lui Dumitru), 07.07.1996. (28)
63. *Dolichopus phaeopus* Haliday in Walker 1851, Records: Rodnei Mountains, Iza Izvor, 06.07.1995. (28)
64. *Dolichopus tanytrix* Loew, 1869, Records: Igniş Mountains, Giuleşti, Tăul lui Dumitru, 07.07.1996. (28)
65. *Dolichopus phorus kerteszi* Lichwardt, 1902 Records: 19.07.1998. (28)
66. *Medetera murina* Becker, Records: Cloşani, 19-20.06.1997. (29)

**Empididae**

67. *Hilara albitarsis* von Rozer, 1840, Records: Maramureş Mountains, Repedea, poiana Smereceni, swamp with Sphagnum in the freyfield, seven km, upstream the forest range, 22.06.1997. (27)
68. *Hilara augustifrons* Strobl, 1892, Records: Igniş Mountains, Săpânţa, Brustan Clearing, (near Colibi forest range), 06.12.1996. (27)
69. *Hilara albiventris* von Roser, 1840, Records: Maramureş Basin, Bârsana (sandy bank of Iza River), 03.08.1995.

Strâmtura, Berşota Streamlet (heyfield in slop, in a decidous forest), 03-09.07.1995. (27)

70. *Hilara pseudochorica* Strobl, 1892, Records: Maramureş Basin, Bârsana, 03.07.1995; Năneşti (the same biotope as in Bârsana), 10.07.1995. (27)
71. *Empis (s. str.) nuntia* Meigen, 1838, Records: Marmureşului Mountains, Bistra, 28.06.1997; Rodnei Mountains, Borşa, 20.08.1997. (27)
72. *Empis (s. str.) planetica* Collin, 1927, Records: Maramureş Mountains, Repedea-Smereceni, 22.06.1997; Rodna Mountains (Iezer Lake), 13.07.1995. (27)
73. *Empis (Copt.) impennis* Strobl, 1902, Records: Maramureşului Mountains, Crasna Vişeu (Paltin), 25.06.1997. (27)
74. *Hilara apta* Collin, 1927, Records: Rodna Mountains, Izvorul Izei, 17.06.1998. (25)
75. *Hilara canescens* Zetterstedt, 1849, Records: Maramureş Basin, Bistra, 21.07.1998. (25)
76. *Hilara ritidorella* Chvala, 1996, Records: Igniş Mountains, Tătarul Gorges, 21.06.1998; Chalet Pleşca – Pârâul Roşu, 22.07.1998. (25)
77. *Hilara lasiopa* Strobl, 1892, Records: Igniş Mountains, Săpânţa, Colibi, 05-12.07.1996. (25)
78. *Hilara morata* Collin, 1927, Records: Maramureş Basin, Bistra, 22.06.1997. (25)
79. *Hilara obscura* Meigen, 1822, Records: Igniş Mountains, Tătarul Gorges, 19.07.1998; Sârbi, 19.07.1998; Izvoarele Resort, 23.07.1998. (25)
80. *Hilara griseifrons* Collin, 1927, Records: Igniş Mountains, Maramureş Mountains, Repedea clearing Semerceni, 22.08.1997, Izvoarele Resort (seven km downstream), 23.07.1998. (25)
81. *Chelifera astigma* Collin, 1927, Records: Igniş Mountains, Izvoarele Resort (one km downstream), 23.07.1998. (25)

**Syrphidae**

82. *Lejogaster nigricans* (Stack, 1922), Records: Maramureş Mountains, Repedea – Poiana Smereceni, 22.06.1997. (2)
83. Myolepta ruficornis (Zettrstedt, 1843), Records: Maramureş Basin, Crasna Vişeului, 23-29.08.1997. (2)
84. *Orthonevra intermedia* (Lundt, 1916), Records: Maramureş Basin, Bârsana, 03.07.1995; Igniş Mountains, Săpânţa – Poiana Nireş, 06-10.07.1996; Records: Maramureş Mountains, Repedea – Poiana Smereceni, 22.06.1997; Baia Borşa, Bălăsâna Valley, 21.08.1997. (2)

85. *Liochrysogaster przewalskii* (Stack, 1924), Records: Igniş Mountains, Săpânţa – Poiana Nireş, 11.06.1996. (2)

**Mycetophilidae**

86. *Mycomya levis* (Dziedzicki, 1885) (pseudocinerascens Strobl, 1901), Records: Maramureş Mountains, Clearing Smereceni, 21.08.1997. (26)
87. *Mycomya maura* (Walker, 1856) Records: Maramureş Basin, Strâmtura, Berşotă Stream, 03.07.1995. (26)
88. *Mycomya pectinifera* (Edwards, 1924): Records: Maramureş Basin, Mara (2 km upstream, right), 18.07.1998. (26)
89. *Mycomya tenuis* (Walker, 185) Records: Maramureş Basin, Rona de Sus, 21.07.1998. (26)
90. *Mycomya trilineata* (Zetterstedt, 1838) Records: Maramureş Mountains, Baia Borşa (four km upstream on Bălăsâna River), 21.07.1997. Igniş Mountains, Pleşca – Pârâul Roşu, 22.07.1998. (26)
91. *Mycomya vittiventris* (Zetterstedt, 1852) Records: Maramureş Mountains, Baia Borşa (four km upstream on Bălăsâna River), 02.1997, Repedea – Clearing Smereceni, 22.08.1997. (26)
92. *Noempheria winnertzi* (Edwards, 1913) Records: Maramureş Basin, Bistra, 28.06.1997. (26)
93. *Acnemia nitidocollis* (Meigen, 1818) Records: Igniş Mountains, Pleşca – Pârâul Roşu, 23.07.1998 (26)
94. *Leptomorphus (s. str.) quadrimaculatus* (Matsumura, 1916) Records: Maramureş Mountains, Repedea – Clearing Smereceni, 22.08.1997. (26)
95. *Sciophola varia* (Winnertz, 1863) Records: Igniş Mountains, Izvoarele Resort (one km downstream), 23.07.1997. (26)
96. *Boletina basalis* (Meigen, 1818) Records: Maramureş Basin, Bistra (on the streamlet bank), 21.07.1998; Igniş Mountains, Pleşca – Pârâul Roşu, 22.07.1991; Maramureş Mountains, Repedea – Clearing Smereceni, 22.08.1997. (26)
97. *Boletina gripha* (Dziedzcki, 1885): Records: Maramureş Mountains, Repedea – Clearing Smereceni, 22.08.1997. (26)
98. *Boletina lundbecki* Lundstrom, 1912, Records: Rodna Mountains, 1,380 m, 11.07.1995. (26)
99. *Boletina moravica* Landrock, 1912 Records: Igniş Mountains, Pleşca – Pârâul Roşu, 22.07.1998. (26)
100. *Grzegorzekia collaris* (Meigen, 1818) Records: Maramureş Mountains, Repedea – Clearing Elmo, 24.06.1997, Igniş Mountains, Izvoarele Resort (seven km downstream), 23.07.1998. (26)
101. *Docosia fuscipes* (von Roser, 1840) Records: Rodna Mountains – Laboratory house (about 1,400 m), 14.09.1995. (26)
102. *Docosia moravica* Landrock, 1916 Records: Rodna Mountains – Labotatory house, 11.07.1995. (26)
103. *Leia maculosa* (Strobl, 1900) Records: Maramureş Basin, Rona de Sus, 20-21.07.1998. Maramureş Basin, Moisei (six km downstream), 21.08.1997. (26)
104. *Rondaniella dimidiata* (Meigen, 1804) Records: Maramureş Basin, Bistra, 28.06.1997. (26)
105. *Dynatostoma majus* Landrock, 1912, Records: Igniş Mountains, Izvoarele Resort (seven km downstream), 23.07.1998. (26)
106. *Dynatostoma reciprocum* (Walker, 1848) Records: Igniş Mountains, Chalet Pleşca – Pârâul Roşu, 22.07.1998. (26)
107. *Mycetophila caudata* Staeger, 1840, Records: Igniş Mountains, Chalet Pleşca – Pârâul Roşu, 22.07.1998. (26)
108. *Mycetophila gibbula* Edwards, 1925 Records: Igniş Mountains, Izvoarele Resort (seven km downstream), 23.07.1998. (26)
109. *Mycetophyla hetshkoi* Landrock, 1918, Records: Igniş Mountains, Izvoarele Resort (seven km downstream). (26)
110. *Mycetophyla zetlerstedii* Lundstrom, 1906, Records: Igniş Mountains, Izvoarele Resort, 23.07.1998. (26)

111. *Phronia flavipes* Winnertz, 1863, Records: Igniş Mountains, Izvoarele Resort (seven km downstream), 07.1998. (26)
112. *Platurocypta fumipennis* (Bukowski, 1934) Records: Igniş Mountains, Izvoarele Resort (seven km downstream), 23.07.1998. (26)
113. *Platurocypta punctum* (Stannius, 1831) Records: Maramureş Basin, Strâmtura – Pod, 03-09.07.1995, Izvoarele Resort (seven km downstream), 23.07.1998. (26)
114. *Platurocypta testata* (Edwards, 1925) Records: Maramureş Basin, Strâmtura – Pod, 03-9.07.1995, Igniş Mountains, Izvoarele Resort (seven km downstream), 23.07.1998. (26)
115. *Trichonta conjugens* Lundstrom, 1909 Records: Igniş Mountains, Izvoarele Resort (one km downstream), 23.07.1998. (26)
116. *Trichonta foeda* Loew, 1869 Records: Maramureş Basin, Bistra, 07. 1998. (26)
117. *Trichonta fusca* Landrock, 1918 Records: Igniş Mountains, Izvoarele Resort (seven km downstream), 23.07.1998. (26)
118. *Trichonta vitta* (Meigen, 1830) (*nigritula* Edwards, 1925) Records: Rodna Mountains – Laboratory house (about 1,400 m), 14.09.1995. (26)
119. *Cordyla fusca* Meigen, 1804 Records: Maramureş Basin, Călineşti – Văleni (La Săcătură), 8.07.1995. (26)
120. *Exechia pseudocincta* Srobl, 1910 Records: Maramureş Basin, Ruscova, the confluence Ruscova 20.08.1997. (26)

HOMOPTERA

**Cicadeliidae**

121. *Psammotettix nardeli* Remane, 1965, Records: Rodna Mountains, Borşa, Staţiunea Borşa, Poiana Ştiol, 1,500 m, 29.07.2002; Maramureş Mountains, Borşa, Cercănel, 1,400-1,800 m, 30.07.2002; Rodna Mountains, Borşa, Gărgălău Peak, 1,900-2,100 m, 31.07.2002; Rodna Mountains, Borşa, Gărgălău Peak, 2,100 m, 02.06.2002. (19)
122. *Streptanus confinis* (Reuter, 1880), Records: Maramureş Mountains, Borşa, Cercănel Peak, 1,400-1,800 m. 30.07.2002. (19)

HETEROPTERA

**Pentatomidae**

123. *Aeglia klugii* Hahn, 1833, Records: Igniş Mountains, Sighetu Marmaţiei, Piatra Ţiganului, 1,200 m, 21.09.2005 and Rodna Mountains, Borşa, Staţiunea Borşa, 1,000-1,200 m, 02.08.2002. (32)

**Miridae**

124. *Stenodema (Brachyopis) trispinosa* (Reuter), Records: Maramureş Basin, Valea Slătiorii, grass en the left river of the Berşota Rivulet 3.07.1995. (34)
125. *Adelphocoris josifovi* (Wagner) Records: Maramureş Basin, Bârsana – Onceşti 10.07.1995. (34)
126. *Orthotylus (s. str.) interpositus* Schmidt, Records: Maramureş Basin, Bârsana 5.07.1995. (34)

ACARINA

**Zerconidae**

127. *Prozercon similis* Bălan, 1992, Records: Igniş Mountains, Staţiunea Izvoare, Tăul lui Dumitru, 1,143 m, 31.08.2004. (11)

**Macrochelidae**

128. *Macrocheles opacus* (Koch, 1839), Records: Igniş Mountains, Sighetu Marmaţiei, Piatra, Şugău Valley, 20.09.2005. (11)

**Unodinychidae**

129. *Uroobevella flagelliger* (Berlese, 1910), Records: Igniş Mountains, Staţiunea Izvoare, mesa Valhani, 1,020 m, 24.09.2005. (11)

**Brachychthoniidae**

130. *Liochthonius strenzkei* Forsslund, 1963, Records: Localites: Igniş Mountains, Vadul Izei, Piatra, Bârlan, 450 m, 20.09.2005. Rodna Mountains, Săcel, Iza River, 700 m, 22.09.2005. Gutâi Mountains, Breb, Creasta Cocoşului, 1,050 m, 23.09.2005. (14)
131. *Sellnickochthonius immaculatus* (Forsslund, 1942), Records: Igniş Mountains, Vadul Izei, Piatra, Bârlan, 450 m, 20.09.2005. (14)

132. *Sellnickochthonius subcricoides* (Balogh and Mohunko, 1979), Records: Gutâi Mountains, Breb, 625 m, 23.09.2005. (14)

**Hermaniidae**

133. *Hermannia convexa* (C. L. Koch, 1839), Records: Maramureş Basin, Rona de Sus, Hera, Zalom Valley, 504 m, 28.06.2005; Igniş Mountains, Staţiunea Izvoare, Cheile Tătarului, 738 m, 01.09.2004. (14)

**Damaeidae**

134. *Adamaeus onustus* (C. L. Koch, 1835), Records: Maramureş Basin, Rona de Sus, Hera Hills, Zalom Valley, 450 m, 20.09.2005. (14)

**Carabodidae**

135. *Carabodes subarcticus* Trägardh, 1902, Records: Maramureş Basin, Rona de Sus, Hera Hills, Zalom Valley, 504 m, 28.06.2005. (14)

**Suctobelbidae**

136. *Suctobelba discrepans* Moritz, 1970, Records: Rodna Mountains, Borşa, Staţiunea Borşa, 878-1,022 m, 28.06.2005. (14)

137. *Suctobelbata prelli* (Märkel et Meyer, 1958), Records: Rodna Mountains, Borşa, Staţiunea Borşa, 878-1,022 m, 28.06.2005. (14)

**Oribatulidae**

138. *Liebstadia willimanni* Miko and Weigmann, 1996, Records: Rodna Mountains, Borşa, Staţiunea Borşa, 878-1,022 m, 28.06.2005; Gutîi Mountains, Breb, 625 m, 23.09.2004. (14)

139. *Phauloppia lucorum* (C. L. Koch, 1841), Records: Gutâi Mountains, Breb, 625 m, 23.09.2004. (14)

**Ceratozetidae**

140. *Ceratozetes parvulus* Sellnick, 1922, Records: Igniş Mountains, Piatra M., Sighetu Marmaţiei, Ţiganu Peak, 1,200 m, 21.09.2005. (14)

**Limnozetidae**

141. *Limnozetes ciliatus* (Schrank, 1803), Records: Rodna Mountains, Săcel Muced Lake, 1,225 m, 22.09.2005. (14)

## CONCLUSIONS

Distinct results can be noted from the researches conducted during 1994-2009 in Maramureş. 12 invertebrate species that are new to science have been identified and described, and Romania's invertebrate species list has been enriched with 141 taxa.

These data also show the high biodiversity of the studied area and the lack of systematic investigations of invertebrates in the very interesting, from this point of view, Maramureș area.

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# NEW SCIS PROPOSAL REGARDING THE ICHTIOFAUNA FOR THE STEPIC BIOGEOGRAPHIC AREA IN ROMANIA

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**KEYWORDS**: Romania, Stepic Biogeographic Region, Natura 2000, SCIs, *Aspius aspius*, *Rhodeus sericeus amarus*, *Gobio albipinnatus*, *Gobio kessleri*, *Misgurnus fosilis*, *Cobitis taenia*, *Sabanejewia aurata*, *Gymnocephalus schraetzer*, *Zingel streber* and *Zingel zingel*.

**ABSTRACT**

The main goals of the European Community in its environmental policy are to conserve, as well as protect and ameliorate the environment quality in the larger context of the optimum use of the ecosystem's resources and services. Over this side of fifty the biodiversity conservation has been one of the main objectives in this context.

The purpose of this study is to give data and arguments for the proposal of new Natura 2000 sites; specifically for ten fish species. At the Stepic Biogeographical Seminar for Romania (held at "*Lucian Blaga*" University of Sibiu, Sibiu, 9-12 June 2008) it was agreed that the distribution zones of some species are not sufficiently covered within the proposed areas and accepted in the past Natura 2000 sites, so extra proposals were called for by the European Union.

Accordingly, this paper proposes new Natura 2000 sites to be considered at the bilateral talks and is to be held after the Continental Biogeographical Seminar for Romania.

The proposed European Community sites of interest in this paper are based on the authors' field survey data using specific selected criteria, (stable fish populations; well preserved fish populations; typical natural habitats; healthy fish populations; favorable geographical position; relatively low human impact). The next species of conservation interest were included: *Aspius aspius*, *Rhodeus sericeus amarus*, *Gobio albipinnatus*, *Gobio kessleri*, *Misgurnus fosilis*, *Cobitis taenia*, *Sabanejewia aurata*, *Gymnocephalus schraetzer*, *Zingel streber* and *Zingel zingel*.

**REZUMAT**: Noi propuneri de SCI-uri pentru ihtiofaună, după Seminarul Biogeografic Stepic pentru România, Sibiu (Transilvania, România), 9-12 iunie 2008.

Principalele ţinte ale Comunităţii Europene în domeniul mediului sunt conservarea, protecţia şi ameliorarea calităţii mediului, în contextul mai larg al utilizării raţionale a serviciilor şi resurselor ecosistemelor. În ultimele decenii, conservarea biodiversităţii a fost unul dintre elementele principalele în această privinţă.

Scopul acestei lucrări este acela de a sugera date şi argumente în favoarea propunerii de noi situri Natura 2000 pentru zece specii de peşti. La Seminarul Biogeografic organizat pentru regiunea Stepică, pentru teritoriul României şi Bulgariei s-a subliniat faptul că arealele unor specii de peşti sunt insuficient acoperite de situri ale reţelei europene Natura 2000 propuse şi acceptate, astfel noi propuneri au fost solicitate de Uniuniunea Europeană.

Ca răspuns la această situaţie, lucrarea propune unele noi situri Natura 2000 pentru discuţiile bilaterale post Seminarii Biogeografice pentru România.

Propunerile de situri de interes comunitar, prezentate în această lucrare, se bazează pe date de teren ale autorilor şi criterii specifice (populaţii de peşti sănătoase, bine menţinute şi stabile, habitate naturale tipice, poziţie geografică favorabilă, impact antropic relativ scăzut). Au fost incluse următoarele specii de peşti de interes comunitar: *Aspius aspius*, *Rhodeus sericeus amarus*, *Gobio albipinnatus*, *Gobio kessleri*, *Misgurnus fosilis*, *Cobitis taenia*, *Sabanejewia aurata*, *Gymnocephalus schraetzer*, *Zingel streber* şi *Zingel zingel*.

**RESUMEN**: Nueva propuesta de Natura 2000 sobre la ictiofauna en el área biogeográfica de Stepic en Rumanía.

Los principales objetivos de la política ambiental en la Comunidad Europea son la protección, conservación y mejoramiento de la calidad ambiental en el contexto del uso racional de los recursos y los servicios ecosistémicos. En este sentido, en las últimas décadas, la protección de la biodiversidad ha sido una de las metas más importantes.

El propósito de este artículo es dar información y argumentos en pro del establecimiento de nuevos sitios "Natura 2000" para 15 especies. En el Seminario sobre Biogeografía Continental del Territorio Nacional Rumano (SBCTR; llevado a cabo en la Universidad "Lucian Blaga", en Sibiu, del 9 al 12 de junio de 2008) se concluyó que las áreas de distribución de algunas especies de peces no están suficientemente representadas dentro de la propuesta ya aceptada de sitios "Natura 2000", de manera que los representantes de la Unión Europea solicitaron planteamientos adicionales.

Sobre la base de lo anterior, en este artículo se proponen nuevos sitios Natura 2000 para ser considerados en las pláticas que se llevarán a cabo de forma previa al Seminario sobre Biogeografía Continental en Rumanía.

La elección de sitios de interés para la Comunidad Europea que se presentan en este artículo, se basa en datos de muestreos realizados por el propio autor del artículo, bajo ciertas consideraciones particulares (poblaciones estables, saludables y bien preservadas de peces); hábitats naturales típicos; sitios con relativamente bajo impacto humano; posición geográfica favorable. Se incluyeron en la propuesta las siguientes especies de peces de interés para la conservación: *Aspius aspius*, *Rhodeus sericeus amarus*, *Gobio albipinnatus*, *Gobio kessleri*, *Misgurnus fosilis*, *Cobitis taenia*, *Sabanejewia aurata*, *Gymnocephalus schraetzer*, *Zingel streber* y *Zingel zingel*.

## INTRODUCTION

The primary purposes of the European Community policy and strategy in the environment field of interest are the conservation, protection and changing of the environment elements and structure quality. This purpose is for an improved use of the natural services and resources of the ecosystems; including the aquatic ones.

During the last 20-30 years the biodiversity was one of the main elements in this respect.

To accomplish this target regarding the European Community environmental issues, the most new scientific information was analyzed.

The action frame in the European Community (to manage the biodiversity issue) was launched based on the Habitats Directive (92/43/EEC) and Birds Directive (79/409/EEC). The main goal these two significant European Directives have is the biodiversity protection in the European Union territory based on the Natura 2000 network; in order to conserve significant habitats and species important for all the European biogeographic areas: Arctic, Boreal, Atlantic, Continental, Alpine, Pannonian Mediterranean, Macaronesian, Steppic, Black Sea and Anatolian (Fig. 1).

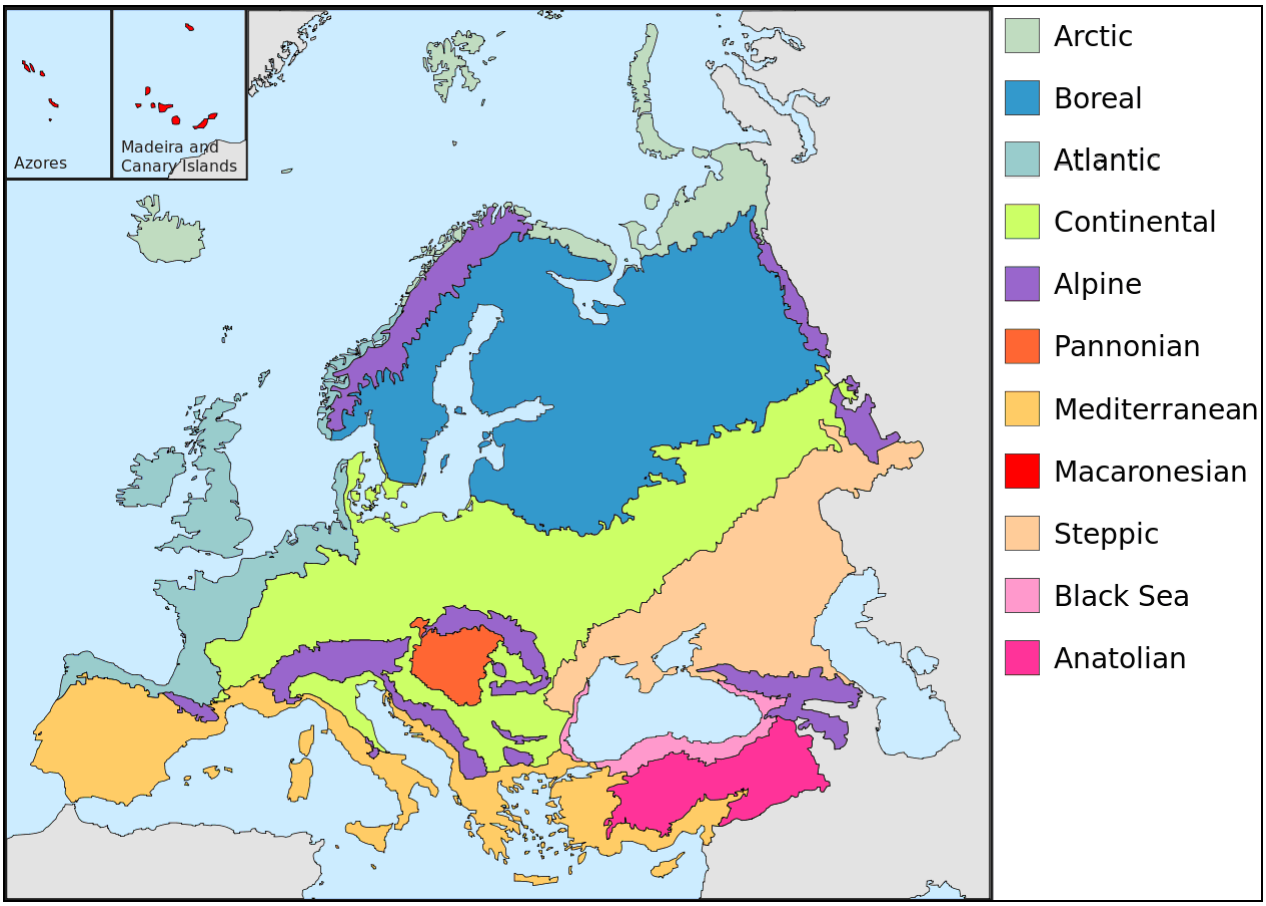


Figure 1: Europe biogeographic regions; European Environment Agency - www.eea.eu.in

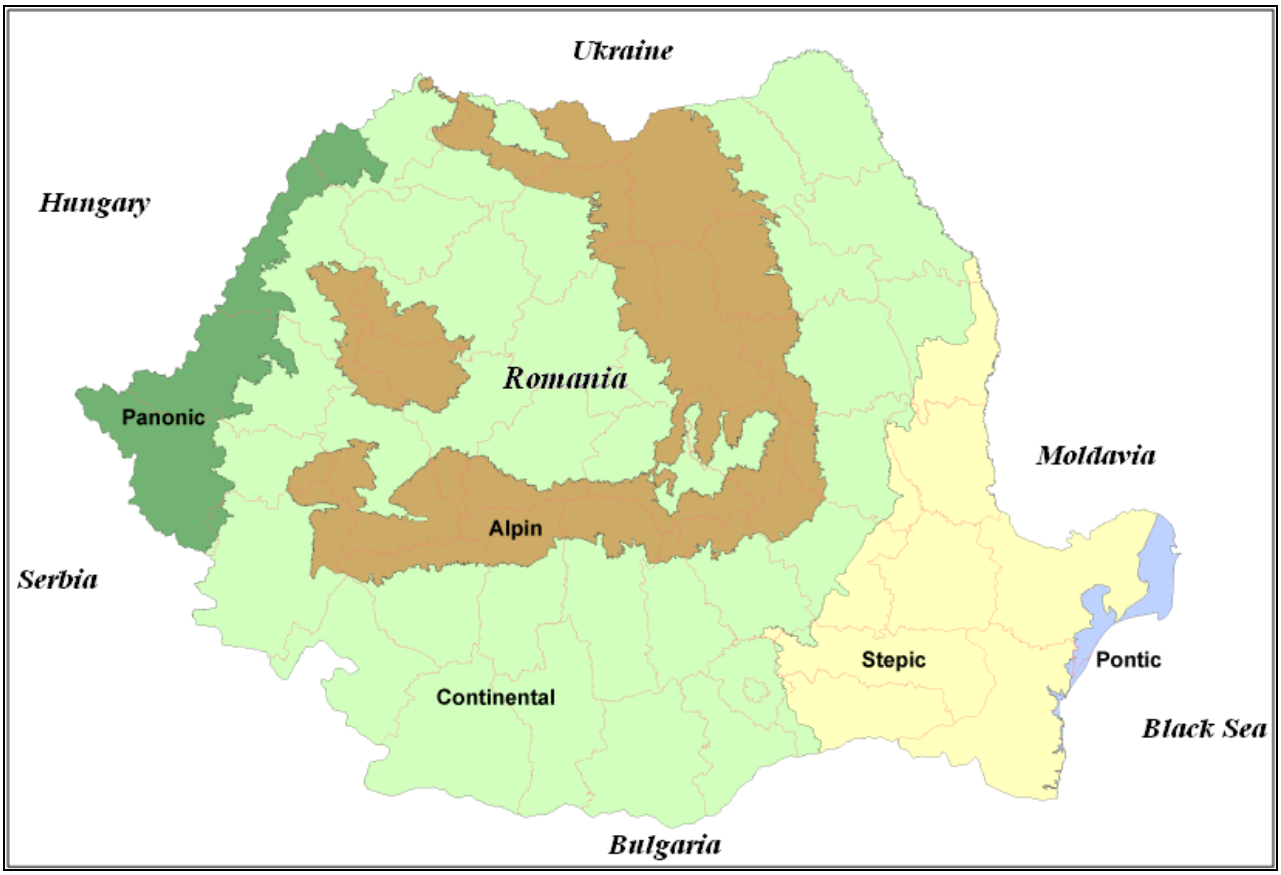


Figure 2: Biogeographic regions of Romania; after Ministry Order 776/2007, Annex 2.

In the Romanian territory, the Stepic region is well represented regarding its surface percentage of the national territory (Fig. 2).

The Stepic biogeographic region stretches from eastern Romania across southern Moldova, Ukraine, Russia and western Kazakhstan to the borders of the Caspian Sea. It is part of a much longer band of steppic vegetation that continues all the way across Asia to China and Mongolia. Only 3% of the so-called European Pontic-Caspian Steppe Region is within the European Union; all of it lies in eastern Romania. (Sundseth and Creed, 2008)

Considerably, Romania has the most biogeographic diversity of all the European Union countries, including a total of five biogeographic regions: Continental, Alpine, Pannonian, Pontic and Stepic (Fig. 2). This country's national territory offers the following to the European natural heritage: around 47% of the territory covered by natural and semi natural ecosystems; 780 types of habitats; 3700 superior plant species; 33,085 invertebrate species and 717 vertebrate species (Bănăduc, 2001, 2006, 2007a, 2007b).

In this geographic and administrative area, there are some major directions through which the Natura 2000 net enterprise on the Romanian territory can enhance its nature conservation: broaden the natural area's surface; the production and carrying out of optimum management plans for all these protected areas; governmental and nongovernmental institutional capacity building; as well as general and specific awareness rising.

One main element of the implementation of these Directives is the foundation of an optimal Natura 2000 network of sites on the Romanian national territory, as a part of this European (E.U.) wide network.

Despite the fact that the Biogeographic Seminars for the Romanian territory were done (at the "*Lucian Blaga*" University of Sibiu, in 9–12 June 2008), it was stated at the end of this official meeting, that the areals of some fish species of the Natura 2000 initiative conservative interest were not sufficiently covered by Natura 2000 proposed sites; so new site proposals were asked for by the European Union delegation members.

As a consequence, this scientific work deals with the proposal of additional Natura 2000 sites to be accepted at a potential second Stepic Biogeographic Seminar for the Romanian territory, or at bilateral E.U. – Romanian Ministry of Environment future negotiations.

The suggested new sites of the European Community interest for this scientific paper are based on data gathered from several field campaigns and specific criteria (stable fish populations; well preserved fish populations; healthy fish populations; typical natural habitats; relatively low human impact; and favorable geographical/hidrographical position) regarding the following protected fish species: *Aspius aspius*, *Rhodeus sericeus amarus*, *Gobio albipinnatus*, *Gobio kessleri*, *Misgurnus fosilis*, *Cobitis taenia*, *Sabanejewia aurata*, *Gymnocephalus schraetzer*, *Zingel streber* and *Zingel zingel*.

## MATERIALS AND METHODS

In the European Natura 2000 process, context for the following site selection criteria were used for this study: healthy fish (oCi) populations; well preserved fish (of Community interest – oCi) populations; stable fish (oCi) populations; typical natural habitats (oCi); lowest (as possible) human impact presence; favorable geographical/ hidrographical position (possibility of species spreading in more than one hydrographic watersheds); best option for species/habitat (oCi) in relation with the needed future Natura 2000 area's general and specific management.

This paper is based on data gathered during the last seven years and focuses on the following fish species of

Natura 2000's conservative interest process: *Aspius aspius*, *Rhodeus sericeus amarus*, *Gobio albipinnatus*, *Gobio kessleri*, *Misgurnus fosilis*, *Cobitis taenia*, *Sabanejewia aurata*, *Gymnocephalus schraetzer*, *Zingel streber* and *Zingel zingel*; Annex II fish species.

It should be stated that no complete data were available in order to definitely and comprehensively establish and border different local stable fish populations. Further multiannual fish population assessment field studies are still needed for the specific quantitative aspects fulfillment.

The fish individuals were caught with specific fishing nets (active and/or passive fishing nets) or through electrofishing, followed by on site identification up to species level, and released unharmed immediately afterwards in their natural habitats for obvious conservative reasons.

## RESULTS AND DISCUSSION

***Aspius aspius*** (Linnaeus, 1758) – Natura 2000 code 1130 (RO-avat, haut, aun, gonaci, peşte-lup, buţoi, guran; DE-Raapf, Rapen; FR-Aspe; GB-Asp; RU-Zherekh; UK-Bilyzna; HU-Balin; CS-Bolen).

A minimal descriptive fact sheet is offered here due to the fact that this fish species can be wrongly determined because of the relative similarities with other fish species (*Leuciscus idus*, *Rutilus rutilus*, *Leuciscus cephalus* or *Vimba vimba*) by the Natura 2000 sites administrations members.

**Minimal descriptive fact sheet.** The body of this species is rather elongated and slightly laterrally compressed. The head dorsal profile smoothly reaches up to the head where it suddenly gets raised up forming a kind of humpback. The head length represents 22-27% of the body (excluding the caudal fin) length. The eyes are small and are placed laterally and ahead. The forehead is almost flat and the snout length represents 25-31% of the head length. The mouth is big, terminal and at an upward oblique which ends under the eye. In addition to thin and continuous lips, the inferior jaw has a protuberance which is fitting in a cavity of the superrior jaw; this morphological adaptation helps the fish to grab its prey. The dorsal fin insertion is situated closer to the caudal fin base than to the top of the snout. The dorsal fin extremity is concave. The pectoral fins do not touch the base of the ventral fins; their length represents 17-20% of the body length and the ventral fins represent 13-17% of the body length. The anal fin extremity is strongly concave and the caudal is deeply holed. The scales are thin, but well fixed. The back is dark-olivewith silvery flanksand the ventral part is white. The dorsal and the caudal fins are dun, the ventral and anal fins are colourless or pale reddish, the pectoral fins are colorlessand the lips are hoary. Usually this species can reach a length of 30-40 cm and a maximum of 80 cm. (Bănărescu and Bănăduc, 2007).

Concerning *Aspius aspius* species, at the Continental Biogeographic Seminar for Romania, in Sibiu 9-12 June 2008, conclusions were emphasized about its proposed sites as insufficient moderate status. More sites were required for this fish species on the Romanian national territory. A new site in this circumstance was proposed below.

**Proposed site.** The proposed site should be created in three administrative units (Bacău, Vrancea and Galaţi), respectively to include the Siret River in its lower part between downstream Adjud localities sector and to its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually, this proposal is an enlargement of an old proposal made by the Natura 2000 working group on fish in 2008; partial and small fragmented sectors were accepted at the beginning of the project.

Supplimentary such scientific researches can improve this proposal with new sites.

***Rhodeus sericeus amarus*** (Bloch, 1782) – Natura 2000 code 1134 (RO-boarță, boarcă, blehniță; GB-Bitterling; DE-Bitterfish; FR-Bouvière; HU-szivárványos ökle; UA-Gorchak).

A minimal descriptive fact sheet is presented here to allow the identification of this fish species by some of the European Natura 2000 sites administrations members for its assessment, monitoring and management.

**Minimal descriptive elements**. Accentuated and high laterally compressed body. Convex dorsal profile, drawing up from the tip of the snout to the dorsal fin insertion; behind the dorsal fin the profile descent is accentuated. Laterally compressed head, and the eyes are situated in the anteriour half of the head. Small, subterminal and crescent shaped with a thin lipped mouth. The dorsal fin is inserted in general at equal distances from the tip of the snout and the caudal fin base. The edge of the dorsal fin is slightly convex. The pectoral fins are short and rounded at the top. The ventral fins insertion are situated under the dorsal fin insertion or very little before it; their tops reach or almost reach the anteriour edge of the annal fin. The annal fin insertion is under the middle of the dorsal fin; its edge is slightly concave. The scales are big, higher than longer, and are persistent. The chest is covered with smaller scales and the lateral line is short. The dorsal part of the body and of the head are greysh-yellowish while the flanks are white; the dorsal and caudal fins are grey and the other fins are a redish shade. Along the bodies posterior half and of the caudal peduncule is a greenish line. It can reach 7.9 cm in length. (Bănărescu and Bănăduc, 2007)

Concerning the *Rhodeus sericeus amarus* species, at the Stepic Biogeographic Seminar meeting from Sibiu, 9-12 June 2008, some final statements about its proposed sites as insufficient moderate status were stressed. More sites were required and also extensions of existing sites were required on the Romanian national territory, especially in the Siret River basin. In this respect a new (enlarged/unified) site for this species is proposed.

**Proposed site.** The proposed site should be created in three administrative units (Bacău, Vrancea and Galați), respectively to include the Siret River in its lower part between downstream of Adjud locality sector and to its confluence with the Danube in the proximity of Galați locality; its major tributaries and wetlands are present in the Stepic region. Actually, this proposal is an enlargement of an old proposal made by the Natura 2000 working group on fish in 2008, and partially accepted at the beginning (relatively small and fragmented sectors).

Supplimentary scientific researches can improve this proposal with new site.

***Gobio albipinnatus*** (Lukasch, 1933) – Natura 2000 code 1124 (RO-porcușor de șes; DE-Weißsflossiger Gründling; GB-White-finned gudgeon; HU-halványfoltú küllő; UK-Pinchkur svitloplavtsovyi; RU-Peskar svetloplavnikovyi).

A minimal descriptive fact sheet is also presented here for this species due to the fact that this species can be misidentified with other species of the genus *Gobio*, by the Natura 2000 sites administrations staff members, and these misidentifications should be avoided.

**Minimal descriptive elements**. The body and the caudal peduncule of this fish species are relatively high and laterally compressed. The peduncle height is a little higher in comparison with the thickness at the level of the annal fin posteriour edge. seven, exceptionally eight divided rays in the dorsal fin. There are four scales between the lateral line and the ventral fins. In Romania *Gobio albipinnatus vladykovi* Fang 1943 can be found. There is a convex dorsal profile and the maximum height of the body is situated at the dorsal fin insertion. The snout is short and obtuse. The eyes are big and close, looking more upward. The wiscкhlers reach in general the posterior edge of the eye. The caudal peduncule is slightly compressed laterally and the caudal fin is profound holed; its superior lobe being

longer than the inferior one. The pectoral fins do not reach the ventral fins insertion, the ventral fins outgrow the annus, but do not reach the annal fin. The annus is closer to the ventral fins than the anal fin. The superior part is light yellowish-grayish. The dorsal side of the head is darker grayish, with even darker spots and lines. On flanks, there are generally seven-eight round spots. The lateral line scales have two black spots which are not very well marked. The ventral face is white. On the dorsal and caudal fins are two rows of black spots, also not very well marked. It can reach 13 cm in length. (Bănărescu and Bănăduc, 2007)

Concerning the *Gobio albipinnatus* species, at the Stepic Biogeographic Seminar meeting for Romania, in Sibiu (Transylvania, Romania), 9-12 June 2008, there were some underlined final conclusions about the proposed and accepted sites as an insufficient moderate status. More sites were required and also the extension of existing sites were required on the Romanian national territory, especially in the Siret River basin. A new (extended/unified) site is proposed in this respect below.

**Proposed site.** The proposed site should to be created in three administrative units (Bacău, Vrancea and Galaţi), respectively to include the Siret River in its lower part between downstream of Adjud localities sector and to its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually, this proposal is an enlargment of an old proposal made by the Natura 2000 working group on fish in 2008, and partially accepted at the beginning (relatively small and fragmented sectors).

Supplimentary scientific researches can improve this proposal with new sites.

***Gobio kessleri*** (Dybowsky, 1862) – Natura 2000 code 1124 (RO-porcuşor de nisip; DE-Sandgressling, Kessler Gründling; GB-Kessler's gudgeon; RU-Dnestrovskii dlinnuosyi peskar; HU-homoki küllő; UK-Pichkur dunaiskyi dovgousyi).

A descriptive minimal fact sheet is presented here because this species can be misidentified with other species of the genus *Gobio* by the Natura 2000 sites administrations members. Also, this species' population needed assessment, monitoring and management which are impossible without their accurate identification.

**Descriptive elements**. The body has a low profile and is thick or relatively high and slightly laterally compressed. The caudal peduncule is thick and cylindrical; its thickness is generally bigger than the minimum height. The eyes are variable in dimensions, usually smaller than the interorbitary space. The lateral scales are higher than they are longer. The whiskers have variable length. The caudal lobes are almost equal (excepting *G. k. banaticus*). (Bănărescu and Bănăduc, 2007)

Regarding the *Gobio kessleri* species, at the Continental Biogeographic Seminar meeting from Sibiu 9-12 June 2008, there were some underlined final conclusions about its proposed sites as insufficient moderate status. More sites were required and also the extension of the existing sites was required in the Romanian national territory. A new site in this respect is proposed below.

**Proposed site.** The proposed site should be created in three administrative units (Bacău, Vrancea and Galaţi), respectively to include the Siret River in its lower part between downstream of Adjud localities sector and to its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually, this proposal is an enlargement of an old proposal made by the Natura 2000 working group on fish in 2008, and partially accepted at the beginning, (relatively small and fragmented sectors).

Supplementary scientific specific researches can improve this proposal with new sites.

***Misgurnus fossilis*** (Linnaeus, 1758) – Natura 2000 code 1145 (RO-ţipar, chişcar, vârlan; GB-Weatherfish; FR-Kerlèche; DE-Wetterfish, Beitzger, Moorgrundel; HU-réti csik, UA-Viun; BG-Zmiorche; HU-Réti csík; CS-Cikov).

A minimal descriptive fact sheet is presented here to allow the identification of this species by some of the European Natura 2000 sites administration members for the necessary assessment, monitoring and management activities.

**Minimal descriptive elements**. Prolongued and thick body with almost uniform height. The dorsal and the ventral profiles are almost horizontal. The head is thick, slightly compressed lateraly. The nostrils are closer to the eyes than to the tip of the snout. The anterior nostril is tubular, round, covered by a skiny operculum. The mouth is inferiour and crescent. The upper lip is fleshy and continuous. The lower lip is fleshy with two pairs of flashy lobes; the anteriour pair (and median) short and thick, the posteriour pair long and thin whiskers like. The caudal peduncle is lateraly compressed, mostly in its posteriour part. The caudal dorsal and ventral peduncule edges are straiten and form two faty streamlines, which is looking like an elongation of the caudal fin. The dorsal and ventral fins are situated at the same level. Small scales. Hardly visible lateral line. The dorsal side is dark dun, with small sooty spots. This dun area is limited by a narrow longitudinal line, almost black, which lay from the superior corner of the operculum to the caudal fin; in the posterior part this line is interrupted by isolated spots. Below this line, the body is light dun; is following a new sooty line, very broad, continuous from the eye to the caudal fin base. Below this line is yelowish-rusty spotted with brown dots. The head is light-fawn with small dark spots. Smoky fins with dark spots. The females reach 30 cm, the males are smaller. (Bănărescu and Bănăduc, 2007)

Regarding the *Misgurnus fossilis* species, at the Continental Biogeographic Seminar meeting in Sibiu 9-12 June 2008, there were drawn some conclusions about this species proposed sites as insufficient moderate. More sites were required and also the extensions of the existing sites, were required in the Romanian national territory. A new site in this respect is proposed below.

**Proposed site.** The proposed site should to be created in three administrative units (Bacău, Vrancea and Galaţi), respectively, to include the Siret River in its lower part between downstream of Adjud localities sector and till its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually, this proposal is an enlargment of an old proposal made by the Natura 2000 working group on fish in 2008, and accepted at the beginning, only partially (relatively small and fragmented sectors).

Supplimentary scientific researches can improve this proposal with new sites.

***Cobitis taenia*** Linnaeus, 1758 – Natura 2000 code 1149 (RO-zvârlugă, fâsă, câră, zmorlă, râmbiţar; DE-Dorngrundel, Steinbeisser; FR-Loche de rivière; GB-Spined Loach; RU-Shtschipovka; UK-Shtschipovka; HU-Vágó csík; BG-Piskal; CS-Vijun).

A minimal descriptive fact sheet is presented here to allow the identification, without confusion with other *Cobitis* and *Sabanejewia* genera species, by some of the Natura 2000 sites administrations staff members for the necessary biological and ecological assessment, monitoring and management activities.

**Descriptive elements**. The dorsal and ventral profiles are almost horizontal. The inter-orbitary space is plain. The two halfs of the inferiour lip are subdivided in 3-4 lobes. The third pair of whiskers is the longest. The caudal peduncule in its posteriour part has a dorsal and a ventral streamline, the last one more developed. The ventral fin insertion is situated a little backward in comparison with the dorsal fin insertion. The caudal

fin is truncated or slightly holed. The pectoral and ventral fins are rounded. The lateral line is short, in general does not overdraw the pectoral fin. The body background is white-yelowish. The dorsal spots are small, rectangular or rounded, close, in variable number (13-24). The lateral pigmentation of the body consist of four zones. At the caudal fin base, in the upper corner, there is a clear vertical black intense spot. On the head there are small spots and an oblique line, from the backhead to the mouth. It can reach 12 centimeters in length. (Bănărescu and Bănăduc, 2007)

Regarding the *Cobitis taenia* species, at the Stepic Biogeographic Seminar meeting from Sibiu, 9-12 June 2008, there were underlined some conclusions about this species proposed sites as in moderate. A new site for this species is proposed below.

**Proposed site.** The proposed site should be created in three administrative units (Bacău, Vrancea and Galaţi), respectively to include the Siret River in its lower part between downstream of Adjud localities sector and till its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually this proposal is an enlargment of an old proposal made by the Natura 2000 working group on fish in 2008, and accepted at the begining, only partialy (relatively small and fragmented sectors).

Suplimentary scientific researches can improve this proposal with new sites.

***Sabanejewia aurata*** (De Filipi), 1863, 1758 – Natura 2000 code 1146 (RO-câră, fâţă, râmbiţă, şărpan, sfârleză, dunăriţă; GB-Goldside Loach, Golden spined loach; SK-Plž zlatistý; UK-Shchypovka zolotistaya).

A minimal descriptive fact sheet is presented here to allow the identification, without confusion with other *Sabanejewia* and *Cobitis* genera species, by some of the Natura 2000 sites administrations staff members for the necessary biological and ecological assessment, monitoring and management activities.

**Minimal descriptive elements**. **Descriptive elements**. Moderate lateraly compressed body. Five to twenty dorsal spots, and five to seventeen lateral spots. At the caudal fin base there is a are a dorsal and a ventral small spot, the dorsal one is vertical. It is characterised by an accentuated variety. It should be stated the fact that the systematic of this taxonomic group is still under international scientific debate and byond the Natura 2000 purposes many other names are proposed and used. (Bănărescu and Bănăduc, 2007)

Regarding the *Sabanejewia aurata* species, at the Stepic Biogeographic Seminar meeting from Sibiu 9–12 June 2008, there were underlined some conclusions about this species proposed sites as in minor. A new site for this species is proposed below.

**Proposed site.** The proposed site should be created in three administrative units (Bacău, Vrancea and Galaţi), respectively to include the Siret River in its lower part between downstream of Adjud locality sector and till its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually, this proposal is an enlargment of an old proposal made by the Natura 2000 working group on fish in 2008, and accepted at the begining, only partialy (relatively small and fragmented sectors).

Suplimentary scientific researches can improve this proposal with new sites.

***Gymnocephalus schraetzer*** (Linnaeus, 1758) – Natura 2000 code 1157 (RO-răspăr, șpârliu, bălos, firizar, ferăstraș; DE-Schraitzer, Schratz; GB-Schraetzer, Striped Ruffe; HU-Selymes durbincs; UK-Yersh polosatyi).

A minimal descriptive fact sheet is present in this paper to allow the identification, without confusion with others species of the *Gymnocephalus* genus, by the Natura 2000 sites administrations members for the necessary biological and ecological assessment, monitoring and management.

**Minimal descriptive elements**. The fish body is relatively prolonged. The dorsal profile draws up almost directly from the tip of the snout to the dorsal fin insertion, descending afterwards. Looking from the lateral sides, the head looks like a triangular shape. The ventral profile is almost horizontal. The eyes are located towards in the posteriour part of the head, looking more lateraly. The mouth is small and terminal, its opening is situated anteriour to the nostrils. The dorsal side and the flanks are yellow and the ventral side almost white. On the dorsal side of the body there are three thin longitudinal black-blueish lines. Two, sometimes three of them are intrerupted. On the hard dorsal fin membrane part exist three rows of round, big and black spots. The soft part of the dorsal fin membrane and the other fins are colourless. The iris is black. It can reach a maximum of 24 cm in body length. (Bănărescu and Bănăduc, 2007)

Regarding the *Gymnocephalus schraetzer* species, at the Continental Biogeographic Seminar meeting in Sibiu 9-12 June 2008, there were stressed some conclusions about this species proposed sites as insufficient minor. It was stated the fact that more sites will be needed and also an extension of the already proposed and accepted sites were required in the Romanian national territory. In this respect a new site for this species are proposed.

**Proposed site.** The proposed site should be created in three administrative units (Bacău, Vrancea and Galaţi), respectively, to include the the Siret River in its lower part between the downstream Adjud localities sector and till its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually, this proposal is an enlargment of an old proposal made by the Natura 2000 working group on fish in 2008, and accepted at the begining, only partialy (relatively small and fragmented sectors).

Suplimentary scientific specific researches can improve this proposal with new sites.

***Zingel streber*** (Siebold, 1863) – Natura 2000 code 1160 (RO-fusar, fus, prundar, peşte de piatră; GB-Streber, Danube Streber; DE-Streber, Strever, Ströber, Strengkatze, Zagel; HU-kis bucó, német bucó; UK-Chop malyi; SK-Kolok malý).

A minimal descriptive fact sheet is presented to allow the identification, without confusion with *Zingel zingel* species, by some of the Natura 2000 sites administrations staff members for the assessment, monitoring and management.

**Descriptive elements**. Elongated body, skewer-like shape. The dorsal profile of the body ascends slightly, uniform and straight from the tip of the snout to the first dorsal fin insertion. The ventral profile is almost plain. The head is much broader than high, from an above perspective is triangular. The snout is obtuse, wide in the posteriour part, narrow in the anteriour part. The mouth is inferiour, crescent-like shape and small. The caudal peduncle is long and thin, round in section. The dorsal fins are distanced and triangular, high anteriour and decreasing gradually to the posteriour part. The pectoral fins with truncated edge. The ventral fins are inserted behind the pectoral fins insertions. The scales are small. The lateral line is complete and plain. The superior side of the head and of the body, and the majority of the flancks are brown-greysh with a green nuance. On this background are five wide sooty lines. The ventral side is white and the fins are colourless. It can reach over 20 cm in length. (Bănărescu and Bănăduc, 2007)

Regarding this species, at the Continental Biogeographic Seminar, there were stressed conclusions about its insuficient minor status and it was stated the fact that more sites will be needed and also the extension of the already proposed sites, was required on the Romanian territory. In this respect, new sites, for this species is proposed.

**Proposed site.** The proposed site should be created in three administrative units (Bacău, Vrancea and Galaţi),

respectively, to include the the Siret River in its lower part between downstream of Adjud localities sector and till its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually, this proposal is an enlargment of an old proposal made by the Natura 2000 working group on fish in 2008, and accepted at the begining, only partialy (relatively small and fragmented sectors).

Suplimentary scientific researches can improve this proposal with some new sites.

***Zingel zingel*** (Linnaeus, 1766) – Natura 2000 code 1159 (RO-fusar mare, pietrar, peşte cu două nume; GB-Zingel; DE-Zingel, Zindel, Zink, Zinne, Zint; CS-Veliki vretenac; HU-nagy bucó; BG-Uretenarka; SK-Kolok velký; UK-Chop).

A minimal descriptive fact sheet is presented here to allow the identification, without confusion with *Zingel streber* species, by some of the Natura 2000 sites administrations staff members for the necessary ecological assessment, monitoring and management activities.

**Minimal descriptive elements**. Elongated body, skewer-like shape, almost circular in section. The head is oval. The dorsal fins are relatively closely apart. Both dorsal fins are triangular, high anteriour and decreasing gradually to the posteriour part. The pectoral fins with truncated edge. The ventral fins are inserted behind the pectoral fins insertions. The scales are small, on the ventral side they reach the ventral fin's base. The dorsal side and the majority of the flancks are brown-greysh. The ventral side and the abdomen are yellowish. It can reach a maximum body length of 49 cm. (Bănărescu and Bănăduc, 2007)

Regarding the *Zingel zingel* species, at the Continental Biogeographic Seminar meeting in Sibiu 9-12 June 2008, there were stressed some conclusions about this species proposed sites as insufficient moderate. It was stated the fact that more sites will be needed and also the extension of the already proposed and accepted sites was required on the Romanian national territory. In this respect, new sites for this species are proposed below.

**Proposed site.** The proposed site should be created in three administrative units (Bacău, Vrancea and Galaţi), respectively, to include the the Siret River in its lower part between downstream of Adjud localities sector and till its confluence with the Danube in the proximity of Galaţi locality, and its major tributaries and wetlands present in the Stepic region. Actually, this proposal is an enlargment of an old proposal made by the Natura 2000 working group on fish in 2008, and accepted at the begining, only partialy (relatively small and fragmented sectors).

Suplimentary scientific specific researches can improve this proposal with new sites.

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# THE SPECIES *HUCHO HUCHO* (LINNAEUS, 1758), (SALMONIFORMES, SALMONIDAE) IN THE RUSCOVA RIVER (NORTHERN ROMANIAN CARPATHIANS)

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**KEYWORDS**: Tisa River basin, lotic system, Danube salmon, ichthyocenoses, fish and macroinvertebrate trophic resources, assessment, human impact, management, conservation.

**ABSTRACT**

The distribution area (including Romania) of *Hucho hucho*, has drastically diminished, especially in the last half of the 20th century.

Based on ichthyological studies, the hydrographic basin in which the species *Hucho hucho* was regularly found was that of the Vişeu River, especially the Ruscova River. This would have been the case even if restocking had not been carried out.

The present study reveals that a good abundance of the individuals of this species are of major conservation interest, and also reveals that the fish species *Hucho hucho* itself and the invertebrate food source of the species are in good condition.

Present and potential anthropogenic threats are identified. Specific management measures for the river, as well as for the protection and conservation of the species *Hucho hucho*, of its food source, of the specific habitats, and of the nearby intra- and inter-lotic basinal connectivity are proposed.

**REZUMAT**: Specia *Hucho hucho* (Linnaeus, 1758), (Salmoniformes, Salmonidae) în râul Ruscova (Carpaţii Româneşti de nord).

*Hucho hucho* a cunoscut un regres drastic al arealului de distribuţie în special, în a doua jumătate a secolului XX, inclusiv în România.

Bazinul hidrografic în care lostriţa, chiar în lipsa repopulărilor, a fost identificată relativ constant pe baza studiilor ihtiologice este cel al Vişeului, în acesta, râul Ruscova fiind de o însemnătate aparte.

Prezentul studiu relevă o abundenţă bună a indivizilor acestei specii de interes conservativ major, precum şi o stare foarte bună a bazei trofice piscicole şi de nevertebrate a speciei *Hucho hucho*.

Sunt identificate ameninţările prezente şi cele potenţiale de natură antropică şi sunt sugerate măsuri de management specific pentru acest râu în vederea protecţiei şi conservării speciei *Hucho hucho*, a bazei sale trofice, a habitatelor specifice şi a conectivităţii lotice intrabazinale şi interbazinale limitrofe.

**ZUSAMMENFASSUNG**: Der *Hucho hucho* Linnaeus, 1758 (Salmoniformes, Salmonidae) art im Ruscova Fluss (nördlichen Teil der Karpaten Rumäniens).

Der *Hucho hucho* hat vor allem in der zweiten Hälfte des 20. Jahrhunderts einen drastischen Rückgang seines Verbreitungsgebietes – Rumänien eingeschlossen – erfahren.

Das Einzugsgebiet in dem der Huchen sogar ohne Wiederbesiedlungs-aktionen auf Grund ichtiologischer Untersuchungen relativ konstant festgestellt wurde, ist jenes des Vişeu-Flusses, wobei dem Ruscova-Fluss eine besondere Bedeutung zukommt.

Die vorliegende Untersuchung belegt eine gute Abundanz der Individuen dieser Art von außergewöhnlicher naturschutzfachlicher Bedeutung sowie einen sehr guten Zustand der Nahrungsgrundlage an Fischen und Wirbellosen für den Huchen.

Es werden auch die gegenwärtigen sowie die potentiellen menschlich bedingten Gefährdungen aufgezeigt. Außerdem werden im Hinblick auf Schutz und Erhaltung von *Hucho hucho* auch spezifische Managementmaßnahmen für den Fluss vorgeschlagen, die auch die Sicherung seiner Nahrunsgg-rundlage der charakteristischen Lebensräume und der Konnektivität der Fließgewässer innerhalb des Einzugsgebiets sowie mit den angrenzenden Einzugsgebieten beinhalten.

## INTRODUCTION

*Hucho hucho* (Linnaeus, 1758) is the biggest, entirely riverine and anadromous fish species that live in: Europe, the Danube, Volga and Pechora watersheds (Munda, 1935; Nelson, 1976; Randík, 1976; Noakes, 1977; Holčik, 1982, 1995; Schulz and Piery, 1982; Hensel and Holčik, 1983; Witkowski, et al., 2012). It is known in the Romanian Carpathians region under different names, such as lostriţă, lostoză, lostosă, lostocă, lostiţă, lostruţă, lostucă or puică (Băcescu, 1947; Vasiliu, 1959; Giurescu, 1964), and it is the largest salmon species in the Romanian national territory waters. It can reach a weight of around 20 kg and a length of over one m. Due to its dimensions, weight and good taste, it was the most popular salmon species in its distribution area in the last centuries. It came under the Romanian ichthyologists notice especially since the XVIII Century (Antipa, 1909).

In undisturbed natural conditions, the Romanian Carpathian lotic systems are very favorable for salmonid species, mainly in their upper and sometimes in their middle sectors. These mountainous and submontainous Carpathian regions offered a protective covering to this valuable salmon species at the end of the 19th century and in the beginning of the 20th century, in many watersheds: Cerna River in the Banat region, rivers Mureş, Jiu, Olt, Lotru, Argeş, Râul Târgului/Târgului River, the Danube River (probably from its tributaries) and possibly in the rivers Crişul Negru, Crişul Alb, Crişul Repede, Strei, Timiş, Râul Doamnei/ Doamnei River, Buzău, Moldova, Suceava and Siret (Bănărescu, 1964).

In the middle of the 20th century this species distribution range in the Romanian Carpathians decreased drastically, and it was found only in Vişeu, Ruscova, Vaser, Novăţ, Dorna, Bistriţa Moldovenească, Suceava and Moldova rivers (Bănărescu, 1964; Decei, 1981).

Regrettably in the last few decades, the total range of this species has decreased in all the Carpathians (Holčik, 1990; Koller, 1970; Kulmatycki, 1931), including the Romanian part of these mountains. Currently, reliable data on the species occurrence exist only for a few lotic systems. Even in these rare cases, the data on the species occurrence show a significant variability in the species presence/absence data along medium periods of time; when the monitoring was done (Bănăduc, 2008b), and also during a numerical decline (Telcean and Bănărescu, 2002).

This clear emphasized regress was induced by the general context of the amplification of the anthropogenic-induced impact, also in the upper salmonid river sectors of the Romanian Carpathians with damaging effects on the aquatic fish communities (Ardelean and Wilhelm, 2007; Bănăduc, 1999, 2005, 2006; Bănărescu, 2005; Bănărescu and Vasiliu-Oromulu, 2004; Curtean-Bănăduc, 2005, 2008; Curtean-Bănăduc et al., 2007; Davideanu et al., 2006; Sandu et al., 2008; Telcean and Károly, 2000; Staicu et al., 1998; Oprean et al., 2009; Telcean, 1997; Olosutean and Ilie, 2008; Sîrbu et al., 2011).

The Danube salmon are actually a protected species by the Law 13 of 1993 (through which Romania became a part of the Bern Convention), the European Directive 92/43/EEC, O.U.G. 57/2007 of the Romanian Government regarding the regime of natural protected areas, and conservation of natural habitats of the wild flora and fauna.

In spite of all the efforts in terms of legal protection of this fish species, the constant and aggressive human impact continues to cause decline, particularly due to: illegal overfishing, man-made lakes, ditches/water abstractions of the river's upper reaches, and pollution. As a result of these impacts, the Danube salmon are now considered as a common species only in around 33% of its past range, rare in 28% and have disappeared in 39% of that range (Holcik, 1990).

It must also be noted that in the last decades this situation has become worse in terms of range.

*Hucho hucho* is extinct in many of the areas of its past range; it has a very fragmented distribution in the present, particularly in its European range where it survives in a majority of the cases due to constant and heavy restocking. In comparison to its extensive original range, no other fish species has been wiped out by humans in such a way (Holčik, 1995).

In Europe, the Danube salmon were originally found only in the Danube Watershed, but mostly in the river's right side tributaries; it was present also in the lower reaches of the streams in the Prut River watershed, though very rarely. During the last decades attempts were made to spread it westward but they often failed as in the Rhine and Thames cases. Nor were attempts in extending the species range into the Elbe very successful since there has been no data about its natural reproduction. The same unsuccessful results were observed in the Poprad and the Dunajec (Vistula's tributaries) lotic systems and also in the stream sections in its distribution range area where it did not appear naturally (Lelek, 1980).

Fortunately some reintroduction attempts in its former Romanian Carpathian range (Cengher, 2007) were successful and encouraging for the species potential conservation. However, the reintroduction areas are under a severe threat due to the overextension of new micro-hydropowerplants in this area.

It must be stated that the farming of this species for restocking purposes is not easy due to problems related to feeding (Jungwirth, 1978; Nikcevic et al., 1998).

The Ruscova River area (Fig. 1) is situated on the Romanian national territory, in the north of Transylvania, in Maramureş County, and flows in the Maramureşului Mountain Nature Park area.

The Ruscova River (a right-hand tributary of the Vişeu River) is formed by the confluence of Socolău and Rica streams. The Socolău, Rosoşu Mare, Rosoşu Mic, Răchita and Rica streams belong to the trout zone (Bănăduc, 2008a).

The Maramureş Mountains release to the Ruscova River all of its affluents. The mountainous altitudes, specific geology and vertical profiles (including the levelled surfaces) induce the declinity which decreases to Vişeu and Tisa lower geomorphological levels; the Ruscova Valley is limited by the Pop Ivan, Farcău and Pietrosu Bardăului mountains, with quartz and metamorphic schists, hard metamorphic rocks – gneiss and limestone, Mesozoic dolomites, and grit stones (Chiş, 2008; Mureşan, 2008; Chiş and Kosinszki, 2011; Iştvan, 2011). With a total basin surface of 43 km², a river length of 39 km and an average annual flow of 11.3 m³/s, this river has a hydrographical regime which belongs to the Carpathian-oriental-moldavian type in its upper basin and to the Transylvanian Carpathian hydrological regime for the middle and lower river basin. The accentuated pluviosity, the late melting of snow and the high spring-summer flows constitute reference displays of this hydrologic type. For Ruscova, the specific average outflow is lower in the sources area of the basin as a consequence of the less abundant oriental regime and higher in the western part of the basin. The characteristic Carpathian region water supply conditions induce a variation of the liquid and solid outflow regime from one period to another with maximum spring flow when the rains are associated with the snow melt. (Chiş, 2008; Costea, 2008)

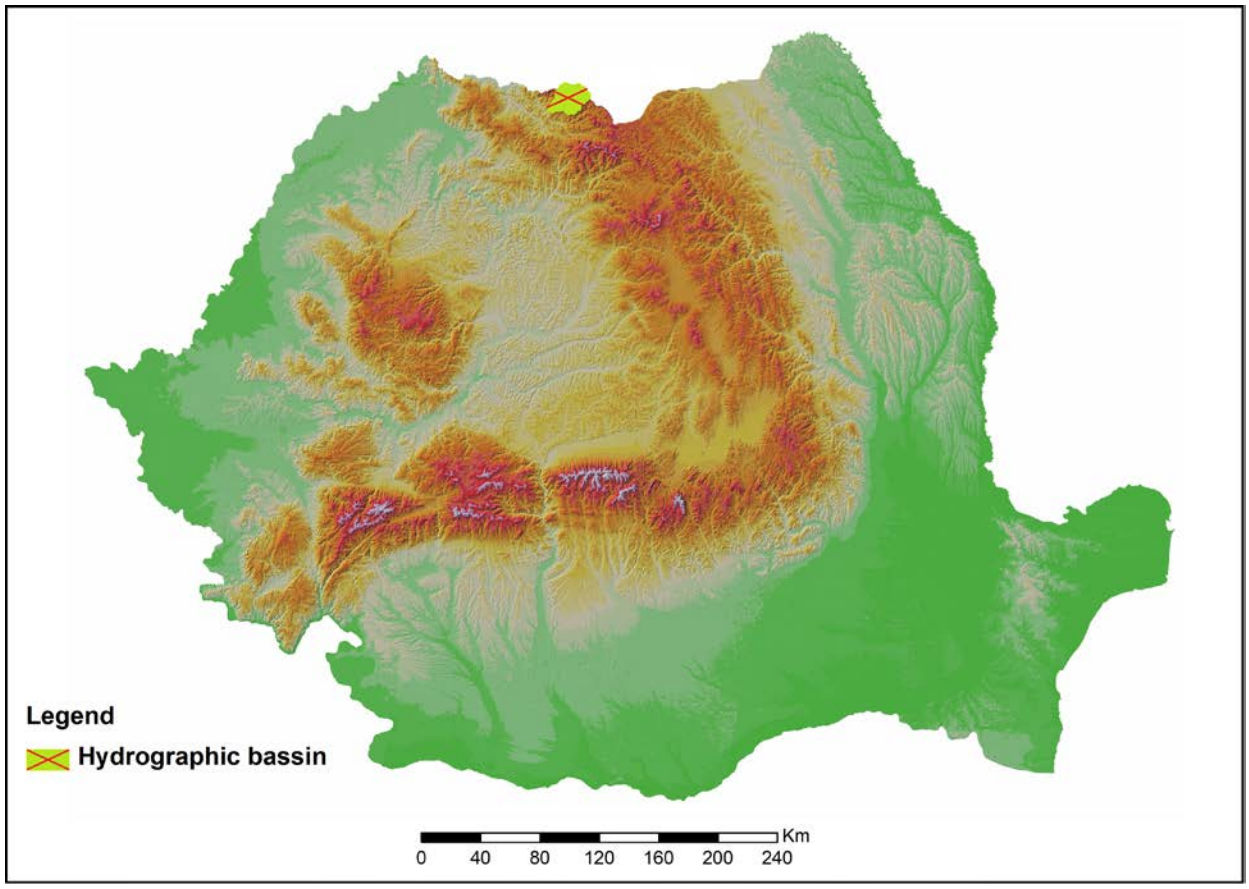


Figure 1: The Ruscova River basin localization, in the northern Romanian Carpathians.

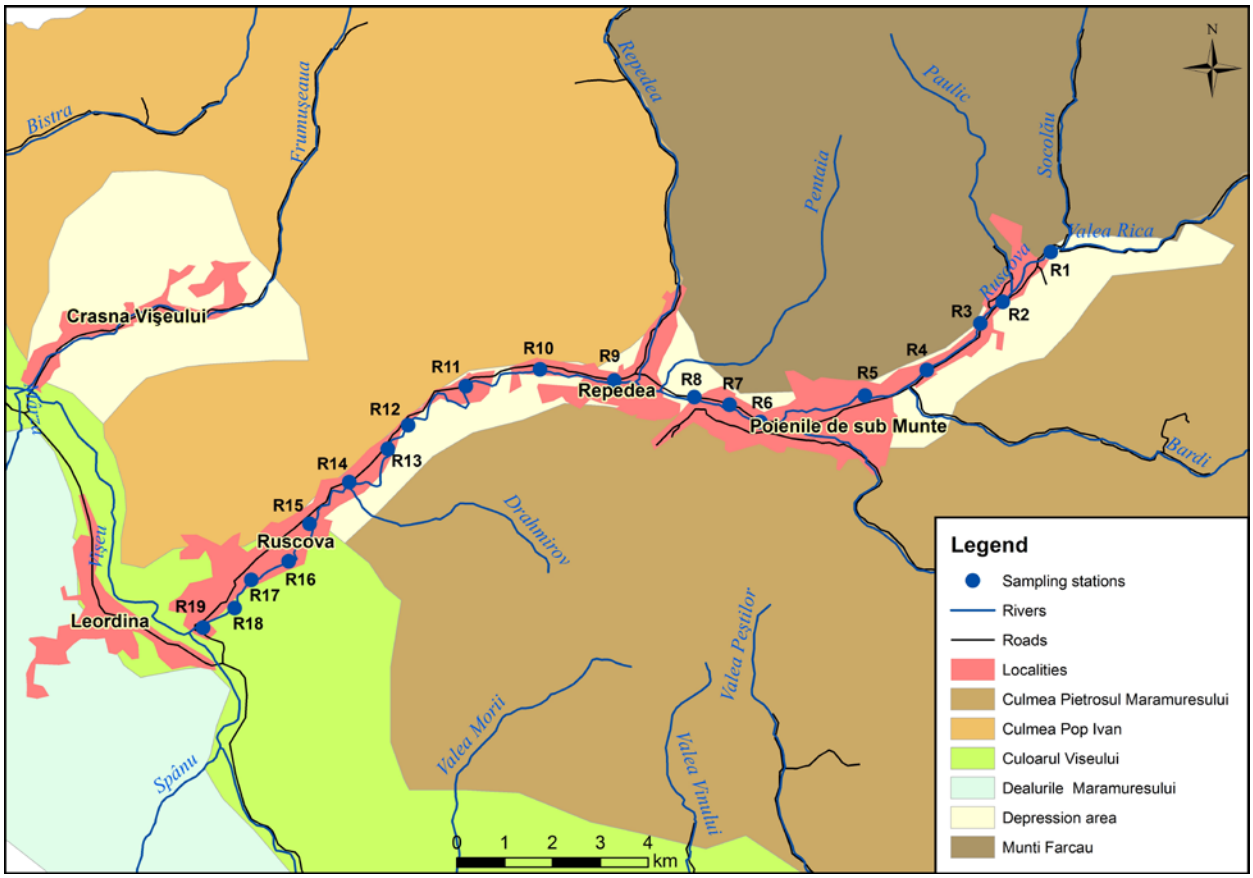


Figure 2: Map of the sampling stations.

## MATERIAL AND METHODS

The fishing method which was used in this study, in April of 2013, to assess the ecological state of the species *Hucho hucho* in the Ruscova River was electrofishing in time/effort unit (one hour). The used device was an Aquatech IG 600, 30 A, 0.65/1.2 kW. The same method was used for sampling other fish species which are the food source of over few month old individuals of *Hucho hucho* (Tab. 1) (Bănărescu, 1964).

All the sampled fish species of the 19 sampling stations (Fig. 2), including the Danube salmon individuals, were identified and counted in situ and released for conservative reasons.

The ichthyological integrity of the river was calculated for every sampled sector based on the Carpathian Fish – Index of Biotic Integrity (CF-IBI) river assessment (Bănăduc and Curtean-Bănăduc, 2002). This index reveals the fish associations' ecological state inclusively in response to river natural and anthropogenic variations in a predictable manner, showing a strong correlation with the habitat degree of degradation. The metrics used in this case are: total number of fish species, proportion of benthic fish species, proportion of water column species, proportion of individuals of intolerant species, proportion of individuals of typically tolerant species, proportion of individuals, which are omnivorous feeders, proportion of insectivorous feeders, number of individuals in the sample and number of introduced species.

At each station, quantitative samples of benthic macroinvertebrates from five points were collected in order to analyze the natural food source (Tab. 2) of *Hucho hucho* individuals younger than a few months (Bănărescu, 1964). A total of 20 quantitative samples of benthic macroinvertebrates were collected and analyzed. The benthic macroinvertebrate quantitative samples were collected with 887 $cm^2$ surface Surber Sampler, with a 250 µ mesh net. The sampled biological material was fixed in 4% formaldehyde solution, where $NaHCO_3$ was added. The invertebrate biological material was sorted and analyzed in the laboratory, preserved in 70% alcohol and included in the collection of the "*Lucian Blaga*" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection and Physics. The relative abundance (A%) and the statistical density (Ds) were used for the quantitative structure description of the benthic macroinvertebrates communities.

## RESULTS AND DISCUSSION

The sampled fish material (Tab. 1) consisted of 16 species: *Eudontomyzon danfordi* (Regan, 1911), *Salmo trutta fario* Linnaeus, 1758; *Hucho hucho* (Linnaeus, 1758); *Thymallus thymallus* (Linnaeus, 1758); *Telestes souffia* (Risso, 1827); *Squalius cephalus* (Linnaeus, 1758); *Phoxinus phoxinus* (Linnaeus, 1758); *Alburnus alburnus* (Linnaeus) 1758; *Alburnoides bipunctatus* (Bloch, 1782); *Chondrostoma nasus* (Linnaeus, 1758); *Gobio gobio* (Linnaeus) 1758, *Barbus barbus* (Linnaeus, 1758); *Barbus meridionalis* Riso 1826; *Orthrias barbatulus* (Linnaeus, 1758); *Cottus gobio* Linnaeus, 1758; *Cottus poecilopus* Heckel, 1837. The collected macroinvertebrate material (Tab. 2) constisted mainly of Ephemeroptera, Plecoptera, Trichoptera and Diptera species.

Table 1: Geographic location of the sampling stations ($R_1$-$R_{19}$) and relative abundance (A%) of the sampled (in time/effort unit) fish species in the Ruscova River basin; *Eudontomyzon danfordi – E. d., Salmo trutta fario – S. t. f., Hucho hucho – H. h., Thymallus thymallus – T. t., Telestes souffia – T. s., Squalius cephalus – S. c., Phoxinus phoxinus – P. p., Alburnus alburnus – A. a., Alburnoides bipunctatus – A. b., Chondrostoma nasus – C. n., Gobio gobio – G. g., Barbus barbus – B. b., Barbus meridionalis – B. m., Orthrias barbatulus – O. b., Cottus gobio – C. g.* and *Cottus poecilopus – C. p.*

| **Sampling station code** | **Geographic location** | | | Fish species | A% |
|---|---|---|---|---|---|
| | Altitude (m) | Latitude | Longitude | | |
| **$R_1$** | 684 | 47°51.372'N | 024°30.672'E | *C. p.* | (11.11) |
| | | | | *S. t. f.* | (22.22) |
| | | | | *C. g.* | (66.66) |
| **$R_2$** | 600 | 47°50.797'N | 024°29.878'E | *E. d.* | (2.94) |
| | | | | *S. t. f.* | (2.94) |
| | | | | *T. t.* | (2.94) |
| | | | | *O. b.* | (8.82) |
| | | | | *H. h.* | (11.76) |
| | | | | *P. p.* | (17.65) |
| | | | | *C. g.* | (52.94) |
| **$R_3$** | 591 | 47°50.550'N | 024°29.504'E | *E. d.* | (3.23) |
| | | | | *H. h.* | (3.23) |
| | | | | *T. t.* | (3.23) |
| | | | | *T. s.* | (3.23) |
| | | | | *A. b.* | (9.67) |
| | | | | *P. p.* | (12.90) |
| | | | | *O. b.* | (19.35) |
| | | | | *C. g.* | (45.16) |
| **$R_4$** | 572 | 47°50.022'N | 024°28.612'E | *H. h.* | (1.41) |
| | | | | *T. t.* | (1.41) |
| | | | | *T. s.* | (1.41) |
| | | | | *C. g.* | (2.82) |
| | | | | *O. b.* | (30.98 |
| | | | | *P. p.* | (61.97) |
| **$R_5$** | 557 | 47°49.729'N | 024°27.578'E | *H. h.* | (2.63) |
| | | | | *T. s.* | (2.63) |
| | | | | *C. g.* | (5.26) |
| | | | | *A. b.* | (5.26) |
| | | | | *T. t.* | (10.53) |
| | | | | *O. b.* | (15.80) |
| | | | | *P. p.* | (57.89) |
| **$R_6$** | 534 | 47°49.424'N | 024°25.835'E | *C. g.* | (6.66) |
| | | | | *O. b.* | (6.66) |
| | | | | *H. h.* | (13.34) |
| | | | | *A. b.* | (20.00) |
| | | | | *P. p.* | (26.67) |
| | | | | *T. t.* | (26.67) |

Table 1 (continuing): Geographic location of the sampling stations ($R_1$-$R_{19}$) and relative abundance (A%) of the sampled (in time/effort unit) fish species in the Ruscova River basin; *Eudontomyzon danfordi – E. d., Salmo trutta fario – S. t. f., Hucho hucho – H. h., Thymallus thymallus – T. t., Telestes souffia – T. s., Squalius cephalus – S. c., Phoxinus phoxinus – P. p., Alburnus alburnus – A. a., Alburnoides bipunctatus – A. b., Chondrostoma nasus – C. n., Gobio gobio – G. g., Barbus barbus – B. b., Barbus meridionalis – B. m., Orthrias barbatulus – O. b., Cottus gobio – C. g.* and *Cottus poecilopus – C. p.*

| **Sampling station code** | **Geographic location** | | | Fish species | A% |
|---|---|---|---|---|---|
| | Altitude (m) | Latitude | Longitude | | |
| **$R_7$** | 522 | 47°49.617'N | 024°25.311'E | *O. b.* | (2.78) |
| | | | | *H. h.* | (5.56) |
| | | | | *A. b.* | (25.00) |
| | | | | *T. t.* | (27.78) |
| | | | | *P. p.* | (38.88) |
| **$R_8$** | 515 | 47°49.701'N | 024°24.723'E | *A. b.* | (1.75) |
| | | | | *B. m.* | (1.75) |
| | | | | *H. h.* | (1.75) |
| | | | | *C. n.* | (3.51) |
| | | | | *T. t.* | (7.03) |
| | | | | *O. b.* | (21.05) |
| | | | | *P. p.* | (63.16) |
| **$R_9$** | 499 | 47°49.882'N | 024°23.378'E | *E. d.* | (2.86) |
| | | | | *T. s.* | (2.86) |
| | | | | *H. h.* | (2.86) |
| | | | | *B. m.* | (2.86) |
| | | | | *O. b.* | (5.71) |
| | | | | *A. b.* | (5.71) |
| | | | | *C. g.* | (8.57) |
| | | | | *T. t.* | (11.43) |
| | | | | *B. b.* | (11.43) |
| | | | | *P. p.* | (45.71) |
| **$R_{10}$** | 492 | 47°50.000'N | 024°22.136'E | *H. h.* | (1.61) |
| | | | | *B. m.* | (1.61) |
| | | | | *O. b.* | (3.23) |
| | | | | *C. g.* | (6.45) |
| | | | | *T. t.* | (6.45) |
| | | | | *B. b.* | (6.45) |
| | | | | *A. b.* | (9.68) |
| | | | | *P. p.* | (64.52) |
| **$R_{11}$** | 475 | 47°49.802'N | 024°20.897'E | *O. b.* | (2.78) |
| | | | | *C. g.* | (5.56) |
| | | | | *P. p.* | (44.44 |
| | | | | *H. h.* | (2.78) |
| | | | | *T. t.* | (27.78) |
| | | | | *B. b.* | (2.78) |
| | | | | *A. b.* | (13.88) |

Table 1 (continuing): Geographic location of the sampling stations ($R_1$-$R_{19}$) and relative abundance (A%) of the sampled (in time/effort unit) fish species in the Ruscova River basin.

| **Sampling station code** | **Geographic location** | | | Fish species | A% |
|---|---|---|---|---|---|
| **$R_{12}$** | 464 | 47°49.357'N | 024°19.934'E | *O. b.* | (2.56) |
| | | | | *H. h.* | (2.56) |
| | | | | *T. t.* | (2.56) |
| | | | | *B. b.* | (2.56) |
| | | | | *T. s.* | (2.56) |
| | | | | *S. c.* | (2.56) |
| | | | | *C. g.* | (5.14) |
| | | | | *A. b.* | (12.83) |
| | | | | *P. p.* | (66.67) |
| **$R_{13}$** | 458 | 47°49.090'N | 024°19.596'E | *H. h.* | (0.92) |
| | | | | *T. t.* | (0.92) |
| | | | | *B. m.* | (0.92) |
| | | | | *B. b.* | (0.92) |
| | | | | *T. s.* | (0.92) |
| | | | | *C. g.* | (3.67) |
| | | | | *O. b.* | (5.50) |
| | | | | *A. b.* | (12.84) |
| | | | | *P. p.* | (73.39) |
| **$R_{14}$** | 452 | 47°48.709'N | 024°18.959'E | *E. d.* | (1.35) |
| | | | | *S. c.* | (1.35) |
| | | | | *T. s.* | (1.35) |
| | | | | *B. b.* | (1.35) |
| | | | | *H. h.* | (2.70) |
| | | | | *T. t.* | (8.11) |
| | | | | *P. p.* | (10.81) |
| | | | | *A. b.* | (16.22) |
| | | | | *O. b.* | (21.62) |
| | | | | *C. g.* | (35.14) |
| **$R_{15}$** | 440 | 47°48.234'N | 024°18.299'E | *E. d.* | (0.75) |
| | | | | *B. m.* | (0.75) |
| | | | | *H. h.* | (1.50) |
| | | | | *C. g.* | (1.50) |
| | | | | *S. c.* | (0.75) |
| | | | | *T. s.* | (0.75) |
| | | | | *G. g.* | (0.75) |
| | | | | *C. n.* | (0.75) |
| | | | | *A. a.* | (0.75) |
| | | | | *T. t.* | (4.52) |
| | | | | *B. b.* | (4.52) |
| | | | | *O. b.* | (7.52) |
| | | | | *A. b.* | (27.07) |
| | | | | *P. p.* | (48.12) |

Table 1 (continuing): Geographic location of the sampling stations ($R_1$-$R_{19}$) and relative abundance (A%) of the sampled (in time/effort unit) fish species in the Ruscova River basin.

| **Sampling station code** | **Geographic location** | | | Fish species | A% |
|---|---|---|---|---|---|
| | Altitude (m) | Latitude | Longitude | | |
| **$R_{16}$** | 431 | 47°47.811'N | 024°17.955'E | *B. b.* | (1.75) |
| | | | | *B. m.* | (1.75) |
| | | | | *C. n.* | (1.75) |
| | | | | *S. c.* | (1.75) |
| | | | | *T. s.* | (1.75) |
| | | | | *T. t.* | (7.02) |
| | | | | *C. g.* | (7.02) |
| | | | | *P. p.* | (10.53) |
| | | | | *O. b.* | (7.02) |
| | | | | *A. b.* | (59.66) |
| **$R_{17}$** | 420 | $47^0$47.592'N | $024^0$17.328'E | *A. a.* | (1.75) |
| | | | | *T. s.* | (1.75) |
| | | | | *C. n.* | (1.75) |
| | | | | *B. m.* | (1.75) |
| | | | | *S. c.* | (1.75) |
| | | | | *G. g.* | (1.75) |
| | | | | *H. h.* | (1.75) |
| | | | | *B. b.* | (3.51) |
| | | | | *T. t.* | (7.02) |
| | | | | *O. b.* | (7.02) |
| | | | | *A. b.* | (35.09) |
| | | | | *P. p.* | (35.09) |
| **$R_{18}$** | 416 | $47^0$47.274'N | $024^0$17.058'E | *A. a.* | (20) |
| | | | | *S. c.* | (20) |
| | | | | *O. b.* | (20) |
| | | | | *A. b.* | (40) |
| **$R_{19}$** | 409 | 47°47.055'N | 024°16.534'E | *S. c.* | (25) |
| | | | | *A. a.* | (25) |
| | | | | *A. b.* | (25) |
| | | | | *H. h.* | (25) |

Important are the significant number of juveniles of *Hucho hucho* (Fig. 3), in the context of this relatively small river; and also the presence of reproductive age individuals, a fact which reveals that the reproduction in this river is happening.

The habitats and fish trophic offer for *Hucho hucho* can be considered as good with respect to diversity and abundance-with the exception of the lower Ruscova River ($R_{18}$-$R_{19}$), where apparently the human impact induces a significant temporary or permanent decrease of the ichthyocenosys diversity and abundance. We can find out if this situation is temporary or permanent only based on a future long term monitoring data. This lower area including the confluence area between the Ruscova and Vişeu rivers should be mostly but not only the target of specific management for fish protection.

The benthic invertebrates as a trophic base for *Hucho hucho* juveniles is very good, in terms of Ephemeroptera, Plecoptera, Trichoptera and Diptera larvae high diversity and density (Tab. 2). This favorable situation has consisted for the last seven years (Curtean-Bănăduc, 2008, 2009, 2010; Curtean-Bănăduc and Radu, 2010).

Figure 3: *Hucho hucho* juvenile.

Table 2: The benthic macroinvertebrate communities structure in the Ruscova River studied sectors (A – relative abundance).

| Benthic macroinvertebrate sampling stations | Taxa | A% |
|---|---|---|
| $r_1$ – at the confluence with the Bardiu River affluent | Cls. Gastropoda<br>Fam. Ancylidae | <br>3.70 |
| | Subcls. Oligochaeta | 1.64 |
| | Ord. Amphipoda<br>Fam. Gammaridae | <br>2.45 |
| | | |
| | Ord. Ephemeroptera | 47.88 |
| | Ord. Plecoptera | 3.28 |
| | Ord. Trichoptera | 26.93 |
| | Ord. Coleoptera | 1.64 |
| | Ord. Diptera<br>Fam. Chironomidae<br>Fam. Blepharoceridae | <br>1.00<br>11.48 |

Table 2 (continuing): The benthic macroinvertebrate communities structure in the Ruscova River studied sectors (A – relative abundance).

| | | |
|---|---|---|
| $r_2$ – between the confluence with Rica tributary and the cofluence with Bardiu tributary | Cls. Gastropoda<br>Fam. Ancylidae | 2.19 |
| | Ord. Tricladida<br>Fam. Planaridae | 1.38 |
| | Subcls. Oligochaeta | 5.17 |
| | Ord. Amphipoda<br>Fam. Gammaridae | 2.61 |
| | Ord. Ephemeroptera | 31.06 |
| | Ord. Plecoptera | 24.06 |
| | Ord. Trichoptera | 5.54 |
| | Ord. Coleoptera | 2.20 |
| | Ord. Diptera<br>Fam. Chironomidae<br>Fam. Blepharoceridae | 21.72<br>4.07 |
| $r_3$ – at the confluence with the Bardiu River tributary | Ord. Tricladida<br>Fam. Planaridae | 2.04 |
| | Subcls. Oligochaeta | 7.80 |
| | Ord. Amphipoda<br>Fam. Gammaridae | 1.42 |
| | Ord. Ephemeroptera | 36.07 |
| | Ord. Plecoptera | 18.25 |
| | Ord. Trichoptera | 15.71 |
| | Ord. Coleoptera | 2.00 |
| | Ord. Diptera<br>Fam. Chironomidae<br>Fam. Blepharoceridae | 12.50<br>4.21 |
| $r_4$ – in the Poienile de Sub Munte locality | Cls. Gastropoda<br>Fam. Ancylidae | 1.07 |
| | Subcls. Oligochaeta | 10.73 |
| | Ord. Amphipoda<br>Fam. Gammaridae | 0.93 |
| | Ord. Ephemeroptera | 34.74 |
| | Ord. Plecoptera | 16.51 |
| | Ord. Trichoptera | 18.14 |
| | Ord. Coleoptera | 2.44 |
| | Ord. Diptera<br>Fam. Chironomidae<br>Fam. Blepharoceridae | 13.88<br>1.56 |
| $r_5$ – in the Ruscova – Vişeu rivers confluence area | Subcls. Oligochaeta | 13.04 |
| | Ord. Amphipoda<br>Fam. Gammaridae | 0.54 |
| | Ord. Ephemeroptera | 25.35 |
| | Ord. Plecoptera | 10.85 |
| | Ord. Trichoptera | 25.33 |
| | Ord. Coleoptera | 2.39 |
| | Ord. Diptera<br>Fam. Chironomida | 22.50 |

Our working hypothesis is that the presence and relatively high numbers of *Hucho hucho* individuals in the Ruscova River have been determined by the river conditions regarding: the trophic (invertebrate and vertebrate) natural sources, natural and human induced habitat conditions, lotic connectivity inside the Ruscova River, and lotic connectivity among Ruscova, Vişeu and Tisa rivers. The results can be used for improving the Ruscova River management plan and for applying good practices to other rivers where *Hucho hucho* populations exist or can spread in the future.

The fish trophic offer is consisting of ten fish species, all of them being potential food for *Hucho hucho* after their individuals are over few months old (Bănărescu, 1964).

The number of fish species (12) and their abundance in the river are high. The majority of these species are present in over 80% of the river sectors and the ichthyologycal integrity is also high. The *Hucho hucho* fish trophic base is not a problem in this river.

The $R_1$-$R_{17}$ river sector has a very good CF-IBI score which reflects very good species richness, intolerant species in particular − sensitive species present. The $R_{18}$-$R_{19}$ sector has a fairly poor CF-IBI score which shows few species and individuals, tolerant species dominating.

The benthic macroinvertebrates natural trophic offer also represents a very good support for juveniles of the *Hucho hucho* in the studied river. It has to be stated that, in the lower area where the ichthyocenosys are affected by the human impact, the macroinevertebrate communities are in good conditions like in the other sectors of the river; here the fish communities' structure can be affected mainly by illegal fishing.

The human impact (riverbed modification/exploitation/regularization and waste water household pollution) is not very high in the present study (with the exception of the lower course of the river) but still has significant potential to become the reason for future regress of *Hucho hucho* from this river. Proper management actions should be enforced regarding these human impact categories, by the Maramureş Mountains Nature Park Administration and governmental agencies for nature protection. These actions will assure a higher habitat quality in the river and a better connectivity for the ichthyofauna in the Ruscova River.

The connectivity among Ruscova, Vişeu and Tisa rivers is essential for the *Hucho hucho*'s continuous presence in Ruscova River due to the fact that the Vişeu-Tisa river's confluences play a role in the aquatic biodiversity-due to the fact that the upper Tisa River has very good ecological conditions for the ichthyofauna.

The connectivity was interrupted in the past by the upstream of Vişeu River basin mining of Cu, Zn, Cd activities; (Staicu et al., 1998), the mining water flowing on Vişeu River sometimes creates chemical barriers and breaks the connectivity between Tisa and Ruscova ichthyofauna, through Vişeu River. The interruption of such mining activities has allowed a better connectivity in this respect nowadays.

Another human impact type present in the Vişeu River sector which represents the connection between Tisa and Ruscova rivers is the mineral exploitation; especially upstream the Vişeu River entering in the Vişeu River lower gorge, before the confluence with Tisa River. These exploitations should not be stopped, but a rigorous programme of functioning in parallel, (avoiding their functioning all together and creating areas of disturbances which create significant obstacles in front of the *Hucho hucho* upwards and downwards mobility) should be done. Of course overexploitation should be avoided.

A proper waste water canalisation and cleaning system should be realized in the riverine localities, both in Ruscova and Vişeu rivers-because their influences as a chemical barrier are not negligible.

The selective collection of the solid wastes should also be a task in the Ruscova and Vişeu rivers adjacent areas.

In the context of the climate warming and the deforestation activities in significant areas of this watershed, the changing (warming) water temperature will affect mainly the cryophilic species/associations, including the *Hucho hucho* populations. In this context, reforestations are needed.

Despite the fact that this area is a protected one, illegal over-fishing is still present. Done with nets, electricity, natural and/or synthetic substances, dung forks, etc., this is a situation which should be stopped somehow for respect of the big/reproductive *Hucho hucho* individuals' protection.

The spawning areas/sectors for *Hucho hucho* are not completely known and proper protection cannot be assured for them in this circumstance.

The status of trophic (fish and macroinvertebrates too) resources for *Hucho hucho* should be permanently included in integrated studies/monitoring activities.

The river sectors management should include implementation of a proper waste water canalisation and cleaning system.

The Ruscova River substratum and banks should not be changed or over-exploited, in the benefit of the Ruscova River biocoenosis too (Curtean-Bănăduc et al., 2012).

No significant water abstraction and hydro-technical constructions should be allowed in this river area.

The forestry activities which cause direct harm to the river and creek beds due to the transport of logs on them and indirect harm due to the increased and unnatural siltation processes should be monitorized.

The relatively low number of individuals of relatively small dimensions, and their general late sexual maturation make this population very prone to disappearance, in the conditions through which this species has been classified as most endangered, both locally and globally (Witkowski et al., 2003; Freyhof and Brooks, 2011).

In its general and local/specific context, this population is threatened by extinction at any lack of proper management of this river basin.

The approach used for this watershed management can be used as a model approach for any other similar Carpathian watershed of conservation interest, where *Hucho hucho* can recover its initial range.

This approach should be based on extensive and intensive biological and ecological data, obtained and checked/ monitored at least along a medium period of time (ten years).

From the perspective of *Hucho hucho* management/conservation objectives and measurements required, in the Ruscova River, for this course and lower Vişeu River watershed a special management zone can be revealed. The zones which should be managed for *Hucho hucho* conservation are the Ruscova watershed and Vişeu River between the confluence with Ruscova and the confluence with Tisa. In these areas the natural structure of the habitats, the aquatic communities, and the natural dynamic of the ecologic processes, are still existing and should be protected.

**CONCLUSIONS**

The management related with this highly endangered species of the Ruscova River and lower Vişeu River basin should include: maintenance of the relatively high and constant water flow; the basin management should include specific measures to counteract the climate warming changes; forest water retention capacity should be encouraged by the appropriate forestry management in all the basin; no hydro-technical works should be allowed to be built on the Ruscova River basin in the future; no important water captures should be allowed for hydro-technical works in the neighbouring watersheds; the water quality in the streams should be improved

everywhere in the basin where it is a necessity in this respect, through (quantitative and qualitative) cleaning activities, centralized canalisation of the riverine localities, sawdust management and avoidance of riverbed alteration; stopping of illegal fishing and enforcing the forbidding of legal fishing for the Danube salmon; the lower gorge sector of the Vişeu River, including the confluence area, should have a highly restricted protection regime not only for Danube salmon but for all the local fish species (as trophic resources) and for the trophic resources of benthic macroinvertebrates; the aquaculture of Danube Salmon and the artificial stocking and restocking of water bodies of interest should be initiated; a permanent integrated monitoring system should be implemented in the Vişeu Basin, as a needed base for an optimum management plan, including for the *Hucho hucho* conservation.

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# HABITAT MANAGEMENT IN A NATURA 2000 SITE – MARAMUREŞ MOUNTAINS CASE STUDY

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**KEYWORDS**: habitat, management measures, Natura 2000 site, Maramureș Mountains.

**ABSTRACT**

The territory chosen for study is the Maramureş Mountains Nature Park (MMNP). This is a relatively new protected natural area, set up by Government Decision 2151/2004, 30 years after Filipaşcu A. recommendation (1975-1976) to "declare some large and representative natural parks within more significant massifs: Maramureş, Rodnei, Călimani, Bucegi and Făgăraş".

In this paper we present the identified habitats in Maramureș Mountains Nature Park and the Maramureș Mountains Natura 2000 Site of Community Interest RO SCI 00124, which overlaps the park area. The purpose of this paper is to offer support in elaborating habitat management plans and monitoring their conservation status. The paper also presents a comparative analysis of habitats identified in the field and of habitats listed in Natura 2000 Standard Data Form.

**REZUMAT**: Managementul habitatelor în siturile Natura 2000 – Studiu de caz Munții Maramureșului.

Teritoriul ales de noi pentru studiu este Parcul Natural Munţii Maramureşului (PNMM), o arie naturală protejată relativ nouă, instituită prin H. G. 2151/2004, la 30 de ani de la recomandarea lui Filipaşcu A. (1975-1976) de „declarare a unor întinse şi reprezentative parcuri naturale în masivele mai importante: munţii Maramureşului, Rodnei, Călimani, Bucegi şi Făgăraş".

Acestă lucrare vizează identificarea tipurilor de habitate din Parcul Natural Munții Maramureșului și implicit din situl Natura 2000 RO SCI 00124 Munții Maramureșului, suprapus peste suprafața parcului. Scopul acestei lucrări este de a oferi suportul pentru realizarea planului de management al habitatelor şi a monitorizării stării de conservare a acestora. De asemenea, lucrarea prezintă și o analiză comparativă a habitatelor prezentate în formularul standard al sitului Natura 2000 cu habitatele identificate de noi pe teren.

**ZUSAMMENFASSUNG**: Habitat Management in Natura 2000-Gebieten – Fallstudie Maramurescher Gebirge/Munții Maramureșului.

Das von der Verfasserin zur Untersuchung ausgewählte Gebiet, der Naturpark Maramurescher Gebirge/Munţii Maramureşului (PNMM) ist ein relativ neues Naturschutzgebiet, das durch den Regierungsbeschluss H. G. 2151/2004 ausgewiesen wurde und zwar 30 Jahre nach der Empfehlung von Filipaşcu A. (1975-1976) betreffend die "Ausweisung einiger ausgedehnter und repräsentativer Naturparks in den bedeutendsten Gebirgsmassiven der Karpaten: Maramurescher Gebirge/Munţii Maramureşului, Rodnaer-Gebirge/Munţii Rodnei, Călimani-, Bucegi- und Fogarascher/Făgăraş-Gebirge".

Vorliegende Arbeit befasst sich mit der Erfassung der Habitattypen des Naturparks Maramurescher Gebirge/Munţii Maramureşului, einschließlich des Natura 2000 Gebietes RO SCI 00124 Maramurescher Gebirge das sich mit der Fläche des Naturparks überlagert. Zweck dieser Arbeit ist es, die Grundlagen zur Ausarbeitung des Managementplanes für die Habitate und das Monitoring ihres Erhaltungszustandes zu liefern. Außerdem umfasst die Arbeit eine vergleichende Analyse der im Standardformular des Natura 2000 Gebietes vorgestellten Habitate und denen, die von der Verfasserin im Gelände erfasst wurden.

## INTRODUCTION

Maramureş Mountains represent the highest mountain massif located on the Romanian national border and is the convergence point of several ethnographic regions (Romanian Maramureş, Zacarpatia, Southern and Northern Bucovina, Galiţia). Maramureş Mountains are located in the northern part of the Oriental Carpathians, and border Ţibăului Mountains in the east, Rodnei Mountains and Maramureş Depression in the south, and Rahiv and Cernahora (from Ukraine) Mountains in the north.

The hydrographical network is highly developed, providing abundant, permanent water runoff during the entire year. Maramureş Mountains include three drainage basins: Vişeu (Tisa), Bistriţa (Siret) and Ceremuş (Prut) (Mureşan, 2008).

Maramureş Mountains are located in the continental moderate climate area, permanently subjected to the influence of western oceanic air masses advection, whose characteristics reflect into the evolution of all climatic elements (Moldovan, 2000). The rainiest season is summer, when 61% of total rainfall registered. The poorest rainfall season is winter, with only 17% of the total rainfall. The annual number of rainfall days is 150-170. The snow layer occurs in September and during the last decade the last snow has typically been in March. The snow layer is maintained between 120-200 days, and the layer thickness ranges from 75-150 cm.

From the large soil groups, significant surfaces are covered by districambosoil, prepodzolic soils, litosoils, humisoils and alluvial soils.

Two towns (Borşa and Vişeu de Sus) and eight communes (Moisei, Vişeu de Jos, Ruscova, Repedea, Poienile de Sub Munte, Leordina, Petrova and Bistra with their villages Valea Vişeului and Crasna Vişeului) are included within the MMNP. These have developed along the courses of the Vişeu, Repedea, Ruscova and Tisza rivers. The population in the ten localities in the MMNP is approximately 90,000 inhabitants.

The evolution of landscape is closely connected to the traditional occupations. Therefore, logging, breeding cattle and mining have affected the landscape and implicitly the natural framework over time. The pre-Christian customs related to nature worship, old and new religious holy days, agricultural customs and traditions related to the human life cycle harmoniously combine in the communities of the MMNP.

The entire surface of the massif (including the depression and marginal hills areas) is 1,500 $km^2$. The area of this study is represented by the territory of the Maramureş Mountains Nature Park (MMNP; Fig. 1), with the limits stipulated by GD 2151/2004. These limits comprise a 133,354 ha surface.

About 70% of MMNP surface was declared as a Natura 2000 Communitarian Interest Site by the Order 1964/2007 regarding the establishment of protected area status for communitarian interest sites, as part of the European Ecological Network Natura 2000 in Romania.

The management plan of Maramureș Mountains Nature Park has to include in it's structure specific information for the management of Natura 2000 site RO SCI 00124 Maramureș Mountains. This paper provides instruments for the elaboration of habitats management plans and monitoring plans.

## MATERIALS AND METHODS

**Identification of habitat types in the growing stock.** For the land surfaces included in the growing stock, sylvic planning was performed. Using the correspondence between the forest types and Natura 2000 habitat types, a map of habitat type distribution can be produced. There is also the possibility to achieve a correspondence with the habitat types of Romania, with a much greater concern for details.

**Identification of other habitat types.** Identification of habitat types other than the forest ones is usually performed by recognition of phytocenoses that characterizes them. That means by considering the significant (generally prevailing) species and ecological and/or cenological markers, as well as by recognition of the characteristics of the site, first by geographical location, altitude, relief, rock and soil. This type of identification may be used also for forest habitats, but also for smaller sites.

**Habitat mapping.** For mapping the habitat types, regardless of their nature, we used the following cartographical materials: Ortophotoplans, satellite images, topographic maps (1:25,000), sylvic maps (1:20,000 and 1:50,000). The information on these maps has been transposed into a Geographical Information System (GIS). On these the land use data resulting from the planning of the growing stock were superimposed. For the forest habitat types we used the limits of land use units as habitat limits, where the transition to a certain type of habitat (identified based on the forest type) to another type of habitat is performed. For the meadow, scrub, swamps and wet land habitat types, we set the limits of the habitats to the changes of the phytocenoses and sites characterizing them. The positioning of habitats on the map is performed by means of the GPS coordinates collected from the field, by using a GPS Trimble ProXH receptor with a zephir antenna and GPS Trimble ProXT. The data were processed using ArcGIS 9.3 software.

**Summary of the identified habitats**. Using the habitat identification means described in the previous chapter, the existing bibliography and setting the correspondence between the Natura 2000 habitat types and Habitats from Romania (Doniţă et al., 2005, 2006; Gafta and Munford, 2008) and then by correlating them to the field data, we summarized the habitat types in Maramureş Mountains Nature Park.


Figure 1: Location of Maramureş Mountains Nature Park.

**RESULTS**

Using the methodology presented above we identified 19 Natura 2000 habitat types (of which six are priority habitats). 36 habitats correspond to the above mentioned habitats, in the sense of Habitats from Romania (Doniţă et al., 2005, 2006) and six habitats which do not have a correspondent in the Natura 2000 habitat types (Tab. 1).

In this summary we included the habitat types we identified until now, without considering that a comprehensive classification of all habitat types was performed and the names used in this summary are the same with those in the Natura 2000 classification system and Habitats from Romania.

Table 1: Correspondence between Natura 2000 habitats and habitats from Romania identified in MMNP.

| No. | Natura 2000 code | Type of Natura 2000 habitat | Romania code | Type of habitat according to Habitats from Romania (Doniţă et al., 2005, 2006) |
|---|---|---|---|---|
| 1. | 3230 | Mountain rivers and wood vegetation with *Myricaria germanica* | 4415 | Dacic shrubs of box thorn (*Myricaria germanica*) |
| 2. | 4060 | Alpine and boreal pastures | 3104 | South – Eastern Carpathian rhododendron scrubs (*Rhododendron myrtifolium*), with bilberry (*Vaccinium myrtillus*) |
| | | | 3108 | South – Eastern Carpathian short juniper shrubs (*Juniperus sibirica*) |
| 3. | 4070* | Shrubs with *Pinus mugo* and *Rhododendron hirsutum (Mugo-Rhododendretum hirsuti*) | 3105 | South – Eastern Carpathian juniper tree shrubs (*Pinus mugo*), with rhododendron (*Rhododendron myrtifolium*) |
| 4. | 6230* | Species rich *Nardus* grasslands on the siliceous substrata of mountainous areas | 3608 | South – Eastern Carpathian grasslands with *Scorzonera rosea* and *Festuca nigrescens* |
| | | | 3609 | South – Eastern Carpathian grasslands with nard grass (*Nardus stricta*) and *Viola declinata* |
| 5. | 6430 | Woodside associations with tall higrophyle grass from the level of plains to the mountainous and alpine level | 3704 | South – Eastern Carpathian communities of tall bushes with *Senecio subalpinus* and alpine dock (*Rumex alpinus*) |
| | | | 3708 | Daco-getic communities with *Angelica sylvestris*, *Crepis paludosa* and *Scirpus sylvaticus* |
| 6. | 6520 | Mountain grasslands | 3801 | South – Eastern Carpathian grasslands with *Trisetum flavescens* and *Alchemilla vulgaris* |
| 7. | 7140 | Transition peat swamps and moving peateries (not fixed in the substrata) | 5408 | South – Eastern oligotrophe Carpathian swamps, with *Carex limosa* |

Table 1 (continuing): Correspondence between Natura 2000 habitats and habitats from Romania identified in MMNP.

| No. | Natura 2000 code | Type of Natura 2000 habitat | Romania code | Type of habitat according to Habitats from Romania (Doniţă et al., 2005, 2006) |
|---|---|---|---|---|
| 8. | 7220* | Petrifying springs with travertine formation (*Cratoneurion*) | 5417 | Fontinal South – Eastern Carpathian communities with *Cratoneuron commutatum* and *C. filicinum* |
| 9. | 8210 | Rocky slopes with chasmophytic vegetation | 6213 | South – Eastern Carpathian communities on rocks with *Saxifraga luteoviridis* and *Silene zawadzkii* |
| 10. | 9110 | *Luzulo-Fagetum* type forests | 4102 | South – Eastern Carpathian spruce forests (*Picea abies*), beech (*Fagus sylvatica*) and firs (*Abies alba*), with *Hieracium rotundatum* |
| | | | 4106 | South – Eastern Carpathian beech forests (*Fagus sylvatica*) and firs (*Abies alba*), with *Hieracium rotundatum* |
| | | | 4110 | South – Eastern Carpathian beech forests (*Fagus sylvatica*) with *Festuca drymeia* |
| 11. | 9130 | *Asperulo-Fagetum* type of forests | 4118 | Dacic beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) forests, with *Dentaria bulbifera* |
| | | | 4119 | Dacic beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) forests, with *Carex pilosa* |
| | | | 4120 | Mixed Moldavian beech (*Fagus sylvatica*) silver lime (*Tilia tomentosa*) forests, with *Carex brevicollis* |
| 12. | 9150 | *Cephalanthero-Fagion* type medio-European forests | 4111 | South – Eastern Carpathian beech (*Fagus sylvatica*) and firs (*Abies alba*) forests, with *Cephalanthera damassonium* |
| 13. | 9170 | Oakery with *Galio-Carpinetum* | 4123 | Dacic holmoak (*Quercus petraea*), beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) forests with *Carex pilosa* |
| 14. | 9180* | Slope, detritus or ravines forests composed of *Tilio-Acerion* | 4117 | South – Eastern Carpathian ash (*Fraxinus excelsior*), sycamore maple (*Acer pseudoplatanus*), elm (*Ulmus glabra)* forests with *Lunaria rediviva* |
| 15. | 91D0* | Wooded peateries | 4412 | South – Eastern Carpathian rare tree spruce (*Picea abies*) and/or Scots Pine (*Pinus sylvestris*) forests |

Table 1 (continuing): Correspondence between Natura 2000 habitats and habitats from Romania identified in MMNP.

| No. | Natura 2000 code | Type of Natura 2000 habitat | Romania code | Type of habitat according to Habitats from Romania (Doniţă et al., 2005, 2006) |
|---|---|---|---|---|
| 16. | 91E0* | Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)* | 4401 | South – Eastern Carpathian grey alder *(Alnus incana)* forests, with *Telekia speciosa* |
| | | | 4402 | Daco-getian forests in hill meadows with black alder *(Alnus glutinosa)*, with *Stellaria nemorum* |
| 17. | 91V0 | Dacic beech forests (*Symphyto-Fagion)* | 4101 | South – Eastern Carpathian spruce *(Picea abies)*, beech *(Fagus sylvatica)* and firs *(Abies alba)* forests, with *Pulmonaria rubra* |
| | | | 4103 | South – Eastern Carpathian spruce *(Picea abies)*, beech *(Fagus sylvatica)* and firs *(Abies alba)* forests, with *Leucanthemum waldsteinii* |
| | | | 4104 | South – Eastern Carpathian beech *(Fagus sylvatica)* and firs *(Abies alba)* forests, with *Pulmonaria rubra* |
| | | | 4109 | South – Eastern Carpathian beech *(Fagus sylvatica)* forests with *Symphytum cordatum* |
| 18. | 91Y0 | Dacic oak and hornbeam forests | 4128 | Daco-getian sessile oak *(Quercus petraea)* forests, with *Dentaria bulbifera* |
| 19. | 9410 | Forests with *Picea* from the alpine – mountainous region | 4203 | South – Eastern Carpathian spruce firs *(Picea abies)* forests with *Soldanella hungarica* |
| | | | 4205 | South – Eastern Carpathian spruce firs *(Picea abies)* forests with *Oxalis acetosella* |
| | | | 4206 | South – Eastern Carpathian spruce firs *(Picea abies)* and firs *(Abies alba)* forests with *Hieracium rotundatum* |
| | | | 4207 | South – Eastern Carpathian spruce firs *(Picea abies)* and firs *(Abies alba)* forests with *Hylocomium splendens* |
| | | | 4208 | South – Eastern Carpathian spruce firs *(Picea abies)* and firs *(Abies alba)* forests with *Luzula sylvatica* |
| | | | 4210 | South – Eastern Carpathian spruce firs forests with *Sphagnum* sp. |
| | | | 4214 | South – Eastern Carpathian spruce firs *(Picea abies)* and beech *(Fagus sylvatica)* forests with *Hieracium rotundatum* |

Table 1 (continuing): Correspondence between Natura 2000 habitats and habitats from Romania identified in MMNP.

| | | | | |
|---|---|---|---|---|
| 20. | | No correspondent | 3610 | *Poa media* South – Eastern Carpathian forests |
| 21. | | No correspondent | 4129 | Dacic holm oak *(Quercus petraea)* and beech *(Fagus sylvatica)* forests with *Festuca drymeia* |
| 22. | | No correspondent | 4209 | South – Eastern Carpathian spruce fir *(Picea abies)* forests with *Leucanthemum waldsteinii* |
| 23. | | No correspondent | 4211 | South – Eastern Carpathian spruce fir *(Picea abies)* and firs *(Abies alba)* forests with *Pulmonaria rubra* |
| 24. | | No correspondent | 4213 | South – Eastern Carpathian spruce fir *(Picea abies)* forests with *Doronicum columnae* |
| 25. | | No correspondent | 5423 | South – Eastern Carpathian spring and rivulet communities with *Carex remota* and *Caltha laeta* |

Note: * = priority European level habitat.

**DISCUSSIONS**

We identified 19 Natura 2000 habitats in the field (Fig. 2), comparing to 15 Natura 2000 habitats presented in the standard form in M.O. 1964/2007 and 18 Natura 2000 habitats presented in the standard form of Maramureş Mountains Natura 2000 Site RO SCI0124, as presented in the review in 2011 by M.O. 2387.

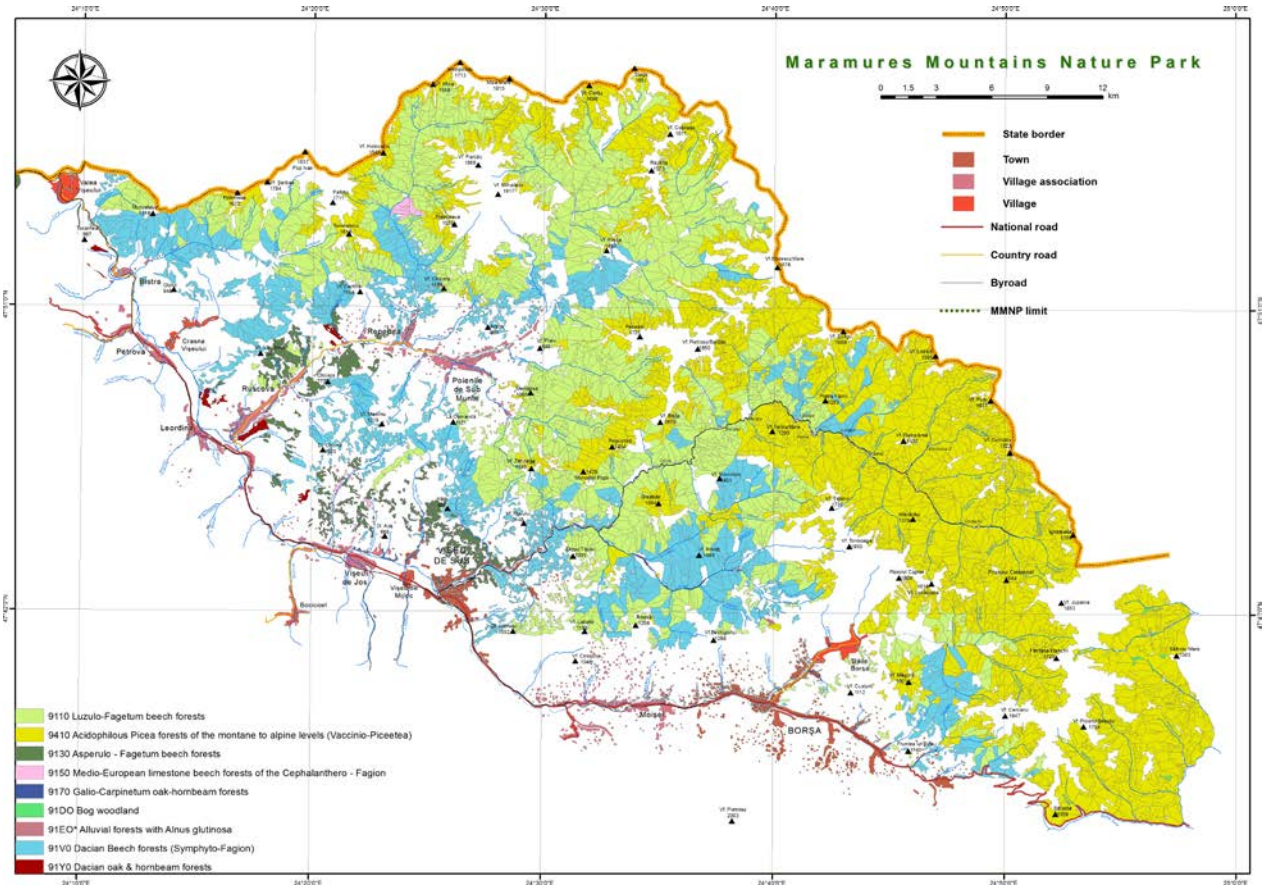


Figure 2: Nine identified Natura 2000 habitat types.

We appreciate this review realised by the Ministry of Environment as very useful for the conservationists and staff involved in protected areas management and in environmental issues in protected areas.

The limit of the communitarian interest site was given in 2007 as 103.391 ha and revised in 2011 to 106.909 ha, the new limit is designed according to the villages inside the park boundaries.

Almost all protected areas management plans in Romania are elaborated according to the manual designed by Michael Appleton, that do not include management plans for Natura 2000 species and habitats that are required for Natura 2000 sites. In addition to this, an appropriate identification of species, their mapping and ecological information for them are required in order to complete the management plan. This paper offers support in the elaboration of habitats management plans in Maramureş Mountains Nature Park and Natura 2000 site by providing a list of habitats more close to the reality in the field. In addition to this paper, we intend in our future work to elaborate management plans for some priority habitats in the studied area.

Management plans, or at least a set of management measures is needed for every Natura 2000 habitat.

Monitoring plans and protocols are required only for the most sensitive habitats, priority ones, or the habitats of rare, vulnerable, endangered or flag species. The list of species and habitats for which there is a need of monitoring plan is specifically designed for every particular protected area.

We consider that for Maramureş Mountains Nature Park and Natura 2000 site monitoring plans are needed for at least the following habitats: mountain rivers and their wood vegetation with *Myricaria germanica*; Shrubs with *Pinus mugo* and *Rhododendron hirsutum (Mugo-Rhododendretum hirsuti)*, species rich *Nardus* grasslands, on the siliceous substrata of mountainous areas, Petrifying springs with travertine formation (*Cratoneurion*); Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae).*

Until now, we elaborated monitoring protocols for the habitat Shrubs with *Pinus mugo* and *Rhododendron hirsutum (Mugo-Rhododendretum hirsuti*) (Danci, 2008; Danci and Cristea, 2009).

**CONCLUSIONS**

The studies that were performed in this paper offer a highly complex image of the habitat types in the Maramureş Mountains Nature Park, of their management and conservation measures and meet the management needs of the Natura 2000 habitats with precise tools and management recommendations.

This paper summarise the habitat types, setting the correspondence between the Natura 2000 habitat types and Habitats from Romania (Doniţă et al., 2005, 2006) and then by correlating them to field data.

Thus, 19 Natura 2000 habitat types were identified (of which six are priority habitats). 36 habitats correspond to the above mentioned habitats, in the sense of Habitats from Romania (Doniţă et al., 2005, 2006) and six other habitats which do not have a correspondent in the Natura 2000 habitat types.

A list of habitats for which we consider necessary to design monitoring plans was designed.

**AKNOWLEDGEMENTS**

This paper presents a part of the results of my PhD thesis; for the scientific coordination of the thesis and for his permanent support I am grateful to Mr. Cristea V.

Also, I would like to thank my former colleagues from Maramureș Mountains Nature Park administration for their help and understanding.

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# SPATIAL DYNAMICS OF THE BIOCAPACITY VALUES AND THE RELATION WITH THE PROTECTED AREAS DISTRIBUTION IN OLTENIA SOUTH-WEST DEVELOPMENT REGION

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**KEYWORDS**: ecological footprint, biocapacity, protected areas, South-West Oltenia, development region.

**ABSTRACT**

The South-West Development Region of Oltenia is one of the Romanian regions with high biodiversity. In the present article, using the Wackernagel-Rees method, biocapacity values were calculated for the territorial administrative units from the region and for protected areas. Biocapacity is an indicator used at a global scale since the 1990s, but very little is used in Romania. The indicator is used in an ecological footprint analysis to indicate the manner in which different bioproductive areas (forests, croplands, grasslands, aquatic surfaces, built-up land) have the capacity to sustain the resources needs of human society. The purpose of this paper is to establish the relationship between the spatial dynamics of biocapacity values and the protected areas distribution in the South-West Development Region.

**REZUMAT**: Dinamica spațială a valorilor biocapacității și relația cu ariile protejate în Regiunea de Dezvoltare Sud-Vest Oltenia.

Regiunea de Dezvoltare Sud-Vest Oltenia, este una din regiunile României cu biodiversitate ridicată. În acest articol, utilizându-se metoda Wackernagel-Rees, au fost calculate valorile biocapacității pentru unitățile administrativ teritoriale din regiune și apoi pentru ariile naturale protejate. Biocapacitatea este un indicator utilizat la scară globală încă din anii 90, dar foarte puțin utilizat în România. Indicatorul este utilizat în analiza amprentei ecologice pentru a indica modul în care diferite arii bioproductive (păduri, terenuri cultivate, terenuri pentru păşunat, suprafețe acvatice, terenuri construite) au capacitatea de a susține cererea de resurse a societății umane. Scopul acestei lucrări este de a stabili legătura dintre dinamica spațială a valorilor biocapacității și distribuția ariilor protejate din Regiunea de Dezvoltare Sud-Vest Oltenia.

**RÉSUMÉ**: La dynamique spatiale des valeurs de la biocapacité et sa relation avec la distribution des aires protegées dans la Région de Développement Sud-Ouest Oltenia.

La Région de Développement Sud Ouest Oltenia est l'une des régions de la Roumanie possédant une grande biodiversité. Dans cet article, on utilise la méthode Wackernagel-Rees pour calculer les valeurs de la biocapacité pour les unités administratives ainsi que pour les aires protegées. La biocapacité est un indicateur utilisé dans le monde depuis les années 90, mais il a été très peu utilisé en Roumanie. Cet indicateur est utilisé dans l'analyse de l'empreinte écologique afin d'obtenir une indication sur la capacité des différentes aires productives à soutenir la demande de la société humaine. L'objectif de cet article est d'établir la liason entre la dynamique spatiale des valeurs de la biocapacité et la distribution des aires naturelles protégées dans la Région de Développement Sud-Ouest Oltenia.

## INTRODUCTION

Since the concept of sustainable development was introduced on the political agenda of the humanity, there were numerous approaches to identify methods and support the decision makers in the planning of the best measures needed to reach the sustainable development targets. Unsustainable consumption and exaggerated production were both considered to be the main factor of the environment degradation (Simpson et al., 2000). The reconsideration of the exploitation model of natural resources and management of the waste is one of the most important challenges for the human society in the 21st century (Barett and Scott, 2001).

Although three decades have passed since the definition of the concept, the developed states continue to consume the natural resources in a way that obviously overpass the carrying capacity of the planet, the differences between the offer of the nature, and the level of consumption leading to a real ecological crisis. Today's society is based on excessive consumption and the model of the western countries seem to extend in other countries. This model was also created by Romania and its impact seems to increase every day. In time, many indicators were developed, like the ecological footprint, that aimed to quantify the impact of the consumption on natural. This concept was launched in the '90s by Mathis Wackarnagel and William Reese from British Columbia University (Ewing et al., 2001) and it is defined as "the amount of biologically productive land and water area required to produce all the resources an individual, population or activity consumes and to absorb the waste they generate, given prevailing technology and resource management practices". Although the concept appeared in the '90s, the Romanian researchers didn't pay too much attention to it, until after 2000, and only a few stories were published. In this paper, the focus is not on the assessment of the ecological footprint in the SW Development Region, but on the assessment of a related indicator which is called biocapacity. This approach was used too for the neighbour Muntenia Development Region (Cherăscu, 2012). The biocapacity, or the biological capacity, is defined as "the amount of the productive area that is available to generate the resources and absorb the waste" mentioned above. The evaluation of the biocapacity values in Oltenia is a part of a larger study which aims to establish the ecological footprint of the consumption in the SW Region and to draw the attention of the decision makers in the area on this indicator.

## MATERIALS AND METHODS

The assessment of the biological capacity is an important step in the analysis of the ecological footprint values in a given space, because the biocapacity is an answer given by the ecosystems to the human society resources demand. Depending on the consumption, the pressure on the ecosystems can be higher or lower. The values of the biocapacity depend on the natural factors (clime, soils), but also on the particularities of the land use. In our analysis, to calculate the values of the biocapacity in the SW Region, we started from the land use types in each of the 448 territorial units in the region. The data were obtained from the Corine Land Cover 2006 system, but also from the national statistics.

In the ecological footprint analysis, five bioproductive areas are considered: cropland, built-up land, forests, grazing land and fishing ground (or water surfaces). For each of these categories, we applied the following formula:

(1) **BC = A x YF x EQF**

BC = biocapacity, YF = yield factor and EQF = equivalence factor.

The results are in global hectares (gha), where a global hectare represents a hectare with the world's average productivity. From the total values, we deducted 13%, which represents the biocapacity reserve necessary to satisfy the needs of other species besides humans.

In table 1, there are the values of the yield factor and equivalence factor used in our calculation. The aim of these factors is to allow a comparison between different lands, but also between different regions.

The same method was used to calculate the biocapacity values for the protected areas.

Table 1: Yield and equivalence factors used to calculate the biocapacity of the SW Development Region.

| Land type | Yield factor | Equivalence factor |
|---|---|---|
| Cropland | 0.9 | 2.64 |
| Grazing land | 2.04 | 0.50 |
| Forests | 2.01 | 1.33 |
| Built-up land | 0.9 | 2.64 |
| Water | 2.8 | 0.40 |

**RESULTS AND DISCUSSION**

The SW Development Region, called also Oltenia, is one of the eight development regions of Romania, and, as it can be seen in figure number 1, it is located in the south-west of the country.

The region has a surface of 29,212 $m^2$ and it is populated by 2,246,033 inhabitants, with a density of 79.3 habitant per square kilometer.

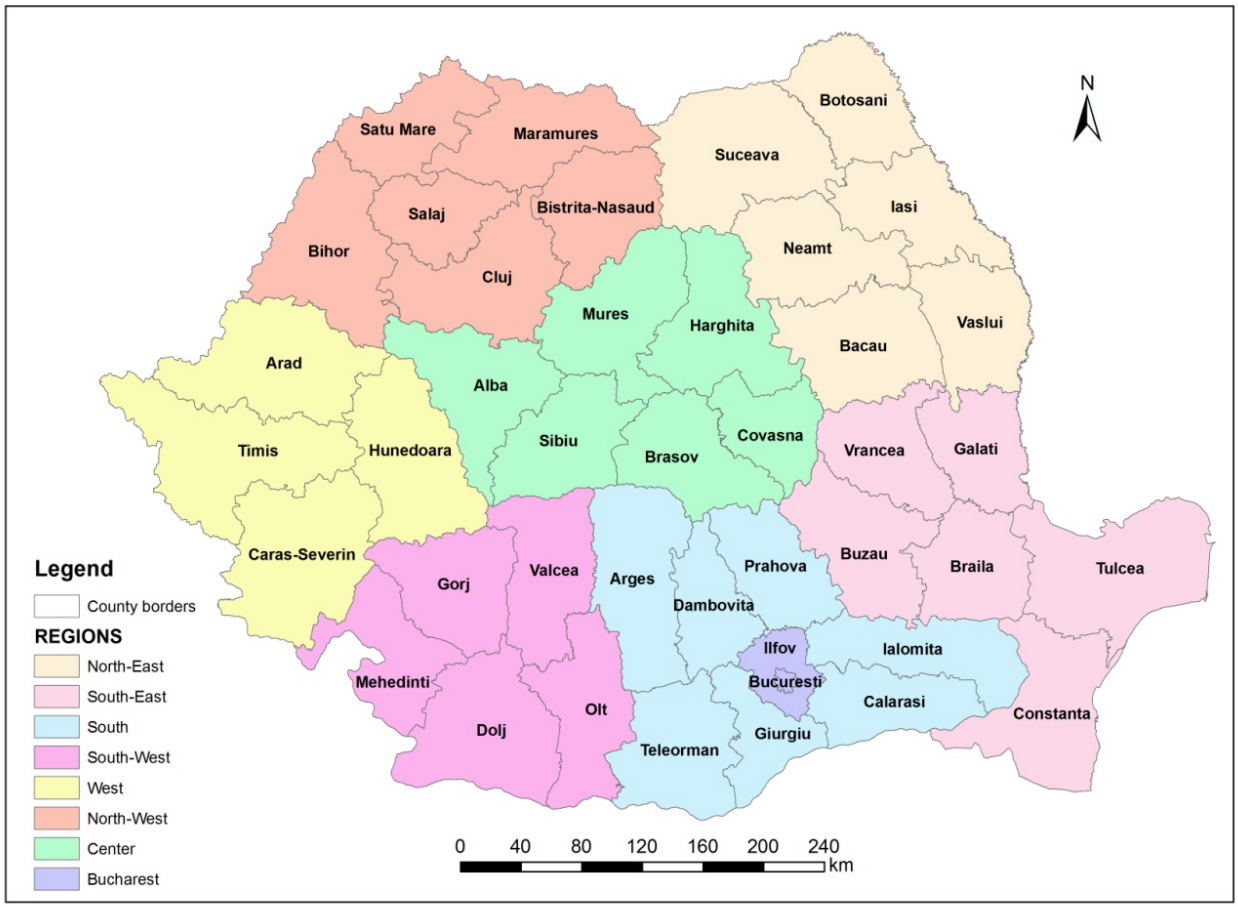


Figure 1: The Development regions in Romania.

For the SW Development Region, the value of the total biocapacity is 5,595,558 gha, although the surface of the region has only 2,922,121 ha. When we take in consideration the whole population of the region, the data show a value of 2.49 gha per habitant, but this value is higher than the national or the world average. Figures 2 and 3 present the value of the total biocapacity and the biocapacity per habitant respectively, in the SW Region.

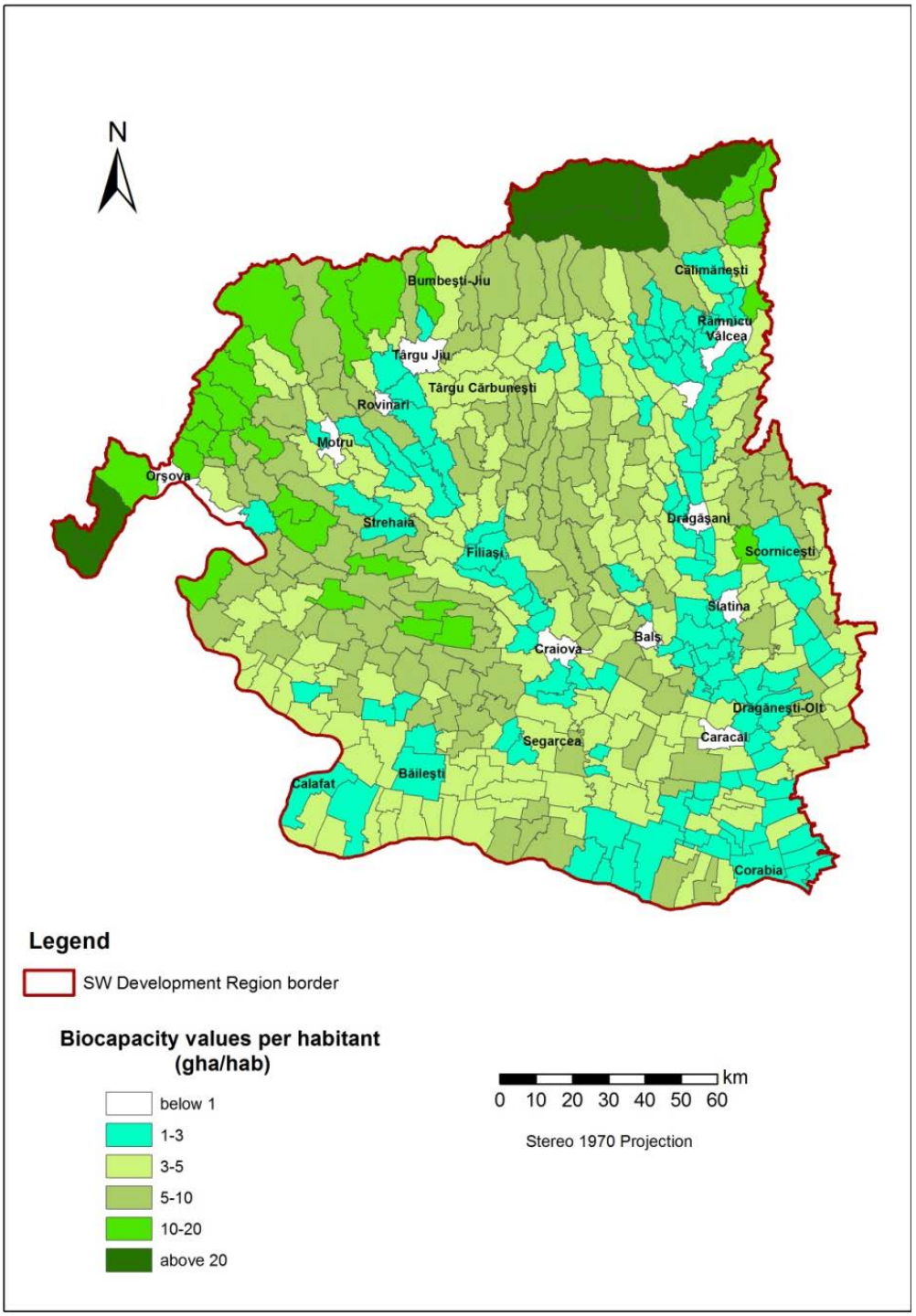


Figure 2: The biocapacity values per habitant in the SW Region.

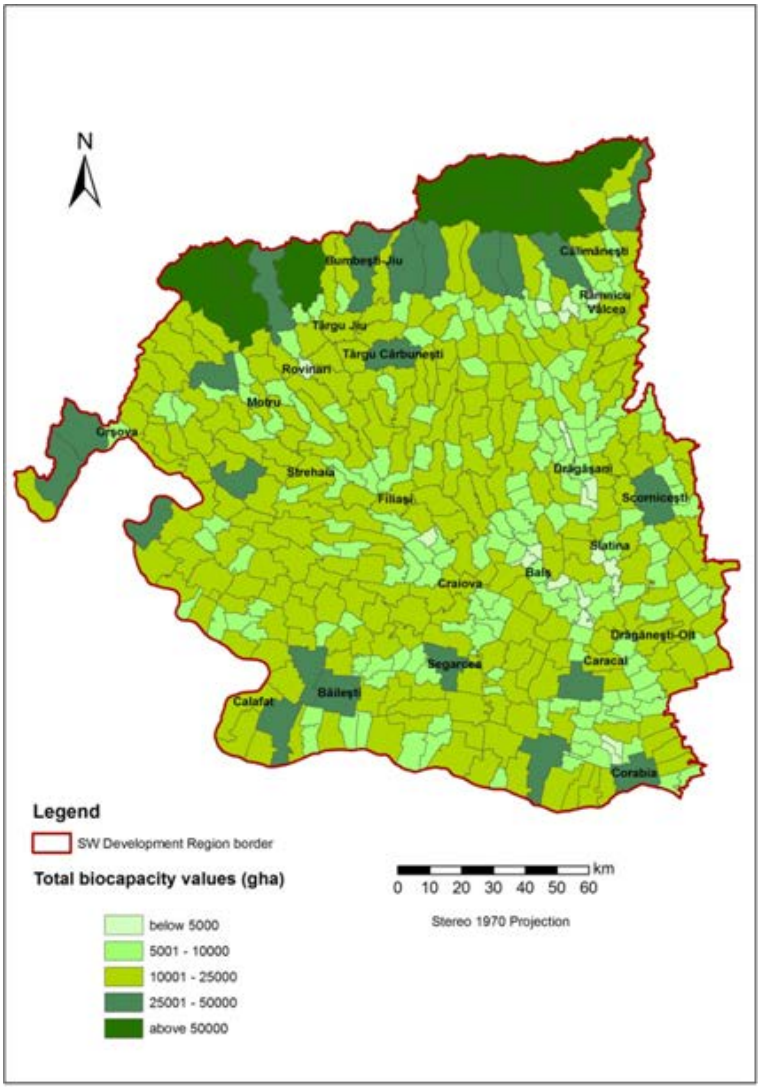


Figure 3: Total biocapacity values in the SW Development Region.

The values are not equally distributed in the region. The highest values of the biocapacity are registered in Dolj County and the lowest in Mehedinți. The high values of the biocapacity in Dolj County are explained by the large surface of the cropland. When we refer to the biocapacity which is distributed to each habitant, the hierarchy is reversed: the first place is occupied by Mehedinți County, which is the least populated county in the region, so the biocapacity per habitant registers 3.20 gha. Craiova, the capital of the SW Region, situated in Dolj, concentrates 40% of the regional population, so, in Dolj County, the values of the biocapacity are the lowest (1.96 gha – Fig. 4).

At the NUTS five level, the highest values are specific to mountain areas. High biocapacity values, over 50,000 gha, are registered in Voineasa (91,155 gha), Mălaia (80,500 gha), Padeș (76,000 gha), Tismana (60,000 gha), Runcu (59,000 gha), Câinenii Mari (53,000 gha) and so on. These territorial unities have a high naturality index because of the large forested areas. The biocapacity values are not too high in the capitals of the counties and this can be a surprising aspect. Craiova, Drobeta Turnu-Severin, Slatina, Râmnicu Vâlcea, Târgu-Jiu have a biocapacity which surpasses 10,000 gha, but these values are given by the different percent of the productive areas. Thus, in Craiova, the

highest biocapacity value is due to the built-up land, in Drobeta Turnu-Severin and Râmnicu Vâlcea is due to the forest, in Târgu-Jiu and Slatina to the cropland. It is necessary to mention that the grazing land and the water surfaces both have very low values in the capitals of the counties. Despite the medium values of the total biocapacity, the numerous populations and the high density are leading to high values of the ecological footprint. Thus, the capitals of the counties are ecological debtors that mean they have to import biocapacity from other areas.

On the other side, low values of the biocapacity are registered in the territorial units with small surface: Ipotești (2,962 gha), Băile Govora (2,976 gha), Oboga (3,740 gha), Mitrofani (3,940 gha), Șopârlița (3,997 gha). Usually, these units have less than 2,000 ha, so the bioproductive potential is very low. Comparatively Voineasa has a total surface of 46,000 ha and Malaia over 38,000 ha.

Differences also exist between the biocapacity value in the urban ecosystems, on one side, and the rural ecosystems, on the other side. Thus, the biocapacity of the urban areas, in Oltenia, has an average of 2.13 gha/habitant and, in the rural areas, the average value is 5.10 gha/habitant. The differences appear because of the different magnitude of the human pressure on the natural ecosystems, which is lower in the rural areas.

The values presented above are for the territory of the administrative units existing in the SW Development Region. Our analysis continues with the calculation of the biocapacity of the protected areas declared in Oltenia.

IUCN defines the protected area as a "clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008).

The first method of the ecological footprint had a strong anthropocentric approach, because only the human needs were taken into consideration. The first ecological footprint researchers considered that Earth's surface was all available for human society, without taking into consideration the needs of other species. The studies show that human population appropriates 32 percent of the net primary productivity (Venetoulis, 2007), a value quite high for a species who represents only 0.5 percent from the Earth biomass (Imhoff et al., 2004). Nevertheless, the human welfare depends on the ressources and services provided by the natural ecosystems (Ewing et al., 2010).

After the improvement of the methods, some parameters regarding the biodiversity were introduced in the calculation formula of the biocapacity. Thus, from the total biocapacity of the Earth, 13.7 percent are reserved for the needs of other species than humans, an aspect which was taken into consideration by us when we calculated the biocapacity values in the SW Development Region.

Studies show that the human population appropriates 32 percent of the net primary productivity, a value quite high for a species who represents only 0.5 percent of the Terra biomass. The value is even higher (89-96 percent) if we take into consideration only the areas accessible to humans. (Sunquist, 2005)

Human well-being requires, in part, the material consumption of provisioning services provided by the ecosystem (Ewing et al., 2010).

We consider that 13.7 percent is not always enough to sustain the needs of other species than humans, because there are areas with high biodiversity and very high human pressure, where a larger protected surface is needed.

In the SW Region, protected areas cover 6,000 square kilometers, that is 23 percent of the region surface. Despite this value, there are a lack of studies to prove if this coverage is enough to insure an efficient protection of the habitats and species. We consider that this kind of studies are absolutely necessary to establish if the vulnerable fauna and flora species are adequately protected through the protected areas network, especialy because the SW Region has a great biodiversity.

There are four main categories of protected areas in the SW Region:

a) **Protected areas of national interest** national parks, nature parks, strict reserves, natural reserves etc.
b) **Protected areas of international interest**: Ramsar sites, biosphere reserves.
c) **Protected areas of community interest**: Natura 2000 sites.
d) **Protected areas of local interest.**

The categories of protected areas are presented in table number 2.

Taking into account the surfaces covered by the bioproductive areas in the protected areas from Oltenia, the yield and equivalence factors, we calculated the biocapacity values in the protected areas. Thus, for the protected area from SW Region, the biocapacity value is 1,389,159 gha, which means 25 percent from the total Oltenia's biocapacity, respectively 5,595,558 gha.

Forested areas have the highest biocapacity value, 986,556 gha, followed by arable land, 253,765 gha, grazing land, 88,144 gha, water, 37,593 gha, and built land, 37,593 gha.

The above mentioned values is additional proof of the importance of the protected areas to maintain biocapacity. The 25 percent point out the important role that protected areas have to produce the resources necessary to the human society, but also to satisfy the needs of other species.

As it can be seen in figure number 4 the forests have the highest biocapacity weight in the protected areas from the SW Region. Actually, only in the Natura 2000 sites, forests cover 60 percent of the total surface. The presence of the forests indicates a high value of the naturality index (Forest area/Total area X 100), so the Natura 2000 sites, especially, but the other categories of protected areas are also less affected by the human impact. Between 1990 and 2006, land cover changes inside protected areas in Oltenia were very small, so the values of the biocapacity in the two years are almost similar. For the future, it will be interesting to follow how the conservation measure for the species and the habitats, inside and outside the protected areas, will affect the land cover and the biocapacity values.

Once the biocapacity values inside protected areas were calculated, we overlapped the map of the total biocapacity with the limits of the protected areas (Fig. 5). Thus, it can be observed that most of the protected areas are distributed in the north of the region and they overlap with the NUTS with the highest values of the biocapacity (over 50,000 gha or between 25,000 and 50,000 gha). The protected areas limitrophes to the big rivers (Danube, Jiu, Olt) are also overllaping administrative units with high values of the biocapacity (over 10,000 gha).

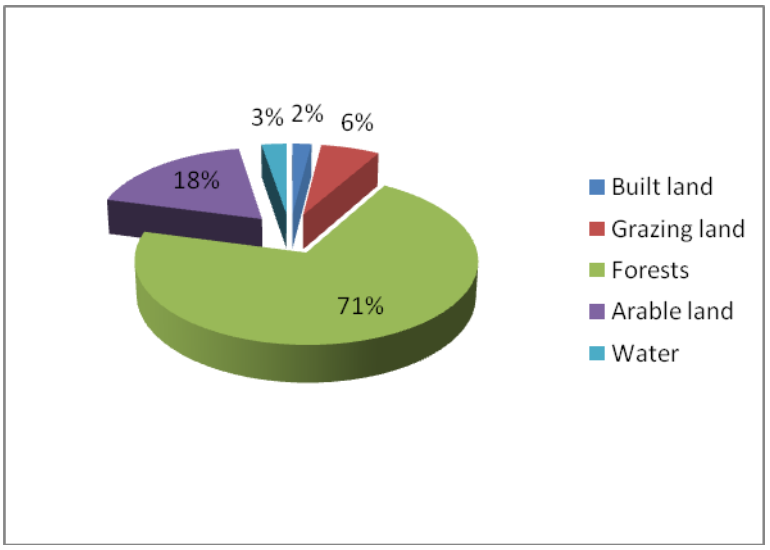


Figure 4: Biocapacity weight values for the main categories of the productive areas in protected areas.

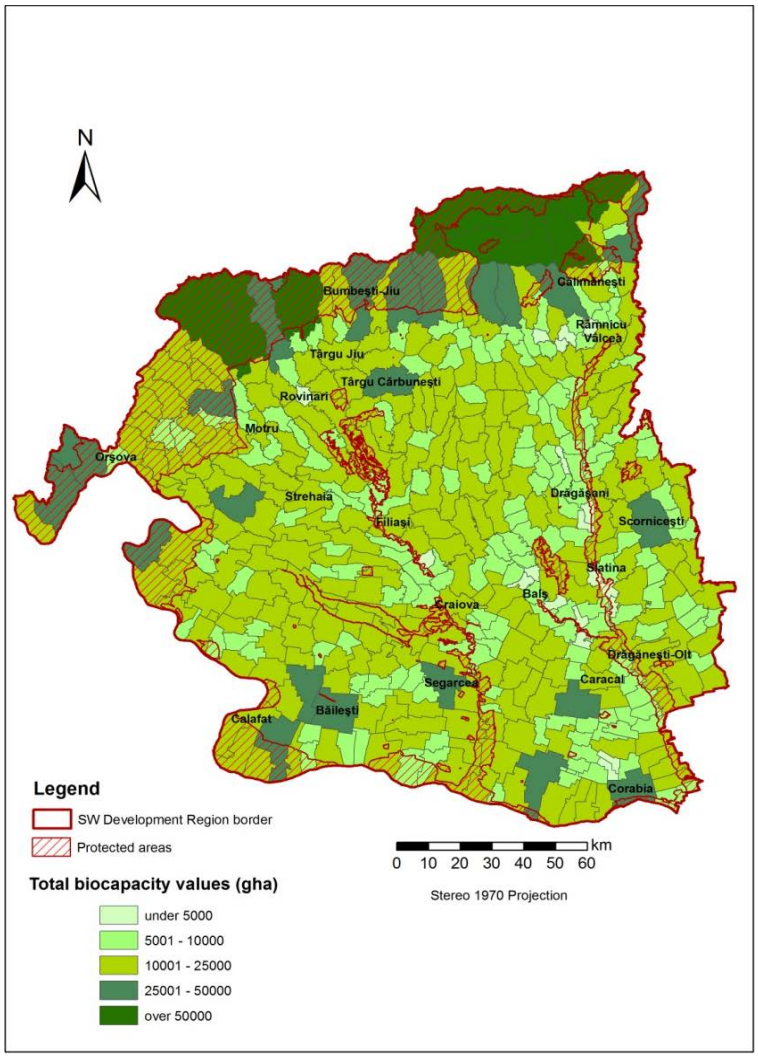


Figure 5: Biocapacity values and the protected areas distribution in the SW Development Region.

Table 2: Categories of protected areas in the SW Development Region.

| Category at the national level | IUCN | Other conventions, directives, conservation programmes, etc. | Exemples |
|---|---|---|---|
| Strict reserves | I | | Piatra Cloşanilor |
| National parks | II | | Parcul Naţional Buila Vânturariţa, Parcul Naţional Domogled – Valea Cernei |
| Nature parks | V | | Parcul Natural Porţile de Fier |
| Nature reserves | IV | | Poiana Bujorului de la Pleniţa, Ciuperceni – Desa |
| Nature monuments | III | | Peştera Lazului |
| Biosphere Reserves | | MAB-UNESCO Programme | Retezat |
| Special protection areas | | Birds Directive | Bistreţ, Confluenţa Jiu – Dunăre |
| Sites of community importance | | Habitats Directive | Coridorul Jiului, Nordul Gorjului de Vest, Nordul Gorjului de Est |
| Special areas of consevation | | Directiva Habitate | They will be designated in six years after the accesion in the EU |
| Geoparks | | UNESCO | Geoparcul Platoul Mehedinţi |

## CONCLUSIONS

The biocapacity values in the SW Development Region were calculated by using the Wackernagel-Rees method. The SW Region has a total biocapacity of 5,595,558 gha, but the real surface of the region is 2,922,121 gha. The average of the biocapacity value per habitant is 2.49 gha, higher than the national (1.95 gha) and global (1.78 gha) average.

The values of the biocapacity in the SW Region are unequaly distributed. The highest values are in the administrative units from the north of the region, where most of the protected areas are concentrated.

In conclusion, the biocapacity can be an indicator to evaluate the needs of protected areas and, together with other indicators, it can be used for the designation of more protected areas.

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# STUDIES REGARDING GLOBAL AND NATIONAL PRODUCTION OF VEGETABLE OILS AND OIL SEEDS

*Mihaela STOIA* [1] and *Simona OANCEA* [2]

**KEYWORDS**: vegetable oils, production, health, organic farming.

**ABSTRACT**

A wealth of epidemiological evidence shows that the consumption of vegetable oils brings important health benefits to humans, specifically the prevention of chronic and degenerative diseases. In this respect, we have analyzed statistics on global, European, and national oilseeds production, concluding that soybean, rapeseed and sunflower seeds occupy an excess share of the market. Common edible oils like olive, soybean, corn or sunflower oil seem to fulfill health claims and consumers' needs, requiring further support for crop diversity and organic farming development. It is therefore useful at this juncture to examine trends in consumption patterns worldwide and deliberate on the potential of the food and agriculture sector to meet new demands and challenges.

**REZUMAT**: Cercetări privind producţia globală şi naţională de uleiuri vegetale şi seminţe oleaginoase.

Consumul de uleiuri vegetale, este demonstrat de către o mare parte dintre dovezile epidemiologice, că aduce oamenilor beneficii importante pentru sănătate, spre exemplu, prevenirea bolilor cronice şi degenerative. În acest sens, am analizat statistici privind producţia de seminţe oleaginoase la nivel mondial, european şi naţional, concluzionând că boabele de soia, precum şi seminţele de rapiţă şi de floarea-soarelui ocupă cota de exces de pe piaţă. Uleiurile comestibile uzuale, cum ar fi uleiul de măsline, soia, porumb sau uleiul de floarea-soarelui par să îndeplinească cerinţele de sănătate şi nevoile consumatorilor, necesitând în continuare sprijin pentru cultivare şi dezvoltarea unei agriculturi ecologice. Prin urmare, la ora actuală este necesară cercetarea tendinţelor modelelor de consum la nivel mondial şi dezbaterea potenţialului sectorului alimentar şi agricol, în scopul de a răspunde noilor cerinţe şi provocări.

**ZUSAMMENFASSUNG**: Untersuchungen zur globalen und nationalen Produktion pflanzlicher Öle und Samen von Ölpflanzen.

Durch einen großen Teil epidemiologischer Nachweise wurde belegt, dass der Verzehr pflanzlicher Öle für die Gesundheit des Menschen von großem Nutzen ist, beispielsweise in der Prävention chronischer und degenerativer Erkrankungen. In diesem Sinne wurden welt- und europaweite Statistiken sowie solche auf lokaler Ebene über die Produktion von Ölpflanzensamen analysiert und daraus gefolgert, dass Sojabohnen sowie Raps- und Sonnenblumenkerne, den überschüssigen Anteil des Marktes einnehmen. Übliche Speiseöle wie: Oliven-, Soja-, Mais- oder Sonnenblumenöl scheinen die Gesundheits- und Verbraucherbedürfnisse zu erfüllen, so dass weiterhin eine Unterstützung für den Anbau und die Entwicklung einer ökologischen Landwirtschaft erforderlich ist. Dementsprechend ist es derzeit sinnvoll, Trends in den Modellen des Konsumverhaltens auf globaler Ebene sowie die Debatten über das Potential im Lebensmittel- und Landwirtschaftssektor zu untersuchen, um auf die neuen Notwendigkeiten und Herausforderungen zu reagieren.

## INTRODUCTION

Diets evolve over time, being influenced by income, prices, individual preferences and beliefs, cultural traditions, as well as geographical, environmental, social and economic factors. According to the World Health Organization (WHO), food strategies must not merely be directed at ensuring food security for all people, but must also ensure the availability of adequate quantities of safe − good quality foods that together make up a healthy diet (WHO, 2003). The main nutrient provided by vegetable oils is fat, generally a highly valued element of the diet to provide energy, palatability to dry foods or to serve as a cooking medium (Zevenbergen et al., 2009). Based on the predominant fatty acid (FA) which is primarily responsible for the functionality of the oil, categorizing fats as "saturated", "monounsaturated" (MUFA) or "polyunsaturated" (PUFA) may be helpful for consumer understanding (Foster, 2009). Vegetable oils are also the main source of natural plant sterols in the diet and contain minor components, such as squalene and sphingolipids, all of which may provide a range of health benefits. The use of vegetable oils in their natural state to help modulate blood lipids and inflammation might be preferred over oil that undergoes the process of hydrogenation. Common vegetable oils that are n-6 rich and PUFA are not recommended for frying because of heat-induced damage to the properties of the oil. Although fried food is considered a health risk, the EPIC-Spain cohort study found no association between the consumption of fried olive or sunflower oil and all causes of mortality (Guallar-Castillón et al., 2012). A bulk of research papers are dedicated to olive oil and Italy is by far the leading consumer. According to the Food and Agriculture Organization (FAO), global olive oil production could suffer a sharp decline, with the total output estimated to fall by 0.7 million tons (FAO, 2012). The nutritional benefits of MUFA-rich diets are well accepted, but olive oil is an expensive commodity. High-oleic-acid sunflower oil represents a cheaper source of dietary MUFA and it could be particularly valuable in enriching the diets of northern Europeans with MUFA at the expense of saturated fatty acids (Roche, 2001).

Vegetable oils are also attractive for the production of biodegradable lubricants and biodiesel, and therefore environmentally-friendly. The growing demand for biodiesel may induce farmers to switch from producing food crops to growing biofuel crops. With respect to the increase of vegetable oil production by the biodiesel industry, which in past years accounted for one-third or more of global consumption growth, demand on biodiesel producers are forecast to only rise by 3–5 percent, compared with at least ten percent in recent years, pointing to a slowdown in demand expansion (FAO, 2012).

As in past years, much of the increase in global demand is expected to originate in Asia, with China as a dominant player where food and oleochemical uses vegetable oils will be the main areas of growth (FAO, 2012).

In the future, it is possible there will be a mismatch of supply and demand, influenced by the growing needs of an expanding urbanized population.

The aim of the present study is to evaluate global, European, and national oilseeds production through market research, MADR official bulletins, and epidemiological evidence.

## MATERIALS AND METHODS

The following methods were used:

- Analysis and market research on main edible plant oils using different sources (specialized publications and press releases);
- Analysis of certain Romanian indicators from bulletins of the Ministry of Agriculture and Rural Development (MADR), and National Institute of Statistics (INS) – crop area and production of sunflowers;
- Epidemiological evidence.

Statistical processing: mathematical extrapolation using Statistica software.

**RESULTS AND DISCUSSION**

Based on the zoom effect, we have analyzed production statistics of major oilseeds worldwide, in the European Union (Figs. 1 and 2), and finally in Romania.

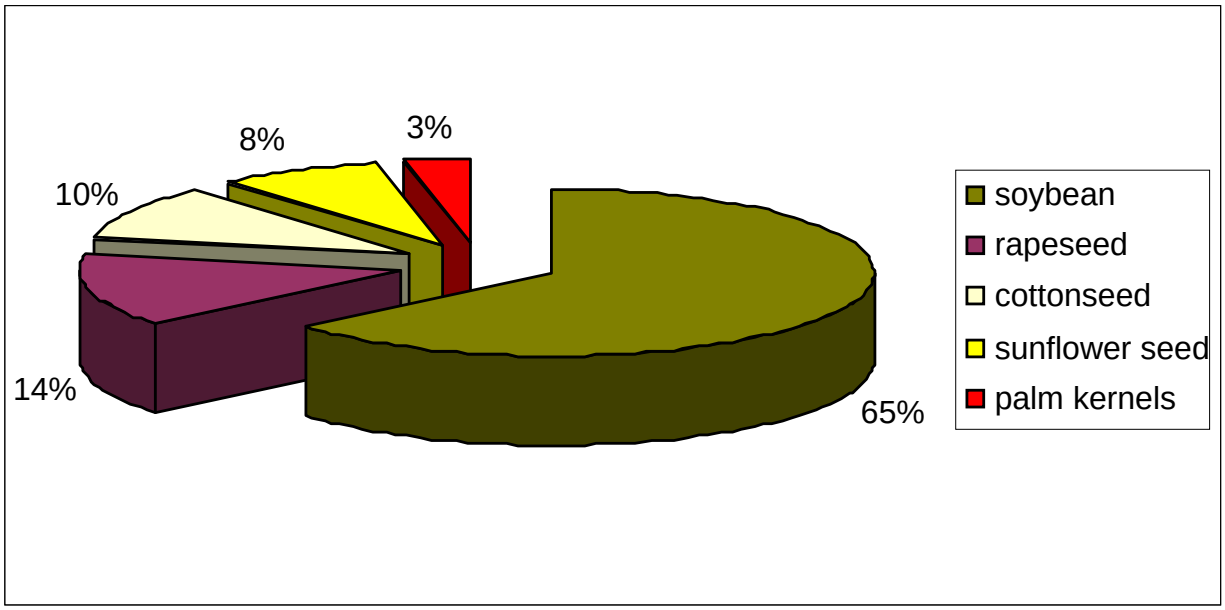


Figure 1: World production of major oilseeds forecasted by 2012/13 (FAO, 2012).

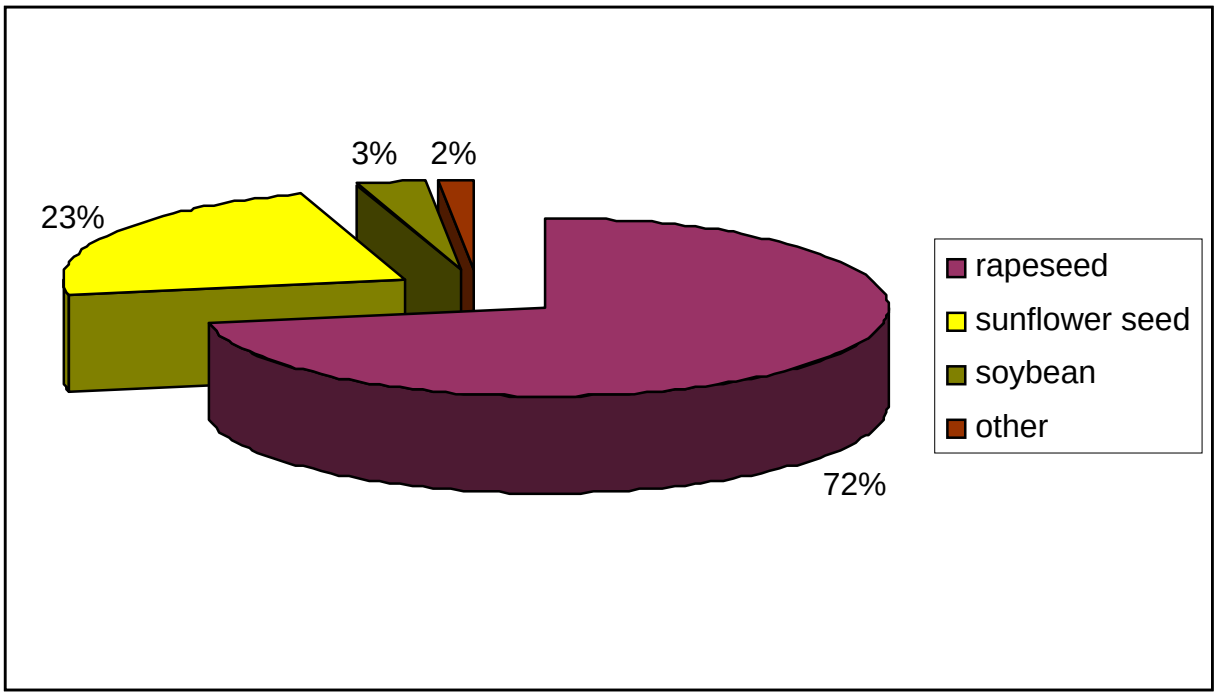


Figure 2: European Union oilseeds production (USDA, 2010).

The European Union is the world's second largest import market for vegetable oils after China, suggesting a high consumption of vegetable oils instead of saturated fats.

Oleaginous plants experienced high growth in Romania, reaching an increase in sown area by 40.7% in 2010. Soy and rapeseed production increased by 73.8%, and 62.1% respectively, while sunflower seed production increased by 15.2% (INS, 2011). Sunflower is a culturally traditional crop in Romania (Fig. 3) and sunflower oil is popular for its mild taste and health benefits. It is an edible oil with a high sensory and nutritional value, but it is rather unstable during storage due to the high content of linoleic acid. The actual edible oil industry is concentrated mainly in the eastern, southern and north-western regions of the Romanian national territory (Fig. 4).

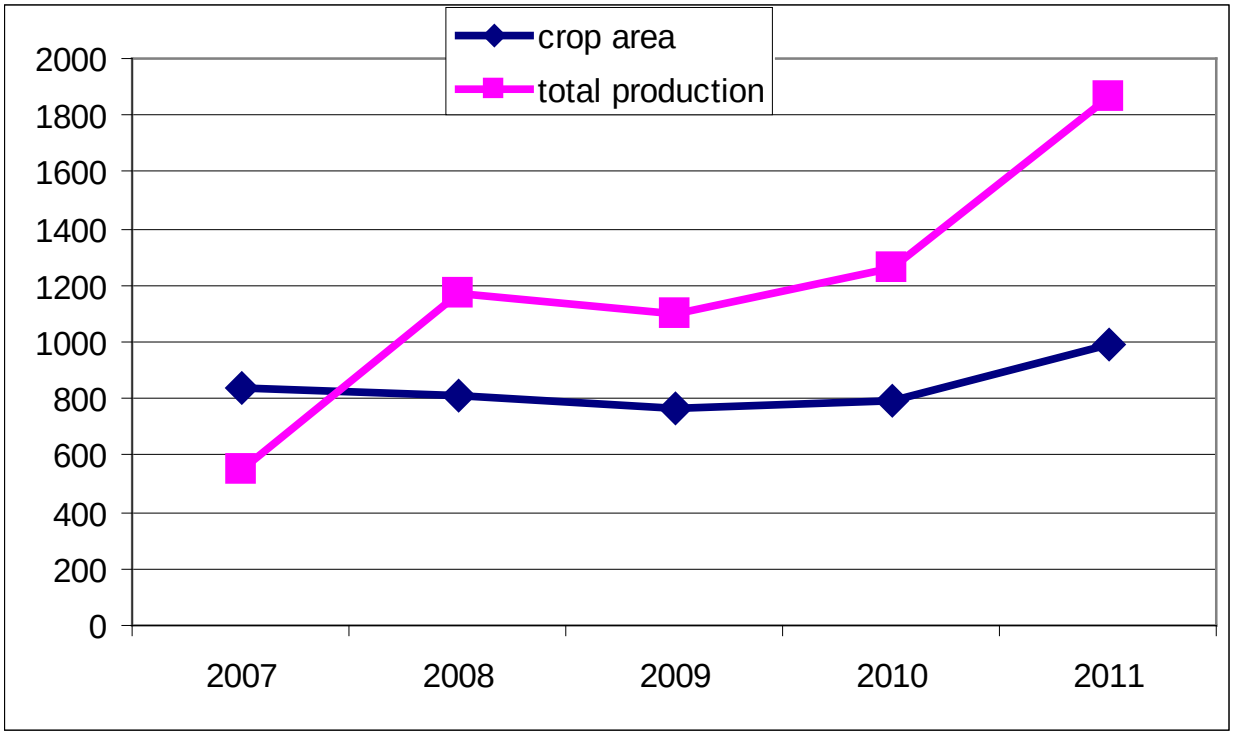


Figure 3: Sunflower crop area (1,000 hectares) and production (1,000 tons) in Romania (Source: MADR).

Vegetable oil consumption is forecasted to grow by 54% during the period 2000-2015 with 37 kg per year per capita consumption expected in the European Union, which is comparable to existing consumption in the United States of America. In 2015, it is projected that almost 80% of Organization for Economic Cooperation and Development (OECD) vegetable oil production will originate in the European Union and the United States (OECD-FAO, 2006).

A negative future consequence of the growing demand for oil crops may involve significant deforestation to create more crop lands.

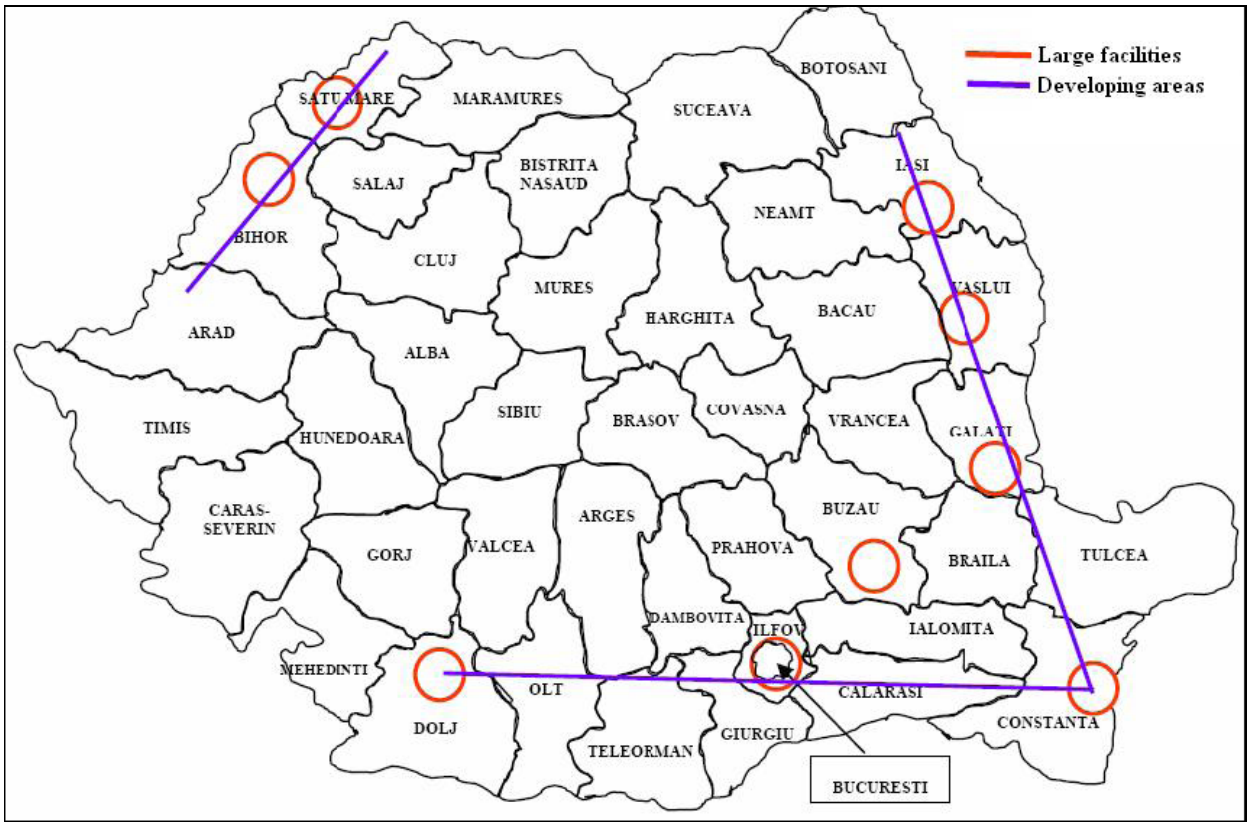

Figure 4: Geographic distribution of the edible oil industry in Romania (Source: Interbiz Group).

In many countries, traditional processes for producing oil are very important, especially among communities which have easy access to raw oleaginous materials. Traditional processing tends to be environmentally sound and typically conducted as a family or group activity. Traditional processing methods need to be encouraged because organic farming and processing fresh and authentic food products respects nature and its systems. Crude oils serve as important sources of β-carotene and tocopherols.

The chemical composition (Beardsell et al., 2002; Pellegrini et al., 2003) and health benefits of common vegetable oils are highlighted in table 1.

Table 1: Edible oils commonly used in the European Union: profile and health benefits.

| Vegetable oil | Chemical composition | | | | Health impact (epidemiological evidence) |
|---|---|---|---|---|---|
| | Fatty acid profile (%) | | Main phyto-chemicals | Antioxidant capacity (mmol Trolox/kg) | |
| | MUFA | PUFA | | | |
| **Olive oil** | 69-82 | 4-13 | Coumaric acid<br>Cinnamic acid<br>Sitosterol | 1.79 | – risk reduction for cardio-vascular and peripheral vascular disease.<br>– lowered platelet rich plasma thromboxane B2 concentrations.<br>– lowered levels of coagulation factor VII activity, which would confer an anti-thrombotic effect.<br>– reduced the concentration of intercellular adhesion molecule 1 (ICAM-1) involved in the inflammatory response.<br>– decreased oxidative stress in liver from aged rats, resulting in lower levels of membrane hydroperoxides and higher coenzyme Q levels in plasma membrane (Roche, 2001). |
| **Soybean oil** | 24 | 54-58 | Sitosterol<br>γ-tocopherol<br>α-tocopherol | 2.20 | – reduced post-menopausal breast cancer risk associated with increased consumption of sunflower seed and soybean (Zaineddin et al., 2012). |
| **Corn oil** | 24 | 59 | Sitosterol<br>γ-tocopherol<br>α-tocopherol | 1.29 | – antioxidant potential of corn oil in vivo (total antioxidative capacity in plasma and LDL) was as efficient as the mixture olive/sunflower oil (Tomasch et al., 2001). |
| **Sunflower oil** | 20-23 | 66 | Sitosterol<br>α-tocopherol | 1.17 | – n-6 PUFA may be harmful. Soybean and sunflower oil treatments (subcutaneous injections) might generate insulin resistance (Poletto et al., 2010). |

As virgin olive oil is the best of the healthy oils, but an expensive commodity, there are trends in finding cheaper sources of dietary MUFA, such as high-oleic sunflower oil or blends. For example a 4:1 proportion of rapeseed and sunflower oil is an inexpensive and simple way to meet current dietary recommendations for fatty acids and vitamin E (Darmon et al., 2006).

**CONCLUSIONS**

Oil extraction from annual oilcrops is anticipated to grow, especially by strong expansion in global soy oil production, whereas sunflower and olive oil could suffer a decline forecasted by 2013-2014. A healthy diet should include the consumption of vegetable oils as functional food.

Crude oils are more broadly beneficial than refined oils as traditional methods of crude vegetable oil production, involve the development of organic farming and organic food processing.

**AKNOWLEDGEMENTS**

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# ECOLOGIE APLICATĂ/ APPLIED ECOLOGY

– REVIEW –

*Leontin PÉTERFI* [1]

In 2013, at the Romanian Academy Publishing House, the book „Ecologie Aplicată”/“Applied Ecology” was published, whose author is the University Professor Stoica Preda Godeanu.

This work is part of the growing concerns about global development and popularization of ecology as the main science to be taken into account in the context of sustainable development, preventing overexploitation of renewable material resources, and the increasingly alarming decline in global biodiversity.

Mr. Stoica Preda Godeanu’s book starts with the persistent question that its author put over two decades ago: “what is ecology good for?” and “who uses it and how?”. The book wants to clarify concepts, to sort out the multitude of activities in which ecology is involved in one way or another, to point out the ecologists’ ability in solving the problems raised by the current and future state of the environment in which we live and we depend on, to achieve sustainable management of natural resources.

This book highlights the humans’ increasingly aggressive interference with the functioning of nature, specifically underlining our dependence on the environment, but also indicates the ways in which we can move forward, in which we can fix what we damaged or disturbed, as well as the methods with which we can better manage natural resources in the long run.

„Ecologie aplicată” includes an introduction (which adresses applied ecology) and 14 chapters in the areas listed below, a glossary and an index of terms.

The following areas of applied ecology are addressed (or discussed) in this book:

– agricultural ecology;
– pest and invasive species ecology;
– praticol ecology;
– landscape ecology;
– forest ecology;
– environment protection ecology;
– aquaculture ecology;
– ecology in tourism;
– degrading processes ecology;
– human ecology;
– ecology of cultivated plants and domestic animals;
– urban ecology;
– ecology in sustainable development;
– ecology regarding Earth’s major issues.

Each chapter begins with a plan, and at the end of the topic there is a selective bibliography specific to each domain.

The book has 805 pages and it is illustrated with 331 figures and 169 tables.

Applied ecology is very vast because the volume of information and publications in the field has grown exponentially in recent years. Therefore, the chapters do not claim an exhaustive treatment of all aspects, but an overview of the field, a summary on the many treaties and publications already printed in major global and national publications. The book was conceived after the author has taught several courses on topics of applied ecology at the University “Ovidius” of Constanța in the last two decades (applied ecology, ecotechnics, human ecology, ecology of human settlements, integrated monitoring, environmental protection, human impacts on environment, etc.).

The book is the result of an extensive documentation and synthesis work of over 20 years, targeting new guidance on the role of ecology and its specialists in the life of mankind.

„Ecologie aplicată" is an interface work between ecologists and practitioners.

It is addressed to specialists in the fields of natural sciences, life sciences, economy and technology, education, political science, futurologists and trainers of views, all who are involved, in one way or another in solving problems of human interest or of the related state and exploitation of environmental resources. It is therefore of interest to people of all categories, as it offers a new vision of the man-environment relationship not only for now, but especially for the future. It can be the basis of new jobs, as well as new specialities, so it allows specialization in new areas for a better future and then will lead to the creation of new jobs for people interested in the future evolution of humanity.

In Romania there is neither a similar work nor any other work which covers approaches such a large range of issues.

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# DIVERSITATEA LUMII VII – MEDIUL SUBTERAN/ LIVING WORLD DIVERSITY – UNDERGROUND ENVIRONMENT

– REVIEW –

*Angela CURTEAN-BĂNĂDUC* [1]

The fourth volume in the series of the "Living world diversity", issued as a homage to the renown Romanian biologist Emil Racoviță, deals with the diversity of the living organisms in the underground environment. In the 423 pages of the volume 636 species are presented (with more than 900 illustrations), which are found in the most diverse subterranean environments (caves, stagnant or running waters, crevices, sinkholes, interstitial waters as well as man made environments such as wells, mines, cellars, subterranean constructions, etc.)

The editor, Mr. Stoica Godeanu, prefaces the book with an interesting and a necessary general introduction to the topic at hand, the subterranean environment.

As a tribute to our forefathers, exceptional specialists in the subterranean environments, the volume presents a touching encounter with the work of Emil Racoviţă, „Speologia", the role and the significance of this synthetic science.

In the introduction chapter the characteristics of the subterranean environment are presented, along with its origins, its biogeography and the so-far accumulated knowledge regarding the subterranean microbiota, the flora and fauna found on the Romanian territory.

The 53 chapters present, in systematical order, the main groups of underground dwellers. Each chapter contains: a brief description of the group, a general and schematic description explaining the specific terms used in the chapter's text, the determination keys for the most common species as well as for the protected species, and the most accessible bibliography related to the group. The determination keys are clear and easy to use. Each species description is accompanied by an adequate illustration.

The volume contains referrals to the following: Prokaryota – Victoria Herlea, Cyanobacteria – Leontin Ştefan Péterfi, Andrei Kozma, Laura Momeu, Ana Rasiga, Rhyzopoda – Stoica Godeanu, Ciliophora – Adriana Petran, Stoica Godeanu, Xanthophyta – Leontin Ştefan Péterfi, Andrei Kozma, Laura Momeu, Ana Rasiga, Bacilariophyta – Leontin Ştefan Péterfi, Andrei Kozma, Laura Momeu, Ana Rasiga, Actinopoda – Stoica Godeanu, Chlorophyta – Leontin Ştefan Péterfi, Andrei Kozma, Laura Momeu, Ana Rasiga, "Funguses" of the Protoctista and Fungi kingdoms – Adriana Pop, Gavril Negrean, Ioan Cristurean, Ascomycotina – Katalin Bartok, Bryophyta – Sorin Ştefănuţ, Emanuel Plămadă, Filicinophyta and Sphenophyta – Ioan Cristurean, Sanda Paula Lițescu, Anthophyta – Ioan Cristurean, Sanda Paula Lițescu, Turbellaria: Tricladida – Doina Codreanu-Bălcescu, Nemertina – Vasile Decu, Nematoda – Iuliana Popovici, Rotatoria – Stoica Godeanu, Gastrotricha – Stoica Godeanu, Annelida – Victor Pop, Gastropoda – Alexandrina Negrea, Tardigrada – Stoica Godeanu, Arachnida – Victoria Ilie, Liviu Vănoaică, Scorpiones – Victoria Ilie, Liviu Vănoaică, Araneae – Maria Georgescu, Palpigradida – Maria Georgescu, Pseudoscorpiones – Maria Georgescu, Acarina: Gamasida, Ixodida, Acaridida and Ortibatida – Vasilica Iavorschi, Hydrachnidia (Hydracarina) – Magdalena Gruia, Opiliones – Vasile Decu, Christian Juberthie, Victoria Ilie, Crustacea – Ionel Tăbăcaru, Cladocera – Ştefan Negrea, Ostracoda, Podocopida – Anghelina Kovalenko, Mircea Vicol, Copepoda: Cyclopoida and Harpacticoida – Corneliu Pleşa, Sanda Iepure, Bathynellacea – Eugen Şerban, Amphypoda – Iorgu Petrescu,

Isopoda – Ionel Tăbăcaru, Decapoda: Astacidae – Vasile Decu, Symphyla – Ionel Tăbăcaru, Diplopoda – Ionel Tăbăcaru, Chilopoda – Ştefan Negrea, Insecta – Marius Skolka, Collembola – Magdalena Gruia, Diplura – Vasile Decu, Microcoryphia – Vasile Decu, Siphonaptera – Carol Prunescu, Paula Prunescu, Heteroptera – Vasile Decu, Psocoptera – Vasile Decu, Coleoptera – Vasile Decu, Eugen Nițu, Diptera – Aurelia Ursu, Victor Gheorghiu, Lepidoptera – Iosif Căpuşe, Dorel Ruşti, Trichoptera – Lazar Botoşăneanu, Hymenoptera: Terebrantia – Vasile Decu, Chiroptera – Victor Gheorghiu, Andrei Giurginca.

It is the first Romanian work treating all organisms living in subterranean environments, many of the presented groups being in the first edition of the identification keys in Romanian scientific literature (all Protists, some worms, millipedes, insects etc.). In conclusion, the present book is a valuable asset due to a correctly performed evaluation of the subterranean environment biodiversity.

The book is targeted to the university teachers in the fields of Biology and Ecology, all students and teachers, members of speleological organizations, all environment-oriented and nature-protecting NGOs, specialists of official agencies in the field of quality control and environmental protection, etc.

Due to the addressed topics, its unique character and comprehensiveness, the present volume on the subterranean plants and animals has a significant value, resulting from the hardy and assiduous efforts of its experienced editor and scientist, Mr. Godeanu S. The book release is also due to the generous efforts of the two volume coordinators, Mr. Decu V. and Ardelean A.

The volume is also a new and significant success for the researchers of the "Emil Racoviță" Speleology Institute of the Romanian Academy, a prestigious and world-wide recognized institution in the field of speleology, who have contributed greatly to the contents.

We congratulate the editor, the volume coordinators and the authors and we hope that the "Living World Diversity" series will continue just as successfully with future issues.

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# TRANSYLVANIAN REVIEW OF SYSTEMATICAL AN ECOLOGICAL RESEARCH 15.1 (2013) – THE WETLANDS DIVERSITY

– REVIEW –

*Kevin CIANFAGLIONE* [1]

Angela Curtean-Bănăduc and Doru Bănăduc, 2013. Transylvanian Review of Systematical and Ecological Research, 15.1 – The Wetlands Diversity, 202 pages, Edit. Universităţii "Lucian Blaga" din Sibiu, ISSN-L 1841-7051, online ISSN 2344-3219.

Wetlands are accepted worldwide as very important ecosystems, being characterised by rich natural services and products.

Considering the important values of wetlands and the need for their protection, conservation and proper use in the spirit of the Ramsar Convention on Wetlands (1971), the editors of the ***Transylvanian Review of Systematical and Ecological Research*** scientific series dedicated Volume 15.1 to the ***Wetlands Diversity***. Most of the scientific papers resulted from the *Aquatic Biodiversity International Conference, Sibiu, Transylvania, Romania, 2013* and offer data from diverse wetland areas around the world.

This Volume is also dedicated to the memory of Eugene Pleasants Odum (1913-2002), a distinguished American biologist well known for his pioneering subtle approach, hard work and very valuable results on ecosystem ecology.

The 16 papers in the Volume explore different aspects of the wetlands diversity, grouped in four thematic sections: *Biotopes*, *Biocenosis*, *Ecosystems*, *Human Impact* and *Protection and Conservation*.

The ***Biotopes*** section starts with a paper entitled "Estimating particle concentration in natural water by speckle contrast" by *Dan Chicea*. It illustrates a coherent light scattering experiment carried out on an aqueous clay suspension with an extended range of concentrations. The far field speckle was recorded as a video clip in an unconventional manner using a charged coupled device. A computer code for image processing, written for this purpose, was used to compute the average far field contrast. The variation of average contrast with particle concentration was analyzed, and a possible fast procedure for assessing the particle concentration over an extended concentration range was suggested.

The second contribution in this section is the paper "*Gerris lacustris* (Linnaeus 1758) and *Gerris costae* (Herrich-Schäffer 1850) species-habitat relations on mountainous tributaries of Vişeu River (Maramureş, Romania)" by *Horea Olosutean* and *Daniela Minodora Ilie*. The study of the semi aquatic Heteroptera species from some mountainous tributaries of the Vişeu River and their relations with habitat variables were investigated. Only two species, *Gerris lacustris* and *Gerris costae* were found, either one or both species, in almost half of the investigated sampling stations. Correlation analysis between samplings and habitat conditions showed that *Gerris lacustris* prefers small deep ponds or river banks with steep slopes and it is easily adaptable to habitat changes, while *Gerris costae* is mostly found in large marshes with low, stagnant water and high amounts of vegetation. Both species are relatively tolerant to human impact on their habitat, *Gerris lacustris* more so. The two species are negatively correlated to each other, as an expression of competition between them. Principal Component Analysis resulted in two dominant factors explaining almost 60% of the habitat variation, and their graphic representation proved the observed correlations.

The third contribution in this section is the paper "Habitat vulnerability for the Nile Crocodile (*Crocodylus niloticus*) in Nasser Lake (Egypt)" by *Ashraf Hussein Ibrahim Salem*. The study presents the results of a field investigation of the crocodile nesting sites on lake Nasser, observed during the breeding season 2009-2010. A relatively low number of nesting sites was found, explained by the intensity of anthropogenic activity in the area and by the low water levels of lake Nasser. Based on analysis of satellite imaging and its correlation with the biotope data of the lake shores, a classification system of habitats and their suitability for crocodile nesting was established. Correlated with land use information, the results can lead to the identification of potential nesting sites for the Nile crocodile, establishing a legal protection system for such habitats.

There are three contributions in the Volume dealing with ***Biocoenosis***. The first is Preliminary observations on the Family Mormyridae in Oyan Dam lake (Nigeria) by *Olaniyi Alaba Olopade.* This study was carried out to investigate the abundance, distribution, diversity and condition factor of Mormyrids in Oyan Dam lake, Abeokuta North Local Government Area of Ogun State, Nigeria. A total of six species belonging to the family of mormyrids were observed during the investigation. In the wet season five species were recorded, while only four species were recorded in the dry season. The result also revealed that the condition factor during the wet season was higher than in the dry season. The following species of mormyrids, *Mormyrus rume*, *Hyperopisus bebe*, *Petrocephalus bane* and *Mormyrops deliciosus* showed a linear relationship in terms of length-weight relationship. Based on the outcome of this study, it is advised that the dam should be replenished with other species of Mormyridae to allow future increases in abundance and regulatory measures should be enforced particularly in the rainy season which coincides with the breeding season for sustainable fishery in Oyan Dam lake.

The second paper of this section is Utilization of periphytic natural food as partial replacement of commercial food in organic tilapia culture – an overview, by *Ana Milstein*, *Alon Naor*, *Assaf Barki* and *Sheenan Harpaz*. This article summarizes the results obtained during five years of research at the Dor Fish and Aquaculture Research Station on partial replacement of commercial food by periphytic natural food in the culture of organic tilapia (hybrid *Oreochromis aureus* (Steindachner) x *Oreochromis niloticus* (L.)). Tilapia culture experiments were conducted in earth ponds with and without substrates and utilizing different substrates. Applying this technology would save food and money in the culture of organic tilapia, and it can also be appropriate in the conventional pond culture of tilapia as a method to reduce feed costs and increase sustainability.

Diversity and abundance patterns of amphibians in rehabilitated quarries of Bamburi near Mombasa (Kenya) is presented by *Dominic Otwori Ong'oa*, *Rossa Nyoike Ng'endo*, *Shadrack Muvui Muya*, *Mathew Mugechi Nyoike*, *Patrick Kenyatta Malomz* and *Zipporah Lagat Osiemo*. Amphibians are sensitive to changes in the environment and are, therefore, excellent indicators of success in restoring degraded habitats. As such, a clear understanding of how amphibian populations respond to changes in the environment is required. In order for conservationists to establish if the declining trends are changing, biodiversity recovery studies are essential especially in reclaimed habitats. This study focused on the recovery of amphibians, particularly on frogs, in reclaimed quarries of the Bamburi Cement Plant near Mombasa whereby the diversity, species abundances and composition at different stages of quarry re-establishment were assessed.

The authors of two papers in the Volume present their research results on wetlands at ***Ecosystem*** level. The authors of the first paper, *Marioara Nicoleta Filimon*, *Patricia Drăguşin*, *Cristina Drăguşin*, *Roxana Popescu*, *Maria Mugur*, *Claudia*

*Ratis* and *Sorin Voia*, discuss "Fisheries management influence on some ecophysiological groups of bacteria in lotic ecosystems of the Cefa Nature Park (Romania)". The nutrient circuit in aquatic ecosystems may seem simple, but the truth is that nutrient biochemical circuits are rather complex. Circuits are established by a series of interconnected biological, chemical and physical processes. Human activities lead to degradation of wet fields. Water quality and quantity have been changed, especially the quantity of polluting substances. Bacteriological studies in lotic ecosystems from Cefa Nature Park were carried out to establish four ecophysiologic microorganism groups: nitrogen-fixing bacteria, amonifying bacteria, nitrifying bacteria and denitrifying bacteria. Recorded values differ greatly from one species to the other according to sample points and season. Higher values in autumn are due to an increased intake of organic matter at the end of the vegetation period. Decomposition processes are intensified because of a growing number of microorganisms. Fishery management influences qualitative and quantitative variations in the microorganism communities of the lotic ecosystems in Cefa Natural Park.

*Angela Curtean-Bănăduc* and *Horea Olosutean* present the results of a study on "The influence of some environmental variables on diversity of Ephemeroptera, Plecoptera and Trichoptera assemblages – Vişeu Basin case study". The study analyses the influence of certain biotope parameters, such as hydro-morphological characteristics, channel modification, bank vegetation and riverine land use, on the diversity of Ephemeroptera, Plecoptera and Trichoptera (EPT) larvae communities, in the case of the Vişeu Basin. The results show that riverbed embankments, mineral substrata exploitation, and forest exploitation of the hillsides of the river basin cause a loss in diversity of EPT communities. Based on the principle that simplification of the structure of these communities has a negative impact on the self-regulating capacity of the lotic system, several steps are necessary in order to preserve the diversity of EPT communities in the types of Carpathian rivers analysed: preserving the natural morphodynamics of the riverbed, limiting substratum exploitation, avoiding changes in the substratum structure due to the extraction of boulders and large cobbles from the riverbed and preserving riparian tree vegetation along the river banks.

Four contributions in the Volume focus on the consequences of ***Human Impact*** on different types of wetlands. The first contribution presents data on "Environmental indicators of water quality in the Cibin River (Transylvania, Romania)" by *Ramona Iancu*, *Letiția Oprean*, *Diana Stegăruș*, *Ovidiu Tița*, *Adrian Boicean* and *Ecaterina Lengyel*. Water pollution has become a worldwide problem and its influence on the health of human populations grows every day. This study was carried out to determine the rate of pollution of the Cibin River (Transylvania, Romania) via physical-chemical and microbiological tests. Water samples were measured at six different locations along the Cibin River for a period of 12 months. Analysis methods were used to determine physical-chemical quality indices for water. The water samples were analyzed also from a sanitary and public health point of view, for example: total number of mesophilic bacteria, total number of yeasts and moulds, total coliforms, total fecal coliforms, *Enterococcus* and *Escherichia coli*, according to current Romanian legislation and normatives. The significant results place the river in the first (sampling stations one, two and three) and second (sampling stations four, five and six) water Quality Class. Due to the fact that the upper dam reservoir at Gura Râului is the main source of drinking water for Sibiu, it is certain that this water presents optimal characteristics for human consumption and is thus declared to be one of the healthiest water sources in Romania.

In the next paper, *Zahra Kohsnud*, *Reza Kohsnud* and *Mehdi Ghobeitihasab* report on the "Effects of the invasive

Ctenophore, *Mnemiopsis leidyi* species, on Caspian Sea". Human interventions in the Earth's natural systems are evident even in remote regions of the Antarctic and rain forests deep within the Amazon. In addition to human-induced climate change and habitat destruction, an emerging anthropogenic threat to biodiversity is the drastic species re-distribution (the movement of species from one place to another due to human intervention) at a global scale. This creates fertile conditions for biological invasions which in turn cause substantial economic and ecological losses. These human-mediated invasions, often referred to as "biological pollution", are a worldwide problem that is increasing in frequency and magnitude, causing significant damage to the environment, economy and human health. Bioinvasions have strong impact on biodiversity and ecosystem functioning and stability. They are ranked as the second most important threat to biodiversity (after habitat destruction) by World Conservation Union.

"The survey of sea cucumber fisheries on Qeshm Island coasts (Persian Gulf)" by *Majid Afkhami*, *Maryam Ehsanpour*, *Amin Mokhleci* and *Kazem Darvish Bastami*. Sea cucumbers are aquatic animals of a wide variety, useful to human health. Increasing demand for beche-de-mer, along with steady price increases, has led to worldwide intensification of sea cucumber harvesting. The rearing of sea cucumbers with shrimp controls is an environmental pollution that results from over- enrichment in nutrients, built up on the pond bottom. These organisms eat detritus and, together with devouring organic materials on the surface, they not only clean the environment, but they also cause the fast growth of shrimps and of themselves. In this study, based on information from local fishermen on Qeshm Island, the authors provide some data about the fishing methods, processing and distribution on the Qeshm Island coastline. Comparative study of fishing status with another part of the world determined that the status of sea cucumber stocks in Qeshm Island is sustainable. For prevention of over-exploitation of the sandy sea cucumber, the prohibition on capturing them should continue.

In this study, seven exploited sites were recognized, the target size for fishermen was more than 20 cm and sandy cucumber was the target species in Qeshm Island. In this area, the fishing operation was only carried out by scuba diving and was done only by men, although in other countries women have an important role in sea cucumber fishing activities. Among the coasts around Qeshm Island, sea cucumbers were found at Hmoon, Tolla, Kovei, Ramchah, Messen and Hengam. A maximum length of 35 cm and maximum weight of 1,080 g was recorded.

The last study of this section, is Health risks evaluation of heavy metals in sea food, by *Zahra Khoshnood* and *Reza Khoshnood*. Fish is an excellent, low-fat source of protein and provides many benefits, such as contributing to low blood cholesterol. Heavy metals are increasingly being released into natural waters from geological and anthropogenic sources. Due to the rapid development of agriculture and industry, and a historical lack of enforcement of regulations, the study areas have become contaminated by heavy metals.

In the **Protection and Conservation** section, there are four papers. The first is, "The relevance of data interchange for the effective protection of threatened species by example of new records of endangered caddisfly species (Insecta, Trichoptera)" by *Christian Scheder* and *Clemens Gumpinger*. All over the world, comprehensive data on aquatic communities is collected in the course of applied investigations (e.g. environmental impact assessments for road or railway construction projects, assessments of wastewater treatment plants, hydropower plants, etc.). At the same time, little is known about certain endangered or rare species, their distribution or their actual conservation status, as the data collected in applied projects is usually not published. It can be stated that applied investigations would offer valuable information on the

distribution of endangered species if there was sufficient data interchange within or data transfer to the scientific community. This thesis is supported by the fact that the authors were able to demonstrate that 72 caddisfly species were quoted in the Austrian Red List in the course of applied investigations in Austria, but that none of this information has been published so far. The present study provides a list of endangered Trichoptera species that were observed by the authors in the context of routine surveys over the past five years. It is intended thus to provide an example of how data that could be relevant for obtaining a comprehensive picture of certain species is often lost on its way to publication.

The second paper of this section is "*Barbus meridionalis* Risso 1827 (syn. *Barbus balcanicus*) monitoring elements proposal for Croatia, in Natura 2000 context" by *Doru Bănăduc* and *Angela Curtean-Bănăduc*. The action framework at the European Union level for the protection of biodiversity was established based on the Habitats Directive (92/43/EEC) and the Birds Directive (79/409/EEC). One main element of the future implementation of these Directives in Croatia is the establishment of a Natura 2000 network of special protection sites, a network which should rely on a specific monitoring plan at national level for each species of community interest. In this context, the present study proposes a set of monitoring elements for *Barbus meridionalis* for the Croatian Continental Biogeographical Region. The proposal is based on seven main criteria: proximity of national border, high quality populations, habitats which should be ecologically reconstructed, key habitats/sectors with high importance for connectivity, point sources of industrial pollution, areas/sectors influenced by diffuse sources of agricultural pollution, and areas/sectors influenced by habitat modifications.

The next paper is "The comparative analysis of pressures and threats to the Natura 2000 sites for wild birds protection. Case studies in wetlands in Romania and Bulgaria" by *Doina Cioacă*. The Natura 2000 concept and wetlands protection are relatively new in Romania and Bulgaria, because they are former communist countries and, after the 1990s, had too little value placed on nature conservation in favour of infrastructure development and agriculture. The development of the European ecological network Natura 2000 in these territories has come as an obligation for accession of these countries to The European Union. In Cernica area there are two Natura 2000 Sites under investigation: the first is ROSPA0122 Cernica Lake and Forest; the other is ROSCI0308 Cernica Lake and Forest, both areas proposed in 2006.

The last paper of the section and of the volume is "Nusa Penida Marine Protected Area (MPA) Bali – Indonesia: Why need to be protected?", by *Toni Ruchimat*, *Riyanto Basuki* and *Marthen Welly*. The last work is concerned with the Nusa Penida which is comprised of a group of islands in the south-east of Bali. This archipelago contains a high level of marine biodiversity and has significant tourism potential. In addition, Nusa Penida has aquaculture and fishing areas which continue to be developed. Efforts towards conservation and sustainable use by means of Marine Protected Areas (MPAs) provide an important solution to counteract increasing pressure on natural resources due to economic activities. Zoning system arrangements to protect marine biodiversity, as well as sustainable economic activities, form the highest priority in the management of the Nusa Penida MPA.

The high variety of studies in the Volume shows the importance of such a scientific forum devoted to Wetlands Diversity.

Hopefully the ***Transylvanian Review of Systematical and Ecological Research*** editors will continue this tradition.

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# TRANSYLVANIAN REVIEW OF SYSTEMATICAL AN ECOLOGICAL RESEARCH 15.2 (2013) – THE WETLANDS DIVERSITY

– REVIEW –

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Angela Curtean-Bănăduc and Doru Bănăduc, 2013. Transylvanian Review of Systematical and Ecological Research, 15.2 – The Wetlands Diversity, 210 pages, Edit. Universităţii „Lucian Blaga" din Sibiu, ISSN-L 1841-7051, online ISSN 2344-3219.

The Transylvanian Review of Systematical and Ecological Research is an important forum for ecological research presenting the results of diverse scientific activities. In its sub-series of Wetlands Diversity, it continuously published a large spectrum of different research related to wetlands around the world. The water and wetland related subjects are more and more in the focus of ecological researchers as the diversity of wetlands, their habitats and communities are threatened by a multitude of human impacts. Therefore the sub-series "The Wetlands Diversity" is considered – as it is mentioned by the editors – as "a scientific debate platform for the wetlands conservation, and not to take in the last moment, some last heavenly "images" of a perishing world".

The content of the volume is based – as mentioned by the editors in the preface – mainly on some of the scientific materials presented at the fourth edition of "Aquatic Biodiversity International Conference" which took place on October 8-11, 2013 at the "Lucian Blaga" University of Sibiu, Romania. The various research papers presented in this scientific journal are of great importance and help expand the knowledge about the functioning of wetland ecosystems, their structure and biodiversity, and at the human impacts and their consequences. In addition, the papers emphasize and demonstrate the need for further research in the field of wetlands for increasing the knowledge about wetland ecosystems, their functioning and health and also their importance for a sound environment in which the people can work and live sustainably.

The volume is dedicated in memoriam of the American biologist Eugene Pleasants Odum (1913-2002) to the anniversary of 100 years from his birth in September 1913. In the scientific world Odum is appreciated and honoured for his pioneering work with very valuable results in ecosystem ecology.

The recently issued volume of Wetlands Diversity 15.2 also presents – like the antecedent volumes – a number of interesting subjects in the field of habitats research, biocoenoses and ecosystems from different countries. The first paper signed by *Dan Chicea* and *Liana-Maria Chicea*, titled "Estimating particle concentration in natural waters by far field speckle intensity", reports on an interesting physical and water related subject. A coherent light scattering experiment was carried on aqueous clay suspension having a concentration that stretches over an extended range. For the realisation of the experiment, a computer code for image processing was written for this purpose and used to extract the scattered light intensity. The variation of the average scattered light intensity with the particle concentration was analysed and a possible fast procedure for assessing the particle concentration was suggested.

*Doru Bănăduc* and *Mircea Mărginean* present in the paper "Geographical and human impact influence on the fish fauna of the Olteţ River (Romania)" their studies on the fish fauna in the lower Olteţ River, a sector which suffered an intensive human impact especially in the last half of the XXth century. The authors state that the management for the protection and

conservation of this river's fish fauna cannot be done without a complete ichthyofauna monitoring, creating through this research the base for later comparative studies of changes in the ichthyofauna over a longer period of time. To realise this purpose the ichthyological study was realised in 2011-2012 on the whole 175 km length of the Olteț River from its mountainous area to the confluence with the Olt River. The monitoring was done at 56 sampling stations. Based on these samples, the authors conducted a detailed analysis of the fish communities along the river course from the upper trout zone in the mountainous sector to the carp zone in the lowest sector of the river. The similarity analysis of the monitored river stretches gives very impressive results about the fish communities and the diversity of habitats. The study is trying to explain the relation between the fish communities and the units of the macro- and micro-relief responsible for the diversified habitats for fish. It resulted very clearly that in the regions without or very small human impact the classic ichthyological zones (sensu Bănărescu, 1964) have a relatively good overlay with the existing geomorphological units, changing simultaneously with them. In the stretches with visible human impact, the classic ichthyological zones have an unremarkable overlay with the existing units of the relief and are not changing with them. The remarkable studies on the Olteț River are important not only for the reason of being the first of this type in the area, but because they also provide a base for further comparative monitoring, as well as an example for similar studies on other Carpathian rivers and for an appropriate management.

The authors *Moh'd Wedyan, Ahmed El-Oqlah, Khalil Altif* and *Khalid Khlifate* from four universities of Jordan present their research concerning a problem with significant ecological consequences in the area – the rapid drying out of the Dead Sea, this being recently one of the most challenging problems facing the scientists and governments of the region. The authors mention that the level of the Dead Sea has dropped more than 20 m in the past decade and had as a consequence a massive precipitation of halite from the water column that led to a decrease in $Na^{2++}$ concentration, concomitant with an increase in Mg, making the lake supersaturated with NaCl. This situation presents a big challenge to the microbial life of the lake. To understand the factors that affect the microbes in the Dead Sea and to predict the possible effects of the planned conveyance of Red Sea water to the Dead Sea, a series of experiments were performed in the field, as well as in the laboratory. The results of the experiments and the observations made on the growth of *Dunaliella* and on the red halophilic *Archaea* are important when attempting to predict how the biological properties of the lake may change in the future and they have important implications for the planning of the Red Sea-Dead Sea conduit.

In their paper concerning the "Climatic influence on the phytoplankton communities of the upper reaches of the Southern Bug River (Ukraine)" the authors *Olena Bilous (Kiev), Sophia Barinova (Haifa, Israel)* and *Petro Klochenko (Kiev)* present the results of their research over the period of one year on the Khmelnitsky monitoring station in the Southern Bug River, Ukraine. A total of 98 taxa of algae were observed in monthly sampled phytoplankton between April 2010 and March 2011. The taxonomic groups are presented and analysed in their seasonal dynamics and their different role in the algal communities in the course of the year. In this context the authors observed that the role of Bacillariophyta in communities was high in January-March being replaced by Green algae in March-September. Euglenoids were developed in February-December and blue-green algae in summer communities only. The authors also observed the strong positive correlations between temperature and species richness, the highest abundance and biovolume of the phytoplankton being in summer. Furthermore the authors underline that the river ecosystem of the Southern Bug has two

periods of trophic levels – high at summer and low at winter. Bioindication characterizes the river as low alkaline and low mineralized with a moderate organic pollution level, originating from the catchment area during ice melting and rains. The authors conclude that the low pollution level in the Khmelnitsky monitoring station can be used as a model of aquatic community dynamics under seasonal fluctuation in the southern boreal province climate, applicable to the monitoring of the Southern Bug River.

The paper entitled, "The economic and ecological potential of macrophytic vegetation in urban lakes" written by *Oriana Irimia-Hurdugan* presents some aspects related to the ecological and economic importance of the aquatic macrophytes common in the Romanian Plain lakes, especially those species belonging to the genera *Myriophyllum* and *Potamogeton* which are also common in Bucharest's urban lakes. She addresses an actual and frequently discussed problem about the use of aquatic plants occurring often abundantly in urban waters exposed to human impact and where careful and well planned management measures are needed. She mentions that the macrophytes of the Bucharest lakes are collected by the personnel of the Lakes, Parks and Leisure Administration by mechanised and manual methods, sun-dried and transported as waste to landfill. The paper also presents a review of international literature about water macrophytes in support of their economic potential as fertiliser for open field crop, orchard and garden crop application, as well as food for farm animals and gives this as an example to think about it in the situation of Bucharest's lakes. The last part of the paper argues for the vital need for the preservation of macrophyte stands in the lacustrine habitat for green, sustainable and integrated management of the urban lakes used for leisure and fishing.

*Joana Sender* and *Weronika Maslanko* present in their paper "Long- and short-term changes of the structure of macrophytes in lake Piaseczno in relation to land use in the Łeczna-Wlodawa Lakeland (Poland)" the situation of the lake Piaseczno supposed to be changed due to increasing pressure by a fast-growing recreation infrastructure. The study of this lake is representative for the long term changes which took place in the whole area of the Łęczna-Włodawa Lakeland since the late 1950's. Based on three time sheets of maps from 1976, 1984 and 2010, the authors present the changes occurred in the lake Piaseczno and its surroundings. They stated that from 1976 until 2010 an area of recreation infrastructure in the studied region increased more than 3.5 times, and in the built-up area more than five times, as well as a doubling of the total length of the roads. Meanwhile the surface area of wetlands and peatbogs significantly decreased – more than 11 times. Long-term changes in the structure of the macrophyte communities show that the number of communities has varied in each year, probably as a consequence of changes in land-use. Analysis showed changes to the surface inhabited by macrophytes, which have decreased significantly over only four years, by more than 25%. However, the proportion of rush communities has increased. Such type of analyses in the wetland landscape is very useful and important as they give a clear picture of major changes occurred due to human pressures. Hopefully they can also help to stop such evolution and plans existing for many other wetland regions which are still in a natural or near natural state.

The paper "High morphological variety of *Gerris argentatus* Schumel 1832 (Heteroptera: Gerridae) and probably Europ's smallest gerrids, in the Danube Delta" presented by *Horea Olosutean*, *Codruţa Olosutean* and *Daniela Minodora Ilie* constitutes a proof that even in areas such as the Danube Delta, considered as a highly studied one, there can be found surprisingly new species or new varieties of species with morphological well distinguishable characters. This is documented by an apterous *Gerris argentatus* male captured during a field trip

on the Busurca Canal, near the city of Sulina, in the Danube Delta, measuring only 5.1 mm from the tip of the head to the last abdominal segment, being the smallest adult pond skater ever recorded in Europe. The apterous form of *G. argentatus* is also mentioned for the first time, the species being known either macropterous or micropterous. All studies related to the individuals of the species *Gerris argentatus* presented in this paper are based on intensive comparative studies with materials of gerrids and confirming the need for further researches in this scientific field.

With their study "Analysis of the microsatellite variation in the common hybrid between Rusian sturgeon (*Acipenser gueldenstaedtii*) and Siberian sturgeon (*Acipenser baerii*) from aquaculture" the authors *Sergiu Emil Georgescu, Oana Canareica, Andreea Dudu* and *Marieta Costache* present a very actual field of research with modern genetically methods. They are highlighting that sturgeons such as *Acipenser baerii* and *Acipenser gueldenstaedtii*, are the most common species farm raised worldwide in aquaculture, because of the dwindling natural sources of caviar and meat. Also, these species can easily participate in the formation of an intraspecific hybrid with a great potential for growth in aquaculture. In this context the major aim is the application of microsatellite DNA for analysis of genetic diversity in common hybrids between *A. gueldenstaedtii* and *A. baerii*, farmed at a hatchery in Romania. The results will be applied to test the purity of hatchery broodstocks at Romanian fish farms and to increase the efficiency of selective breeding and performance testing programs.

This research is important as the natural sturgeon populations all over the world has been overexploited by fishing and poaching and are strictly protected by international conventions.

Another paper also based on modern genetic research "Brown trouts populations genetic diversity using mitochondrial markers in relatively similar geographical and ecological conditions – a Carpathian case study" is presented by *Gina-Oana Popa, Miad Khalaf, Andreea Dudu, Angela Curtean-Bănăduc, Doru Bănăduc, Sergiu Emil Georgescu* and *Marieta Costache*.

The authors point out that the brown trout (*Salmo trutta*, morpha *fario*, Linnaeus, 1758), under consideration in their study, is the most common among the six species of salmonids that exist in Romania and has high commercial potential, being used for aquaculture or fishing. The present study aims to analyse the genetic diversity of three Romanian brown trout populations from rivers found in Făgăraş Mountains area using as mitochondrial marker – the D-loop control region. The study proved that the three *Salmo trutta fario* populations analysed were genetically distinct and that in Romania there are still pure Danubian brown trout populations. The results are of great interest for the conservation of the brown trout in their natural habitats as well as for the aquaculture and fishing. This study is a first step in the molecular characterization of *Salmo trutta fario* from Romania using mitochondrial DNA markers and could provide precious information in future management strategies.

With his studies of mangroves titled "Reproductive ecology of mangrove flora: conservation and management" the author *Jacob Solomon Raju Aluri* refers to a worldwide important subject of the mangroves, a unique inter-tidal ecosystem of the tropical and subtropical coastal environments. In the paper, the importance of the mangroves ecosystem is highlighted, their multiple functions and services and their threats from human impact. The authors emphasize the importance of mangroves being among the world's most productive ecosystems with a great role in protecting coasts from erosion, in promoting the diversity of marine organisms and fisheries by contributing a quantity of food and providing favourable habitats for animals. At the same time, it is mentioned that the mangrove forests are under extreme threat worldwide due to their multiple economic uses and alterations of freshwater inflows by various upstream activities in the

catchment areas. Further the importance of mangrove plants is discussed which play a crucial role in sustaining life in mangrove forests. They have unique adaptations and their reproductive biology is central to understanding the structural and functional components of mangrove forests. Under focus in the present paper are viviparous and crypto-viviparous species, which are self-compatible, self-pollinating and also cross-pollinating; such a breeding system is a requirement for the success of sexual reproduction and subsequent build up and expansion of population. Both viviparous and crypto-viviparous species exhibit mixed mating system and adaptations for entomophily. Included in the study are the plants: *Ceriops tagal*, *C. decandra*, *Rhizophora apiculata*, *R. mucronata*, *Bruguiera gymnorrhiza* and *B. cylindrica.* From the non-viviparous plants are studied *Avicennia alba*, *A. marina*, *A. officinalis*, *Aegiceras corniculatum* and *Aegialitis rotundifolia.*

The study is not only relevant for the new results concerning the ecology of mangrove-tree flowers and the complex pollination and cross pollination and the complex functioning of mangrove ecosystems. The detailed information included in this paper is also useful for designing effective measures for conservation and management of the studied mangrove plants as these are the characteristic species of mangrove forests. The study further provides a basis for taking up larger studies of mangrove plants for the sustainability of mangrove forests.

A second study also dealing with the Mangrove forests included in this volume "Analysing learning at the interface of scientific and traditional ecological knowledge in a mangrove ecosystem restoration scenarios in the eastern coast of Tanzania" presents them from another point of view. The authors *Daniel Sabai* and *Heila Sisitka* are discussing an important problem related to the involvement of local communities in coastal management. The authors bring into attention possible challenges of adapting and applying scientific indicators in community-based monitoring of mangrove ecosystem and suggests a new approach that may lead to the development of indicators which are less objectified, more contextually and culturally congruent to users and likely to attract a wider social learning in the mangrove restoration context.

The whole volume with the above discussed eleven contentful papers have an extent of 209 pages. Each of the studies include informative maps, figures (graphics, fotographic images), tables all together forming a complete work with many different facets, being recommended for scientists with interest in wetlands based studies with all theoretical and practical aspects.

Therefore congratulations to the meritorious work, not only to the authors for their papers, but also to the editors, for their hard work for arranging the volume as a whole, coordinating the reviewers' work, and bringing it in the appropriate form ready for printing.

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