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CONTENTS / CUPRINS

I. GEOLOGY / GEOLOGIE

URSACHI Laurenţiu, VENCZEL Márton, CODREA Vlad - Additional upper pleistocene mammals at Movileni (Vaslui county, Romania) / Mamifere pleistocen superioare adiționale de la Movileni (județul Vaslui, România) 7

STELEA Ion, GHENCIU Monica - Geological vulnerability of the A1 highway. Case study on the Aciliu sector (Sibiu county) / Vulnerabilitatea geologică a autostrăzii A1. Studiu de caz pe sectorul Aciliu (județul Sibiu) 15

MACOVEI Monica, GRIGORE Dan, SEBE-RĂDOI Oana Gabriela, GHINESCU Eduard Costin, RUSU Simona, SIMION George Cătălin - Four paleontological sites near the Sinaia city – Suggestions for protection and ecotourism use / Patru situri paleontologice lângă orașul Sinaia - Sugestii pentru protecție și utilizare eco-turistică 21

ASIMOPOLOS Laurenţiu, ASIMOPOLOS Natalia-Silvia - Considerations about infrastructure, devices and physical principles in geomagnetic field metrology / Considerații privind infrastructura, dispozitivele și principiile fizice în metrologia câmpului geomagnetic 27

FOCIRO Oltion, MUCI Redi, SKRAME Klodian - Design, development and testing of a system that reflects the evolution of the coastline - Case study Lalzi bay, Albania / Proiectarea, dezvoltarea si testarea unui sistem care reflectă evoluția liniei de coastă - Studiu de caz golful Lalzi, Albania 35

MEÇAJ Majlinda, DURMISHI Çerçis, PRIFTI Irakli - Back thrust of molasse deposits in western Albania / Forța din spate a depozitelor de molasă din vestul Albaniei 42

KARRIQI Altin, PEKMEZI Jeton - Evaluation of limestones compactness using electrical resistivity method. Case study: Melova / Evaluarea compactității calcarelor prin utilizarea metodei rezistivității electrice. Studiu de caz: Melova 49

II. VEGETAL BIOLOGY / BIOLOGIE VEGETALĂ

DRĂGHICI Reta, DIACONU Aurelia, STRĂJERU Silvia, DRĂGHICI Iulian, CROITORU Mihaela, PARASCHIV Alina Nicoleta, DIMA Milica - Studies on the conservation of biodiversity of the traditional yellow melon genetic resources / Studii asupra conservării biodiversității la resursele vegetale tradiționale de pepene galben 55

RĂDUŢOIU Daniel, MĂCEŞEANU Daniela Mihaela - Xeric meadows affected by the zoo-anthropogenic factor from the Oltenia region (Romania) / Pajişti xerice afectate de factorul zoo-antropogen din regiunea Olteniei (România)..... 62

GONCEARIUC Maria, BUTNARAŞ Violeta, MAŞCOVŢEVA Svetlana, BALMUŞ Zinaida, COTELEA Ludmila, BOTNARENCO Pantelimon - Variability of content and chemical composition of the essential oils with heterosis effect in hybrids of *Lavandula angustifolia* Mill. / Variabilitatea conţinutului şi componenţei chimice a uleiului esenţial la hibrizi cu efect al heterozisului de *Lavandula angustifolia* Mill. 66

NICULAE Marilena - Chorology of *Sedum urvillei* (Crassulaceae) in Romanian Dobrogea, implications for conservation / Corologia *Sedum urvillei* (Crassulaceae) în Dobrogea Română, implicaţii pentru conservare 75

III. ANIMAL BIOLOGY / BIOLOGIE ANIMALĂ

III.a. INVERTEBRATES VARIOUS / NEVERTEBRATE DIVERSE

CHIHAI Oleg, ERHAN Dumitru, RUSU Ştefan, NISTREANU Victoria, LARION Alina, TĂLĂMBUŢĂ Nina, MELNIC Galina, ZAMORNEA Maria, ANGHEL Tudor - Parasite fauna of *Myodes glareolus* from the natural reserve "Plaiul Fagului" of the Republic of Moldova / Fauna parazită de *Myodes glareolus* din Rezervaţia Naturală „Plaiul Fagului” din Republica Moldova 83

FERENŢI Sára, COVACIU-MARCOV Severus-Daniel - Beyond the rule: a mountainous cave species, *Mesoniscus graniger* (Isopoda, Oniscidea) on a plain of south-western Romania / Dincolo de regulă: o specie de peşteri montane, *Mesoniscus graniger* (Isopoda, Oniscidea) într-o zonă de câmpie din sud-vestul României 89

BOUGUESSA-CHERIAK Linda, DJABRI Majda, BOUGUESSA Slim - Distribution of the araneides fauna according to vegetation and altitude in Tebessa region (extreme East of Algeria) / Distribuţia faunei de araneide în funcţie de vegetaţie şi altitudine în regiunea Tebessa (Estul extrem al Algeriei) 93

MOLNÁR Krisztina, CICORT-LUCACIU Alfred-Ştefan - New data on the distribution of large branchiopods (Branchiopoda: Anostraca, Notostraca, Spinicaudata) in Bihor county, north-western Romania / Noi date asupra distribuţiei branhiopodelor mari (Branchiopoda: Anostraca, Notostraca, Spinicaudata) în judeţul Bihor, nord-vestul României 101

VARVARA Mircea, ROŞCA Monica - Some observations on the diversity, abundance and dominance of epigeal arthropods in three orchards (cherry orchards, apple orchards, plum orchards), Crâng village, Vaslui county, Moldavia, Romania, 1996 / Unele observaţii privind diversitatea, abundenţa şi dominanţa artropodelor epigee din trei livezi (livada de cireşi, livada de meri, livada de pruni), satul Crâng, judeţul Vaslui, Moldova, România, 1996 105

NEŢOIU Constantin, TOMESCU Romică, OLENICI Nicolai, BUZATU Andrei, BĂLĂCENOIU Flavius, ILIESCU Ovidiu - The invasive insect species in the Oltenia region (Romania) / Specii de insecte invazive din zona Olteniei (România) 111

LILA Gima - Preliminary data regarding interspecific relationships beetle species collected from different ecosystems met in Dolj county in 2017. Note 1 / Date preliminare privind relaţii interspecifice la coleoptere din diferite ecosisteme din judeţul Dolj colectate în 2017. Nota 1..... 124

BÂRCĂ Valentin, NICULAE Marilena - Distribution of the species *Zerynthia polyxena* (Lepidoptera, Papilionidae), in natural and anthropic habitats in the Carpathian Piedmont between the rivers Buzău and Prahova (Romania), implications for its conservation / Distribuţia speciei *Zerynthia polyxena* (Lepidoptera, Papilionidae), în habitate naturale şi antropice în Subcarpaţii dintre râurile Buzău şi Prahova (România), implicaţii pentru conservarea ei 127

STANCĂ-MOISE Cristina - The critical endangered taxa within the Lepidoptera Collection of the "Lucian Blaga" University in Sibiu / Taxoni critic periclitați existenți în cadrul Colecției de Lepidoptere a Universității „Lucian Blaga" din Sibiu 135

III.b. VERTEBRATES / VERTEBRATE

COVACIU-MARCOV Severus-Daniel, CICORT-LUCACIU Alfred-Ștefan, FERENȚI Sára - In water with the enemy! A *Lissotriton vulgaris* (Amphibia: Salamandridae) paedomorph living together with the non-native fish, *Perccottus glenii* (Pisces: Odontobutidae) in Romania / În apă cu dușmanul! Un paedomorph de *Lissotriton vulgaris* (Amphibia: Salamandridae) trăind alături de peștele non-nativ *Perccottus glenii* (Pisces: Odontobutidae) în România 139

BONDAR Alexandra, CICORT-LUCACIU Alfred-Ştefan, SAS-KOVÁCS István - New distribution records of the danube crested newt *Triturus dobrogicus* (Kiritzescu, 1903) in southern Romania / Noi localități de răspândire a tritonului cu creastă dobrogean *Triturus dobrogicus* (Kiritzescu, 1903) în sudul României 145

GACHE Carmen - Aspects on the breeding season of bird fauna in the ROSPA0063 Reservoirs Buhuși-Bacău-Bereşti (Romania) / Aspecte ale sezonului de cuibărit al ornitofaunei în ROSPA0063 Lacurile de acumulare Buhuși-Bacău-Bereşti (România) 149

MESTECĂNEANU Adrian, POP Oliviu, MESTECĂNEANU Florin - Preliminary data on the species of birds from the Leaota Mountains included in the Annex I to Directive 2009/147/EC / Date preliminare asupra speciilor de păsări din Munţii Leaota incluse în Anexa I a Directivei 2009/147/CE 158

ALEXE Vasile, DOROȘENCU Alexandru, MARINOV Mihai, KISS J. Botond, SÁNDOR D. Attila, CEICO Tănase, NANU Cristina, MURARIU Dumitru, TOŠIĆ Katarina - Research regarding the success of white-tailed eagle nesting (Aves: *Haliaeetus albicilla* Linnaeus 1758) between 2009 and 2017 within the Danube Delta Biosphere Reserve and its surroundings (Romania) / Cercetări privind succesul cuibăritului la codalb (Aves: *Haliaeetus albicilla* Linnaeus 1758) în perioada 2009 – 2017, din Rezervația Biosferei Delta Dunării şi împrejurimi (România) 171

IV. ECOLOGY - THE ENVIRONMENT PROTECTION / ECOLOGIE - PROTECŢIA MEDIULUI

MARINICĂ Andreea Floriana, CHIMIŞLIU Cornelia, MARINICĂ Ion - The warm winter of 2017-2018 from south-western Romania in the context of climatic changes / Iarna caldă 2017-2018 în sud-vestul României în contextul schimbărilor climatice 178

ILIE Aurelian Leonardo, NĂSTASE Adrian, CIOBOIU Olivia - Phenological anomalies regarding the flowering of spontaneous and subspontaneous plants from four different parts of Romania / Anomalii fenologice privind înflorirea plantelor spontane şi subspontane din diferite părți ale României 193

VICOL Ioana - The assessment of the atmospheric pollution by accumulation of the heavy metals in central and peripheral parts of *Xanthoria parietina* (L.) Th. Fr., Romania / Evaluarea poluării atmosferice prin acumularea metalelor grele în părțile centrale şi periferice ale speciei *Xanthoria parietina* (L.) Th. Fr., România 200

CÎRSTEA Doina Maria, ŞTEFĂNESCU Mugur Cristian - Considerations on the bioremediation capability of some bacterial strains isolated from contaminated areas / Consideraţii privind capacitatea de bioremediere a unor tulpini bacteriene izolate din zone contaminate 205

FLORESCU Larisa, CATANĂ Rodica, GAVRILIDIS Athanasios-Alexandru, MOLDOVEANU Mirela - The impact of invasive species on urban ecosystems / Impactul speciilor invazive asupra ecosistemelor urbane 212

CIOBOIU Olivia, CISMAȘIU Carmen - Mădălina, TOMUȘ Nicolae, GAVRILESCU Elena, BREZEANU Gheorghe - The research on the metabolic characteristics of gastropods and the acidophilic bacteria to identify potential technological implications / Cercetări privind caracteristicile metabolice ale gasteropodelor și bacteriilor acidofile cu implicații în identificarea potențialului tehnologic 218

CUPȘA Diana, CICORT-LUCACIU Alfred Ștefan, TELCEAN Ilie Cătălin, KECSKES Beata - Modifications induced by anthropic activities upon the macrozoobenthic invertebrate communities from the Brătcuței Valley (Bihor county, Romania) / Modificări ale comunităților de nevertebrate macrozoobentice din Valea Brătcuței (județul Bihor, România), induse de activitățile antropice 224

MOLDOVEANU Mirela, FLORESCU Larisa, COJOC Roxana, NEAGU Simona, ENACHE Mădălin - Variations of the structure of biological communities related to salinity in some saline lakes from Romania / Variații în structura comunităților biologice în relație cu salinitatea în câteva lacuri saline din România 231

CISMAȘIU Carmen-Mădălina, CIOBOIU Olivia, GAVRILESCU Elena, TOMUȘ Nicolae - Ecological implications of biodiversity specific to industrially contaminated ecosystems in northwestern Oltenia / Implicații ecologice ale biodiversității specifice ecosistemelor contaminate industrial din nord-vestul Olteniei 240

PETRIŞOR Alexandru-Ionuţ - 2006-2012 land cover and use changes in Romanian Natural Protected Areas / Modificări în acoperirea şi utilizarea terenului din ariile naturale protejate din România în perioada 2006-2012 247

AVRAM Marga-Elena, MITITELU-IONUȘ Oana, GOGA Ionelia Claudia - The place and the role of the urban oxygenating areas in the urban landscape renaturation / Locul și rolul suprafețelor oxigenante urbane în renaturarea peisajului urban 253

V. SCIENTIFIC ESSAYS / REFERATE ŞTIINŢIFICE

GRIGORE Stelian, CREȚU Elena-Paula - A life devoted to museography: Zoe Apostolache Stoicescu / O viață închinată muzeografiei: Zoe Apostolache Stoicescu 259

Recommendations regarding the elaboration of the papers for the scientific journal "*Oltenia. Studii şi comunicări. Ştiinţele Naturii"/* Recomandări privind elaborarea lucrărilor științifice pentru revista "*Oltenia. Studii şi comunicări. Ştiinţele Naturii"*..... 261

ADDITIONAL UPPER PLEISTOCENE MAMMALS AT MOVILENI (VASLUI COUNTY, ROMANIA)

URSACHI Laurenţiu, VENCZEL Márton, CODREA Vlad

Abstract. Situated on the Scythian Platform, the locality of Movileni (Vaslui County, Eastern Romania) yielded few years ago a fragmentary skull of the Upper Pleistocene steppe bison (*Bison priscus*), unearthed on the Hreasca Creek. Subsequent systematic surveys and diggings carried out in this locality added few new fossil vertebrates. They refer to large mammals as: cave hyena (*Crocuta spelaea*), mammoth (*Mammuthus* sp.), giant deer (*Megaloceros giganteus*) and horse (*Equus* sp.). All these mammals are documenting an Upper Pleistocene (the glacial Würm/ Weichsel) steppe cold environment, with large open areas. Among these mammals, the cave hyena is found in an open-air locality, a rather rare case in Romania. All the bones and teeth have been found isolated, in fluvial sand channel fills.

Keywords: Late Pleistocene, large mammals, Scythian Platform, Moldavia, Romania.

Rezumat. Mamifere pleistocen superioare adiţionale de la Movileni (judeţul Vaslui, România). Situată în Platforma Scitică, localitatea Movileni (judeţul Vaslui, Romania estică) a furnizat cu un număr de ani în urmă un craniu fragmentar al bizonului de stepă pleistocen superior *Bison priscus*, adus la zi în Ogaşul Hreasca. Monitorizarea sistematică şi săpăturile efectuate subsecvent în această localitate au adăugat noi resturi de vertebrate fosile. Sunt in discuţie o serie de mamifere mari: hiena de peşteră (*Crocuta spelaea*), mamut (*Mammuthus* sp.), cerb gigant (*Megaloceros giganteus*) şi cal (*Equus* sp.). Toate aceste mamifere dovedesc existenţa unui mediu stepic pleistocen superior (glaciarul Würm/Weischsel), cu extinse spaţii deschise. Între aceste mamifere, hiena de peşteră este semnalată dintr-un sit non-cavernicol, caz mai degrabă rar în România. Resturile au fost în totalitate descoperite izolate, în umplutura nisipoasă a unor canale fluviale.

Cuvinte cheie: Pleistocen Superior, mamifere mari, Platforma Scitică, Moldova, România.

INTRODUCTION

Pleistocene sedimentary deposits are largely exposed on various areas of the Scythian Platform (SĂNDULESCU, 1984, RĂILEANU et al., 2012). Although their thickness is rather low, the areal distribution is important. These geologically young rocks cover the older formations (Miocene and Pliocene) of the last sedimentary megasequence (Badenian-Pleistocene; 'megacycle' in IONESI, 1994). Frequently, such deposits form the river terraces in this area of Moldavia (Eastern Romania). They bear various Pleistocene invertebrate and vertebrate fossils, the last ones being sometimes unearthed either fortuitously, or rarely, by systematic diggings. Therefore, in Moldavia the Upper Pleistocene large mammal remains (mainly large herbivores as mammoth, rhinoceros, bison, giant deer etc.) are found either on the Scythian Platform, or to northwest, on the Moldavian Platform. There are several localities that have yielded vertebrate fossils. Among these Movileni (Vaslui District), located on the Scythian Platform (Fig. 1; more precisely, in the sector so-called the 'Bârlad Platform' by IONESI, 1994; in fact, nothing but a local name for the south-western area of the Scythian Platform), is a Pleistocene locality from where a steppe bison (*Bison priscus* Bojanus, 1827) fragmentary skull has been reported by CODREA & URSACHI (2010) on the Hreasca Creek at the Hreasca Ravine, about 2.5 km north to the centre of the village (Fig. 2). Subsequent field works carried out in this locality in the last years supplied few additional bones and teeth documenting other Upper Pleistocene mammals, reported herein.

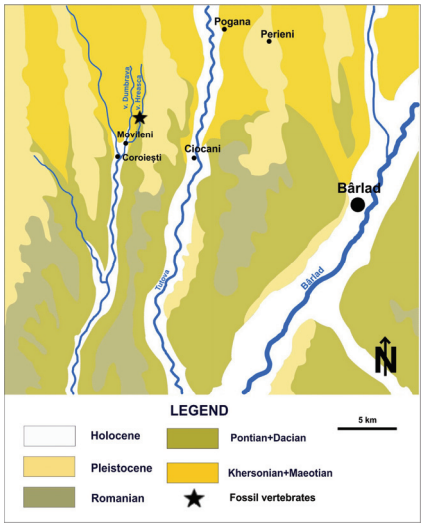

Figure 1. Location of Movileni locality on the geological map.

Figure 2. General view of Hreasca Ravine, on Hreasca Creek; forward, a bone unearthed from the Pleistocene limonitic sand.

The regional as well as the local geology of the area were discussed in the aforementioned paper. However, a closer look on the lithology of Hreasca Creek reveals the following succession (Fig. 3): i. in the basal most portion (ca. 2 m) there are gray-yellowish cross-bedding gravels and micro-gravels composed mainly by white quartzite lithoclasts, and sands; this level is the richest in bone remains, occurring mainly inside a channel infill; ii. ca. 1.5 m of yellowish sands with convolute lamination and plan-parallel stratification; these rocks bear vertebrate remains, but fewer compared to the previous level; iii. ca. 1 m of sands with ripple cross-lamination; iv. 0.6 m of sands with plan-parallel stratification; v. 1.5 m of yellowish loess-like deposits, covered by soil.

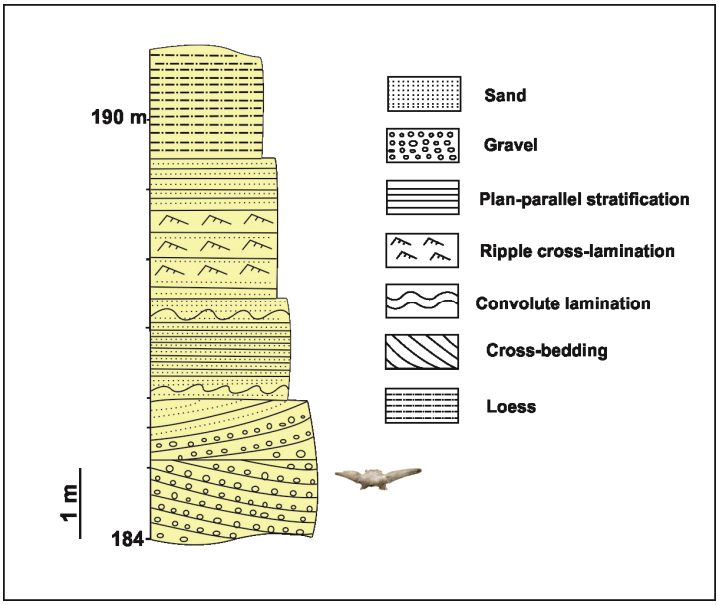

Figure 3. Lithologic log at Movileni, Hreasca Ravine; the bison skull fragment indicates the vertebrates bearing level.

It is worth to mention that the monocline dipping NNW-SSE of the Scythian Platform controlled the sediment distribution probably since the Miocene, as well as later, when the entire region became emerged, along with the river flow directions and their erosion tendencies.

MATERIAL AND METHODS

All the fossils are curated by the "Vasile Pârvan" Museum of Bârlad, Natural Science Branch (hereinafter, abbreviated VPMNS). The fossils did not require special preparation, being cleaned in the VPMNS laboratory. The rock matrix still remaining on bones and teeth surfaces was removed by basic mechanic techniques (professional chisels), then reinforced and/or glued by professional polymer (mowillit) at different concentrations.

Photographs were taken with a Nikon D-7000 camera and a 50 mm fl.8 lens and processed in Photoshop in order to sharpen the bone texture.

The lower cheek teeth herein are reported as p*x* (premolars) and m*x* (molars), *x* meaning the position of the tooth inside the teeth row, while the upper ones as P*x* and M*x*. The terminology and measurements follow for cave hyena those of BONIFAY (1971) and WERDELIN & SOLUNIAS (1991), for mammoth SHOSHANI & TASSY (1997), for horse those of SAMSON (1975), and EISENMAN (1981, 1986), and for 'giant deer' those of GUÉRIN (1996) and DRIESH (1976).

Systematic paleontology

Class Mammalia Linnaeus 1758
Order Carnivora Bowdich 1821
Suborder Feliformia Kretzoi 1945
Family Hyaenidae Gray 1821
Genus *Crocuta* Kaup 1828
Species *Crocuta crocuta* Erxleben 1777
Crocuta crocuta spelaea (Goldfuss 1823)
Plate 1, A, B.

Material: fragment of left mandible with p3 – p4 (VPMNS C5542).

The single specimen documenting the 'cave hyena' at Movileni is a jaw fragment still nesting the couple of the rear premolars. It documents a prime adult (wear stage VII of p3 in STINER, 2004), but not far from the first stage of

an old individual (stage VIII). The teeth wears are nearly at same stage illustrated by DIEDRICH (2012, Fig. 6A) from the Moravian Karst or in Baranica Cave by DIMITRIEVIĆ (2011, Fig. 2c).

Both premolars are typical for this species, robust and powerful, mainly due to the presence in each one of a large protoconid. The p4 has a small paraconid near to the anterior cingulum, being distinct from the protoconid; ȘTIUCĂ et al. (2007) mentioned this character as a 'spelaean feature'. The bone is devoid of marks of scavenging or cannibalistic activities.

Measurements (mm): mandible, breadth of the horizontal ramus under p3 – ca. 25.0, same under p4 – ca. 19.5; teeth, p3 – length: 22.5, breadth: 16.0, p4 – length: 23.0, breadth: 15.2.

Discussions. Compared to the mandible from the Igrița Cave (HMT III 8481 in CODREA, 1990), the sizes in both premolars are nearly similar (however, the last one is shorter in Movileni). Although the p3 length is smaller than in Muierilor Cave (ȘTIUCĂ et al., 2007), it remains enough illustrative for a Weichsel/Würm representative than for an older one from the Eemian interglacial, such specimens having a smaller third premolar (KURTÉN, 1963; BONIFAY, 1971), feature underlined also by ȘTIUCĂ et al. (2007). The mandibles from Râpa (Bihor County, in CSÁK, 1978) expose p3 of higher or of equal length, but broader, while p4 are all longer and broader (in a single specimen the breath is smaller). According to JURCSÁK et al. (1983, 1984) the fauna from Râpa documents a mild climate phase of Würm. In Baranica Cave (DIMITRIEVIĆ, 2011) most premolars are longer, but inside the sample one can find also similar sizes as in Movileni. On the other hand, in Rösenbeck Cave (KEMPE & DÖPPES, 2009), the p3 is smaller and the p4 less broad. These both sites document Weichsel/Würm representatives. The increase in size of the Middle-Upper Pleistocene large carnivores is well known for a rather long time (KURTÉN, 1968). The increase in size of the hyenas from this geological time span during the cold episodes *vs*. smaller sized specimens in warmer ones was underlined also by BARYSHNIKOV (1999). In this respect the Movileni specimen is rather illustrative for the last glacial.

It is already known that the so-called 'cave hyena' is not specific at all for cave environments, but cave environments offered the best taphonomy for preserving the remains of this carnivore. This rule is the same in Romania too, where most fossils have been found in caves (see a repertory of finds with related references in CODREA, 1990). Nonetheless, the presence of the 'cave hyena' in open-air sites is rare. Apart from Movileni, open air sites that yielded hyena remains are represented by the gravel open pits located around Bucharest (mostly in Băneasa), in northwestern Romania at Domănești (Satu Mare District), or in Drăghici (Argeș District), Feldioara (Brașov District), Jucu de Jos (Cluj District), Râpa (Bihor District), Cetea (Alba District), Streisângeorgiu (Hunedoara District) and probably at Cetea (Alba District). For instance, Movileni is the single open-air locality with 'cave hyena' in Moldavia. In this region, the single locality that has yielded hyena remains is Ripiceni, at Stânca Ripiceni Cave (on Prut River). There, into an Aurignacian layer few skeletal remains were unearthed mainly in the first half of the 20th (CODREA, 1990 and references therein).

In Romania, the most outstanding find is the one from the Weichsel/Würm locality of Râpa, Burzău Hill, where a hyena den (17 m long) excavated in Upper Miocene sands was unearthed, preserving both hyena remains (eight skulls, numerous postcranial bones and a large amount of coprolites) and their prey bones [large herbivores as mammoth - *Mammuthus primigenius* (Blumenbach, 1799), wooly rhinoceros – *Coelodonta antiquitatis* Blumenbach, 1807, horse – *Equus germanicus* Nehring, 1884 as well as micromammals (HAMAR & CSÁK, 1969), birds (KESSLER, 1974), amphibians and reptiles (VENCZEL, 1989) and fish]. Unfortunately, the paleontological diggings at Râpa initiated by CSÁK (1978) never continued, despite the peculiar rich paleontological message of this locality.

Order Proboscidea Illiger 1821
Suborder Elephantiformes Tassy 1988
Family Elephantidae Gray 1821
Subfamily Elephantinae Gray 1821
Plesion *Mammuthus* Brookes 1828
Mammuthus sp.
Plate 1, C.

Material: fragment of a tusk (VPMNS C5536).

Only a tusk fragment meaning a limited portion of the external wall is available from this site. This poor sample affords only to evidence the presence of a mammoth in this assemblage, but a closer assignment would be speculative. As a matter of course, such a presence is natural in this deposit. Probably, this tusk fragment originated from a specimen of wooly mammoth (*Mammuthus primigenius*).

Discussions. The Pleistocene localities with mammoth are numerous in Moldavia. Some repertories of these localities already issued in various references (*e.g.* APOSTOL, 1968; SIMIONESCU, 1990), but very few of them have clear stratigraphy. A lot of such fossils (mainly cheek teeth, tusks or tusk fragments) are hosted in various museum collections but, in a lot of cases, even the name of the locality of origin is missing from the inventories. Numerous fossils are originating either from river terraces or were found already reworked into recent alluvia. Surprisingly, even the geological unit they originated from is sometimes wrongly named (e.g., "Carpathian Basin" in HAIDUC et al., 2018 for several fossils found in fact, in the Dacian Basin).

Order Perissodactyla Owen 1848
Family Equidae Gray 1821
Genus *Equus* Linnaeus 1758
Equus sp.
Plate 1, D, E.

Material: left M3 (VPMNS C5000), left m3 (VPMNS C5002), a fragmentary Mt III (VPMNS C5537).

The fossils documenting the horse are not numerous. They refer to three isolated teeth, subject of pre-burial hydrotaphonomy, and an isolated fragmentary Mt III.

Measurements (mm): teeth, M3 (VPMNS C5000) – length: 32, breadth: 26, height: 38.5, m3 (P 342) – length: 31.2; breadth: 13; height: 70; m3 (VPMNS C5002) – length: 34.8; breadth: 15; height: 76.5; hind leg: Mt III (VPMNS C5537) – proximal antero-posterior diameter (Dp): 60.0; proximal transverse diameter (lp): 58; antero-posterior diameter of the diaphysis (Dm): 41; transverse diameter of the diaphysis (lm): 38.5.

Discussions. The size of the metatarsal is very close to the Late Würm *Equus* sp. reported from La Adam Cave, in Dobrogea (SAMSON, 1975). *E.* cf. *transilvanicus*, *E. spelaeus* and *E. spelaeus cibinensis* are of smaller sizes.
In an overview of the Pleistocene horses from Central Balkans FORSTEN & DIMITRIEVIĆ (2004) underlined the difficulties in the assignment to a species in the Upper Pleistocene horses. These difficulties are the same in Romania, and basically, we agree that for the presence of different sympatric species of horses in a locality one should find credible paleoenvironmental arguments, *i.e.* different ecological niches as FORSTEN & DIMITRIEVIĆ (2004) underlined. In a lot of cases, such detailed interpretations were not done (e.g. MUNTEANU et al., 2008). For instance, at Movileni we can presume the presence of a single horse species, based on this rather restricted sample.

Order Artiodactyla Owen 1848
Family Cervidae Goldfuss 1820
Subfamily Cervinae Goldfuss 1820
Genus *Megaloceros* Brookes 1828
Megaloceros giganteus (Blumenbach 1803)
Plate I, F, G, H.

Material: fragment of a right mandible horizontal branch with p4-m3 (VPMNS C5596).

The mandible fragment concerns a portion of the horizontal ramus nesting into the alveoli of the p4 (the mesial prism, damaged) - m3. The bone is massive due to pachyostosis, with highest effect under m3. The distal alveoli of p3 are also preserved, but this tooth is missing. The advanced tooth wear documents an adult or senior individual. On the m2 and m3, well expressed metaconids can be noticed. Ectostylids are present in all molars, the m3 with a post-hypoconide one too, but very faintly expressed. On the first molar the advanced wear made the ectostylid confluent with the wear surface of the hypoconide. Only small portions of weak cingulum can be noticed mesially on the labial and lingual walls, as prolongations of the mesial cingulum. The most obvious external cingulum is on m2, but it is also very weak.

Measurements (mm): mandible horizontal ramus, height of the dentary, lingual – ante - p4 - 43.8, p4/m1 - 43.2, m1/m2 - 49.5, m2/m3 - 53.4, post-m3 - 61.0; same, labial, ante - p4 - 44.6, p4/m1 - 44.1, m1/m2 - 49.0, m2/m3 - 52,0, post-m3 - 59.5, maximal transverse diameter: 39.5, minimal transverse diameter: 29.2; teeth, p4 - breadth (distal): 15.5, m1 – length: 25.5, breadth, 20.0, m2 – length : 34.5, breadth - 20.4, m3 – length: 48.0, breadth : 19.1, length m1 – m3 = 105.5

Discussions. The size of the mandible of the 'giant deer' from Movileni is extremely close to the one reported from Seleuş, in Transylvania (CODREA & SOLOMON, 2011). Therefore, following LISTER (1994) and CROITOR (2008), we are interpreting this mandible as originating from a male.

In Romania, there are several reports concerning this species. The oldest ones are from the 19th century, being usually devoid of clear stratigraphy, originated from scattered and fortuitous finds (CODREA & SOLOMON, 2011 and references therein). However, in these early reports are often mentioned that these finds refer to Würm/Weichsel representatives. Same ages are reported in 20th century in northwestern Romania by JURCSÁK (1974) or in southeastern Transylvania (Braşov Depression) by RĂDULESCU & SAMSON (1985). In this last region, the geological history of the 'giant deer' can be followed in older times too, until Riss/Saale (Bodoc-3).

In Moldavia, this large herbivore was reported from various localities, but all are concerning exclusively the last glacial: Ripiceni Izvor (Botoşani County; Mousterian I-IV), Iaşi (Iaşi County, in the so-called 'Ciric sands'), Hulubăţ (Vaslui County, in the lower terrace of Vasluieţ river) (SIMIONESCU, 1990 and references therein). Obviously, in none of the localities of Moldavia, as well as in none of Romania, there is no evidence about the survival of this species into the Holocene. Moreover, this Upper Pleistocene extinction (AARIS-SØRENSEN & LILJEGREN, 2004) is valid for the whole European continent, and our country follows the same rule. In Asia, the survival of the 'giant deer' was longer lasting, as showed by STUART et al. (2004).

Unfortunately, this single cranial bone offers too few data (*e.g.*, the length of premolar series is incomplete, so it is not clear if it is a primitive or an advanced specimen; CROITOR, 2008; CROITOR et al., 2014) to advance a better stratigraphy for Movileni based on this large herbivore.

CONCLUSIONS

The vertebrates collected from the deposits exposed on the Hreasca Ravine can be added now to the previous steppe bison find (CODREA & URSACHI, 2010). Only the 'giant deer' mandible fragment was found reworked in the recent alluvia, about eight hundred meters downstream on Hreasca Valley. All the other fossils were unearthed from the same level, where white-yellowish limonitic sand is in dominance. The presence of a mammoth, as well as of the other large herbivores is indicative for a Weichsel/Würm assemblage, documenting a cold stadial. There is no evidence for an older age (*e.g.* the "cave hyaena" features, a steppe bison is smaller compared to the Elster/Mindel or Saale/Riss specimens reported by RĂDULESCU & SAMSON, 1985 from Braşov sedimentary basin).

All the fossils were found isolated, without any anatomical connection. It is presumed that all these teeth and bones were carried by water streams before their definitive burial. The long bones were trended in such manner as one may presume a SW-NE direction of the stream that accumulated the pile of sands from Hreasca Creek (Fig. 4). Such a direction would be very different compared to the actual course of the rivers in the area, but it could be simply explained if one considers a meandering Pleistocene river. For a conclusion about the Pleistocene river network in Moldavia, a more detailed sedimentology would be desirable, but for instance the number of outcrops on Hreasca Creek is too few for an extended work.

Figure 4. A steppe bison (*Bison priscus*) vertebra in situ at Hreasca Ravine, illustrating the Pleistocene stream orientation.

Obviously, this locality still has a high potential in yielding vertebrate remains and a systematic survey should continue. Eventually, an extended digging could reveal much more vertebrate fossils and additional sedimentological details that could offer a better understanding of the local Upper Pleistocene environment.

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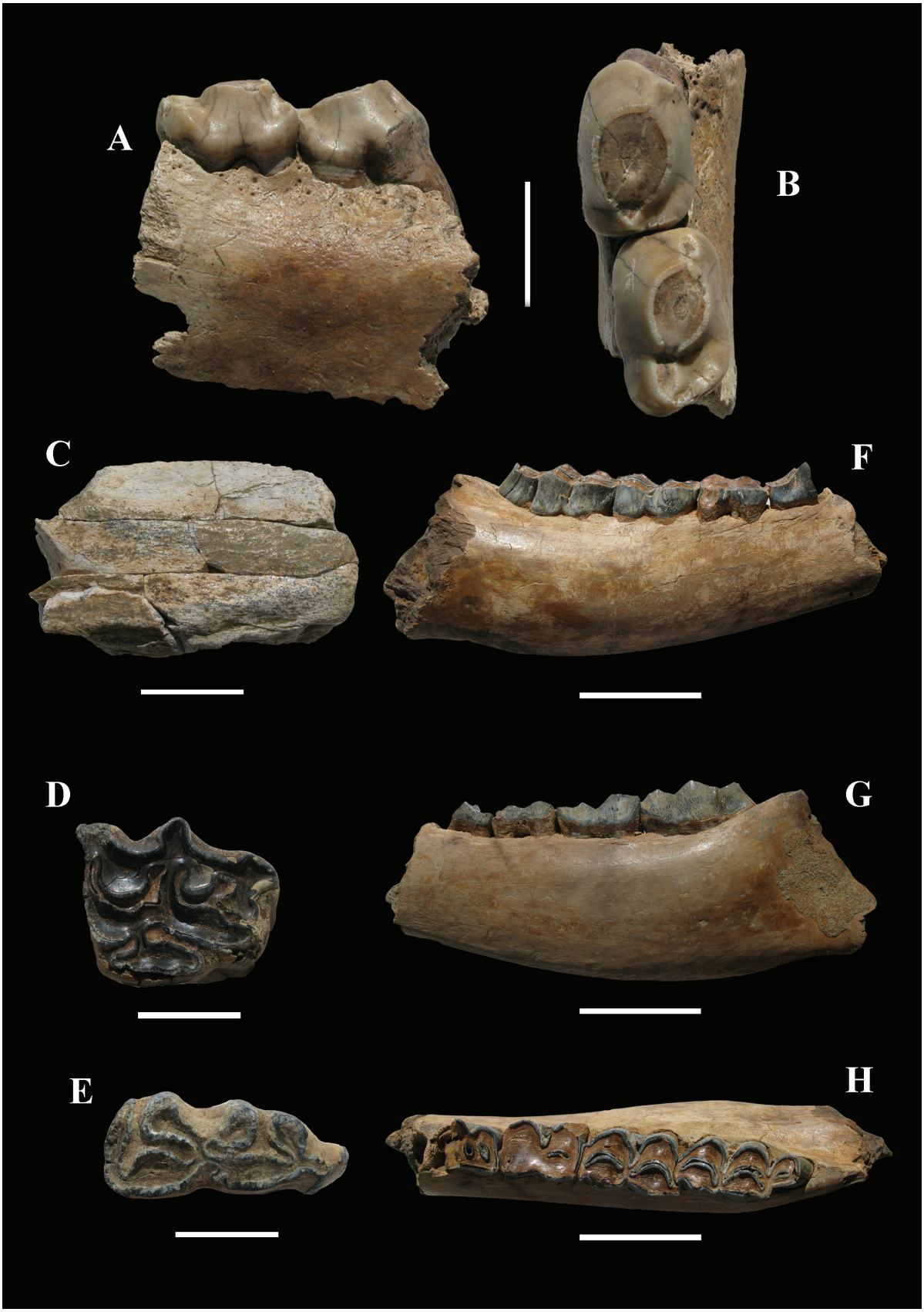
Plate I



Upper Pleistocene vertebrates from Movileni. *Crocuta crocuta spelaea*, mandible fragment: A - lateral view, B – occlusal view. ?*Mammuthus*, tusk fragment: C – external view. *Equus* sp.: D – M3 occlusal view, E – m3 occlusal view. *Megaloceros giganteus*, mandible fragment with p4 - m3: F – labial view, G – lingual view, H – occlusal view. Scale bars: 20 mm.

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GEOLOGICAL VULNERABILITY OF THE A1 HIGHWAY. CASE STUDY ON THE ACILIU SECTOR (SIBIU COUNTY)

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Abstract. This paper examines the connections between the regional geological context and the local geological conditions on the Aciliu sector of the A1 highway, in order to identify the geological vulnerability factors of the construction works made in this sector. We refer to the cutting on the southern side of the Bucium Hill and to the Aciliu Viaduct, affected by landslides, deep gallies and major malfunctions after the opening of highway traffic. On this occasion, the necessity of geological studies on both regional and local scale in choosing the optimal route of roads is emphasized.

Keywords: geological vulnerability, A1 highway, Aciliu Viaduct.

Rezumat. Vulnerabilitatea geologică a autostrăzii A1. Studiu de caz pe sectorul Aciliu (judeţul Sibiu). În lucrare sunt analizate conexiunile dintre contextul geologic regional şi condiţiile geologice locale din sectorul Aciliu al autostrăzii A1, pentru identificarea factorilor geologici de vulnerabilitate ale lucrărilor de construcţii executate în acest sector. Ne referim la debleul de pe versantul sudic Dealul Bucium şi la viaductul Aciliu, afectate de alunecări de teren, ogaşe adânci şi defecţiuni majore după deschiderea circulaţiei publice pe autostradă. Cu această ocazie, este subliniată necesitatea studiilor geologice la scară regională şi locală în alegerea traseului optim al căilor rutiere.

Cuvinte cheie: vulnerabilitate geologică, autostrada A1, viaductul Aciliu.

INTRODUCTION

The deteriorations that have occurred on the Sibiu-Orăştie section of the A1 highway after the traffic opening, especially on the Aciliu sector, are of public notoriety. Partially, these problems are the result of insufficient knowledge of the geological structure of the ground, superficially treated in the pre-construction geotechnical studies. Anyway, such studies have a local character, and the local geological data cannot be correctly interpreted outside of a wider geological context, especially the structural and the tectonic data.

The geological vulnerability of a road appears more clearly if is first analyzed on a regional scale. Such an analysis should take into account three geological factors of vulnerability: lithological, structural and tectonic. We will also use the phrase "geological structure of the ground" in this text, as a synonym for all three factors of vulnerability.

The lithological factor is important for sedimentary terrains consisting of weakly consolidated rocks, such as sands, clays or marls. It is the case of Neogene sedimentary formations on the orogen border and from the intramontane depressions. Frequently, permeable and impermeable rocks alternate in their lithological constitution. Large open excavations in such geological formations represent new ways of infiltration of water in the permeable sequences to their waterproof substrate, which softens by favouring the sliding of the overlying rock layers.

The lithological vulnerability is lower for magmatic and metamorphic terrains, made up of rocks much stronger than the sedimentary ones. The boundaries between the formations with contrasting lithologies from mechanical and rheological point of view may be vulnerable in the metamorphic terrains. These boundaries may become locally unstable due to seismic movements and to the permanent vibrations caused by road traffic.

The structural vulnerability factor is important for sedimentary and metamorphic terrains, especially for those wich are weakly metamorphosed. For example, a cutting that is excavated parallel with the strike of a monoclinal structure can produce landslides on the cutting slope inclined according to the monoclin. The same thing happens by severing the limb of an anticlinal parallel with its axial plane, as the rocks in the fold hinge tending to slide into the excavation. In both situations, lithological and tectonic factors can aggravate the landslides. A local geological study can not reveal a regional geological structure.

Tectonic vulnerability exists in all geological types of terrains. The faults weaken the cohesion of rocks and increase their permeability, facilitating the water infiltration in the subsurface, on the crossed structural discontinuities and the permeable rock layers severed by tectonic planes. Crustal earthquakes frequently occur along the major active faults increasing the terrain instability. Most of the time, the characteristics of a tectonic plane cannot be understood on a local scale, especially in sedimentary formations with non-cohesive and monotone lithologies which do not preserve the faults traces and the movement markers.

This study tries to show how the regional geological context is reflected at a local scale as well as the consequences of ignoring the context on the A1 highway, with reference to the Aciliu sector. The biggest construction on the highway route was erected here, i.e. the Aciliu Viaduct, as well as the largest anthropic intervention in the geological environment, i.e. the Aciliu cutting, excavated on the southern side of the Bucium Hill, near the Aciliu Village, and on the northern foot of the Furcilor Hill, very close to the Sibiu-Sebeş railway.

LITHOLOGICAL AND STRUCTURAL DATA

The geological formations in the studied region belong to the metamorphic basement (Getic Crystalline) of the Cibin Mountains from their north-eastern edge, and to the sedimentary deposits of the Transylvanian Depression from its south-western border.

Metamorphic formations. The metamorphic basement of the Cibin Mountains in this region mainly consists of gneissic rocks representing the lower complex of the Getic Crystalline (Fig. 1). This includes two metamorphic formations, one of micaceous gneisses with lenses of amphibolites and pegmatites, at the top, and one of augen gneisses with remnants of undeformed coarse-grained granitoids, at the bottom. Micaschists and quartzo-feldspathic gneisses from the upper complex appear only on small areas. A diverse range of fine-grained mylonitic schists, mainly chlorite and feldspathic schists, with interlayered marbles and amphibolites outcrop along a major tectonic lineament corresponding to the Răşinari Shear Zone.

The Hercynian structure of the Getic Crystalline is tabular and subhorizontal at a regional scale, but in the north-eastern part of the Cibin Mountains it was weakly folded during the Late-Alpine orogenesis. On the contact with the Transylvanian Depression the basement is cut by vertical dip-slip faults, N-S and NE-SW trended, the tectonic blocks in the Tilişca, Sălişte-Sibiel and Orlat areas being moved downward. The entire basement gradually sinks under the sedimentary cover on normal faults parallel with the orogen, reaching depths of over 1,000 meters in the Sibiu Town area (e.g. GHEORGHIAN et al., 1975).

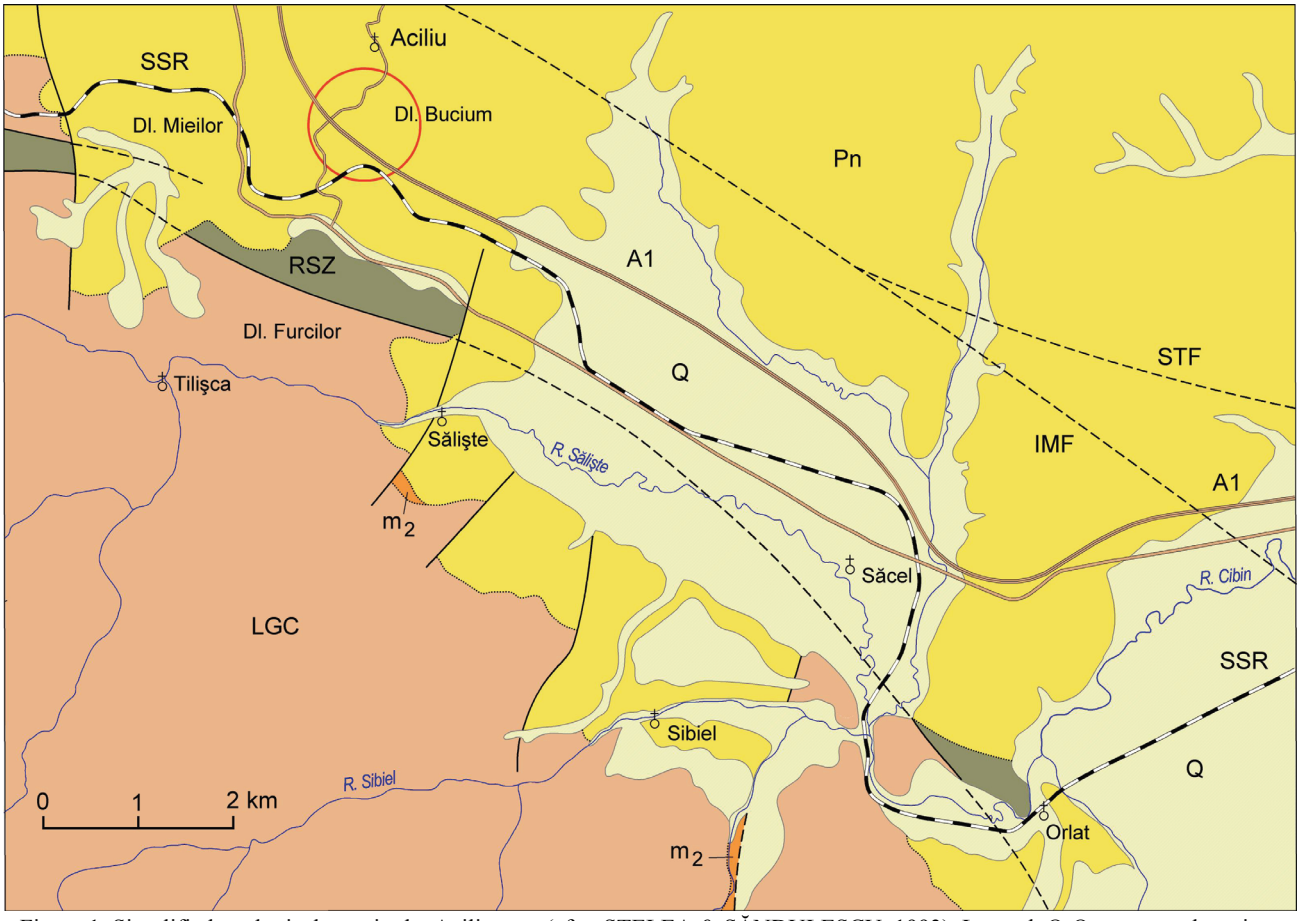

Figure 1. Simplified geological map in the Aciliu area (after STELEA & SĂNDULESCU, 1993). Legend: Q-Quaternary deposits; Pn-Panonian formations; m_2- Badenian formations; LGC-Lower Getic Complex; RSZ-Răşinari Shear Zone; IMF-Intramoesian Fault; STF- South Transylvanian Fault; A1-A1 highway; SSR-Sibiu-Sebeş railway; Red circle- Location of the photos in Figs. 2 and 3. Details in text.

Sedimentary formations. The sedimentary deposits of the Transylvanian Depression are made up of Upper Cretaceous-Lower Miocene sequences, representing the post-tectonic cover of the orogenic structures, and of Mid to Upper Miocene sequences, representing the depression molasse fill (SĂNDULESCU, 1984). The stack thickness generally increases from the orogen to the central part of the basin, but the drilling data show that the stratigraphic terms of the pile have neither constant thickness nor continuous areal development. For example, in the drilling near Daia, a village situated 14 km east of Sibiu, the Badenian lies on the Eocene, intercepted at the meter 940. In the drilling near the Ilimbav Village, situated 30 km east-northeast of Sibiu, the Sarmatian lies directly on the metamorphic basement, met at 1,355 meters deep (VANCEA, 1960).

At the topographic surface, the Pannonian formations develop on large areas in this region (Fig. 1), while Badenian and Sarmatian formations outcrop on small areas, only on the basement margin (STELEA & SĂNDULESCU, 1993). The Badenian is represented by dacitic tuffs and tuffites with rare intercalations of marls, sometimes marls and clays. The Sarmatian is represented by calcareous sandstones, sands and gravels with intercalations of marls. The Pannonian deposits consist of thick sequences of sands and clayey sands with thin lenses of gravels, and marls with thin intercalations of unconsolidated sandstones.

Details in the Aciliu area. The total thickness of the Pannonian deposits exposed in outcrops is about 300 meters in the Aciliu sector of the A1 highway. The general strike of the beds varies from NNW-SSE to NNE-SSW, with dip of 2-5 degrees towards the ENE and ESE respectively.

A succession of marls and sands with decimetric levels of fine gravels outcrops on the northern side of the Bucium Hill. On its southern side, reddish clays outcrop in the eastern part of the highway cutting slope, severely affected by landslides with gullied scarps of 1-4 meters high (Figs. 2a, b). Yellow-reddish clayey sands with decimetric levels of sands and gravels outcrop in the western part of the cutting slope, affected by a branched system of 2-3 meters deep gullies exposing the marls beneath (Fig. 2c). The same marls outcrop on the western side of the hill, under the Aciliu Viaduct (Fig. 2d). Yellow-reddish clayey sands also outcrop on the opposite cutting slope, affected by parallel gullies following the line of greatest slope.

Figure 2. Outcrop photographs in the Bucium Hill area (original, September 2017). a, b) Landslides in the clays from the eastern part of the cutting slope; destroyed drenaige works and textile net are seen. c) Gullies in the clayey sands from the western part of the cutting slope, with marls (m) on the bottom of the deep gullies. d) Sistematically fissures on NW-SE direction in the Pannonian marls under the Aciliu Viaduct (detail).

REGIONAL TECTONICS

Four major tectonic lineaments join on the south-western border of the Transylvanian Depression, without taking into consideration the presumed Oltului Fault, insufficiently documented. These are the Intramoesian Fault, on NW-SE direction, the South Transylvanian Fault, on E-W direction, the Răşinari Shear Zone, on the NW-SE direction in this region, and the Sadu Fault, on the WSW-ENE direction. The first three faults cross the Aciliu area, their trace being buried under the Pannonian sedimentary deposits (Fig. 1). Only the Intramoesian Fault is active, but the frequent

seismic movements along it could cause local reactivations on the other faults, most likely on the South Transylvanian Fault, parallel to the European road, Sibiu-Braşov.

These faults also favoured the emergence of mud volcanoes (locally named *gloduri*) in this region, on the Alba Iulia-Sibiu and Sibiu-Făgăraş alignments (CIUPAGEA et al., 1970). On the A1 highway route are mentioned mud vulcanoes at the Sibiu Town (Guşteriţa district) and the Apoldu de Jos Village, 10 km north-northwest of Aciliu.

The Intramoesian Fault. The well-known crustal earthquakes in the Făgăraş Mountains area are related to the Intramoesian Fault, with dextral strike-slip movement on the alignment Sibiu-Câmpulung Muscel. The fault crosscut the metamorphic basement as well as the pre-Pliocene terms of its sedimentary cover. The geological trace is partly coincidental with the geophysical trace of the tectonic line Oradea-Cumpăna, gravimetrically highlighted at the level of the Moho discontinuity (SOCOLESCU et al., 1964).

In its western compartment, the Intramoesian Fault is accompanied by secondary faults with the same general direction, representing the expression at the topographic surface of a deep structure, asymmetrically branched (STELEA, 2017). Consequently, the related seismic activity is asymmetric with respect to the main tectonic plane, chiefly affecting the western fault compartment, from Târgovişte to Sibiu (VISARION et al., 1988).

The South Transylvanian Fault. This fault was active with dextral strike-slip movement during the Cretaceuos, allowing the eastward translation of the Intracarpathian crustal block and thus the synchronous nappes emplacement in the East Carpathians (SĂNDULESCU, 1984). In the Sibiu region, the South Transylvanian Fault was subsequently intersected by the Intramoesian Fault and dextral displaced on the Apoldu de Jos-Sibiu alignment. On the fault segment east of the Intramoesian Fault, the metamorphic basement of the Făgăraş Mountains is 500 meters moved downward under the sedimentary deposits of the Transylvanian Depression (CIUPAGEA et al., 1970).

The Răşinari Shear Zone. This tectonic lineament crosscut the entire northern margin of the Sebeş-Cibin Massif from the Streiului Valley to the Lotrului Valley, on an arcuate trace with the length of 150 km. It is a Hercynian fault with dip-slip movement which accommodated the differential up-lift of the getic metamorphic pile, with higher rates in the axial area of the orogen than on its northern margin. The fault was intermittently reactivated with sinistral strike-slip movement during the Early-Mid Alpine orogeneses, when the medium-grade mylonites inside the shear zone as well as the adjacent host rocks were dynamically retrogressed. Usually, the fault zone segment south of Răşinari is considered as thrust plane of the Supragetic Nappe.

Between the localities Sălişte and Cisnădioara, the shear zone is covered by the sedimentary deposits of the Transylvanian Depression, starting with Cenomanian conglomerates (GHEORGHIAN et al., 1975). Very likely, secondary faults from the western compartment of the Intramoesian Faults overlap over the shear zone in this area.

The Sadu Fault. It is a Tertiary fault with sinistral strike-slip movement which displaced *en echelon* the Răşinari Shear Zone between the localities Râul Sadu and Sadu; the fault plane is subvertical at present. Toward WSW, the fault crosscut the left side of the Sadu Valley then follows the Frumoasei Valley and reaches the basin of the Eastern Jiu River. It is possible that this fault may have contributed to the formation of the sedimentary Petroşani Basin, in tandem with the Cerna-Jiu Fault, with dextral strike-slip movement during the Eocene and dip-slip movement during the Oligocene and the Miocene (BERZA & DRĂGĂNESCU, 1988). Toward ENE, the Sadu Fault is covered by the Mid Miocene sedimentary deposits from the Cisnădie-Boiţa area and probably stops in the Intramoesian Fault.

Details in the Aciliu area. In the outcrops of marls on the western side of the Bucium Hill, under the Aciliu Viaduct, have been measured a set of equally spaced fissures, NW-SE oriented (Fig. 2c), and a set of joints NNE-SSW oriented. Joints with NW-SE and NNE-SSW orientations also occur in the marls on the northern side of the hill. In the marls levels that occur in the sands on the eastern side of the Mieilor Hill, on the other side of the A1 highway, have been measured NW-SE and N-S oriented joints, with calcite efflorescences.

One thing draws attention, namely the systematic character of the joints and fissures with NW-SE orientation. These appear on both sides of the highway on a distance of at least 2000 meters, from the Bucium Hill to the Mieilor Hill, indicating the existence of a tectonically controlled joint corridor along the highway. We also note that the joints occurring under the viaduct are open and that the joints occurring on the northern side of the Bucium Hill sometimes coincide with the slide surface of some old landslides. These field data suggest that the joint set with NW-SE orientation is active, which is why we associate it with the tectonic movemens along the Intramoesian Fault, the only active fault în this region.

IMPACT ON THE HIGHWAY IN SEPTEMBER 2017

In September 2017, all the drainage works made in the Aciliu cutting slope on the Bucium Hill (drainage channels, pipes and collecting channels), as well as the textile net for soil protection, were practically destroyed by still active landslides and gullies (Figs. 2a, b; 3a). Water is gathering and a hydrophilic vegetation grow behind the sliding mass (Fig. 2a). The landscape is desolated. We mention that there were no landslides on the southern side of the hill prior to the cutting excavation.

Gullies of 1-4 meters deep appeared at the heads of the Aciliu viaduct, between the abutments and the downstream pilots (Figs. 3b, c), especially at the north-western head, toward Apoldu de Jos, where the works at the abutment were affected; the drainage channels were broken and the concrete slabs for the embankment protection were cracked and dislocated (Figs. 3c, d). The two abutments have already fallen once, the north-western one in 2015, and

the south-eastern one, toward Sălişte, in 2016. Although these have been repaired, the problems appeared again. Considering the geological structure of the ground and the vibrations caused by the road traffic, correlated with the effects of atmospheric precipitation, we anticipate that these damages will increase in the future.

Figure 3. Photographs of the highway construction works (original, September 2017). a) Broken collecting channel on the cutting slope (Bucium Hill). b) Gullies at the pilots down the eastern head of the Aciliu Viaduct. c) Broken collecting chanel and the subsequent gully at the western head of the Aciliu Viaduct. e) Cracked and dislocated concrete slabs at the western head abutment.

CONCLUSIONS

The Pannonian formations outcrop at 450 meters elevation under the Aciliu Viaduct, and at 315 meters elevation in the banks of the Secaş River near Apoldu de Jos. Therefore, the thickness of the sands, clayey sands and marls deposits in this sector of the A1 highway is of 100-130 meters. This means that the viaduct pilots, buried 40 meters deep, are fixed in the Pannonian soft rocks noway in hard rocks, term geologically equivalent with magmatic and metamorphic rocks. Evidence is the stability problems which appeared and continue to appear at the viaduct heads.

The technical solution for crossing through cutting the Bucium Hill did not consider the geological structure of the ground. Cannot stop with textile nets the sliding of a high hill of 613 meters excavated down to the highway elevation which is 550 meters in this sector. Above the highway there are over 50 meters of sedimentary formations with alternation of permeable and waterproof lithologies, systematically fissured on NW-SE direction, parallel to the highway in the Aciliu sector, but intersecting the highway in the Apoldu de Jos sector. The hill will continue to slide until it reaches the natural slope of the rocks from which it is constituted and the drainage works will be permanently destroyed. It is possible that the railway above the opposite cutting slope to be also affected.

The geotechnical studies for the roads and highways construction, in general for civil and industrial construction, must be done with utmost responsibility and must be preceded by geological studies at regional scale and even at detailed scale if the geological structure of the ground requires this.

And last but not least, we must never forget that “civilization exists by geological consent, subject to change without notice” (DURANT, 1946).

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FOUR PALEONTOLOGICAL SITES NEAR THE SINAIA CITY – SUGGESTIONS FOR PROTECTION AND ECOTOURISM USE

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Abstract. The Sinaia Formation sedimentary deposits are abundant in fossils that are important not only for Romania, but also for international paleontological correlations and interpretation. Four fossil abundant sites placed in the area of the Bucegi Natural Park are considered in this paper: one of them is an already declared Geological and Biological Monument (Sfânta Ana). The outcrops have been studied in the past, but a thorough and integrated research has not been carried out. Also, they are not yet mentioned as paleontological sites in the Bucegi Natural Park Integrated Management Plan and we propose that a more careful attention should be attributed to this natural monuments and some minimal setup for tourism.

Keywords: paleontological site, Sinaia, ecotourism.

Rezumat. Patru situri paleontologice lângă orașul Sinaia - Sugestii pentru protecție și utilizare eco-turistică. Partea superioară a depozitelor sedimentare din zona Sinaia abundă în fosile care sunt importante nu numai pentru România, ci și pentru corelațiile și interpretările paleontologice internaționale. În această lucrare sunt luate în considerație patru situri paleontologice abundente în fosile plasate în zona Parcului Natural Bucegi, unul dintre ele este deja declarat Monument Geologic și Biologic (Sfânta Ana). Aflorimentele au fost studiate în trecut, dar nu a fost efectuată o cercetare aprofundată și integrată. De asemenea, acestea nu sunt încă menționate ca situri paleontologice în Planul Integrat de Management al Parcului Natural Bucegi și propunem să se acorde o mai mare atenție acestor monumente naturale și o minimă amenajare pentru turism.

Cuvinte cheie: situri paleontologice, Sinaia, ecoturism.

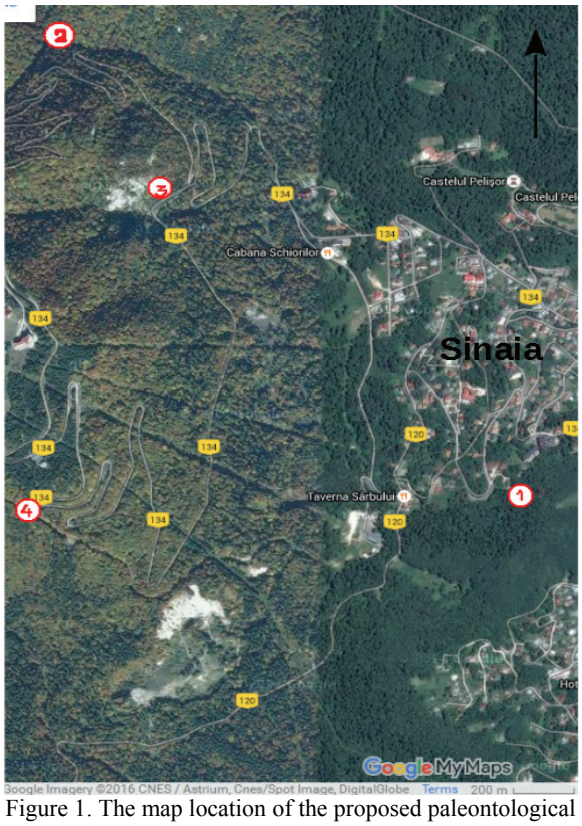

Figure 1. The map location of the proposed paleontological sites: 1 - "Stânca Piticului", 2 - The Olistolith from the Peleș Valley, 3 - Sf. Ana, 4 - Stânca Izvor - Valea Zgarburei (Google Maps, 2017 with additions).

INTRODUCTION

West from Sinaia, just after the city limits, lies the Bucegi Natural Park founded by Ministry Order 7/27.01.1990 and reconfirmed by the law no. 5/2000, a complex protected area (STANCIU & FLORESCU, 2009). In this region (as seen in Fig. 1) there are 4 paleontological sites of a big scientific interest and also, they can become of interest for the tourists but only with some precautions and regulations.

The fist paleontological site, "Stânca Piticului" is located just at the limit of the Natural Park with the Sinaia City, in the durable management area (Planul de Management Integrat al Parcului Natural Bucegi și al Sitului Natura 2000 ROSCI 0013, 2017, 2017); is placed right beside a private property. The second site, known as The Olistolith from the Peleș Valley (PATRULIUS, 1969) is placed in the maximum protection area of the Bucegi Natural Park. The third one, Sfânta Ana is between the two protection areas: maximum protection and durable management. "Stânca Izvor" – Zgarburei Valley, the last paleontological site proposed in this paper is located in the durable management area due to the vicinity to the communal road 134 (the way to Cota 1400).

Regarding the geological setting, the area of interest is part of the Sinaia Formation of Barremian - Aptian age. The Sinaia Formation is up to 2500 m thick and consists mainly of flysch represented by carbonate-rich siliciclastic and thick sedimentary deposits. The stratigraphy of the area has been studied by many authors starting with POPOVICI-HAȚEG (1898), PROTESCU (1936), ONCESCU (1965), PATRULIUS (1953, 1954, 1959, 1964, 1966, 1969 and 1970), MURGEANU & PATRULIUS (1957) and others. The sites have been described in detail by PATRULIUS (1969, 1970). They have even been marked on the geological map 1:50,000 of Bucegi Masive and Dâmbovicioara Couloir (PATRULIUS,1969). Recent researches related to the general geological context and stratigraphy have subsequently been made and new data and theories are emerging: BARBU & LAZĂR (2010), SANDY et al. (2012).

SITES DESCRIPTION

The limestones around Sinaia are consisting in 3 types of imposing facies (Furnica, Sf. Ana, Piatra Arsă), of more than one kilometer long as klippes, and some other smaller ones as blocks/cliffs. Until 1952 this limestones were considered to be of Tihonian – Berriasian age (POPOVICI – HATZEG, 1897 and ONCESCU, 1934 in PATRULIUS, 1969) or only Tithonian (JEKELIUS, 1938 in PATRULIUS, 1969). PATRULIUS (1969) says that the facies of Piatra Arsă and its subordinated type of limestones is the most abundant in macro - fossils.

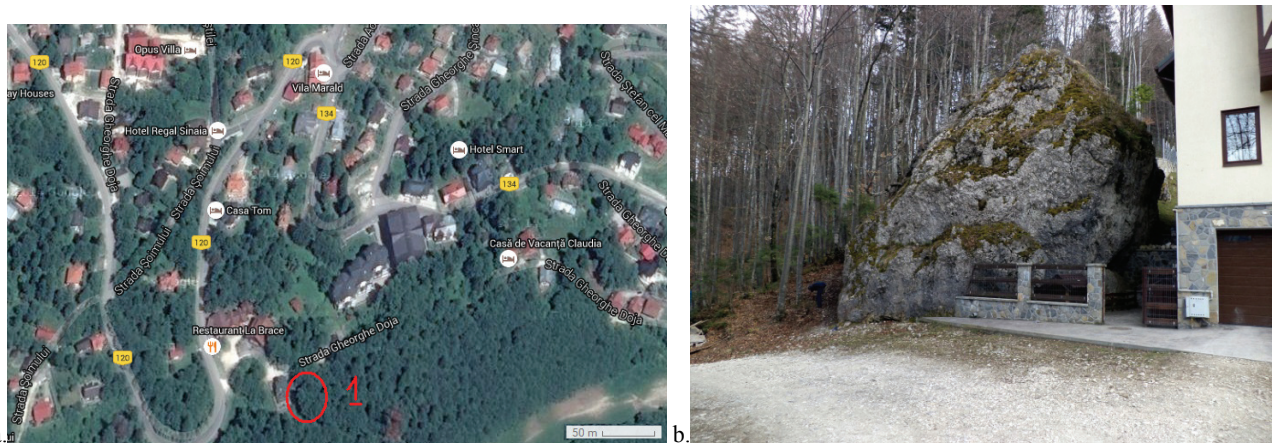

Figure 2. The paleontological site named "Stânca Piticului": a. map location of the site (Google Maps, 2016 with additions); b. the outcrop and the private property next to it (original).

The first point of interest named "Stânca Piticului" (see Figs. 2a, b) was considered a geological monument (PATRULIUS, 1969) but the new law (no. 5/2000) didn't take regard of it. In 2010 a new private construction was build right next to it.

The outcrop (Fig. 2b) represents a limestone block with circa 7 meters height, 8 meters width and 40 meters length, situated near Gheorghe Doja (current name) street and the secondary road which climbs to Cota 1400 – Sinaia, just at the limit of the town with the Natural Park Bucegi.

Near the intersection of Furnica Street and Coştila Street, PATRULIUS (1969, 1970) mentions a fossil bearing limestone. It is an Upper Jurassic - Lower Cretaceous (150 -140 m.y.) reef limestone with a rich fossil fauna comprised of corals, sponges, bryozoans, gastropods, bivalves, cephalopods (nautilus, ammonites), echinoids, crabs (the most impressive collection in the world with the biggest number of identified species), and last but not least, *Protocypraea tithonia* Gemmellaro, as first representatives of Cyprinidae. In the National Geological Museum's Paleontological Collection there are more than 1500 fossils from this site (Fig. 3).

This small block of recifal limestone might be the most rich in fossils to be documented in the Romanian Carpathians, for its age – Tithonian; here were described more than 200 fossil species: cephalopods (17), brachiopods (10), bivalves (80), gastropods (60), echinoids (7), crabs (40), corals and sponges; this block is *locus tipicus* for many species which have been discovered and described by PATRULIUS (1959, 1964, 1966, 1969). This site has a scientific importance of the first category according to the IUCN classification (see conclusions).

The second paleontological site is found on the protected territory of the Bucegi Natural Park, near another objective – The Stone of Saint Ana/Stânca Sfânta Ana - on the road that goes up to the Poiana Stânii Regale, which departs from the road that goes to Cota 1400. Part of the site is right near the roadside, at the first serpentine, and continues on the path that crosses the Peleş Valley and climbs to the Poiana Stânii Regale. The eastern part of the site is comprised of sandstones, marls and jaspers and the western part of nodular limestones. The site is larger than the first one, approximately 350 meters in length and 50 meters in height.

PATRULIUS (1970) noted that the course of Peleş River passes through a block of limestone. At the bottom of that limestone he observed some red jasper that in thin sections proved the presence of Oxfordian radiolars. The fossil content of all the deposits from this olistolith is scarce, but of stratigraphic and tectonic importance. It is one of the rare occurrences of Callovian age in our country, with fossiliferous beds representing a small interval of geological time. The site can be further studied and potentially new fossil species can be found here for Callovian – Kimmeridgian interval. It also has a paleogeographic importance for this interval that might prove very important for the tectonic evolution of this region.

Figure 3. Images of the D. Patrulius Collection (from the collections of the National Museum of Geology, Bucharest) from the "Stânca Piticului" and Sfanta Ana olistolith – Upper Jurassic rocks in this perimeter of Sinaia: a, d - ammonites, b, c, e, f, g – bivalves, e – brachiopods, h, i, j – gastropods, k – crabs (original).

The limestone olistolith from the Peleș Valley displays significant faults (Figs. 4a, b) and many limestone pieces can be found on the ground, detached from the olistolith. These smaller blocks have fossils and their collection without authorization from the responsible authorities of the Bucegi Natural Park is forbidden, as stated, in a general way (without a punctual reference), in the Integrated Management Plan of the Bucegi Natural Park (R. N. Pad. Romsilva, Adm. Bucegi Natural Park, 2017). The erosion degree in the Sinaia area is medium (COCEAN et al., 2010).

a. b.

Figure 4. a - The limestone olistolith from the Peleş Valley with erosion signs, most important is a quasivertical fault of aproximatly 6 m (original); b - *Macrocephalites* sp. found near the olistolith, in grey slates (original).

The third site, Sfânta Ana olistolith (Fig. 5a), is constituted by Middle-Upper Jurassic siliciclastic and carbonate deposits with ammonites, belemnites, bivalves, echinoids, rare brachiopods and radiolarians (BECCARO & LAZĂR, 2007) (Fig. 3). Compared to the other three sites described, it is the poorest in fossils, but until present times no studies on the higher part of the site's walls have been conducted. They are possible but only by climbing routes. The site has been known since the early 19th century. It is more of a historical and geomorphologic site, but the paleontological value can't be overviewed. The exposure of the limestone in the site is very large, including the Valley of St. Ana with waterfalls; the width appraised at 400 m with a height of the walls of 60-80 m.

The fourth site, "Stânca Izvor" –Zgarburei Valley (Fig. 5b) is part of a set of rocks embedded in a limestone breccia matrix with stratiform extension in the slopes of Zgarbura Valley. This olistolith is located in a bend of the communal road 134, which goes to Cota 1400, near Davila's Spring Fountain; the marked tourist path passes right beside it, therefore it can be easily accessed by tourists. The olistolith has a height of approximately 10 m and it extends over 200 m in length. The reddish limestone of this olistolith has a fossil content that certifies the age of the Kimmeridgian - Tithonian. The fossil fauna is represented mainly by ammonites and brachiopods and rare bivalves. The limestone also contains a microfauna studied by PROTESCU (1936) and PATRULIUS (1969).

a. b.

Figure 5. a - Stânca Sfânta Ana – panoramic view, in the middle can be seen an old hermitage build in 1453 (MĂGUREANU, 2000) (Photo credit to Radu Lipşa); b - "Stânca Izvor" – Zgarburei Valley, sight from the main road, the outcrop has vegetation cover (Google Maps, 2017).

CONCLUSIONS

From these paleontological sites originate more than 3000 specimens of various Jurassic fossils, among which the most famous collection of fossil crabs in the world and 3 specimens out of 4 from *Protocypraea thithonia*, Gemmellaro known in the world (see Fig. 3k). The scientific value of the "Stânca Piticului" site is significant; it might be included in the UNESCO Heritage.

Legislation regarding the paleontological and geological protected areas is assured by the law no. 5 from March 6, 2000 regarding the approval of The National Territory Planning Plan – Section III, protected areas, Government Emergency Ordinance no. 57/2007 on the regime of natural protected areas, conservation of natural habitats, wild flora and fauna, approved with amendments and completions by Law no. 49/201. A newer consideration must be taken and the first step for it, regarding that we are in a National Park area is to address to the National Agency for Environmental Protection to assign administration (Article 18, paragraph 4 of Law no. 49/2011).

Ecotourism can be considered the most suitable way of conservation and exploitation of these places. That means more than tourism in nature, is a form of tourism with a double exigency: the development of local tourism and the long-term nature protection. Ecotourism is based on nature conservation and has an educational character (for tourists but also for the local community), implies a responsibility of tourists and produces minimal impact on the environment. It's recommended that the tourists should benefit from professional guidance. These principles should be applied to all four proposed sites.

The sites can be arranged as a touristic local circuit, also, the non-consolidated paleontological material (loose fossils) can be arranged in situ as a Paleontological Collection for a better understanding of the taxonomy or it can be used as an exhibition for the local museum in Sinaia.

The most important thing is the signage of the sites (with route indicators and placement of indicator plates at the paleontological site (***. *Ghid pentru dezvoltarea unei destinații de ecoturism*) and a minimal surveillance to prevent the damages. Also, after the scientific documentation, a printed material for the tourists can be distributed into the informative points along Prahova Valley.

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CONSIDERATIONS ABOUT INFRASTRUCTURE, DEVICES AND PHYSICAL PRINCIPLES IN GEOMAGNETIC FIELD METROLOGY

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Abstract. The continuous development of data acquisition and processing techniques in planetary geomagnetic observatories allows at this time to extract as complete information about the morphology and evolution over time of the terrestrial geomagnetic field. In the evolution of the acquisition of geomagnetic data, different physical phenomena were used for the realization of magnetic sensors for both absolute and triaxial variometric measurements. These magnetic sensors communicate through specialized software programs with acquisition systems and process computers. This whole chain together with the underground labs where the sensors are located make up the infrastructure of a geomagnetic observer. The paper describes the physical phenomena underlying the geomagnetic field metrology, the equipment used and the software programs for communication and data transmission. We made a breakdown of equipment and infrastructure at the Surlari National Geomagnetic Observatory (located in an area without magnetic anomalies, about 30 km North of Bucharest), as well as the way we performed the transfer functions of different devices to improve data quality to the standards accepted by IAGA (International Association for Geomagnetism and Aeronomy) and used in all observatories from INTERMAGNET network. The main research objectives are also presented, along with the applicative importance of measurements in the geomagnetic observatories.

Keywords: geomagnetic field, declination, inclination, magnetic sensors, INTERMAGNET network.

Rezumat. Consideraţii privind infrastructura, dispozitivele şi principiile fizice în metrologia câmpului geomagnetic. Dezvoltarea continuă a tehnicilor de achiziţie si procesare a datelor în observatoarele geomagnetice planetare permite în acest moment extragerea unor informaţii cât mai complete despre morfologia şi evoluţia în timp a câmpului geomagnetic terestru. În evoluţia achiziţiilor datelor geomagnetice au fost folosite diferite fenomene fizice pentru realizarea de senzori magnetici atât pentru măsurătorile absolute cât şi pentru măsurătorile variometrice triaxiale. Aceşti senzori magnetici comunică prin programe software specializate cu sistemele de achiziţie şi calculatoarele de proces. Tot acest lanţ împreună cu laboratoarele subterane în care sunt amplasaţi senzorii alcştuiesc infrastructura unui observator geomagnetic. În lucrare sunt descrise fenomenele fizice care stau la baza metrologiei câmpului geomagnetic, aparatura folosită şi programele software de comunicare şi de transmitere a datelor. Am făcut o detaliere a aparaturii şi infrastructurii de la Observatorul Geomagnetic Naţional Şurlari (situat într-o zonă fără anomalii magnetice, la cca. 30 km nord de Bucureşti), precum şi a modului în care am realizat funcţiile de transfer pentru diferite echipamente pentru îmbunătăţirea calităţii datelor la standardele acceptate de IAGA (Asociaţia Internaţională pentru Geomagnetism şi Aeronomie) şi utilizate în toate observatoarele afiliate reţelei INTERMAGNET. Sunt prezentate şi principalele obiective de cercetare precum şi importanţa aplicativă a măsurătorilor din observatoarele geomagnetice.

Cuvinte cheie: câmpul geomagnetic, declinaţie, înclinaţie, senzori magnetici, reţeaua INTERMAGNET.

INTRODUCTION

The main research and development objectives of a geomagnetic observatory (BENOIT, 2012) are:

– permanent knowledge of the structure and evolution of transitional geomagnetic field during several solar cycles;

– providing highly accurate absolute values of the magnetic field direction and intensity;

– characterization of the planetary and local "magnetic state" by the regular computing of geomagnetic activity indices;

– regular comparison of the base levels of geomagnetic records (national magnetic standards) to other planetary observatories;

– study of various temporal geomagnetic variations with periods in a very wide range in time from seconds to hundreds of years;

– determining the spatial distribution of the geomagnetic field, mainly at national level and integrate these images into continental or planetary maps. These distributions are obtained by repeated measurements in a network of points evenly distributed across the country. Determined values are used to obtain the secular variation of the normal geomagnetic field and building of magnetic maps made in different times;

– contribution to establish periodic coefficients of the IGRF (International Geomagnetic Reference Field) in the IAGA (International Association of Geomagnetism and Aeronomy) with shaping local peculiarities reported in our country.

Important applications are related to the appropriate dimensioning of the energy networks, in communications, aviation transport and oil pipeline transport due to additional induced currents. Other application of measurements of geomagnetic field are in environmental domain in wastewater treatment (ZGAVAROGEA et al., 2016).

Metrological elements of the geomagnetic field at a point on the Earth's surface can be characterized by the following items:

- the horizontal geomagnetic field intensity (H) representing the horizontal projection of the total magnetic field vector;

- the vertical geomagnetic field intensity (Z) denotes the projection onto the downward vertical of the total magnetic field vector with positive value in the northern hemisphere and negative in southern hemisphere;
- the intensity of the geomagnetic field direction N (X) denotes the projection onto the direction of geographic North vector horizontal geomagnetic field intensity;
- the direction of the geomagnetic field intensity E (Y) denotes the projection onto the direction east of the geographical location of the vector horizontal geomagnetic field intensity;
- the declination is the angle between the North geographic direction and North magnetic direction, determining the orientation of the horizontal geomagnetic field;
- the inclination (in degrees) is the angle between the horizontal and total geomagnetic field.

A schematic diagram of the contribution of physical processes to the geomagnetic field is presented in Fig. 1.

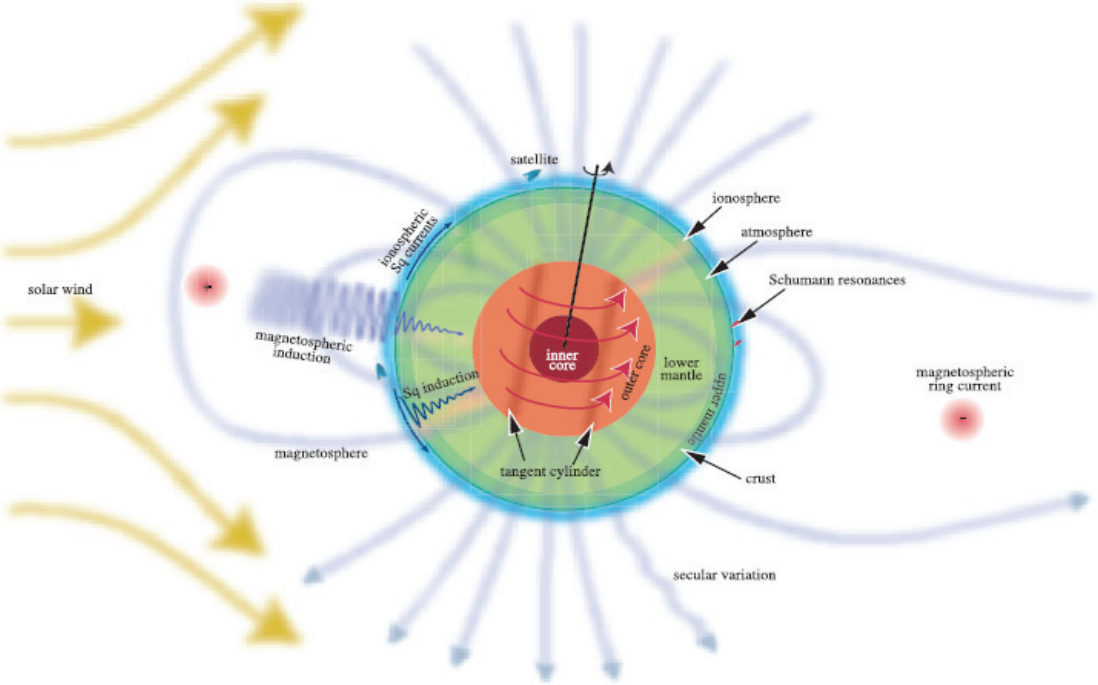

Figure 1. Scheme with the contribution of physical processes to the geomagnetic field (CONSTABLE, 2005).

A schematic representation of the frequency spectrum of the geomagnetic field is shown in Fig. 2.

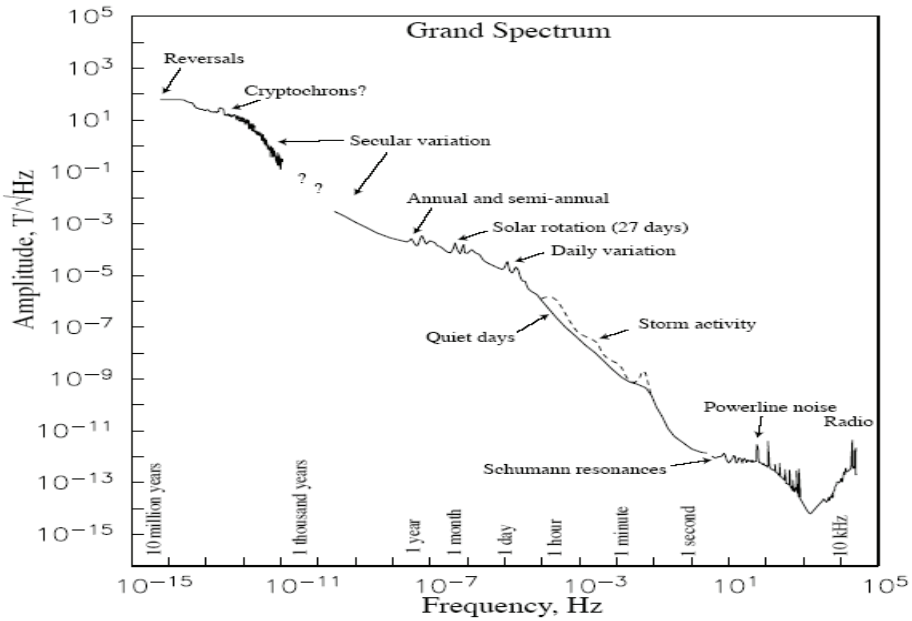

Figure 2. Broad amplitude spectrum for geomagnetic variations according to frequency and causality (internal or external) (CONSTABLE C.- 2005).

PHENOMENA USED IN GEOMAGNETIC FIELD METROLOGY

More physical phenomena have been used over time for the quantitative determination of the geomagnetic field as absolute values and its variations in space or time, based on traditional measurements of geomagnetism and magnetic prospecting.

The first phenomenon uses the tracking of the position of equilibrium of a permanent magnet under the exclusive action of the geomagnetic field or the action of a torque generated by it and determining the period of oscillation for quantitative assessment of the direction and intensity of the geomagnetic field. The action of the geomagnetic field on a magnet leads to a determined orientation, which coincides with the geomagnetic field orientation only when the magnet is not subject to any foreign constraints.

The magnetization of materials with high susceptibility, i.e. the phenomenon of magnetic induction led to the construction of devices and the development of appropriate measurement techniques has played an important role in the development of geomagnetic metrology, terrestrial and air, and even in measurements made with artificial satellites of Earth. The directional distribution of the magnetic induction represents the cumulative effects through the relative parts of the magnetic sensor by materials, magnetization and amplification of each of these effects. All of these have provided excellent conditions for a highly accurate quantitative determination of the geomagnetic field, in terms of direction and size, in its evolution in time and space distribution (GEBBINS & HERRERO-BERVERA, 2007).

The phenomenon of electromagnetic induction has contributed to the metrological technique. Rotating coils have been used since the first half of the nineteenth century for measuring the intensity of the geomagnetic components, or to track their space orientation. The axis of rotation of the coil must be orthogonal on the field direction and measure the induced current in these conditions, which means the parallelism between the rotation axis and field direction.

Characteristic for the traditional geomagnetic measurements, based on the use of the phenomena mentioned, is the fact that they lead to the knowledge of the geomagnetic field through angles that define its direction and the intensity of its components after certain directions. These parameters vary depending on the location of the observation point on Earth. Reported to a local reference system, defined by the horizontal and the north direction, i.e. to the tri-rectangular axis system oriented in the directions north, east and vertical (downward), the geomagnetic field is determined without ambiguity, if are known three geomagnetic elements: either two angles and the total intensity (or the intensity of a component of it), or two components of the intensity and an angle, or the intensity of three components.

The first way of defining was the first used and is in use today for absolute determinations.

The geomagnetic elements measured in this way are: 1) magnetic declination D, represented by the angle between projection on the horizontal of the field and the north direction, 2) magnetic inclination I, i.e. the angle between the total field direction and its projection on the horizontal plane and 3) horizontal component H, the projection of the total magnetic field F on the horizontal plane.

The second way is used in particular for the geomagnetic observatory records, where the following are tracked: declination changes ΔD, variations of the horizontal and vertical component, ΔH and ΔZ.

Determining the field by the third method (north component (X), east component (Y) and vertical component downward (Z) is performed by means of a device, based on magnetic induction, with the magnetized bars oriented properly.

Two phenomena able to highlight the existence of the geomagnetic field, and to serve, ensuring the required accuracy, for quantitative assessment, began to be taken into account for geomagnetic metrology purposes around 1960. Later on they were effectively introduced and used on a larger scale in the measurements: nuclear precession and optical pumping.

Intra-atomic processes occur in both phenomena, governed by the laws of quantum mechanics.

They were used for indirect measurement of the geomagnetic field intensity, led to the construction of devices and the development of methods of modern geomagnetic metrology, designated through the term of quantum magnetometry.

The case of nuclear precession, by applying an intense auxiliary magnetic field, with about two orders of magnitude stronger than that of the Earth , and with a transversal direction thereon on it, nuclei possessing a magnetic moment of some atoms – hydrogen is currently used in geomagnetic metrology, whose nucleus is an even proton, resulting in the term of proton precession (or resonance), commonly used in this area – are oriented with their magnetic axes by this direction required by the auxiliary field (polarizing field).

When this field is suppressed, small magnets represented by nuclei with magnetic moment (for hydrogen: protons) remain under the exclusive influence of the geomagnetic field, whose orientation tends to return from the polarization magnetic field direction to that of the geomagnetic field. This takes place through a precession motion, whose frequency is proportional to its intensity. Thus, the knowledge of frequency of precession and the proportionality constant will be determining the total geomagnetic field intensity.

Optical pumping is an excitation process of atoms or ions in an environment through irradiation with electromagnetic radiation. Radiation and intensity spectrum, passing from higher energy levels on lower level, result in a population inversion between two energy levels. The Zeeman effect indirect method, because of the very low magnitude of the geomagnetic field, cannot be used directly to determine its intensity by measuring the "splitting" of

spectral lines emitted by the atoms subjected to his influence. The redistribution of electrons between two levels can be achieved by excitation with radiation of lower frequency corresponding to the energy difference between them.

In both these determinations, through proton precession or optical pumping, frequency is directly measured - a measure that requires complicated electronic devices but can be made with great precision - and resulting in a total geomagnetic field value.

THE GEOMAGNETIC EQUIPMENT USED IN THE SURLARI OBSERVATORY

An analog recording system for the D, H and Z components of geomagnetic field was installed at the Surlari geomagnetic Observatory in 1943. This system is composed of a counterbalanced clockwork mechanism and 3 wire-twisting magnetometers. This mechanism ensures that the photographic paper advances speeds of 20, 60 and 120 mm/h. The magnetometers consist of permanent magnets attached to non-magnetic material provided with mirror and snap at the end of the quartz wire (for sensors D and H). The Z component sensor consists of a permanent magnet located on two quartz slides which allow vertical movement. The whole mechanism is enclosed in a box so as not to be disturbed by possible air currents produced in the room. The temporary resolution in continuous shooting mode (speed 20 mm / h) obtained with this device is 3 minutes (1mm). The first daily magnetogram recorded in this format is shown in Fig. 3.

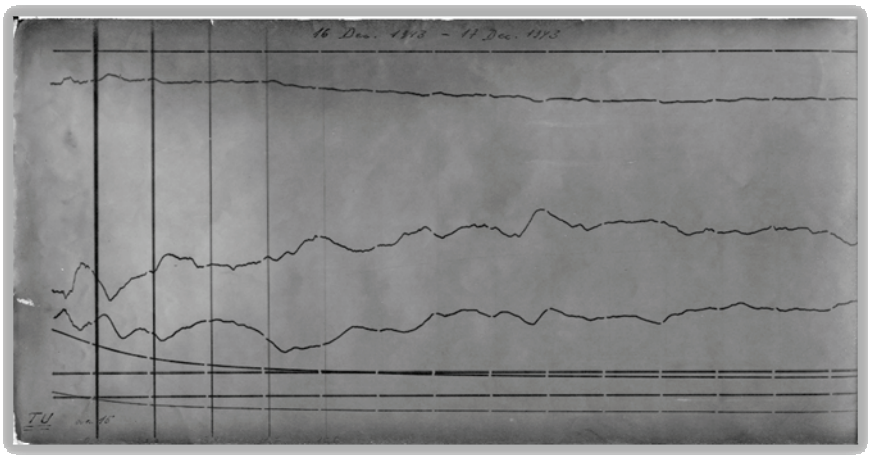

Figure 3. First magnetogram recorded at Surlari Geomagnetic Observatory.
Registered physical parameters are explained in the column on the right side of the figure).

In addition to this system, an analog recording system consists of 3 Bobrov variometers and a clockwork mechanism Matting Weissenberg were brought to our observatory in 1959. Unlike Askania variometers, the Bobrov variometers have better stability in time, a reduced sensitivity to temperature changes and are less sensitive to shocks. The clockwork mechanism has four gears: 20, 60, 120, 240 mm / h which is used for the permanent records that of 20mm / h. In 1972 a fourth variometer is attached to this system,whose magnet is oriented in the total magnetic field vector plane.

An important operation in the functioning of these magnetometers is the calibration for establishing the sensitivity of each component records (nT/mm). This is done by means of DC powered coils placed in the directions perpendicular to the axis sensors. The DC power has a known intensity. The two systems have operated continuously until 2003, producing analogue records on photographic paper.

It is also very important to obtain a base level of records with absolute measurements made with theodolite Matting Weissenberg, ground inductor and oscillations box in a first phase and then theodolite Matting Weissenberg and quartz horizontal magnetometer for the H component QHM. In addition to these device, a Varian proton precession magnetometer was brought in 1968, measuring the scalar value of the total field.

The triaxial magnetometer MAG-03MC allows simultaneous recording of the components Hx (North direction), Hy (on the East) and Hz (vertical direction down) of the geomagnetic field. The sensors of this magnetometer are magnetic inductive type and are made of coils with a large number of turns and a magnetic core with high permeability (Permalloy).

The characteristic response (floor type) of this magnetic sensor shows a very good functionality for a band of frequencies between 1Hz and 2000 Hz.

The MAG 03 DAM logger has two connectors for analog input signal from two flux gate magnetometers and a RS-232 connector with 25 pins for output signal. The logger is controlled by software developed in FORTRAN that allows selecting the number of channels to be recorded (from 1-6), the choice of sampling rate (between one second and 10 seconds) and the measuring range. The sampling rate refers to the frequency of purchase and not the storage, it is 10 times lower.

MAG-01h DI Fluxgate Magnetometer produced by Bartington Instruments Ltd., England, with THEO 010b nonmagnetic theodolite, measuring declination and inclination of the geomagnetic field in absolute terms. These measurements are used to establish the base level of permanent records.

Measurements with DI Fluxgate are run at regular intervals, especially during periods of magnetic calm, and are national magnetic standards for the geomagnetic mapping work of the national territory. With their help, the magnetometers of other research or industrial companies are calibrated. The MAG-01h DI Fluxgate is recommended by the International Association of Geomagnetism and Aeronomy (IAGA) for use in observatories and to achieve precision of 0.1 nT for magnetic field values and ± 1 seconds for declination and inclination.

This type of magnetometer can be used mounted on a Wild T1 theodolite nonmagnetic. It can measure both declination and inclination of the geomagnetic field with an accuracy of ± one second sexagesimal degree.

Typically, this device works with the zero method (when the magnetic sensor is positioned perfectly horizontal) and the declination of the magnetic field can be determined. When placed in a perpendicular plane to the horizontal component of geomagnetic field, the inclination of the magnetic field can be determined. Also, when the sensor is placed in a vertical plane, perpendicular to the horizontal geomagnetic field, the total field gradient can be determined.

Geometrics G-856 proton precession magnetometers are used for absolute measurements of total magnetic field. They have a very good thermal stability and resolution consistent with the standards of IAGA. Data can be stored in the internal memory of electronic units or by connecting it to a computer. G-856 can be used in differential version using two sensors, mounted on a particular tripod to obtain geomagnetic field variation with distance.

In early 2009 a new system was installed at OGNS for the continuous recording of variation of the magnetic field (Hx, Hy, Hz and F) with the support of German Research Centre for Geosciences (GFZ).

The acquisition system consists of:

- triaxial fluxgate magnetometer FGE;
- scalar Overhauser proton magnetometer GEM Systems GSM90;
- MAGDALOG data logger;

The FGE vector magnetometer was built by the Danish Meteorological Institute using three commercial fluxgate sensors, mounted in a block of marble 12x12x12cm^3 through the quartz tube. Offset coils ensure maximum stability or drift to 3 nT / year. The variation with temperature of recorded values due sensors is below 0.2 nT/°C and of the electronics, as 0.1 nT /°C.

For a good stability of the baseline, a suspended version of the cube of marble was adopted in most of geomagnetic observatories. In this way the baseline drift is less than 3.2 nT / year, the result obtained even where one classical fluxgate would have a drift over 100 nT / year. The alignment error of the three vector components is maximum 2mrad (7 min of arc.). And the shaft suspensions error is +/-0.5°. Sensitivity: 400 nT / V.

GSM90 Overhauser proton magnetometer is a scalar magnetometer designed for magnetic observatories and other applications (Volcanology), where stability and accuracy are absolutely necessary. With a resolution of 0.01 nT, 0.2 nT absolute accuracy and drift of 0.05 nT / year can be successfully used in calculating basic values for a magnetic observatory. With a resolution of 0.01 nT, an absolute accuracy of 0.2 nT and drift of 0.05 nT / year can be successfully used in calculating baseline values for a magnetic observatory.

The torsion photoelectric magnetometer PSM

The magnetometer is composed of a set of 3 torsion variometers. The variometers are connected to an electronic system based on the principle of compensation (feedback). The compensation current is proportional to the intensity of the geomagnetic field to be compensated by current injected in coils located on the variometer. The resolution of these variometers is 0.1 nT and the variation with temperature is below 0.01nT/°C. This magnetometer is connected to the Bartington MAG 03-DAM data logger. The technical specifications of the logger are presented above.

An alternative solution recommended by specialists of the Institute of Geophysics Polish Academy and Belsk Observatory is the multifunction logger NDL (Network Data Logger), that meets four very important functions:

- perform AD conversion on 24-bit, 6 channels, with variable sampling step;
- ensure universal time synchronization through GPS;
- store information on Compact Flash Card;
- provide direct connection to the Internet with a speed of 10 Mb / s through a specialized processor.

We compared different magnetometers within Surlari National Geomagnetic Observatory (SNGO). Differences between the results lead to interesting conclusions regarding the strengths and weak points of each magnetometer (ASIMOPOLOS L.et.al. - 2010, 2012a, 2012b).. By using different calibration methods, further exemplified, we obtained the transfer functions for the recorded values with each magnetometer. For each device we make a calibration and we calculate transfer functions. For example we show PSM transfer function (Hx channel) in correspondence with MAG03MC, transfer functions for geomagnetic components (Hx, Hy, Hz) for PSM magnetometer in correspondence with FGE magnetometer (Figs. 4-6) and correlation between PSM and FGE (Fig.7).

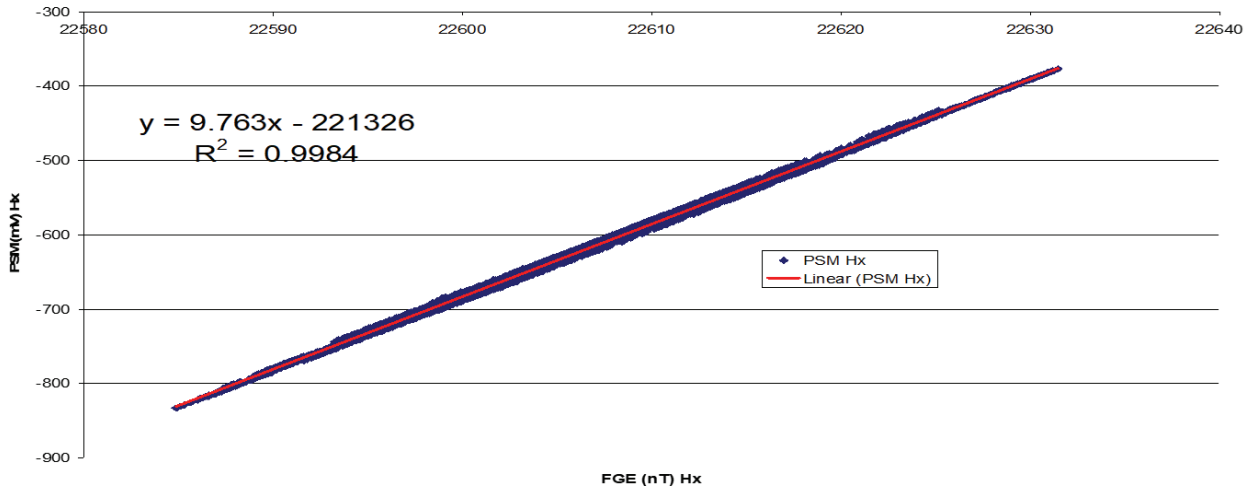

Figure 4. Transfer function for Hx (North geomagnetic component) (mV to nT);
PSM magnetic sensor and MAG03DAM logger.

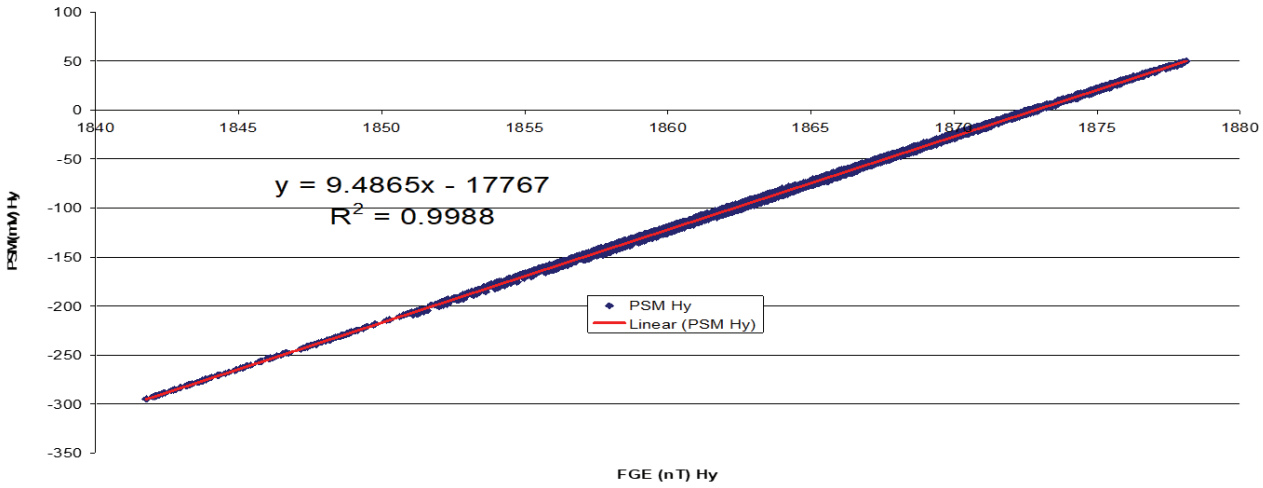

Figure 5. Transfer function for Hy (East geomagnetic component) (mV to nT);
PSM magnetic sensor and MAG03DAM logger.

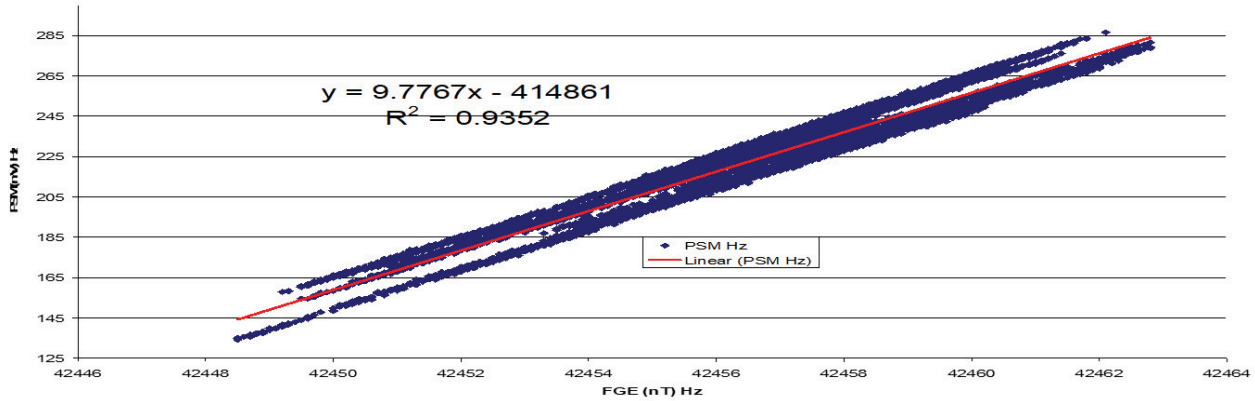

Figure 6. Transfer function for Hz (Vertical geomagnetic component (mV to nT);
PSM magnetic sensor and MAG03DAM logger.

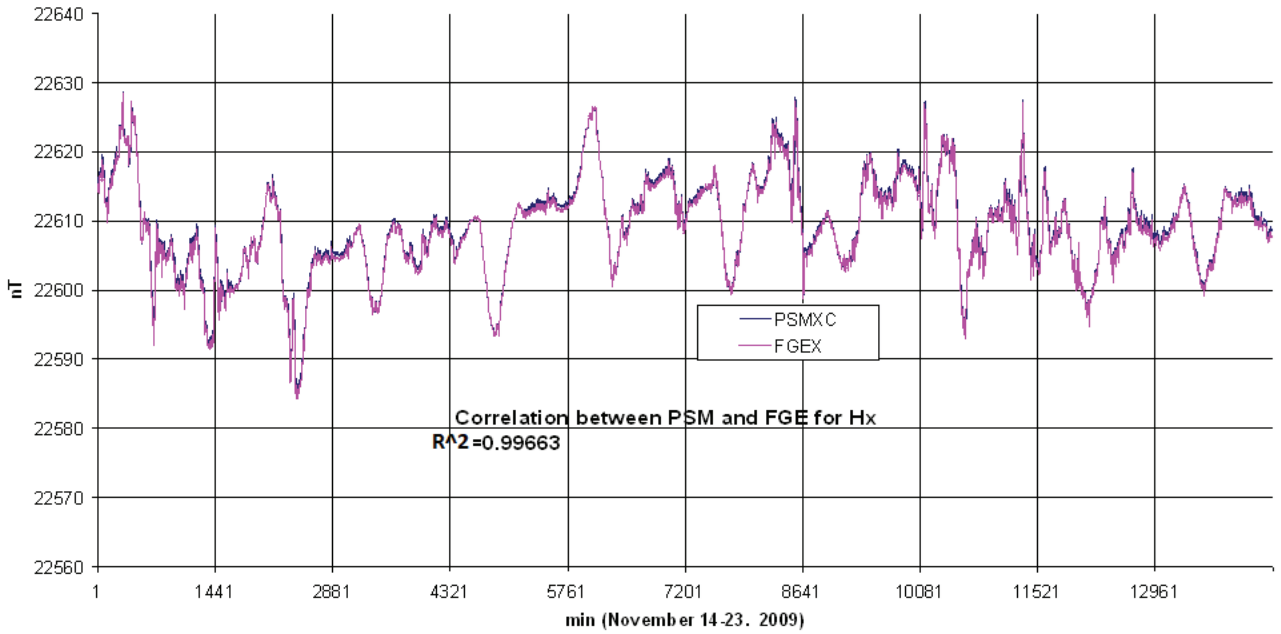

Figure 7. Correlation between Hx (North geomagnetic component) acquired with the PSM sensor, after applying the transfer function (PSMXC), and the FGE sensor (FGEX).

The differences between the two curves obtained after calibration are very small (maximum 0.5 nT) so they seem overlapped. The curve in blue colour is only visible in some points, while only the red curve can be seen otherwise.

This effect occurs because the red curve is in the front plane and the blue curve is in the back plane.

The calibration operation involves following steps:

- recording a time series of values with a non-calibrated magnetometer;
- introduction of a calibration pulse whose parameters are known (the value of current intensity introduced (mA) and instrumental characteristics of each component measured (nT / mA);
- calculating the pulse amplitude calibration;
- scale transformation of values from pixels recorded to the nT by comparing each registered value with the calculated calibration factor.

CONCLUSIONS

The observation of the geomagnetic field variation over time represents the basic activity of geomagnetic observatories and aims at collecting the necessary data for the elaboration of models and theories on the internal/external mechanisms about variation of the magnetic field. The geomagnetic field variation study provides information on the Earth's internal conductivity, their knowledge being also useful in magnetic prospecting works whose results need to be processed to extract the effects of diurnal variations, the value of the normal field at the date and location of the prospecting, and of secular variation when using panels measured in different epochs.

An important application of observer data is the determination of the magnetic declination (the angle between the geographic and magnetic north) used for the correction of navigational instruments on board aircraft during landing and take-off maneuvers, for GPS guidance systems used in civil aviation, and military, satellite trajectories, missiles and missiles, etc.

This parameter can be estimated with good accuracy for magnetically calm days. For agitated days, and even more so during magnetic storms, the variation of the declination parameter becomes significant. A geomagnetic storm is known to have different characteristics (amplitudes, gradient, geomagnetic coefficients) depending on the latitude at which it is measured. Thus, at the beginning of a geomagnetic storm, the data from the closest to ground (geomagnetic observation points) is needed on-line for the corrections of the guidance systems.

Another important application is related to the appropriate dimensioning of energy networks (transformers, transport cables, etc.), depending on the underground conductivity of the respective area, the local geomagnetic pattern as well as the on-line geomagnetic data on which certain energy protection systems can be coupled or decoupled during geomagnetic storms of varying degrees.

It is very important to calculate the additional currents induced in large pipelines used for the transport of petroleum products during geomagnetic storms to determine the necessary stresses to be applied to different segments of anticorrosive conduit.

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We gratefully acknowledge the many and significant contributions and comments provided by our colleagues from geomagnetic observatories. The manual about observatories methodologies is based on the original document (INTERMAGNET Technical Reference).

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DESIGN, DEVELOPMENT AND TESTING OF A SYSTEM THAT REFLECTS THE EVOLUTION OF THE COASTLINE - CASE STUDY LALZI BAY, ALBANIA

FOCIRO Oltion, MUCI Redi, SKRAME Klodian

Abstract. The study of the coastal area constitutes one of the basic scientific problems in all countries of the world, who have direct contact with the sea. Considering that the coastal area represents a complex natural and socio-economic environment, where processes are continuous and dynamic, rational decisions about the uses of resources need to be made. These decisions should be based on scientific studies that require long amount of time, endurance and fatigue. Our goal as geoinformatics engineers is to reduce the factors that affect the progress of these studies. For this purpose we will have to define the problems a researcher encounters in these kinds of studies, such as: the long amount of time needed for carrying out the study, the difficulty in image georeferencing, the need for a central database and the implementation of analytical formulas for concerned analysis.

Keywords: Coastline Evolution, Geographic coordinates conversion, Programming, Server-Client Architecture.

Rezumat. Proiectarea, dezvoltarea si testarea unui sistem care reflectă evoluția liniei de coastă - Studiu de caz golful Lalzi, Albania. Studiul zonei de coastă constituie una dintre problemele științifice fundamentale din toate țările lumii care au contact direct cu marea. Având în vedere că zona costieră reprezintă un mediu natural și socio-economic complex, unde procesele sunt continue și dinamice, trebuie luate decizii raționale cu privire la utilizarea resurselor. Aceste decizii ar trebui să se bazeze pe studii științifice care necesită mult timp, rezistență și oboseală. Scopul nostru ca inginer geoinformatician este de a reduce factorii care afectează progresul acestor studii. În acest scop, va trebui să definim problemele pe care un cercetător le întâlnește în astfel de studii, cum ar fi: timpul necesar pentru realizarea studiului, dificultatea în georeferențierea imaginii, necesitatea unei baze de date centrale și implementarea formulelor analitice pentru analiza în cauză.

Cuvinte cheie: Evoluția coastei, conversia coordonatelor geografice, programare, arhitectura server-client.

INTRODUCTION

After we have determined the problems, we will perform an overview of the current solution where we will explain their positive and negative sides. By “solution” we understand the existing system which may serve to study the coastline dynamics. We will introduce our solution and perform a confrontation with the current solutions where we explain the reasons why the system that we propose may be the most appropriate for studying the coastline evolution. After that we will make a presentation of the system construction where we will support the use of a client-server structure and we will explain the reason why we chose to use this type of structure.

To conclude we will perform various tests to evaluate the achievements where, as a case of study we picked the Lalzi Bay area, then we will submit a draft of conclusions and introduce further developments and modifications that are needed to fully complete the system.

MATERIAL AND METHODS

One of the first problems posed is the conversion of coordinates from one system to another. After the conversion is performed, the problem of georeferencing the map with the study area arises. This kind of problem in itself contains another problem which occurs when the researcher doesn't have sufficient knowledge of georeferencing the image with a software. In this kind of situation a third party is included in the process. This new player does the georeferencing and carried out the coordinates laying. The involvement of the third party increase the studies cost.

Another problem shows up when the researcher obtains the map, now he should define the changes that the coast line has undergone. A particular problem arises when the researcher must make comparisons between different data. In this case, a database it is very necessary. The lack of a database complicates and delays the analytical processes that characterize the study.

The major problem is the lack of primary data and historical data. In order to possess the first type of data the researcher must go to the field and acquire the ones with a GPS which is long and tiring process. The second type of data can be retrieved from old maps - this process is boring and takes a long time.

In summary, the problems that must be solved are: converting coordinates, avoiding third party involvement, using analytical algorithms to help with the analysis, provide a database and create facilities in obtaining data. The main goal is the automation of study processes for saving researchers time, money and effort.

The best current solutions to study coastline dynamics are: ArcGIS, QGIS and AutoCAD. ArcGIS is a comprehensive system that allows people to collect, organize, manage, analyze, communicate, and distribute geographic information. AutoCAD is a programme used to create high-precision drawings or technical illustrations. This type of programme can be used to create 2D or 3D models.

The difference between these two software programmes is that ArcGIS is a programme that works with a

database while AutoCAD is more a graphic program. In AutoCAD, lines are much more important than in ArcGIS where lines are just a representation of the data.

Even though these programs are quite powerful and helpful for researchers, they are not at all easy to use and cost too much. In this situation, the researcher faces two sources of dissatisfaction: the involvement of third parties in research and high costs for conducting the study.

On the other hand, QGIS is an open source solution that supports most of the GIS features and spatially graphical rapresentation of the geographical problems. Although the QGIS system offers a number of tools for coastline evolution, this system is deficient from the point of view of the unification of geographical coordinates expressed in different systems such as Gauss-Krueger, UTM, Geographic and Geodecimal. Another problem observed in QGIS is the fact that the QGIS Server system does not offer any graphical interface and no control over the data that a system user can launch for the seaside coast line. Also QGIS Server has no control on the user rights over the system itself.

The solution we propose is a programme which uses the client-server architecture. A programme that uses this type of architecture is built in such a way that the database is placed in a central computer known as a server and can be used by many users. In this case users use an application that is installed locally on a personal computer. This application is known as a client and connects to the server through the network. The client is used to display the results to the user, it requests information from the server. To deal with multiple users the server use multithread. When the server received a request it connect to the database retrieve the information needed and pass those to the client.

The proposed programme will have the ability to convert coordinates and storing them in two forms of coordinates initial and final. The map will be georeferenced and the coast line will appear automatically with just one click. If the users will need to add new coordinates, they will have the opportunity to choose between 4 coordinative systems: Geographic, UTM, Gauss-Krueger and Geodecimal. UTM is used as a based system for the programme. The reasons why this system was chosen are:

- It presents little deformation and provides normal constant interactions distance across the map.
- The coordinates are expressed in meters.
- It is used in many countries of the world.
- There is no need to use fake north and east because negative values aren't present

The analysis of the coast line dynamics will be done using analytical algorithms that will enable researchers take results in a short time and in a simple way. The users of this programme will have the opportunity to extract coordinates directly from the system and save them into the database.

As shown in Fig. 1 the steps to get the server up and running are as below :

1. Create a server socket
2. Name the socket
3. Prepare the socket to listen
4. Wait for a request to connect, a new client socket is create here.
5. Read data sent from client
6. Close client socket.
7. Loop back
8. Close server if problem

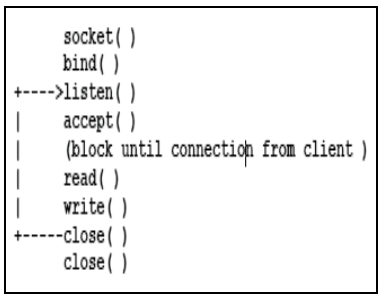

Figure 1. Socket server flow.

By following the steps above we can create a simple server that manages a customer for time. In my case the server is not sufficient because we want the server to offer the possibility of managing more than one client at the same time. To attain it this server must use multithreading.

Multithreading is the ability of a programme or an operating system process to manage its use by more than one user at a time and to even manage multiple requests by the same user without having to have multiple copies of the programming running in the computer.

As a relational database management system we choose to use MySQL for this reason:

1. Scalability and Flexibility
2. High Performance
3. High Availability
4. Strong Data Protection

5. Open Source Freedom and 24 x 7 Support

The database will be created based on the model rapresented in Fig. 2.

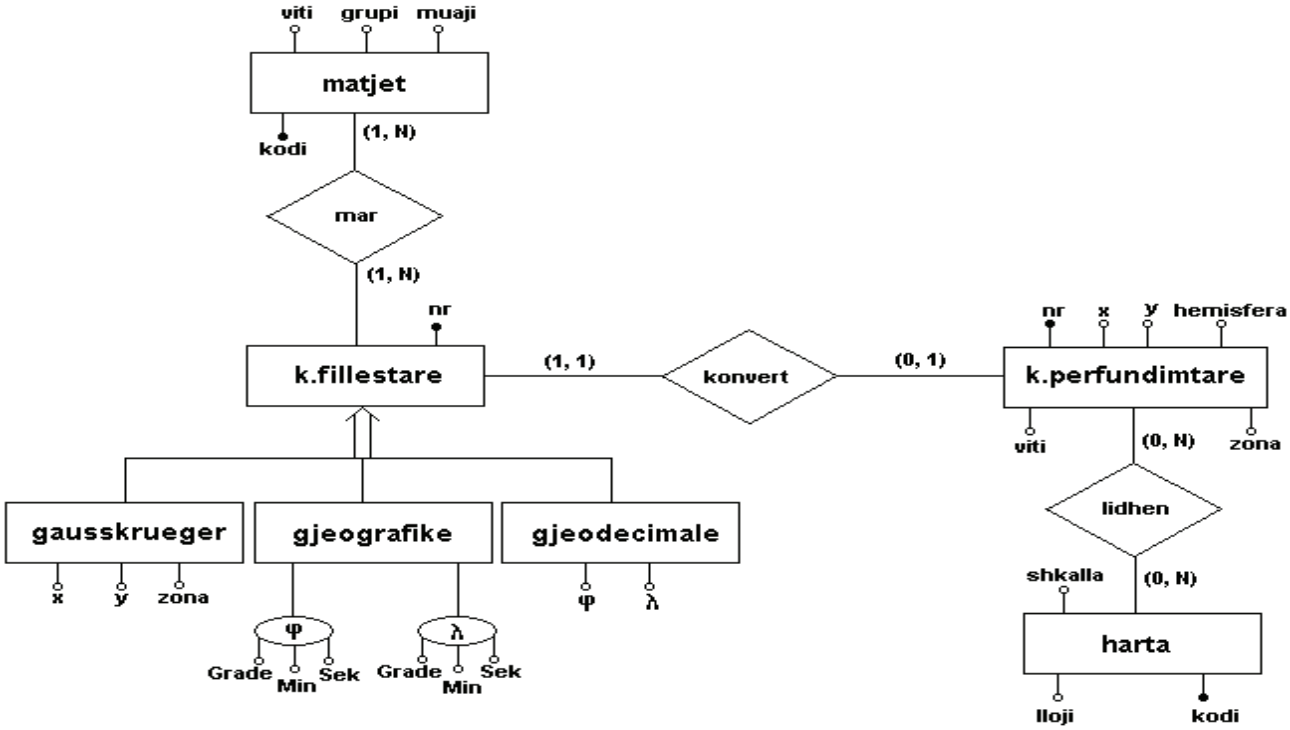

Figure 2. Entity-Relationship model.

In order to communicate with the server the client needs this steps:

1. Create a socket with the server IP address.
2. Connect to the server, this step also names the socket.
3. Send data to the server.
4. Read data returned back from the server.
5. Close the socket.

The methods that make possible the comunication of the client with the server are rapresented in Fig. 3.

```
socket( )
connect( )
write( )
read( )
close( )
```

Figure 3. Socket client flow.

Communication channels are used to create a connection between the client and the server are used, they are network protocols such as: NetBIOS, RPC (Remote Procedure Call), DCOM, Pipe, IPC (Inter - Communication process, etc.). But in this case we will only use TCP / IP and IPv4 in particular because it is the current version and is supported by more modern networks.

To build the graphical user interface we decided to use wxWidget because:

- It gives a nice look and feel to the application.
- It is very complete. There are many utility classes like: wxRegEx, wxFTP, wxSplashScreen, wxZipInputStream, etc.
- Many compilers and platforms are supported: Windows, Linux, Mac, Unix.
- It's free for personal and commercial use, and is more flexible than the LGPL license.
- It can be supported by different platforms like: Windows, Linux, Mac.
- A lot of ready to use classes are available.

We choose to use the client-server structure because offers the following advantages:

- Any given information is stored in a central system all users can work with. This way of storing data gives user the option to use other data that has been extracted from another user, thus resulting in a

reduction of working time.

- Maintenance is simplified because data is focused on a central server.
- The cost of the physical parts of the computer is minimized because the data is not stored on the client.

When the data are sent to the server, a client window appears to ensures that the data was successfully sent.

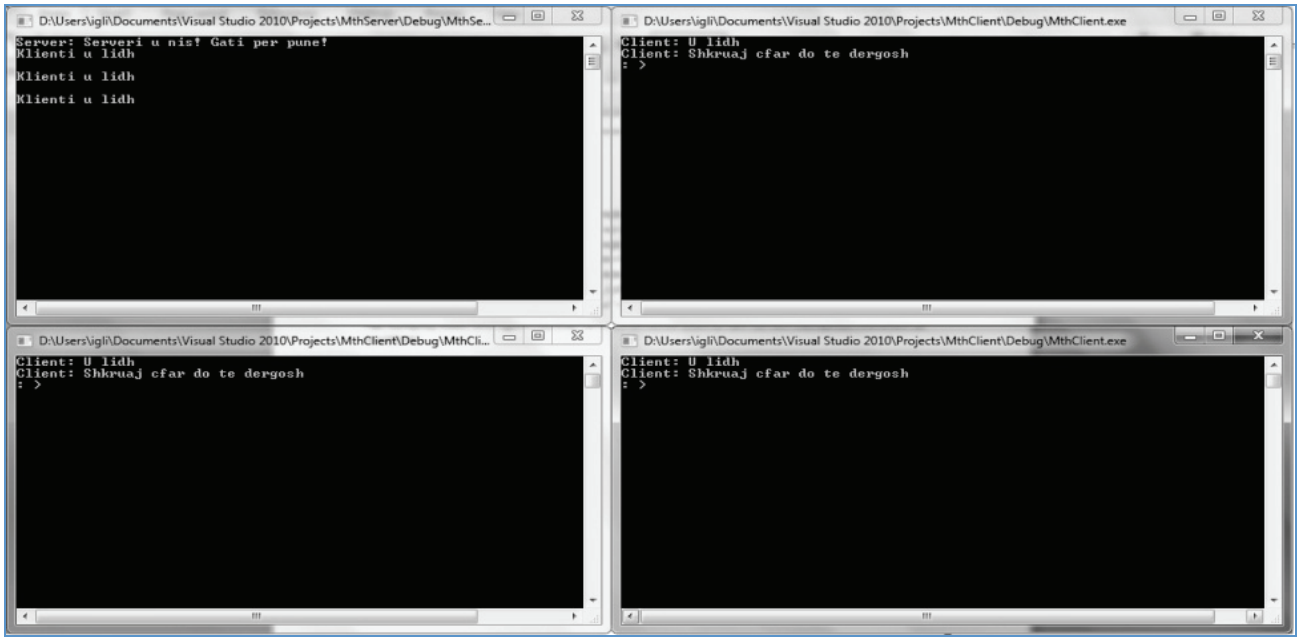

Figure 4. Opening socket connection and wating for client request.

As shown in Fig. 4 the server is wating for a client connection. In the moment that a client is connected, the server creates some welcome message and notifies the client that it is waiting for orders from him.

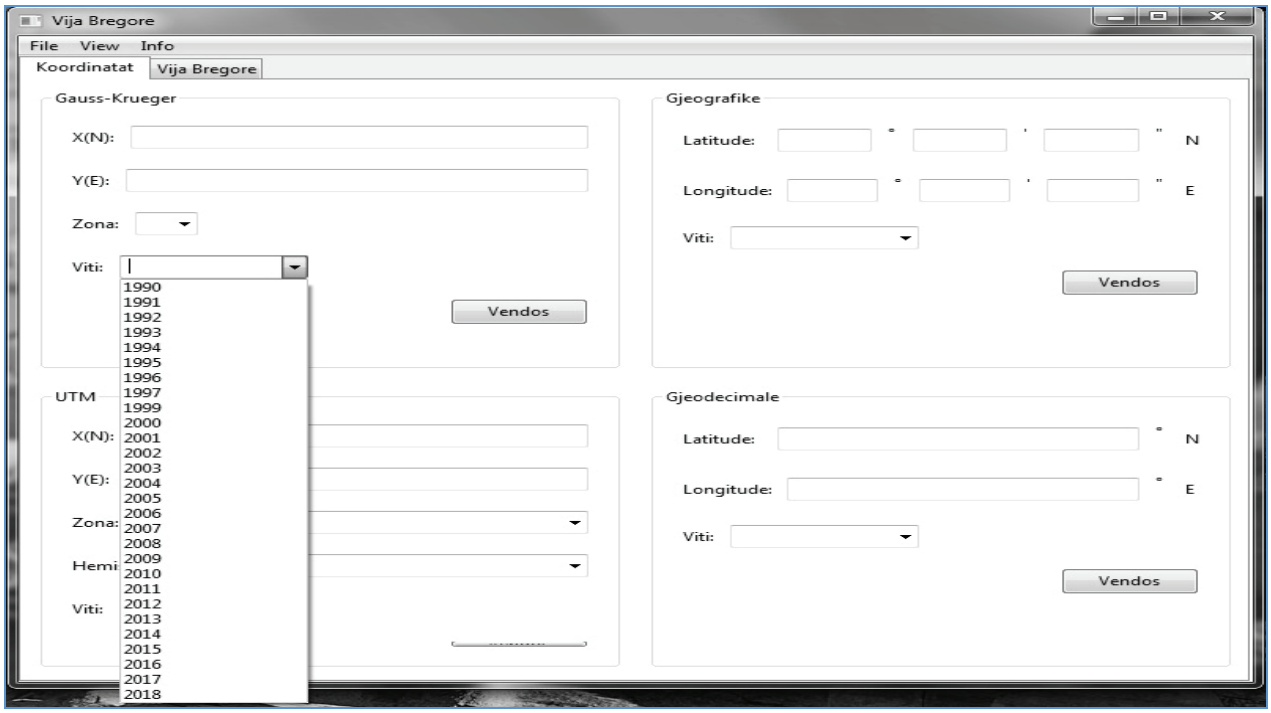

Figure 5. Sending data from the client.

An example is shown in Fig. 5 of how the client throws the GUI (Graphical User Interface) sends messages to the server.

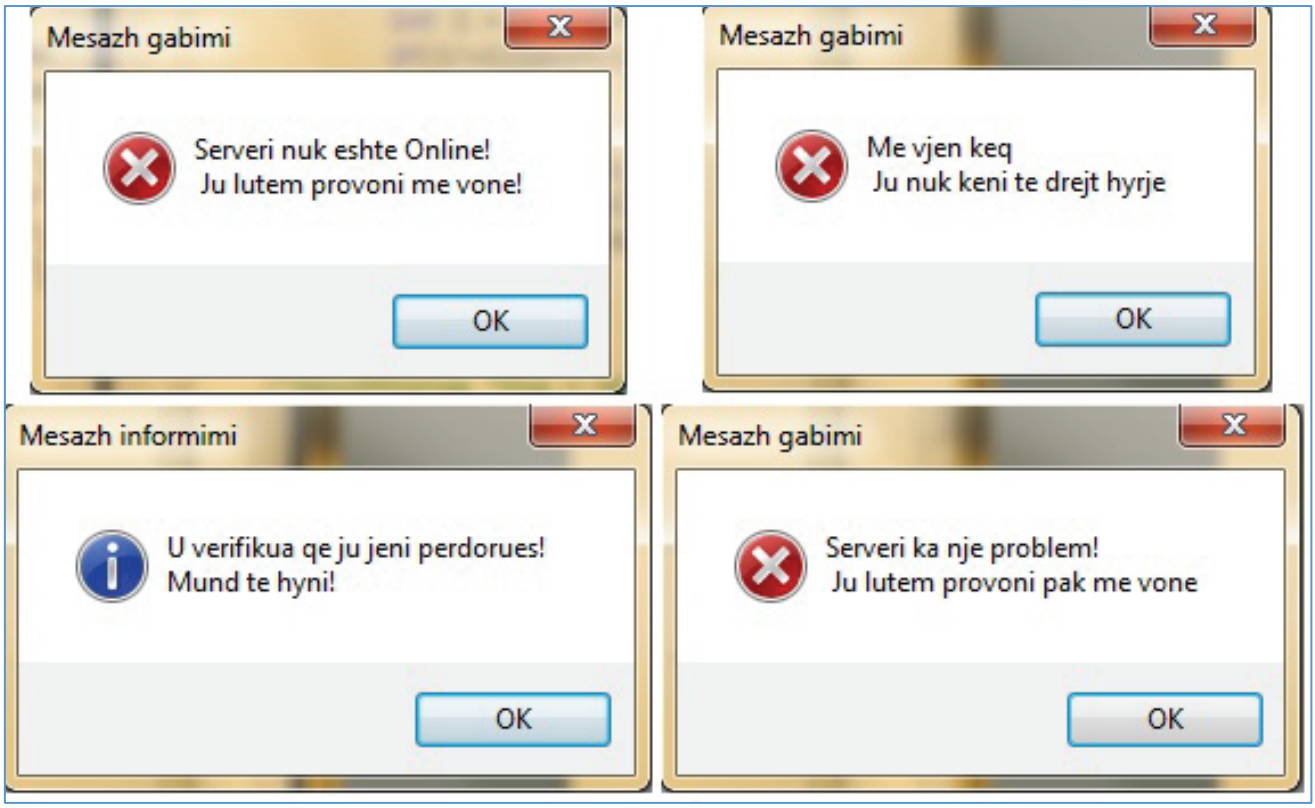

Figure 6. Possible answer from the server throught socket.

On the other hand, the server sends information messages, through the sockets, which are displayed in the client as shown in the Fig. 6.

RESULTS

In order to carry out system testing, some measurements of the litoral line in the Gulf of Lalzi were carried out over a number of years. It should be mentioned that the coordinates placed in the system had different coordinating systems each year. The measurements that were made refer to the years: 1867, 1939, 1984, 1990, 2002, 2003, 2005 and 2014.

When a year is chosen from the column the coast line corresponding to that year will be automatically created. In this case we have chosen two years to carry out system testing and analyse the coastline evolution over the years.

As shown in Fig. 7, when the user selects two years of collected data, the system will build a blue line that represents the year 1984 and a yellow line that represents the year 1990. The system uses diferent colours to represent the coast line of each year. This way, the user has a clear idea of the evolution of the coast line as represented in Fig. 8.

The system that we propose has in the first place a high level of usability since the coordinates a user can place are in different coordinating systems and is the server that unifies all these coordinates in a unique coordinate system. The proposed graphics interface is very simple as it consists of only two panels: a panel where the user puts the data and a panel where the results are graphically visualized. Both of these panels are managed by the server according to the rights a user has. The presentation of the results is graphical where the user has the ability to perform visual analysis of the coastline shift in two or more years. For each year the system provides a different color of the coastline.

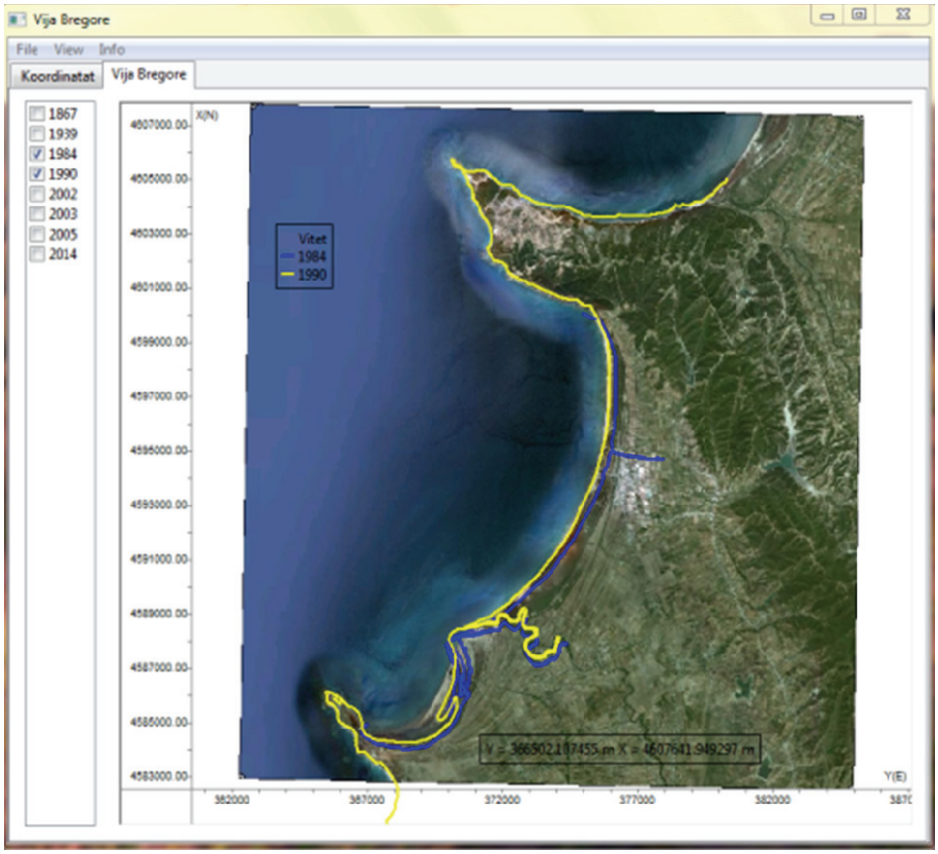

Figure 7. Choosing the years to build the coastline.

Figure 8. Image produced from the system with two coast lines, 1984 the blue and 1990 the yellow.

CONCLUSIONS

After a long work a functional programme is created. It is based on a central database, provides information protection and gives the possibility to use it at any time and moment. The possibility to convert coordinates with minimal error allows researchers to save time and gain highest security in studies.

The creation of the coast line in a simple and quick way, as well as the presence of a georeferenced environment for the Lalzi Bay Area helps researchers save up time, money and avoid third party involvement in studies. The construction of the graphical interface in a simple way makes it accessible and usable by persons who do not have high informatics knowledge. Preservation of data in a central system all users can work with helps different researchers to have information without necessarily going on the field.

The use of UTM as a basic coordinative system shows little deformations and provides normal distance interactions across the map, the use of fake north and east is not needed in this projection because negative values aren't present. Despite the good results achieved by the system, modifications will still be needed to achieve perfection.

In the current situation we recommend some improvement of the system. The new developments that are expected to be added to the software are:

- The involvement of analytical algorithms in the system which will allow carrying out the analysis of the dynamics of the coast line.
- The ability to add other maps and the ability to georeference them in a simple and understandable manner.
- The ability to create lines and to store data in the system, thus reducing the time of extracting coordinates from old maps.
- Improved client / server architecture, bringing a better data transmission.

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BACK THRUST OF MOLASSE DEPOSITS IN WESTERN ALBANIA

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Abstract. The back thrust of molasse deposits in western Albania has been studied based on geological and geophysical methods as well as by borehole data. These studies pointed out that the External Albanides are mainly composed of westward thrusting structures. We shall try to explain back thrust of the molasse deposits in the Peri-Adriatic Depression. Based on the age of the deformed deposits, it results that the final shapes of the back thrusts were formed in and post-Pliocene. The main control factors of back thrusts are the buried overthrust (involved during pre-Serravalian tectogenic phase) and their westward movements. Here, the initial point of back thrust formation and development is related with the early stage of tip line of the orogene movements. A typical example to be analysed and for which we provide a lotof clear data is the Preza back thrust. The most advanced part of the back thrust occurred on that area where the duration of thrusting was longer. In our case because of westward thrusting, which produce westward curving features (westward curving of the thrust front), the back thrust response is eastward curving. That is why we do see only eastward curving of the back thrusts. Several back thrusts in a certain area, which appear like stair-case geometry, are having an overall single fault plane on a deeper cut (Back thrust at North of Shkumbini Area). The major back thrust is expected to be the most advanced one. In the western flank sometimes secondary faults are observed, due to compression and folding of deposits. These faults are observed near to the most uplifted part (crests area) of the back thrusts, giving the wrong impression of a flower structure.

Keywords: back thrust, westward thrusting, fault, Albania.

Rezumat. Forţa din spate a depozitelor de molasă din vestul Albaniei. Forţa din spate a depozitelor de molasă din vestul Albaniei a fost studiată pe baza metodelor geologice şi geofizice, precum şi a informaţiilor din forajele. Aceste studii au subliniat că Albanidele externe sunt compuse în principal din structuri de împingere spre vest. Vom încerca să explicăm împingerea depozitelor de molasă din Depresiunea Peri-Adriatică. Pe baza vârstei depozitelor deformate, rezultă că forma finală a tracţiunilor spate a fost definitivată în - şi post-Pliocen. Principalii factori de control al împingerilor înapoi sunt încălecarea îngropată (implicată în faza tectogenică pre-serravaliană) şi mişcările spre vest. Aici, punctul iniţial al formării şi dezvoltării împingerii în spate este legat de stadiul incipient al liniei de vârf a mişcărilor orogene. Un exemplu tipic care trebuie analizat şi pentru care aducem o mulţime de date clare este forţa de întoarcere Preza. Cea mai avansată parte a tracţiunii în spate a avut loc în zona în care durata de împingere a fost mai lungă. În cazul nostru, din cauza împingerii spre vest, care produce caracteristici înclinate către vest (curbarea spre vest a frontului de împingere), răspunsul de împingere a spatelui este curbarea spre est. Acesta este motivul pentru care vedem doar curbarea spre est a spatelui. Câteva împingeri din spate într-o anumită zonă, care par a fi scari geometrice, au un singur plan general de faliere atunci când se taie mai adânc (Împingerea de la nord de Shkumbini Area). Se aşteaptă ca forţa majoră împingere să fie cea mai avansată. În flancul de vest se observă uneori falii secundare, datorită comprimării şi plierii depunerilor. Aceste falii sunt observate în apropierea celei mai ridicate părţi (zona fisurilor) a tracţiunilor din spate, dând impresia greşită a unei structuri de floare.

Cuvinte cheie: împingere înapoi, împingere spre vest, falie, Albania.

INTRODUCTION

The western areas of the External Albanides are mainly composed of westward thrusting structures. The faulting planes are dipping eastward, generally not exceeding 35°- 40°. In almost all cases, these faults stop below the pre-Serravalian erosion surface. Only in a few case the activation in later deposits has been recognized. The erosion surface of the Upper Oligocene deposits is noticeable in some cases, along with the transgressing surface of Burdigalian deposits in many uplifted structures, the pre-Serravalian deep erosion with its transgressive surface, all over the western pre-mountainous part of Albanides. This phenomenon show that the main folding and uplifting phase took place prior to Serravalian (Oligocene-Miocene tectonic phase).

Triassic salt alongside the major faults or as massive diapers acted as sliding surfaces during the westward horizontal movements phase. This period of time is characterized not only by structural compression and folding, but also by their westward slipping on considerable distances. This slipping continued even during younger geological times (post-Pliocene) and in our opinion, it was responsible in the Neogene structuring and faulting, starting from Serravalian (BEGA et al., 1995).

We shall try to explain the back thrust phenomenon of the molasse deposits of the Peri-Adriatic Depression. Theoretically, the main cause of back thrusts concerns the buried overthrusts (MCCLAY, 1992; FISCHER & WOODWARD, 1992). The buried overthrusts are, in our opinion, the initiating control factors of back thrusts.

The configuration of the back thrusts is controlled by their horizontal slipping and transfer faults (Shkoder-Peje and Vlora-Diber transverse faults). Hence, back thrusts took place as a result of the pre-Serravalian basement.

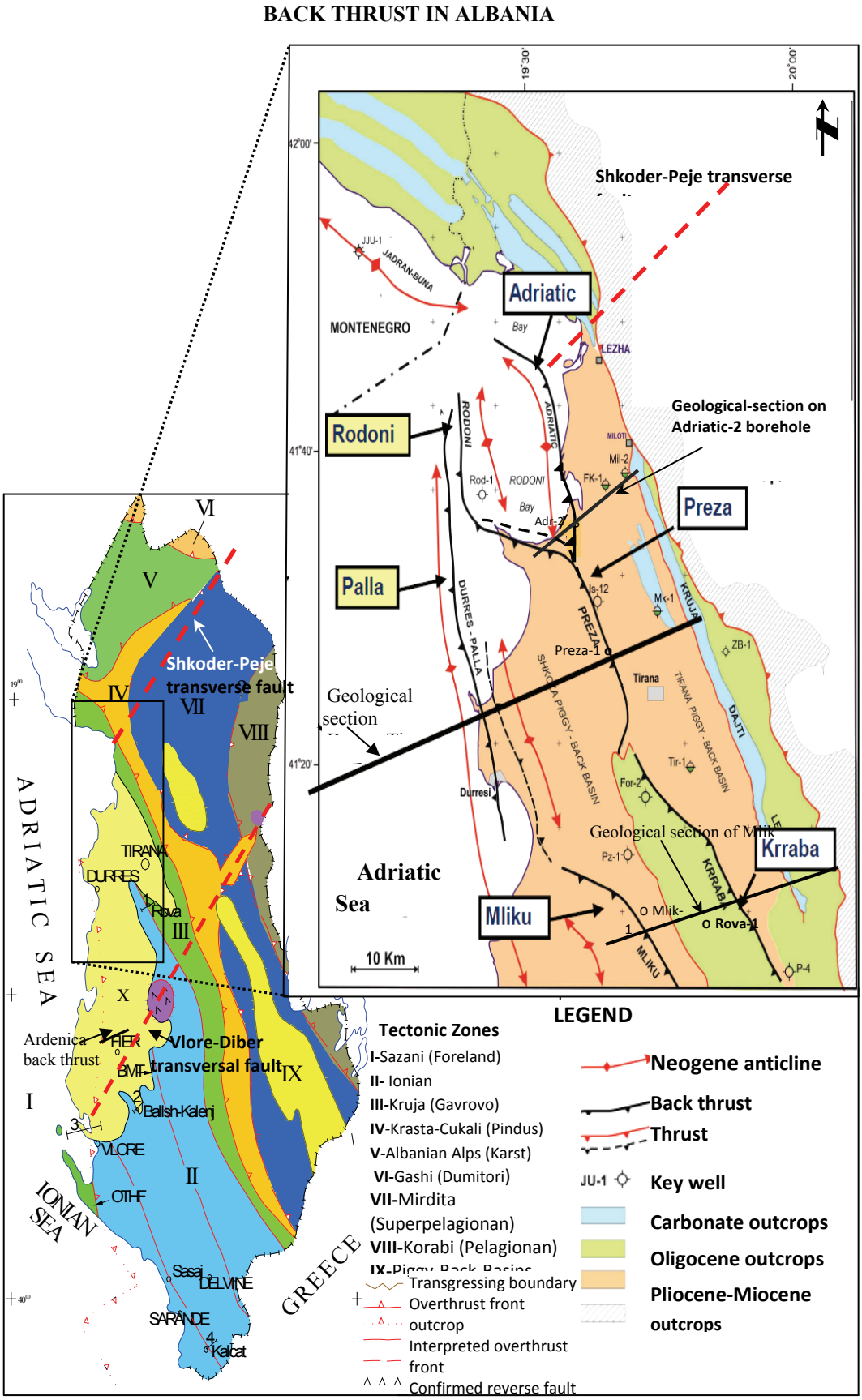

Figure 1. Back thrust sections on the tectonic map of Albania (XHOMO et al., 2002).

Back thrusts are recognized in many areas such as in Preza, Durres, Mlik, Ardenica etc. (Fig.1). Seismic data, sometimes nice outcrops and deep wells data contributed to better explain and define their behavior. Satellite spot images added a contribution in recognizing them in the External Albanides, as well. Preza, Durresi and Ardenica back thrusts are documented by deep wells, while Mlik back thrust relies on the outcrops dipping westward, as well as on seismic sections. Based on the age of the deformed deposits, it results that the final shapes of the back thrusts formed in and post-Pliocene.

Preza back thrust

The main causes of back thrusts are buried overthrusts (involved during pre-Serravalian tectogenesis) and their westward movements. Here, the initial point of back thrust formation and development is related with the early stage of the tip line of the orogene. A typical example to be analyzed and for which we possess lots and clear data is Preza back thrust (BEGA & JANOPULLI, 1995).

The geological phenomenon of Preza is known by the Albanian geologists as the "Preza monocline". Seismic and drilling data at the Preza-1 well (geological formations crossed by Preza-1well: 0–950 m Tortonian; 950–1250 m Messinian–Tortonian; 1250–2150 m Tortonian; 2150–2400 m Serravalian) evidence the back thrust fault plane dipping westward. The Preza-1 well crossed Serravalian turbiditic deposits (dominant clayish, with few interbedded sandstone), into the deltaic deposits (Fig. 2).

Seismic sections show different dipping events. In the West of the Preza-1 well, the Miocene dips are westward, whereas obviously in the East the Miocene is almost flat. Molasse deposits of the Tirana-Ishmi Depression have a wide spread distribution on the East of Preza back thrust. They lay transgressively on top of the carbonate and flysch deposits of the Kruja Zone (BEGA, 2013).

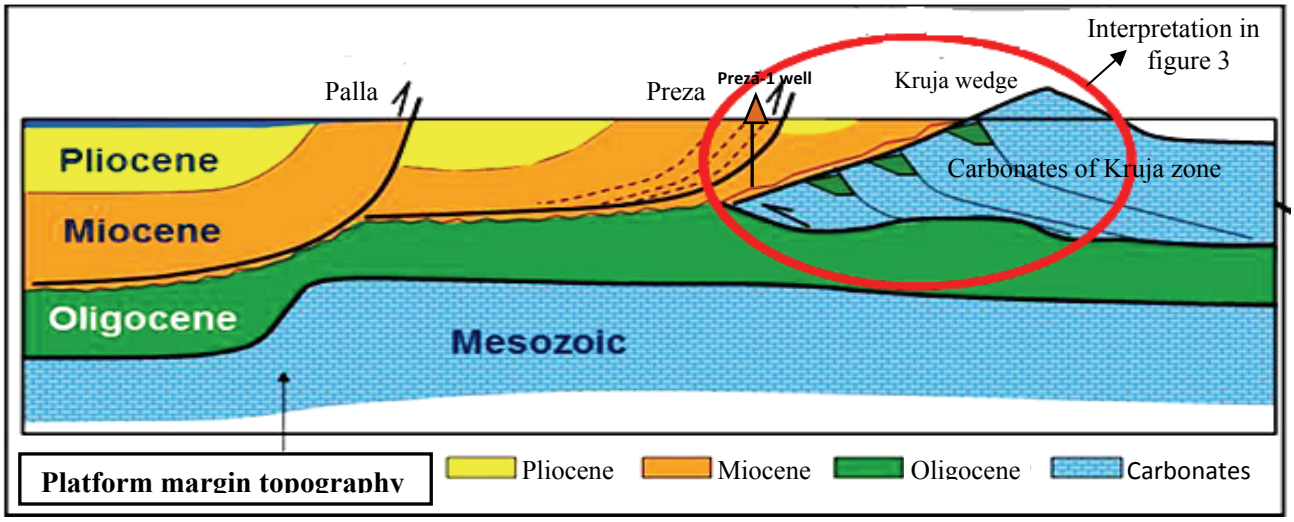

Figure 2. Back thrusts of Miocene section from Durres to Tirana (Palla to Preza).

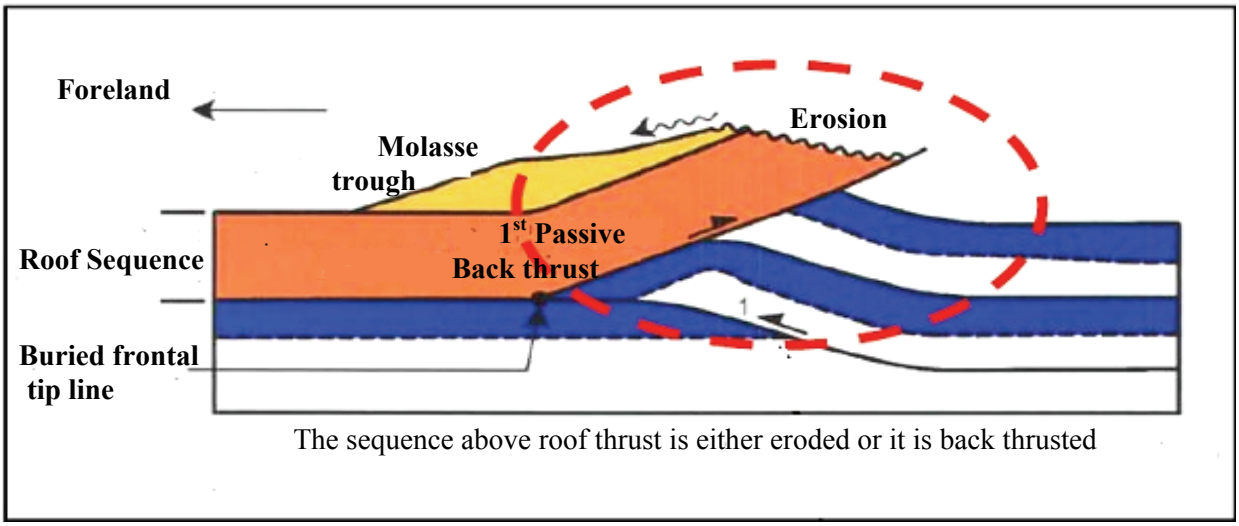

Figure 3. Interpretation of the Preza back thrust (based on FISCHER & WOODWARD, 1992).

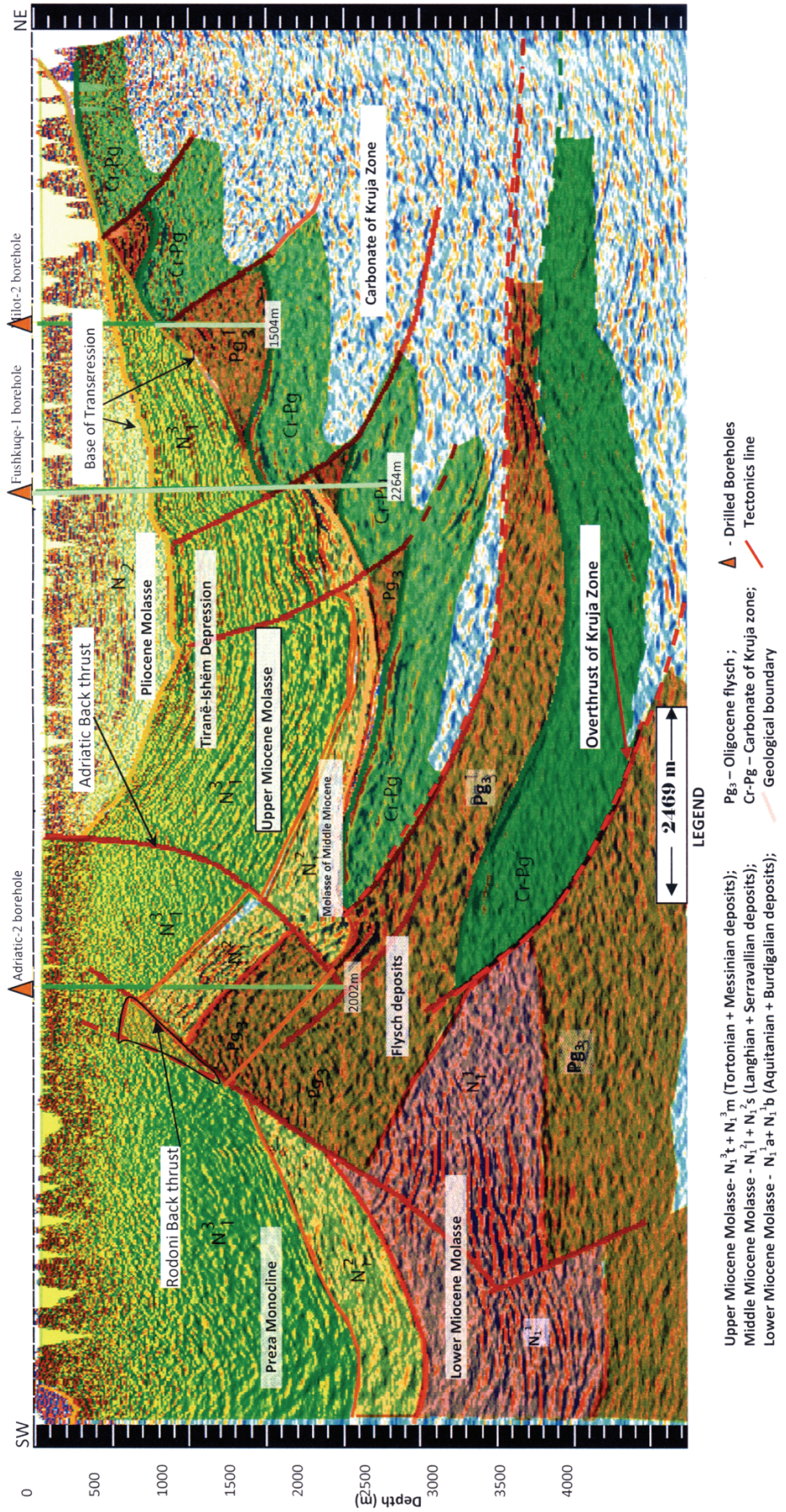

Figure 4. Geophysical section in the Rodon area (SILO et al., 2009)

Transgression is recorded in many borehole logs and it is obviously seen also on the seismic sections. Underneath transgression, the pre-Serravalian structure of Kruja Zone is distinguished, as well as the deep erosion of the carbonate structures of Kruja Zone (Figs. 2, 3). Faults formed exactly during this time, the structures were above the sea level (before Serravalian).

After erosion and subsidence took place, the molasse deposition started, where the littoral-lagoon and deltaic sedimentation played a major part.

The delta has advanced gradually towards West until the end of Miocene. This delta facies remains part of the actually western flank of Preza back thrust. During that time, the Preza back thrust and the Tirana- Ishmi Depression was a single, undivided basin. The same situation lasted even later, during Pliocene, despite the fact that a large part of Tirana-Ishmi Depression area remained emerged.

In the pre-Pliocene phase, after studying the cross section, it results that we have to deal with a non-folding uplift movement and horizontal movement. However, the biggest horizontal shift that caused the Preza back thrust with the above-mentioned characteristics happened in Pliocene and post-Pliocene (Fig. 2). It might have happened that at this period of time Preza was uplifted and, later on the erosion has brought about separation of depositions, especially the deltaic ones, which are continuous and uninterrupted depositions (GURI et al., 2002)

The back thrust of Preza in the position of the Adriatic-2 well is divided into two back thrusts; Rodoni and Adriatic back thrusts (Figs. 2, 4). This division is conditioned by several factors:

- the impact of Shkoder-Peja transverse tectonic line,
- the influence of the overthrust of the Kruja zone,
- high sedimentation rates,
- influence of the Apulia plate eastward.

Other back thrusts

The Durres back thrust. It is verified in deep wells, and it is clearly observed in the seismic sections. It has the same trend (S-N) as the Preza back thrust. To the East of the back thrust, Pliocene deposits are common with the Tortonian ones. Part of the Tortonian deposits is eroded alongside the ridge. According to the available seismic data even this back thrust is due to horizontal movements of the pre-Serravalian structuring, which are predicted as buried and to the East of the back thrust track.

The Mliku back thrust. It is difficult to be detected, though being outcropped well with westward dipping deposition. The seismic sections are very helpful for showing these westward dipping events, which support the back thrust. There are some of these events which are observed from one place to another. On the West a normal fault takes place also due to the compression of deposits, during the same time the back thrust was developed (Fig. 5).

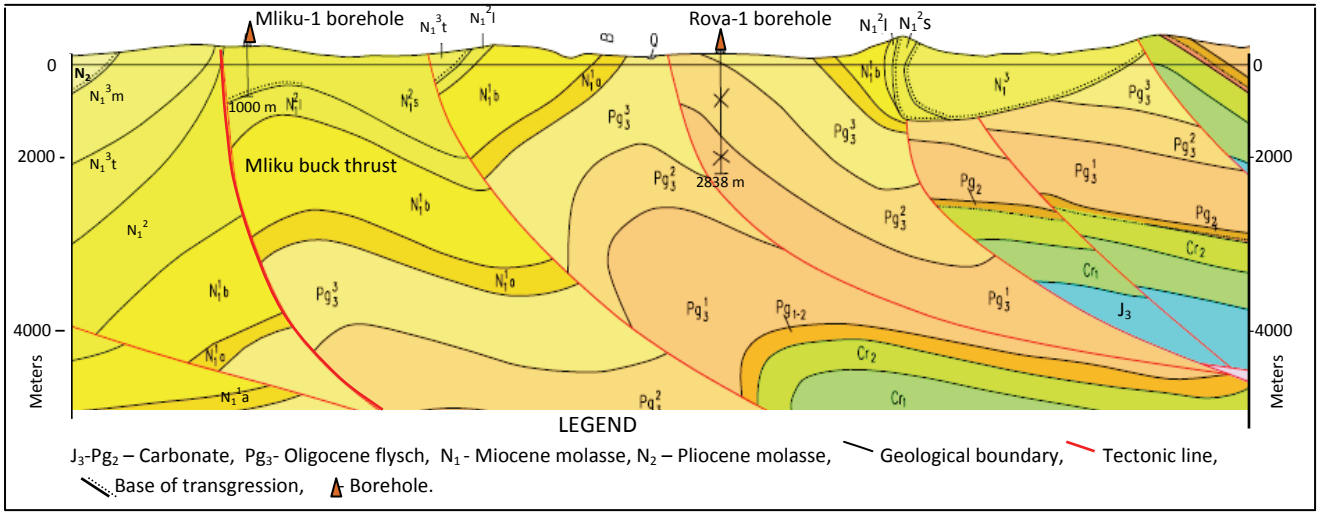

Figure 5. Mlik back thrust of Miocene deposits.

The Ardenica back thrust. It is proved by deep wells (Ard-18 well etc.) and as well as by many seismic sections. The origin of this back thrust is easy to be understood, because to the east of there is the buried big Patos-Verbas anticline of pre-Serravalian age. Westward, the folding and thrusting of other units are detectable (Fig. 6).

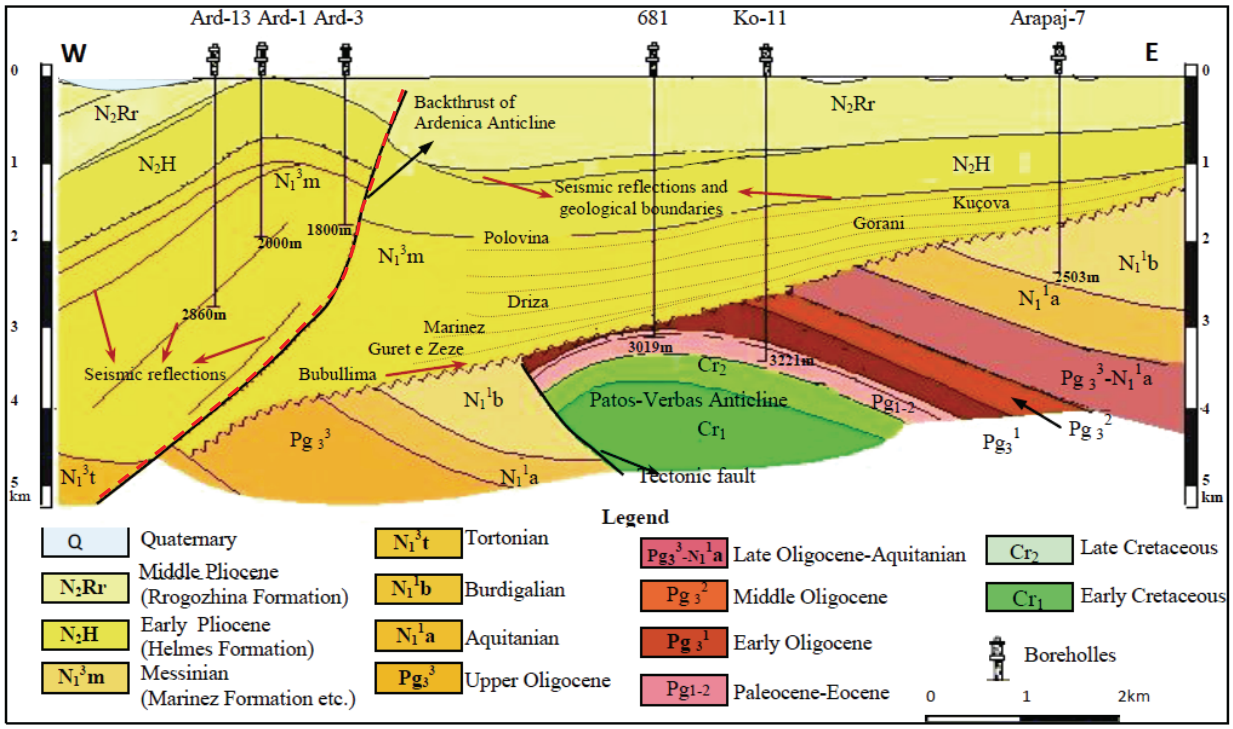

Figure 6. Back thrust of Ardenica anticline (based on PRIFTI & DORRE, 2015).

The most advanced part of the back thrust occurred on that area where the duration of thrusting has been longer. In our case, because of westward thrusting, which produces westward curving features (westward curving of the thrust front), the back thrust response is eastward curving. Several back thrusts in a certain area, which appear like stair-case geometry, are having an overall single fault plane when cutting deeper. The main backt hrust should be the most advanced.

In the western flank sometimes secondary faults (normal faulting) are noticed, due to compression and folding of deposits. These faults are observed near to the most uplifted part of the back thrusts, which giving the wrong impression of a flower structure.

CONCLUSIONS

The main cause of the back thrusts are the buried thrust fronts of the Kruja and Ionian structures. The origin (first tracks) of the back thrusts seems happened during pre-Serravalian thrusting and folding, while their final shape is post-Pliocene, because of horizontal movements.

In most of the cases, back thrusts are considered as stair-case geometry, but the major one is the most-eastern-advanced one. The outcrop dips are very steep, some time overturned. They gradually smooth down, when going deeper. The upper parts of the back thrusts are very important for gas exploration.

Back thrusts are considered to be indirect indicators of orogenic structures, beneath and nearby them (more to the east), in which the most advanced and uplifted area should be related with the duration of early orogeny.

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EVALUATION OF LIMESTONES COMPACTNESS USING ELECTRICAL RESISTIVITY METHOD. CASE STUDY: MELOVA

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Abstract. In Albania (and abroad) companies have an increased interest in limestone rocks exploitation in use for construction materials and decorative stones. The aim of this paper is to help the evaluation of limestone compactness at depth using the 2D apparent resistivity method. Compact limestones have high resistivity values compared with cracked limestones. Cracks usually are filled with water or other low resistivity material like clay. Those materials decrease the general resistivity of limestone, sometimes to very low ranges of resistivity values. The contrast between apparent resistivity values of massif and cracked limestone is high, making possible to delineate the massif and compact limestone at depth. The later limestones are mined in big blocks (2 -3 m^3 / block) and are used like decorative stones. The delineation of massif limestones at depth will help concentrate mining work only in those areas, preserving natural conditions of other areas and helping in rehabilitation of the area after mining.

Keywords: Limestones, electrical tomography, Apparent Resistivity "Real Section", mapping.

Rezumat. Evaluarea compactității calcarelor prin utilizarea metodei rezistivității electrice. Studiu de caz: Melova. În Albania (și în străinătate), companiile au un interes sporit față de exploatarea calcarului, utilizat pentru materiale de construcție și roci decorative. Scopul acestei lucrări este de a ajuta la evaluarea compactității calcarului la adâncime, utilizând metoda de rezistivitate aparentă 2D. Calcarele compacte au valori de rezistivitate ridicate comparativ cu calcarele fisurate. Fisurile sunt de obicei umplute cu apă sau cu alt material de rezistivitate scăzută, cum ar fi argila. Aceste materiale scad rezistența generală a calcarului, uneori la valori foarte mici ale rezistivității. Contrastul dintre valorile aparente ale rezistivității masivului și a calcarului fisurat este ridicat, făcând posibilă delimitarea masivului și a calcarului compact la adâncime. Ulterior, calcarele sunt exploatate în blocuri mari (2 - 3 m^3 / bloc) și sunt folosite ca roci decorative. Delimitarea masivelor calcaroase la adâncime va contribui la concentrarea muncii miniere numai în acele zone, la conservarea condițiilor naturale din alte zone și la ajutarea în reabilitarea zonei după minerit.

Cuvinte cheie: calcare, tomografie electrică, Rezistivitate Aparentă "Secțiunea reală", cartografiere.

INTRODUCTION

Electrical Tomography is known to help in resolving geological problems due to electrical resistivity variations between basement rocks and overlying sediments which form an unconsolidated cover. As a rule, basement rocks are more compact and present higher electrical resistivity values, compared to the loose sediments of the cover, that consist of clays, silts and sands. The first several meters though, in dry season, have higher resistivity values compared to sediments of the cover saturated with water (*below water table*). The use of rock resistivity enables us to delineate several rock layers, their lithology and their structural condition. Limestone resistivity values vary to a high extent, from 50 to 10^7 Ωm (REYNOLDS, 2011).

Figure 1. Surveyed line location (red line) and the mining pit (Google Earth image).

This wide range of resistivity values depends on several factors like limestone compactness, karst development, type of material (water, clay or air) filling the karst, temperature etc. Using those properties, we surveyed the apparent resistivity on a line near a limestone mining pit (Fig. 1).

This survey area is located in central SE part of Albania (Fig. 2), in the Skrapari district near the village of Melova, which is known for the mining of dolomitic limestones used for construction and decorative stones.

Figure 2. Location of the surveyed area (Google Earth image).

The purpose of our survey was the definition of massif limestone at depth. Defining massif limestone will help orienting the limestone mining towards massif parts and, also, will contribute to the preservation (as much as possible) of the nature and environment.

OVERVIEW OF REGIONAL GEOLOGY AND TECTONIC

The study area consist of Upper Cretaceous (Cr_2) carbonatic sediments represented by massif limestones with rudists and dolomitic limestones (Fig, 3). In some parts there are layered limestones, biomicritic and with Globotruncana. Further South we have Eocene (Pg2) carbonates represented by biomicritic and turbiditic limestones overlaying Upper Cretaceous limestones. Near the surface the limestones are affected by the erosion process, creating carst voids filled with red clays material. The limestones have crystaline structure with a light beige color, mostly recrystallized organogenic limestones, are compact and contain micro craks filled with calcite. In massif interlayers we can find oolites that give the rock a considerable solidity. In microscopic analysis this limestone rocks are described like biomicritic limestones where bio mass is represented mostly by foraminiferes non well preserved while micritic mass is the dominant part of the rock composed of limestone micrograins partly recrystallized. In the massif part of limestones it is noticed a dolomitization process developed after litification and connected with the circulation of magnesian waters. Facies of this region are migrated in time and space and today are represented like a compact level containing macro and micro fauna in coral form as: Diabole, Stilophora, Rhizoide, Heliastrea , Isastrea Affinis etc. also big foraminifera and Rudistes accompanied by nummulites and Lepidocyclina.

Lower Oligocen (Pg^1_3) and Middle Oligocen (Pg^2_3) deposits are represented by clay- alevrolitic – sand flysch, containing limestones olistolite horizons.

Paleogene, Neogene and Quaternary deposits are represented by deluvial formations, sometimes mixed with carbonates. They are located generally in all the area in the form of small spots from several cm to 30 cm thickness. They are more widespread in the lower part of the massif, mostly along the road, thus favouring the development of local vegetation, mostly composed of bushes, beech forests and various cultivated trees.

This region is affected by Middle Oligocen tectogenesis. Is limited by two NE – SW main tectonics. Later are developed secondary tectonics deeping SE and extending almost normal to the two main ones. Primary natural fissure system is developed normal to the primary tectonics delineation. Other secondary fissures are caused by erosion of limestones and are not expected to be developed below 3 m of depth.

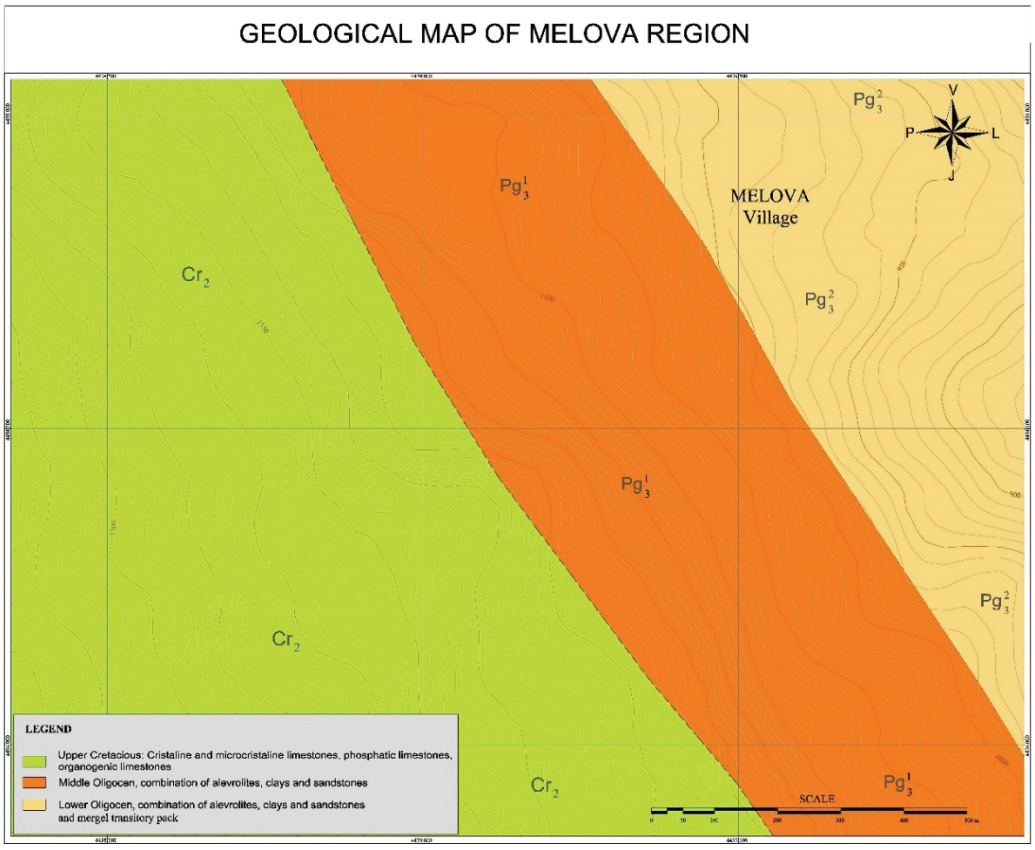

Figure 3. Geological map of the surveyed area.

APPARENT RESISTIVITY METHOD

Apparent Resistivity is a physical parameter of heterogeneous media from an electrical point of view. It is numerically equal with the resistivity of an isotropic homogenous media where, between potential electrodes M and N, for the same current I flowing at current electrodes A and B (Fig. 4) it is created a potential difference ΔU equal with that of the heterogeneous medium.

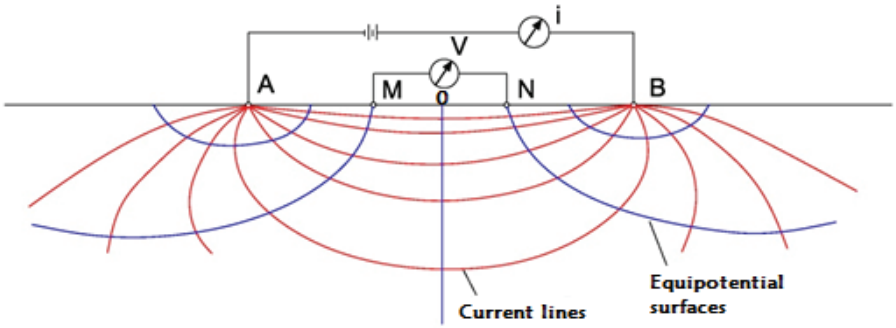

Figure 4. Apparent resistivity survey array.

Through the current electrodes, a current with intensity ***I*** is injected in soil and generates an electrical field. Using potential electrodes, we measure the potential difference ***ΔU*** resulting from the electrical field. This potential difference is proportional with the intensity I and the resistivity ***ρ*** of the rocks underlying the survey line. By measuring ***I*** and ***ΔU***, the apparent resistivity of the rocks may be calculated. This resistivity value corresponds to point O which is the midpoint of M and N distance and is calculated using relation (1):

$$\rho_d = k \cdot \frac{\Delta U}{I} \ [Ohm \cdot m] \qquad (1)$$

where k – geometric constant of the electrical array.

The mathematical expression of this constant and its value depend on the distances between electrodes A, B, M and N.

Some of the most used arrays in apparent resistivity surveys are Schlumberger, Wenner, Dipole – Dipole and Gradient arrays. In our surveys we have used the Multiple Gradient array for 2D apparent resistivity survey.

FIELD PROCEDURE OF RESISTIVITY SURVEYS

The 2D apparent resistivity survey was performed using a technique of survey and interpretation called "Real Section" (*Alikaj P, etc.2012*), which provides a good vertical and horizontal resolution for the maximum required depth of investigation, in our case 30 m, with 5 m interval between stations. The measurements were carried out with five or six multiple gradient arrays, starting from AB = 150 m to AB = 30 m. Line 1 (*see Fig.1*) is located in N - S direction and is surveyed in an interval of 100 m. The measurements were carried out with a Time Domain transmitter IPC- 8. A Syscal (*Iris Instruments, France*) was used as a receiver. A transmitter time (*pulse*) of T = 2 sec and receiving time t = 2 sec was used for these measurements. Data processing of the "Real Section" survey is carried out using a proprietary software (called by authors "*Physical Inversion"*) which, in addition to terrain correction, includes the shape of underground current lines distribution between the current electrodes. Because electrical noise caused by mining activity markedly distorts the signal generated by the underground geological section, the company was asked to switch off power during the surveys. That enabled us to obtain good quality field data.

DATA PROCESSING/INTERPRETATION METHODOLOGY

The Resistivity "Real Section" technique (ALIKAJ & GORDON 1999; KARRIQI & ALIKAJ 2011), employs the data acquisition from multiple gradient arrays or Schlumberger VES to provide a presentation that is close to the true distribution of the electrical resistivity in a geological section.

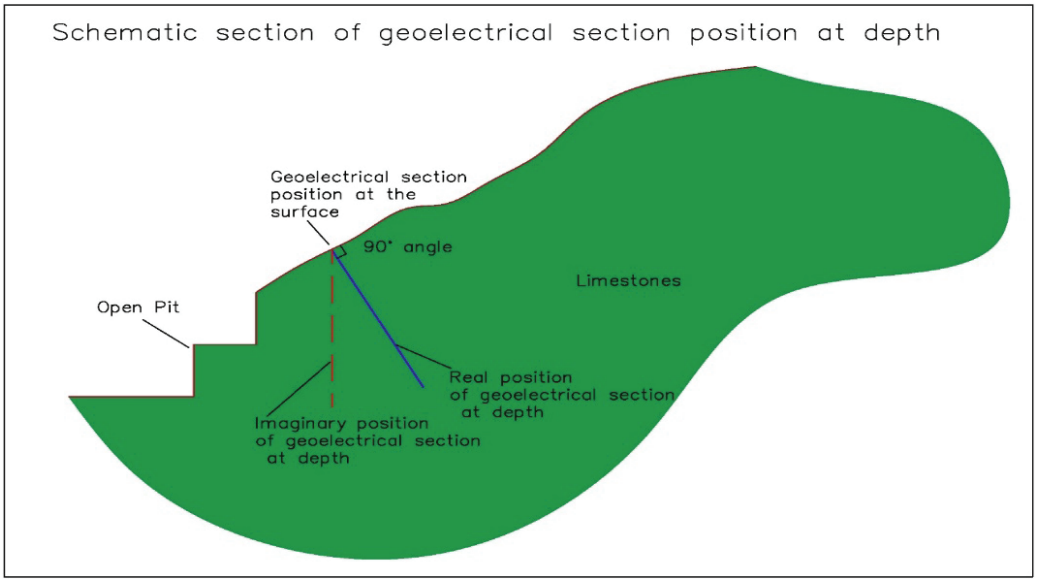

Figure 5. Schematic illustration of geoelectrical section position at depth.

The focus of development of the "Real Section" configuration has been to overcome limitations that have traditionally existed with respect to location, resolution and depth of investigation, inherent in conventional configurations. It is not a mathematical inversion, but rather a presentation of the physical measurements in compliance with the general distribution of the electrical field at depth. Algorithms, developed in conjunction with these configurations, based on scale and mathematical modelling as well as orientation of surveys over known targets allow presentation and interpretation of "Real Section" technique in relation to the true depth and location. The data processing is basically done with Oasis Montaj (Geosoft) software, with some modifications made by our geophysical group regarding the terrain correction. Prior to geoelectrical section interpretation we should give some important information about the position of section at depth defined by the topographic relief of the survey area. Depending of this relief shape, it is also defined the position of surveyed section at depth. In Fig. 5 it is presented a schematic section to

better illustrate the idea. It should be noted that the purpose of this section is only illustrative and has nothing to do with the geological reality of the surveyed area.

As we can note in this illustrative section, the geoelectrical section position at depth is not perpendicular to the horizon (at imaginary position of geoelectrical section), but perpendicular to the topographic relief (same as real position of geoelectrical section at depth). This explanation will give a better picture in understanding geological patterns at depth according to the resistivity section position.

RESULTS AND DISCUSSIONS

Fig. 6 presents the apparent resistivity "Real Section" of the surveyed line.

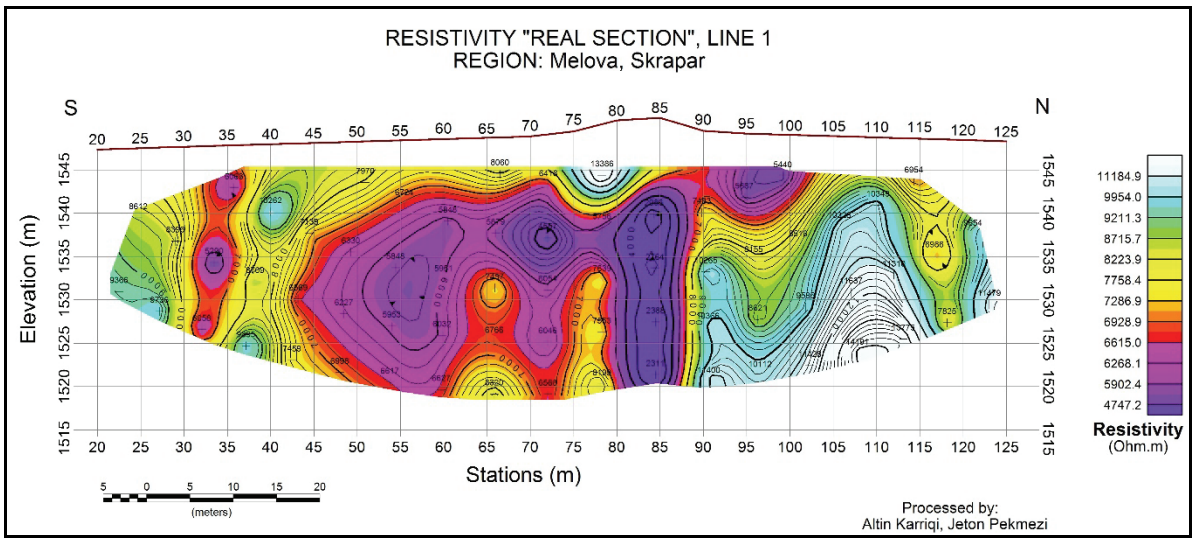

Figure 6. 2D Apparent Resistivity section of surveyed line.

The measured apparent resistivity is characterized by values varying between 2000 ohm.m and 14000 ohm.m. This high range of resistivity indicates limestones in different conditions.

Lower resistivity values are probably connected with the presence of cracks and karst in the limestones. These cracks and karst may be filled with clay or may be caused by high soil humidity. The lowest resistivity values at station 35 and stations 50 – 60, 70 – 75 and 80 – 85 indicate the presence of other materials in limestones that may decrease the resistivity. At the stations 80 – 85 we can observe very low resistivity values from the depth to the surface. This may be probably caused by a cracked zone in the limestones filled with soft material like clay (or presence of humidity or underground water in the cracks). The most probable areas of compact limestones according to the apparent resistivity values in this sections are:

Stations 20 to 30 and 35 to 45, where we can observe an area of high resistivity values coming from the depth toward the surface. This area has an average resistivity of 9000 ohm.m, which is typical for compact limestones.

Stations 75 - 85 define an area of high resistivity from the surface down to the depth of 10 m, which most probably is caused by the presence of compact limestones.

Stations 90 to 115 define the most important area where compact limestones are most probably located. The high values of resistivity (up to 14000 ohm.m) coming from depth and up to 10 m below surface are caused by lithology (most probably compact limestones) and by a factor called lack of mass, caused by a road escarp in the vicinity of the surveyed stations (15 m far from the surveyed stations). Anyway, this factor is not the main cause for the recording of high resistivity values (in this specific case, lack of mass may rise the values by 15% - 20% in the deepest part of the section and by less than 10% in the upper part). The high resistivity values are most probably the result of compact limestones presence in the section.

CONCLUSIONS

The results presented in this paper contribute to defining the massif limestone at depth, helping the mining works to be orientated in this kind of rocks. In the surveyed test line, we can clearly define areas at depth where these massif limestones are located. The apparent resistivity method, and the 2D apparent resistivity section in particular, is very accurate and helpful in resolving the problem of mapping limestone compactness at depth. It easily defines the area at depth where limestones are cracked and subject to karst activity. In the section these areas are represented by relatively average apparent resistivity values (4000 – 6000 ohm.m). Also, we can define areas where this cracks are larger and filled with low resistivity material (mostly clays). In the section these areas are represented by low apparent

resistivity values (2000 - 3000 ohm.m). The massif limestone area at depth is indicated by high apparent resistivity values (> 9000 ohm.m). This area represents the zone of interest for the mining company. Authors suggest 2D apparent resistivity surveys in a regular grid, making possible the mapping of massif limestones in the license area and defining in maps the trend direction and the depth of those rocks. Doing this, we can have enough data to present a 3D model of apparent resistivity in the area, which will be very helpful because, taking in consideration that massif limestones are in the interest of the mining company, it is possible to locate mining works only in the area where this kind of rocks are located and make efforts to preserve other areas in natural conditions.

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STUDIES ON THE CONSERVATION OF BIODIVERSITY OF THE TRADITIONAL YELLOW MELON GENETIC RESOURCES

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Abstract. The research was carried out between 2016 and 2017 at R&DSPCS Dăbuleni, on a sandy soil with low natural fertility. In the 0-20 cm soil layer, the content in organic carbon was 0.09-0.67% and a pH_{H2O} varied between 5.23 and 6.49. There were regenerated 18 yellow melon genotypes, preserved in Suceava Genebank, as part of a Project ADER 3.1.4, funded by MADR through the Sectoral Program 2015-2018. The obtained results showed a good behavior of the melon culture in the conditions of sandy soils. In case of the studied genetic resources of yellow melon, it was identified a great variety of physiological and morphological characteristics, which can be used in the future in the improvement of the existing varieties. Analyzing the diurnal variation of the photosynthesis according to the intensity of the active radiation, during the blooming phase, it was found that, at an active radiation between 1,800 and 1,815 µmol / m^2 / s, photosynthesis recorded the highest value of 30.97 µmol CO_2 / m^2 / s at 12 o'clock, with a consumption of 8.73 mmol H_2O / m^2 / s through the transpiration process. The correlation established with the second-order polynomial function between plant transpiration and photosynthesis, recorded at the three moments of the day during the blooming phase at the 18 melon genotypes reveals a distinct positive functional relationship (r = 0.393 **), which indicates the efficient utilization of water losses of up to 8.72 mmol H_2O / m^2 / s by accumulating a maximum of the photosynthesis rate of 36.33 µmol CO_2 / m^2 / s, in case of TEMP-1180 genotype. The best results in terms of fruit weight (1.8-2.3 kg) were recorded in the following genotypes: TEMP-288, TEMP-77, TEMP-1180, TEMP-1182, TEMP 1029. The soluble dry matter content varied in the range of 5-10%, being also a character of each variety, which can be influenced also by environmental conditions.

Keywords: plant, physiology, fruit, color, quality.

Rezumat. Studii asupra conservării biodiversităţii la resursele vegetale tradiţionale de pepene galben. Cercetările au fost efectuate în perioada 2016-2017 la SCDCPN Dăbuleni pe un sol nisipos cu o fertilitate naturală redusă, având în stratul de sol 0-20 cm, un conţinut de carbon organic de 0,09-0,67% şi un pH_{H2O} de 5,23-6,49. Au fost regenerate 18 genotipuri de pepene galben păstrate în Banca de Gene de la Suceava în cadrul unui Proiect ADER 3.1.4., finanţat de MADR prin Programul Sectorial 2015-2018. Rezultatele obţinute au evidenţiat o comportare bună a culturii de pepene galben în condiţiile solurilor nisipoase. În cadrul resurselor genetice de pepene galben luate în studiu, a fost identificată o diversitate mare a caracterelor fiziologice şi morfologice, care pot fi utilizate pe viitor în procesul de ameliorare a soiurilor existente. Analizând variaţia diurnă a fotosintezei în funcţie de intensitatea radiaţiei active, în faza de înflorire a plantelor, se constată ca la o valoare a radiaţiei active cuprinse între 1800-1815 µmol/m2/s fotosinteza a înregistrat cea mai mare valoare de 30,97 µmol CO2/m2/s la ora 12, cu un consum de 8,73 mmol H2O/m2/s prin procesul de transpiraţie. Corelaţia stabilită cu ajutorul funcţiei polinomiale de gradul 2, între transpiraţia plantei şi fotosinteza înregistrată în cele trei momente ale zilei în faza de înflorire a plantelor la cele 18 genotipuri de pepene galben, evidenţiază o legătură funcţională distinct semnificativ pozitivă (r = 0,393**), care arată valorificarea eficientă a pierderilor de apă de până la 8,72 mmol $H_2O/m^2/s$, prin acumularea a unui maxim al ratei fotosintezei, de 36,33 µmol $CO_2/m^2/s$, la genotipul TEMP-1180. Cele mai bune rezultate privind greutatea fructului (1,8-2,3 kg) s-au înregistrat la genotipurile: TEMP-288, TEMP-77, TEMP-1180, TEMP-1182, TEMP 1029. Conţinutul de substanţă uscată solubilă a variat în intervalul 5-10%, fiind un caracter de soi, care poate fi însă influenţat şi de condiţiile de mediu.

Cuvinte cheie: plantă, fiziologie, fruct, culoare, calitate.

INTRODUCTION

Yellow melon (*Cucumis melo* L.) is an important crop in the world with a total annual production of 26.8 million tonnes and a cultivated surface of approximately 1.3 million hectares (***. FAO, 2007). It is grown for fruits that are consumed fresh, when reaching physiological maturity, being appreciated by consumers according to their taste, juiciness and special aroma. The fruit contains carbohydrates, proteins, vitamins (C, B1, B2, B6), carotene (orange mesocarp), mineral salts (Ca, P, K, Fe). The yellow melon is a thermophilous plant, with very high heat requirements, which finds good conditions for development in arid areas (CIUCIUC, 2003; CABELLO et al., 2009). Certain research made in Argentina on melon genotypes indicates the existence of major post-transplant stress, depending on temperature (BOUZO & KÜCHEN, 2012).

Changing the microclimate by soil mulching has a positive influence on the growth and development of melon plants (CIUCIUC, 2001). Plant requirements towards soil and water are lower because of the root system structure that gives the plant a greater resistance to drought and a better utilization of mineral elements (CIUCIUC, 2003; CASTELLANOS et al., 2011). Being a short day plant, the lack of light determines the stretching of seedlings and cultivated plants (CIOFU et al., 2003). Intense light influences favorably the accumulation of sugar in the fruit, and its lack, delays the ripening of the fruit. As agricultural lands decrease in surface, as well as water resources in availability, and diseases and pests incidence increases, it is essential to cultivate varieties of melon tolerant to drought and increased resistance to pathogens (PANAGIOTOPOULOS, 2001; RUBAIYAT SHARMIN & MAHABUBUR RAHMAN, 2014).

Conservation of biodiversity is a priority that results from the need to understand the combined functions of ecological and social agrobiodiversity, which are of major importance for both the ecosystem and society (PLATON, 2012). Traditional seeds, which are genetic resources in case of most plants, among which melon, were used and improved during the period when the system was organized at a small-scale in order to satisfy food requirements

locally. Traditional amelioration was done under specific conditions, when there were not used practices that enhanced soil erosion or CO_2 emissions or chemical inputs; this is why traditional seeds are appropriate to support local economic systems. In this respect, the present study aims at conserving the characters in some melon genotypes stored in Suceava Genebank for the purpose of their use in the process of plant improvement.

MATERIAL AND METHODS

The researches were carried out during 2016-2017 at R&DSPCS Dăbuleni on a sandy soil with a reduced natural fertility; in the 0-20 cm soil layer, the content in organic carbon was of 0.09-0.67% and pH of H_2O varied from 5.23 to 6.49. From the point of view of NPK content, the sandy soil used in the experiments was characterized as poorly supplied with nitrogen (0.067-0.078%), well supplied with extractible phosphorus (70 ppm and 81 ppm) and poorly to medium supplied with exchangeable potassium (49 ppm and 123 ppm). There were regenerated 18 melon genotypes preserved in Suceava Genebank as part of a Project ADER 3.1.4, funded by MADR through the Sectoral Program 2015-2018. In this regard, the seeds of the used melon genotypes were planted in 6.2 cm diameter alveolar trays, filled with peat substratum (Photo 1), that were kept in plastic greenhouses, in a tunnel-protected system.

In the greenhouse, an optimal microclimate was provided by irrigation and ventilation, so that temperature did not fall below 14-15^{0}C at night and reached the optimum of 25-30 °C during the day. When seedlings reached 20-25 days, they were transplanted into the field; the soil registered a temperature of approx. 20-25 °C at that time, temperature that favors a normal growth of the root system and good absorption of water and mineral salts. There were made observations and determinations with regard to the plant resistance to diseases, plant vigor, weight, size and shape of the fruit, core color, soluble substance, seed dimensions. The physiology determinations (photosynthesis rate, foliar transpiration rate, stomatal conductance, active radiation in photosynthesis, leaf temperature) were performed during the blooming phase of plants, using the LC Pro+ Portable Photosynthesis Device.

RESULTS AND DISCUSSIONS

Analyzing the climatic conditions recorded in the field during the vegetation period of the yellow melon (May-July), we notice the increase of the drought in the studied period (2016-2017), compared to the multiannual average. The thermal regime is considerably higher, as a result of the increase of the average air temperature by about 1.45^{0}C, compared to the multiannual average. The reduction of the amount of precipitation by 17.86 mm compared to the average and maximum temperatures in the air above 40°C for several consecutive days, coupled with temperatures above 65°C at ground level and a low relative humidity of about 25%, act as stressors on plants, which dehydrate because of pronounced foliar transpiration. Under these circumstances, choosing specific plants for cultivation in these areas and finding solutions to counteract the negative effects of thermohydric stress is a necessary measure to promote sustainable agriculture in the area of sandy soils. Abiotic factors, including temperature, light, water and nutrients, can alter the action of genetic factors and therefore the size of the fruit or the development of physiological processes (KATSUMI et al., 1999).

The plants perform their metabolic processes optimally at 80-85% relative humidity. Air humidity or hygroscopicity decreases as temperatures increase to 30%. In the period of fruit formation, the high temperatures of 35-40ºC cause rapid maturation, to the detriment of their quality. Water requirements are moderate due to the root system structure better developed than in case of cucumbers and watermelons. In the active growth phase, the soil moisture must be 65-70% of the field capacity, and during the flowering-fructification period 70-75%.

The excess moisture determines the decrease of the sugar content. Yellow melons prefer medium light soil with a good structure and a pH of 6-7. The results obtained by SIMSEK & COMLEKCIOGLU (2011) highlight that melon can be grown successfully in semi-arid areas in Turkey, where annual precipitation amounts are between 314.1 and 364.2 mm. From a climatic point of view, the area of sandy soils in southern Oltenia, where the experiment was located, has a temperate continental character, with a slight Mediterranean influence; the multiannual rainfall amount is 505.4 mm, but the amounts are unevenly distributed during the year (TOMA et al., 2011), which requires careful selection of plant species in culture. The same author mentions that the annual sum of sunlight hours in the area of psamosoils in southern Oltenia exceeds 2,000 hours, which makes this area have significant heliothermal resources that are successfully capitalized by melon and watermelon (Table 1).

Table 1. Analysis of climatic conditions recorded at ADCON Telemetry Weather Station located on R&DSPCS Dăbuleni in the vegetation period of *Cucumis melo*.

Period / Climate		May	June	July	Average (^{0}C)	$\sum$ ^{0}C / mm
2016-2017	Monthly average temperature (^{0}C)	17.3	23.8	24.8	21.97	1998.97
	Monthly maximum (^{0}C)	32.9	41.2	40.8	41.2	
	Rainfall (mm)	91.5	35.3	76.2		111.5
Multiannual climate data 1956-2016	Monthly average temperature (^{0}C)	16.8	21.6	23.1	20.5	1865.5
	Sum of monthly precipitation (mm)	62.12	69.30	53.15		184.57

Throughout the melon growing season there have been reports of plant infections with *Fusarium oxisporium* (Schlecht.) *f. sp. niveum* and *Cucumis virus I* (Doolitte). The observations on plant resistance to pathogens highlight their differentiation according to the year of culture and genotype (Table 2). Thus, in 2016, the low temperatures associated with higher rainfall amounts, recorded during the first part of the vegetation period, favored the infection of the genotypes with pathogens (mean scores of 1.67-3.33). Thus, we may conclude that the plant loves heat and needs an optimal soil temperature of 20-25 °C, which favors a normal growth of the root system and a good absorption of water and mineral salts. The studied genotypes had an indefinite increase and a differentiated plant force, most of them (72%) having an average plant force. Of the 18 studied genotypes, 13 were displayed a good resistance to pathogens, noted in the range of 1-2.

Table 2. Behavior of *Cucumis melo* genotypes in the pedoclimatic conditions of the sandy soil area.

Genotypes	Plant resistance to *Fusarium oxisporium* and *Cucumis virus* (F.A.O. scoring system with grades on a scale of 1-9)				Average	Plant vigor	Growth type of the plant
	Stretching phase of the haulm		Blooming-fructified phase				
	2016	2017	2016	2017			
SVGB-16821	3	1	5	2	2.75	7	2
TEMP-176	2	2	3	1	2	7	2
TEMP-231	2	1	3	1	1.75	5	2
TEMP-286	1	1	4	1	1.75	5	2
TEMP-287	1	1	3	2	1.75	5	2
TEMP-288	1	3	3	2	2.25	5	2
TEMP-289	3	2	3	1	2.25	5	2
TEMP-290	1	2	3	1	1.75	5	2
TEMP-467	2	1	5	2	2.5	5	2
TEMP-502	1	1	5	2	2.25	5	2
TEMP-514	1	1	5	2	2.25	7	2
TEMP-1029	1	1	3	2	1.75	5	2
TEMP-1180	2	1	2	1	1.5	7	2
TEMP-1182	2	1	3	1	1.75	5	2
TEMP-1183	1	1	1	2	1.25	5	2
TEMP-1184	2	1	3	1	1.75	5	2
TEMP-155	2	1	3	1	1.75	5	2
TEMP-77	2	1	3	2	2	7	2
Media	1.67	1.28	3.33	1.5	1.94	5.56	2
Average temperature (°C)	May- June 16.8 - 23.6	May- June 17.8 - 24	May- June 16.8 - 23.6	May- June 17.8 - 24	Legend of disease resistance: 1- very resistant 9- very sensitive	Legend: 3. small 5. average 7. Great	Legend: 1. determined 2. undetermined
Rainfall (mm)	May- June 104.4-53.2	May- June 78.6-17.4	May- June 104.4-53.2	May- June 78.6-17.4			

Photo 1. Obtaining melon seedlings in alveolar trays filled with peat substratum (original)

Photo 2. Physiological determinations with LC Pro + Portable Photosynthesis Device (original)

The research on the physiology of the plant at the 18 genotypes of melon grown in the sandy soil area of Dabuleni aimed to determine their tolerance to the thermo-hydric stress characteristic to the area. Taking into account the primary role in the formation of photosynthesis products, light is considered the main environmental factor influencing the photosynthesis process. Analyzing the diurnal variation of photosynthesis, depending on the intensity of active radiation, during the blooming phase, a positive correlation is found, which emphasizes the increase of CO_2 absorption through photosynthesis up to an active radiation value of 1,800-1,815 µmol / m^2 / s (Table 3).

At 12 o'clock, the determinations revealed that SVGB-16821, TEMP-288, TEMP-289, TEMP-1183, TEMP-155, TEMP-1180, TEMP-1180, TEMP-1180 genotypes present photosynthesis values exceeding 32 μmol CO_2 / m^2 / s (maximum value of 36.33 μmol CO2 / m^2 / s at TEMP-1180), while at 3 p.m., we mention SVGB-16821, TEMP-286, TEMP-288 and TEMP-1184 genotypes, in case of which photosynthesis also exceeds 30 μmol CO_2 / m^2 / s. During the day, as solar radiation increases, temperature increases as well, reaching 37.6 $^{\circ}$C at the leaf level. At these temperature values, the capacity of the air to retain water vapor increases, which causes the relative air humidity to decrease and, consequently, intensifies foliar transpiration process.

The diurnal maximum was recorded at 3 p.m. at the TEMP-514 genotype (11.24 mmol H_2O / m^2 / s). Through foliar transpiration, the plants avoided overheating, the evaporated water being efficiently utilized, as the genotypes with the highest water loss also had the highest photosynthetic yield. As it prefers light and heat, the yellow melon is a plant tolerant to the thermo-hydric stress characteristic of this sandy soil area, with a high photosynthetic yield over the entire vegetation period. Plant dehydration occurs under the cumulative action of high temperatures in the air and low relative humidity, due to the pedological drought. Thus, the plant suction force increases to several dozen atmospheres inducing the increase of water loss on the foliage. Rainfalls have a beneficial effect on crop plants. They supply the soil with water, which will later be available to plants for a longer period, depending on the growing season, plant consumption and atmospheric conditions. Due to the well-developed root system, water requirements are moderate, which means a greater drought resistance of this species. The reactions of plants to drought action suppose different adaptation strategies, including morphological, physiological and molecular adaptations. Stomatal regulation of water loss is identified as the earliest reaction of plants o insufficient moisture (ŞTEFÎRŢĂ et al., 2013).

As temperature increases at the leaf level at 3 p.m., water conductivity of yellow melon leaves decreases to 0.66 mmol / m^2 / s, 39.5% less than the one registered at 12.00 o'clock. Under these conditions, the carbon dioxide assimilation by the leaves was reduced in the plant. The analysis of the correlation between the plant transpiration and the photosynthesis process, recorded at the three moments of the day during the blooming – fructification phases at the 18 melon genotypes (54 determinations) reveals a distinct significant positive functional relationship that shows an effective use of the water loss through transpiration up to 8.72 mmol H_2O / m^2 / s, for the accumulation of a maximum photosynthesis rate of 36.33 μmol CO_2 / m^2 / s at 12 o'clock at the TEMP-1180 genotype (Fig. 1).

Table 3. Daily variation of the physiological processes recorded in some *Cucumis melo* genotypes cultivated on sandy soils.

Genotype	9 a.m.			12 o'clock			3 p.m.		
	Photosynthesis rate μmol $CO_2/m^2/s$	Leaf transpiration rate mmol $H_2O/m^2/s$	Stomatal conductance for H_2O mmol/m^2/s	Photosynthesis rate μmol $CO_2/m^2/s$	Leaf transpiration rate mmol $H_2O/m^2/s$	Stomatal conductance for H_2O mmol/m^2/s	Photosynthesis rate μmol $CO_2/m^2/s$	Leaf transpiration rate mmol $H_2O/m^2/s$	Stomatal conductance for H_2O mmol/m^2/s
SVGB-16821	22.01	4.83	0.9	32.42	7.26	1.85	34.05	9.51	0.81
TEMP-176	14.73	3.92	0.42	26.84	6.44	1.01	19.53	9.39	0.88
TEMP-231	29.74	5.3	0.95	29.72	8.37	1.34	23.81	10.19	0.75
TEMP-286	28.31	6.38	1.95	28.52	9.44	2.11	32.54	10.61	0.87
TEMP-287	25.14	5.37	0.81	28.79	8.02	0.81	29.29	10.41	0.91
TEMP-288	30.17	5.2	0.62	32.96	8.96	1.02	32.22	10.02	0.86
TEMP-289	28.11	5.78	0.84	32.62	9.26	1.27	31	8.73	0.47
TEMP-290	27.03	5.13	0.54	31.83	8.49	1	27.22	8.84	0.5
TEMP-467	27.5	6.29	1.03	30.53	9.42	1.32	28.88	10.33	0.83
TEMP-502	25.02	5.58	0.76	31.49	9.85	1.23	25.49	7.83	0.39
TEMP-514	29.04	5.9	0.78	29.24	8.87	0.79	22.44	11.24	0.9
TEMP-1029	27.89	5.7	0.71	32.48	9.79	1.12	23.07	7.2	0.27
TEMP-1180	20.61	5.98	0.77	36.33	8.72	0.77	31.26	11.21	0.95
TEMP-1182	25.07	5.34	0.52	20.71	7.3	0.46	22.5	10.52	0.63
TEMP-1183	26.35	5.79	0.61	34.07	9.42	1.06	27.11	8.21	0.36
TEMP-1184	25.61	6.15	0.69	31.88	9.18	0.92	30.06	10.51	0.66
TEMP-155	26.89	6.05	0.63	34.38	9.22	0.91	25.17	9.45	0.48
TEMP-77	23.2	4.83	0.49	32.64	9.19	0.76	23.77	10.19	0.5
Average	25.69	5.57	0.77	30.97	8.73	1.09	27.19	9.68	0.66
Active photosynthesis radiation limit (μmol/m^2/s)	1408 - 1418			1800 - 1815			1728 - 1733		
Air temperature limit (^{0}C)	27.4 - 31.5			30.7 - 34.8			34.5 - 37.6		

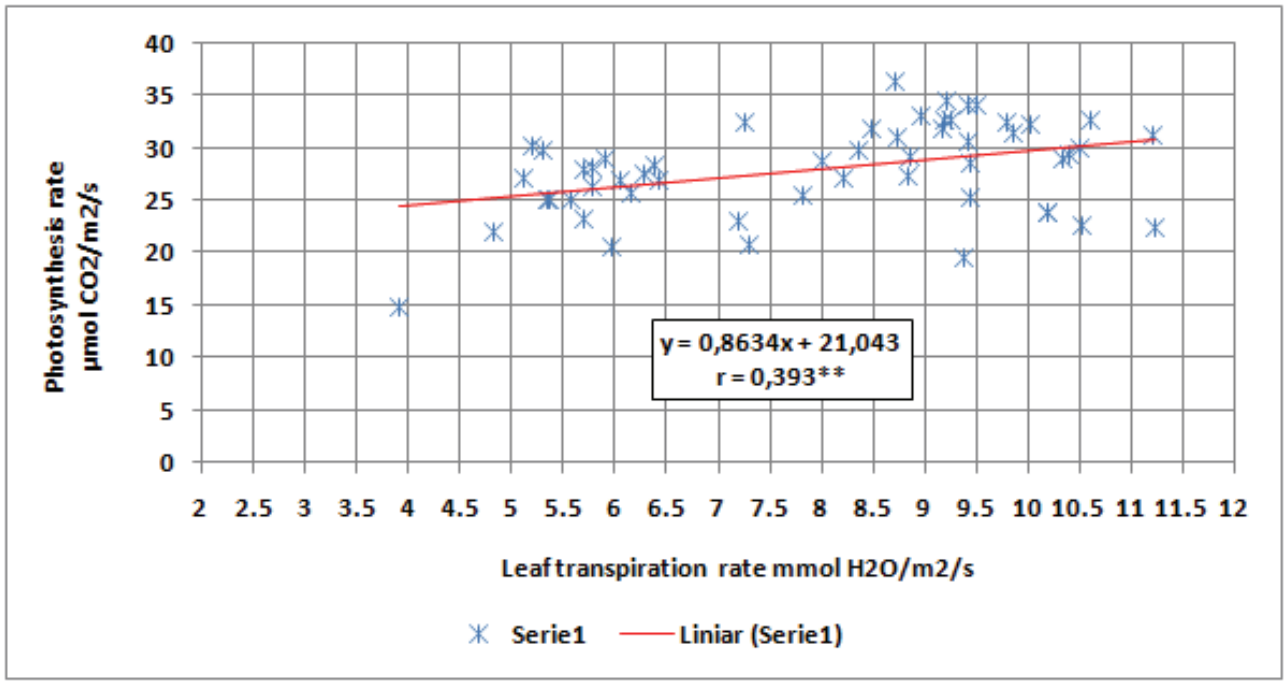

Figure 1. The relationship between transpiration and photosynthesis in *Cucumis melo* plant in the conditions of sandy soils from southern Oltenia.

The analysis of the morphological characters of melon genotypes (Table 4) highlights a wide range of the fruit shape, color and quality, enabling the breeder to select the desired character. The length of the melon fruit was in the range of 13.6-25.8 cm, with an average of 20.12 cm, while the diameter showed average values of 15.48 cm in the interval 11.1-23.6 cm, thus resulting different shapes of the fruit: oval, round, elongated. From the point of view of the exterior color of the rind, it was mostly yellow and the core presented different colors, the percentage of participation in the studied range being: 22.2% - green, 44.5% - yellow, 16.8% - orange, 5.5% - white, 5.5% - greenish yellow, 5.5% - whitish green (Photo 4). The soluble dry matter content ranged from 5-10%, being a variety character that can be influenced by climatic conditions.

The determinations regarding the size and weight of the seeds highlight a high variability in the weight of one thousand seeds (WTS), ranging from 23.7-45.7 g, with an average of 34.14 g (Photo 5). The length of the seed varied between the 9.1 and 11.8 mm, with an average of 10.62 mm; the width ranged between 4 and 5.2 mm, with an average of 4.62 mm. Corroborating the physiological and productivity determinations, the best results were obtained with the genotypes TEMP-288, TEMP-77, TEMP-1180, TEMP-1182, TEMP 1029, which recorded 1.8-2.3 kg / fruit.

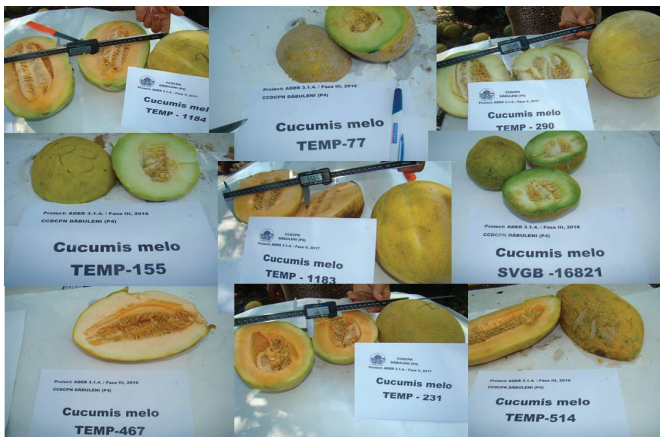

Photo 4. Shape and color in some melon genotypes (original).

Photo 5. Seeds obtained from different melon genotypes (original).

Table 4. Variability of some morphological characters at the *Cucumis melo* genotypes studied in the conditions of sandy soils in southern Oltenia.

Genotype	Fruit dimensions		Fruit weight kg	The shape of the fruit	The color of the rind	The color of the core	Soluble dry substance %	Seed characters		
	Fruit length cm	Fruit width cm						length (mm)	width (mm)	(WT S g
SVGB - 16821	14.6	14.3	1.3	round	yellow	greenish	9	9.7	4.2	28.8
TEMP-176	24.3	13.2	1.4	elongate	yellow	yellow	7	9.9	4.3	30.4
TEMP-231	19.5	15.5	1.7	oval	yellow	orange	5	10.8	5.2	39.4
TEMP-286	22	23.6	1.5	round	yellow	Yellow	6.8	11.2	4.6	31.5
TEMP-287	19.5	15.3	1.7	oval	yellow	white	6	11.5	4.5	32.0
TEMP-288	22	16.7	2	oval	yellow	greenish	6.4	10.8	4.6	37.2
TEMP-289	14.6	14.6	1.1	round	yellow	yellow	7	9.1	4.7	34.3
TEMP-290	19.5	15.9	1.3	oval	yellow	yellow-greenish	8.2	10.6	4.5	31.4
TEMP-467	22.3	18.2	1.5	elongate	yellow	yellow	9	10.8	5.1	37.7
TEMP-502	23.6	14.6	1.6	elongate	yellow	yellow	8	10.5	4.4	39.3
TEMP-514	21	12.8	1.5	elongate	yellow	yellow	10	10.9	4.9	35.6
TEMP-1029	25.8	15	2.2	elongate	yellow	yellow	9.4	11.4	5.1	37.7
TEMP-1180	25	11.1	2.3	elongate	yellow-greenish	yellow	9	10.2	4.6	31.2
TEMP-1182	22.6	17.4	1.9	elongate	yellow	greenish	7.4	11.8	4.7	45.7
TEMP-1183	19.2	15.3	1.5	oval	yellow	orange	6.4	11.7	4.7	38.1
TEMP-1184	17.3	15.8	1.5	elongate	yellow-greenish	orange	6	11.0	4.9	34.1
TEMP-155	13.6	13.2	1	round	yellow	greenish	9	9.8	4.0	26.5
TEMP-77	16	16.1	1.8	round	yellow	greenish	9.2	9.4	4.1	23.7
Average	20.12	15.48	1.6				7.87	10.62	4.62	34.14
Maximum	25.8	23.6	2.3				10	11.8	5.2	45.7
Minimum	13.6	11.1	1				5	9.1	4	23.7

CONCLUSIONS

The obtained results revealed a good behavior of the melon culture in the conditions of sandy soils. Within the genetics of yellow melon studied between 2016 and 2017, a great diversity of physiological and morphological characters has been identified, which can be used in the future for the improvement of the existing varieties.

At a photosynthetic active radiation value of 1,800-1,815 μmol / m^2 / s, during the blooming phase, the melon genotypes recorded a maximum accumulation at 12 o'clock, when the average photosynthesis was 30.97 μmol CO_2 / m^2 / s and the water consumption through the transpiration process 8.73 mmol H_2O / m^2 / s.

The melon genotypes TEMP-288, TEMP-77, TEMP-1180, TEMP-1182, TEMP 1029 were the ones remarked due to the weight of their fruit of 1.8-2.3 kg.

The soluble dry matter content ranged from 5 to 10%, being dependent on the variety, which may be influenced by environmental conditions.

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XERIC MEADOWS AFFECTED BY THE ZOO-ANTHROPOGENIC FACTOR FROM THE OLTENIA REGION (ROMANIA)

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Summary. The xeric meadows in Oltenia are very well represented in the south part of this region. Because of the zoo-anthropogenic activities from the last 15 years (irrational grazing, throwing garbage at these places edge, sheepfold installation, the waste spill from roads construction nearby, etc.), the physiognomy has changed substantially. The lack and/or the extinction of the important fodder species, the development of the invasive species represent other contributing factors for the irreversible degradation of the xeric meadows in Oltenia. The presence of some rare taxa in these meadows is an important reason for considering a sustainable management of these places.

Keywords: zoo-anthropogenic factor, Oltenia, grazing, Romania.

Rezumat. Pajiști xerice afectate de factorul zoo-antropogen din regiunea Olteniei (România). Pajiștile xerice din Oltenia au o bună reprezentare la partea sudică a acestei regiuni. Datorită activităților zoo-antropogene din ultimii 15 ani (păşunat iraţional, aruncarea gunoaielor menajere la marginea acestor locuri, târlitul unor suprafețe datorită instalării stânelor, deversarea resturilor rezultate de la construirea drumurilor din apropiere, etc.), fizionomia acestora s-a schimbat substanțial. Lipsa și/sau dispariția speciilor bune furajere, dezvoltarea speciilor invazive sunt alți factori care contribuie la degradarea ireversibilă a pajiștilor xerice din Oltenia. Prezența unor taxoni rari în aceste pajiști este un motiv important pentru care considerăm utilă gestionarea durabilă a acestor locuri.

Cuvinte cheie: factor zoo-antropogen, Oltenia, păşunat, România.

INTRODUCTION

The influence of the zoo-anthropogenic factor on the xeric meadows vegetation condition in Oltenia is varied in terms of intensity and manifestation. On one hand, in some areas, a reduction of the surfaces occupied by these meadows took place while, on the other hand, this fact has brought the extinction of some valuable species as food but especially for science. As a result of the negative activities made by man and domestic animals on these meadows, many changes have occurred regarding their floristic composition, the important fodder species being replaced with the non-fodder ones or sometimes with species manifesting an invasive potential on the surfaces where they installed.

The first information regarding the natural meadows in Romania is found in the research papers published by D. Brândză (1879-1883) and D. Grecescu (1898). Subsequently, we find important data in the research paper published by Enculescu (1923). In this research paper are found details regarding the grassy vegetation, especially in the steppe and silvosteppe area, in correlation with the climatic and soil factors.

I. Prodan (1924-1939) grouped the grassy vegetation in large ecological groups, bringing extensive information about these places flora (PRODAN, 1939). In the same period, the first floristic and phytocoenology studies have appeared regarding some territories.

Generally, the complete characterization of the xeric meadows from this country side is combining the information from the specialty literature (BUIA & POPESCU-MIHĂILĂ, 1952; BUIA, 1959; 1960; BUIA & PĂUN, 1960; BUIA et al., 1961; POPESCU et al., 2003) with the personal experience gained during researching on meadows in Oltenia (RĂDUȚOIU, 2006; 2008). While the meadows from the nord part of Otenia have been carefully studied by a researchers group coordinated by prof. univ. dr. Buia et al. (1962) and another one coordinated by prof. univ. dr. Popescu Gh. (POPESCU et al., 2001), data regarding the meadows from the south part of the region is sporadic found in papers regarding the flora or vegetation of a specific territory (BUIA & POPESCU-MIHĂILĂ, 1952; BUIA, 1959; 1960; BUIA & PĂUN, 1960; PĂUN, 1969; PĂUN & POPESCU, 1975).

MATERIAL AND METHODS

The present paper refers to the meadows from the south part of Oltenia region namely to those from Oltenia Plain (Fig. 1). The research has been performed both on route and stationary. The route research involved the establishing of some routes which include those areas where the negative influence on these meadows is becoming higher and higher. All the vegetal formations met in field have been noted in the notebook. These itineraries have been few times repeated during one year (from April to October) to observe the dynamics of these meadows flora throughout vegetation. From the collected data over 15 years of studying, it can be observed a multiannual dynamics under the influence of numerous climatic and zoo-anthropogenic factors.

The research in stationary is very important because it completes the study on routes, offering information about the dynamics aspects of vegetation on a longer or shorter time period and how the climatic and zoo-anthropogenic factors have influences on these meadows composition and floristic structure and especially the succession of these vegetal association.

Authors' names were provided by BRUMMITT & POWELL (1992).

Figure 1. The delimitation of the researched area related to the Romania floristic provinces (from Ciocârlan, 2000).

RESULTS AND DISCUSSIONS

The xeric meadows in the south part of Oltenia belong to *Festuco-Brometea* Br.-Bl. et R. Tx. in Br.-Bl. 1949. It is the specific class of this area.

The presence of steppe vegetation in Oltenia has been debated from 1960 when professor Buia was saying that a natural steppe does not exist in this part of the country, but an artificial one, resulting from the anthropogenic activities although on some areas are met some elements characteristic to the steppe vegetation (BUIA, 1960).

The actual vegetation shape from the south part of Oltenia is represented almost entirely by secondary steppe association which have been formed from primary vegetation only as small fragments placed along some valleys or on some steeper slopes.

These primary and secondary meadows represent the only evidences of some extinct vegetation, with a special phytogeographic significance (PUȘCARU-SOROCEANU EVD. et al., 1963).

Following the analysis of these xeric meadows we can say that these are the most affected vegetal association by the zoo-anthropogenic factors: *Medicagini – Festucetum valeasiacae* Wagner 1940 including the surfaces added by Păun et Popescu (1972) to *sternbergietosum colchiciflorae* Păun et Popescu 1972, *Stipetum capillatae* Schneider-Binder 1967, *Haynaldietum villosae* Buia et Păun 1959, *Bothriochloetum ischaemi* (Krist. 1937) Pop 1977.

From the associations mentioned above, the *Medicagini – Festucetum valesiacae* association occupies the largest area in the south part of Oltenia, even if in the specialty literature (PUȘCARU-SOROCEANU EVD. et al., 1963) is mentioned that *Festuca valesiaca* Schleicher in Gaudin 1811 association with different species is rare, occupying small surfaces and measuring few hundreds square meters.

The association is found on dry slopes with south, south-east or south-west exposure and flat lands. These are not present on the north exposure slopes.

Almost all the surfaces covered by these association phytocoenosis are strongly influenced by the zoo-anthropogenic factor. An irrational grazing is practiced during all vegetation period, with higher intensity in spring. The sheepfolds installation determines the extinction of all species from these surfaces.

By comparing the actual data with those in specialty literature about this association floristic composition is found a great reduction of species number. In the past, 92 species have been discovered in the florisitic composition (BUIA et al., 1959) while today the number is reduced to 48.

The presence of some potential invasive species in some areas (e.g. *Ambrosia artemisiifolia* Linnaeus 1753, *Carthamus lanatus* Linnaeus 1753, *Echium italicum* Linnaeus 1753 (Fig. 2) etc.) makes us believe that in the future, if grazing and sheepfolds installation are not going to be stopped, the terms of meadows will be replaced by ruderalised places. If we consider also that the sheepfolds position and irrational grazing are found on recongnized reservations (ex. Valea Rea Radovan) or enlightened by rare species: *Sternbergia colchiciflora* Waldstein et Kitaibel 1805 (*sternbergietosum colchiciflorae* Păun et Popescu 1972) we can measure the gravity of the actual meadows situation.

Figure 2. Xeric meadows with *Echium italicum* (original).

Figure 3. The physiognomy of the meadows enlightened by *Dichanthium ischaemum* (original).

The importance of these meadows is given not only by some species with scientific value but also by their food, honey or medical value (*Hypericum perforatum* Linnaeus 1753, *Cichorium intybus* Linnaeus 1753, *Agrimonia eupatoria* Linnaeus 1753 etc.).

Bothriochloetum ischaemi (Krist. 1937) Pop 1977

The meadows with *Bothriochloetum ischaemi* are usually placed on the fields with moderate inclination, less fertile, which hardly can be used for something else except grazing. These areas phytocoenosis have a characteristic physiognomy. Besides the species characteristic to the alliance, order and class are found others belonging to *Sisymbrietalia* Tuxen in Lohmeyer et. Al. 1962: *Carthamus lanatus*, *Verbena officinalis* Linnaeus 1753, *Lactuca serriola* Torner 1756, *Erigeron annuus* Persoon 1807 subsp. *strigosus* (Mühl. ex Willd.) Wagenitz, *Cephalaria transylvanica* (Linnaeus 1753) Schrader 1814 etc., fact which proves that these meadows are under an intense process of ruderalization.

The surfaces enlightened by *Bothriochloetum ischaemi* are poorly in terms of food, appearing after the association enlightened by *Festuca valesiaca* or *F. rupicola* Heuffel 1858 by their degradation.

The floristic composition of some areas covered by *Bothriochloetum ischaemi* is decreasing although as physiognomy, these meadows are uniform (Fig. 3). This is due to the dominant species called *Dichanthium ischaemum* (Linnaeus 1753) Roberty which has a good coverage. It is a poorly fooder species.

While in the research made by M. Păun (1969) regarding the floristic composition of this association 59 species were present, today the number was reduced to 38. If we consider also that some species belong to *Sisymbrietalia*, we can realize the need for these meadows protection.

Stipetum capillatae Schneider-Binder 1967

The meadows enlightened by *Stipetum capillatae,* characteristic to this area, are found as clusters on small surfaces, on dry and sunny slopes. The area is small in Oltenia (Radovan and Mărăcine localities –Dolj County).

They are affected by irrational grazing, practiced especially during spring. Although they have a low economic importance, these surfaces have a great phytosociological value.

Haynaldietum villosae Buia et Păun 1959

These are meadows characteristic to the south part of Oltenia, being found as isolated surfaces and varying as size. It has been identified in Olt, Dolj and Mehedinți Counties, both on flat lands and sunny slopes.

In the past the surfaces occupied by these association phytocoenosis had a great phytodiversity (around 100 species) (BUIA et. al., 1959). Today, from this meadows floristic composition numerous richly fooder species have disappeared (*Trifolium campestre* Schreber 1804, *T. pallidum* Waldstei et Kitaibel 1802, *T. resupinatum* Linnaeus 1753, *Medicago arabica* (Linnaeus 1753) Alioni 1785, *M. orbicularis* (Linnaeus 1753) Alioni 1785, *M. falcata* Linnaeus 1753, *M. rigidula* (Linnaeus 1753) Desrousseaux in Lamarck 1789 *Hordeum bulbosum* Torner 1756 etc.). The number of species from the surfaces enlightened by *Haynaldia villosa* (Linnaeus 1753) Schur 1866 has been halved.

The main cause of these meadows degradation is grazing with horses and cattle until the extinction of all species from some areas. These animals are eating inclusive the dominant species during its first stages of vegetation.

The need of these meadows protection is sustained by the limited area in this side of the country, by the rare species from some areas dominated by *Haynaldia villosa* (*Hordeum bulbosum*, *Medicago arabica*, *M. polymorpha* Linnaeus 1753) and by numerous southern elements from their floristic composition (ex. *Chrysopogon gryllus* (Linnaeus 1753) Trinius 1820).

CONCLUSIONS

The influence of the zoo-anthropogenic factor on these areas is very high, this contributing to the extinction or reducing of some rare species (*Medicago arabica*, *M. polymorpha*, *Ziziphora capitata* Linnaeus 1753, *Sternbergia colchiciflora*) or to the replacement of some good fooder species with the ruderal, adventive or invasive ones.

The actual stage of the xeric meadows in Oltenia, highlighting the necesity of their protection and conservation

Urgent measures like a rational grazing, prohibiting the disposal of garbage at these meadows edges, wool abandoning and soil collection from the places where we still can find important species from a scientific point of view, are recommended to be taken.

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VARIABILITY OF CONTENT AND CHEMICAL COMPOSITION OF THE ESSENTIAL OILS WITH HETEROSIS EFFECT IN HYBRIDS OF *Lavandula angustifolia* MILL.

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Abstract. We have developed and assessed intraspecific *Lavandula angustifolia* Mill hybrids. The indices of the quantitative characters have been shown to vary between the hybrids and maternal forms. The content of essential oil quantified via hydrodistillation in the Ginsberg apparatus is much higher (3.939 – 5.480%, dry matter) in the hybrids produced than in the maternal forms from which they originated (2.722 – 3.413%). The effect of heterosis for the essential oil content varies considerably in different hybrids derived from different maternal parents and constitutes +37.8 – +110.5%. The quantitative and qualitative analyses of the essential oil assessed with the aid of GC-SM techniques have demonstrated considerable differences of the oil in different hybrids depending on the maternal form. The number of the components identified in the essential oil ranges between 18 and 38. The major components in the essential oil are as follows: linalool (24.15 – 50.84%); linalyl acetate (27.29 – 44.40%); α – terpineol (3.82 – 4.84%); terpinen-4-ol (1.11 – 9.21%); lavandulol acetate (0 – 2.22%). The hybrids with a very high content (4.939-6.164 %, dry matter) of essential oil, different vegetation period from early- to late-ripening and resistant to drought have been selected. Their cloning has resulted in new varieties named Fr.5S8-24, VM-18V and Fr.8-5-15V.

Keywords: *Lavandula angustifolia*, hybrid, heterosis, essential oil, chemical composition.

Rezumat. Variabilitatea conţinutului şi componenţei chimice a uleiului esenţial la hibrizi cu efect al heterozisului de *Lavandula angustifolia* Mill. Au fost creaţi şi evaluaţi hibrizi intraspecifice de *Lavandula angustifolia* Mill. S-a demonstrat că indicii caracterelor cantitative variază între hibrizi şi formele materne. Conţinutul în ulei esenţial, determinat prin hidrodistilare în aparate Ginsberg, este mult mai ridicat (3,939 – 5.480% s.u.) la hibrizii creaţi decât la formele materne de la care au provenit (2.722 – 3.413). Efectul heterosis la conţinutul de ulei variază considerabil la diferiţi hibrizi, derivaţi de la diferite forme parentale şi constituie +37.8 – +110.5%. Analiza cantitativă şi calitativă a uleiului esenţial, evaluat prin tehnici GC-SM a stabilit diferenţe considerabile ale uleiului la diferiţi hibrizi în funcţie de forma maternă. Numărul componenţilor identificaţi în uleiului esenţial variază de la 18 pînă la 38. Componenţii majori în uleiul esenţial sunt următorii: linalool, 24,15 – 50,84%; linalyl acetate, 27.29 – 44,40%; α – terpineol, 3.82 – 4.84%; terpinen-4-ol, 1.11 – 9.21%; acetat de lavandulol, 0 – 2.22%. Au fost selectaţi hibrizi cu conţinut foarte ridicat (4.939-6.164 % s.u.) de ulei esenţial, cu perioada de vegetaţie diferită de la timpurie până la tardivă, rezistenţi la secetă. Clonarea acestora a rezultat elaborarea soiurilor noi Fr.5S8-24, VM-18V, Fr.8-5-15V,

Cuvinte cheie: *Lavandula angustifolia*, hibrid, heterosis, ulei esenţial, componenţa chimică.

INTRODUCTION

Lavandula angustifolia Mill., lavender is a perennial semi-shrub from the Lamiaceae family, a medicinal, aromatic, as well as melliferous and decorative species of Mediterranean origin. Lavender and the products derived from this species have been used for ages as a therapeutic agent (CAVANAGH & WILKINSON, 2005; GONCEARIUC, 2008) in traditional medication in Asia, Europe, antique Greece and Rome. The utilization of lavender for medicinal, phytotherapeutic and pharmacologic reasons is due to the essential oil and its components separated from inflorescences (GONCEARIUC, 2008). The essential oil is appreciated as a disinfectant, analgesic and scar-healer; it is also known for its choleretic, diuretic, carminative and sudorific actions (PĂUN, 1995). Lavender and lavender oil are well-known for tonic, antifebrile and antiseptic properties (STANOJEVIĆ et al., 2011). Like other essential oils, lavender oil is an excellent anti-inflammatory (HANCIANU et al., 2013), antimicrobial (CESUR TURGUT et al., 2017) and antifungal (antimycotic) agent (STANOJEVIĆ et al., 2011; BEHMANESH et al., 2015). The pronounced antiseptic action and beneficial capacity of the essential oil in wound healing have been known since World War I (VOITKEVICI, 1999). Some researchers believe that lavender oil is the strongest antibacterial and the best inhibitor of bacterial growth (CZERWIŃSKA & SZPARAGA, 2015; VARBAN et al., 2017). Studies have demonstrated a sedative action of the essential oil on the central nervous system (LOPEZ, 2017), efficiency in treating depression, stress and anxiety (AKHONDZADEH et al., 2003; KHITAN et al., 2006; SETZER, 2009; KASPER, 2010, 2013; HANCIANU et al., 2013; ANDRYS & KULPA, 2016), including postnatal depression; other disorders of the central nervous system (WHEATLEY, 2005; LOPEZ et al., 2017; RAHMATI et al., 2017) and improvement of spirit and general health condition (CONRAD & ADAMS, 2012; UEHLEKE et al., 2012). Preclinical studies have found anxiolytic effects of lavender essential oil (CHIOCA et al., 2013; RAHMATI et al., 2017).

The employment of lavender to treat neurological disorders such as migraine, stress, anxiety, including depression, have been traditional (AKHONDZADEH et al., 2003; KASPER et al., 2010; KASPER, 2013; ANDRYS & KULPA, 2016; RAHMATI et al., 2017). The findings of a thorough study have proved that lavender oil is a viable option for dealing with such neurological dysfunctions as stroke due to its antioxidant properties (WANG et al., 2012). Both essential oil and inflorescences are used in treating migraines, headaches, heart disorders with a nervous substrate through regulation of anxiety conditions of some internal receptors; in neuro-vegetative dystopias, digestive

disturbances, abdominal bloating, insomnias, kidney diseases, rheumatic diseases, biliary dyskinesia, influenza, cold, coughing, bronchial asthma and stomatitis (BOJOR & ALEXAN, 1994; PĂUN, 1995; GRIGORESCU & SILVA, 1997; STEVENSON & WAITE, 2011). Externally, lavender essential oil is used to treat burns, frost-bite and allergic rash. The researches show that it serves as a natural treatment for the Alzheimer disease, as well. The studies carried out on rats demonstrate that inhalation of lavender essential oil vapours may help prevent stress and improve cognitive disorders (HANCIANU et al., 2013; KASPER, 2013; PAN XU et al., 2017). In aromatherapy and massage, this oil is also frequently used, due to the major benefits, in treating central nervous system disorders as a sedative, antioxylitic and modulator of mood condition.

Lavender is a valuable melliferous species since the flower nectar is rich in carbohydrates, while the blossoming period is quite long making 35-40 days. Lavender is also known and employed as a decorative plant (CUCU et al., 1982; GONCEARIUC, 2004, 2008; GONCEARIUC et al., 2011). The excellent aspect of evergreen plants, inflorescences with flowers of different hues of blue, quite long blossoming period, delicate smell of the flowers are exploited with a particular success in southern France and in whole Europe, as well.

The above mentioned influences constantly the studies on the chemical composition, qualities, benefits of the utilization of flowers, essential oil and other derivatives of lavender, as well as the diversity of essential oil employment depending on its qualitative and quantitative composition.

A particular area includes the studies carried out to develop new hybrids and cultivars that are resistant to abiotic factors that would ensure an enhanced production of inflorescences with a higher content of essential oil and a quality that corresponds to the purpose proposed for utilization. Such studies have evidently intensified during the last decade as a consequence of the climatic changes, slow but steady processes of global warming, transformation of some zones into a desert including in south-eastern Europe where farm crops are increasingly impaired by drought and scorching heat while *L. angustifolia, Salvia sclarea* and *S. officinalis* cultivars have ensured more enhanced production of high quality essential oil during the dry years than in the years with normal atmospheric precipitations. This work also belongs to this area of research.

MATERIAL AND METHODS

The biologic material is represented by polycross hybrids of the first generation of *Lavandula angustifolia* derived from six maternal forms of different genetic and geographic origin. The evaluation of the biomorphological characters (quantitative) have been accomplished in integral experiments according to applicable requirements. Moldovan cultivars named Moldoveanca 4, Vis Magic 10 and Alba 7 (GONCEARIUC, 2014) served as witnesses. The content of essential oil was quantified in fresh inflorescences at the technical maturation stage through hydrodistillation in Ginsberg apparatus for 45 min. The findings were recalculated for dry matter. The qualitative and quantitative composition of essential oil was determined by GC GC-MS. The analysis equipment included gas-chromatograph Technologies Agilent 7890 equipped with Selective Mass Detector with Quadruple MSD Agilent Technologies 5975C, capillary column (30 м/0.25 мм/0.25 μм) with non-polar stationary phase HP-5ms. The analysis was performed at a temperature of 250 °C; the injector and detector temperature was 280 °C, temperature gradient from T1 = 70 ° C (2 min), T2 = 200 °C (5 °C/min), T3 = 300 °C (20 °C/min, 5 min) was used. Mobile phase: Helium 1 ml/min, injected volume was 0.03 ml of essential oil, split rate - 1:100. Identification of chromatographic peaks was performed using the software package AMDIS ™, coupled with the NIST database.

RESULTS AND DISCUSSION

The earlier studies have demonstrated that intraspecific hybridization is an efficient technique to develop valuable genotypes due to pronounced variability of the indices of biomorphological character values including those of the content, qualitative and quantitative composition of essential oil. This technique is quite difficult to perform for *L. angustifolia* subspecies *angustifolia*. Lavender flowers are small in size; therefore emasculation works on them are meticulous. Mostly, this operation, as well as further manual pollination damages a floral organ, which leads to very low setting of hybrid seeds. For these reasons, and because of the lack of the staff trained to carry out this kind of activity, it has been decided to develop more hybrids through free pollination, this being a new stage of inducing genetic variability in lavender and in the development of promising genotypes. The difference between the conventional free pollination and the method of producing polycross hybrids we have used consists in the fact that in the hybridization nursery, the parental forms assessed earlier were involved and selected for particular biomorphological characters to be inherited by the hybrids resulted from the hybridizations, including a large number of floral stems per plant, enhanced content of essential oil, enhanced content of linalyl in the oil, resistance to frost, wintering, drought, diseases etc. Ten parental forms selected are of different genetic and geographic origin and are distinguished not only by the high values of the indices of the above biomorphological characters but by the vegetation period, the colour of flower corolla, the colour and density of leaf pubescence etc.

L. angustifolia is an allogamous species, thus, each parental form might have been, in the case of some hybrids, a maternal form and a paternal form for other hybrids. While collecting hybrid seeds from a particular genitor, it was known that it was a maternal form. Hybrids of the first generation (F1) were produced and assessed from six maternal forms in

further studies. Each form was attributed a cipher Fr.1, Fr.5, Fr.8, Cr.13, Cr.26 and VM. The maternal forms Fr.1, Fr.5 and Fr.8 are of French origin. The maternal forms Cr.13 and Cr.26 are generative offsprings of the Ukrainian cultivar Crîmcheanca. The cipher VM identifies the Moldovan cultivar Vis Magic 10 used as a maternal form.

The newly developed and assessed hybrids differ from the maternal forms by vegetation duration (Table 1) and a number of biomorphological characters including essential oil content (Table 1; Fig. 1).

The same late-ripening maternal forms (Fr.1 and Fr.2) have been found to produce hybrids with different vegetation duration, both late- and early ripening ones, while the technical maturity period being average. The difference between the vegetation duration calculated from the beginning of vegetation and up to technical maturity makes from 2 to 19-20 days (Table 1, Fig. 1) (BUTNARAŞ, 2016). Such early-, mid- or late-ripening lavender hybrids propagated vegetative may become the cultivars that would produce a conveyer during harvesting. Each cultivar might be harvested in optimal dates, which allows elimination of raw material and essential oil losses. Simultaneously, the cultivated-processed areas under lavender might be extended without increasing the number of agricultural machinery and the capacity of processing equipment.

Table 1. Essential oil content in the lavender hybrids derived from the maternal forms (♀) Fr.1, Fr.8.

Vegetation period	Hybrid, maternal form	Essential oil content, % (dry matter*)			
		2011	2012, dry year	2013	X
early	Fr.1-3-2V	4,141	5,386	5,290	**4,939**
	Fr.1-3-23V	5,165	5,613	5,436	**5,405**
	Fr.8-5-15V	4,214	5,080	4,965	4,753
	Fr.8-5-23V	4,492	**5,682**	4,682	**4,952**
middle	Fr.1-3-9V	4,648	5,568	5,425	**5,214**
	Fr.1-3-20V	3,939	4,403	4,497	4,279
	Fr.8-5-21V	4,158	4,337	5,444	4,646
	Fr.8-5-26V	3,950	4,645	4,560	4,385
	Fr.8-5-40V	4,172	4,765	4,965	4,634
late	Fr.1-3-5V	4,274	5,382	4,324	4,659
	Fr.1-3-13V	4,125	4,250	5,269	4,543
	Fr.8-5-34V	5,096	5,157	5,287	**5,181**
	Fr.1.♀	**3,353**	**3,379**	**3,012**	**3,248**
	Fr.8.♀	**2,555**	**3,123**	**3,833**	**3,168**

Legend: * Essential oil content, recalculated to dry matter.

All the first generation hybrids selected and presented in Table 1, 2 and Figure 1 have recorded a much more enhanced content (3.621– 5.682%, dry matter) of essential oil than the maternal forms Fr.1, Fr.8, Fr.5, Cr.26 and Cr.13 from which they originate.

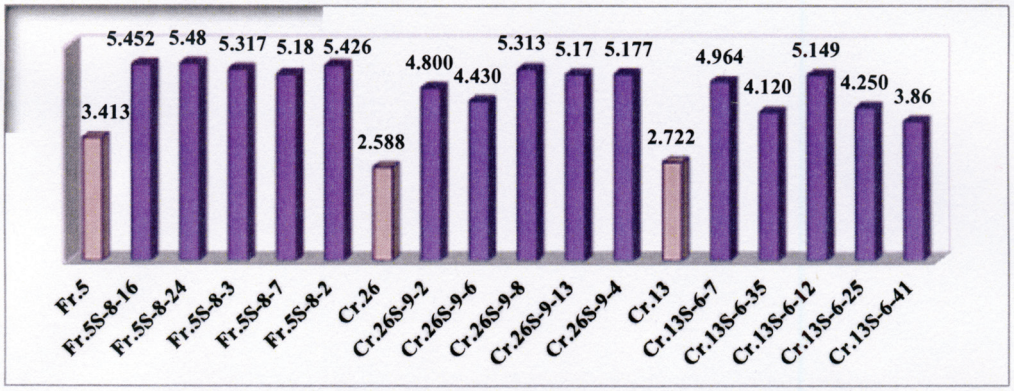

Figure 1. Essential oil content (%, dry matter) in *L. angustifolia* F1 hybrids in relation to the *L. angustifolia* maternal forms Fr.5, Cr.26 and Cr.13.

Importantly, the hybrids developed are greatly resistant to drought. Thus, in the dry years, the content of essential oil is higher in all the hybrids than in the previous year (in this case, 2011, Table 1). Acute drought is known to have a negative impact on species and perennial farm crops in both the year of major deficit of atmospheric precipitation and in the subsequent year (years). In the case of the lavender hybrids, we have developed and selected, the consequences of the 2012 year drought were different. In 2013, all the F1 hybrids recorded a higher content of essential oil in comparison with the maternal forms from which they originate (as in the years 2011 and 2012), while five of these hybrids synthesized and accumulated even higher content of essential oil in the year 2013 than in 2011 and 2012.

The similar results (Table 2) were recorded in the years 2015-2017 while testing the promising hybrids Fr.5S8-24, VM-18V and Fr.8-5-15V in comparison with the patented cultivars.

Table 2. Essential oil content in the *Lavandula angustifolia* varieties, comparative competitive crops.

Hybrid F_1, variety	Essential oil content, % (dry matter)			
	2015, dry year	2016	2017	
Fr.5S8-24	6.164	5.786	5.915	5.955
VM-18V	5.103	4.924	4.829	4.952
Fr.8-5-15V	5.803	4.691	5.454	5.316
Vis Magic 10, witness	4.575	4.597	4.518	4.563
Alba 7, witness	5.762	5.915	5.256	5.644
Moldoveanca 4, witness	5.404	4.318	4.981	4.901

Considerable variability of the F_1 hybrids is attested for the character vegetation period. For example, the hybrids derived from the late-ripening maternal forms Fr.1 and Fr.8 have an average vegetation period ranging between 54.6 days and 70 days (Fig. 2). The high content of essential oil is due to the heterotic effect exhibited in the lavender hybrids from the first generation F_1. The long-term studies have demonstrated that the F1 hybrids produced from polycross hybridization manifest heterosis in a number of quantitative characters that have a direct impact on the productivity. All the hybrids derived from all the maternal forms exhibit heterosis for essential oil content (Figs. 3 and 4), it being supported by the biomorphological quantitative characters.

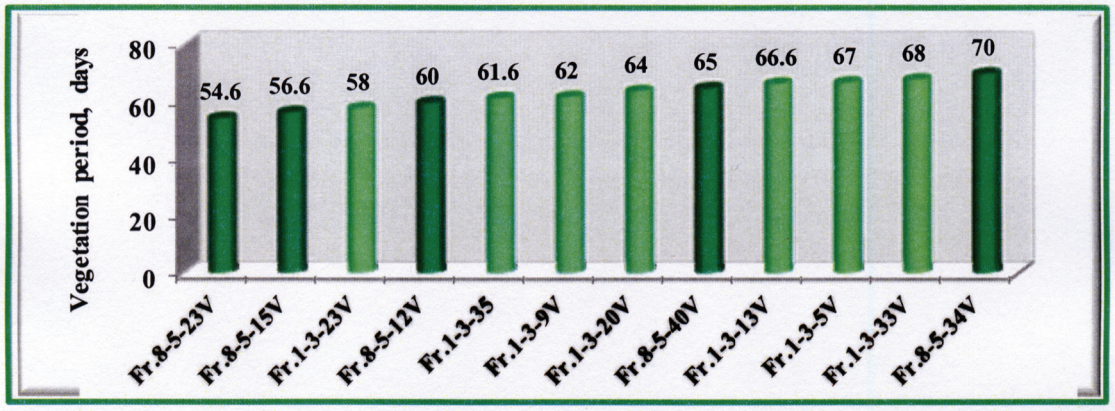

Figure 2. Vegetation period (days) of the hybrids derived from the late-ripening maternal forms Fr.1 and Fr.8.

The amplitude of the heterosis recorded in each first generation hybrid (F_1) for the character essential oil content is influenced by the maternal form. This statement is confirmed by the fact that the hybrids that originate from the maternal form Cr 26 exhibit a heterotic effect for this character within +55.3% and +103.3% (Fig. 3).

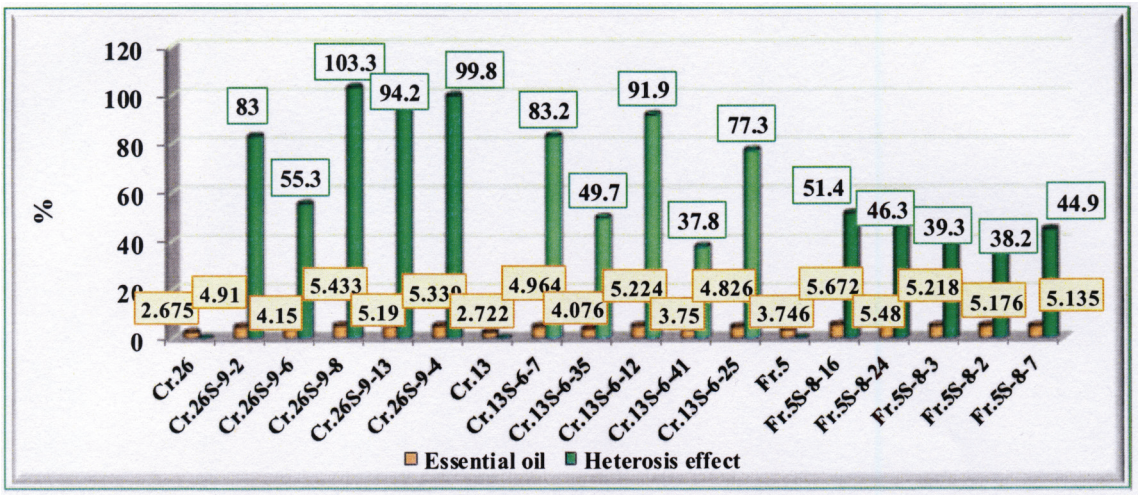

Figure 3. Heterosis effect (%) for essential oil content (%, dry matter) exhibited by the *L. angustifolia* F1 hybrids derived from the maternal forms Cr. 26, Cr. 13 and Fr. 5.

In the hybrids derived from the maternal form Cr.13, the heterotic effect for the essential oil content varies between +37.8 and 91.9% depending on the hybrid. The hybrids with a higher heterotic effect for this character belong to the form Fr.5, the heterotic effect varying in different hybrids between +38.2% and +51.4%. These results can be explained by the fact that Fr.5 is a maternal form with the highest content of essential oil (3.746%, dry matter).

Importantly, some hybrids derived from this form, such as Fr.5S-8-16 are distinguished by a very high content of essential oil (5.672%, dry matter) (Fig. 3).

The expression of the heterosis recorded in the hybrids derived from the maternal form Fr.8 is more significant, the variation being less spectacular than in the hybrids originated from the maternal forms Cr.26, Cr.13 and Fr.5. Thus, the heterotic effect attested in the hybrid Fr.8-5-5V is very high making +65.3%, so this value is the lowest vs. other hybrids of this maternal form in which this important index makes +70.1 – +110.5% (Fig. 4).

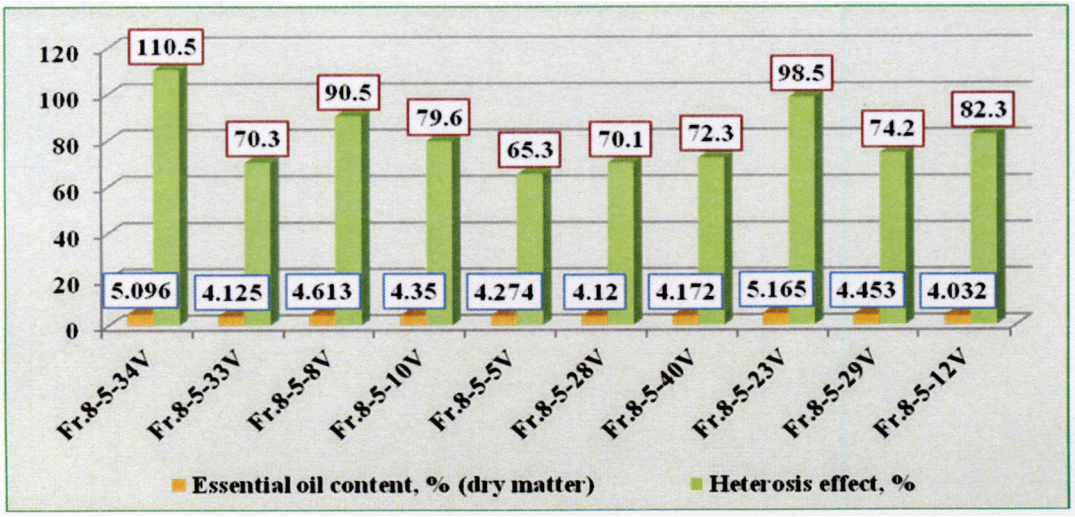

Figure 4. The heterosis effect to the essential oil content by *L. angustifolia* F_1 hybrids originated from the maternal form Fr.8.

We can state that a new generation of hybrids has been developed, some of them recording a high heterotic effect for essential oil content from 37.8% up to 110.5%. The same hybrids exhibit positive heterotic effects for both the character length of floral spike (+13.3 – +23.0%) and the number of verticiles per floral spike (+5.4 – +18.1%), including other biomorphological characters (MASHCOVTZEVA & GONCEARIUC, 2012, 2013; BUTNARAŞ, 2012, 2016; BUTNARAŞ et al., 2013; MAŞCOVŢEVA, 2018).

Taking into consideration the fact that valuable hybrids can be reproduced vegetatively through cloning and may serve a basis for the development of new varieties that inherit all the biomorphological and biochemical characters of the initial hybrid genotypes, this genetic material is invaluable. For example, the hybrids Fr.5S-8-24, Fr.8-5-15V andVM-18V which were further propagated vegetatively and, thus, became cultivars (clone cultivars) are distinguished by accumulation of considerable content of essential oil from 4.691 up to 6.164% (dry matter) (Table 2) including in the dry years.

Evaluation of the content of essential oil in these cultivars (F1 hybrids) vs. the certified and patented cultivars has confirmed the results obtained earlier (Table 2). (It should be mentioned that our certified and patented cultivars are also F1 hybrids). The findings confirm the fact that the hybrids and cultivars developed are characterized by a very high content of essential oil with values ranging between 4.691 and 6.164% (dry matter) in both the dry year 2015 and the following years 2016 and 2017.

The qualitative and quantitative analyses of the essential oil separated through hydrodistillation in laboratory conditions performed using gas chromatography coupled with mass-spectrometry (GC-MS) have demonstrated that the number of the components identified in the essential oil varies from 21 up to 38 (Tables 3 and 4). The concentration of each component varies with the hybrid, distinctness being attested between both hybrids and maternal forms from which they have derived and between the maternal forms of the hybrids (GONCEARIUC et al., 2011; BUTNARAŞ et al., 2013; BUTNARAŞ, 2016; MAŞCOVŢEVA, 2018). A pronounced variation of the concentration of some components such as linalyl acetate depending on the year of evaluation has been found. For example, the findings published earlier (BUTNARAŞ et al., 2013) show that the content of linalyl acetate in the essential oil isolated from the F1 hybrid Fr. 1-3-23V makes 25.44% while the further studies (BUTNARAŞ, 2016) demonstrate that its concentration constitutes 37.27%. The GC-MS analyses have recorded a content of camphor making within 0.25 and 0.75%.

The European Pharmacopoeia, 6th edition envisages the following content of the constituents in the essential oil of *L. angustifolia*: linalool (20.0-45%); linalyl acetate (25.0-46%); α- terpineol below 2.0 %; lavandulol acetate above 0.1 %; camphor below 1.2 % (ROBU, 2012). Thus, the major components in the essential oil isolated from the F1 hybrids we have developed meet the pharmacological requirements with the exception of the α- terpineol content. This compound has a pronounced smell of lilac. Terpineols are generally intermediate compounds of flavour enhancer synthesis; they are also components of food essences. These compounds are used as solvents and floating agents. Terpineols have antimicrobial properties. Terpineol esters and acetic acid (terpinyl acetate) as a mixture of isomers are used to produce perfume compositions and perfumes.

Summing up the results obtained in assessing the most advanced F_1 hybrids we can conclude that the qualitative and quantitative composition of the major constituents in the essential oil varies within the following limits: linalool: 24,15 – 50,84%; acetat de linalyl acetate: 27.29 – 44,40%; α - terpineol: 3.82 – 4.84%;

Summarizing the results of the evaluation of the most promising F1 hybrids developed we can conclude that the qualitative and quantitative composition of the major constituents in the essential oil varies within the following range. Terpinen-4-ol at high concentrations (above 2%) is considered to diminish the perfumery value of essential oil. rendering it an herbal flavour and scent. In our view, herbs have a smell of freshness and lavender oil is particularly appreciated due to the freshness and delicacy of the aroma. On the other side, this oil is used not only in perfumery.

Table 3. Variation of the qualitative and quantitative components of the essential oil in the *Lavandula angustifolia first generation* hybrids vs. maternal forms VM.

No.	Components	Aria, (%)									
		Fr.8*♀	Fr.8-5-21V	Fr.8-5-34V	**Fr.1*♀**	Fr.1-3-23V	Fr.1-3-9V	**VM*♀**	VM-9V	VM-32V	VM-56V
1	o-xylene	0,16	-	0,28	-	0,17	0,13	0,14	-	-	-
2	α –Pinene	-	-	-	-	0,05	-	-	-	0,02	-
3	Camphene	-	-	-	-	-	-	-	0,03	0,04	0,04
4	1-Octen-3-ol	-	-	-	-	0,04	0,51	0,12	-	0,11	0,08
5	**α –** Phellandrene	-	-	-	-	-	-	0,46	-	0,02	-
6	β – Pinene	-	-	-	-	-	0,09	-	-	-	-
7	3- Octanone	0,31	0,34	0,47	1,11	0,08	-	0,09	-	-	0,02
8	β-Myrcene	0,28	0,21	0,40	-	0,28	0,41	0,19	0,33	0,25	0,34
9	4-Methyl-3-octanol	0,13	0,14	0,11	-	0,26	0,09	0,07	-	-	0,08
10	Hexyl acetate	0,41	0,18	0,36	-	0,36	0,42	0,15	0,14	0,08	0,20
11	ρ – Cymene	-	-	-	-	-	0,11	0,08	-	-	-
12	Limonene	0,16	0,13	0,20	0,92	2,84	0,57	-	0,31	0,65	0,65
13	β-Cadinene	-	-	-	0,51	0,50	-	-	-	-	-
14	1.8-Cineole	0,87	0,34	0,31	-	-	1,56	1,61	0,51	1,23	0,61
15	*trans*- β-Ocimene	1,16	0,15	4,68	1,83	3,12	2,2	0,66	1,71	0,34	0,63
16	*cis*- β –Ocimene	0,41	0,21	1,24	1,18	0,52	1,58	0,35	1,17	0,16	0,30
17	γ-Terpinene	-	-	-	-	0,27	0,11	0,10	-	-	-
18	α-terpinen terpinolen	-	-	-	-	0,16	0,10	0,12	-	-	-
19	(+) Linalool oxide	0,15	-	-	-	-	0,30	-	-	-	-
20	**Δ^3**-Carene	0,25	0,12	0,15	-	0,11	0,38	0,27	-	0,12	0,23
21	**(-)-Linalool**	**39,95**	**50,84**	**36,66**	**42,96**	**27,44**	**28,63**	**40,98**	**32,30**	**38,83**	**35,83**
22	l-Octen-3-yl acetate	0,23	0,72	0,19	1,31	1,24	1,85	-	0,10	0,11	0,11
23	(+) Camphor	0,35	0,25	0,20	-	0,28	0,20	0,54	0,34	0,23	0,29
24	Lavandulol	-	0,95	-	-	0,98	0,37	-	-	0,91	-
25	Borneol	1,16	0,47	0,75	0,84	0,75	1,04	2,22	1,22	1,21	1,58
26	**Terpinen-4-ol**	**0,72**	**6,08**	**5,55**	**6,54**	**6,97**	**5,76**	**6,40**	**9,21**	**7,39**	**9,59**
27	Krypton	0,15	0,31	0,13	-	0,09	0,39	0,49	-	-	-
28	α –terpineol	4,71	4.77	3,82	4,74	4,84	4,22	3,45	4,02	2,77	3,96
29	Nerol	0,49	0,27	0,30	0,68	0,38	0.54	0,34	0,27	0,20	0,39
30	Iso-borneol	0,09	-	-	-	-	-	0,14	0,02	0,02	0,02
31	Geraniol	0,09	-	-	-	-	0,22	0,19	0,14	-	-
32	**Linalyl acetate**	**39,98**	**38,47**	**37,00**	**29,28**	**37,27**	**40,62**	**33,92**	**43,42**	**41,05**	**37,40**
33	Borneol acetate	0,27	-	0,32	0,05	0,18	-	0,12	0,22	-	-
34	Lavandulyl acetate	0,42	-	1,95	3,25	0,26	1,57	0,77	1,56	0,91	0,90
35	Nerol acetate	0,82	0,30	0,64	0,96	0,48	0,83	0,50	0,62	0,37	0,65
36	Geranil acetate	1,58	0,64	1,22	1,77	0,88	1,64	0,95	1,22	0,76	1,32
37	β- Caryophyllene	2,00	2,49	1,44	1,61	2,45	1.86	1,66	1,41	1,59	1,59
38	(E)-β-Farnesene	0,60	0,76	0,81	-	-	-	0,88	0,75	0,57	1,77
39	Germacrene D	-	-	0,20	-	0,12	-	0,20	-	0,15	0,27
40	Caryophyllene oxide	0,16	-	-	0,52	0,55	0,14	0,74	-	0,39	0,47
Nr. components		**29**	**22**	**26**	**18**	**31**	**31**	**33**	**23**	**28**	**29**
Identification, %		**99,41**	**99,99**	**99,96**	**99,99**	**99,36**	**99,66**	**99,90**	**99,96**	**99,70**	**98,53**

Legend: *maternal forms♀: Fr.8, Fr.1, VM.

Table 4. Qualitative and quantitative composition of essential oil in the *L. angustifolia* F_1 hybrids vs. maternal forms.

Compound	Aria (%)						
	Cr.26*♀	Cr.26 S-9-8	**Cr.13*♀**	**Cr.13**S-6-12	**Fr.5*♀**	**Fr.5**S-8-16	**Fr.5**S-8-24
o-xylene	0,014	0,018	0,100	0,020	–	0,125	0,120
α –Pinene	–	–	–	–	–	0,050	–
Camphene	0,060	–	–	–	–	–	–
1-Octen-3-ol	–	0,210	–	–	–	0,230	0,050
β-Myrcene	0,265	0,220	0,270	0,120	0,365	0,350	0,360
4-Methyl-3-octanol	–	0,120	–	–	–	0,090	–
Hexyl acetate	0,145	–	–	–	–	–	–
ρ – Cymene	0,090	–	–	–	–	0,090	–

Limonene	0,197	0,080	–	0,100	–	0,290	0,270
β- Phellandrene	0,960	–	–	–	–	–	–
8-Cineole	1,550	0,210	–	–	–	1,900	0,390
trans- β-Ocimene	1,599	1,020	1,630	2,250	1,501	0,310	0,417
α - terpinen	0,128	–	–	–	0,310	0,430	0,170
cis- β –ocimen	0,918	0,610	1,630	0,250	0,535	0,330	0,354
γ- Terpinene	0,128	0,080	0,140	0,140	–	1,370	1,120
δ- Terpinene	0,070	0,080	–	–	–	0,430	–
Linalool oxide	–	0,270	–	–	0,227	0,070	0,090
(-)-Linalool	**39,554**	**42,570**	**45,500**	**43,560**	**34,196**	**24,150**	**37,250**
1-Octen-3-yl acetate	–	0,210	–	–	–	0,230	0,050
(+) Camphor	**0,248**	**0,210**	–	–	**0,753**	**0,390**	**0,186**
Borneol	0,596	0,570	0,420	0,510	2,491	5,040	0,374
Terpinen-4-ol	**9,721**	**4,490**	**12,580**	**10,500**	**8,449**	**3,830**	**1,118**
α-Terpineol	3,551	3,340	2,720	2,790	4,110	3,740	3,420
Nerol	0,132	0,390	0,300	0,290	0,470	0,620	0,410
iso – borneol	–	–	–	–	–	0,070	–
Linalyl acetate	**33,533**	**38,800**	**27,290**	**32,930**	**31,497**	**33,730**	**44,403**
Borneol acetate	0,135	–	–	–	0,918	1,960	1,380
Lavandulol	–	0,210	–	–	–	0,330	0,410
Neryl acetate	0,555	–	–	0,350	0,740	0,720	0,599
Geraniol acetate	–	1,100	–	–	–	1,910	1,460
Nerol acetate	–	0,530	0,420	–	–	0,360	0,220
β- Caryophyllene	**1,265**	**1,280**	**1,060**	**1,430**	**2,609**	**3,720**	**1,598**
Caryophyllene oxid	0,201	0,520	–	–	0,890	0,710	0,455
(E)-β-Farnesene	–	0,610	0,590	0,400	–	0,480	0,290
Germacrene D	0,527	–	0,190	–	0,255	0,640	0,133
3-Octanol	–	–	–	–	0,194	–	–
Δ^3-Carene	–	0,310	–	0,140	0,350	0,380	0,130
Eucalyptol	0,437	–	–	–	0,229	–	–
Hexyl acetate	0,145	–	–	–	–	–	–
n-Octen-acetate	0,605	–	0,750	0,400	1,230	0,805	0,365
Carvacrol	–	–	–	–	–	–	–
Lavandulol acetate	0,981	–	0,980	**1,080**	**4,511**	**2,220**	0,707
Timol	–	–	–	–	–	–	–
Geranyl acetate	**0,976**	–	**0,830**	**0,670**	**1,417**	**1,310**	**1,203**
p-xylene	–	–	0,100	–	–	0,100	0,100
n-Octen-1-ol	–	–	0,180	0,140	0,186	0,200	0,148
Krypton	–	–	–	–	–	**1,970**	0,250
Nr. components	**29**	**27**	**20**	**21**	**26**	**38**	**34**
Identification, %	**99,495**	**97,628**	**97,900**	**97,890**	**98,441**	**97,050**	**100.0**

Legend: * maternal form Cr.26, Cr.13, Fr.5

Terpinen-4-ol is known to have pronounced antimicrobial (HAMMER et al., 2012) and antifungal (MONDELLO et al. 2006), properties, these qualities being successfully exploited. Importantly, the content of camphor in the essential oil of all the hybrids developed and assessed meet the ISO standards and the requirements of the European Pharmacopoeia varying within the limits of 0-0.753%. Camphor at concentrations of more than 2% is known to certainly diminish the quality and aroma of essential oil.

CONCLUSIONS

F_1 hybrids of *Lavandula angustifolia* were created with high (3.939 - 5.480%) content of essential oil. The indices of the quantitative characters have been shown to vary between the hybrids and maternal forms. The effect of heterosis for the essential oil content varies considerably in different hybrids derived from different maternal parents and constitutes from +37.8 up to +110.5%. The quantitative and qualitative analyses of the essential oil assessed with the aid of GC-SM techniques have demonstrated considerable differences of the oil in different hybrids depending on the maternal form. The number of the components identified in the essential oil ranges between 18 and 38. The major components in the essential oil are as follows: linalool (24.15 – 50.84%); linalyl acetate (27.29 – 44.40%); α – terpineol (3.82 – 4.84%); terpinen-4-ol (1.11 – 9.21%); lavandulol acetate (0 – 2.22%). The hybrids with a very high content (4.939-6.164 %, dry matter) of essential oil, different vegetation period from early- to late-ripening and resistant to drought have been selected. Their cloning has resulted in new varieties named Fr.5S8-24, VM-18V and Fr.8-5-15V2.

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CHOROLOGY OF *Sedum urvillei* (CRASSULACEAE) IN ROMANIAN DOBROGEA, IMPLICATIONS FOR CONSERVATION

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Abstract. *Sedum urvillei* DC. is a xerothermic yellow-flowered perennial species of Crassulaceae with Balkano-Pontic and East-European sub-mediterranean distribution. Its Romanian range includes several disputable populations North of Danube and certainly Dobrogea, where *S. urvillei* is widespread, despite lack of precise data about its actual occurrence in this region. The typical *S. urvillei* has a pronounced xero-thermophylic preference for rocky habitats with shallow topsoil where it escapes competition, being most often but not exclusively found on rocky calcareous outcrops. The lack of a botanical work describing the complete distribution range of *S.urvillei* in Romanian Dobrogea, since more than half a century ago when the only monographic treatment of Crassulaceae family in Romanian flora was published, prompted me to present herein comprehensive (albeit not exhaustive) precise data about the actual occurrence sites of *S.urvillei* in Romanian Dobrogea resulted from personal fieldwork surveys during over 30 years, results comprising over 150 occurrence sites for *Sedum urvillei* was seen, around >30 human settlements, spanning the whole province, from practically sea level up to about 400m elevation a.s.l. The data presented herein document for S. *urvillei* a much larger distribution in Dobrogea than previously precisely documented but co-occurence of *S. urvillei* with the very similar but more common species *S. acre* and S. annuum and/or *S. sexangulare*, predisposes it to confusions with these two species and leads to underreporting. It also is quite important for biodiversity conservation as it participates in several associations harbouring the much rarer congeneric *Sedum caespitosum* and builds the Assoc. *Sedo hillebrandtii-Polytrichetum-piliferi* Horeanu et Mihai 1974 in which it is the main species. Understanding the environmental and phytocoenotic characteristics fostering *S.caespitosum* occurrence in this association would certainly benefit its conservation, together with other rare and locally threatened species like *Festuca callieri*, *Gagea szovitzii*, *Campanula romanica*, *Dianthus nardiformis*, and *Moehringia grisebachii.*

Keywords: *Sedum urvillei* DC, Chorology, Dobrogea, biodiversity conservation, Crassulaceae.

Rezumat. Corologia *Sedum urvillei* (Crassulaceae) în Dobrogea Română, implicaţii pentru conservare. *Sedum urvillei* DC. este o specie perenă, xerothermofilă de Crassulaceae cu flori galbene, cu distribuţie Balcano-Pontică şi Est-Europeană, sub-mediteraneană. Arealul ei românesc include câteva populaţii disputabile Nord-Dunărene şi unele certe în Dobrogea, unde *S. urvillei* e larg răspândit, în ciuda lipsei de date precise despre existenţa ei actuală în regiune. *S. urvillei* tipic are pronunţate preferinţe xerotermofile şi pentru habitate stâncoase cu sol superficial unde evită competiţia, fiind găsită adesea dar nu exclusiv pe iviri stâncoase calcaroase. Lipsa unei lucrări botanice dedicată descrierii precise a arealului complet al *S. urvillei* în Dobrogea Română, de la publicarea cu mai mult de jumătate de secol în urmă a singurei monografii a familiei Crassulaceae în flora românească, m-a impulsionat să prezint aici date cuprinzătoare (deşi nu exhaustive) despre actuala existenţă a *S. urvillei* în Dobrogea Română, rezultate din cercetări de teren efectuate în aproximativ 20 de ani, cuprinzând peste 150 situri pentru *Sedum urvillei*, în jurul a >30 aşezări umane, întinse în toată provincia, practic de la nivelul mării până la cca. 400 m m.d.m. Datele prezentate documentează o mult mai largă distribuţie a S. *urvillei* în Dobrogea decât fusese precis documentată, dar coexistenţa *S. urvillei* cu speciile similare dar mult mai comune *S. acre* şi *S. annuum* şi/sau *S. sexangulare*, predispune la confuzii cu aceste specii şi duce la sub raportare. S. *urvillei* este foarte important pentru conservarea biodiversităţii întrucât participă în câteva asociaţii adăpostind mult mai rara congenerică *Sedum caespitosum* şi edifică Assoc. *Sedo hillebrandtii-Polytrichetum-piliferi* Horeanu et Mihai 1974 în care e specia principală. Înţelegerea caracteristicilor de mediu şi fitocenotice care promovează apariţia *S. caespitosum* în aceste asociaţii ar fi cert benefică pentru conservarea ei, împreună cu alte specii rare şi periclitate local precum *Festuca callieri*, *Gagea szovitzii*, *Campanula romanica*, *Dianthus nardiformis* şi *Moehringia grisebachii.*

Cuvinte cheie: *Sedum urvillei* DC, corologie, Dobrogea, conservarea biodiversitaţii, Crassulaceae.

INTRODUCTION

Sedum urvillei DC. is a xerothermic yellow-flowered perennial species of Crassulaceae with Balkano-Pontic and East-European sub-Mediterranean distribution, described by A. P. de Candolle in 1828. Since then, according to International Crassulaceae Network, several taxa were synonymised with it, including the following which are more relevant to the territory of my study:

- *S. stribrnyi* Velenovsky (1892) and its derivatives *Sedum acre* var. stribrnyi (Velenovsky) Stojanov & Stefanoff, *Sedum* sexangulare ssp. stribrnyi (Velenovsky) Fröderström (1932), *Sedum sartorianum* ssp. *stribrnyi* (Velenovsky) D. A. Webb (1963);
- *Sedum ponticum* Velenovsky (1891) with its derivatives: *Sedum acre* var. *ponticum* (Velenovsky) Stojanov & Stefanoff, *Sedum sartorianum* ssp. *ponticum* (Velenovsky) D. A. Webb (1963);
- *Sedum sartorianum* Boissier (1856) with its derivatives: *Sedum acre* ssp. *sartorianum* (Boissier) J. A. Huber (1936), *Sedum urvillei* ssp. *sartorianum* (Boissier) Byalt (1997);
- *Sedum hillebrandtii* Fenzl (1856) with its derivatives: *Sedum urvillei* ssp. *hillebrandtii* (Fenzl) D. A. Webb, *Sedum sexangulare* ssp. *hillebrandtii* (Fenzl) Nyman (1890), *Sedum sartorianum* ssp. *hillebrandtii* (Fenzl) D. A. Webb (1963) *Sedum acre* var. *hirsutum* Wierzbicki; and *Sedum novakii* Domin (1929).

Although the first taxa are correctly synonymised with *S. urvillei*, in my opinion and based on the data available from Romanian populations, *Sedum hillebrandtii* Fenzl (1856) which also is native to Romania, shows enough distinctive characters to warrant taxonomic formal recognition at the level of species (but see also PARNELL & FAVARGER, 1993 and HART t', 1991).

Morphologically characterized by fibrous roots and trailing, multi-ramified ascending to erect lignified reddish-brown stems 10-15cm tall, with persistent dried leaves remaining like whitish-grey scales attached to the naked stems with apical tufts of densely imbricate leaves. The non-flowering shoots are quite brittle and easily break apart; the detached segments serve as propagules and lead to formation of wide clonal mats.

The flowering shoots are also ramified, a few centimeters taller than the sterile shoots, usually erect or ascending. The inflorescences are cymes with 2-5 cincinni, usually having 2 bracts per flower.

The leaves are alternate, densely imbricate, semi-terrete with broadly truncate spur and conical distal third, linear-oblong, sub-acute, about 10mmong and 1-2mm at the widest part, with highly variable color. Depending on the insolation degree, they vary in color between yellow-grey-green with reddish papillae in the early spring, dark green or glaucous to dark red to burgundy in summer under bright sun.

The flowers are (ob)diplostemonous, sessile to very shortly-pedicellate, the calyx consists of dark-red to glaucous dark-green basally fused lanceolate, subacute sepals, much less unequal than in *S. annuum*, the corola is pentamerous, with yellow lanceolate, acuminate, petals 5 - 8 mm long, 1-2mm wide, the staminal filaments yellow, anthers yellow, pollen yellow.

With 3-20 flowers/plant, *S. urvillei* shows a certain degree of polymorphism and variability, similar to *S. annuum* L (see BÂRCĂ, 2016b; NICULAE & BÂRCĂ, 2006) with a considerable variation in many characters as: number of stem branches, shoot length, size and shape of floral parts and inflorescence, and floral morphology. Typically, it perennates through "sterile" lignified and apically densely foliated shoots.

According to International Crassulaceae Network (which submerges *Sedum* hillebrandtii Fenzl into *S. urvillei*), its general distribution comprises Southeastern Europe, from Danube planes in Hungary, Serbia and Southern and Eastern Romania, through the Balkan Peninsula and Greece down to Central and Southern Anatolia in Turkey, and Eastwards through R. Moldova to Southern Ukraine and Crimea.

In my opinion, I maintain these two taxa separated as bona species and I regard *S. urvillei* as a truly Ponto-euxinic species extending through the Balkans and Greece into Anatolia and probably the Caucasus.

Its Romanian range includes several disputable populations North of Danube and certainly Dobrogea, region where *S. urvillei* is considered widespread, despite lack of exhaustive, precise data about its actual occurrence in this region (but see also PETRESCU 2012).

The typical *S. urvillei* develops well in rocky habitats with shallow topsoil where it doesn't face a lot of competition from taller plants. It has a pronounced xeric- and thermophylic preference, as opposed to *Sedum borissovae* which prefers milder habitats with better water availability. It is most often, -but not exclusively, found on calcareous substrates, on rocky outcrops, and the nominotypical taxon spans habitats up to 2000m, although in Dobrogea it just reaches about 400m elevation a.s.l.

The area covered by this study extends East of the Danube and comprises approximately the entire province of Dobrogea, between Danube river in the West and the shores of the Black sea in the East. This region encompasses a wide variety of habitats from the Danube flood plain to the highest peaks of the Hercynian-age Macinului Mountain range (elevations ranging roughly between 0m and about 450m a.s.l.).

The climate in the studied region is extreme continental, characterized by wide annual and diurnal variations in temperature and rainfall, with milder winters towards the sea shore and very arid Central-South region. The edaphic conditions are not so diverse, with a characteristic blanket of loess covering Sarmatic/Triassic or other types of limestones, but also some of the oldest rocks like green schists of hercynic origin.

No botanical work precisely describing the complete distribution range of *S. urvillei* D.C. in Romanian Dobrogea is available since the only monographic treatment of Crassulaceae family in Romanian flora has been published more than half a century ago (RAVARUȚ 1956). This fact, together with the increasing interest for the taxonomy, ecology, chorology and medicinal properties of Crassulaceae from the Carpathians (ARBUNE et al., 2009), (NICULAE & BÂRCĂ 2005, 2006), (BÂRCĂ & NICULAE 2005, 2006, 2008, 2011, 2018a), (BÂRCĂ 2015, 2016a, 2018b), (STANCIU et al., 2009), (NICULAE, 2018a, 2018b), prompted me to present hereby comprehensive (albeit not exhaustive) precise data about the actual occurrence sites of *S. urvillei* in Romanian Dobrogea.

MATERIAL AND METHODS

This distribution study includes data obtained by surveys performed mainly by me and dr. BÂRCĂ Valentin during fieldwork trips; and locations cited in unpublished personal communications by other researchers, that we verified on spot.

The geographical coordinates for the locations cited were derived from GPS coordinate readings from surveys done by the author, using a handheld GPS with a reported error of less than 5m at full reception, and where later crosschecked in the lab using ACME MAP version 2.1.

The data are presented in tabular format in Table 1, with the actual sites grouped around the closest human settlement from where the sites could be reached by foot by the author.

The "locality" names for the collection sites were given when possible for the closest human permanent settlement available, and due to the lack of space here and because the sites could be reached using the given geographical coordinates with the help of a handheld GPS, no toponyms are given for the actual sites besides the geographical coordinates which are given as indications to where the plants were found. Because of the limited available space and because this was not the objective of the present study, I give in this report only distribution data, omitting the collection dates which, together with phenological, edaphic, ecological and phytosociological information, will form the object of a future article.

To avoid any confusion, I mention the diagnostic criteria used to positively assign the individual plants to species, as follows:

– **General habitus**: – plants with dark red lignified, erect or ascending sterile glabrous stems, 5-15cm tall, Fresh leaves glaucous; with dried white/grey leaves persistent.

– **Flower habitus**: – (ob)diplostemonous, 5-merous flowers with pale-yellow petalls, patent follicles, dark brown, with recurved margins inflorescence cime, with 7(3-25) flowers.

– **Leaf habitus**: – leaves oblong-eliptic acute small papillose, acute conical subacute, with the tip abruptly rounded of obtuse The leaf spur is broad and massive.

The morphological characters used as diagnostic features to distinguish other similar species locally sympatric are:

- from *S. acre S. urvillei* differs s in flower by the sepals basally fused with the receptacle, and
- from S. *annuum S. urvillei* differs by more uniform calyx with sepals more equal and shorter.

RESULTS

I present herein results of over 30 years of fieldwork, results which comprise over 150 sites of occurrence where *Sedum urvillei* D.C. was seen, linked to locations of more than 30 human settlements. Spanning the whole province of Romanian Dobrogea, from the southernmost point in Canaraua Fetei/Băneasa literally just a few meters north of the Romanian-Bulgarian state border, to Niculitel hills close to the village of Niculitel, which is one of the northern-most points in Dobrogea. Out of these, most are new locations or older locations in which I positively confirmed the presence of *S. urvillei*. The data are presented below in tabular format (Table 1; Fig. 1). The locations were sorted alphabetically by local geographic name (mostly village names), and then the geographical coordinates of the actual sites followed in the next column. I also present some descriptive documentary in situ photographs of *S. urvillei* taken by Barca Valentin from the surveyed populations.

Table 1. List of the sites of occurance of *Sedum urvillei* in Romanian Dobrogea, with their geographical coordinates, grouped around the closest human settlement.

No.	Closest human settlement	Geographical coordinates of the sites of occurrence of *Sedum urvillei* situated close to this locality
1	**Adamclisi**	N 44 6' 3" E 27 57' 15**";** **---N 4**4 6' 5" E 27 57' 19**";** **---N 4**4 6' 5" E 27 57' 22**;**
2	**AlahBair**	N 44 30' 2" E 28 12' 40; # 44 29' 53" E 28 12' 47; # 44 29' 51" E 28 13' 10; # 44 30' 3" E 28 13' 21; # 44 30' 10" E 28 13' 12; # 44 30' 12" E 28 13' 25; # 44 30' 13" E 28 13' 44; # 44 29' 58" E 28 13' 49; # 44 29' 53" E 28 13' 48; # 44 30' 36" E 28 13' 34; # 44 30' 41" E 28 12' 53; # 44 30' 52" E 28 12' 40; # 44 30' 47" E 28 12' 43; # 44 30' 34" E 28 12' 23; # 44 30' 50" E 28 12' 6; # 44 31' 25" E 28 12' 30; # 44 31' 19" E 28 12' 43; # 44 31' 26" E 28 12' 12**;**
3	**Albești**	N 43 48' 14" E 28 27' 15; # N 43 47' 54" E 28 27' 38; # N 43 48' 25" E 28 27' 37; # N 43 47' 54" E 28 27' 49;
4	**Băltagești**	N 44 28' 46" E 28 12' 13"; ---N 44 29' 6" E 28 13' 6"; ---N 44 29' 47" E 28 12' 16;
5	**Băneasa Canaraua Fetei**	N 44 2' 49" E 27 38' 34; # N 44 2' 51" E 27 38' 41; # N 44 2' 43" E 27 38' 17; # N 44 2' 30" E 27 37' 59; # N 44 3' 47" E 27 38' 40; # N 44 3' 41" E 27 38' 59; # N 44 4' 36" E 27 38' 39; # N 44 5' 14" E 27 38' 13; # N 44 5' 20" E 27 38' 16;
6	**Camena**	N 44 47' 57" E 28 36' 51"; ---N 44 48' 4" E 28 36' 50"; ---N 44 48' 13" E 28 36' 31"; ---N 44 48' 22" E 28 36' 18"; ---N 44 48' 14" E 28 35' 58;
7	**Capidava**	N 44 29' 48" E 28 5' 55"; ---N 44 29' 31" E 28 5' 46"; ---N 44 29' 36" E 28 6' 27"; ---N 44 29' 4" E 28 6' 38;
8	**Casimcea**	N 44 43' 44" E 28 23' 9"; ---N 44 43' 52" E 28 22' 11"; ---N 44 43' 54" E 28 23' 24"; ---N 44 41' 20" E 28 22' 37"; ---N 44 41' 14" E 28 22' 50"; ---N 44 41' 25" E 28 22' 25"; ---N 44 40' 22" E 28 22' 40"; ---N 44 39' 8" E 28 21' 49"; ---N 44 39' 1" E 28 22' 26"; ---N 44 38' 46" E 28 22' 21"; ---N 44 38' 36" E 28 22' 22"; ---N 44 38' 41" E 28 22' 43"; ---N 44 38' 46" E 28 22' 39"; ---N 44 38' 38" E 28 22' 49"; ---N 44 38' 33" E 28 23' 1"; ---N 44 38' 28" E 28 23' 4"; ---N 44 38' 21" E 28 22' 54;
9	**Cassian**	N 44 29' 17" E 28 28' 4"; ---N 44 28' 58" E 28 28' 19"; ---N 44 28' 54" E 28 28' 32"; ---N 44 28' 43" E 28 28' 22"; ---N 44 28' 28" E 28 28' 29; N 44 29' 20" E 28 27' 43"; --- N 44 29' 42" E 28 29' 43"; ---N 44 29' 43" E 28 29' 15"; ---N 44 29' 57" E 28 29' 9;
10	**Cerna**	N 45 3' 42" E 28 19' 18"; ---N 45 3' 34" E 28 19' 19"; ---N 45 3' 5" E 28 19' 35"; ---N 44 52' 47" E 28 50' 39;
11	**Cernavodă**	N 44 20' 16" E 28 1' 7;
12	**Cheia**	N 44 30' 50" E 28 25' 9"; ---N 44 30' 32" E 28 25' 30"; ---N 44 30' 27" E 28 25' 45"; ---N 44 30' 24" E 28 25' 55"; ---N 44 29' 57" E 28 26' 31"; ---N 44 29' 31" E 28 27' 0"; ---N 44 29' 23" E 28 27' 21"; ---N 44 29' 17" E 28 27' 40"; ---N 44 29' 17" E 28 27' 49;
13	**Corugea**	N 44 44' 19" E 28 20' 0"; ---N 44 44' 33" E 28 20' 22;
14	**Enisala**	N 44 52' 38" E 28 51' 1"; ---N 44 52' 50" E 28 50' 29"; ---N 44 53' 5" E 28 50' 10"; ---N 44 53' 7" E 28 49' 58"; ---N 44 53' 7" E 28 49' 58"; ---N 44 53' 3" E 28 50' 12"; ---N 44 52' 58" E 28 50' 8"; ---N 44 53' 4" E 28 50' 2"; ---N 44 47' 43" E 28 37' 14;

15	**Făurei**	N 44 2' 22" E 27 41' 30;
16	**Greci**	---N 45 13' 33" E 28 12' 3"; ---N 45 13' 32" E 28 12' 7"; ---N 45 13' 28" E 28 12' 11"; ---N 45 13' 27" E 28 12' 17"; ---N 45 12' 51" E 28 12' 29"; ---N 45 12' 53" E 28 12' 17"; ---N 45 12' 53" E 28 14' 25"; ---N 45 12' 46" E 28 14' 27"; ---N 45 12' 42" E 28 14' 32"; ---N 45 12' 40" E 28 14' 37"; ---N 45 12' 42" E 28 14' 43"; ---N 45 12' 31" E 28 15' 6"; ---N 45 12' 39" E 28 15' 9"; ---N 45 12' 40" E 28 15' 8"; ---N 45 12' 43" E 28 15' 9"; ---N 45 12' 41" E 28 15' 16"; ---N 45 12' 38" E 28 15' 28"; ---N 45 12' 39" E 28 14' 45"; ---N 45 12' 36" E 28 14' 46"; ---N 45 12' 35" E 28 14' 41"; ---N 45 12' 34" E 28 14' 58;
17	**Gura Dobrogei**	N 44 28' 8" E 28 29' 24"; ---N 44 28' 3" E 28 29' 46"; ---N 44 27' 51" E 28 29' 27"; ---N 44 27' 45" E 28 30' 13"; ---N 44 27' 27" E 28 30' 30"; ---N 44 27' 50" E 28 30' 50"; ---N 44 28' 21" E 28 30' 43"; ---N 44 28' 32" E 28 30' 8"; ---N 44 29' 1" E 28 29' 40" N 44 28' 24" E 28 28' 47"; ---N 44 27' 58" E 28 28' 13"; ---N 44 27' 57" E 28 28' 34"; ---N 44 28' 2" E 28 28' 47" N 44 28' 6" E 28 28' 58" N 44 29' 11" E 28 29' 30;
18	**Hagieni**	N 43 47' 31" E 28 29' 0; # N 43 47' 53" E 28 29' 3; # N 43 47' 55" E 28 29' 32;
19	**Istria**	N 44 33' 50" E 28 45' 33"; ---N 44 33' 45" E 28 45' 27"; ---N 44 33' 53" E 28 45' 44"; ---N 44 34' 21" E 28 45' 53;
20	**Iulia/Izvoarele**	N 45 1' 19" E 28 30' 50"; ---N 45 1' 26" E 28 31' 10"; ---N 45 1' 16" E 28 31' 8"; ---N 45 0' 53" E 28 31' 17"; ---N 45 0' 48" E 28 31' 46"; ---N 45 0' 28" E 28 31' 9"; ---N 44 59' 58" E 28 31' 59;
21	**Limanu**	N 43 48' 31" E 28 30' 51"; ---N 43 48' 55" E 28 30' 53;
22	**Luminița C-ța**	N 44 22' 11" E 28 38' 30"; ---N 44 21' 44" E 28 38' 40"; ---N 44 21' 43" E 28 38' 57"; ---N 44 21' 43" E 28 37' 41"; ---N 44 21' 37" E 28 38' 25;
23	**Nicolae Bălcescu**	N 44 59' 24" E 28 32' 20"; ---N 44 58' 57" E 28 31' 3"; ---N 44 57' 50" E 28 30' 59;
24	**Niculițel**	N 45 9' 57" E 28 28' 15"; ---N 45 10' 34" E 28 28' 16"; ---N 45 10' 38" E 28 27' 27"; ---N 45 11' 20" E 28 27' 30"; ---N 45 11' 30" E 28 27' 29;
25	**Nistorești**	N 44 37' 34" E 28 22' 33"; ---N 44 37' 20" E 28 22' 47"; ---N 44 37' 0" E 28 23' 4"; ---N 44 36' 52" E 28 22' 53"; ---N 44 36' 47" E 28 22' 46"; ---N 44 36' 42" E 28 22' 30"; ---N 44 36' 49" E 28 22' 17"; ---N 44 36' 30" E 28 22' 26"; ---N 44 36' 10" E 28 22' 39"; ---N 44 35' 46" E 28 22' 51;
26	**Palazu**	N 44 27' 6" E 28 30' 48"; ---N 44 26' 46" E 28 30' 47"; ---N 44 26' 44" E 28 30' 13"; ---N 44 26' 30" E 28 30' 17"; ---N 44 26' 14" E 28 30' 30"; ---N 44 25' 49" E 28 31' 1"; ---N 44 25' 15" E 28 30' 33"; ---N 44 25' 5" E 28 31' 12"; ---N 44 24' 41" E 28 31' 18"; ---N 44 24' 35" E 28 33' 5"; ---N 44 24' 12" E 28 33' 2"; ---N 44 23' 58" E 28 32' 9"; ---N 44 24' 10" E 28 31' 57"; ---N 44 23' 5" E 28 32' 33"; ---N 44 23' 1" E 28 33' 7"; ---N 44 22' 50" E 28 33' 31"; ---N 44 22' 32" E 28 34' 47;
27	**Măcin**	--- N 45 15' 47" E 28 10' 3"; ---N 45 15' 46" E 28 10' 16"; ---N 45 15' 53" E 28 10' 24"; ---N 45 15' 57" E 28 10' 31"; ---N 45 15' 53" E 28 10' 32"; ---N 45 15' 54" E 28 10' 35"; ---N 45 15' 57" E 28 10' 35"; ---N 45 16' 0" E 28 10' 29"; ---N 45 16' 1" E 28 10' 32"; ---N 45 16' 3" E 28 10' 29"; ---N 45 16' 7" E 28 10' 28"; ---N 45 16' 3" E 28 10' 32"; ---N 45 16' 3" E 28 10' 37"; ---N 45 16' 16" E 28 10' 42"; ---N 45 16' 10" E 28 10' 47"; ---N 45 16' 13" E 28 10' 49"; ---N 45 16' 6" E 28 10' 50"; ---N 45 16' 3" E 28 10' 52"; ---N 45 15' 56" E 28 10' 44"; ---N 45 15' 51" E 28 10' 44"; ---N 45 15' 51" E 28 10' 59"; ---N 45 15' 48" E 28 10' 58"; ---N 45 15' 42" E 28 10' 50"; ---N 45 15' 39" E 28 10' 49"; ---N 45 15' 39" E 28 10' 44"; ---N 45 15' 37" E 28 10' 40"; ---N 45 15' 34" E 28 10' 43"; ---N 45 15' 36" E 28 10' 53"; ---N 45 15' 34" E 28 10' 59"; ---N 45 15' 28" E 28 10' 59"; ---N 45 15' 25" E 28 11' 1"; ---N 45 15' 23" E 28 11' 13"; ---N 45 15' 20" E 28 11' 14"; ---N 45 15' 16" E 28 11' 15"; ---N 45 15' 14" E 28 11' 19"; ---N 45 15' 10" E 28 11' 19"; ---N 45 15' 4" E 28 11' 22"; ---N 45 15' 13" E 28 11' 35"; ---N 45 15' 10" E 28 11' 40"; ---N 45 15' 4" E 28 11' 41"; ---N 45 15' 2" E 28 11' 46"; ---N 45 14' 58" E 28 11' 47"; ---N 45 14' 57" E 28 11' 45"; ---N 45 14' 53" E 28 11' 52"; ---N 45 14' 54" E 28 12' 1"; ---N 45 14' 52" E 28 12' 4"; ---N 45 14' 49" E 28 12' 6"; ---N 45 14' 47" E 28 12' 1"; ---N 45 14' 47" E 28 11' 58"; ---N 45 14' 44" E 28 12' 8"; ---N 45 14' 41" E 28 12' 10"; ---N 45 14' 38" E 28 12' 10"; ---N 45 14' 39" E 28 12' 4"; ---N 45 14' 41" E 28 12' 2"; ---N 45 14' 37" E 28 11' 58"; ---N 45 14' 34" E 28 12' 1"; ---N 45 14' 37" E 28 11' 52"; ---N 45 14' 33" E 28 11' 50"; ---N 45 14' 30" E 28 11' 44"; ---N 45 14' 27" E 28 11' 38"; ---N 45 14' 22" E 28 11' 48"; ---N 45 14' 19" E 28 11' 38"; ---N 45 14' 16" E 28 11' 43"; ---N 45 14' 12" E 28 11' 48"; ---N 45 14' 12" E 28 11' 47"; ---N 45 14' 12" E 28 11' 43"; ---N 45 14' 9" E 28 11' 43"; ---N 45 14' 8" E 28 11' 47"; ---N 45 14' 8" E 28 11' 49"; ---N 45 14' 6" E 28 11' 47"; ---N 45 14' 4" E 28 11' 50"; ---N 45 14' 3" E 28 11' 49"; ---N 45 14' 4" E 28 11' 55"; ---N 45 14' 7" E 28 11' 58"; ---N 45 14' 8" E 28 12' 2"; ---N 45 14' 10" E 28 12' 1"; ---N 45 14' 13" E 28 12' 5"; ---N 45 14' 16" E 28 12' 3"; ---N 45 14' 19" E 28 12' 7"; ---N 45 14' 22" E 28 12' 5"; ---N 45 14' 20" E 28 12' 7"; ---N 45 14' 24" E 28 12' 17"; ---N 45 14' 33" E 28 12' 20"; ---N 45 14' 15" E 28 12' 22"; ---N 45 14' 9" E 28 12' 20"; ---N 45 14' 6" E 28 12' 4"; ---N 45 14' 3" E 28 12' 7"; ---N 45 14' 0" E 28 12' 8"; ---N 45 13' 59" E 28 12' 10"; ---N 45 13' 57" E 28 12' 7"; ---N 45 13' 58" E 28 12' 2"; ---N 45 14' 0" E 28 11' 58"; ---N 45 13' 59" E 28 12' 3"; ---N 45 13' 57" E 28 12' 8"; ---N 45 13' 56" E 28 12' 7"; ---N 45 13' 53" E 28 12' 10"; ---N 45 13' 55" E 28 12' 13"; ---N 45 13' 56" E 28 12' 18"; ---N 45 14' 0" E 28 12' 19"; ---N 45 13' 56" E 28 12' 13"; ---N 45 13' 56" E 28 12' 9"; ---N 45 13' 54" E 28 12' 8"; ---N 45 13' 52" E 28 12' 11"; ---N 45 13' 50" E 28 12' 10"; ---N 45 13' 48" E 28 12' 7"; ---N 45 13' 45" E 28 11' 58"; ---N 45 13' 41" E 28 11' 59"; ---N 45 13' 35" E 28 11' 53"; ---N 45 13' 31" E 28 11' 46;
28	**Pantelimon**	N 44 33' 4" E 28 22' 43"; ---N 44 32' 56" E 28 23' 0"; ---N 44 32' 26" E 28 23' 47"; ---N 44 32' 22" E 28 24' 11"“; ---N 44 33' 8" E 28 21' 8";
29	**Pantelimon de jos**	N 44 34' 26" E 28 21' 42"; ---N 44 34' 26" E 28 22' 13"; ---N 44 34' 14" E 28 22' 31;
30	**Războieni**	N 44 45' 42" E 28 25' 40"; ---N 44 44' 51" E 28 23' 49"; ---N 44 44' 46" E 28 23' 35;
31	**Runcu**	N 44 35' 49" E 28 18' 55"; ---N 44 35' 51" E 28 18' 22"; ---N 44 34' 42" E 28 18' 59"; ---N 44 34' 48" E 28 19' 15"; ---N 44 35' 4" E 28 19' 39"; ---N 44 35' 8" E 28 20' 12"; ---N 44 34' 51" E 28 20' 40"; ---N 44 34' 34" E 28 21' 20;
32	**Sipotele**	N 44 2' 27" E 27 58' 7; # N 44 2' 43" E 27 57' 58; # N 44 3' 0" E 27 58' 8; # N 44 3' 19" E 27 57' 53; # N 44 3' 49" E 27 57' 41; # N 44 3' 53" E 27 57' 33;
33	**Turcoaia**	N 45 7' 29" E 28 14' 55"; ---N 45 7' 21" E 28 15' 1"; ---N 45 7' 16" E 28 15' 4"; ---N 45 7' 9" E 28 15' 12"; ---N 45 7' 9" E 28 15' 24"; ---N 45 6' 59" E 28 15' 27"; ---N 45 6' 49" E 28 15' 41"; ---N 45 6' 42" E 28 15' 51"; ---N 45 6' 32" E 28 16' 6"; ---N 45 6' 25" E 28 16' 19"; ---N 45 6' 19" E 28 16' 31"; ---N 45 6' 5" E 28 16' 50"; ---N 45 5' 54" E 28 16' 59"; ---N 45 5' 46" E 28 17' 11"; ---N 45 5' 47" E 28 16' 15"; ---N 45 5' 37" E 28 16' 1"; ---N 45 5' 57" E 28 15' 27"; ---N 45 5' 50" E 28 15' 26"; ---N 45 5' 44" E 28 15' 30"; ---N 45 6' 14" E 28 15' 15"; ---N 45 6' 19" E 28 15' 10"; ---N 45 6' 32" E 28 14' 57"; ---N 45 6' 43" E 28 14' 43"; ---N 45 6' 53" E 28 14' 28"; ---N 45 7' 1" E 28 14' 26"; ---N 45 7' 8" E 28 14' 20"; ---N 45 6' 28" E 28 12' 52"; ---N 45 6' 26" E 28 12' 30"; ---N 45 6' 40" E 28 12' 30;
34	**Zorile**	N 44 3' 57" E 27 55' 57; # N 44 4' 17" E 27 56' 0; # N 44 3' 21" E 27 56' 2; # N 44 3' 22" E 27 56' 51; # N 44 3' 40" E 27 56' 34"

Figure 1. *Sedum urvillei* general habitus of 2 forms, in characteristic habitat on Triassic limestone, in situ in Dobrogea; -1A a 1-year-old fresher plant, a bit later in spring, with unlignified greener stems with old leaves persistent like whitish-grey scales, Figure 1B: the habitus of a2 years-old, overwintered shoot in very early spring, behaving like a vegetative propagule, with the characteristic lignified stems and with similarly persistent last-year's leaves.

DISCUSSIONS

The data presented herein (Table 1) indicate that, like for *Sedum hispanicum* L (NICULAE & BÂRCĂ, 2005) and *S. annuum* L in the Southern and Eastern Carpathians (NICULAE & BÂRCĂ, 2006; BÂRCĂ, 2016b), the range occupied by S. *urvillei* D.C. is larger than previously documented (RĂVĂRUȚ, 1956; WEBB, 1964; MEUSEL et al., 1965; LIPPERT, 1995; JALAS et al., 1999). Like with S. annuum in the Carpathians, S. *urvillei* D.C. was probably confounded with *S. acre* L. and/or *Sedum sexangulare*, or *Sedum annuum*, as the last 2 species share the same comparium of Ser. Alpestria A. Berger ('t Hart 1991) and probably often under-reported by previous authors, and similarly to *S. annuum* L. and *Sedum. hispanicum* L its occurrence was probably considered unworthy of mentioning from all locations where it was found. This fact combined with the misidentification issue mentioned above hinders the effort to ascertain a correct distribution range of *S. urvillei* in Dobrogea.

In Figure 1 A and B I present the general habitus of the plants in situ near Casian in Dobrogea, exemplifying two forms; in Figure 1B the habitus of a2 years-old, overwintered shoot in very early spring, behaving like a vegetative propagule, with the characteristic lignified stems with old leaves persistent like whitish-grey scales; and in Figure 1A a 1-year-old fresher plant, a bit later in spring, with unlignified greener stems but with similarly persistent last-year's leaves.

From an ecological standpoint, typically the species prefers sunny, dryer or well drained slopes with shallow topsoil, and early succession with open canopy as it cannot stand competition. It apparently has a pronounced calciphilous character, sometimes dominating the open xerothermophilic pioneer communities developing on shallow calcareous soils, but it is not restricted to calcareous soils, just that in the region studied most of the habitats are developed on such calcareous bedrock (see figure 1 for the aspect of the extreme habitat, where S. urvillei grows on karstic pockets in Triassic reef limestone, in situ near Cheile Dobrogei, Dobrogea).

Throughout the whole Dobrogea it builds an Assoc. *Sedo hillebrandtii-Polytrichetum piliferi* Horeanu et Mihai 1974 included in Western Pontic thyme steppes with *Thymus zygioides* (code 34.9211), a peculiar association on skeletal, shallow soils, in which it is the main founder species, together with some mosses in the genus *Polytrichum* like *P. piliferum.* According to PETRESCU (2012) and PETRESCU et al. (2014) this association also hosts several species of European interest, like *Campanula romanica*, *Dianthus nardiformis*, *Moehringia grisebachii* and also other rare locally threatened species like *Festuca callieri* and *Gagea szovitzii*, which warrant more thorough sozological research .

One important finding is that it is sometimes accompanied by *Sedum caespitosum* (Cav) D.C. as species much less frequent and which is considered of community interest for conservation (see also NICULAE 2018b). Interestingly though, they do not always associate, even on very similar habitats with similar edaphic characteristics which promote building the special Assoc. *Sedo hillebrandtii-Polytrichetum piliferi* Horeanu et Mihai 1974, fact which, when studied, could give hints to the differences in frequency and abundance between these two species of Crassulaceae.

In several populations of *S. urvillei* in Dobrogea adult weevils of the steno-monophagous Aizobius sedi Germ. (Apionidae, Coleoptera) were seen associated with plants, and plants showed characteristic bite-marks suggesting that the wevils are using *S. urvillei* as food plant in Dobrogea; albeit further research is needed to ascertain this fact, this does not seem impossible.

The Assoc. *Sedo hillebrandtii-Polytrichetum piliferi* Horeanu et Mihai 1974, build by *S. urvillei*, also hosts, besides Aizobius sedi, another steno-monophagous weevil Pericartiellus telephii Bedel, 1900 (Nanophyidae, Coleoptera) and the butterfly Scolitantides orion Pallas, (Lycaenidae, Lepidoptera) which is locally endangered and protected in Northern Europeall of them used as food plant Crassulacean species which accompany *S. urvillei* in Dobrogea.

Like the cases of other species (BÂRCĂ & NICULAE 2011, 2018a, b; BÂRCĂ et al., 2011; BÂRCĂ, 2018a), this makes *S. urvillei* even more important in biodiversity conservation, not only for the conservation of plants, but also in the conservation of the steno-monophagous insects using it or other Crassulacean species hosted in the associations formed by *S. urvillei*.

The ecological and phyto-sociological characteristics of *S. urvillei* in Dobrogea warrant a more thorough study in comparison with those of the putative sister taxon *Sedum hillebrandtii* Fenzl from Banat, and form the substance of another article (NICULAE & BÂRCĂ in presse)

CONCLUSIONS

The number of new sites presented herein documents for S. *urvillei* a distribution in the Romanian Dobrogea that is much larger than previously documented. In many of the sites, *S. urvillei* occurs together with the very similar species *S. acre* and/or *S. sexangulare*, fact that predisposes it to confusions with these two species and leads to underreporting.

It also is quite important from a conservation point of view as it builds associations which harbour the much rarer congeneric *Sedum caespitosum* (Cav) D.C. of which in the Assoc. *Sedo hillebrandtii-Polytrichetum piliferi* Horeanu et Mihai 1974 it being the main species. Therefore, the understanding of the environmental and phytocoenotic characteristics which foster *Sedum caespitosum* occurrence in this association would certainly benefit its conservation, together with other rare and locally threatened species like *Festuca callieri* and *Gagea szovitzii*, and several species of European interest, like *Campanula romanica*, *Dianthus nardiformis*, *Moehringia grisebachii* which occur in these associations built with the more or less important contribution of S. *urvillei.*

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PARASITE FAUNA OF *Myodes glareolus* FROM THE NATURAL RESERVE "PLAIUL FAGULUI" OF THE REPUBLIC OF MOLDOVA

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Abstract. *Myodes glareolus* is a forest species that can be met in woods, forest glades, in shrubs at the forest edge, in wet biotopes with tree and shrub vegetation. Parasitological investigations of the species revealed a prevalence of *Plaghiorchis elegans* with13.8%, of *Mesocestoides lineatus larvae* – 14.0%, of *Paranoplocephala omphaloides* – 10.3%, of *Rodentolepis straminea* – 69.0%, of *Hydatigera taeniaformis* – 10.3%, of *Catenotaenia cricetorum* – 10.3%, of *Skrjabinotaenia lobata* – 10.3%, of *Taenia pisiphormis* – 13.7%, of *Calodium hepaticum* – 27.5%, of *Syphacia stroma* – 17.2%, of *Syphacia obvelata* – 24.1%, of *Heligmosomoides polygirus* – 10.0%, of *Strongyloides ratti* – 6.9%, of *Mastophorus muris* – 17.2% and of *Trichocephalus muris* with 17.2%. Taxonomically the parasite fauna is constituted from representatives of 4 classes, 12 families, 14 genera and 15 species. The diversity structure is formed by one parasite species from the class Trematoda (*Plaghiorchis elegans*), by 7 species from the class Cestoda (*Skrjabinotaenia lobata, Catenotaenia cricetorum*, *Paranoplocephala omphaloides*, *Rodentolepis straminea*, *Hydatigera taeniaeformis*, *Taenia pisiformis*, *Mesocestoides lineatus*), 5 species from the class Secernentea (*Syphacia stroma*, *Syphacia obvelata*, *Heligmosomoides polygirus*, *Mastophorus muris*, *Strongyloides ratti*) and 2 species from the class Adenophorea (*Trichuris muris*, *Calodium hepaticum*).

Keywords: parasites, *Myodes glareolus*, prevalence, rodents.

Rezumat. Fauna parazită de *Myodes glareolus* din Rezervaţia Naturală „Plaiul Fagului" din Republica Moldova. *Myodes glareolus* fiind o specie silvicolă se întâlneşte în păduri luminoase (poiene), în sectoare cu subarboret şi la lizieră, pe terenuri umede de la marginea bălţilor, poate fi întâlnit în depozite şi locuinţele oamenilor. Investigarea parazitologică a speciei respective pune în evidenţă o prevalenţă cu *Plaghiorchis elegans* de 13,8%, respectiv cu *Mesocestoides lineatus larvae* - 14,0%, *Paranoplocephala omphaloides* – 10,3%, *Rodentolipis straminea* – 69,0%, *Hydatigera taenieaformis* – 10,3%, *Catenotaenia cricetorum* – 10,3%, *Skrjabinotaenia lobata* – 10 ,3%, *Taenia pisiformis* – 13,7%, *Calodium hepaticum* – 27,5%, *Syphacia stroma* – 17,2%, *Syphacia obvelata* – 24,1%, *Heligmosomoides polygirus* – 10,0%, *Strongyloides ratti* – 6,9%, *Mastophorus muris* – 17,2%, iar cu *Trichocephalus muris* prevalenţa este 17,2%. Taxonomic parazitofauna este constituită din 4 clase, 12 familii, 14 genuri şi 15 specii. Astfel, structura diversităţii este constituită dintr-o specie parazitară din clasa Trematoda (*Plaghiorchis elegans*), din 7 specii din clasa Cestoda (*Skrjabinotaenia lobata, Catenotaenia cricetorum*, *Paranoplocephala omphaloides*, *Rodentolepis straminea*, *Hydatigera taenieaformis*, *Taenia pisiformis*, *Mesocestoides lineatus*) şi 5 specii din clasa Secernentea (*Syphacia stroma*, *Syphacia obvelata*, *Heligmosomoides polygirus*, *Mastophorus muris*, *Strongyloides ratti*), 2 specii din clasa Adenophorea (*Trichuris muris*, *Calodium hepaticum*).

Cuvinte cheie: paraziţi, *Myodes glareolus*, prevalenţă, rozătoare.

INTRODUCTION

Parasitism in natural ecosystems is considered an ecological phenomenon, also representing a form of interspecific relation. Due to the diversity of ecological connections, parasites are an important factor for the numerical regulation of host populations and, respectively, for its functioning (BEKLEMISHEV, 1970; KONTRIMAVICHYUS, 1982).

Anthropisation becomes an omnipresent phenomenon where the anthropic factor has a considerable influence on the processes in nature. The action of an anthropogenic factor on parasites as essential components of biota can lead to changes in biodiversity and ecological status. In such conditions some helminth species may have epidemiological and epizootic significance. This makes necessary the monitoring of the biodiversity and ecology of helminth associations in concrete areas (ROMASHOVA, 2003).

Many small rodent species are considered pest animals because they cause damage to agricultural production, are involved in the transmission of various pathogen agents (viruses, bacteria, parasites) both in humans and domestic and wild animals (SINGH et al., 1995; DURDEN et al., 2000; STOJCEVIC et al., 2004; MALSAWMTLUANGI et al., 2009). Helminths from genera *Trichinella*, *Angiostrongylus*, *Capillaria*, *Hymenolepis*, *Raillentina*, *Echinococcus*, *Schistosoma*, *Paragonimus* and *Echinostoma*occuring in small rodents have zoonotic impact upon human health, while *Capillaria hepatica* and *Angyostrongylus cantonensis* cause severe syndromes in humans, as well as wild and domestic animals (CHECHULIN et al., 2011; FUEHRER et al., 2011).

The parasites of wild rodents have been studied for a long period in various European countries, such as Poland (KISELEWSKA, 1970; KISELEWSKA at al., 1973), Czech Republic (TENORA, 1967; TENORA & STANEK, 1995), Finland (HAUKISLAMI, 1986; HAUKISLAMI & HENTONEN, 1993), Great Britain (ELTON, 1931; LEWIS, 1968; MONTGOMERY & MONTGOMERY, 1988, 1989, 1990), Latvia (KONTRIMAVICHYUS, 1964, 1982), Russia (SHALDYBIN, 1963, 1969, 1972, 1983; RYJIKOV et al., 1978, 1979; SHAHMATOVA, 1989; ROMASHOVA, 2003), Ukraine (SHARPILO, 1973, 1975, 1976; VYSOTSKAYA, 1997), Belarus (ARZAMASOV, 1983; CHIKILEVSKAYA, 1986, 1987, 1990), Moldova (ANDREYKO, 1960, 1961, 1973, 1984), Romania

(CHIRIAC & BARBU, 1962, 1963; CHIRIAC & HAMAR, 1966; POPESCU & BARBU, 1971; POPESCU et al., 1974) and Hungary (MESZAROS F, 1980; MURAI, 1987; KRISKA, 1993).These studies describe the influence of different ecological factors (host species, density, age, sex, range, season etc.) and elucidate the temporality, location, abundance as well as diversity of parasite communities in wild rodents from different regions.

Infestation in humans can occur through direct contact with rodent excretions or consumption of food contaminated by fallen fur, feet, urine or faeces, and indirectly by bites of the ectoparasite vectors such as fleas and ticks (SINGLA et al., 2008). In carnivorous mammals such as foxes (ESKERT & DEPLAZES, 2004), dogs (DESPOMIER, 2003; DEPLAZES et al., 2005), cats (HILL & DUBEY 2002; KAPEL et al., 2006) infestation occurs during the direct consumption of infected rodents.

The extensive description of parasite fauna in small rodents in the Republic of Moldova was firstly performed by Andreico O. in 1958-1984. Thus, Trematoda species have a share of 2.14%, Cestoda - 17.54%, Nematoda - 61.7% and Acanthocephala - 0.58%. The class Trematoda includes 3 species, Cestoda - 16 species, and Nematoda - 18 species of parasites. In the helminth fauna of the investigated rodents, parasites specific to man and domestic animals were found: *Echinococcus granulosus*, *Mesocestoides sp*., *Hymenolepis diminută*, *Strobilocercus fasciolaris*, *Tricihinela spiralis*, *Hepaticola hepatica*, *Syphacia stroma* and *Syphacia obvelata* (ANDREIKO, 1960, 1961, 1973, 1984).

Thus, from the above mentioned, the monitoring of parasite fauna in small rodents in different areas holds a bio-ecological, medical and veterinary importance in the prevention of the transmission of pathogens to humans and other animals involved in biological cycles of zoonotic and epizootic pests.

The bank vole (*Myodes glareolus*) is one of the dominant rodent species among small mammal fauna of the republic, especially in forest ecosystems. *M. glareolus* is a forest species that can be met in woods, forest glades, in shrubs from the forest edge, in wet biotopes with tree and bush vegetation, as well as different ecotone zones between forest and adjacent habitats. In previous studies from the "Plaiul Fagului" reserve, the bank vole is mentioned as common and wide spread species with constant and eu-constant ecological significance for all reserve ecosystems (MUNTEANU et al., 2004; NISTREANU et al., 2015).The aim of this research was the study of parasite fauna in the bank vole from the Natural Reserve "Plaiul Fagului".

MATERIAL AND METHODS

The reserve is located in the Ungheni district, at a distance of 70 km to the north-west of Chisinau, with coordinates N 47°18' and E 28°02'. The landscape is fragmented, with steep slopes and deep valleys, representing almost a mountain landscape. The capture of small rodents was carried out at the ecotone zone of forest and paludous ecosystem. The tree and bush vegetation is rather abundant and rich, represented by oak, hornbeam, ash, burning bush, hazelnut, horn. Grassy vegetation is abundant and dense, represented by hygrophilous and meadow species. The given ecosystem is a recreational area for visitors, and direct or indirect contact with rodents is particularly high, thus increasing the risk of wildlife parasites spreading to humans. 100 live traps were placed at a distance of 5 m from each other, which is recommended for biotopes with well-developed bush vegetation and abundant herbaceous vegetation (PELIKAN et al., 1975).

The parasitological studies were carried out within the laboratory of Parasitology and Helmintology of the Institute of Zoology of the ASM. The individuals of *M. glareolus* collected for parasitological investigations were euthanized with chloroformi pro narcosi solution that inhibits conductibility at the level of heart centers, causing instant death without suffering. Laboratory investigations were performed by total rodent dissection and microscopic examination of the muscles (masseter, arms and diaphragm muscles), of thoracic organs (trachea, lungs, heart) and of abdominal organs (aesophagus, stomach, intestine, colon, liver, spleen, kidney, urinary bladder) to establish parasitological indices. The identification of parasite species was carried out after (RYJIKOV, 1978, 1979]. Degree of infestation with *Calodium hepaticum*, was estimated by volumetric established of affected portion liver (+ is 25.0%, ++ – 50.0%, +++ – 75.0%, ++++ – 100%). For the parasitological assessment the prevalence (%), the intensity (specimens per animal) and the abundance (specimens per lot) of the parasitic species in the rodents were determined. The results obtained were statistically processed in the Excel software.

RESULTS AND DISCUSSIONS

In total 8 rodent species were caught (*Apodemus sylvaticus, A. falvicollis, A. agrarius, A. uralensis, Mus musculus, Microtus rissiaemeridionalis, Myodes glareolus* and *Pitymys subterraneus*). At the ecotone between forest and pond 29 individuals of *M. glareolus* were collected. The trappability coefficient of rodents varied between 10.7% and 34.6%, that of the bank vole was 2.7% to 29.3%. The bank vole was the second species after its abundance (18.4%-39.8%) among all the species and was registered in most of the studied biotopes of the reserve. The species frequency constituted 100% in woods, tree plantations, ecotone zone of forest and 88% in forest belt, in paludous biotopes with shrub vegetation. The ecological significance of the bank vole was constant at ecotone zone, in paludous biotopes with shrub vegetation (H'=7.48%) and characteristic in forest biotopes (12.87%). At forest-pond ecotone the ecological significance of the species was characteristic (11.73%).

Thus, the bank vole is a typical forest species, common in deciduous forests, widely spread in wood habitats, at forest edge and in various ecotone zones of the woods. The species was mentioned as one of the dominant in various forest ecosuystems all over the republic territory (SAVIN et al., 2011; NISTREANU et al., 2015).

The parasitological studies included the investigation of 29 individuals of *M. glareolus* collected from the Reserve „Plaiul Fagului" at the ecotone between forest and pond.

The taxonomic structure (Table 1) of parasite fauna in collected *M. glareolus* is formed by 4 classes, 12 families, 14 generaand 15 species. The diversity structure consists of one parasite species from the Trematoda class (*Plaghiorchis elegans*), 7 species from the Cestoda class (*Skrjabinotaenia lobata, Catenoteania cricetorum, Paranoplocephala omphaloides, Rodentolepis straminea, Hydatigera taeniaeformis, Taenia pisiformis, Mesocestoides lineatus*), 5 species from the Secernentea class (*Syphacia stroma, Syphacia obvelata, Heligmosomoides polygyrus, Mastophorus muris, Strongyloides ratti*) and 2 species from the Adenophorea class (*Trichuris muris, Calodium hepaticum*). It must be mentioned that among parasite species, 2 have a zoonotic impact (*Syphacia stroma, Syphacia obvelata*).

Table 1. Taxonomic structure of parasite fauna in *M. glareolus.*

Class	Family	Species	Total
Trematoda	*Plagiorchidae*	*Plagiorchis elegans* (Rudolphi, 1802)	**1 species**
Cestoda	*Catenotaeniidae*	*Skrjabinotaenia lobata* (Baer, 1925)	**7 species**
		Catenotaenia cricetorum (Kirshenblat,1949)	
	Anoplocephalidae	*Paranoplocephala omphaloides* (Herman, 1783)	
	Hymenolepididae	*Rodentolepis straminea* (Goeze, 1782)	
	Taeniidae	*Hydatigera taeniaeformis* (Batsch, 1786)	
		Taenia pisiformis (Bloch, 1780)	
	Mesocestoididae	*Mesocestoides lineatus* (Goeze, 1782)	
Secernentea	*Oxyuridae*	*Syphacia obvelata* (Rudolphi, 1802)	**5 species**
		Syphacia stroma (Linstow, 1884)	
	Heligmosomidae	*Heligmosomoides polygirus* (Dujardin, 1845)	
	Spirocercidae	*Mastophorus muris* (Gmelin, 1790)	
	Strongyloididae	*Strongyloides ratti* (Sandground, 1925)	
Adenophorea	*Trichuridae*	*Trichuris muris* (Scrank, 1788)	**2 species**
	Capilariidae	*Calodium hepaticum* (Bancroft, 1893)	

The diversity structure highlighted prevalence with *Plaghiorchis elegans* of 13.8%, intensity of 3.8 specimens and abundance of 0.51 sp., with *Mesocestoides lineatus larvae* – 14.0%, 1.5 sp., 0.2 sp., *Paranoplocephala omphaloides* – 10.3%, 2.7 sp., 0.28 sp., *Rodentolepis straminea* – 69.0%, 3 sp., 0.2 sp., *Hydatigera taeniaeformis* – 10.3%, 1 sp., 0.1 sp., *Catenotaenia cricetorum* – 10.3%, 2.7 sp., 0.28 sp., *Skrjabinotaenia lobata* – 10.3%, 3 sp., 0.31 sp., *Taenia pisiphormis* – 13.7%, 1.0 sp., 0.14 sp., *Calodium hepaticum* – 27.5%, and intensity was average (+++), *Syphacia stroma* – 17.2%, 94 ex, 22.8 ex, *Syphacia obvelata* – 24.1%, 84.9 sp., 23.4 sp., *Heligmosomoides polygirus* – 10.0%, 5.3 sp., 0.72 sp., *Strongyloides ratti* – 6.9%, 23.3 sp., 2.4 sp., *Mastophorus muris* – 17.2%, 3.6 sp., 0.62 sp. And with *Trichuris muris* the prevalence is of 17.2%, intensity of 3.8 sp. and abundance of 0.65 sp. (Table 2).

Table 2. Structure of parasite fauna diversity in *M. glareolus.*

Class	Species	Prevalence %	Intensity sp.	Abundance sp.
Trematoda	*Plagiorchis elegans*	13,8	3,8	0,51
Cestoda	*Skrjabinotaenia lobata*	10,3	3,0	0,31
	Catenotaenia cricetorum	10,3	2,7	0,28
	Paranoplocephala omphaloides	10,3	1,0	0,1
	Rodentolepis straminea	69,0	3,0	0,2
	Hydatigera taenieaformis	10,3	1,0	0,1
	Taenia pisiformis	13,7	1,0	0,1
	Mesocestoides lineatus	14,0	1,5	0,2
Secernentea	*Syphacia obvelata*	24,1	84,9	23,4
	Syphacia stroma	17,2	94,0	22,8
	Heligmosomoides polygirus	10,0	5,3	0,72
	Mastophorus muris	17,2	3,6	0,6
	Strongyloides ratti	6,9	23,3	2,4
Adenophorea	*Trichuris muris*	17,2	3,8	0,6
	Calodium hepaticum	27,5	+++	-

The most abundant were the species *Syphacia stroma* with an intensity of 94 sp./host and *Syphacia obvelata* with an intensity of 84.9 sp./host.

The increase of the invasive indices of all rodent species of investigated hosts is due to the fact that some Nematoda species are geohelminths (*Heligmosomoides polygirus*, *Trichocephalus muris, Calodium hepaticum*), which do not require intermediate hosts, the larvae of which are resistant, live freely and feed in the environment with successive development (*Syphacia stroma, Syphacia obvelata*), whose females lay fertilized eggs in the perianal region of the host, and infestation occurs by self-invasion or individual contact between the hosts thus omitting the

development in the environment or their eggs are transmitted by predators (*Vulpes vulpes*) that consume the infested hosts. Biohelminths (*Mesocestoides lineatus, Hydatigera taenieaformis*) have the fox as final host, which at their turn represent the main way of spread of invasive forms in the environment. The individual activity area of a fox is about 500 ha and in the Republic of Moldova the fox density exceeds 10 individuals per 1000 ha. The massive abundance of foxes on large areas, including thigh ecological plasticity with a synanthropic tendency, are the primary factors in the formation, maintenance and spread of parasitosis outbreaks with zoonotic and epizootic impact in different natural and anthropogenic ecosystems.

The results of the studies performed in the Republic of Moldova at the beginning of 60's of the past century are different from our data, where the infestation level with the Cestoda species varies depending on the host. Thus, the prevalence of the species *Paranoplocephala omphaloides* in *Microtus arvalis* was of 0.76%, *Catenotaenia cricetorum* in *M. arvalis* – 1.51%, in *Clethrionomys glareolus* – 22.32% and of *Skrjabinotaenia lobata* in *Apodemus flavicollis* constituted 4.37%, in *A. sylvaticus* – 2.67%. Some Nematoda species suc as *Heligmosomoides polygirus* in *A. flavicollis* constituted 0.95%, in *A. sylvaticus* – 1.06%, *Trichocephalus muris* in *A. sylvaticus* – 1.62% and in *Mus musculus* – 2.5%. Te most abundant species were *Syphacia obvelata* in *A. flavicollis* with intensity of 21.9% and *Syphacia stroma* – 10.47% (ANDREIKO, 1973). In Russia the helminth fauna in *A. flavicollis*is constituted by *Syphacia stroma* with a prevalence of 76.2%, *Heligmosomoides polygirus* – 29.3% *Syphacia obvelata* – 15.7% and *Trichocephalus muris*with 0.82% (ROMASHOVA, 2003). Some parasite species ave been reported from Lituania, as follows: *Trichocephalus muris* wit a prevalence of 33.3% in *C. glareolus*, 16.7% in *Microtus agrestis*; *Syphacia* sp. – 33.3% in *M. agrestis* (MAZEIKA et al., 2003). In Hungary the results of parasitological investigations in *Mus musculus* revealed the prevalence of some parasitic species: *Trichocephalus muris* of 8.5%, *Heligmosomoides polygirus* – 10.8%, *Syphacia obvelata* – 5.4% and *Syphacia stroma* – 0.2% (KRISKA, 1993).

Compared with previous years, the obtained results show a significant increase in invasive indices. This is probably due to large areas of fallow ground with favourable conditions for the development of small rodents. These factors would add to the considerable increase in the number of foxes (by 10 times), in which diet the rodents dominate (70%), and as a result they spread the parasitic forms, polluting different areas.

Similar parasitological studies were performed in Romania, where in 13 species of small mammals (*Crocidura leucodon*, *C. suaveolens*, *Sorex araneus*, *S. minutus*, *Neomys anomalus*, *Apodemus agrarius*, *A. flavicollis*, *A. sylvaticus*, *A. uralensis*, *Microtus agrestis, M. arvalis*, *M. subterraneus*, *Clethrionomys glareolus*) 29 parasite species were registered, among which: 3 species (10.3%) of Digenea, 14 species (48.3%) of Cestoda, one species (3.5%) of *Acanthocephala* and 11 species (38.0%) of Nematoda (GUBANYI et al., 2015). In Russia the parasite fauna in *A. flavicollis* is constituted: 16 species (18.8%) of Trematoda, 4 species (25.0%) of Cestoda, 8 species (50,0%) of Nematoda and one species (6.25%) of Acanthocephala (ROMASHOVA, 2003).

Some authors from Russia (ROMASHOVA, 2003) report a more diverse helminth fauna that is spread among more habitats in the host *A. flavicollis*. The longsome was (era scris gresit, Trebuie sa fie "In lung some species were found" found (*Syngamus* sp.) in the thoracic cavity – 2 species (*Alaria alata*, *Macrocanthorynchus catulinus*), in the liver – 4 species (*Taenia hydatigena larvae*, *Hydatigera taenieaformis larvae*, *Skrjabinoplagiorchis vigisi*, *Capilaria hepatica*), in the small intestine – 5 species (*Syphacia stroma*, *Heligmosomoides polygirus*, *Anoplocephaloides dentata*, *Plaghiorchis elegans*), and in the large intestine – 3 species (*Syphacia obvelata*, *Ganguloterakis spumosa*, *Trichocephalus muris*).

The obtained data elucidates the potential of the parasitic pollution risk of the interfering area between natural and anthropized ecosystems and as a result the transmission of invasive forms from wild animals to domestic animals, including to humans. At the same time, the rodents as component of the trophic chain of larger predators, and at their turn they as vectors of invasive forms in the environment, ensure the functional stability of the host-parasitic systems within the investigated biocenoses.

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CONCLUSIONS

1. The taxonomic structure of parasite fauna is constituted of 4 classes, 12 families, 14 genera and 15 species, of which 6.6% belong to the Trematoda class, 46.7% belong to the Cestoda class, and 46.7% belong to the Nematoda class. La fel: class Trematoda etc.
2. The rodents *M. glareolus* have the role of formation and maintenance of parasitic diseases foci, because they have individual activity sectors of several square meters.

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BEYOND THE RULE: A MOUNTAINOUS CAVE SPECIES, *Mesoniscus graniger* (ISOPODA, ONISCIDEA) ON A PLAIN OF SOUTH-WESTERN ROMANIA

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Abstract. *Mesoniscus graniger* (Frivaldsky, 1865) is a terrestrial isopod species generally known from mountainous karstic caves. Nevertheless, we found an endogeic population in Blahniţa Plain, south-western Romania, on a stream bank, at 81 m altitude. The presence of this endogeic plain population may represent a new proof upon the species' habitat of origin.

Keywords: woodlice, tolerance, limestone, distribution, adaptation.

Rezumat. Dincolo de regulă: o specie de peşteri montane, *Mesoniscus graniger* (Isopoda, Oniscidea) într-o zonă de câmpie din sud-vestul României. *Mesoniscus graniger* (Frivaldsky, 1865) este un izopod terestru cunoscut, în general, din zone montane carstice. Totuşi, noi am găsit o populaţie endogee în Câmpia Blahniţei, sud-vestul României, pe malul unui pârâu, la 81 m altitudine. Prezenţa acestei populaţii endogee la câmpie poate reprezenta o nouă dovadă asupra habitatului de origine al speciei.

Cuvinte cheie: izopode terestre, toleranţă, zone calcaroase, distribuţie, adaptare.

INTRODUCTION

Mesoniscus graniger (Frivaldsky, 1865) is a Carpatho-Dinaric terrestrial isopod species (TĂBĂCARU & GIURGINCA, 2013), present in Slovenia, Serbia, Bosnia and Herzegovina, Slovakia, Romania (SCHMALFUSS, 2003) and Hungary, where it was described (FRIVALDSZKY, 1865) and re-identified subsequently (VILISICS et al., 2008, 2011). In Romania, it occurs first of all in the karstic caves of the Carpathian Mountains, but surface dwelling populations in mountainous areas were also recorded (e.g. GIURGINCA, 2000-2001, 2009; TĂBĂCARU & GIURGINCA, 2013). Nevertheless, there are too few endogeic occurrences known in order to establish their distribution (GIURGINCA, 2000-2001, 2009), although new cases were recently recorded (IANC & FERENŢI, 2014; FERENŢI & COVACIU-MARCOV, 2016). The species is considered to be absent in Dobrogea and the Romanian Plain (GIURGINCA, 2000-2001, 2009). *M. graniger* occurs in mountains in other areas than its distribution range (e.g. PIKSA & FARKAS, 2007; GIURGINCA, 2009).

MATERIAL AND METHODS

In order to investigate the terrestrial isopod fauna in the south-western Romanian plains, we used the direct, hand-sorting method. The investigated habitat is situated in the Blahniţa Plain, near Scăpău village (44°26'58.39"N / 22°43'01.92"E), at an altitude of 81 m. After the first identification of *M. graniger* in the autumn (September) of 2012, we monitored the habitat four more years (2013-2016). Each time the investigation method was represented by the direct method. We searched for terrestrial isopods in the wet soil near the water, but also under stones or concrete pieces. The identified individuals were stored in alcohol, and identified subsequently in the laboratory.

RESULTS

We identified *M. graniger* near Scăpău village in the Blahniţa Plain in south-western Romania (Fig. 1), in September 2012, 2013, 2015 and 2016. The individuals of *M. graniger* were present on the bank of a small stream, under a bridge. The stream has a stony substratum with some abandoned concrete pieces (Fig. 2). Even in the driest years, when the stream is dried out, there was moist under the concrete pieces. The stream is surrounded by rich herbaceous vegetation, reeds and some willows followed by agricultural zone. The closest forest habitat is few km away. Nine *M. graniger* individuals (1 male and 8 females) were collected in three of the four years monitoring.

DISCUSSIONS

Taking into account *M. graniger* mountainous distribution, (e.g. GIURGINCA, 2009), we did not expect to encounter it on a plain. Based on the present data (e.g. GIURGINCA, 2000-2001, 2009) this seems to be the first record of *M. graniger* in a plain within its entire distribution range. Its presence during the four years of monitoring let us suppose that *M. graniger* has a constant presence in the region. Previously, *M. graniger* was recorded in limestone free area in Romania only in the north-western part of the Transylvanian Plateau (see in: GIURGINCA, 2000-2001). Although the species was mentioned at low altitude (70 m) before, the locality was a cave in a limestone area with steep slopes and typical mountainous region of the Danube Gorge (GIURGINCA, 2009). At Scăpău *M. graniger* occurs in a flat plain

without forest (Blahnița Plain), being the warmest and driest region from Romania (STOENESCU et al., 1966) where the species was recorded. Previously *M. graniger* was considered adapted to a stenothermal environment with a low temperature range (e.g. GERE, 1964; ŠUSTR et al., 2005), but it seems to be more tolerant to the temperature. Probably the cave populations are more stenothermic (ŠUSTR et al., 2005) compared with the endogeic ones.

Figure 1. The distribution of *Mesoniscus graniger* in south-western Romania: ❍-old records (GIURGINCA, 2009), ●- new record.

Figure 2. The habitat of *M. graniger* from Scăpău (original picture).

The presence of *M. graniger* at Scapău is unexpected compared to to the previous distribution data on this species (GIURGINCA, 2009). This plain population found in a region without limestone, provides a good argument in the debate regarding the species origin (see in: TĂBĂCARU & GIURGINCA, 2013), probably advocating for its primarily endogeic nature. In Romania, another terrestrial isopods species, considered to be a cave species, was recently recorded at the soil surface (FERENȚI et al., 2016) The zoogeography of Mesoniscus has been discussed in different papers (e.g. STROUHAL, 1951; GIURGINCA, 2009; TĂBĂCARU & GIURGINCA, 2013). Because in the region there aren't caves, the individuals from Scăpău had not been resurfaced accidentally from caves in the soil's superficial layers, but they normally populate the soil. In the case of other invertebrates, like centipedes, species considered to be cave or typically mountain species, were recently identified in soil; the presence in soil was considered a consequence of their preference for low temperature (TUF et al., 2017). *M. graniger* seems to occupy the soil at 25-65 cm in depth, in karst areas (RENDOŠ et al., 2016). Nevertheless, being easier to identify it in caves than in soil, the number of *M. graniger* records from caves is higher than the one from soil (GIURGINCA, 2009). In the same time, the species was not identified in artificial underground habitats like abandoned railroad tunnels which are isolated from the natural substratum (COVACIU-MARCOV et al., 2017a). The species presence in Blahnița Plain may suggest that *M. graniger* is present also in other plains from its distribution range.

The presence of *M. graniger* in Blahniţa Plain is an additional example of the peculiarities in the distribution of some animal groups in this region. In Blahniţa Plain other epigeic mountain terrestrial isopods (*Hyloniscus transsilvanicus* (Verhoeff, 1901)*, Ligidium germanicum* Verhoeff, 1901) were recorded at their lowest altitude in the country, being also considered relicts (FERENŢI & COVACIU-MARCOV, 2014). In addition, the Blahniţa Plain shelters a forest lizard species in unforested habitats (COVACIU-MARCOV et al., 2009). Moreover, recently a *Salamandra salamandra* (Linnaeus, 1758) population was identified near Scăpău, at the lowest altitude in Romania (COVACIU-MARCOV et al., 2017b), at only few km from *M. graniger* habitat. Probably, *M. graniger* is also a relict species in the region, the endogenous population being able to survive in the glacial periods only in refuge areas without permafrost. Nevertheless, this plain population opens a new perspective in the global insight of *M. graniger* distribution range, origin and ecology.

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DISTRIBUTION OF THE ARANEIDES FAUNA ACCORDING TO VEGETATION AND ALTITUDE IN TEBESSA REGION (EXTREME EAST OF ALGERIA)

BOUGUESSA-CHERIAK Linda, DJABRI Majda, BOUGUESSA Slim

Abstract. The spider fauna is the subject of a bioecological study according to the vegetation cover and the altitude in the region of Tébessa, which is located at the East of Algeria. A total of 347 individual belonging to 18 families are enumerated, 14 families at El Merdja and 11 families at Ain Fodda. The families Gnaphosidae, Lycosidae and Salticidae are very abundant at El Merdja and the most diversified, while Gnaphosidae is the dominant family in Ain Fodda. The peak abundance of this fauna is found in April at El Merdja and in May at Ain Fodda which is due to the abundance of Gnaphosidae during these months, in both stations. The results showed a decreasing evolution of the diversity according to the altitude, accompanied by a high abundance of the tolerant fauna whereas the prairial vegetation allows the appearance of a great richness within this fauna.

Keywords: spider families, Tebessa, diversity, abundance, dominance.

Rezumat. Distribuția faunei de araneide în funcție de vegetație și altitudine în regiunea Tebessa (Estul extrem al Algeriei). Fauna arahnidelor face subiectul unui studiu bioecologic în funcție de acoperirea cu vegetație și de altitudine, în regiunea Tébessa, din estul Algeriei. Sunt enumerate în total 347 de exemplare din 18 familii, 14 în El Merdja și 11 în Aid Fodda. Familiile Gnaphosidae, Lycosidae și Salticidae sunt foarte abundente în El Merdja și sunt cele mai diversificate, în timp ce familia dominantă în Ain Fodda este Gnaphosidae. Abundența maximă a acestei faune se înregistrează în luna aprilie în El Merdja și în luna mai în Ain Fodda, ceea ce se datorează abundenței Gnaphosidae în aceste luni în ambele stații. Rezultatele au prezentat o evoluție descrescătoare a diversității în funcție de altitudine, însoțită de o abundență ridicată a faunei tolerante, în timp ce vegetația de prerie permite apariția unei bogății semnificative la nivelul acestei faune.

Cuvinte cheie: familii de arahnide, Tebessa, diversitate, abundență, dominanță.

INTRODUCTION

As generalist predators, spiders colonize all habitat types, although they are more diverse and abundant in natural environments (NYFFELER, 2000). Present in many terrestrial biotopes, spiders are represented by many species whose stands are indicative of precise ecological conditions (POZZI et al., 1998). Their sensitivity to changes in environmental structures have made these animals fine indicators of habitat evolution (DERRON & BLANDENIER, 2002). Habitat structure and, more precisely, vegetation complexity, has been consistently recognized as one of the most important factors in determining the presence of spider species, as well as their species richness and composition (BALFOUR & RYPSTRA, 1998), to the point where some authors have been able to propose methods of ecological classifications of natural habitats, based solely on the diversity of spiders (SCHIRMEL & BUCHHOLS, 2011). JOGAR et al. (2004) found that spider abundance is correlated with specific vegetation, suggesting that habitat availability is important for settlement and colonization of spiders. The oldest works on the Araneological fauna in Algeria are those of SIMON (1914, 1929, 1937), followed by those of Bosmans in collaboration with several Algerian researchers such as BOSMANS & BELADJAL (1988, 1989) in the park of Chrea; BOSMANS & ABROUS (1990); BOSMANS & BOURAGBA (1992) in the Algerian Atlas; BOSMANS & DESMET (1993). Later, BRAGUE-BOURAGBA et al. (2007) BRAGUE- BOURAGBA (2007) and (BOURAGBA et al. (2016) at Djelfa, KHERBOUCHE-ABROUS (2006), MANSOURI et al. (2013) at Algiers, and many others.

Research in this subject is non-existent in the east of Algeria, that's why we are interested in this work, which aims to complete the inventory of this fauna and to know the spatio-temporal evolution of this fauna in the study area.

MATERIALS AND METHODS

The region of Tébessa is located in the far east of the country on the highlands, it is coordinated 35° 29'N., 08° 8'E, it has an area of 13878 km2. It is limited by the wilayas of Souk-Ahras in the North, El-Oued in the South, Oum El-Bouaghi and Khenchela in the West and East by the Tunisian territory (Fig. 1). The climate is typically semi-arid continental type (cold winter and hot summer) and the region belongs to the steppe with an agro pastoral vocation Fig. 1.

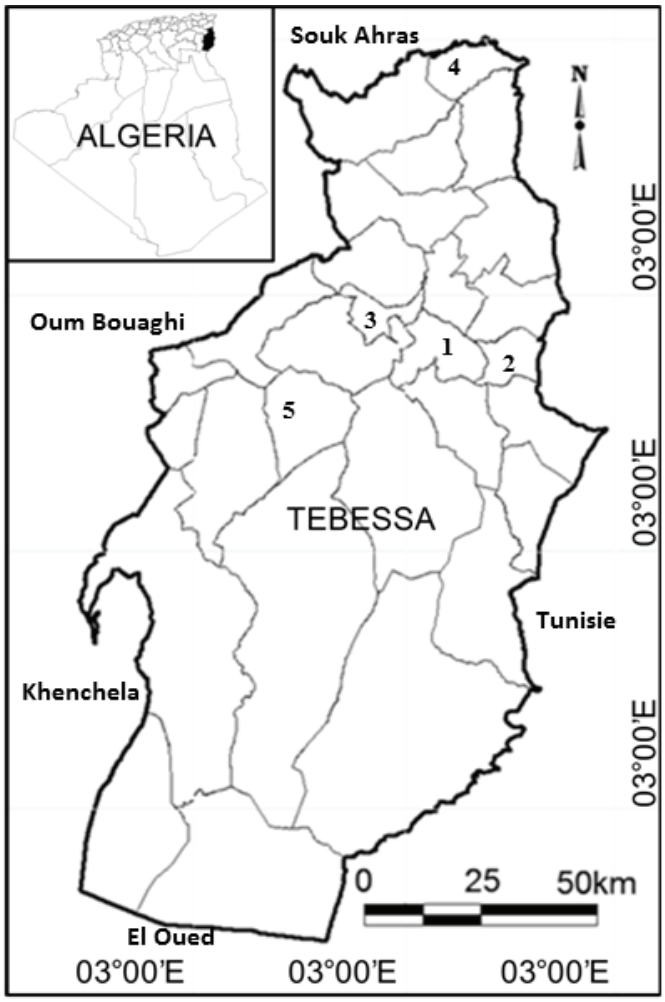

Figure 1. Geographical location of the study area (DJELLAB, 2013).

Based on altitude and vegetation cover, two stations were chosen for this study:

Station 1: El Merdja (35 ° 24 '52,55' 'N.8 ° 08'00,15"E) is located in the high Tellian Plain area east of Tébessa at 811m altitude. Grassland type, with very varied vegetation , we mainly encounter Borraginaceae (*Borago officinalis* L. 1753), Poaceae (*Hordeum* sp.) and Apiaceae (*Daucus carota* L.1753).

Station 2: Ain Fodda (35° 33'17, 51''N, 7° 49'00, 40''E) is located in a mountainous area west of Tebessa at 1103m altitude. The vegetation cover is limited to a pine forest (*Pinus halepensis* Mill. 1768) and a very spaced vegetation composed mainly of medicinal plants including lamiaceae (*Rosmarinus officinalis* L.1753 and *Thymus algeriensis* Boiss. & Reut.) and Asteraceae (*Artemisia herba alba* Asso 1779).

The visits take place every fortnight for 5 months. The spiders are harvested using ground traps (Barber) for the soil species, the species at canvas are captured by hand or with a filleting net.

Eight traps are placed at the rate of four per station, under the dominant plants of the study station.

The samples are kept in alcohol at 70°, they are sorted, identified, counted then stored in boxes of the collections. The spider families are determined with a binocular loupe based on identification keys (PERRIER, 1972; HUBERT, 1979; GODET, 1994; JONES et al., 2001) it is pushed to the genera and species for some dominant families.

The results obtained are exploited by ecological indices of composition (specific richness, abundance and relative abundance).

RESULTS

A total of 347 individuals were captured during the study period in the Tebessa region, belonging to 18 families (Table 1).

Table 1. inventory of spider families from Tebessa region during the study period.

Sub Phylum	Class	Order	Sub Order	Families
Chelicerata	Arachnida	Araneae	Araneomorphae	Gnaphosidae **Pocock,1889**
				Clubionidae **wagner, 1887**
				Lycosidae **Sundevall,1833**
				Dysderidae **C.L. Koch, 1837**
				Salticidae **Blackwall,1841**
				Thomisidae **Sundevall,1833**
				Agelenidae **C.L. Koch, 1837**
				Linyphiidae **Blackwall,1859**
				Araneidae **Clerck,1757**
				Pholcidae **C.L. Koch, 1850**
				Pisauridae **Simon,1890**
				Theridiidae **Sundevall,1833**
				Tetragnathidae **Menge,1866**
				Zodariidae **Thorell,1881**
				Oxyopidae **Thorell, 1870**
				Oonopidae **Simon,1890**
				Sicariidae **Keyserling, 1880**
				Filistidae **Ausserer, 1867**

Some families are nocturnal, hunters without a web like Gnaphosidae and Dysteridae, others are diurnal and without web like Thomisidae and Salticidae while others weave webs like Agelenidae and Araneidae. With 14 families, El Merdja is more diversified than Ain Fodda (11 families). Three families of spiders are mainly found at El Merdja where Gnaphosidae with 34,12 % is the dominant family followed by Lycosidae (24,17 %) and Salticidae (17,06 %). The other families are weakly found (Fig. 2).

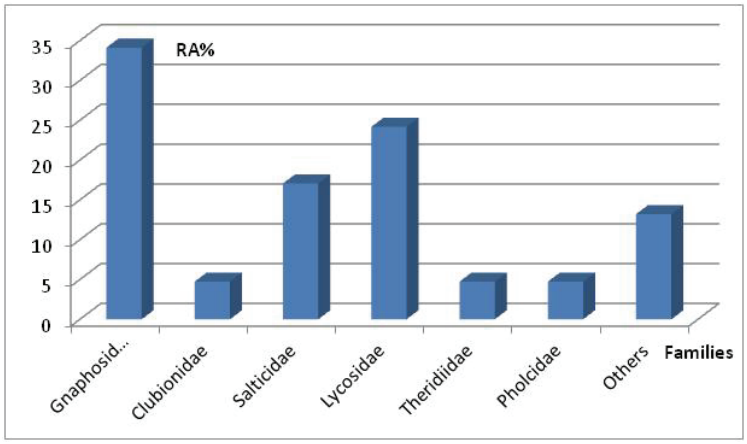

Figure 2. Relative abundance of spider families at El-Merdja station.

At Ain Fodda station, more than 3/4 of the spider population is represented by the family Gnaphosidae (75,73%), while the other families are weakly found (Fig. 3).

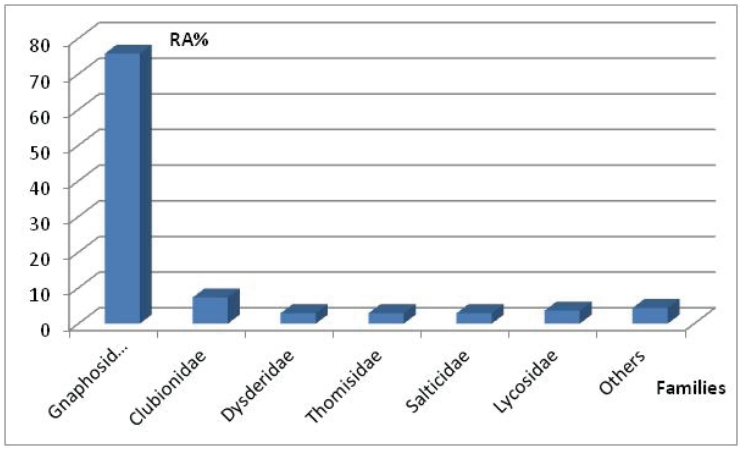

Figure 3. Relative abundance of spider families at Ain Fodda station.

Phenology of the Spider Stan

The distribution of abundance of spider families varies from month to month and from station to another (Table 2).

Table 2. Monthly variations in the abundance of spider families at study stations.

Stations / Months / Spider familys	Ain Fodda					El Merdja				
	March	April	May	June	July	March	April	May	June	July
Gnaphosidae	4	22	33	37	7	13	40	5	8	6
Clubionidae	2	6	1	1	0	3	5	0	2	0
Dysderidae	0	1	1	2	0	0	2	0	0	0
Thomisidae	2	1	0	1	0	0	2	0	2	0
Salticidae	1	2	1	0	0	0	5	9	14	8
Lycosidae	0	2	1	1	1	3	9	11	13	15
Oonopidae	0	0	1	0	0	0	0	0	0	0
Pisauridae	0	0	1	0	0	0	0	0	0	0
Sicariidae	0	0	0	1	0	1	1	0	0	0
Filistidae	0	0	0	1	0	0	0	0	0	0
Theridiidae	0	0	0	0	0	0	4	1	4	1
Pholcidae	0	0	0	0	0	1	5	2	2	0
Zodariidae	0	0	0	0	0	0	0	0	1	0
Araneidae	0	0	0	0	0	0	1	0	2	0
Agelenidae	0	0	2	0	0	0	0	0	0	0
Linyphiidae	0	0	0	0	0	1	4	2	0	0
Oxyopidae	0	0	0	0	0	0	1	0	0	0
Tetragnathidae	0	0	0	0	0	0	0	1	0	1

The evolution curve of the abundance of spider families at El Merdja station over the months presents 2 picks, the most important is recorded during April, probably because Gnaphosidae is represented by an important abundance, while the second pick is less important and is noted in June because of the simultaneous abundance of Salticidae and Lycosidae (Fig. 4).

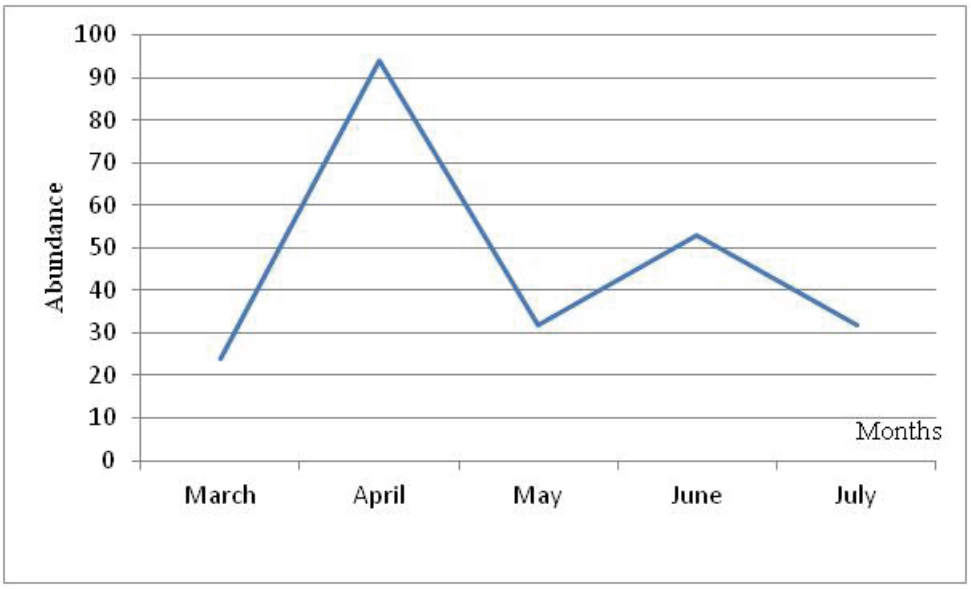

Figure 4. Evolution of abundance spider's families during the study period at EL-Merdja station.

At Ain Fodda station the maximum abundance is recorded in June, probably because of the family Gnaphosidae which is very abundant during this month (Fig. 5).

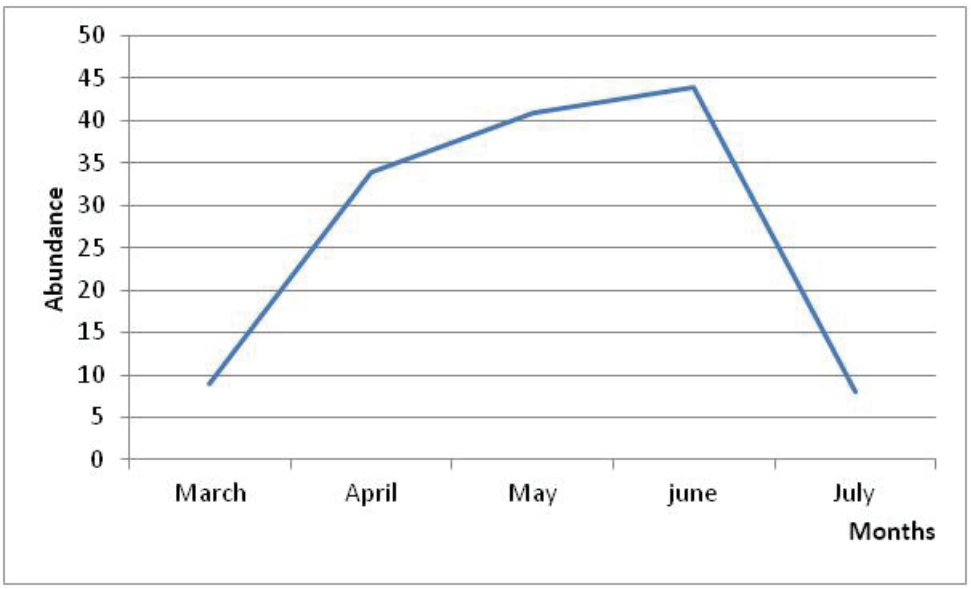

Figure 5. Evolution of abundance spider's families during the study period at Ain Fodda station.

Evolution of the main families of spiders during the study period

At El Merdja station, the main spider families show a variable relative abundance over the months of study, Gnaphosidae is the most dominant family during March and April (85.71%, 73.07%) respectively, Salticidae (50%, 41.02%) in June and Lycosidae in May and July (35,48% and 53.84%) (Fig. 6).

These are the same families that are the most diverse: Lycosidae with 9 genera like *Pardosa* and *Lycosa,* Gnaphosidae with 8 genera like *Gnaphosa* and *Drassodes* and Salticidae with 4 genera such as *Chalcoscirtus*; other families are not very diversified (between 1-2 genera).

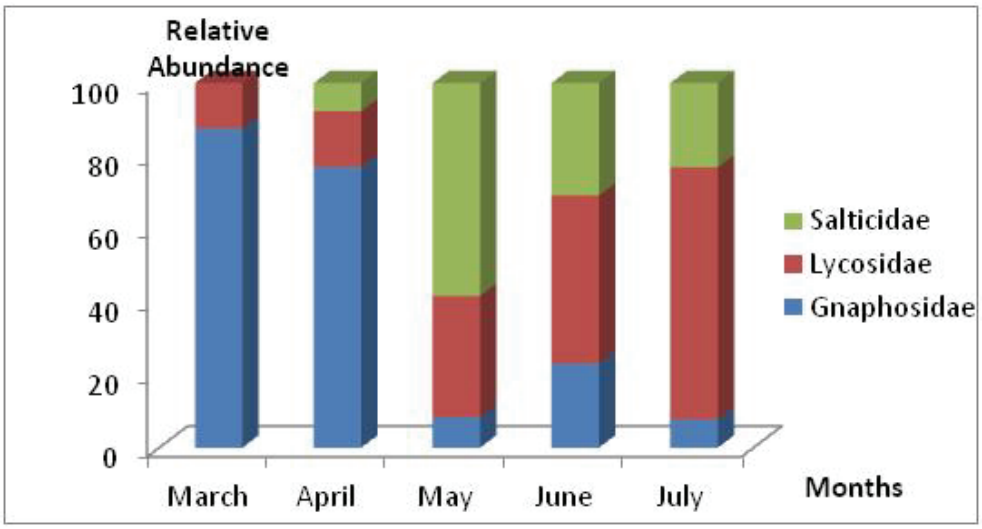

Figure 6. Relative frequencies of the main families at El-Merdja station.

It is interesting to note that Gnaphosidae is the most constant family in this station, followed by Lycosidae and Salticidae the other families are rare or accidental.

In Ain Fodda station, Gnaphosidae represents the dominant family during the five months of study recording a maximum in June (84,09 %) and a minimum in March (44,44%), it is supported during the last month by Thomisidae and Clubionidae ; the other families are weakly found (Fig. 7).

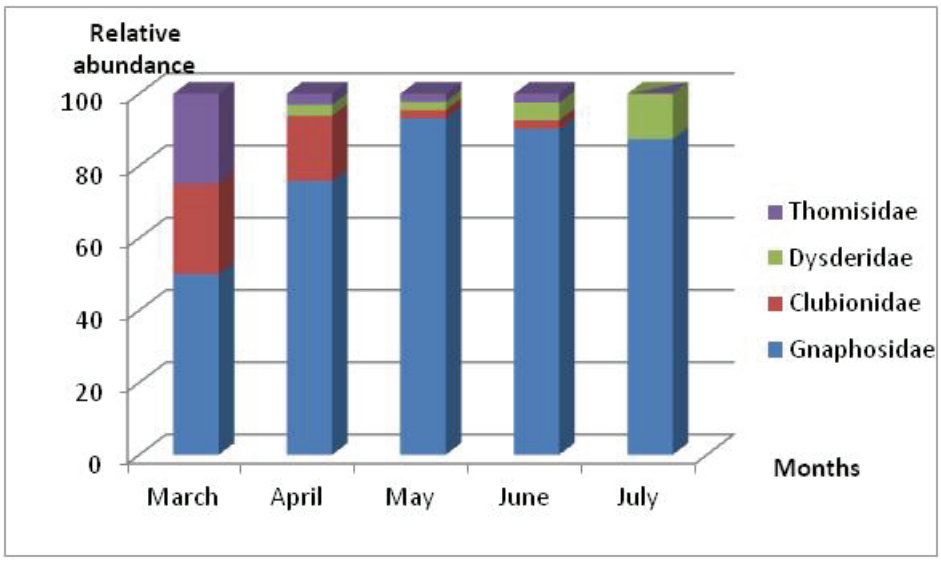

Figure 7. Relative frequencies of the main families at Ain Fodda station.

These are Gnaphosidae and Thomisidae with 5 genera and 4 genera respectively which are the richest where *Zelotes*, Trochosa and *Oxyptila* are the most common kinds.

DISCUSSION

The total number of individuals captured (347) with a diversity of 18 families during a five month period from March to July is comparable with other results recorded in the world: 21 families in Greece (CHATZAKI et al. 1997) , 15-17 in the arid grasslands of New Mexico (MUMA, 1980), 20-22 family in a maquis in Greece (PARASCHI, 1988) and 17 families in northern Poland (SZYMKOWIAK & WOZNY, 1997).

With 14 families, El Merdja station is more diversified than Ain Fodda station (11 families), since the altitudinal factor acts only on its diversity. While 20 families were recorded in the first station in 2003 (DJABRI, 2004). In the Djellal station at Djelfa (semi-arid climate at western Algeria), BOURAGBA et al. (2016) identified 21 species in 1992 and 33 species in 1993, demonstrating the influence of several factors on the diversity of this fauna.

Gnaphosidae is the dominant and most abundant family in both study stations, this dominance is explained by the installation of this family in dry habitats (CHATZAKI et al., 1997) and is cited among the most dominant families in Egypt (SALLAM, 2006) and it's also the most abundant at Sicily in Italy, and is one of the largest xerophilous spider families in Greece like for all Mediterranean countries (CHATZAKI, 2008).

Lycosidae is the most diverse family at El Merdja with a fairly high abundance in this station because of the type of this habitat, since lycosides are the spiders of the grasslands par excellence and are emerging on Poaceae which form thin rows of grass (JOCQUÉ & ALDERWEIRELDT, 2005). However BOUMEZZOUGH (1983) has noted the dominant place occupied by this family among epigeic and riparian fauna of the watershed of "Aille" river in France. This family is absent in the second station since it is particularly rare in dense forests (WARUI et al., 2005). This family with a succession of species makes its appearance from March to July in 2003 (DJABRI, 2004), and is the most abundant spiders in this station on 2007 (CHERIAK, 2017).

The dominance of Salticidae during this period coincides with the appearance of the flowers because this family is nectivorous (JACKSON et al., 2001) in Greece. It is diversified and demonstrates a better density to compare with the other families of the site (CHATZAKI et al., 1997), and its diversity is correlated with the height of the vegetation in the environment (JACKSON et al., 2001).

Thomisidae has large distribution, with a wide ecological tolerance but with a great dependence of environmental factors because of its life cycle (JIMENEZ-VALVERDE & LABO, 2007).

With 211 individuals Araneological fauna is more abundant at El Merdja than Ain Fodda (136 individuals).

The peak of abundance which take place in April at El Merdja reflects the availability of this family in this site, since the cohabiting wading birds (*Ciconia ciconia*) and *Bulbulcus ibis* consumes their biggest share of spiders prey during this same month in this station (SELMANE, 2009; GHERISSI, 2010), on the other side the peak of abundance shifted in May at Ain Fodda station represents probably the first peak since the phenology of spiders in Mediterranean ecosystems show two peaks in spring and autumn (CHATZAKI et al., 1997).

Despite the dominance of Gnaphosidae Analysis of changes in the abundance of dominant families revealed at El Merdja station a succession of peaks of dominant families and the replacement of one by the other. In Poland Lycosidae is replaced by Erigonidae, and Tetragnatidae (SZYMKOWIAK & WOZNY, 1997) whereas at Ain Fodda station Gnaphosidae is the most abundant during all months of study, probably it has a large ecological tolerance, CHATZAKI et al. (2005)

considered this result from relaxation of competitive interactions with other species. In Crete (Greece) 76% family's species are found at more than 500m, while 24% are at more than 1000m (CHATZAKI et al., 2005).

CONCLUSION

The study of habitat and altitude impact on spider fauna in the Tebessa region of Algeria has shown that the maximum diversity of the araneological population is found in grassland type habitat (El Merdja) where the number of spider families is higher. Abundance of this fauna also varies depending on the habitat probably due to the activity of spiders that respond to local habitat conditions, with the exception of Gnaphosidae which is dominant in both habitats. The altitudinal factor acts on the phenology of spiders, they are early and more abundant at low altitude; and on diversity too which is higher in low altitude.

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NEW DATA ON THE DISTRIBUTION OF LARGE BRANCHIOPODS (BRANCHIOPODA: ANOSTRACA, NOTOSTRACA, SPINICAUDATA) IN BIHOR COUNTY, NORTH-WESTERN ROMANIA

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Abstract. In the year 2017 we identified in the northern and central regions of Bihor County from western Romania large Branchiopods in 19 habitats from 17 localities. They were represented by four species: *Branchipus schaefferi*, *Lepidurus apus*, *Triops cancriformis* and *Leptestheria dahalacensis*. *B. schaefferi* was the only common species, the others being encountered in just one, two or three localities. *L. dahalacensis* was mentioned for the first time in the region. According to the literature, this is the second record of *L. dahalacensis* in western Romania.

Keywords: temporal waters, crustaceans, distribution, agricultural areas.

Rezumat. Noi date asupra distribuției branhiopodelor mari (Branchiopoda: Anostraca, Notostraca, Spinicaudata) în județul Bihor, nord-vestul României. În anul 2017 am identificat în regiunile centrale şi nordice ale judeţului Bihor din vestul României, Branchiopode mari în 19 habitate din 17 localităţi. Acestea au fost reprezentate de patru specii: *Branchipus schaefferi*, *Lepidurus apus*, *Triops cancriformis* şi *Leptestheria dahalacensis*. *B. schaefferi* a fost singura specie comună, celelalte fiind întâlnite în doar una, două sau trei localităţi. *L. dahalacensis* a fost menţionată pentru prima dată în regiune. Conform literaturii, acesta este a doua semnalare a speciei *L. dahalacensis* în vestul României.

Cuvinte cheie: ape temporare, crustacee, distribuție, zone agricole.

INTRODUCTION

Although temporary waters were common in Europe in the past, they were eliminated from large areas because of human interventions (WILLIAMS et al., 2001). In these habitats, large Branchiopods are considered helpful in testing the habitat's quality and functions (see in: BRENDOCK et al., 2008). They are threatened by agricultural activities, which directly eliminated their habitats, and also by hydrological changes (EDER & HÖDL, 2002). The protection of this important group implies maintaining high habitat diversity (BOVEN et al., 2008). Romania is a country with a high number of large Branchiopod species (26 species) compared to other European countries (DEMETER & STOICESCU, 2008). This great diversity of the large Branchiopod fauna indicated the importance of Romania for the protection of this group (DEMETER & STOICESCU, 2008). Nevertheless, with all the high species richness, there are very few recent data on this group in Romania, regions without any recorded species still existing in the country (DEMETER & STOICESCU, 2008). Bihor county in western Romania is not one of those zones, but the number of known species is still low (DEMETER & STOICESCU, 2008). In the region there are some old fauna notes on large Branchiopods (COVACIU-MARCOV & POP, 1999; CUPŞA & COVACIU-MARCOV, 2001, 2002) and some new data in a review article from 2008 (DEMETER & STOICESCU, 2008). However, in Bihor county there is no more recent information on this group, and the number of known distribution localities is low (DEMETER & STOICESCU, 2008). Thus, in the year 2017 we investigated some localities from the northern and central regions of Bihor County in order to contribute with new data to the knowledge on the distribution of large Branchiopods in this region.

MATERIAL AND METHODS

The field study was made in the year 2017. We have investigated 26 localities; large Branchiopods were present in 17 localities. Bihor County is situated in western Romania (TUFESCU, 1986). The investigated region was represented by the northern and central sectors of the county, containing parts from the Romanian Western Plain and Western Hills (MÂNDRUŢ, 2006). The region is covered almost completely by agricultural areas. Large Branchiopods were collected over many field trips, made especially in spring and autumn, when the rainfalls caused the accumulation of water in their habitats. On the field we investigated different localities from Bihor county looking for habitats suitable for large Branchiopods. The individuals were collected with a round net with an opening of 10 cm², mounted on a handle of approximately 1 m length. The collected individuals were conserved in test tubes and determined in the laboratory at a stereomicroscope. The species were determined with the help of the literature (BOTNARIUC & ORGHIDAN, 1953; ŠRAMEK-HUŠEK et al., 1962).

RESULTS

In the central and northern areas of Bihor County we have encountered large Branchiopods in 17 localities (Fig. 1). From those localities we collected 19 samples in which we determined four species: *Branchipus schaefferi* Fisher, 1884, *Lepidurus apus* Linnaeus, 1758, *Triops cancriformis* Bosc, 1801 and *Leptestheria dahalacensis* Rüppel, 1837 (Table 1.). Two species, *L. apus* and *T. cancriformis* belonged to Notostraceae, one species *B. schaefferi* belonged

to Anostraceae, and one species *L. dahalacensis* to Spinicaudatae. Totally we collected 235 large Branchiopod individuals, from which 222 belonged to the species *B. schaefferi*. The other three species were represented by a much lower number of individuals. Thus, *L. apus* was represented by six individuals, *T. cancriformis* was represented by four individuals and *L. dahalacensis* was represented only by three individuals. The percentage abundance of large Branchiopods in Bihor County was the following: *B. schaefferi* 94.46%, *L. apus* 2.55%, *T. cancriformis* 1.70% and *L. dahalacensis* 1.27%. Like in the case of the percentage abundance, *B. schaefferi* held the first place also in terms of frequency of occurrence. This species was present in each locality with large Branchiopods, having a frequency of 100%. *L. apus* registered a frequency of 10.52%, *T. cancriformis* registered a frequency of 20.05% and *L. dahalacensis* a frequency of only 5.26%.

Figure 1. Large Branchiopods habitats in Bihor County (S1 – Abrămuț; S2 – Cadea; S3 – Cherechiu; S4 – Cherechiu / Cheşereu; S5 – Cheriu; S6 – Cheşereu; S7 – Cheț; S8 – Cihei; S9 – Crestur; S10 – Ineu de Criş; S11 – Niuved; S12 – Parhida; S13 – Petreu; S14 – Săcuieni border; S15 – Sânlazăr; S16 – Tămăşeu / Parhida; S17 – Tarcea).

Table 1. Distribution of large Branchiopods in Bihor County, Romania.

Locality	***B. schaefferi***	***L. apus***	***T. cancriformis***	***L. dahalacensis***
Abrămuț	X	X	X	-
Cadea	X	-	-	-
Cherechiu 1	X	-	-	-
Cherechiu 2	X	-	-	-
Cherechiu / Cheşereu 1	X	-	-	-
Cherechiu / Cheşereu 2	X	-	-	-
Cheriu	X	-	-	X
Cheşereu	X	-	-	-
Cheț	X	-	-	-
Cihei	X	-	X	-
Crestur	X	-	-	-
Ineu de Criş	X	-	-	-
Niuved	X	-	-	-
Parhida	X	-	-	-
Petreu	X	-	-	-
Săcuieni border	X	-	-	-
Sânlazăr	X	X	X	-
Tămăşeu / Parhida	X	-	-	-
Tarcea	X	-	-	-

In the northern and central areas of Bihor County, large Branchiopods were recorded in three habitat types: wheel tracks in agricultural areas produced by the passing of agricultural machineries, temporary waters situated near more natural zones (forest or pasture) and near some unpaved country roads, covered with stones. Most individuals were collected from wheel tracks in agricultural areas (119). Fewer individuals were collected from more natural areas (38). *B. schafferi* was encountered in all three habitat types, but he majority of individuals were present in agricultural

areas. *L. apus* was encountered both in agricultural areas and in more natural ones. *T. cancriformis* was recorded in all three habitat types. Unlike the previous species, *L. dahalacensis* was collected only in more natural habitats.

DISCUSSIONS

One of the four large Branchiopod species identified in the year 2017 (*L. dahalacensis*) was recorded for the first time in Bihor County according to the most recent data upon the distribution of this group in Romania (CUPŞA & COVACIU-MARCOV, 2001, 2002; DEMETER & STOICESCU, 2008). Moreover, for *L. dahalacensis* the locality from Bihor County seems to be the second record of this species in western Romania (DEMETER & STOICESCU, 2008). These results, despite the small investigated area, indicate how little is known about the distribution of this group in western Romania.

In Bihor County from western Romania the most common large Branchiopod species was *B. schaefferi*. Thus, from the four species identified in the region, *B. schaefferi* is the most capable to use all analyzed types of habitats, previously being indicated that it can survive both in temporal waters and in deeper ones (BELADJAL et al., 2003). In Romania the species seems to be common, being mentioned in numerous localities in the country, with the exception of eastern Romania (DEMETER & STOICESCU, 2008). The species proved to be common also in other regions from the Pannonian Plain, like the central areas of Hungary (BOVEN et al., 2008). Nevertheless, in other regions like Poland, even if the number of populations from some areas seems high, the species seems however in decline, surviving only in few regions (GOŁDYN et al., 2007, 2012), being threatened by the modifications of habitats (MIODUCHOWSKA et al., 2017). The species is considered rare in Portugal as well (MACHADO et al., 2017). Unlike these, *B. schaefferi* is very common in western Romania, being distributed uniformly in the entire studied area. The fact that most individuals were recorded in wheel tracks in agricultural areas is not surprising. This was also mentioned in other regions, where wheel tracks remained the only temporary aquatic habitats (VANSCHOENWINKEL et al., 2013). Probably this is the case in the northern and central areas of Bihor County too, where the investigated region was mostly represented by agricultural areas.

L. dahalacensis was identified only in a single locality, being the rarest species in the investigated region. The identification of *L. dahalacensis* in north-western Romania extends its previously known distribution range in the country (DEMETER & STOICESCU, 2008). However, its identification was expectable, taking into account the general distribution range of this species, which was recorded both eastwards and westwards from Romania (e.g. BRENDONCK et al., 1989; HÖDL & EDER, 1996; DOBRYNINA, 2010). Although in the studied region it was encountered only in relatively natural habitats, in other areas from the Pannonian Plain it was observed only in wheel tracks (BOVEN et al., 2008). Nevertheless, just like in the studied region, this species was rarely encountered in the central areas of Hungary (BOVEN et al., 2008).

T. cancriformis, although it was rare in the studied region, was mentioned in the past in different areas from Bihor County (COVACIU-MARCOV & POP, 1999; CUPŞA & COVACIU-MARCOV, 2001, 2002; DEMETER & STOICESCU, 2008), being a species with a large distribution range in Europe (EDER & HÖDL, 2002). Nevertheless, in the past, *T. cancriformis* was usually recorded near forests (COVACIU-MARCOV & POP, 1999; CUPŞA & COVACIU-MARCOV, 2001, 2002). This fact could explain the species rarity in the northern areas of Bihor County, where the forests are rare. Moreover all three localities, where it was identified in the studied region, are situated close to some forests. *L. apus* is even rarer than *T. cancriformis*, being recorded only in two localities. The relation of this species with transparent waters with vegetation (BOVEN et al., 2008) is also clear in the studied region. Thus, *L. apus* was encountered in deeper habitats (up to 50 cm) with reeds on the banks, in contrast to the ephemeral habitats from agricultural terrains with no aquatic vegetation. At least in the area with such habitats the species seems well represented. We have observed *L. apus* individuals even in concreted canals situated near asphalted roads, but which communicated with canals from agricultural terrains or pastures. Probably these habitats are remnants of some more natural areas, which were present in the region before the modernization of roads and the intensification of the agriculture.

Compared to the 26 large Branchiopod species in Romania (DEMETER & STOICESCU, 2008), the four species recorded in Bihor County are very few. Nevertheless, taking into account the fact one species was recorded for the first time in the region, the scarcity of knowledge on this group is obvious. The fact that only one species was well represented clearly shows the degree of the human impact upon this group in the region. Most habitats are artificial or heavily modified. Thus, the protection of these invertebrates, which can be realized by protecting their habitats (HODL & EDER, 1996), seems quite difficult.

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SOME OBSERVATIONS ON THE DIVERSITY, ABUNDANCE AND DOMINANCE OF EPIGEAL ARTHROPODS IN THREE ORCHARDS (CHERRY ORCHARDS, APPLE ORCHARDS, PLUM ORCHARDS), CRÂNG VILLAGE, VASLUI COUNTY, MOLDAVIA, ROMANIA, 1996

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Abstract. The paper is a synthesis of the original collection data of epigee arthropods from three orchards: cherry orchard, apple orchard, plum orchard. The aim of the paper is to present comparatively the variation of relative abundance and dominance of epigee arthropods (classes, orders of insects, Coleopteran families, Carabidae species) from the three orchards. The material was collected from the Crâng village, Vaslui County, 1996, Central Moldavian Plateau (Bârlad Plateau), by biology professor Roşca Monica, using Barber pitfalls in each orchard with preservative liquid, 4 % formalin solution and protected against rainfalls, five pitfalls in eich every orchard. The pitfalls have been operating in ecosystems continuously for 56 days. 1,217 specimens of epigeal Arthropods were collected in total, of which 605 (49.71 %) from the cherry orchard; 403 (33.11 %) from the apple orchard; 209 (17.17 %) from the plum orchard. In the cherry orchard, four classes of arthropods were collected; insects were eudominant, 587 (97.02%); seven orders of insects, Choleoptera 538 (91.75%), ten families of Coleoptera, the Carabidae family 441, (80.92) with 15 species. *Pseudoophonus rufipes* De Geer 1774 with 379 specimens (85.94%). Three classes of arthropods were collected in the apple orchard; insects 397 (98.51%) - six orders of insects; Choleoptera 373 (98.43%) - nine families of coleoptera; Carabidae, 326 (87.40) with 13 species, *Pseudoophonus rufipes* De Geer 1774, 286 individuals (87.73%). In the plum orchard, insects, 199 (95.22%) - 6 orders of insects, Choleoptera 158 (81.91%); 9 families of Choleoptera; Carabidae, 60 (37.97%); 8 species, *Pseudoophonus rufipes* 38 (63.33%). The presence of taxa in all those orchards is the following: two classes (Crustacea (Isopoda), Insecta; four orders of insects (Orthoptera, Choleoptera, Hymenoptera, Diptera; eight families of Choleoptera (Carabidae, Staphylinidae, Dermestidae, Elateridae, Tenebrionidae, Scarabaeidae, Chrysomelidae, Curculionidae); five species of Carabidae (*Pseudoophonus rufipes, P. griseus, Harpalus distinguendus, Zabrus tenebrioides, Amara consularis*).

Keywords: epigeal arthropods, abundance, dominance, cherry, apple, plum trees orchard.

Rezumat. Unele observații privind diversitatea, abundența și dominanța artropodelor epigee din trei livezi (livada de cireși, livada de meri, livada de pruni), satul Crâng, județul Vaslui, Moldova, România, 1996. Lucrarea este o sinteză a datelor originale de colectare a artropodelor epigee din trei livezi: livada de cireși, livada de meri, livada de pruni. Scopul lucrării este de a prezenta comparativ variația abundenței relative și a dominanței artropodelor epigee (clase, ordine de insecte, familii de Coleoptere, specii de Carabidae) din cele trei livezi . Materialul a fost colectat din satul Crâng, județul Vaslui, 1996, Podișul Central al Moldovei, (Podișul Bârladului) de către profesor de biologie Roșca Monica, folosind capcane Barber cu lichid conservant, 4 %, soluție de formalină, protejate împotriva precipitațiilor, cinci capcane în fiecare livadă. Capcanele au funcționat în ecosisteme, continuu, 56 de zile. În total, au fost colectate 1.217 exemplare de artropode epigee din care 605 (49,71%) din livada de cireși; 403 (33,11%), livada de meri; 209 (17,17 %), livada de pruni. În livada de cireși au fost colectate patru clase de artropode; insectele au fost eudominante, 587 (97,02 %); șapte ordine de insecte, Choleoptera 538 (91,75%), zece familii de coleoptere, familia Carabidae 441, (80,92), cu 15 specii. *Pseudoophonus rufipes* De Geer 1774 cu 379 exemplare (85,94%). În livada de meri au fost colectate trei clase de artropode; insecte 397 (98,51%) - șase ordine de insecte; Choleoptera 373 (98,43 %) - nouă familii de coleoptere; Carabidae, 326 (87,40) cu 13 specii, *Pseudoophonus rufipes* De Geer 1774, 286 indivizi (87,73 %). În livada de pruni, insecte, 199 (95,22 %) - 6 ordine de insecte, Choleoptera 158 (81,91%); 9 familii de Choleoptera; Carabidae, 60 (37.97 %); 8 specii, *Pseudoophonus rufipes* 38 (63,33 %). Prezența taxonilor în toate cele trei livezi: două clase, Crustacea (Isopoda), Insecta; patru ordine de insecte (Orthoptera, Choleoptera, Hymenoptera, Diptera); opt familii de Coleoptere (Carabidae, Staphylinidae, Dermestidae, Elateridae, Tenebrionidae, Scarabaeidae, Chrysomelidae, Curculionidae); cinci specii de Carabidae (*Pseudoophonus rufipes, P. griseus, Harpalus distinguendus, Zabrus tenebrioides, Amara consularis*).

Cuvinte cheie: artropode epigee, abundență, dominanță, livada de cireși, livada de meri, livada de pruni.

INTRODUCTION

Taxonomic units and subunits in the animal kingdom operate in action and interaction with the environment. Relief, the major structure of the environment, influences the main climate values, temperature, precipitations. The main relief form in Moldova is the Moldavian Central Plateau, subdivided into three subunits: the Suceava Plateau, the Moldavia Plateau and the Bârlad Plateau. Multiannual average values of temperatures are between 8-10 C, annual average rainfall, 400-500 mm, outdoor climatic influences are those of aridity.

Collection and research were performed in the South of Moldavia, Crâng locality, Vaslui County, 1996, subunity, Bârladului Plateau. The main forms of relief of the Bârlad Plateau are the hills. The maximum altitude of the Bârlad Plateau is 561 m. The climate is moderate-continental, with annual average temperatures of 8-10 degrees Celsius, average rainfall of 400-500 mm, outdoor climatic influences are those of aridity.

"In Moldavia (Romania), there were two phases in the knowledge of the species of ground beetles: a the first phase had a faunistic character and the second one, modern and of perspective, an ecological one. Ecology is the science of concrete biology".

The authors who published papers about the species of Carabids in Moldavia (Romania), apple trees orchards, are: TĂLMACIU M., TĂLMACIU NELA, DIACONU A., ARTENE I. (2006); TĂLMACIU M., TĂLMACIU N., DIACONU A. (2007); TĂLMACIU M., TĂLMACIU N., DIACONU A. (2008); TĂLMACIU M., TĂLMACIU N., DIACONU A. (2008).

As for plum trees orchards, the main authors are: TĂLMACIU NELA, TĂLMACIU M., GEORGESCU TH., FILIPESCU C. (2001); TĂLMACIU NELA, TĂLMACIU M., GEORGESCU TH., FILIPESCU C. (2002); TĂLMACIU NELA, TĂLMACIU M., FILIPESCU C., GEORGESCU TH. (2003); TĂLMACIU M., TĂLMACIU NELA, GEORGESCU TH. (2004); TĂLMACIU NELA, TĂLMACIU M., DIACONU A. (2007).

MATERIAL AND METHODS

The entomologic material is completely original and it was collected from the three orchards mentioned earlier, in order to show the influence of the kind of the ecosystem on the number of taxonomic arthropods (classes of arthropods, orders of insects, families of Choleoptera, species of Carabidae), 1996.

The entomological material was collected by Roşca Monica, teacher of Biology, first degree. 5 Barber pit-falls were used in each orchard to collect the material ecologically, rationally and continually. The traps were arranged in one row in each orchard. The distance among pit-falls was 5 m. The pit-falls were protected against rainfalls.

The pitfalls functioned continually in each ecosystem, in total 56 days, from May 20th till July 15th, 1996. Four collections were made and 60 samples were analysed, that is the content from 15 pit-falls (4 x 15) to determine the individuals belonging to classes of arthropods, orders of insects, families of Choleoptera, species of Carabidae.

The aim of the paper is to present the taxonomic structure of the epigeal arthropods (classes, orders of insects, families of Choleoptera, species of Carabidae, their abundance and dominance from three orchards Crâng Village, Vaslui County, southern Moldavia, Romania, 1996).

Objectives of the paper. 6 objectives of the paper were established, expressed in their natural and logical order: **1**. Documentation on the subject of the paper; **2.** Collecting the material from the three orchards; **3**. Taxonomic determination of the material; **4.** Knowledge of the presence of classes of Arthropods, orders of insects, families of Choleoptera and the species of the family Carabidae in the ecological conditions of those three orchards, 1996, Locality Crâng, Galaţi County, Southern Moldavia, Romania, 1996; **5**. Knowledge of the variation of the concrete values of the relative abundance and dominance of the classes of Arthropods, orders of insects, families of Choleoptera, species of Carabidae; **6**. Discussion of results.

The studied region (collections and researches) belongs to the South of Moldavia. The material is completely original and was collected from three orchards, mentioned above, to show the influence of the ecosystem on the number of taxonomic Arthropods (classes of Arthropods, orders of insects, families of Choleoptera), species of Carabidae, and their number of individuals, 1996. The scientific material was collected by Paşa Marin, a teacher of Biology. To collect the material ecologically, rationally and continually, 5 Barber pit-falls were used in each orchard. The traps in each orchard were arranged in one row. The distance among pit- falls was 5 m. The pit-falls functioned continually in the ecosystems 61 days, from May20 till July 20, 1996.

Four collections were made from each orchard and 60 samples were analysed in total, that is the content from 15 pit-falls x 4 to determine the individuals belonging to classes of arthropods, orders of insects, families of Choleoptera and species of Carabidae. The taxonomic order of the species of Carabidae in tables is according to NECULISEANU & MATALIN (2000).

RESULTS

The results of the paper are shown in four tables and represented graphically in three hystograms. In presenting the sub-units, results, discussions and conclusions, we followed and respected the natural, logical, pedagogical and psychological principle from general to particular.

Taxa exist through individuals having specific morphological characters from kingdom to species.

The main numerical characteristic of each taxon is the number of individuals. The number of individuals specific to a taxon is the result of evolution in perfect concordance with all the conditions of the environment. The total number of collected individuals was 1,217 (Table 1).

Table 1.The taxonomic structure, abundance and dominance of the epigeal Arthropods (classes) from three orchards, Crâng village, Vaslui County, Moldavia, Romania, 1996.

	Choleoptera, Name of classes	**Cherry orchard**		**Apple orchard**		**Plum orchard**		**Total**	
		A	**D %**	**A**	**D %**	**A**	**D %**	**A**	**D %**
1	Crustacea	2	0.33	4	0.99	10	4.78	16	1.31
2	Arachnida	15	2.48	2	0.50	-	-	17	1.40
3	Myriapoda	1	0.17	-	-	-	-	1	0.08
4	Insecta	587	97.02	397	98.51	199	95.22	1,183	97.21
5	**Total classes**	**4**		**3**		**2**		**4**	
6	**Total individuals**	**605**		**403**		**209**		**1,217**	
7	**% of total**	**49.71**		**33.11**		**17.17**			**100**

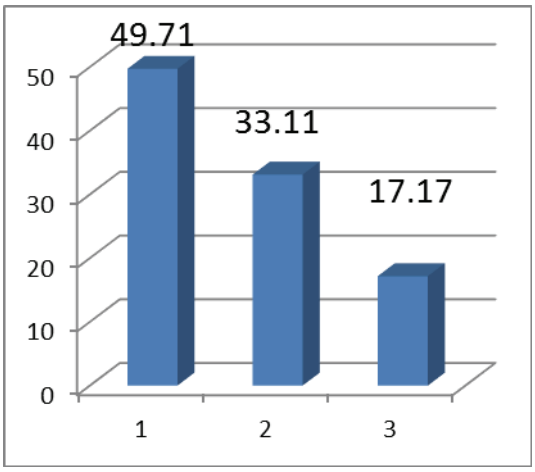

Figure 1. The percentage variation of the total number of individuals, collected from three orchards, Crâng Village, Vaslui County,Moldavia, Romania, 1996.
Subtitles 1. Cherry trees orchard; 2. Apple trees orchard; 3. Plum trees orchard.

Insects are represented by eight orders. Numerically, the best represented order in all the orchards is the order of Choleoptera, on average, 91.73 %, with a variation between 81.91 % (plum trees orchard) and 98.43 % (apple trees orchard) (Table 2).

Table 2. The taxonomic structure, abundance and dominance of Orders of the epigeal insects from three orchards, Crâng village, Vaslui County, Moldavia, Romania, 1996.

No	**Insecta, Name of Orders.**	**Cherry trees orchard**		**Apple trees orchard**		**Plum trees orchard**		**Total**	
		A	**D %**	**A**	**D %**	**A**	**D %**	**A**	**D %**
1	Orthoptera	2	0.34	1	0.26	9	4.52	12	1.02
2	Gryllodea	2	0.34	1	0.26	-	-	3	0.26
3	Dermaptera	17	2.86	4	1.04	-	-	21	1.79
4	Heteroptera	-	-	-	-	4	2.01	4	0.34
5	Homoptera	3	0.51	-	-	8	4.02	11	0.94
6	Choleoptera	545	91.75	373	98.43	158	81.91	1,076	91.73
7	Hymenoptera	11	1.85	13		13	6.53	37	3.15
8	Diptera	7	1.18	1	0.26	2	1.01	10	0.85
	Total orders:	**7**		**6**		**6**		**8**	
	Total individuals:	**587**		**393**		**193**		**1,173**	
	% of total:	**49.74**		**33.70**		**16.55**			**100**

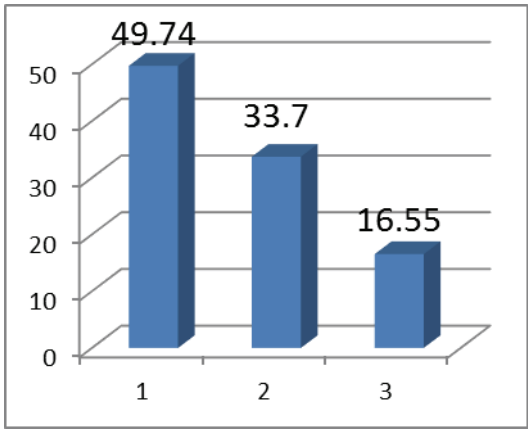

Figure 2. The percentage variation of the total number of individuals of the orders of insects, collected from three orchards, Crâng Village, Vaslui County, Moldavia, Romania, 1996.
Subtitles: 1. Cherry trees orchard; 2. Apple trees orchard; 3. Plum trees orchard.

10 families were identified in the Choleoptera order. The best represented family in those three orchards is the family Carabidae, on average 827 specimens (77.36 %) with a variation between 60 individuals, 37.97 % (plum trees orchard) and 441 specimens, 80.92% (cherry trees orchard) (Table 3).

Table 3. The taxonomic structure, abundance and dominance of families of the epigeal Choleoptera from three orchards, Crâng village, Vaslui County, Moldavia, Romania, 1996.

No	Choleoptera, Name of families	Cherry orchard		Apple orchard		Plum orchard		Total	
		A	D %	A	D %	A	D %	A	D %
1	Carabidae	441	80.92	326	87.40	60	37.97	827	77.36
2	Staphylinidae	4	0.73	3	0.80	7	4.43	14	1.31
3	Dermestidae	38	6.97	13	3.49	11	6.96	62	5.80
4	Elateridae	2	0.37	2	0.54	11	6.96	15	1.40
5	Anthicidae	4	0.73	-	-	8	5.06	12	1.12
6	Tenebrionidae	18	3.30	9	2.41	36	22.78	63	5.89
7	Scarabaeidae	3	0.55	6	1.61	8	5.06	17	1.59
8	Coccinellidae	1	0.18	1	0.27	-	-	2	0.19
9	Chrysomelidae	6	1.10	2	0.54	2	1.27	10	0.94
10	Curculionidae	21	2.02	11	2.95	15	9.49	47	4.40
	Total families	**10**		**9**		**9**			
	Total individuals	**538**		**373**		**158**		**1,069**	
	% of total:	**50.23**		**34.75**		**15.02**			**100**

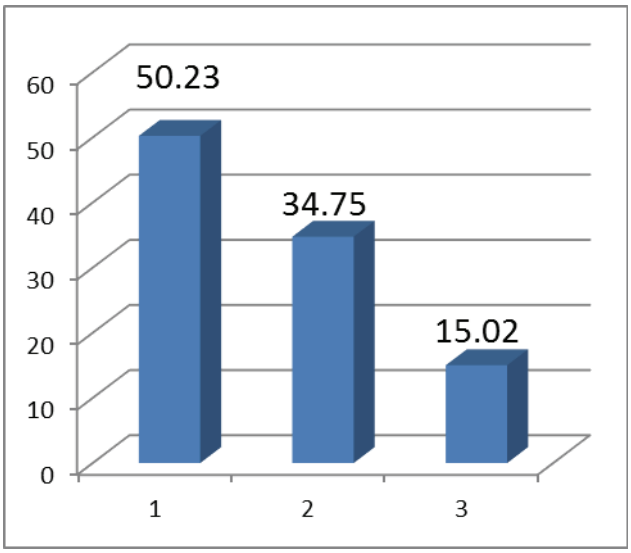

Figure 3. The percentage variation of the total number of individuals of the families of Choleoptera, collected from three orchards, Crâng Village, Vaslui County, Moldavia, Romania, 1996.
Subtitles: 1. Cherry trees orchard; 2. Apple trees orchard; 3. Plum trees orchard.

Within the Carabidae family there were determined 20 species. The best represented: species is *Pseudoophonus rufipes* De Geer 1774*:* 63.33 % (plum trees orchard) and 85.94 % (cherry trees orchard) (Table 4).

Table 4. The taxonomic structure, abundance and dominance of species of the epigeal Carabidae from three orchards, Crâng village, Vaslui County, Moldavia, Romania, 1996.

No	Carabidae, Name of species	Cherry trees orchard		Apple trees orchard		Plum trees orchard		Total	
		A	D %	A	D %	A	D %	A	D %
1	*Calosoma auropunctatum* Herbst 1784	1	0.23	-	-	-	-	1	0.12
2	*Carabus besseri* Fischer von Waldheim 1822	1	0.23	-	-	-	-	1	0.12
3	*Poecilus sericeus* Fischer von Waldheim 1822	5	1,13	-	-	-	-	5	0.60
4	*Poecilus cupreus* Linne 1758	-	-	1	0.31	-	-	1	0.12
5	*Pseudoophonus rufipes* De Geer 1774	379	85.94	286	87.73	38	63.33	703	85.01
6	*P. griseus* Panzer 1797	1	0.23	6	1.84	2	3.33	9	1.09
7	*Anisodactylus signatus* Panzer 1797	2	0.45	1	0.31	-	-	3	0.36
8	*Harpalus distinguendus* Duftschmid 1812	9	2.04	1	0.31	5	8.33	15	1.81
9	*H. aeneus* Fabricius 1787	4	0.91	-	-	-	-	4	0.48
10	*H. tardus* Panzer 1797	1	0.23	-	-	2	3.33	3	0.36
11	*H. dimidiatus* Rossi 1790	-	-	1	0.31	-	-	1	0.12
12	*Metophonus azureus* Fabricius 1775	2	0.45	-	-	-	-	2	0.24
13	*Calathus fuscipes* Goeze 1777	4	0.91	5	1.53	-	-	9	1.09
14	*C. melanocephalus* Linne 1758	1	0.23	6	1.84	-	-	7	0.85
15	*C. abiguus* Paykull 1790	5	1.13	2	0.61	-	-	7	0.85

16	*C.(Dolichus) halensis* Schaller 1783	-	-	1	0.31	1	1.67	2	0.24
17	*Zabrus tenebrioides* Goeze 1777	17	3.85	13	3.99	5	8.33	35	4.23
18	*Amara consularis* Dufschmid 1812	9	2.04	2	0.61	4	6.67	15	1.81
19	*Amara similata* Gyllenhall 1810	-	-	-	-	3	5.00	3	0.36
20	*Licinus casideus* Fabricius 1792	-	-	1	0.31	-	-	1	0.12
	Total species	**15**		**13**		**8**		**20**	
	Total individuals	**441**		**326**		**60**		**827**	
	% of total	**53.33**		**39.42**		**7.27**			**100**

DISCUSSIONS

Discussions have to point out some generalizations and interpretations of results.

The fundamental form of existence of life is the individual within a taxon that has all the hierarchical general and specific characteristics.

The environment of a taxon is concretized in three components: biological, ecological and physical factors.

Both the presence of taxa and the number of individuals within taxa in the cherry orchard, apple orchard and plum orchard are variable due to the concrete ecological conditions in orchards.

The total number of collected specimens was 1,217 individuals. The cherry orchard offers better ecological conditions for all the taxa and their individuals, then it is followed by the apple orchard.

Thus, four classes of arthropods, 7 orders of insects, 10 families of Choleoptera and 20 species of Carabidae were collected in the mentioned orchard, with 605 individuals.

The best represented species of Carabidae in the cherry orchard was *Pseudoophonus rufipes*, it was collected in a percentage of 85.94 % in comparison with those 14 species from the same orchard. It is a meso-xerophilous pantophagous species of open habitats.

This is not a general truth in all apple orchards. In one of our papers (VARVARA & ANDRIESCU, 2003) with material collected from four apple orchards, Chicerea in 1979, Miroslava in 1991, Breazu in 1980; Botanical Garden Iaşi in 2000, (Iasi County, Moldavia), the total number of collected individuals of the mentioned species varied among 4 individuals, Breazu in 1980 and 213 at Chicerea in 1979, reprezenting 35.85 % in comparison with those 20 species of collected Carabids.

Favorable or unfavorable local ecological factors dictate the number of species and individuals belonging to a biocoenosis. We can safely deduce that the moisture factor of the soil was the one that reduced the number of species and individuals in the plum trees orchard, where it was collected a total number of individuals, 60, that is 7.35 % less in comparison with the cherry orchard (441 individuals) and a total number of species, 8, 1.87 % less in comparison with the cherry orchard.

CONCLUSIONS

The collecting effort of the epigeal entomological material in the year 1996 from three orchards (cherry trees orchard, apple trees orchard and plum trees orchard), Crâng village, Vaslui County, Moldavia, Romania, 1996, the taxonomic identification of those 1,217 individuals (classes of Arthropods, orders of insects, families of Choleoptera, species of Carabidae) give us the scientific right to conclude the following:

Within the epigeal fauna of Arthropods, the following taxa are present in all three orchards, Crâng village, 1996: Crustacea (Isopoda), Insecta; four orders of insects, Orthoptera, Choleoptera, Hymenoptera, Diptera; 8 families of Choleoptera (Carabidae, Staphylinidae, Dermestidae, Elateridae, Tenebrionidae, Scarabaeidae, Chrysomelidae, Curculionidae); 5 species of Carabidae (*Pseudoophonus rufipes* De Geer 1774; *P. griseus* Panzer 1797; *Harpalus distinguendus* Duftschmid 1812; *Zabrus tenebrioides* Goeze 1777; *Amara consularis* Dufschmid 1812).

The best represented taxa through individuals in those three orchards in the south of Moldavia, Crâng village, 1996 are: Insecta, Choleoptera, Carabidae, Tenebrionidae, Dermestidae , *Pseudoophonus rufipes* De Geer 1774.

The translation of the text from Romanian into English was done by Varvara Mircea and verified by PhD. Vlăduț Alina, Craiova. The paper was edited by Dr. Lila Gima, Craiova.

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THE INVASIVE INSECT SPECIES IN THE OLTENIA REGION (ROMANIA)

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Abstract. Given the generally negative impact of non-native organisms, and particulary the arthropods, in the ecosystems of a given area, the paper presents new information about the presence and distribution of invasive insect species on woody plants in the forests and green spaces of Oltenia region. Starting from a list of forest insect species already reported in Romania and in the neighbouring countries, and assumed to be present in the south-western part of the country, a network of monitoring points was set up, fixed or along the routes, with known geographic coordinates. The detection of these species was achieved either by the presence of insects in the adult stage, captured in the traps baited with different attractants (pheromones or kairomones) in the case of beetles, or by the characteristics of the attack and the presence of insects on the attacked organs, in the case of the other insect groups. 18 species of invasive insects were found, of which 6 species were already reported in Oltenia and 12 species can be considered new reports in Oltenia region.

Keywords: invasive insects, Oltenia region, distribution.

Rezumat. **Specii de insecte invazive din zona Olteniei (România).** Având în vedere impactul negativ, în general, al organismelor non-native asupra ecosistemelor dintr-o anumită zonă, şi în special cel al artropodelor, lucrarea prezintă informaţii noi despre prezenţa şi răspândirea speciilor de insecte invazive pe plantele lemnoase din pădurile şi spaţiile verzi, din zona Olteniei. Plecând de la o listă a speciilor de insecte forestiere invazive semnalate deja în România sau în ţările vecine şi presupuse a fi prezente şi în zona de sud-vest a ţării, s-a amplasat o reţea de puncte de monitorizare fixe sau pe itinerar, de coordonate geografice cunoscute, iar depistarea acestor specii s-a realizat fie după prezenţa insectelor în stadiul de adult, capturate la capcane amorsate cu diverşi atractanţi (feromonali sau kairomonali) în cazul coleopterelor, fie după caracteristicile atacului ori după atac şi prezenţa, pe organele atacate, a insectelor aflate în diverse stadii de dezvoltare, în cazul celorlalte grupe de insecte. Au fost depistate 18 specii de insecte invazive, dintre care 6 specii erau deja semnalate în Oltenia, iar 12 specii pot fi considerate ca semnalări noi pentru regiunea Olteniei.

Cuvinte cheie: insecte invazive, Oltenia, distribuţie.

INTRODUCTION

Through their activities and especially by the transport of goods from one area to another, people have contributed, deliberately or unintentionally, to the spread in time and space of the organisms (plants, animals, microorganisms etc.) which could find suitable living conditions in new geographical areas. Where these species multiplied greatly, became dominant and adversely affected the ecosystems they entered. Such species are considered invasive and the phenomenon of penetration, establishment and spread into new territories is called biological invasion (SIMBERLOFF, 2013).

In the recent decades, as a consequence of intensified global exchange of goods and of the climate changing, the biological invasions represent the second biggest threat to biodiversity after the habitat fragmentation (SCHMITZ & SIMBERLOFF, 1997).

Insects are around 85% of invasive invertebrates in Europe (ROQUES et al., 2009), and of these the species associated with woody plants prevail (ROQUES, 2015). MATTSON et al. (2007) mention 109 species of phytophagous exotic insects who already have stable populations in the forests of Europe, including 57 in North America and 52 in Asia and the pace of obtaining new species in Europe is growing exponentially (ROQUES et al., 2009).

These trends, which occur in Europe, are also present in Romania and they are more obvious especially after the EU accession, when customs controls were reduced and border crossing and transportation of goods and people greatly intensified. As a result, every year new species that have entered Romania are recorded (OLENICI & DUDUMAN, 2016).

Before 1989, only a few species of forest invasive insects were found in Romania, such as: *Gilletteella cooley* (Gillette, 1907), *Eopineus strobus* (Hartig, 1837), *Aphrastasia pectinatae* (Cholodkovsky, 1888), *Diaspidiotus perniciosus* (Comstock, 1881), *Megastigmus spermotrophus* Wachtl, 1893, *Nematus tibialis* Newman, 1837, *Hyphantria cunea* (Drury, 1773) and *Ips duplicatus* (Sahlberg, 1836) (OLENICI, 2008).

The increase in trade and movement of people after 1989 has facilitated the penetration in our country of a growing number of new species, such as: *Parectopa robiniella* Clemens, 1863, *Macrosaccus robiniella* (Clemens, 1859) (NEŢOIU 1994, 2003), *Phyllonorycter issikii* (Kumata, 1963) (KOVÁCS et al., 2006; URECHE, 2006), *Cameraria ohridella* Deschka & Dimic, 1986 (RÁKOSY & RUICĂNESCU, 1999; ŞANDRU, 1999), *Leptoglosus occidentalis* Heidemann, 1910 (RUICĂNESCU, 2009), *Obolodiplosis robiniae* (Haldeman, 1847) (BÁLINT et al., 2010), *Aproceros leucopoda* Takeuchi, 1939 (BLANK et al., 2010), *Xylosandrus germanus* (Blandford, 1894) (OLENICI et al., 2014).

During 2016-2017, INCDS 'Marin Drăcea" has conducted extensive research on the detection and distribution of invasive forest insect species within a national project (TOMESCU, 2016, 2017) and this paper presents new information about the presence of these species in the forests and green spaces of the Oltenia region.

MATERIAL AND METHODS

Oltenia is a region in the south-western part of Romania and comprises an area of about 12% the country's territory. It encompasses the three main types of landforms (mountain, hill and plain), arranged from north to south in gradual elevation, decreasing from the height of 2500 m (Southern Carpathians), to average heights of 500-800 m of the plateau of Subcarpathians and Mehedinţi Plateau, to values of 150-400 m of the Getic Piedmont and below 50 m in Olteniei Plain (BOENGIU & GOLEA, 2012) (Fig. 1).

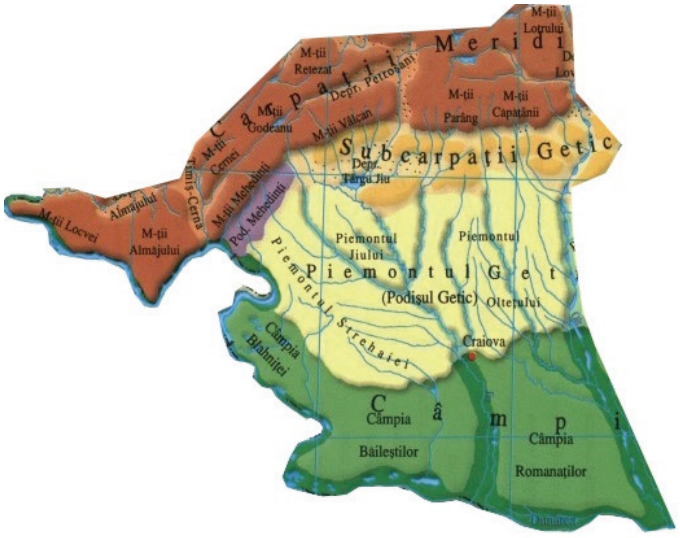


Figure 1. Physical map of Oltenia region (BOENGIU & GOLEA, 2012)

A list of invasive insect species expected to be present in Romania and in Oltenia was drawn up using information from literature and a network of monitoring points, fixed and on routes, with known geographical coordinates, was established across forests and outside them (airports, parks, green spaces, deposits of wood, etc.). During the growing season (April to September) of 2016 and 2017, observations and/or regular collection of biological material were performed every 7-14 days, depending on the biology of each.

For the species whose presence can be detected easily by the features of the attack or after the attack and the presence of insects in various stages, the place of observation was directly related to the presence of host tree species. Depending on the biology of each species of insect, samples of biological material were taken from the places of observation, such as traces of damages and various stages of insects to be identified.

In the cases of xylophagous and xylomycetophagous species, whose penetration in the country is most likely related to imported wood, detection was performed using traps with different attractants (pheromones or kairomones), located in areas of wood concentration (imported or of autochthonous production), but also in tree stands containing the host species, both in the vicinity of log-yards and in other areas (Photos 1-2).

Because no specific attractants were available for most species, pheromones of other species were used (*Ips typographus* - atraTYP, *Trypodendron lineatum* - atraLINEA) or substances with kairomonal role (ethanol, alpha-pinene). Biological material collected from research places was analyzed and the species that caused the damages were identified.

Photos 1-2. The two types of traps baited with attractants used to collect the beetles (original).

RESULTS AND DISCUSSIONS

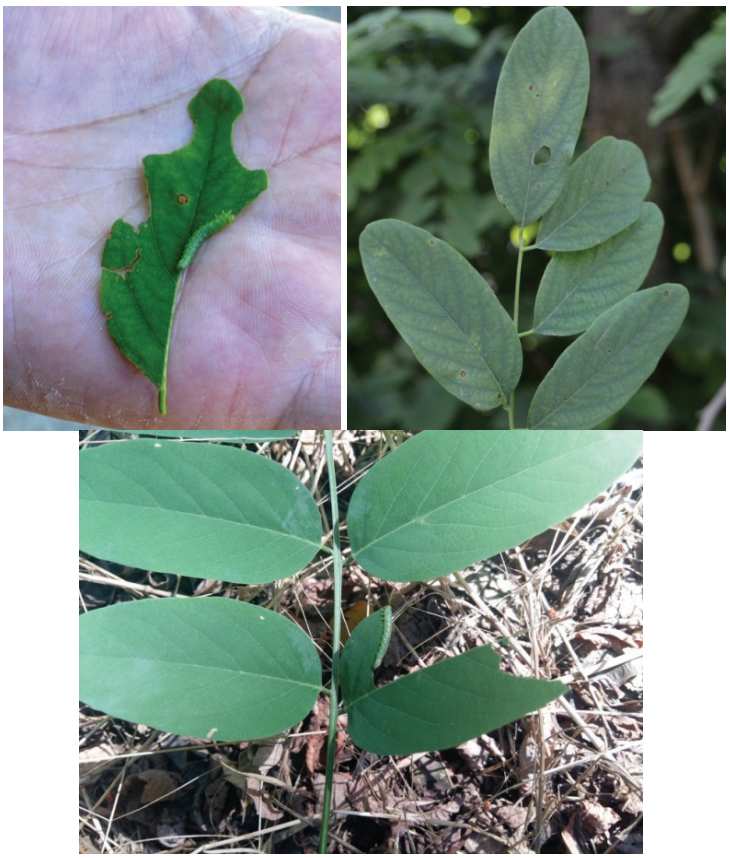
Invasive forest insect species previously reported in Oltenia

***Ips duplicatus* (Sahlberg, 1836) (Coleoptera, Curculionidae, Scolytinae) – the double-spined bark beetle**

Between 2016-2017, this species was found in the adult stage only in a location out of nine monitoring places in Oltenia, namely near Râmnicu Valcea (Băbeni - N44.953471º, E24.239173º), in a softwood timber yard. Until the early twentieth century, it was found only in the Euro-Siberian taiga, from Sweden to the island of Sakhalin, then gradually expanded in Austria, Slovakia, Poland, Germany, France, Belgium, the former Yugoslavia, Hungary. In Romania, the species was observed in 1948-1967 in Suceava, Neamț, Bacău, Buzău, Covasna, Harghita, Mureș, Maramureș and Voineasa (Vâlcea) (VASILIU et al., 1978; OLENICI et al., 2009; DUDUMAN et al., 2011). The first outbreak was recorded after 2002 in Norway spruce (*Picea abies* (L.) H. Karst.) stands aged of 30-40 years, installed outside the natural range, at an altitude of 300-400 m, in the Suceava area, due to many years of deficient rainfall (OLENICI et al., 2011). It has a striking secondary pest behavior, but can kill the trees debilitated by other factors.

***Nematus tibialis* Newman, 1837 (Hymenoptera, Tenthredinidae) - the locust sawfly**

During the 2016-2017 groeth season, obsevations have been made in numerous nursery crops, tree stands and isolated black locust trees (23 locations), but the insect has been detected in only five locations across the whole area at Crivina forest (44.519167º N, 22.576944º E), Piscu vechi forest (N 43.883889º, E 23.165556º), Cobia (N 44.141667º, E 23.738333º), Ostroveni (N 43.791944º, E 23.931944º) and Brădet (N 44.892222º, E 23.050000º). Detection was done after the characteristic attack (holes in the leaf) and the presence of larvae that, at the end, eat the ends of the leaflets to the main rib (Photos 3-5). The species has been previously reported from Alba, Arad, Harghita, Ilfov, Mehedinți and Tulcea (Scobiola-Palade, 1981) and recently in the counties of Moldova (OLENICI et al., 2018).



Photos 3-5. Aspects of attack produced by *Nematus tibialis* in Crivina Forest, Şimian Forestry District (original).

***Cameraria ohridella* Deschka & Dimic, 1986 (Lepidoptera, Gracillariidae) - the horse-chestnut leaf miner**

During 2016-2017 several parks, gardens, paths and alignments were inspected all over Oltenia, where chestnut and sycamore trees are present. In all sampled locations, we found some features of damage caused by the larvae and individuals in various life stages of the insect (Photos 6-8). The species was found in Drobeta Turnu Severin (N 44.622222º, E 22.650000º), Orşova (N 44.722778º, E 22.398611º), Şimian (N 44.610556º, E 22.734167º), Craiova (N 44.298333º, E 23.802222º), Melineşti (N 44.565833º, E 23.711389), Corabia (N 43.774444º, E 24.501667º), Caracal

(N 44.116111º, E 24.332778º), Balș (N 44.350556º, E 24.100000º), Tg. Jiu (N 45.039722º, E 23.267222º), Călimănești (N 45.241111º, E 24.341389º) and Rm. Vâlcea (N 45.102500º, E 24.353611º).

The species was first observed in Romania in 1996, at Lovrin, in Timis county (ȘANDRU, 1999), and has been reported in various parts of the country, including the mountain area (NEȚOIU at al., 2004; OLENICI & DUDUMAN, 2016). So far, injuries have only been observed on ornamental chestnut trees (*Aesculus hippocastanum* L.), although the literature states that can attack also the mountain maple (*Acer pseudoplatanus* L.).

Photos 6-8. Aspects of the *Cameraria ohridella* attack at trees along the G. Enescu Street, Craiova (original).

***Hyphantria cunea* (Drury, 1773) (Lepidoptera, Arctiidae) - the fall webworm**

During the 2016-2017 growing season, the observations made by the working group in the stands, orchards, alignments, parks, isolated mulberry trees, American maple trees, plum trees, and other broadleaf species regarding to the presence of larvae and nests showed that the species infested the area of the Oltenia plains and hills, but the intensity of the attack was different from one location to another. Defoliation caused by caterpillar ranges from weak to very heavy, especially on tree alignments located along the roads, in parks and at forest edge, but also in orchards (Photos 9-11). Infestation with this species was noted in Caracal (N 44.112161º, E 24.343994º), Deveselu (N 44.067484º, E 24.383237º), Vlădila (N 44.006911º, E 24.414022º), Balș (N 44.343200º, E 24.129778º), Leu (N 44.188147º, E 23.998733º), Balasan (N 44.026619º, E 23.268739º), Radovan (N 44.160131º, E 23.601883º), Ostroveni (N 43.826752º, E 23.881396º), Băilești (N 44.069883º, E 23.371253º), Poiana Mare (N 43.919663º, E 23.066763º), Crivina (N 44.484167º, E 22.641944º) and Drăgășani (N 44.565231º, E 24.268483º). The species was reported in Romania since 1949 and currently widespread in all areas of the country where environmental conditions are favorable (OLENICI & DUDUMAN, 2016).

Photos 9-11. Aspects of *Hyphantria cunea* attack in Zaval and Băilești – Dolj (original).

***Macrosaccus* (*Phyllonorycter*) *robiniella* (Clemens, 1859) (Lepidoptera, Gracillariidae) - the locust leaf miner**

This species, native to North America, had been recorded in Romania since 2002 (NEȚOIU, 2003) and currently is widespread in most of Romania (NEȚOIU & TOMESCU, 2006, 2009).

The injuries caused by the larvae are represented by a stigmatonom type mine located on the underside of the black locust leaves. First, the larvae consume the lacunar tissue, take away the lower epidermis of mesophill, then enters into palisade tissue and consume the whole mesophill, inside the mine leaving only the veins. Over time, the lower epidermis becomes white and the upper epidermis and conductive vessels become brown and dry (Photos 12-14).

From July to August, when the attack is obvious and leaves have not yet started to fall prematurely, there have been inspected many nurseryes or tree stands and isolated black locust trees (including parks), and the insect has been detected in most locations, as follows: Streahaia (N 44.618889º, E 23.179722º), Poienari (N 45.143889º, E 23.771111º), Rm. Vâlcea (N 45.103889º, E 24.353056º), Dăești (N 44.952500º, E 24.110556º), Hinova (N 44.558889º, E 22.764722º), Bulzești (N 44.492778º, E 23.890556º), Giulești (N 44.883333º, E 24.044722º), Ostroveni (N 43.791944º, E 23.931944º), Pisculeț (N 43.883889º, E 23.165556º), Brădet (N 44.892222º, E 23.050000º), Segarcea (N 44.141667º, E 23.738333º), Rovinari (N 44.902222º, E 23.161944º), Arginnești (N 44.576389º, E 23.434167º), Cârlogani (N 44.577500º, E

23.117222º), Balasan (N 44.037222º, E 23.250278º), Pinoasa (N 44.898889º, E 23.104444º), Crivina (N 44.519167º, E 22.576944º), Tunari (N 43.898333º, E 23.104444º), Rovinari (N 44.928333º, E 23.166944º), Bechet (N 43.792222º, E 23.931667º), Dăbuleni (N 43.818056º, E 24.050833º), Ostroveni (N 43.806667º, E 23.924444º), Apele Vii (N 44.068596º, E 23.997664º), Tismana (N 45.094495º, E 22.922233º) and Călimăneşti (N 45.236667º, E 24.341389º).

Photos 12-14. Aspects of the attack produced by *Macrosaccus robiniella*. Piscu-Tunari Forest, Poiana Mare Forestry District (original).

***Parectopa robiniella* Clemens, 1863 (Lepidoptera, Gracillariidae) – the locust digitate leaf miner**

The observations carried out during 2016-2017 in many nurseries, tree stands and isolated trees (including parks) have led to the detection by the symptoms of attack of this species (Photos 15-17) in all places investigated in Oltenia, together with *M. robiniella*.

Originating in North America, the species was introduced in Europe through Italy, from where it spread rapidly in many European countries, arriving in Romania since 1988 (NEŢOIU, 1994; RUŞTI, 1994) in the Crivina Forest, on the border with Serbia, and currently it is widespread in most of the country (NEŢOIU & TOMESCU, 2006).

Photos 15-17. Aspects of attack produced by the *Parectopa robiniella* on the upper face of the lamellae (a) and on the back of lamellae (b) (original)

New invasive forest insect species reported in Oltenia

***Xylosandrus germanus* (Blandford, 1894) (Coleoptera, Curculionidae, Scolytinae) – the black timber bark beetle**

In 2016 and 2017, adult individuals of this species were captured in only three out of 9 fixed observation places in Oltenia. It was found in a log-yard at Băbeni (N 44.953471º, E 24.239173º), in the neighborhood of a

company selling ornamental plants in Bunesti (N 45.086768º, E 24.217583º) and in a forest nursery at Tismana (N 45.071749º, E 22.933806º). All three locations are in the northern part of the region, in the submontane zone.

The species is native to eastern Asia, from the Kuril Islands to Vietnam and currently is present in North America and in many European countries. In Romania it was detected in 2009 in Runcu Groşi Nature Reserve (Arad), then in Suceava county, in Voievodeasa Forest Reserve (2011-2012) and in a tree stand near Cacica (2014) (OLENICI et al., 2014, 2015).

It is distinguished by his polyphagia and can colonize many species of forest interest in our country, both softwood and hardwood, but also fruit trees as apple, apricot, walnut and even vines. At the same time, the species has the ability to attack both dying or debilitated trees and apparently healthy trees which release ethanol, due to stress generating action of other factors (RANGER et al. 2013, 2015).

***Gilletteella (Adelges) cooleyi* (Gillette, 1907) (Hemiptera, Adelgidae) - Cooley spruce gall adelgid**

Detection was done looking after heavy waxy, white secretions, covering larvae, and after the deformation and discoloration of needles caused by them (Photos 18-19). During the growth seasons of 2016 and 2017 (May to September), by observing 10 stands, orchards or duglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) nursery crops in Oltenia, the species was detected in four locations: on isolated trees in the park of Rm. Vâlcea (N 45.103889º, E 24.353056º), at Călimănești (N 45.241111º, E 24.341389º), on trees growing in the yard of Polovragi forest district (45.191667º N, 23.791111º E), and in Târnava forest, Perișor forest district (N 44.151667º, E 23.540000º).

This species is native in North America, and it was reported in Romania after 1963 in Caraş-Severin, Hunedoara, Timiş and Bihor (BLADA, 1963; NANU, 1971; CEIANU 1971; SCUTĂREANU, 1970).

Photos 18-19. Aspects of the attack traces produced by the aphid *Gilletteella cooley*, Târnava Forest, Perişor Forestry District (original).

***Oxycarenus lavaterae* (Fabricius, 1787) (Hemiptera, Lygaeidae) – the lime seed bug**

The insects live in colonies which split as they become larger. In the crowns of mature trees, they remain unnoticed even in large populations, but in the fall, when they gather in large colonies on the bark of tree truncks and thick branches, they are easy to see. Colonies, of an intense red color, consists mainly of larvae that do not have wings, while shiny silver colonies, are comprised mainly of adults. They have dark red color and shining silver wings membranes (WERMELINGER et al., 2005). The detection of this species started in the autumn of 2016 and continued in 2017, wherever lime trees were found, especially in places where the colonies which form on the trunks and thick branches of the trees (Photos 20-22) are more easily noticed. Up to now, this species was found on the lime trees (*Tilia* species) which grow along the streets in Craiova (N 44.325833º, E 23.789722º). It seems that it avoids the tree stands.

The species was reported in Romania since 2008 and currently is spread across almost the entire country, at altitudes below 600 m (RĂDAC & PETROVICH, 2015). Both larvae and adults suck lime tree stems and branches during the growing season.

Photos 20-22. Aspects of winter colony formed by *Oxycarenus lavaterae* at INCDS Craiova (original).

***Aproceros leucopoda* Takeuchi, 1939 (Hymenoptera, Argidae) - the zig-zag sawfly**

During the 2016-2017 growing seasons, observations have been made in tree stands containing elms (*Ulmus* spp.) or in forest nurseries and to isolated trees in parks. Detection was done observing the characteristic attack (zigzag leaf consumption), but also the presence of the larvae on leaves with characteristic appearance (Photos 23-24). The species was detected in five locations out of eleven investigated places, in Dolj and Mehedinți (on isolated trees in the Botanical Garden Craiova - N 44.324722º, E 23.785278º; in the forests of Șimian - N 44.604444º, E 22.757222º, Ciochiuța - N 44.606944º, E 23.136944º, Lunca Banului - N 44.633056º, E 23.190278º and Argineşti - N 44.577222º, E 23.43388º). It was reported in Romania since 2006, both in Banat and Moldova (BLANK et al., 2010). Initially, larvae eat elm leaves in zigzag, but this injury aspect gets indistinct as it expands, leading eventually to consumption of the entire leaf, except for the midrib. Total defoliation of trees is possible.

Photos 23-24. Aspects of attack produced by *Aproceros leucopoda* in Argineşti Forest, Strehaia Forestry Department (original).

***Obolodiplosis robiniae* (Haldeman, 1847) (Diptera: Cecidomyiidae) – the locust gall midge**

Detection was made by the presence of characteristic galls on black locust leaves. The galls appear after the females lay eggs on the underside of the black locust leaves. The leaf becomes turgid and hypertrophied, the leaflet edge thickening, bending toward the lower side. In the gall thus formed are 1-2 larvae, exceptional even 7-8 larvae. On a leaflet it develops 1-4 attacks. After the larvae are leaving the galls, the leaflets dry and fall (Photos 25-27). The species was detected in all cultures in the nurseryes or stands inspected across the entire area, where *M. robiniella* and *P. robiniella* were also found (see the locations mentioned for these species).

The species has been observed in Romania since 2007 and it is widespread in Ilfov, Prahova, Argeș, Dâmbovița, Arad (BÁLINT et al., 2010), but also in the northern part of Romania (OLENICI & DUDUMAN, 2016).

Photos 25-27. Aspects of attack produced by *Obolodiplosis robiniae* (original).

***Phyllonorycter issikii* (Kumata, 1963) (Lepidoptera, Gracillariidae) – the lime leaf miner**

In 2016 and 2017 several stands, nursery crops or isolated trees in parks were inspected in 16 places. Detection was done by looking for irregular spoted mines, located on the underside of leaves, generally toward the center of the leaf, between the veins (Photos 28-30). The species was found in the forest of Ciochiuța (N 44.595833º, E 23.140556º) and in Tismana (N 45.071667º, E 22.935833º). Previously it was reported in Romania from Iași and Bacău counties (2002), and after that from Harghita, Vaslui and Suceava (KOVÁCS et al., 2006; URECHE, 2006; STOLNICU, 2007; STOLNICU & URECHE, 2007; OLENICI & DUDUMAN, 2016).

Photos 28-30. Attack and the larva of *Phyllonorycter issikii* on lime tree leaves in Tismana – Gorj (original).

***Corythucha arcuata* (Say, 1832) (Hemiptera, Tingidae) – the oak lace bug**

Numerous nurseries and forest stands with various oak species were inspected in Oltenia since June, when females lay black eggs on the underside of the leaves, until September, when chlorotic discoloration on the upper side of leaves and characteristic black spots on the lower side can be seen (Photos 31-33). Adults and nymphs feeding on the underside of leaves were also noted.The species was detected in the most of investigated locations, except for those located in the forested hilly area of Mehedinți and Gorj counties, as follows: Balasan (N 44.037500º, E 23.250556º), Bratovoiești (N 44.090000º, E 23.905278º), Fărcaș (N 44.675833º, E 23.752778º), Botanical Garden Craiova (N 44.324167º, E 23.788056º), Nicolae Romanescu Park in Craiova (N 44.298333º, E 23.801944º), Eșelnița (N 44.649444º, E 22.275833º), Caracal (N 44.110833º, E 24.346944º), Crivina (N 44.696667º, E 22.505000º), Bulzești (N 44.473611º, E 23.856111º), Dăești (N 44.954722º, E 24.111389º), Rm. Vâlcea (N 45.103889º, E 24.353056º), Murta (N 44.006944º, E 23.916667º), Segarcea (N 44.117222º, E 23.741667º), Gura Vării (N 44.211944º, E 23.780000º) and Seaca de Pădure (N 44.350833º, E 23.300556º).

It is a North American species, found in Europe (Italy) since 2000 (BERNARDINELLI & ZANDIGIACOMO, 2000), then spread in Turkey (MUTUN, 2003), arriving in Bulgaria in 2012 (DOBREVA et al., 2013), Serbia and Hungary in 2013 (HRAŠOVEC et al. 2014). In Romania, it was noted for the first time in 2015, in the western part of the country, and shorthly thereafter in the southern part (CHIRECEANU et al., 2017), but is present also in Moldova, the eastern region of Romania (OLENICI et al., 2018).

Photos 31-33. Attack produced by *Corythucha arcuata* in the Botanical Garden, Craiova (original).

***Appendiseta robiniae* (Gillete, 1907) (Hemiptera, Aphididae)**

Of the total of 25 locations sampled in Oltenia during the growing seasons of 2016 and 2017, it was detected in only two places, in Strehaia and in Râmnicul Vâlcea Park. In 2017, there were found more individuals of different development stages, mainly winged adults, approx. 1.5 mm long, having a pale green-yellow color with a black pigment to the top of the antennae and the rear femurs and one large black spot near the top (Photos 34-35), but no visible injuries were noted. The species was firts found in Romania in 2016, in Bacău, and in many other locations of Moldova in 2017 (OLENICI et al., 2018).

Photos 34-35. Various development stages of *Appendiseta robiniae* (original)

***Prociphilus fraxinifolii* (Riley, 1879) (Hemiptera, Aphididae) – the leafcurl aphid**

The species has been found on the branch tips of the red ash trees with pseudogalls and aphid excretions (Photos 36-38). The trees were growing along the streets in Craiova (N 44.326111º, E 23.790000º), Strehaia (N 44.620556º, E 23.185833º), Tg. Jiu (N 45.039167º, E 23.269444º) and Milostea (N 45.130000º, E 23.827222º).

The species has not been reported in Romania before, but most likely it was present, beeing reported in Hungary (Remaudière & Ripka, 2003), Serbia (Petrović-Obradović et al., 2007) and Bulgaria (Trenchev & Trenchev, 2009). Now it is also present in the eastern part of the country (OLENICI et al., 2018).

Photos 36-38. Attack of *Prociphilus fraxinifolii* on trees along the G. Enescu Street in Craiova (original).

***Dasineura gleditchiae* (Osten Sacken, 1866) (Diptera, Cecidomyiidae) – the honeylocust pod gall midge**

Several tree stands, shelter-belts, isolated trees, and parks have been inspected during June to August in 2016 and 2017, when the leaves already formed galls on honey locust (*Gleditsia triacanthos* L.) trees, (Photos 39-41). The species has been found in seven locations out of 19 investigated places: Orşova (N 44.701944º, E 22.400556º), Zăval (N 43.827222º, E 23.881944º), Bratovoieşti (N 44.107778º, E 23.916944º), Craiova (N 44.330833º, E 23.783611º), Argineşti (N 44.573611º, E 23.421667º), Ocniţa (N 45.086389º, E 24.277222º) and Poienari (N 45.144722º, E 23.772222º).

The species originates in eastern part of North America (DROOZ, 1985), where its only host, *Gleditsia triacanthos*, is native. The young larvae feeding on leaves cause the formation of pod like galls, green to purple. Strong infestations cause defoliation, reduced growth, death to branches. According to EPPO (2008), the species has been reported in Europe since 1975 and is widespread in many European countries. In Romania it was also found in the eastern part of the coutry (OLENICI et al., 2018).

Photos 39-41. Galls on honey locust and larvae of *Dasineura gleditchiae* (original).

***Cydalima perspectalis* Walker 1859 (Lepidoptera, Crambidae) - the box tree moth**

The larvae feed on the leaves, sometimes causing total defoliation, which may lead to the drying of the plant. The small larvae feed on the upper side of the leaf, and the large larvae eat the leaves completely (Photos 42-43). The species was found in many green spaces in cities across the country and in the yards of citizens, in Craiova (N 44.313865º, E 23.809392º), Calafat (N 43.996806º, E 22.934100º), Segarcea (N 44.094922º, E 23.742852º), Cetate (N 44.111579º, E 23.645370º), Caracal (N 44.112873º, E 24.342084º) and other places in Oltenia.

The moth is native in East Asia (Japan, China, Korea, India) and is particularly dangerous for *Buxus sempervirens*, due to the rapid spread and aggressiveness of attack on host plants.

The insect was first detected in Germany in 2006, then in Switzerland and the Netherlands, in 2007, France, Britain and Austria, in 2009. In 2011 it was reported the presence in Hungary, Romania and Turkey (SZÉKELY et al., 2011). Its spreading seems to have been made from Asia with cargo containers. The species has 2-3 generations per year and in warmer regions even four generations.

Photos 42-43. Specific injury caused by *Cydalima perspectalis* larvae (original).

***Megabruchidius tonkineus* (Pic, 1904) (Coleoptera, Chrysomelidae, Bruchinae) – the East Asian seed beetle**

Species of oriental origin, it was detected for the first time in Europe, in Germany, in 1980, from whence it spread to other countries among which Romania and it is now present almost throughout the country (PINTILIOAIE et al., 2018).

We found it as larva, pupa and adult stage, in spring 2016 in various locations in and around Craiova, where we found honey locust trees with fructification (Photos 44-45).

Photos 44-45. *Megabruchidius tonkineus* female adult and honeylocust pods with exist holes made by adult beetles (originial).

CONCLUSIONS

The observations and collectings of the entomological material conducted during 2016-2017 in 152 locations throughout Oltenia revealed 18 species of invasive forest insects, of which 6 species have been previously reported and 12 species are new records for this region.

From the first group, *I. duplicatus* and *N. tibialis* do not cause significant damages, while *H. cunea* is producing outbreaks cyclically throughout the region, with weak infestations in the tree stands and severe infestation on isolated trees or in street and road alignments. *C. ohridella* is present every year on the trees of green areas, frequently with severe infestations. *M. robiniella* and *P. robiniella* are present throughout the Oltenia and cause significant injuries to the black locust stands in southern part of the region.

The newly found species are taxonomically and ecologically quite diverse and have a varied status. The Order Hemiptera is represented by five species, Coleoptera, Diptera and Lepidoptera each by two species, and Hymenoptera by one species. There were found two new species of aphids, *A. robiniae*, *P. fraxinifolii*, an adelgid – *G. cooleyi*, a lygeid bug – *O. lavaterae* and a tingid bug – *C. arcuata*. The first four species are quite rare, while the last one is found almost everywhere in the county, particularly in the oak stands of plains and hills.

The two new species of beetles are an ambrosia beetle and a seed beetle. *X. germanus*, a polyphagous species, was caught in only three locations, within mixed hardwood and softwood forests from the Southern Carpathians and the

populations seem to be very low so far, while *M. tonkineus* was found in honey locust pods and seeds collected in Craiova and in the city surroundings.

Both dipteran species are gall midges, one on the black locust, and the second on the honey locust. The first, *O. robiniae* is already a common species in the region, while the second, *D. gleditchiae,* is quite rare, still spreading.

From Lepidoptera Order, two monophagous species were found, the lime leaf miner and the box tree moth. *P. issikii* has been found in mixed forests of the hilly area, without causing visible injurie, while *C. perspectalis* is present in the cities and causes severe damages on box trees. *A. leucopoda,* a wasp whose larvae feed on elm tree foliage, was detected in the mixed forest of oaks and other broadleaves in the plain and hilly areas, without causing significant damage so far.

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PRELIMINARY DATA REGARDING INTERSPECIFIC RELATIONSHIPS BEETLE SPECIES COLLECTED FROM DIFFERENT ECOSYSTEMS MET IN DOLJ COUNTY IN 2017. NOTE 1

LILA Gima

Abstract. The research studies on the diversity of interspecific relationships from Dolj County exposed in this paper were achieved between 2016-2017. The beetle biological material (2 specimens) was collected from terrestrial ecosystem - Craiova. The host, from the systematic viewpoint, belong to the order Choleoptera, respectively to family Dynastidae. The interspecific relationship identified is transport or spread, respectively phoresy. The species on which mites were found are *Oryctes nasicornis* Linnaeus 1758. From the systematic viewpoint, the identified mites are belong arachnids - *Hypoaspis* sp. (Mesostigmata: Laelapidae). The species by mites identified at *Oryctes nasicornis* is new for Dolj, Romania.

Keywords: interspecific relationships, beetles, mites, ecosystem.

Rezumat. Date preliminare privind relaţii interspecifice la coleoptere din diferite ecosisteme din judeţul Dolj colectate în 2017. Nota 1. Cercetările privind diversitatea relațiilor interspecifice la coleoptere din judeţul Dolj expuse în lucrarea de faţă au fost realizate între anii 2016-2017. Materialul biologic de coleoptere (3 exemplare, din care 1 exemplar prezintă acarieni) au fost colectate din ecosistemul terestru, oraşul Craiova. Gazda, din punct de vedere sistematic, aparţine ordinului Choleoptera încadrându-se în familia Dynastiidae. Specia pe care s-a găsit acarieni este *Oryctes nasicornis* Linnaeus 1758. Relaţia interspecifică identificată este de transport sau răspândire, respectiv forezie. Acarienii identificaţi în urma cercetărilor de specialitate, din punct de vedere sistematic, aparţin genului *Hypoaspis* (Mesostigmata: Laelapidae).

Cuvinte cheie: relaţii interspecifice, coleoptere, acarieni, ecosistem.

INTRODUCTION

The purpose of this paper is to present some contributions to the knowledge of the diversity of mites, analyzing beetle species present in different types of ecosystems in Dolj County.

In recent years, insects have undergone the complex action of ecological factors (climatic, soil and biotic factors) affecting the biological cycles of insects, spread emergence of mass propagation or decrease the number of the specimens of certain species, the emergence of new pests, etc. As a result, the number of beetle specimens found in the studied ecosystems was low.

All the material found on land was identified and analysed; then, the level of infestation was assessed. The beetle biological material (2 specimens) was collected from terrestrial ecosystem – Craiova city. The host, from the systematic viewpoint, belong to the order Choleoptera, respectively to family Dynastidae. The species on which mites were found are *Oryctes nasicornis* Linnaeus in 1758.

From the systematic viewpoint, the identified mites are belong arachnids - *Hypoaspis* sp. (Mesostigmata: Laelapidae).

MATERIALS AND METHODS

The material used in this paper consisted in 2 specimens found in Craiova city, which were identified, analysed and studied, one species having parasites.

The species of beetles are presented in systematic order according with Fauna Europaea.

The material was collected in 2016. Collections were made at different dates, each year in May. And collection date is mentioned. Collection methods were different according to the analysed host species.

1. *Collection methods* for *Oryctes nasicornis*

The insect was sampled from the ground with a pair of tweezers and put in a jar containing filter paper soaked in alcohol 4%. There were taken photos and the material was transported to the Faculty of Biology, biology laboratory, where the specialists took samples from the surface of the insect-body. To analyze the mites, after taking photos, they were placed in a solution of paraffin and sent to the expert for determination.

2. *Collection and research methods for mites*

Using tweezers, mites were collected from *Oryctes nasicornis* females, more precisely from the feet and the ventral side of the abdomen. For identification, the mites were prepared in paraffin. That was stored at room temperature until they were transported and examined carefully under the microscope.

To determine the collected material, there were used the works of PANIN (1957), the determination of the species of beetles being in the entomology laboratory of the Department of Natural Sciences of the Museum of Oltenia Craiova. Some of the photos were taken with DMC-FZ62 Panasonic FullHD digital camera by Lila Gima and another

category was taken by Marinela Boicea - chemist in the laboratory of Restoration - Oltenia Museum Craiova by means of the stereomicroscope OLYMPUS 3D.

The taxonomy and nomenclature of the identified species is made according to Fauna Europea.

RESULTS AND DISCUSSION

The analysed material was represented by 3 specimens of which 1 specimen had mites. The material was collected betwin years 2016-2017 in Craiova city.

Host: *Oryctes nasicornis* Linnaeus 1758 ♀
Parasite: *Hypoaspis* sp.
Collection site: Craiova
Date of collection: May 3, 2016; May 2017

***Oryctes nasicornis* Linnaeus, 1758 - gândacul rinocer**
Choleoptera: Scarabaeidae: Dynastinae: *Oryctes*
Status according to IUCN: low-risk species, endangered.

The species appears in forests, forest steppes, as well as in steppes.

The Choleopteran was collected in the street. This year, several specimens of rhinoceros beetle females were found near a small park located in the vicinity of the museum.

Sexual dimorphism in this species is very pronounced.

The female collected and identified has the frontal part of the head convex, with a conical, sharp horn; the harsh punctuated pronotum, which is thick at the anterior part, and with a simple punctuation at the posterior part, has an anterior impression, bordered posteriorly by a wave; the body length is 23-43 mm (Fig. 1).

Figure 1. *Orictes nasicornis*, female (original).

The reproductive cycle lasts 4 years. The larvae grow in plant composts and decomposing vegetable matter, often in the rotten wood of different deciduous species. Adults are active during April-August period and survive only one year. The species was also reported flying near light sources (PANIN, 1957).

The species is widespread in Europe (Austria, Belgium, Denmark, Germany, the Netherlands, Poland, Romania, Russia, Hungary, the Baltic countries, etc.), Crimea, the North Caucasus, Middle Asia, North Kazakhstan, Syria, Iran, Western Siberia, North Africa.

Protection and conservation measures. Protecting old trees in deciduous forests; prohibiting the collection of the species by amateur collectors.

The species is included in the annexes of the Berne Convention as a rare and threatened with extinction species.

***Hypoaspis* sp.**
Arthropoda: Arachnida: Acari: Mesostigmata: Laelapidae: *Hypoaspis* G. Canestrini, 1884

The Laelapidae family includes about 800 species of mites, including obligate and facultative parasites of vertebrates, paraphagous insects and free-living predators that inhabit the soil litter habitats, as well as nests of vertebrates and arthropods (EVANS until 1966, FARAJI and HALLIDAY, 2009; et al., 2009; JOHARCHI et al., 2011; JOHARCHI et al., 2012a, b - in JOHARCHI & SHAHEDI, 2016).

At present, the family is classified in approximately 144 genera, including *Hypoaspis* with 36 species. In recent years, specialty studies on the presence of mites of the genus *Hypoaspis* sp. have been carried out especially by researchers in Iran (MOHAMMAD KHANJANI et al., 2013; JOHARCHI & SHAHEDI, 2016). Almost all species of *Hypoaspis* sp. (Fig. 2) which appear in Iran are associated with Choleoptera, especially with the species of the Scarabaeidae family, while few were collected in the soil (JOHARCHI & SHAHEDI, 2016).

Fifteen species considered as belonging to *Hypoaspis* sp. have been reported from Iran so far, including new species (JOHARCHI & SHAHEDI, 2016).

On the other hand, it is difficult to draw firm conclusions about the specificity of the host because the studies performed on them are brief.

Figure 2. Deuteronymph of *Hypoaspis* sp. on the ventral side of *O. nasicornis*, female (original).

CONCLUSIONS

The work joins the efforts of specialists who contribute to the knowledge of entomofauna diversity.

Craiova city represent new collection site for species *Orictes nasicornis* of Choleoptera.

This study only signals the presence of the mite *Hypoaspis* sp. at the choleoptera. The mite identified in the studied beetle are specie reported by foreign authors, but there are no mentions of them in the Romanian specialized literature.

The present paper, for the time being, signals the presence of the mite in this species of coleopter. We will continue to collect beetles and make observations.

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DISTRIBUTION OF THE SPECIES *Zerynthia polyxena* (LEPIDOPTERA, PAPILIONIDAE), IN NATURAL AND ANTHROPIC HABITATS IN THE CARPATHIAN PIEDMONT BETWEEN THE RIVERS BUZĂU AND PRAHOVA (ROMANIA), IMPLICATIONS FOR ITS CONSERVATION

BÂRCĂ Valentin, NICULAE Marilena

Abstract. *Zerynthia polyxena* is a Palearctic species, spanning across Europe through Central Asia, in disjunct populations restricted to patchy habitats providing its food plants from the genus *Aristolochia* and suitable habitat. It is a beautiful flag-species for conservation programs and a remarkably interesting model-system for toxicologists studying resistance mechanisms against the genotoxic and malignant lethal effects of Aristolochic Acids, against which this species is immune. Native to most of Southeastern Europe (where it is declining by 6-30%), and extinct in Germany and Switzerland, it was relatively rare allover its vast European range, due to its narrow steno-monophagous diet and its relatively strict habitat requirements. In Romania, it is widely distributed in patchy, disjunct and vulnerable local populations in all provinces, feeding mainly on *Aristolochia clematitis*, and it is listed as endangered species in Romanian fauna declining >30%, and a Natura 2000 species protected by law. Therefore, knowing the actual population range, population sizes and trends in a given region is an objective of great importance to which our study is herein bringing a first contribution. We present herein more than 30 locations where we documented the occurrence, abundance and habitat data for this species in the Carpathian Piedmont between the rivers Prahova and during more than previous 10 years of fieldwork. Despite the apparently encouraging numbers, the populations are small and very vulnerable especially to indiscriminate use of chemical insecticides, often not only in the vineyards and crop-fields, but also on the fallow/ruderal land bordering the cultivated fields which both harbor the weed-like *A. clematitis* food-plants. The data we gathered indicate the occurrence of resident populations with fluctuating distribution and abundance between the sites, having the characteristics of a metapopulation, increasing its conservations hopes. This first batch of results prompted newer research aimed at validating the hypotheses we hereby formulated.

Keywords: *Zerynthia polyxena, Aristolochia clematitis*, chorology, conservation, metapopulation.

Rezumat. Distribuția speciei *Zerynthia polyxena* (Lepidoptera, Papilionidae), în habitate naturale și antropice în Subcarpații dintre râurile Buzău și Prahova (România), implicații pentru conservarea ei. *Zerynthia polyxena* este o specie Palaearctică, distribuită de-a latul Europei până în Asia Centrală, în populaţii disjuncte, restrânse la habitate care oferă planta gazdă din genul *Aristolochia* şi habitate adecvate. Este o superbă specie-fanion pentru programe de conservare şi un remarcabil sistem-model pentru toxicologii care studiază mecanismele de rezistenţă împotriva efectelor genotoxice şi maligne, mortale, ale Acizilor Aristolochici, împotriva cărora această specie este imună. Spontană în mai toată Europa de Sud - Est (unde specia este în declin cu 6-30%), a dispărut din Germania şi Elveţia şi este relativ rară în tot vastul ei areal European, datorită dietei steno-monofage şi cerinţelor de habitat relativ stricte. În România, este larg răspândită în populaţii locale disjuncte şi vunerabile în toate provinciile, hrănindu-se în special cu *Aristolochia clematitis*, şi este listată ca specie periclitată în fauna Românei, în declin >30%, şi specie Natura 2000 protejată de lege. Ca urmare, cunoaşterea distribuţiei actuale, a mărimii populaţiilor şi a tendinţelor dintr-o regiune, este un obiectiv de mare importanţă, la care studiul nostru aduce aici o primă contribuţie. Prezentăm aici peste 30 locaţii unde am documentat existenţa, abundenţa şi informaţii despre habitat pentru această specie în Subcarpaţii dintre rîurile Prahova şi Buzău în decursul a peste 10 ani de observaţii în teren. În ciuda aparent încurajatoare, populaţiile sunt mici şi foarte vulnerabile în special la folosirea fără discriminare a insecticidelor chimice, adesea nu doar în vii şi terenuri cultivate, dar şi pe terenuri virane-ruderale mărginind terenurile cultivate care ambele adăpostesc planta gazdă - buruiana *A. clematitis*. Datele culese de noi indică prezenţa unor populaţii rezidente cu distribuţii şi abundenţe fluctuante între locaţii, având caracteristicile unei metapopulaţii, ceea ce creşte speranţele de conservare. Această primă tranşă de rezultate a impulsionat noi cercetări destinate validării ipotezelor formulate în acest cadru.

Cuvinte cheie: *Zerynthia polyxena, Aristolochia clematitis*, corologie, conservare, metapopulaţie.

INTRODUCTION

Zerynthia polyxena (Denis & Schiffermüller, 1775), is a Palaearctic species, spanning across Europe and Western and Central Asia, in disjunct populations restricted to patchy habitats where it can find its specialized food plants from the genus *Aristolochia* and suitable habitat. It is native to the southeastern France, Italy (including Sicily) through most of Southeastern Europe (Albania, Austria, Greece, FYR Macedonia, Bosnia and Herzegovina, Montenegro, Bulgaria, Croatia, Serbia, Slovenia, Romania, Moldova) extending North-Eastwards through Hungary, Slovakia, Czech Republic, Belarus, Ukraine, Russian Federation, Turkey to Southern Urals and Northwest Kazakhstan where it occurs between 0-1700m, but usually at lower elevations than 900 m (VAN SWAAY et al., 2010). Formerly also native to Germany and Switzerland, more recent work do not mention the current occurrence in these countries (BERGMANN, 1952; TOLMAN & LEWINGTON, 1998; KUDRNA, 2002) and according to (VAN SWAAY et al., 2010) it has gone extinct in these countries.

From taxonomic point of view, *Zerynthia polyxena* (Dennis & Schiffermuller, 1775) is a complex species which reportedly has more than 31 subspecies (NARDELLI & HIRSCHFELD, 2002) distinguished by a complex of

morphological characters set forth by FORD (1944a, 1944b) and EISNER (1974) and which have an intricate intra- and inter-specific hybridization pattern investigated by DESCIMON & MICHEL (1989) and LUX (1990).

DINCĂ & VILA (2008) reported successful molecular DNA-based identification *Zerynthia polyxena* and distinction from *Z. cerisyi ferdinandi* based on larvae found feeding on *Aristolochia clematitis* in Canaraua Fetei natural reserve in Southern Romania, while DAPPORTO (2010) segregated *Zerynthia cassandra* (Geyer, 1828) from *Zerynthia polyxena* (Dennis & Schiffermuller, 1775) on morphological grounds via geometric morphometry.

Its sozological status is rather precarious, according to the IUCN evaluation from 2010 (VAN SWAAY et al., 2010), still valid at current moment, *Zerynthia polyxena* is reported extinct from Germany; Switzerland with a "strong decline in distribution or population size of more than 30% reported from Romania, while decline in distribution or population size of 6-30% has been reported from Albania, Austria, France, Serbia, Turkey (European part) and Ukraine.

While the species has a vast range in Europe, it was not very abundant all over its range, due to its narrow steno-monophagous diet and its relatively strict habitat requirements, which make the species use much less of the available food sources (DINCĂ et al, 2009; DAPPORTO, 2010).

Despite its decreasing current population trend the current threat status at European level is LC (Least Concern) but the species is listed on the Habitats Directive Annex 4 and Bern Convention Annex 2 (VAN SWAAY et al., 2010).

Due to their attractive habitus, *Z. polyxena* is very popular among lepidopterologists who studied their life history and ecology in considerable detail.

Depending on the availability at a certain location, its larvae feed on various *Aristolochia* species, such as *Aristolochia clematitis*, *A. rotunda*, *A. pallida* and *A. pistolochia*, all of which are very toxic. Like many other Papilionidae, the larvae of *Z. polyxena*are capable of sequestering phytotoxines from their food-plant, which render both the caterpilars, pupae and the adults toxic and unpalatable for predators.

Unlike the case of other lepidopteran food-plants which are less dangerous for humans, *Aristolochia* species are quite dangerous to humans, being incriminated as causal agents in lethal conditions involving the excretory system, as their main toxines, the Aristolochic Acids and their aristolactams are believed to cause both upper transitional epithelial cancers and kidney progressive fibrosis leading to terminal failure (known as Balkan Endemic Nephropathy).

In Romania, the main food-plant for *Z. polyxena* is *Aristolochia clematitis* and much less frequently other species of the genus, which are much rare and less abundant, like *A. rotunda / A. pallida* complex. *Aristolochia clematitis* with the vernacular names in Romanian "marul lupului", or "Oesterluzei" in German,

is (along with the other *Aristolochia* species) of paramount importance for the conservation of not only *Zerynthia polyxena* but also of another rare and important Papilionidae species from Romanian fauna , viz. *Z. (Allancastria) cerisyi ferdinandi* (Stichel, 1907), as they are the only known food-plants for these lepidopteran species.

Knowledge regarding the biology and sozology of *Z. polyxena* in Romania is relatively good, and it is considered endangered at a country level as declines of more than 30% have been reported, (VAN SWAAY et al., 2010), it is listed as an endangered species in the Romanian fauna (RÁKOSY, 2003) and a Natura 2000 species of conservative interest being in principle protected by law.

It is relatively widely distributed in Romania, but indisjunct patchy, local populations. in all provinces, being rediscovered in Southern Dobrogea, (DINCĂ & VILA, 2008; DINCA et al., 2009), 80 years from the last report (MANN, 1866).

Not many precise chorological data from Romania were available at the beginning of this study (but ,see NICULESCU, 1961; SZÉKELY, 1985) and the situation still has room for improvement, despite some new data from reports in recent years , SZÉKELY, 1996; RÁKOSY et al., 2003; DINCĂ et al., 2009)

Continuing our previous work on chorology and conservation of interesting plant or insect taxa (also see ARBUNE et al., 2009; BÂRCĂ & NICULAE, 2005, 2006, 2009, 2011; BÂRCĂ, 2016a, 2016b; NICULAE & BÂRCĂ, 2005, 2006; BÂRCĂ et al., 2011), we present herein the results of more than 15 years of field research in this region rather poorly explored until recently.

In addition to being a beautiful species with a great potential for serving environmentalists as a flag-species for conservation programs beyond its individual benefit, *Z. polyxena* is a remarkably interesting species as a model system for toxicologists trying to understand the mechanism used by it to escape the genotoxic and malignant lethal effect of the Aristolochic Acids, towards which this species is apparently immune. Therefore, knowing the actual population range, population sizes and trends in a given region is an objective of great importance to which our study is herein bringing a first contribution.

MATERIAL AND METHODS

The area involved in the present work is situated on the territory of two counties, Prahova and Buzău, in the Eastern-part of Romania, covering the hills of the Carpathian Piedmont spanning betweenthe river Prahova to the West and the river Buzău to the North and East, being limited to the south by a virtual arch passing through Ploiesti and cities and the villages Drăgănești de Prahova, Fulga, Lacu Sinaia, Amaru, Margineanu, Movila Banului, Costești, Pietrosu, Spătaru. The survey could not be performed with an exhaustive approach, being more focused on the areas where natural stands with populations of *Aristolochia* sp. were identified by us or had been previously reported. Thus,

some areas with known or presumed to have *Aristolochia* natural populations or a higher biodiversity were over-surveyed for several years while others were much less thoroughly surveyed. Therefore, a place not mentioned in the present work might very well harbor a viable population of *Z. polyxena*.

On the other hand, like previously reported for the *Aristolochia clematitis* in Southern Dobrogea (BÂRCĂ, 2018), some of the populations surveyed in several (even consecutive) years showed fluctuating sizes, some populations even disappearing altogether and reemerging in subsequent years. In some cases factors contributing to the fluctuating population sizes could be inferred as the local farmers heavily use insecticides for the agricultural management of vineyards and other crops, but in some other instances no factors could be detected, while entire, previously thriving stands of *Arostolochia* vanished without trace or apparent cause, just to reemerge years later without any logical explanation.

The sites were surveyed personally by the first author and positive occurrence was recorded only when either adult specimens (imagines) or larvae where personally seen. A few locations are mentioned after records from the scientific literature and are marked accordingly in the table, and one site is derived from a photographic record found over the internet and it is also marked accordingly. In all instances ,I avoided collecting butterfly specimens, identification being easy and straight forward for both adults and larvae (under the assumption that the other similar species *Z. (Allancastria) cerisyi ferdinandi* (Stichel, 1907) does not occur in the studied region).

The geographical coordinates are given in the WGS84 system, and were collected either on spot using a GPS device with a reported error of less than 5 m, or, for older sites, were inferred where possible from field notes using ACME Mapper 2.1 software.

When recording the food-plant locally available, in order to avoid confusions with related species (*A. rotunda / A. pallida*) I mention the diagnostic criteria used to positively assign the individual plants to *A. clematitis* species, criteria that were the same as in BÂRCĂ, 2018, as follows:

– **General habitus**: – tall plants, with whirling stems 1–1.5 m tall, growing in rather dense colonies.
– **Flower habitus**: – yellow, concolor (without dark spots or stripes), multiple, growing often several at each one node.
– **Leaf habitus**: – leaves are cordiform, with pointed apices, with well-defined and longer stalks.
– **Roots/underground stems habitus**: – the plants present elongated tuberiform rhizomes, not rounded, ovalar or spherical bulbiform.

The results are presented in tabular format in Table 1, together with some ecological characteristics of the sites of occurrence where available. We also present data regarding the abundance of the individuals recorded on site (population sizes) and about the life stages found at the time of survey at the site, i.e. larvae or adults, and the number of individuals seen each year (if here have been visits in multiple years).

RESULTS AND DISCUSSIONS

During the last 30 years, our fieldwork research in the Carpathian Piedmont region between the rivers Prahova and Buzău, resulted in a number of 3+ sites where I have positively identified either flying imagines or larvae of *Zerynthia polyxena* (Dennis & Schiffermuller, 1775) on *Aristolochia clematitis* oftentimes redundantly. These individuals belonged presumably to resident populations of *Zerynthia polyxena* despite living in mostly seminatural, more anthropic habitats.

The sites where I have found *Zerynthia polyxena* in the studied region studied are listed in tabular format below (Table 1), sorted in descending order by counties and by location geographical coordinates. For most of the sites I present some notes about the habitat and about the number of colonies and abundance of the host-plants *Aristolochia clematitis* and about the abundance of *Zerynthia polyxena* at the site at the moment of my visit.

Table 1. List of the sites with their geographical coordinates where we have positively identified the occurrence of *Zerynthia polyxena* or from which credible data are published.

No	County	Closest human settlement	Site code	Coordinates WGS84 system	Notes, Host/ Habitat	Data Source
1	PH	?unverified source Drăgăneşti	NA	N 44 49' 39" E 26 17' 15"	Photo Date Taken: May 1, 2014 Retrieved from https://yourshot.nationalgeographic.com/photos/7795648/	Photo on the WWW, See Notes in the previous cell at the left
2	PH	Fulga de sus	FU	N 44 53' 25" E 26 26' 35"	Adults on flight on pasture by the lake shore **SANTH**	BV14[2A]
3	PH	Gura Vadului	GVN	N 45 2' 8" E 26 25' 58"	by a flood-control ditch along the ditch and inside cultivated fields and/or vine-yards **SANTH**	BV2011-2017[#A, #L]
4	PH	Gura Vadului	GV2	N 45 2' 10" E 26 25' 52"	by ditch 2-3AC **SANTH**	BV2011-201[#A, #L]7
5	PH	Gura Vadului	GV3	45 2' 13" E 26 25' 36"	by ditch 1-3AC **SANTH**	BV2011-2017[#A, #L]
6	PH	Gura Vadului	GV4	45 2' 17" E 26 25' 20"	by ditch some adults perching on a large Rubus stand! 1-3AC **SANTH**	BV2011-2017[#A, #L]

7	PH	Gura Vadului	GV5	45 2' 19" E 26 25' 10"	uncult field by the road 2AC **SANTH**	BV2011-2017[#A, #L]
8	PH	Gura Vadului	GV6	45 1' 46" E 26 25' 31"	ditch 2 uncult 1AC **SANTH**	BV2011-2017[#A, #L]
9	PH	Gura Vadului	GV7	45 1' 42" E 26 25' 8"	ditch 2 crossing uncult 1AC **SANTH**	BV2011-2017[#A, #L]
10	PH	Gura Vadului	GV8	45 1' 27" E 26 24' 42"	seminatural field by natural ravine 2-4AC **SANTH**	BV2011-2017[#A, #L]
11	PH	Gura Vadului	GV9	45 1' 23" E 26 24' 48"	Natural ravine along a temporary creek 2-4AC	BV2011-2017[#A, #L]
12	PH	Vadu Sapat	VS	N 45 1' 14" E 26 24' 10"	Ravine by a natural creek between Vadu Sapat and "Bozieni" 1AC	BV2007[2A, #L]
13	PH	Călugăreni	CASW	N 45 4' 41" E 26 21' 48"	natural ravine by Călugăreni 1AC	BV2007[3A, #L]
14	PH	Călugăreni	CASE	N 45 5' 4" E 26 23' 1"	natural? ravine by Călugăreni 2AC	BV2007[3A, #L]
15	PH	Călugăreni	CASE	N 45 5' 8" E 26 23' 17"	natural ravine by Călugăreni 1AC	BV2007[1A, #L]
16	PH	Călugăreni	CASE	N 45 4' 49" E 26 24' 15"	natural ditch between Călugăreni (Valea Scheilor) and Boboci –Jugureni 1AC **SANTH**	BV2007 [1A,#L]
17	PH	Jugureni	JUNW	N 45 6' 0" E 26 25' 33"	natural ravine by the road towards "Marginea Padurii" village 2AC **SANTH**	BV2007[3A, #L]
18	PH	Jugureni	JUSE	N 45 5' 12" E 26 25' 20"	natural ravine in uncultivated field /pasture towards Tohani village 1-4AC, large stands	BV2005[1A]; B2007[2A, 5L]; BV2008[3A, #L]; BV2010[4A, #L]; BV2012[2A]; BV2013[2A, #L]; BV2014[6A, #L]; BV2017[1A]; BV2018[#L]
19	PH	Tohani	ToNW	N 45 4' 15" E 26 25' 39"	natural ravine in uncultivated field /pasture by a forest plantation between 2 limestone hills 1-4AC, small stands	BV2005[1A]; B2007[4A, #L]; BV2008[1A, #L]; BV2010[3A, #L]; BV2011[8L]; BV2012[1A]; BV2013[1A, #L]; BV2014[8A, #L]; BV2017[1A]; BV2018[#L]
20	PH	Tohani	TON	N 45 4' 20" E 26 26' 13"	Vast pasture with limestone and calcareous breccia, conglomerate outcrops N of limestone hills by Tohani village, multiple small AC. In 2018 remarkable abundance of AC	BV2005[2A]; B2007[5A, #L]; BV2008[1A, #L]; BV2010[2A, #L]; BV2011[4L]; BV2012[2A]; BV2013[2A, #L]; BV2014[3A, #L]; BV2017[2A]; BV2018[#L]
21	PH	Tohani	TON2	N 45 3' 57" E 26 26' 22"	natural ravine in uncultivated field /pasture by a forest plantation between 2 limestone hills 1-2AC **SANTH**	BV2008[2A, #L]; BV2010[3A, #L]; BV2011[5L]; BV2012[1A];
22	PH	Persunari	PENW	N 45 3' 31" E 26 26' 43"	natural ravine in uncultivated field /pasture with brushes **SANTH**	BV2005[1A];; BV2007[1A]; BV2008[#L];BV2010[#L]; BV2011[3L];
23	PH	Persunari	PENW2	N 45 3' 41" E 26 26' 42"	natural ravine in uncultivated field /pasture by a limestone hill multiple AC	BV2005[1A]; BV2007[1A]; BV2008[7L]; BV2010[#L]; BV2011[2L];
24	PH	Persunari	PENE	N 45 3' 39" E 26 27' 12"	natural ravine in uncultivated field /pasture by a limestone hill multiple AC	BV2005[1A]; BV2007[1A]; BV2008[5L]; BV2010[#L]; BV2011[2L];
25	PH	Persunari	PEE	N 45 3' 29" E 26 27' 8"	natural ravine by a meandered creek multiple AC	BV2005[1A]; BV2007[1A]; BV2008[6L]; BV2010[8L]; BV2011[3L];
26	PH	Muntele Roşu/cheia	MR1	NA	close to Izvorul Nicolaie Ioan" spring 4th instar Larvae 1AC	BV1976[?L];
27	PH	Muntele Roşu	MR2	NA	"valea Berii 4th instar Larvae 1AC	BV1976[?L];
28	BZ	Ratesti	RAN	N 45 18' 17" E 26 37' 52"	forest margins close to "Manastirea Ratesti" monastery multiple AC **SANTH**	BV2010[#L];
29	BZ	Nehoiu	NE	NA	Larvae on multiple AC ruderal by the railway station	BV2008[#L];
30	BZ	Siriu	SIN	N 45 31' 31" E 26 12' 13"	uncultivated slope towards the lake Siriu by a motel with thermal/mineral springs 3AC	BV2004[#L];
31	BZ	Siriu	SIN2	N 45 31' 45" E 26 12' 0"	pasture by the river/lake Siriu (at the uphill end of the lake Siriu) by a forestry hut ("canton forestier") multiple AC	BV2004[#L];
32	BZ	Mizil	Istrița Hill IH	NA.	relatively frequent 1 West-Asiatic Mediterranean xerothermophilous Endangered	DINCA, 2006
33	BZ	Dănciulești	NA	NA	20.V.2007 (collected as last instar larva)	RVcoll.07-D396 DINCA et al., 2009

Legend: abbreviations used in the table: #AC=number of colonies of *A. clematitis*; AC= Number of colonies of *A. clematitis* observed at site; SANTH =semi-anthropic habitat. The number attached to the source (date0 depicts the abundance of *Zerynthia polyxena* at the site at that respective moment, eg BV 2008[3A] BV2008[4L] represents occurrence of 3 adult specimens or 4Larvae seen in 2008 by the author Bârcă Valentin. For other sources see references; [#A] or [#L] represents more than 9 specimens seen per visit on site.

The data gathered during over 15 years of fieldwork observations in just a rather small part of the Carpathian Piedmont region between the rivers Prahova and Buzău document more than 30 populations of with fluctuating sizes and abundance. The clustering exhibited by our data does not necessarily or adequately reflect the real, natural distribution of *Z. polyxena* in the region, due to an inherent biased pattern of visitation during our research, so the fact that no populations were mentioned from other locations does not guarantee the absence of the species in other locations.

The species is rare in the studied region and very vulnerable mainly to insecticide use and secondarily to habitat degradation and only in the last instance by host-plant destruction –as *Aristolochia clematitis* has all the characteristics of a weed which seems quite resistant to local efforts to eradicate it from the cultivated fields and vineyards (see Fig. 1 for the general habitus and morphological details of the host-plant growing in abundant patches in ruderal habitats).

Despite the fluctuating character of the populations, the data presented here document multiannual presence of the species in many of the sites, suggesting the case of resident populations and not of just vagrant individuals.

Even if that were the case for some sites, the fact that I found larval stages well represented in many sites over several years suggest that, despite fluctuations in size and even presence, we are dealing in effect with a metapopulation of *Z. polyxena sensu* HANSKI (1999), a fact which could increase the chances of survival of this species in the region.

The population sizes are small especially if we take into account the number of adults seen, despite the relatively higher abundance of individuals in larval stages and the fact this species is toxic enough to have many natural predators. A likely explanation for the fact that this species is so rare despite the abundance of its food-plant, as evidenced by our study, is the nefarious synchronization of larval stages with the (abundant, indiscriminate, useless and negligently) applications of insecticides on the ruderal lands and on the strips of land bordering the cultivated fields and vineyards encroaching the patches of otherwise perfectly adequate habitat, which could wipe out entire populations of thriving larvae before reaching pupal stage –during which the individuals could presumably be less sensitive.

The populations found occupy various habitats and such habitat diversity didn't allow observable retrospective evaluation of habitat quality for the populated patches (which alternated spatially and temporally with patches of seemingly identical habitat with apparently equal quality).

HANSKI's (1999) criteria for metapopulation, i.e. discrete local breeding populations of the species; all of which have a high risk of extinction (due to indiscriminate, large-scale use of insecticides); but between which recolonization seems possible (due to *Z. polyxena*'s behavior and it being a strong flyer with good inter-patch mobility) seem to be fulfilled in this case and such a supposition might be valid. The metapopulation supposition is further supported by the arguments of DAPPORTO (2010) who states that *Z. polyxena* maintains reproductively isolated populations because it is a *"sedentary butterfly showing a short-flight period, forming small and scattered populations linked to a single plant genus"*.

Albeit the data gathered in this study were not sufficient to allow validation of such a model, they prompted a new prospective research investigating the population trends and the impact on patch occupancy of both patch size and isolation as historically hypothesized by THOMAS et al., (1992) and HANSKI (1994) and that of habitat quality as demonstrated by later studies (DENNIS & EALES, 1997; THOMAS et al., 2001; WAHLBERG et al., 2002; KRAUSS et al., 2005), especially as *Z. polyxena* is virtually monophagous in the studied region.

CONCLUSIONS

The most important contribution of the present research is that it documents a relatively constant (albeit fluctuating in size) *presence* of *Zerynthia polyxena* in the region and that its occurrence is not an exception -as it was previously believed, but rather something quite normal.

The species is rare in the studied region and very vulnerable mainly to insecticide use and secondarily to habitat degradation and only in the last instance by host-plant *Aristolochia clematitis* destruction.

The main protective measure applicable for decreasing the threats for the local *Z. polyxena* populations is completely avoiding applications of insecticides on the ruderal lands and on the strips of land bordering the cultivated fields and vineyards or at least delaying the applications of insecticides until larvae reached the pupal stage –during which the individuals could presumably be less sensitive, as the nefarious synchronization of the applications of insecticides with larval stages uselessly kill them on patches of otherwise perfectly adequate habitat, destroying entire viable populations.

The study reported herein was not aimed at finding and predicting trends, and the weak quantitative data presented do not allow for such a retrospective approach, but it represented an encouraging start and also provided a basis for a newer prospective research started recently which should provide such insights, which we will use for adequate population management programs.

Based on our findings presented herein we hypothesized that some of the populations reported in this region are interlinked in one or more metapopulations, as we believe that they fulfill HANSKI's (1999) metapopulation criteria.

The data reported herein prompted a new prospective research investigating the population trends and the impact of patch size, patch isolation and of habitat quality on patch occupancy towards the validation of such a model.

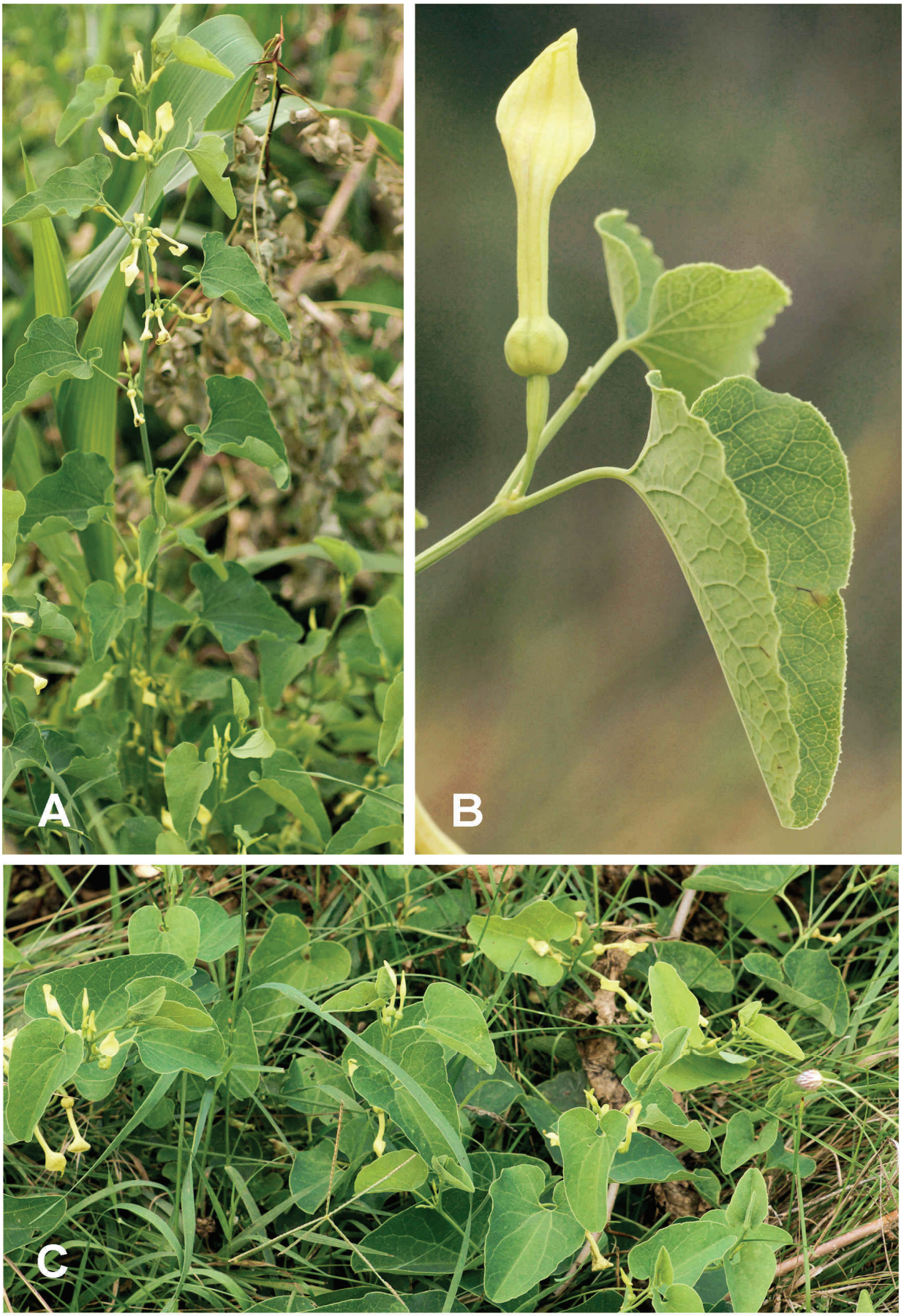

Figure 1. Typical aspect of *Aristolochia clematitis*, the host plant of *Z. polyxena*; A: Flowering hoot general habitus; B: Aspect of the flower and leaf; C: Clump of individuals by a ditch in Gura Vadului, PH, Photo Bârcă V., original.

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THE CRITICAL ENDANGERED TAXA WITHIN THE LEPIDOPTERA COLLECTION OF THE "LUCIAN BLAGA" UNIVERSITY IN SIBIU

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Abstract. The present paper is an analysis of the Lepidoptera species having the statute of critical endangered taxa within the Lepidoptera Collection of the ″Lucian Blaga″ University in Sibiu. After the last inventory, this collection contains 1,195 samples with 660 ♂♂ and 357 ♀♀, that belong to 21 families, 334 genera and 560 species. This paper presents a list with 6 species with the statute of critical endangered taxa. There are analysed the data and the collecting place of every species, the height of the zone and its framing into the zoogeographical regions of Romania, and also the flight period, host plants that constitute the food sources for larvae, the development stage when they enter in the stage of hibernal diapause, in case of migratory species. The analysis of this material represents an important contribution to the knowledge of these species in the fauna of Romania because it is presented the data from the speciality literature with a scientific value for the natural patrimony.

Keywords: Lepidoptera, Collection of the "Lucian Blaga" University in Sibiu, critical endangered taxa, protection statuts, habitat.

Rezumat. Taxoni critic periclitați existenți în cadrul Colecției de Lepidoptere a Universității „Lucian Blaga" din Sibiu. Prezenta lucrare este o analiză a speciilor de lepidoptere cu statutul de taxoni critic periclitați existenți în cadrul Colecției de Lepidoptere a Universității "Lucian Blaga" din Sibiu. Analiza materialului prezentat reprezintă o contribuție importantă la cunoașterea acestor specii de lepidoptere din fauna României, prezentând date din literatura de specialitate cu valoare științifică pentru patrimoniului natural. În colecția de lepidoptere a Universității "Lucian Blaga" din Sibiu, după ultima inventariere, se găsesc 1.195 exemplare din care 660 ♂♂ și 357 ♀♀, aparținând la 21 familii, 334 genuri, 560 specii. Prezenta lucrare descrie lista celor 5 specii care au statutul de taxoni critic periclitați. Sunt prezentate datele și locul de colectare ale fiecărei specii, altitudinea, denumirile zonei și încadrarea în regiunile geografice ale României, precum și aspecte legate de: perioada de zbor, plantele gazdă care constituie surse de hrană pentru larve, stadiul de dezvoltare în care intră în diapauză hibernală, dacă sunt specii migratoare.

Cuvinte cheie: Lepidoptera, Colecția Universității "Lucian Blaga" din Sibiu, taxoni critic periclitați, statutul de protecție, habitat.

INTRODUCTION

The present paper is a part of a study about the protective statute of the Lepidoptera species within the Collection of the ″Lucian Blaga″ University in Sibiu and numerous collections kept in museums in Romania (POPESCU-GORJ, 1964; NEMEȘ & VOICU, 1973; KÖNIG, 1975; CIOCHIA & BARBU, 1980; CIOCHIA & STANCĂ, 2000; MARCU & RÁKOSY, 2002; SZÉKELY & CERNEA, 2007; ANTOFIE & SAVA SAND, 2015), from amateur collectors or educational institutions. Of the 560 common species, Lepidoptera Collection of Lucian Blaga University contains also rare and endemic fauna of Romania (STANCĂ-MOISE, 2015a, b; 2016 a, b; 2017). The critical endangered taxa from this collection have their importance to the knowledge of the Lepidoptera in Romania. They complete in this way the speciality literature with faunal data of a latest actuality for the value of the natural patrimony (NICULESCU & KÖNIG, 1970; KOCH, 1991; SZÉKELY, 1995, 1996, 1999a, b; 2003, 2006, 2008; WEIDEMANN & KÖHLER, 1996; KARLSHOLT & RAZOWSKI, 1996; WINIARSKA, 2003; ANTOFIE, 2015).

This paper presents a list with 6 species with this statute from the zoogeographical regions of Romania. The framing in the IUCN categories has a distinct documentary value.

MATERIALS AND METHOD

The present paper was elaborated on the basis of existent data within the Lepidoptera Collection of the ″Lucian Blaga″ University in Sibiu. There are presented 6 Lepidoptera species having the statute of the critical endangered taxa. The analyzed samples with this statute are presented below, being described every species with the information about their spreading in Romania, their preferred ecosystems, protective statute in accordance with IUCN (International Union for Conservation of Nature) and the EU legislation (RÁKOSY, 2002; RÁKOSY et al., 2003; RÁKOSY, 2003; RÁKOSY, 2005), the flight height, period of flight, the host plants that constitute the food sources for larvae, the development stage when they enter in the hibernal diapause, in case of a migratory species, the number of collected samples , with data in accordance with their labels in collection.

1. Malacosoma castrensis castrensis Linnaeus, 1758 sin. *M. castrensis shardaghi* Daniel, Foster & Osthelder, 1951 (3, 3319 Ro, K. & R. 6744)

Biogeographic region: Present in all provinces of Romania (TR, MM, OT) (RAKOSY & SZEKELY, 1996).
Habitat type(s): pastures and hay fields.
Statute: rare and common.

Altitude: 400- 1000 m.
Flight period: ½ VI- VIII.
Protection statute: Critical endangered.
Feed plants for larvae: *Euphorbia cyparissias, Sanguisorba minor.*
Overwintering stage: Hibernates in egg stage.
Migratory statute: non migratory.
No. specimens collected: 1♂, Canaraua Fetii (DB), June 13, 1997, 150 m alt., Leg. Szekely L.

2. Ourapteryx sambucaria Linnaeus, 1758 (72, 3844 Ro, K. & R. 7659)

Biogeographical region: It is present in all the provinces of Romania (BT, CR, TR, MM, OT, MT, MD; DB).
Habitat type(s): marshy forests, wet hay-lands, wet grasslands.
Statute: rare and common.
Altitude: 800- 1200 m.
Flight period: V- ½ VIII.
Protection statute: Critical endangered.
Feed plants for larvae: *Ourapteryx sambucaria*.
Overwintering stage: It hibernates in the pupa stage.
Migratory statute: non migratory.
No. of collected specimens: 2♂♂, Timişul de Jos (Bv), July 25, 1994, 750 m alt., Săcele (Bv.), July 5, 1999, 650 m alt., Leg. Szekely L.

3. Zerynthia cerisyi ferdinandi Stichel, 1907 (436, 3452 Ro, K. & R. 6947)

Biogeographical region: Present in Southern Dobrogea.
Habitat type(s): limestone gorges, karst canyons, steppe meadows, limestone areas, bush areas, wooded steppe.
Statute: very local and common.
Altitude: 0- 200 m.
Flight period: ½ V-½ VI.
Protection statute: Critical endangered.
Feed plants for larvae: *Aristolochia pistolochia.*
Overwintering stage: Hibernates in pupa stage.
Migratory statute: non migratory.
No. of collected specimens: 3♂♂, Canaraua Fetii (DB), May 1, 1978, May 24, 1997, 150 m alt., Şipotele (DB), May 21, 1994, 120 m alt., Leg. Szekely L.
Records: Oltina, Băneasa, Canaraua Fetii, Valea Iortmac, Esechioi, Bugeac, Şipotele, Negureni (SZEKELY, 2008).

4. Lycaena helle (Denis & Schiffermüller, 1775) (456, 3503 Ro, K. & R. 7035)

Biogeographical region: It is present in all the provinces of Romania (BT, TR, MM, OT, MT, MD), except the: Rodna and Muntenia Mountains.
Habitat type(s): marshy forests, marsches, moorlands, wet hay-lands, wet grasslands.
Statute: rare and common (SZEKELY, 2008).
Altitude: 200- 1000 m.
Flight period: IV- ½ VI, ½ VII- ½ VIII.
Protection status: Critical endangered.
Feed plants for larvae: *Rumex acetosella, R. acetosa, Polygonum bistorta, P. viviparum.*
Overwintering stage: It hibernates in the pupa stage.
Migratory statute: non migratory.
No. of collected specimens: 1♂, Mujdeni (Satu Mare county), May 3, 1996, Leg. Szekely L.

5. Boloria titania transsylvanica Tiltscher, 1913 (491, 3608 Ro, K. & R. 7221)

Biogeographical region: It is present in Eastern Carpathians.
Habitat type(s): forest edges, sylvan glades, mountain meadows, grasslands (SZEKELY, 2008).
Statute: rare and common.
Altitude: 600- 1800 m.
Flight period: ½ VII- ½ VIII.
Protection status: Critical endangered.
Feed plants for larvae: *Polygonum bistorta.*
Overwintering stage: It hibernates in the larval stage.

Migratory statute: non migratory.
No. of collected specimens: 1♂, West-Les-Dialerets (Switzerland), Juny 9, 1997, Leg. Szekely L.

6. Hyponephele lupines lupines (O. Costa, 1836) (519, 3687 Ro, K. & R. 7354)

Biogeographical region: Present in Danube Delta (SZEKELY, 2008).
Habitat type(s): sandy wastelands.
Statute: common.
Altitude: 0- 400 m.
Flight period: ½ VII- ½ VIII.
Protection status: Critical endangered.
Feed plants for larvae: *Poa* sp.
Overwintering stage: It hibernates in the larval stage.
Migratory statute: non migratory.
No. of collected specimens: 1♂, Letea Forest (DD), July 19, 1997, Leg. Szekely L.
Records: Brănești (București), Cerneți (Mehedinți), Danube Delta, C. A. Rosetti, Letea, Periprava, Caraorman, Chilia Veche (SZEKELY, 2006).

RESULTS AND DISCUSSIONS

After the processing data, of a total of 560 species, there are recorded a number of 6 species with a statute of critical endangered taxa that there were collected from different bio-geographical regions of Romania: Dobrogea (Canaraua Fetii, Pădurea Letea, Şipotele), Braşov county (Timişul de Jos and Săcele), Mujdeni (Satu Mare county), but also one species collected outside of Romania, in West-Les-Dialerets (Switzerland).

The species were collected in the period between 1994-1997.

CONCLUSIONS

In accordance with the obtained results, the number of species with the statute of critical endangered taxa are six.

Although the proceeded data from sporadic collections among the years 1994-1997, it is completed the knowledge of the presence, diversity and distribution of Lepidoptera species known for the Romanian territory.

For a better knowledge of this diversity group and for reconfirmation or information about the presence of some species in Romania, there are necessary methodical studies. The presence of critical endangered species existent in the ″Lucian Blaga″ Collection of the University in Sibiu, beside with other protected species, rare or menaced with the disappearance, increase its scientific value and reconfirm the importance of insect collections for the knowledge of the biodiversity and the species distribution.

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IN WATER WITH THE ENEMY! A *Lissotriton vulgaris* (AMPHIBIA: SALAMANDRIDAE) PAEDOMORPH LIVING TOGETHER WITH THE NON-NATIVE FISH, *Perccottus glenii* (PISCES: ODONTOBUTIDAE) IN ROMANIA

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Abstract. Paedomorphosis is a rare phenomenon, with remarkable evolutionary and conservative implications. Paedomorphic newts are sensitive to different threats, invasive fish eliminating many populations. In spite of this, in March 2016 we identified in south-western Romania a *Lissotriton vulgaris* paedomorphic female, together not only with fish, but with the invasive fish *Perccottus glenii*, known as a great danger for newts. This is the eighth record of paedomorphic newts in Romania, and the first in the Banat region. The habitat was an artificial channel surrounded by agricultural plain areas. The paedomorhic female's dimension, colour and cloacal shape were as in adult metamorphs. Probably in the region *P. glenii* did not yet succeed to eliminate paedomorphic or metamorphic newts. If in other areas *P. glenii* had this effect, it is hard to believe that something from south-western Romania will succeed to modify the result of this interaction.

Keywords: altered habitats, facultative paedomorphosis, invasive fish, newts.

Rezumat. În apă cu dușmanul! Un paedomorph de *Lissotriton vulgaris* (Amphibia: Salamandridae) trăind alături de peștele non-nativ *Perccottus glenii* (Pisces: Odontobutidae) în România. Pedomorfoza este un fenomen rar, cu implicații evolutive și conservative remarcabile. Tritonii pedomorfi sunt sensibili față de diferite pericole, peștii invazivi eliminând multe populații. În ciuda acestui fapt, în martie 2016 am identificat în sud-vestul României o femelă pedomorfă de *Lissotriton vulgaris*, împreună nu cu oricare pește, ci cu specia invazivă *Perccottus glenii*, cunoscută ca un mare pericol pentru tritoni. Aceasta este a opta identificare a unor tritoni pedomorfi în România, şi prima semnalare în regiunea Banatului. Habitatul a fost canal artificial, înconjurat de zone de câmpie agricole. Femela a avut dimensiunile, coloritul şi cloaca ca la adulţii metamorfi. Probabil în regiune *P. glenii* nu a reușit încă să elimine atât tritonii metamorfi cât și pe cei pedomorfi. Dacă în alte zone *P. glenii* are acest efect, este greu de crezut ca ceva din sud-vestul României va reuși să modifice rezultatul acestei interacțiuni.

Cuvinte cheie: habitate alterate, pedomorfoză facultativă, pește invaziv, tritoni.

INTRODUCTION

One of the many threats for paedomorphic newts are non-native fish introduced in their habitats (e.g. DENOËL et al., 2005a, 2016). One of the most invasive non-native fish in Europe, which colonised large areas in the eastern part of the continent, is *Perccottus glenii* Dybowski, 1877 (e.g. RESHETNIKOV, 2004, 2013). This fish has a very negative impact on newts (e.g. RESHETNIKOV & MANTEIFEL, 1997; KUZMIN, 2001; RESHETNIKOV, 2003, 2008; POPOV, 2014), but, to our best knowledge, it was not recorded beside paedomorphic newts. Although the negative impact of fish is also clear in the case of metamorphic newts (e.g. HECNAR & M'CLOSKEY, 1997; WINANDY et al., 2015; CABRERA-GUZMÁN et al., 2017; PRÉAU et al., 2017; TIBERTI, 2018), their impact upon paedomorphic newts is even greater (e.g. DENOËL & FICETOLA, 2014; WINANDY & DENOËL, 2015). Paedomorphosis was registered in many European newts (e.g. LITVINCHUK et al., 1996; DENOËL et al., 2001; CEACERO et al., 2010; GVOŽDÍK et al., 2013, PIZZUTI PICCOLI, 2013; MESTER et al., 2013; PATERSON, 2017; SOTIROPOULOS et al., 2017). In Romania, the paedomorphic newts are rare, mentioned only in *Lissotriton vulgaris* Linnaeus, 1758, in seven localities (COVACIU-MARCOV et al., 2013; STĂNESCU et al., 2014). The present paper mentions a new distribution locality for paedomorphic *L. vulgaris* in Romania.

MATERIAL AND METHODS

The paedomorphic newt habitat is situated in the Banat region in south-western Romania, near the border with Serbia, in the region of Otelec locality. This region is localized in the drainage basin of the Bega River, in the Timiș Plain (MÂNDRUȚ, 2006). The Banat plains are transformed in agricultural terrains, being more unfavourable for amphibians than other western Romanian plains (BOGDAN et al., 2013). This is also obvious in Otelec, a locality surrounded by intensively exploited agricultural areas. Wetlands are just some remnants of the original large wetlands of the area, many of the actual wet areas are drainage canals situated between agricultural terrains. The habitat in which the paedomorphic newts were encountered is an artificial canal, situated close to a road.

The paedomorphic female was captured with a round net with a long metallic handle. Because we did not expect such discovery, we did not have an aquarium, so the newt was photographed in a small bucket. After being photographed, the paedomorph was released in its habitat, like the other amphibians. We did not measure it because of its fragility. Its size was given relatively, reporting its dimensions to the recipient where it was photographed.

RESULTS

On 13 March 2016 we identified a *L. vulgaris* paedomorphic female south from Otelec (Fig. 1). It was encountered in an artificial canal, close to a road. South, it continues with a network of ditches situated near roads and agricultural fields, and north with a larger channel, of at least four metres width and one meter depth, diverged from the Bega River. In the place where the newt was identified, the channel has one meter width with 80 cm deep water, with steep edges, and concrete wall near the road (Fig. 2). The water has rich aquatic vegetation.

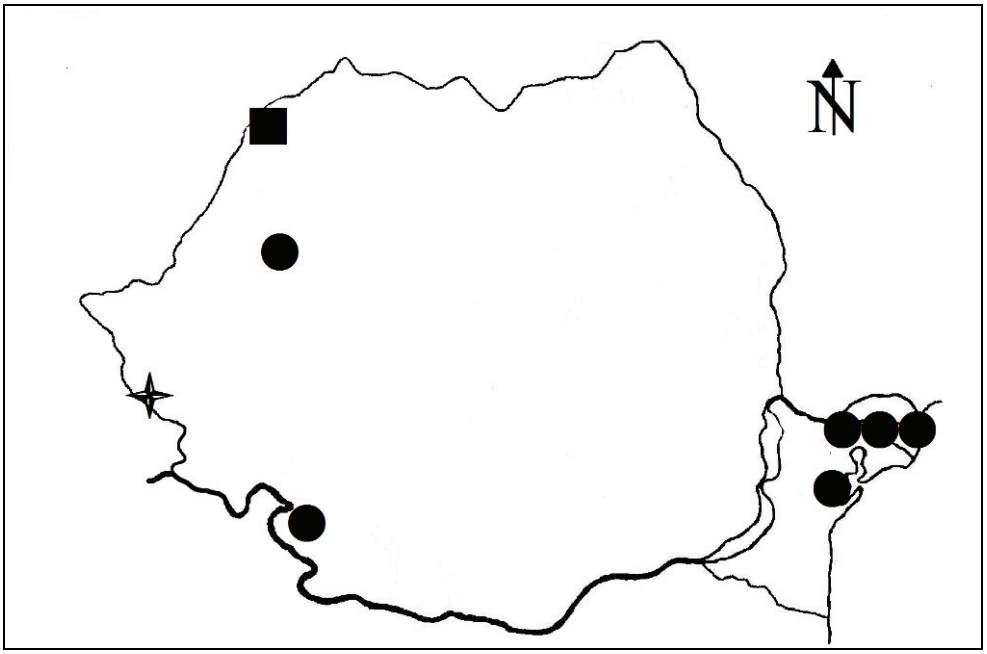

Figure 1. *L. vulgaris* paedomorphs` distribution in Romania (●- previous records mentioned in Stănescu et al., 2014, ■ - previous record in Covaciu-Marcov *et al.* 2013, + - new record at Otelec).

Figure 2. The *Lissotriton vulgaris* paedomorph`s habitat from Otelec (original).

Beside the paedomorphic *L. vulgaris* female, we also captured *L. vulgaris* metamorphs (7 males and 9 females), *Bombina bombina* (Linnaeus, 1761) and *Pelophylax ridibundus* (Pallas, 1771) individuals. Among fish we captured seven *P. glenii*, and some *Carassius gibelio* (Bloch, 1782) individuals. Reporting it to the dimensions of the recipient in which the paedomorph female was photographed, it had a total length of approximately 7.5 cm, with more than 5 mm length guilds (Fig. 3).

Figure 3. The paedomorphic *L. vulgaris* female from Otelec.

DISCUSSION

The record at Otelec is the eighth in Romania (COVACIU-MARCOV et al., 2013; STĂNESCU et al., 2014). The habitat is artificial as in the case of many paedomorphic populations (e.g. COVACIU-MARCOV et al., 2011a; GVOŽDÍK et al., 2013; PIZZUTI PICCOLI, 2013; SOTIROPOULOS et al., 2017). At Otelec, the fact that the paedomorph was present beside fish is unusual, because the negative impact of fish on newts (e.g. HECNAR & M'CLOSKEY, 1997; WINANDY et al., 2015; CABRERA-GUZMÁN et al., 2017; PRÉAU et al., 2017; TIBERTI, 2018). Although in Romania paedomorphs were encountered in other cases beside fish (GHERGHEL et al., 2010; COVACIU-MARCOV et al*.,* 2011a; STĂNESCU et al., 2014), paedomorph and metamorph newts are present at Otelec alongside the fish *P. glenii*. This is a real danger for newts and other amphibians (MANTEIFEL, 1997; KUZMIN, 2001; e.g. RESHETNIKOV et al., 2002; RESHETNIKOV, 2003, 2008; POPOV, 2014). Generally the appearance of paedomorphosis is difficult to explain (e.g. WHITEMAN, 1994; DENOËL et al., 2001, 2005b), especially at Otelec, where the paedomorph newt was present beside an invasive fish, which is known to negatively affect the newts (e.g. KUZMIN, 2001; RESHETNIKOV, 2003, 2008; POPOV, 2014). Probably the time was not yet enough for *P. glenii* to eliminate both newt morphs, because it reached the region recently (COPILAȘ-CIOCIANU & PÂRVULESCU, 2011; COVACIU-MARCOV et al., 2011b, 2017). It is also possible that the rich aquatic vegetation favour newts, like in other cases (e.g. JOLY et al., 2001; HARTEL et al*.,* 2007). The coexistence between paedomorphic newts and fish was previously considered possible because of the aquatic vegetation (e.g. COVACIU-MARCOV et al., 2011a; STĂNESCU et al., 2014; KIZIL et al., 2016). But in his turn *P. glenii* also use the sectors with aquatic vegetation (e.g. RESHETNIKOV, 2008; RESHETNIKOV & CHIBILEV, 2009; RECHULICZ et al., 2015) and can feed with smooth newts (RESHETNIKOV & MANTEIFEL, 1997; RESHETNIKOV, 2008; TELCEAN & CICORT-LUCACIU, 2016).

The appearance of paedomorphosis has multiple possible explanations (e.g. WHITEMAN, 1994; DENOËL et al., 2001, 2005b; DENOËL & FICETOLA, 2014). In Romania was considered that a mild winter could favor the phenomenon (COVACIU-MARCOV & CICORT-LUCACIU, 2007; GHERGHEL et al*.,* 2010). The captured paedomorph had the dimensions and the colour of an adult metamorph female; the cloacae external morphology was like at adult females, this being the most reliable differential character between overwintering larvae and paedomorphs (DENOËL, 2017). At least the larger channel is too deep to freeze to the bottom in normal winters, and the Banat region has warmer climate than many regions in Romania (MÂNDRUȚ, 2006). It is possible that the paedomorph lives in this deep channel, and has accidentally reached the narrow and shallow sector. Possibly in this large part of the channel the paedomorphs avoided the contact with *P. glenii*, because they manage better in the water mass, where they feed, compared with metamorphs (e.g. DENOËL & JOLY, 2001; LEJEUNE et al., 2018), while *P. glenii* prefers the vegetation near the banks (e.g. RESHETNIKOV, 2008; RESHETNIKOV & CHIBILEV, 2009; POPOV, 2014; RECHULICZ et al*.,* 2015).

At Otelec the habitat is surrounded by strongly altered areas, the newts being deprived of terrestrial habitats, which is a general situation in Banat plains (BOGDAN et al., 2013). Terrestrial habitat alteration was previously indicated as a possible cause for paedomorphosis in Romania (e.g. COVACIU-MARCOV et al., 2011a). Probably in this case the change of their terrestrial habitat in agricultural terrains keeps the newts in the water where *P. glenii* is waiting for them. It is difficult to believe that if in other cases *P. glenii* negatively affected metamorphic newts

(RESHETNIKOV & MANTEIFEL, 1997; e.g. KUZMIN, 2001; RESHETNIKOV, 2003, 2008; POPOV, 2014), in south-western Romania this interaction will not take place. Large *P. glenii* individuals consumed newts even in Romania, and their food composition is similar (TELCEAN & CICORT-LUCACIU, 2016). Consequently, it is possible that the paedomorphic newt is both the first and the last mention in the region. At Otelec the phenomenon was probably caused by a combination between favorable climatic conditions and terrestrial habitats that became unfavorable to metamorphs, but it will be definitively abolished from the region by the negative effect of the invasive fish on newts.

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NEW DISTRIBUTION RECORDS OF THE DANUBE CRESTED NEWT *Triturus dobrogicus* (KIRITZESCU, 1903) IN SOUTHERN ROMANIA

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Abstract. In the spring of the years 2016 and 2017 we identified seven new distribution localities of the Danube crested newt, *Triturus dobrogicus*, in southern Romania. All seven localities are situated in the Danube floodplain or in its close proximity, at an altitude below 100 m. Thus, the new distribution records are situated inside the species distribution range. Nevertheless, the locality from Olt County represent, compared with the previous data from the literature, the first mention of *T. dobrogicus* in the region. This underlines the precarity of the information concerning the distribution of *T. dobrogicus* in southern Romania, even nowadays.

Keywords: distribution, plain, newts, habitats, endemic species.

Abstract. Noi localități de răspândire a tritonului cu creastă dobrogean *Triturus dobrogicus* (Kiritzescu, 1903) în sudul României. În primăvara anilor 2016 şi 2017 am identificat şapte noi localităţi de distribuţie a tritonului cu creastă dobrogean, *Triturus dobrogicus*, în sudul României. Toate cele şapte localităţi sunt situate în Lunca Dunării sau în vecinătatea acesteia, la o altitudine mai mică de 100 de m. Astfel, noile localităţi de distribuţie se află în interiorul arealului speciei. Totuşi, localitatea din judeţul Olt, reprezintă, în raport cu datele anterioare din literatură, prima semnalare a specie în regiune, subliniind precaritatea informaţiilor despre răspândirea speciei în sudul României, chiar şi în prezent.

Cuvinte cheie: distribuţie, câmpie, tritoni, habitate, specie endemică.

INTRODUCTION

Although the knowledge about the distribution of amphibians in Romania improved greatly in the last decade (see COGĂLNICEANU et al., 2013), new and zoogeographical relevant information upon their distribution in the country are published even in present (e.g. CICORT-LUCACIU et al., 2017). From the five newt species that are present in Romania, only one, *Triturus dobrogicus*, is distributed exclusively in plain areas, the others being distributed either regardless of altitude or only in higher areas (COGĂLNICEANU et al., 2000, 2013). In Romania, *T. dobrogicus* is present in the plain areas from the western part of the country, and also in the plain areas from the southern part of the country alongside the Danube, until the Danube Delta (e.g. ARNTZEN et al., 1997; COGĂLNICEANU et al., 2013). In the Danube Delta the largest individual from this species was recorded (GHERGHEL & IFTIME, 2009). Those two distribution range segments are separated by the Danube Gorge, a region where the species is completely absent nowadays (e.g. COGĂLNICEANU et al., 2000, 2013; GHERGHEL & PAPEŞ, 2015), and also the other crested newt species present in Romania, *T. cristatus*, seems to be absent (e.g. COVACIU-MARCOV et al., 2009; COGĂLNICEANU et al., 2013). Nevertheless, two possible connections between those two distribution ranges segments were recently mentioned (GHERGHEL & PAPEŞ, 2015). Two subspecies were recognized in the past (LITVINCHUK & BORKIN, 2000), but previous authors accepted numerous varieties (FUHN 1953). Nevertheless, recent data suggests that *T. dobrogicus* must be considered a monotypic species (see in: WIELSTRA et al., 2016), even more because the species seems to have survived in two different glacial refuges, both situated in the Pannonian Plain (VÖRÖS et al., 2016). In Romania, the highest number of this species records are in the north-western part of the country (COGĂLNICEANU et al., 2013). Even if *T. dobrogicus* was rarely found in the Banat region (COGĂLNICEANU et al., 2013), it was recently identified in more localities, but the populations seems small and vulnerable (BOGDAN et al., 2013). Unlike western Romania, the records from the southern part of the country are much fewer (e.g. COGĂLNICEANU et al., 2013; GHERGHEL & PAPEŞ, 2015). In the western parts of the Danube floodplain, in Oltenia region, the species is even rarer; it seems absent from large areas because of a higher environmental resistance (GHERGHEL & PAPEŞ, 2015). Nevertheless, recent detailed studies in some areas from the eastern part of the Romanian Plain lead tot the discovery of more populations (IFTIME & IFTIME, 2017). Thus, we have hypothesized that the species is not so rare also in Oltenia region, but only its distributions was not studied appropriately. As a consequence, this note mention some new *T. dobrogicus* populations in the Danube floodplain, and especially in Oltenia region, where this species was very rare and its distribution range seems even discontinuous (GHERGHEL & PAPEŞ, 2015).

MATERIAL AND METHODS

The field activity took place in the years 2016 and 2017, in each year in April. On the field we did not targeted explicitly the newts, but data upon their distribution were collected occasionally during field trips made in the plain areas from southern Romania, belonging to the Romanian Plain (POSEA & BADEA, 1984). During those field trips we investigated amphibians from different aquatic habitats in the region, with the help of a net with round opening, mounted on metal handles of approximately two meters length, used both from the shores and from the water. This net

was previously used to capture newts (e.g. CICORT-LUCACIU et al., 2017), but also other aquatic vertebrates (e.g. SAS-KOVÁCS et al., 2015). Nevertheless, the efficacy of the method is negatively influenced by the amount of aquatic vegetation (BØRRE et al., 2014), and the investigated habitats usually contained a lot of aquatic vegetation. After we established the captured individuals' species and sex, all newts were immediately released in their habitats. In some habitats, certain newts were photographed in a small aquarium before they were released. Also, we took photos of some of the newts' habitats.

RESULTS

T. dobrogicus was identified in seven localities in southern Romania (Figure 1): Gogoşu/Jiana (Mehedinţi County), Ursa (Olt County), Vieru (Giurgiu County), Căscioarele/Greaca (limit between Giurgiu and Călăraşi Counties), Băneasa/Pietrele (Giurgiu County), Berteştii de Jos (Brăila County) and Gighera (Dolj County). Totally, we captured 21 *T. dobrogicus* individuals, of which 11 were females and 10 were males. Beside *T. dobrogicus*, in the studied habitats were present *Lissotriton vulgaris*, *Bombina bombina* and *Pelophylax ridibundus* individuals. All seven localities where we recorded *T. dobrogicus* individuals are situated at altitudes between 5 and 81 meters. The Danube crested newts' habitats have generally small dimensions, being represented either of artificial channels or small water courses of the type of streams (Fig. 2), but which in their turn were partially arranged, deepened and regularized. Both habitat types were usually surrounded by agricultural areas. Nevertheless, generally willows are present on their shores, and a rich aquatic vegetation exists in the water. Usually the water is shallow, but with mud on the bottom. As an exception, the habitat between Giurgiu and Călăraşi Counties was represented by a pond area formed by a spring situated in the loess walls that bordered the floodplain tot the north. The pond was situated in the middle of the loess wall, on the side of a dirt road, having clean water and a lot of aquatic vegetation.

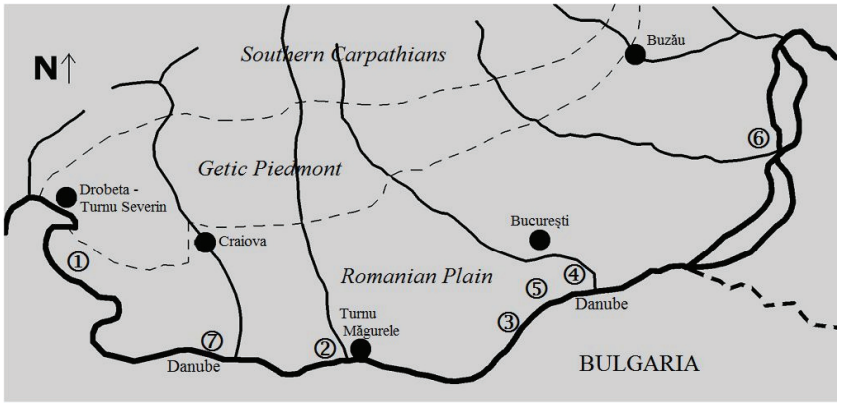

Figure 1. New distribution records of *T. dobrogicus* in southern Romania (1 – Gogoşu/Jiana, 2 - Ursa, 3 - Vieru, 4 -Căscioarele/Greaca, 5 - Băneasa/Pietrele, 6 - Berteştii de Jos, 7 - Gighera).

Figure 2. *Triturus dobrogicus* habitat at Ursa, Olt County.

DISCUSSION

The seven new distribution records of *T. dobrogicus* identified between the years 2016 and 2017 extend the knowledge regarding the distribution of this species in southern Romania. Thus, compared with the previous data from the literature that were centralized in the year 2013 (COGĂLNICEANU et al., 2013), the new distribution records represent almost a half from the total distribution records known at that moment in southern Romania. Nevertheless, in the meantime, new distribution localities of the Danube crested newt were recorded in south-eastern Romania, in Călăraşi County (IFTIME & IFTIME, 2017). However, even nowadays the information upon this species distribution is scarce. Thus, to our best knowledge, Ursa locality represents the first record of *T. dobrogicus* in the Olt County. This, alongside with the other localities form Oltenia region and especially the one from the Dolj County, have a special importance, because they prove that the species distribution range is southern Romania is continuous, even if the environmental resistance seems high for *T. dobrogicus* in this region (GHERGHEL & PAPEŞ, 2015), and the number of records are very reduced (COGĂLNICEANU et al., 2013). Our results proves clearly that *T. dobrogicus* is continues distributed in the Danube floodplain in Romania, as well as in Bulgaria, where is constantly present along the Danube, but only on its close proximity (NAUMOV & BISERKOV, 2013). Nevertheless, it is difficult to state how much the species distribution range extends to the north, because the known distribution localities are situated very close tot the Danube. At least in Dolj, in the county northern and central regions the other crested newt species *T. cristatus* is already present (LAZĂR et al., 2005).

Even if this species was generally observed in large aquatic habitats (e.g. LITVINCHUK et al., 1997; COGĂLNICEANU et al., 2000), we found it almost in all cases in small sized, generally artificial or modified habitats. Also, in other regions from Romania, *T. dobrogicus* was usually identified in such habitats, because of the antropogenic disturbance or even disappearance of natural habitats (e.g. COVACIU-MARCOV et al., 2006; BOGDAN et al., 2013). Thus, even if *T. dobrogicus* seems to be distributed continuously in the Danube floodplain in Romania, it has very few, both terrestrial or aquatic, habitats, because most of its favorable territory was transformed in agricultural terrains, like in other areas (e.g. ARNTZEN et al., 1997; LITVINCHUK et al., 1997). The survival of other crested newt species is insured by maintaining suitable aquatic and terrestrial habitats (GUSTAFSON et al., 2011). However, it is possible that in very large habitats from the Danube floodplain there are still large *T. dobrogicus* populations, which are impossible to encounter with our resources. Anyway, the remained available territory for this species is extremely reduced. The situation is valid also in the case of some herpetofauna species in the region, like *Dolicophis caspius*, which is present in the region's steep loess walls (e.g. COVACIU-MARCOV et al., 2012). Close to the habitats of the crested newts there are no roads with high traffic, and in some cases there are no roads, or they are not modernized. Thus we did not identified individuals killed by cars, even if this was mentioned in other regions (e.g. BOGDAN et al., 2013; CICORT-LUCACIU et al., 2012; COVACIU-MARCOV et al., 2017).

T. dobrogicus is one of the most protected amphibian species in Romania (O.U.G. 57/2007). Nevertheless, the species distribution in the country is less known even in the present, although its suitable areas can be easily intuited taking into account its ecological demands presented in the literature (e.g. COGĂLNICEANU et al., 2000). Moreover, the number of known distribution localities is biased, their majority being in the north-western part of the country (e.g. COGĂLNICEANU et al., 2013). Our results indicated that this situation is in the first place a consequence of the lack of detailed studies in the region, because even by accident we managed to identify some new distribution records, and recent studies dedicated to some regions in southern Romania mentioned even more localities (IFTIME & IFTIME, 2017). Thus, detailed field studies are needed in the future in order to clarify the species' distribution in southern Romania. In the same time, our result indicated that the territory that can be use by *T. dobrogicus* nowadays became very limited because of intensive agriculture. Thus, the aquatic habitats populated by this species in southern Romania should be protected otherwise its future will be uncertain.

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ASPECTS ON THE BREEDING SEASON OF BIRD FAUNA IN THE ROSPA0063 RESERVOIRS BUHUȘI-BACĂU-BEREȘTI (ROMANIA)

GACHE Carmen

Abstract. Our ornithological study ran from May 2011 until August 2016 in the perimeter of the five lakes that form the territory of ROSPA0063 Reservoirs Buhuși – Bacău – Bereşti (Lilieci, Bacău, Galbeni, Răcăciuni and Bereşti) and on the Gârleni reservoir from the vicinity of the Nature 2000 site. In the present note, we focus on the diversity of breeding bird species in the area. The list of breeding bird fauna include 102 regular breeding species, other five being irregular breeding species (*Anser anser*, *Recurvirostra avosetta*, *Himantopus himantopus*, *Haematopus ostralegus* and *Podiceps nigricollis*), while one could probably breeds in the vicinity of this territory using it like feeding area (*Haliaeetus albicilla*). The suitable habitats cover large, but different surfaces, on the territory of all six investigated reservoirs. Despite this, the breeding effectives of bird species present low values due to large and frequent oscillations of water level, sometimes with huge flooding phenomena in the area and high anthropogenic pressure (especially fishing poaching).

Keywords: bird fauna, breeding, Nature 2000, climate, anthropogenic impact.

Rezumat. Aspecte ale sezonului de cuibărit al ornitofaunei în ROSPA0063 Lacurile de acumulare Buhuși-Bacău-Bereşti (România). Studiul nostru ornitologic s-a desfășurat începând din mai 2011 până în august 2016, în perimetrul celor cinci lacuri de acumulare ce formează teritoriul ROSPA0063 Lacurile de acumulare Buhuși – Bacău – Bereşti (Lilieci, Bacău, Galbeni, Răcăciuni și Bereşti) și a acumulării Gârleni, din vecinătatea sitului Natura 2000. În această notă, urmărim diversitatea speciilor de păsări clocitoare în acest teritoriu. Lista avifaunei reunește 102 specii clocitoare constant în acest teritoriu, alte cinci specii fiind clocitoare neregulate (*Anser anser*, *Recurvirostra avosetta*, *Himantopus himantopus*, *Haematopus ostralegus* și *Podiceps nigricollis*), în timp ce o specie ar putea cuibări în vecinătatea acestui teritoriu folosit ca zonă de hrănire (*Haliaeetus albicilla*). Habitatele favorabile acoperă suprafețe largi, dar diferite, pe suprafața celor șase lacuri luate în studiu. În ciuda acestui aspect, efectivele păsărilor clocitoare sunt mici ca urmare a oscilațiilor ample și frecvente ale nivelului apei, asociate uneori cu viituri majore în acest perimetru și cu presiunea antropică ridicată (în special, braconajul piscicol).

Cuvinte cheie: avifaună, cuibărit, rețea Natura 2000, climat, impact antropic.

INTRODUCTION

Part as the Nature 2000 network (HG no. 1284/2007), the ROSPA0063 Reservoirs Buhuși – Bacău - Bereşti present the geographic coordinates $46^0$14’50’’ northern latitude and $27^0$7’12’’ eastern longitude. The site covers a surface about 5575.5 hectares and includes five reservoirs: Lilieci, Bacău, Galbeni, Răcăciuni and Bereşti, all of them situated around the confluence of Bistrița and Siret Rivers. These lakes receive the waters of some tributaries from middle sector of Siret River basin: Răcătău, Marvila, Rogoaza and Racova.

The Lilieci reservoir is located in the minor bed of the Bistrița River, has a length of about 4 kilometres and a surface of about 338.8 hectares. The left bank of this lake is high and steep, with the northern middle part covered by some trees and bushes. The edge of the lake appears like one mosaic of vegetation comprising grasslands with bushes, open waters and canals, large compact reed beds with sedges (*Carex* sp.), rushes (*Scoenoplectus lacustris* and *Juncus* sp.) and osiers (*Salix* sp.). In the same area, is present one large island covered by a meadow forest formed by willows (*Salix* sp.) and poplars (*Populus alba*), surrounded by shrubs and red beds. There are some stumps of trees and mounds of pebble near reed beds, surrounded by open waters. This lake shelters one high diversity and large groups of bird species during the whole year.

The Bacău reservoir is located in the minor bed of Bistrița River too, inside the north-eastern part of Bacău city. It has a length of about 2.3 kilometres, covering a surface of about 216.9 hectares. The suitable habitats for birds are present in the edge of lake, but also on the north-eastern and north-western banks. There exist one island covered by a meadow forest with old willow and poplar trees, large compact reed beds with sedges and rushes, grassland with shrubs, open waters and canals.

The Galbeni reservoir, situated in the area of confluence between Bistrița and Siret Rivers, is the third lake in size from the Nature 2000 site: 6.3 kilometres in length and a surface of about 1063.8 hectares. The north-eastern part represents the former natural reserve Balta Albastră. The suitable habitats for birds cover about half of the whole surface: open waters and canals, large compact reed beds with sedges, rushes, willows and osiers (*Salix* sp.), small islands formed by pebble.

The Răcăciuni reservoir is located in minor bed of Siret River, covering a surface of about 1702.4 hectares, with a length of about 13 kilometres. In the northern middle part of the lake, the eastern (left) bank is very high and partial steep. This section of lake is silted and covered with large compact reed beds with osiers, while in the southern limit of it, there exists some islands of pebble and clay. A large deciduous forest, with trees of different ages, is present in the north-eastern side of this lake.

The Bereşti reservoir is located in minor bed of Siret River, too, being the largest from the site with a length of about 15 kilometres and a surface of about 2253.7 hectares, but only the northern third part of the lake has

ornithological interest, where the left bank is also high and near steep, covered by grasslands and shrubs. This section is like one huge mosaic of compact reed beds, canals and open waters, with some islands with grasslands and willows. In the edge of the lake, there are present canals and compact reed beds areas, large but narrow islands formed by pebble, sand and clay, respectively, some islands with high clay banks and covered by willows and different shrubs. The lake is under a very high risk of silting phenomenon.

One small reservoir, Gârleni Lake, is not part of the Nature 2000 site, but has ornithological importance in the area. Situated in the minor bed of the Bistrița River and about 4.5 kilometres distance from the Lilieci reservoir, this lake cover about 200 hectares and is subject to a strong silting phenomenon. In front of the dam is present one large open water area, the rest pf perimeter being a mosaic of canals, compact reed beds and one meadow forest with willows and some poplars, shrubs and grasslands.

The climate is temperate-continental, winter is long and very cold, while summers are hot and dry. The average annual temperature is 9 ^{0}C and the average annual rainfalls are about 500 - 550 millimetres. The dominant winds from the south-eastern, north-western and north-eastern directions. The flooding risk is very high in early summer (especially in June).

Ornithological data in this area are available starting from the early '70s (RANG, 2002), while a focused study of the aquatic bird fauna from the reservoir was performed in the late '90s (FENERU, 2002), data about the ornithological importance of the area being included in some synthesis works (MUNTEANU, 2004 and PAPP & FÂNTÂNĂ, 2008). MULLËR et al. (2005) and GACHE (2012) did more recent evaluations on the status of bird' fauna from this area.

The Nature 2000 site has a management plan and one custodian who implements this plan – the Regional Centre of Ecology Bacău (CRE Bacău). All the field investigation work was carried out with the large logistical support of the custodian, like component of bird species' monitoring activities in the management plan.

METHODS AND PERIOD OF STUDY

Our field investigations on the birds' fauna from the ROSPA0063 Reservoirs Buhuși – Bacău - Bereşti began in May 2011 in the perimeter of Bacău, Galbeni and Răcăciuni lakes, but starting from January 2012, we included the whole territory of the Nature 2000 site in our study. Beginning with January 2015, we included also the reservoir Gârleni in our field investigation.

In this paper we present the results of one focused monitoring on the breeding season of bird fauna developed during the period 2011 – 2014 and in 2016, the area being visited twice per month. The monitoring of birds was done using the methods of transect and fixed points, following the western and northern bank for the Lilieci, Bacău, Galbeni, Răcăciuni and Bereşti reservoirs, respectively, the eastern bank for the Bacău reservoir, while for the Gârleni reservoir, our transect followed the northern and eastern banks. In year 2014 and 2016, we included the observation by boat trips that allowed us to obtain a better image on the breeding season of bird species inside the perimeter of these large reservoirs.

We identify the birds (BRUUN et al., 1999) through direct observation by binoculars (Pentax 10x42 DCF HRc and Olympus 8-16x40) and telescope (HAKUBA 40x70). We aimed estimating the bird populations, too, by counting each bird from the small groups and used quantitative evaluation in band for the groups or flocks larger than 200 individuals. We used calling activity in order to identify and estimate the populations of passerines from the reed beds, the crepuscular and nocturne bird species. In the analysis of our results, we are using SIBLEY & AHLQUIST taxonomic system (1995) with subsequent additions and modifications (http://avibase.bsc-eoc.org/).

RESULTS AND DISCUSSIONS

As it results from the official presentation of the Nature 2000 site ROSPA0063 Reservoirs Buhuși – Bacău – Bereşti, this territory offers suitable habitats and rich feeding territories for the birds, especially in migration and wintering period, through the richness and diversity of vegetation and fauna. During the migration time, the Nature 2000 site shelters groups of more than 20,000 aquatic bird species, while during winter, thousands of waterfowls were found in the area (GACHE, 2012). The first data on the breeding season of bird species in the perimeter of these six reservoirs appeared in the late 90s and small breeding populations are noticed, along with some interesting breeding presences like that of the tufted duck (*Aythya fuligula* Linnaeus 1758), previously mentioned just as a passage or wintering presence in Romania (FENERU, 2002).

The principal aims of our monitoring study were to evaluate the specific diversity and to estimate the breeding population of bird fauna, but also to identify the reason of the mentioned small breeding birds' population despite the large surfaces covered by suitable habitats on the territory of the Nature 2000 site.

During the period of study, we recorded 121 bird species (Table 1) that find suitable habitats during the breeding season in the area, but we must notice that not all these bird species are breeding in the area. Some of them are unusual presence in the area – for example, the appearance of one adult Dalmatian pelican (*Pelecanus crispus* Bruch 1832), flying from the south-eastern direction to the north on the 8th June 2016. We mention also the constant summer presence of adult red kites (*Milvus milvus* Linnaeus 1758) in the north-eastern part of Lilieci reservoir despite the absence of breeding suitable habitat there or in the nearest of this area.

Table 1. List of bird species in the perimeter of dam lakes around the confluence of Bistriţa and Siret Rivers in the breeding season.

No.	Species	Gârleni		Lilieci		Bacău		Galbeni		Răcăciuni		Bereşti		Birds Directive Annex 1
		Breeding (pairs)	Presence (individuals)	Breeding (pairs)	Presence (individuals)	Breeding (pairs)	Presence (individuals)	Breeding (pairs)	Presence (individuals)	Breeding (pairs)	Presence (individuals)	Breeding (pairs)	Presence (individuals)	
1.	*Perdix perdix*	-	-	8 – 11	6 - 8	-	-	3 – 4	3 - 5	4 – 7	3 – 7	2 – 4	3 – 5	-
2.	*Coturnix coturnix*	-	-	4 – 6	2 – 6	-	-	1 – 2	1 – 3	3 – 4	3 - 5	2 – 3	1 - 3	-
3.	*Phasianus colchicus*	3 - 4	3 - 5	3 – 5	2 - 9	1 - 2	2 - 7	2 – 3	2 - 5	2 – 3	2 – 8	4 – 7	4 – 11	-
4.	*Cygnus olor*	0 – 1?	8 – 64	–	48 - 352	1 - 2	4 - 156	5 – 6	78 – 345	-	28 - 42	7 – 8	8 - 156	-
5.	*Anser anser*	1?	0 - 1	-	-	-	-	-	-	-	-	-	-	-
6.	*Anas platyrhynchos*	6 – 7	24 - 62	7 – 11	18 - 318	5 – 9	12 - 72	15 – 18	14 - 92	8 – 10	56 - 96	6 – 12	36 – 114	-
7.	*Anas strepera*	3 – 5	14 - 28	6 – 8	5 – 56	1 - 2	5 – 17	6 – 8	6 – 18	3 – 6	7 - 21	7 - 8	8 – 18	-
8.	*Anas querquedula*	2 - 4	16 - 42	4 – 7	6 – 22	1 – 2	3 - 8	7 – 9	10 - 25	5 – 6	-	6 – 8	8 – 12	-
9.	*Anas clypeata*	-	0 - 14	-	0 – 8	-	-	-	0 – 4	-	0 - 14	-	-	-
10.	*Aythya ferina*	4 - 5	7 - 56	5 – 8	14 - 65	1 - 2	6 - 11	10 - 13	24 - 56	4 – 5	7 - 82	3 – 5	8 – 22	*
11.	*Aythya nyroca*	1 - 2	6 – 12	1 - 2	3 – 12	-	-	2 – 3	6 – 19	1 – 2?	3 - 10	3 – 5	7 – 18	-
12.	*Aythya fuligula*	-	0 - 14	-	0 – 36	-	-	-	0 – 10	-	-	-	-	-
13.	*Phalacrocorax carbo*	1 – 2?	5 - 38	2 – 3	2 – 48	-	0 - 5	0 – 35	12 - 62	-	2 – 48	1 – 3	7 – 16	-
14.	*Microcarbo pygmeus*	-	-	-	0 - 2	-	-	-	-	-	-	-	-	*
15.	*Pelecanus crispus*	-	-	-	-	-	-	-	0 – 1	-	-	-	-	*
16.	*Botaurus stellaris*	1 - 2	1 - 3	0 – 1?	0 – 2	1 - 2	2 - 4	2 – 3	2 – 4	0 – 1?	0 – 1	3 – 5	2 – 4	*
17.	*Ardeola ralloides*	-	-	0 – 1?	0 – 2	0 – 1?	0 - 1	1 – 2?	1 – 3	0 – 1?	0 – 2	0 – 2?	0 – 3	*
18.	*Ixobrychus minutus*	2 - 3	3 - 7	4 – 7	2 – 8	2 – 3	3 – 12	5 – 6	4 – 11	4 – 5	3 – 6	8 – 12	5 – 13	*
19.	*Nycticorax nycticorax*	-	-	1 – 2	2 – 7	4 – 5	6 – 11	1 - 2	1 – 8	-	-	1 - 2	3 – 10	*
20.	*Egretta garzetta*	3 – 4?	2 – 22	-	5 – 12	0 – 2?	5 – 7	4 – 5	13 - 54	-	2 – 11	2 - 3	3 – 32	*
21.	*Ardea alba*	5 – 6?	4 – 32	-	3 – 32	0 – 1?	1 – 3	-	4 – 8	-	2 – 6	-	2 – 11	*
22.	*Ardea cinerea*	4 – 5?	3 – 17	-	4 – 7	0 – 1?	2 – 5	2 - 3	3 – 14	-	1 – 6	1 – 2	3 – 13	-
23.	*Ardea purpurea*	1 – 2?	3 – 7	-	1 – 3	1 - 2	3 – 5	1 - 2	2 - 7	1 – 2?	2 – 5	1 – 3	2 – 7	*
24.	*Platalea leucorodia*	-	-	-	-	-	-	-	-	-	0 - 52	-	-	*
25.	*Ciconia ciconia*	-	-	-	-	-	-	-	156 – 307	-	0 – 149	-	2 – 162	*
26.	*Haliaeetus albicilla*	-	-	-	-	-	-	-	-	0 – 1?	0 – 1	-	-	*
27.	*Buteo buteo*	-	-	-	-	-	0 – 2	-	-	1 – 2	1 – 3	-	1 – 2	-
28.	*Milvus milvus*	-	-	-	0 - 1	-	-	-	-	-	-	-	-	*
29.	*Milvus migrans*	-	-	-	0 – 1	-	-	-	-	-		-	-	*
30.	*Circus aeruginosus*	0 – 1	0 – 2	0 – 1	0 – 3	2	2 – 4	2 – 3	2 – 5	1 - 2	1 – 3	1 – 2	2 – 4	*
31.	*Circus pygargus*	-	-	-	-	-	-	-	-	-	-	-	0 – 1	*
32.	*Falco subbuteo*	-	-	-	-	0 - 1?	1 – 2	1 – 2	1 – 3	1 - 2	1 – 5	-	-	-
33.	*Falco tinnunculus*	-	-	0 - 1?	1 – 3	-	-	1 - 2	1 – 4	11 - 15	6 – 32	1 - 2	1 – 4	-
34.	*Gallinula chloropus*	4 – 5	3 - 12	2 – 5	3 – 10	3 – 4	3 – 11	8 – 10	6 – 31	7 – 8	2 – 14	10 - 11	4 – 23	-
35.	*Fulica atra*	6 – 8	8 - 38	8 – 11	26 – 186	8 – 9	16 - 72	18 – 20	12 – 138	8 – 10	9 – 56	12 – 18	22 – 132	-
36.	*Vanellus vanellus*	-	-	-	-	-	-	12 – 14	24 – 88	11 – 12	16 – 136	20 – 22	23 – 72	-
37.	*Haematopus ostralegus*	-	-	-	-	-	-	-	-	-	-	0 – 1?	1 – 3	-
38.	*Charadrius dubius*	-	-	-	-	1 – 2	2 – 5	3 – 7	4 – 12	2 – 3?	-	2 – 4	2 – 6	-
39.	*Limicola falcinellus*	-	-	-	-	-	-	-	-	-	0 – 12	-	-	-
40.	*Tringa ochropus*	-	0 - 1	-	-	-	-	-	-	-	0 - 9	-	0 – 8	-
41.	*Tringa glareola*	-	-	-	-	-	-	-	-	-	0 – 14	-	0 – 6	*
42.	*Tringa nebularia*	-	-	-	-	-	-	-	-	-	-	-	-	-
43.	*Tringa stagnatilis*	-	-	-	-	-	-	-	-	-	0 – 6			-
44.	*Recurvirostra avosetta*	-	-	-	-	-	-	-	-	0 - 1?	0 – 2	-	-	*
45.	*Himantopus himantopus*	-	-	-	-	-	-	0 – 2?	0 - 6	-	-	0 – 3?	4 – 8	*

46.	*Larus cachinnans*	-	7 - 18	8 – 10	8 – 18	2 – 4	5 – 26	12 - 18	8 – 71	8 – 10	6 – 67	8 – 12	8 – 34	-
47.	*Chroicocephalus ridibundus*	-	16 - 52	12 – 28	24 – 52	75 - 80	56 - 162	33 – 35	26 – 286	12 – 14	8 – 278	16 – 22	12 - 92	-
48.	*Chlidonias hybrida*	-	12 – 28	14 – 16	14 – 34	46 - 65	32 - 108	28 – 37	16 – 46	13 – 14	16 – 42	8 – 18	18 – 44	*
49.	*Chlidonias niger*	-	0 – 32	-	0 – 82	-	-	0 – 5?	2 – 26	0 – 3?	0 – 24	0 – 5?	-	*
50.	*Sterna hirundo*	-	12 – 32	13 – 19	22 – 38	5 - 10	10 - 17	32 – 49	32 - 76	14 – 15	18 – 26	15 – 56	18 – 32	*
51.	*Podiceps cristatus*	2 - 3	4 – 12	7 – 8	12 – 32	6 – 8	11 - 15	5 – 6	10 - 28	5 – 8	3 – 16	5 – 7	7 – 19	-
52.	*Podiceps grisegena*	0 - 1	1 – 3	-	-	-	-	-	-	0 – 1?	0 – 2	-	-	-
53.	*Podiceps nigricollis*	-	-	-	-	-	-	1 – 2?	0 - 22	2 – 4?	0 – 9	-	-	-
54.	*Tachybaptus ruficollis*	0 - 1	1 - 4	-	-	0 - 1?	1 - 2	0 – 2?	0 - 5	1 – 2?	0 – 3	0 – 3?	0 - 4	-
55.	*Columba palumbus*	1 – 2	3 - 17	3 – 4	4 – 18	2 – 3	2 - 5	3 – 5	4 - 21	6 – 7	4 - 36	2 - 4	1 – 18	-
56.	*Streptopelia turtur*	-	-	2 – 3	3 – 7	1 - 2	2 - 3	2 - 3	3 - 8	12 – 14	10 - 32	1 - 2	2 - 7	-
57.	*Streptopelia decaocto*	2 – 3	4 - 11	8 – 10	9 - 32	4 – 5	4 – 11	8 – 10	6 - 28	6 – 7	5 - 16	5 – 6	6 – 21	-
58.	*Cuculus canorus*	3 – 4	6 – 7	8 – 12	10 - 13	6 - 7	5 - 8	13 – 17	15 - 18	18 – 20	8 – 19	18 – 20	18 - 22	-
59.	*Alcedo atthis*	1 – 2	1 – 3	-	-	-	-	-	-	-	-	1 - 2	2 – 3	*
60.	*Merops apiaster*	-	-	15 – 18	16 – 42	-	-	-	2 – 16	19 – 23	21 – 45	-	12 – 35	-
61.	*Coracias garrulus*	-	-	-	-	-	-	-	-	-	-	0 – 2?	0 - 3	*
62.	*Upupa epops*	1 – 2	1 - 4	1 – 2	1 – 3	-	-	1 – 2	1 – 5	3 – 5	2 - 6	1 - 2	0 – 4	-
63.	*Dendrocopos major*	-	-	2	2 – 3	1 - 2	1 - 3	4 – 5	3 - 6	12 – 14	8 - 15	0 - 1	1 - 2	-
64.	*Dendrocopos syriacus*	1 - 2	1 - 4	2 – 3	3 – 5	2 - 3	3 - 5	3 – 4	2 - 5	3 – 5	3 - 6	1 – 2	2 - 3	*
65.	*Oriolus oriolus*	2 - 3	3 - 6	3 – 5	4 – 7	3 – 5	4 - 11	5 – 7	6 - 13	14 – 15	12 - 28	3 – 5	5 - 8	-
66.	*Lanius collurio*	3 – 4	3 - 14	4 – 5	4 – 17	1 - 2	2 - 7	2 – 3	3 - 11	7 – 8	5 – 26	2 - 3	3 - 14	*
67.	*Lanius minor*	1 – 2	1 – 4	2 – 3	3 – 7	-	0 - 2	1 – 2	2 - 10	4 – 5	5 – 12	-	0 - 3	*
68.	*Pica pica*	-	2 – 11	28 - 30	32 – 46	4 – 5	8 – 18	7 – 8	8 – 17	4 – 5	7 - 17	3 – 4	4 - 15	-
69.	*Garrulus glandarius*	-	-	1 – 2	2 – 7	1?	2 - 4	2 – 3	1 – 6	5 – 6	3 - 21	-	-	-
70.	*Corvus monedula*	-	-	2 – 5	4 – 17	2 – 3	2 - 7	5 – 7	4 - 18	8 – 9	6 – 32	1 – 2	0 – 6	-
71.	*Corvus frugilegus*	-	3 - 36	-	13 – 28	-	2 - 12	-	8 - 87	-	2 - 32	-	3 - 43	-
72.	*Corvus cornix*	-	1 - 7	-	7 – 11	-	0 - 6	2 – 3	3 - 9	3 – 5	5 - 11	1 – 2	2 - 5	-
73.	*Corvus corax*	-	-	-	0 – 2	-	-	-	-	1 – 2	1 - 4	-	-	-
74.	*Galerida cristata*	2 – 3	4 – 7	5 – 6	6 – 9	1 – 2	1 - 5	4 – 5	2 - 12	8 – 12	7 - 15	7 – 10	5 - 13	-
75.	*Alauda arvensis*	8 – 11	10 – 14	16 – 18	17 – 24	2 – 3	1 - 7	12 – 14	13 - 21	14 – 16	11 - 23	12 – 13	14 - 23	-
76.	*Hirundo rustica*	-	42 – 78	-	32 – 68	-	22 - 56	-	32 – 118	-	58 – 92	-	21 - 86	-
77.	*Delichon urbicum*	-	12 – 38	-	12 – 26	-	12 - 32	-	9 - 34	-	12 - 45	-	5 - 34	-
78.	*Riparia riparia*	62 - 125	126 – 320	92 – 234	180 – 530	85 - 152	170 – 380	98 – 420	100 – 960	92 - 230	120 - 675	132 - 340	270 - 840	-
79.	*Phylloscopus collybita*	3 – 4	4 – 6	4 - 5	6 – 11	3 – 4	5 - 11	7 - 8	10 - 18	18 – 20	16 - 24	2 – 3	3 – 5	-
80.	*Phylloscopus sibilatrix*	1 - 2	2 – 3	1 – 2	0 - 3	1 - 2	1 – 3	4 – 5	3 - 9	4 – 6	2 - 11	1 - 2	0 - 3	-
81.	*Locustella luscinioides*	6 – 8	5 – 11	5 – 6	6 - 11	7 – 9	10 - 20	8 - 10	12 - 16	6 - 8	6 - 12	10 – 12	11 - 22	-
82.	*Acrocephalus scirpaceus*	32 – 35	33 – 48	28 – 32	30 – 42	15 – 16	18 – 34	58 – 60	65 - 87	30 – 35	32 - 45	60 – 80	53 – 82	-
83.	*Acrocephalus arundinaceus*	23 – 25	24 - 37	18 – 25	20 – 32	18 – 20	18 – 26	50 - 52	54 – 65	28 – 32	30 - 42	50 – 60	45 - 78	-
84.	*Acrocephalus schoenobaenus*	12 – 14	9 - 18	10 – 14	9 - 18	8 – 10	9 - 22	22 – 26	24 - 34	18 – 20	20 - 26	32 – 35	28 - 35	-
85.	*Hippolais icterina*	-	-	1 – 2	1 – 4	1 – 2	1 - 3	2 – 3	2 – 5	5 – 7	4 – 8	1 – 2	1 – 4	-
86.	*Sylvia curruca*	1 – 2	2 - 4	1 - 2	1 - 3	2 – 3	2 - 6	5 – 6	4 - 11	7 – 8	8 - 15	2 – 3	3 - 9	-
87.	*Sylvia atricapilla*	1 – 2	2 - 7	1 – 3	2 - 9	1 – 2	1 - 5	4 – 5	6 - 11	6 – 8	9 - 13	1 – 2	1 - 4	-
88.	*Sylvia borin*	2 – 3	3 - 7	2 – 3	2 - 9	1 - 2	1 - 6	5 – 7	7 - 13	7 – 9	10 - 18	3 – 5	6 – 11	-
89.	*Sylvia communis*	3 - 4	5 - 11	4 – 5	7 - 13	3 – 5	2 - 6	7 – 9	9 - 15	9 – 12	8 - 19	4 – 5	6 - 12	-
90.	*Panurus biarmicus*	14 - 16	18 – 48	13 – 15	20 - 52	16 – 18	-	32 – 35	28 – 72	18 – 20	32 - 76	24 – 30	-	-
91.	*Muscicapa striata*	-	-	2 – 3	3 - 8	1	0 - 4	2 – 3	1 - 8	3 – 5	2 - 8	1 – 2	0 - 5	-
92.	*Ficedula albicollis*	-	-	-	-	-	-	-	-	2 – 3	1 - 6	-	-	*
93.	*Oenanthe oenanthe*	1 – 2	3 – 7	2 – 3	3 - 8	-	-	2 – 3	1 - 9	2 – 3	4 – 11	4 – 5	3 - 14	-
94.	*Saxicola rubetra*	2 – 3	3 – 11	2 – 4	3 - 9	1 – 2	1 – 6	3 – 4	3 - 11	5 – 6	4 - 13	1 – 2	2 – 7	-

95.	*Saxicola torquata*	1 – 2	1 - 5	1 – 2	1 – 4	1?	0 – 3	1 - 2	0 - 5	3 – 4	2 – 7	0 - 1	0 - 3	-
96.	*Phoenicurus phoenicurus*	-	-	1 - 2	1 – 5	1	1 – 4	1 – 3	2 – 7	4 – 5	4 – 12	0 - 1	0 – 5	-
97.	*Phoenicurus ochruros*	-	-	2 – 4	1 – 7	2 – 3	1 – 7	4 – 6	3 – 11	5 – 7	4 – 14	1 – 2	1 – 7	-
98.	*Erithacus rubecula*	2 - 3	3 – 7	5 – 6	3 - 11	1 – 2	1 - 4	2 – 3	3 - 5	8 – 12	3 – 18	1 – 2	1 - 8	-
99.	*Luscinia luscinia*	2 – 3	3 – 5	3 - 4	3 - 5	2 – 3	2 - 5	5 – 8	5 – 9	14 – 16	15 – 17	3 – 5	4 - 6	-
100.	*Turdus merula*	3 – 4	6 – 13	3 – 4	5 - 19	2 – 3	4 - 7	4 – 5	7 – 21	8 – 12	10 – 26	2 – 4	2 - 9	-
101.	*Turdus philomelos*	5 - 6	7 – 22	8 – 10	9 - 24	4 – 5	6 - 14	8 – 10	9 – 35	14 – 18	15 – 32	5 – 6	5 - 17	-
102.	*Sturnus vulgaris*	15 – 18	32 - 520	21 – 23	38 - 470	22 – 24	32 - 280	32 – 35	42 – 318	32 – 40	54 - 1320	22 – 25	46 - 630	-
103.	*Sitta europaea*	2 – 3	3 – 7	3 – 5	5 - 11	2 – 3	3 - 6	5 – 7	11 – 22	10 – 13	14 – 34	2 - 3	3 – 9	-
104.	*Troglodytes troglodytes*	-	-	3 – 5	2 - 5	-	-	1 – 2	0 – 3	4 – 6	3 – 7	-	-	-
105.	*Parus major*	4 – 5	7 – 19	5 – 6	5 – 15	6 – 8	7 - 18	12 – 14	15 - 28	28 - 32	32 - 38	3 – 4	5 - 13	-
106.	*Cyanistes coeruleus*	1 – 3	2 – 5	2 – 3	3 - 7	1 – 2	2 - 5	3 – 4	4 - 7	10 – 12	8 – 15	1 – 2	0 - 5	-
107.	*Remiz pendulinus*	5 – 6	6 – 18	3 – 5	4 - 11	2 - 3	3 – 9	4 – 6	5 – 8	2 – 3	2 - 7	3 – 5	5 – 9	-
108.	*Passer domesticus*	8 - 10	16 - 94	25 – 30	32 - 198	50 – 60	78 - 173	80 – 100	92 – 178	65 – 70	87 – 156	30 – 35	56 - 118	-
109.	*Passer montanus*	12 - 13	18 - 56	13 – 15	21 – 42	10 – 12	14 - 38	32 – 38	28 – 56	42 – 45	38 – 79	14 – 16	18 - 42	-
110.	*Anthus campestris*	5 – 6	7 - 18	4 – 6	3 - 16	1 – 2	2 - 6	2 – 4	3 – 16	5 - 7	4 – 17	3 – 5	4 - 22	*
111.	*Motacilla flava*	6 – 8	9 – 32	5 – 6	5 – 28	2	3 - 7	6 – 8	11 - 21	3 – 4	5 – 21	5 – 8	12 – 32	-
112.	*Motacilla alba*	3 – 4	6 – 21	3 – 5	7 - 31	2	4 - 9	3 - 5	7 – 23	7 – 8	7 – 23	5 – 7	8 – 35	-
113.	*Fringilla coelebs*	2 - 4	4 - 11	7 – 8	8 – 26	8 – 9	9 - 21	11 – 13	15 – 48	24 – 26	25 – 42	-	-	-
114.	*Coccothraustes coccothraustes*	1 – 2	2 – 6	2 – 3	3 - 5	1 – 2	2 – 5	2 – 3	3 – 7	8 – 10	9 – 13	-	-	-
115.	*Serinus serinus*	-	-	1 – 2	1 – 3	-	-	1 – 2	1 – 8	4 – 6	3 – 9	-	-	-
116.	*Chloris chloris*	3 – 4	6 – 11	4 – 6	5 - 19	4 – 5	5 - 17	7 – 11	10 – 14	12 – 15	13 – 18	3 – 4	4 – 9	-
117.	*Carduelis carduelis*	5 - 6	12 – 38	5 – 7	11 - 42	3 – 4	8 - 26	5 – 6	8 - 52	14 – 18	15 - 78	-	-	-
118.	*Carduelis cannabina*	-	-	1 – 2	2 – 5	-	-	2 – 3	1 – 7	3 – 5	2 – 11	-	-	-
119.	*Emberiza calandra*	4 – 6	8 – 25	4 – 5	6 – 17	2 - 3	3 - 5	6 – 8	10 – 18	10 – 12	11 – 21	5 – 8	7 – 15	-
120.	*Emberiza schoenichlus*	6 - 7	11 - 34	6 – 8	7 – 24	3 – 5	4 - 11	18 – 20	21 – 25	12 – 15	12 – 28	14 – 18	17 – 22	-
121.	*Emberiza citrinella*	0 - 1	1 - 3	3 – 4	5 - 13	2 – 3	2 – 6	4 – 5	5 - 11	8 – 10	10 - 15	3 – 4	2 - 7	-

The breeding effectives mentioned in the Table 1 represent the result of direct observation of the pairs on the nest or in mating display, of the pairs or females with offspring. We not exclude the possibility of underestimated effectives for the bird species that are living hidden and discrete inside the compact reed beds or shrubs. We notice also the large variation from one year to other of the breeding pairs' success in the area due the climate conditions (for example in 2016 breeding season) and to the high and constant human activity (especially in the perimeter of Galbeni, Răcăciuni and Berești reservoirs). The irregular breeding presences are marked by "?" in the table. Regarding the present effectives presented in this table, we give the minimum and maximum-recorded values for one daily field observation. The big effectives for some species are not related to the breeding activity, but with the migration time (in late April – early May, respectively, in late July – early August), when the birds use the area of the Nature 2000 site as a stopover territory to rest and feed.

Starting from the first year of field monitoring we noticed that the diversity of suitable habitats for the breeding birds is similar on the all lakes, but the surfaces covered by them are different from one reservoir to other, still appropriate for birds' breeding activity on the all of them. The water level presents very large oscillations from one lake to other and even from one month to the next, being correlated with the rainfall level. Last but not least, the level of anthropogenic pressure is a decisive factor in modelling the breeding bird fauna's diversity and effectives on the each of investigated reservoirs.

From the recorded 121 bird species on the territory of ROSPA0063 Reservoirs Buhuși – Bacău – Berești, the breeding bird fauna includes 102 regular breeding species using a high variety of suitable nesting habitats (reed beds, humid and dry grasslands, steep clay banks, trees, hollows and shrubs in the meadow forests). Other five bird species are irregular breeding species:

- the greylag goose (*Anser anser* Linnaeus 1758) was met just during the autumn migration, but we met one adult displaying territorial behaviour in the vicinity of the compact reed beds from the Gârleni reservoir, during one boat trip on the 23rd May 2016, the bird retreated into the reed bed just on the approach of our boat;

- the pied avocet (*Recurvirostra avosetta* Linnaeus 1758) appears as a breeding species in the basic report of Nature 2000 site's management plan. We met it with groups about 16 – 22 individuals during the emptying of the Bacău lake in the summer of 2011 for some hydrotechnic works. In the April 2016, we recorded one pair in mating display in the perimeter of one strip of pebble on the surface of the Răcăciuni reservoir;

- the black-winged stilt (*Himantopus himantopus* Linnaeus 1758) was recorded as a breeding species on the territory of Galbeni (one – two pairs) and Berești (three pairs) reservoirs during the breeding season in 2012 and 2013, respectively, two pairs on the sector of Siret River downstream of the dam of Răcăciuni reservoir;

- the oystercatcher (*Haematopus ostralegus* Linnaeus 1758) was observed first in May 2013, on the perimeter of the Galbeni reservoir, respectively, on the 21st June 2014, we met one pair displaying mimics of injury behaviour on one strip of pebble on the territory of Berești reservoir, one pair being recorded in the same area in early June 2016;

- the black-necked grebe (*Podiceps nigricollis* Brehm 1831) could try to breed in 2016 in the perimeter of Galbeni and Răcăciuni reservoirs.

In 2016, we must mention the constant summer presence, from May to July, of adult white tailed-eagles (*Haliaeetus albicilla* Linnaeus 1758) in the perimeter of forest from the eastern bank of the Răcăciuni reservoir, where we met adult and juveniles birds too, in the August 2016, but we did not find the nest in the area. Previously, we met this species just during the wintering time in the area – in the perimeter of Răcăciuni and Bacău reservoirs.

From the group of waterfowls, the mute swan (*Cygnus olor* Linnaeus 1758) present a good breeding population on the Nature 2000 site's territory, missing just on the Lilieci reservoir, despite the fact that here we met the largest summer non-breeding presence of this species – 352 individuals in 2016. Probably, these immature birds use the perimeter like feeding territory, avoiding the presence of the territorial breeding pairs of swans. We notice the increase of breeding effectives of mute swans from 2 pairs in 2011 to six pairs in 2016 on the territory of Galbeni reservoir, but also the presence of one pair that had nine offspring in 2014 and twelve offspring in 2016 in the perimeter of Berești reservoir. Between the duck species, we mention the slow increase of breeding effectives for *Anas strepera* Linnaeus 1758 and the breeding presence of *Aythya nyroca* Gűldenstädt 1770, a globally threatened species, presenting the biggest breeding effectives in the perimeter of Berești reservoir. We cannot reconfirm the breeding presence of *Aythya fuligula*, mentioned before here (FENERU 2002).

The great cormorant (*Phalacrocorax carbo* Linnaeus 1758) was a constant presence during summer, but they did not breed in the area until 2013, coming here just to feed. In the breeding season of the year 2013, we met a breeding colony with about 35 nests built in the osiers from the southern part of Galbeni reservoir. The colony was present with just 27 nests in 2014 (probably, abandoned the eggs or even the offspring due the high level of fishing activity in the area) and disappeared in 2016, when we found small breeding effectives of great cormorants on the territory of Lilieci and Berești reservoirs.

The egret and herons group presents a good diversity, but small breeding effectives in the area and we found just one monospecific colony formed by five pairs of night herons (*Nycticorax nycticorax* Linnaeus 1758) in the spring of year 2016, on the northern side of island from the Bacău reservoir. We assume that one mixed colony including at least the species *Egretta garzetta* Linnaeus 1758, *Ardea alba* Linnaeus 1758 and *A. cinerea* Linnaeus 1758 could exist in the meadow forest from the territory of Gârleni Lake, where we met adult and juvenile birds but we could not reach this area by boat due the low level of waters. For the spoonbills (*Platalea leucorodia* Linnaeus 1758), we have just one

summer presence – on the 25th August 2011, we met a group of 52 individuals, including juvenile birds, feeding in the edge of Răcăciuni reservoir.

Among wader species, only two are constant breeding species in the area: *Vanellus vanellus* Linnaeus 1758 and *Charadrius dubius* Scopoli 1786. The gulls and terns (*Larus cachinnans* Pallas 1811, *Chroicocephalus ridibundus* Linnaeus 1766, *Sterna hirundo* Linnaeus 1758, *Chlidonias hybrida* Pallas 1811 and *C. niger* Linnaeus 1758) form breeding colonies of about tens of pairs on the all five lakes from the Nature 2000 site. The substrate on which they are building their nests is different from one reservoir to other: stumps of trees and mound of pebble on the Lilieci lake, strips of pebble, sand and clay on the lakes Galbeni, Răcăciuni and Bereşti, respectively, osiers and floating plants (*Scoenoplectus lacustris*) on the Bacău reservoir.

In the grebes group, we mention the breeding presence of *Podiceps grisegena* Boddaert 1783 in the perimeter of Gârleni Lake, where we met one pair with two offspring in late July 2016, but we cannot exclude the breeding in the perimeter of Răcăciuni Lake, too.

From the riparian bird species that dig nest-tunnels, we mention the breeding presence of kingfisher (*Alcedo atthis* Linnaeus 1758), bee-eaters (*Merops apiaster* Linnaeus 1758) and roller (*Coracias garrulus* Linnaeus 1758). The last one is a very rare breeding species in this part of Romania, two pairs being present in one mixed colony with 15 pairs of *Merops apiaster* and some tens pairs of *Riparia riparia* Linnaeus 1758 in the clay bank from the north-western part of Bereşti reservoir. The last species present a breeding population about 1300 pairs overall investigated territory, the largest colonies being recorded in the area of Lilieci, Galbeni, Răcăciuni and Bereşti reservoirs, but also in the sectors of Bistriţa River (before the entry in Lilieci lake) and Siret River (around the confluence with Bistriţa River).

Some breeding raptor species (Accipitriformes and Falconiformes) are also present, most of them with small effectives in the area due the high level of human pressure especially. As an exception, we mention the marsh harrier (*Circus aeruginosus* Linnaeus 1758) that presents a positive trend in the territory including by the appearance of two pairs in the northern part of Bacău reservoir, but also the common kestrel (*Falco tinnunculus* Linnaeus 1758). The last one forms a breeding colony in the sector that looks like a rocky cliff in the middle sector of the Răcăciuni reservoir, on the left high and steep bank. In 2014, we recorded the biggest number of pairs – 15, mostly having two offspring, but there were three nests with three offspring, one with four offspring and one with five offspring. In 2016, there were just 11 pairs, mostly of them having two offspring, just two having three offspring and one with four offspring, but also one with just one chick.

The passerines present a big specific diversity and breed in very different habitats: compact reed beds (warblers – *Acrocephalus* sp., *Panurus biarmicus* Linnaeus 1758 or *Emberiza schoeniclus* Linnaeus 1758), willows (*Remiz pendulinus* Linnaeus 1758), surrounding dry and humid grasslands (*Motacilla alba* Linnaeus 1758, *M. flava* Linnaeus 1758, *Anthus campestris* Linnaeus 1758, *Alauda arvensis* Linnaeus 1758), shrubs (*Lanius collurio* Linnaeus 1758 or *L. minor* Gmelin 1788). The greatest diversity of this group is present inside the meadow forest and in the deciduous forest from the north-eastern side of Răcăciuni reservoir.

The oscillations of the water level are the most important natural factor of risks for the breeding bird species on the territory of the Nature 2000 site ROSPA0063 Reservoirs Buhuşi – Bacău – Bereşti. For example, during the breeding season of the year 2014, at the 21st June, we met the gulls and terns building new nests in order to lay the second clutch (double-clutching behaviour) on the territory of the Lilieci reservoir, first being removed by waters during the flooding phenomenon from the middle June in the area.

During the breeding season of the year 2016, this phenomenon disturbed the efforts of adult breeding birds twice, and some species losing the breeding season completely (riparian ones, like *Alcedo atthis* and *Riparia riparia* that lost their nests when the flood has broken the banks along large sectors of rivers and lakes). All the birds that use to build their nest on the ground (reed beds, floating vegetation, beaches and strips of pebble, different stumps of trees in the water), but also on young osier lost their nests and even their twice due the flooding phenomenon from the 25th – 26th May 2016, respectively, 20th – 21st June 2016.

For example, the grebes (*Podiceps* sp.) and the rails (*Fulica atra* Linnaeus 1758 and *Gallinula chloropus* Linnaeus 1758) lost the offspring recorded on the 23rd May, because they were too little in order to swim in high flood conditions. The same waters removed the nests of gull, terns and waders, washing completely the floating nests and the strips of pebble from the all investigated reservoirs. In the early June, we found the terns and gulls rebuilding their nests on the stumps of trees in Lilieci Lake perimeter, respectively, on the osier and rushes (*Scoenoplectus lacustris*) in the area of Bacău Lake. In the perimeter with osier from the western side of the last lake, we observed individuals of *Chroicocephalus ridibundus* stealing plants of *Scoenoplectus lacustris* from the nests of *Chlidonias hybrida*, trying to build more solid nests. However, the birds lost once again the nests and clutches during the second flooding phenomenon. The gulls and the common tern (*Sterna hirundo*) abandoned completely the breeding activity on the Lilieci reservoir, while the whiskered tern (*Chlidonias hybrida*) moved on the western side of this lake, building new nest on the floating plants and forming a mixed breeding colony with grebes (*Podiceps cristatus* Linnaeus 1758). Nor on the Bacău reservoir, the situation was better – the birds began to build the third nests, but the breeding effectives decrease to the third part of recorded values in middle May.

From the riparian bird species, just the bee-eaters (*Merops apiaster*) succeeded in breeding and just the pairs that organised their colonies in the high and more solid eastern banks of Lilieci and Răcăciuni reservoirs. All the other colonies were lost due to the complete break and collapse of banks on a width of 1 – 1.5 metres.

Regarding the wader species, just those that built their nests at some distance from the banks of lakes succeeded in breeding: *Vanellus vanellus* and *Himantopus himantopus*.

Starting from the late spring of 2014, the level of human pressure increased obviously, especially in the southern part of the Nature 2000 site, with strong impact on the breeding bird fauna from this territory. The most important risk factors generated by the local community in the area are the fishing activity, the extraction of osiers and the grazing activity.

Sport fishing, but also fishing poaching can reach very high values, especially in the perimeter of the Galbeni, Răcăciuni and Bereşti reservoirs. For example, on the 22nd June 2014, we estimated a presence of at least 420 sport anglers and at least 60 boats sailing on the surfaces of these three lakes. Even more, we took out from the waters kilometres of fishing nets in the same area, the biggest one being more than 2000 metres long, stretched as a zigzag mesh in the perimeter of the former breeding colony of cormorants (*Phalacrocorax carbo*) from the perimeter of Galbeni reservoir. The fish poaching activity disturbs the waterfowls feeding in the area and places the diving ducks (like *Aythya sp*.) at risk of death by swimming to exhaustion and drowning, being caught in the abandoned immersed nets. Also, fish poachers and sport anglers have laid out large corridors inside the compact reed beds in order to facilitate their access in the areas where they cannot be observed easily by the mixed patrols formed by the gendarmerie and custodians of the Nature 2000 site. This situation is present in all the reservoirs, Lilieci, Galbeni, Răcăciuni and Bereşti, disturbing the breeding birds in the area, but also causing a fragmentation of suitable habitats.

The extraction of osiers in order to manufacture and market different gardening props, especially from the territory of Galbeni and Răcăciuni reservoirs, disturbs the breeding birds present in the area, but also makes this important habitat completely unsuitable for the nests' building.

The herds of sheep and goats are a constant presence in the proximity of the Lilieci and Bacău lakes, sometimes using the grasslands, the rushes and the sedges areas from the edge of the lakes disturbing the birds that can breed in these habitats. We also mention the abandon of domestic animal carcasses (especially, cattle, horse and pigs) in the waters of lakes, mostly seen in the area of Galbeni Lake.

From our list of bird fauna, 30 bird species appear in Annex 1 of Birds Directive (2009/147/EC), being species that need special conservation measures concerning their habitats in order to ensure their survival and the reproduction in their distribution range. From these, 23 are breeding species on of the Nature 2000 site ROSPA0063 Reservoirs Buhuşi – Bacău – Bereşti a, mostly with small number of pairs.

Finally, we mention the breeding presence of some bird species included in the Red Book of Vertebrates from Romania (BOTNARIUC & TATOLE, 2005) with three different threatening statuses: one critically threatened species (*Haliaeetus albicilla*), 7 threatened species (*Egretta garzetta*, *Ardea alba*, *A. purpurea* Linnaeus 1766, *Haematopus ostralegus*, *Recurvirostra avosetta*, *Himantopus himantopus* and *Corvus corax* Linnaeus 1758), respectively, 5 vulnerable species (*Aythya nyroca*, *Ardeola ralloides* Scopoli 1769, *Nycticorax nycticorax*, *Streptopelia turtur* Linnaeus 1758 and *Upupa epops* Linnaeus 1758).

CONCLUSIONS

During our study, we recorded 121 bird species with summer presence on the territory of the Nature 2000 site ROSPA0063 Reservoirs Buhuşi – Bacău – Bereşti.

The breeding bird fauna includes 102 regular breeding species, other 5 being probably or irregular breeding species, mostly of them with small breeding effectives in the area despite the large surfaces covered by suitable habitats.

In our list of bird fauna, we mention 30 bird species that appear in Annex 1 of Birds Directive, respectively, 13 bird species that are included in the Red Book of Vertebrates from Romania with three different threatening statuses: one critically threatened species, 7 threatened species and 5 vulnerable species.

The most important risk factors for birds are the frequent oscillations of water level, including the flooding phenomenon, fishing activities, osier extraction and grazing activity.

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PRELIMINARY DATA ON THE SPECIES OF BIRDS FROM THE LEAOTA MOUNTAINS INCLUDED IN THE ANNEX I TO DIRECTIVE 2009/147/EC

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Abstract. The current paper is the first published study on the avifauna from the Leaota Mountains, an area located in the north-east side of Argeş County (Romania). A part of the results of the researches performed here in 2016 referring to the species from the Annex I of the Birds Directive are showed. The obtained data were compared to similar data obtained in Europe and Romania, particularly following the distribution according to the type of habitat occupied, the age of the forest, in the case of the forestry species, and the sea level altitude at which the species were observed. It has been found that the most of them preferred the 91V0 habitat, mature forests and the altitude range of 1,000-1,499 m, resulting in the need for urgent protection of the natural forest ecosystems. Several considerations have been made about hydrographic zoning, too, highlighting the basins of the main rivers or streams where significant concentrations of protected species have been found, and also in terms of their density and population. Some information about the migration of diurnal rapacious birds through the area was provided as well.

Keywords: Birds Directive, habitats, Argeş, Romania.

Rezumat. Date preliminare asupra speciilor de păsări din Munţii Leaota incluse în Anexa I a Directivei 2009/147/CE. Lucrarea de faţă se constituie în primul studiu publicat asupra faunei de păsări din Munţii Leaota, zonă localizată în nord-estul judeţului Argeş (România). Sunt arătate o parte a rezultatelor cercetărilor efectuate aici în anul 2016 cu privire la speciile din Anexa I a Directivei Păsări. Datele prezentate au fost comparate cu altele similare obţinute în Europa şi în România, punându-se accent pe distribuţia speciilor în funcţie de tipul de habitat ocupat, vârsta pădurii, în cazul speciilor forestiere, şi altitudinea faţă de nivelul mării a locului în care acestea au fost observate. S-a constatat că cele mai multe dintre ele au preferat habitatul 91V0, pădurile mature şi intervalul de altitudine cuprins între 1000 şi 1499 m, de unde rezultă necesitatea ocrotirii urgente a ecosistemelor forestiere naturale. S-au mai făcut unele consideraţii referitoare la zonarea hidrografică, evidenţiindu-se bazinele principalelor râuri şi pâraie unde au fost găsite concentrări însemnate de specii protejate, precum şi la densitatea şi populaţia acestora. De asemenea, au fost date unele informaţii privitoare la migraţia unor păsări răpitoare diurne prin zonă.

Cuvinte cheie: Directiva Păsări, habitate, Argeş, România.

INTRODUCTION

Works about the avifauna of the Leaota Mountains have not been published so far, because the attention of ornithologists was attracted by the more spectacular mountains Bucegi and Piatra Craiului from the neighbourhood. An avifaunistical image from the area could have been made by analogy with avifauna of these neighbourhood mountains or extracting information from generalist or atlas type works (BĂCESCU, 1961; BRÂNZAN et al. 2013; CIOCHIA, 1992; GEORGESCU & GEORGESCU, 1996; MUNTEANU, 1998, 2005, 2012; MUNTEANU et al., 1994; MUNTEANU et al. 2002; PETROVICI, 2015; RADU, 1967; VASILIU & ŞOVA, 1968).

MATERIAL AND METHODS

As mentioned above, **the place of research** was the Leaota Mountains. They are located in the Eastern part of the Southern Carpathians, in the group of Bucegi – Leaota – Piatra Craiului, between the Bucegi Mountains (towards East) and Piatra Craiului and Iezer-Păpuşa (towards West), (Fig. 1). The area of these mountains is cca. 240 km^2 over fractions of the Argeş, Dâmboviţa and Braşov Counties. Bângăleasa, Brateiul and Ialomiţa Valleys toward East, an alignment of hills of Dâmboviţa Subcarpathians toward South, the Dâmboviţa Valley toward West and the Rucăr-Bran Corridor toward North are the limits. Leaota (2,133 m) is the highest peak (https://www.hartaturistului.com/munte/), but, generally, the ridges are below 2,000 m.

The relief is strongly fragmented, formed by long, rounded ridges, without shapes of glacial erosion, that link the other peaks: Cumpărata (1,996 m), Pietrele Albe (1,888 m), Cioara (1,853 m), Sfântul Ilie (1,794 m), Albescu (1,793 m), Secările (1,766 m), Românescu (1,714 m), Făgeţelul (1,618 m), Ghimbav (1,406 m), Priseaca (1,358 m), etc. (BARCO & NEDELCU, 1974).

The crystalline schists from Leaota series are largely extended and the brown-acid and podzolic soils are well

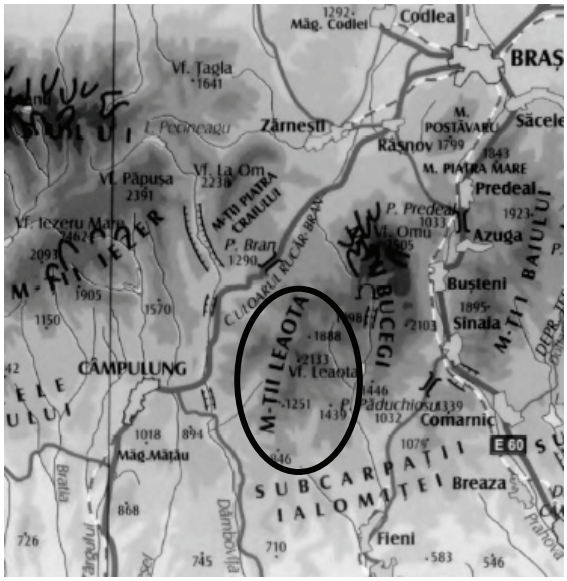

Figure 1. The map of the group of mountains Piatra Craiului – Leaota – Bucegi, with their surroundings (modified, by http://elearning.masterprof.ro/).

represented here (MÂCIU et al., 1982).

The streams radiate from the Bucşa – Sântilia – Marginea Domnească central crest. Bângăleasa, Moieciul Cald and Moieciul Rece flow toward North, to the Olt River. From West and South-West, the Dâmboviţa River takes Valea Caselor, Valea Bădenilor (Bădeanca), Valea lui Coman and Valea Chiliilor and, from East and South-East, Ialomiţa River intercepts Brătei, Rătei, Raciu and Ialomicioara (http://www.carpati.org/ghid_montan/).

The climate of the area is temperate continental with mountain features. The average annual temperature is 6-0°C, between 800 and the highest peaks, with the average temperature of January between –6 and –11°C and the one of July between 16 and 6°C. The average of precipitations is between 800 and 1,200 mm, on the highest peaks.

As for the flora, 884 taxons have been inventoried so far; among them, 84 species belong to the Red List of the vascular plants from Romania (1 endangered species, 7 vulnerable species, 70 rare species): *Aquilegia nigricans* Baumg., *Arnica montana* L., *Campanula carpatica* Jacq., *Centaurea pinnatifida* Schur., *Dianthus henteri* Heuff. Ex Griseb. & Schenk., *Erysimum witmannii* Zawadsk., *Gypsophila petraea* (Baumg.) Reichenb., *Hepatica transsilvanica* Fuss., *Heracleum palmatum* Baumg., *Hesperis nivea* Baumg., *Leontopodium alpinum* Cass., *Ligularia glauca* (L.) O. Hoffm., *Peltaria alliacea* Jacq., *Phyteuma tetramerum* Schur., *Salvia transsilvanica* Schur., *Taxus baccata* L., *Trollius europaeus* L., *Viola dacica* Borbás, *Spiranthes spiralis* (L.) Chevall., etc. There are three level of vegetation: mountain, subalpine and alpine. The forestry vegetation is composed by: *Fagus sylvatica* L., *Acer platanoides* L., *A. pseudoplatanus* L., *Fraxinus excelsior* L., *Abies alba* Mill., *Picea abies* (L.) H. Karst., etc. *Rhododendron myrtifolium* Schott & Kotschy, *Vaccinium myrtillus* L., *Pinus mugo* Turra, and *Juniperus communis* subsp. *nana* (Willdenow) Syme appear in the subalpine level. The alpine level is characterised by: *Carex curvula* All., *Juncus trifidus* L., *Potentilla aurea* subsp. *Chrysocraspeda* (Lehm.) Nyman, *Festuca airoides* (Koeler) Mutel, *Loiseleuria procumbens* (L.) Desv., etc.

The main habitats found in the area are: 91V0 - Dacian Beech forests (Symphyto-Fagion), (12,495.59 ha), 4060 - Alpine and Boreal heaths (11,577.79 ha), 9410 - Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea), (8,343.89 ha), 6230 - Species-rich *Nardus* grassland, on siliceous substrates (1,389.14 ha), 6150 - Siliceous alpine and boreal grasslands (946.64 ha), 9110 - Luzulo-Fagetum beech forests (380.21 ha), 6520 - Mountain hay meadows (230.19 ha), 4070 - Bushes with *Pinus mugo* and *Rhododendron hirsutum* (Mugo-Rhododendretum hirsuti), (33.97 ha), and 91E0 - Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Pandion, Alnion incanae, Salicion albae), (4.70 ha). A mosaic of habitats appears on limestone (206.23 ha), so, the whole area sighted in the project was 25,417.48 ha (Fig. 2).

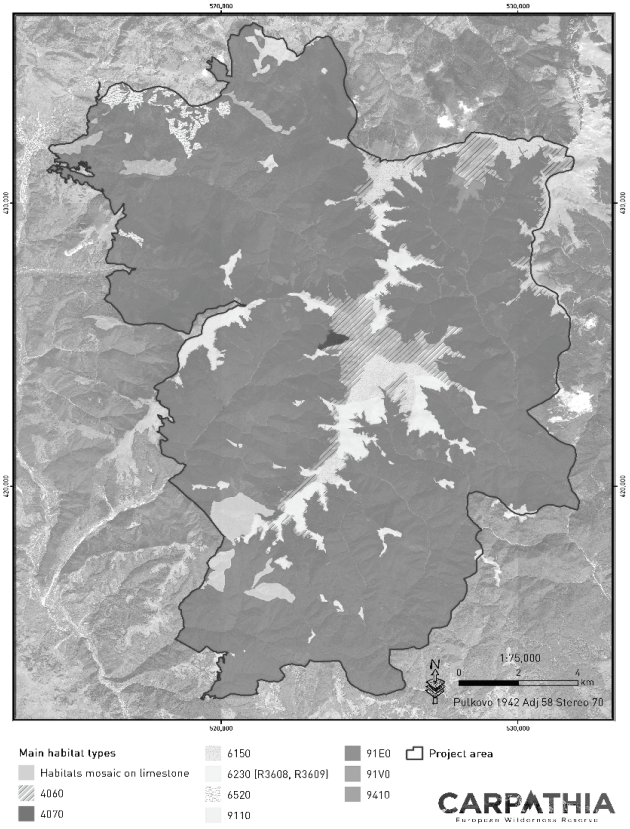

Figure 2. The main habitats types of Leaota area (original).

The invertebrate fauna is rich and is represented by numerous species that live in the vegetal floor. The vertebrates include: *Salamandra salamandra* (Linnaeus, 1758), *Bombina variegata* (Linnaeus, 1758), *Lacerta agilis* Linnaeus, 1758, *Anguis fragilis* Linnaeus, 1758, *Ursus arctos* Linnaeus, 1758, *Lynx lynx* (Linnaeus, 1758), *Canis lupus* Linnaeus, 1758, *Felis silvestris* Schreber, 1777, *Capreolus caprelous* (Linnaeus, 1758), *Cervus elaphus* Linnaeus, 1758, *Martes martes* (Linnaeus, 1758), *Sus scrofa* Linnaeus, 1758, etc. (cf. The Management Plan of Natura 2000 Site ROSCI0102 Leaota).

A part of the Leaota Mountains is included in ROSCI0102 Leaota (1,393 ha), Natura 2000 site administrated by the Foundation Conservation Carpathia, that contains alpine pastures and subalpine forests of spruces (https://www.carpathia.org/ro/, http://natura2000.eea.europa.eu/), (Fig. 3).

A multidisciplinary team studied the fauna and the flora, through the "Contract for the supply of research on biodiversity analysis", beneficiary, SC Wildland SRL. From an ornithological point of view, the main purpose was to draw up a preliminary list of the species from the area of interest and to correlate the gathered data with the conservation status of the investigated habitats. In this paper we intended to present some data regarding the protected species from the area, other aspects of the project (the list of all species, indicator species, measures of conservation etc.) following to be discussed on another occasion.

The **period of observations** was May 15 – September 30, 2016. There were 28 days of field research: 6 in May, 7 in June, 6 in July, 6 in August and 3 in September. The majority of the observations were performed during the day, and no complex **methods of monitoring** for the groups of birds (elaborated in Romania by the Romanian Ornithological Society) were applied. In an optimal mode, the period of monitoring is: March 10 – April 20, for the woodpeckers, June 15 – August

25, for the diurnal raptors, except *Aquila chrysaetos*, *Falco peregrinus*, *Falco tinnunculus* (and *Corvus corax*) which are monitored in March – May (in the high areas until June 15), May 10 – June 20, for the species of open habitats (*Asio otus*, *Athene noctua*, *Tyto alba*, *Crex crex*, *Caprimulgus europaeus*, *Coturnix coturnix*, *Perdix perdix*), February – March and October – November, for *Strix aluco* and *S. uralensis*, January 10 – April 20 and September 10 – December 15, for *Glaucidium passerinum*, April 15 – June 15 for the most of the Passeriformes, May-June for the species associated with the rocky habitats, the spring and the autumn for the migratory birds (DOMŞA et al., 2014). Instead, the itinerary and the fixed points of observations field methods were used, but some observations were performed during the rainy weather and along the streams, making difficult the hearing of the distant singing males. A total of 46 tracks (280 km length) and 37 points of observations, which covered the whole area, were crossed.

Binoculars, a photo camera and a play-back device (in the case of the species of Strigiformes) were availed.

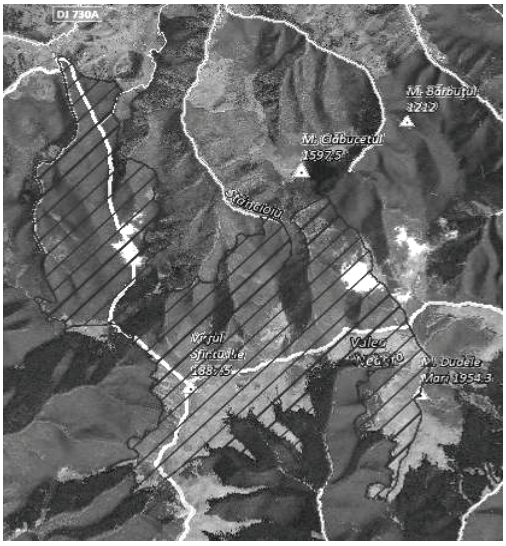

Figure 3. The limits of the ROSCI0102 Leaota (hachured area, by http://atlas.anpm.ro/atlas#).

RESULTS AND DISCUSSIONS

17 species from the Annex I of the Birds Directive (Directive 2009/147/EC) were registered in the area of interest in the previously mentioned period. They shall be the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution (http://eur-lex.europa.eu/legal-content/).

They belong to 6 orders (Falconiformes, 5 species, 29.41%), Galliformes (2 species, 11.76%), Gruiformes (1 species, 5.88%), Strigiformes (1 species, 5.88%), Piciformes (4 species, 23.52%) and Passeriformes (4 species, 23.52%).

For every species, the distribution on habitats, types of forests (where it was the case) and the altitudinal repartition were discussed and compared with the data from other studies. Also, it was tried to determine the densities and the populations, but because the observations were performed in conditions that did not respected always the norms of the methods of monitoring, the strengths of some species were under evaluated. Therefore, these are only as a rough guide and will be confirmed or corrected by other researches, managed on every species.

1. Aquila chrysaetos Linnaeus, 1758.

The golden eagle breeds in mountains and large upland forests, more rarely in restricted lowland forests (SVENSSON et al., 2009, 2017). In Romania, it breeds on both versants of the Carpathians, in rocky areas or large forests, where the population is estimated at 10 pairs (CIOCHIA, 1992) or 30-40 pairs (MUNTEANU et al., 2002).

In Leaota, 3 individuals were observed flying over the North-Eastern crests, above the level of coniferous forests, inclusively (Table 1). By comparison, in the Siret hydrographical basin, it was identified on the mountain meadows and in exploitations of pure forest of *Picea abies* (RANG, 2002).

The species probably breeds here (but rather in the Bucegi Mountains), because there are good conditions of nest and provisions, less in winter when we suppose that the food shows a deficit. The estimated population is 0-1 pairs (or 0-1 pairs/254 km^2). In Europe, density varies between 50 and 200 (300) km^2/pair (HAGEMEIJER & BLAIR, 1997), 1-2 pairs/100 km^2 (FERGUSON-LEES et al., 2001). Theoretical maximum density is 1-6 pairs/100 km^2 (WATSON, 2010). In our country, in Apuseni Mountains, 15-16 pairs were counted; no density was shown (KOVÁCS et al., 2008).

2. Pernis apivorus (Linnaeus, 1758).

The honey buzzard breeds in forests with clearings, glades, small wetlands, fields (SVENSSON et al., 2009, 2017). In Romania, it mostly breeds in the hilly region, in forests. The population is formed by 300-700 pairs (MUNTEANU et al., 2002). Except the individuals seen in migration (8, 42.10% of all), that moved on South-North axis (1 individual, 12.5% of them moving toward North and 7 individuals, 87.5% of them moving toward South), over the ridges, and that, practically, flew over the entire area, the others (11, 57.89%) were observed over the habitats: 91V0 - Dacian Beech forests (Symphyto-Fagion) – 10 individuals (90.90% of them) and 6520 - Mountain hay meadows – 1 individual (9.09% of them). In the Siret hydrographical basin, it was identified in exploitations of pure forest of *Picea abies* and on mountain meadows (RANG, 2002). The individuals in the nesting area were seen flying over heights situated between 962 and 1,314 m. In the hydrographic basin of the Bistriţa Moldovenească River, it was signalled in summer between 500 and 1,600 m (MUNTEANU, 2000). In migration, the overflow maximum elevation where they were observed was 1,915 m (Table 1).

It is a certain breeder in the area, where the estimated population is 10-15 breeding pairs or 1 pair/13.8-20.8 km^2 of forest. By other studies, the breeding density is up to 1 pair/2.5-5 km^2 in forests, with the home range of 20-50 km^2 (FERGUSON-LEES et al., 2001). The migratory birds count, probably, a few tens, particularly in autumn.

3. Milvus migrans (Boddaert, 1783).

Generally, the black kite breeds in forests, near lakes, rivers or wetlands, also close to the human settlements (SVENSSON et al., 2009, 2017). In Romania, breeds in a few areas from the Danube Delta, and in the open forests,

with glades and bushes along the Danube and the big rivers (bellow 600 m elevation), where population is 50-100 pairs (CIOCHIA, 1992; MUNTEANU et al., 2002).

In the area, it was observed only 1 individual, in passage (Table 1). In other parts (the Siret hydrographical basin), it was observed in exploitations of pure forests of *Fagus sylvatica* and on mountain meadows (RANG, 2002).

The species not breeds in the Leaota Mountains, and, probably, a few individuals cross the area every season of migration.

4. Circus aeruginosus (Linnaeus, 1758).

The marsh harrier breeds on shallow freshwater lakes or rivers with lining of fairly extensive reedbeds (SVENSSON et al., 2009, 2017). In Romania, it breeds mainly in the wetlands from the plain area with large reed beds, especially in the Danube Delta; the strength is estimated at 700-1,500 pairs (CIOCHIA, 1992; MUNTEANU et al., 2002).

All the 5 recorded individuals were observed over the habitats: 6150 - Siliceous alpine and boreal grasslands, 4060 - Alpine and Boreal heaths, and 6230 - Species-rich *Nardus* grassland, on siliceous substrates, when moved to the breeding grounds (1 individual, 20.00% of all) or to the winter quarters (4 individuals, 80.00% of all). They were spotted over the heights of 1,690-1,906 m (Table 1).

Even if the species does not breed in the researched area, probably a few tens of individuals overflew it every year, in migration.

5. Falco peregrinus Tunstall, 1771.

The peregrine falcon breeds on steep coastal cliffs or in mountains, also on cliffs in lowlands (SVENSSON et al., 2009, 2017). In Romania, breeds mainly in the Carpathians, in the grouse ornithological level, rarely in other places, even in towns (CIOCHIA, 1992), where the population is fewer than 20 pairs (MUNTEANU et al., 2002).

In the area of researches, the species was seen in (3 individuals, 18.75% of all) or over (13 individuals, 81.25% of all) the following habitats: mosaic of habitats on limestone – 5 individuals (31.25%), 4060 - Alpine and Boreal heaths – 4 individuals (25.00% of all), 6520 - Mountain hay meadows – 2 individuals (12.50% of all), 9410 – Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea) – 2 individuals (12.50% of all), 6150 - Siliceous alpine and boreal grasslands – 1 individual (6.25% of all), 6230 - Species-rich *Nardus* grassland, on siliceous substrates – 1 individual (6.25% of all), and 91V0 - Dacian Beech forests (Symphyto-Fagion)– 1 individual (6.25% of all). In the Siret hydrographical basin, it was identified on the mountain meadows (RANG, 2002). A part of the registered individuals can be vagrant. The overflow elevations were situated between 822 and 1,937 m. When they were seen sat, this was 802, respectively 2,094 m (Table 1).

Certainly, it breeds in the area of the Leaota Mountains (one confirmed place being the gorges known as Cheile Dâmboviţei – Cheia Mare, down to the Ghimbav confluence). The overall estimated population is 1-2 breeding pairs, that means 1 pair/1-2 km^2 of habitats on limestone or 0.3-0.7 pairs/100 km^2 of mountain area. The highest breeding densities were reported from Great Britain (up to 8.5 pairs/100 km^2 inland), locally, 5 pairs/6.5 km^2, in Gibraltar (HAGEMEIJER & BLAIR, 1997); also, 8 pairs in one 10 km square or 1 pair/12.5 km^2 (FERGUSON-LEES et al., 2001). In Apuseni Mountains, 6-8 pairs were registered; no density was shown (KOVÁCS et al., 2008).

6. Tetrao urogallus Linnaeus, 1758.

The capercaillie lives in mature coniferous forests, preferring areas with old pines on rocky ground with abundance of berry-bearing shrubs and moss and with element of aspen and spruces, avoiding open ground (SVENSSON et al., 2009, 2017). In Romania, it breeds in the massive forests of resinous; above the treeline it is occurred only in the mating time (CIOCHIA, 1992). Resides in large coniferous forests, with tall trees and, often, with well developed underwoods, mainly *Vaccinium* sp. (MUNTEANU, 2000). It is frequent in Făgăraş and Bucegi (NEGRUŢIU, 1983). The population of Romania is ca. 10,000 individuals (MUNTEANU et al., 2002).

All 5 individuals were seen in the habitat 9410 - Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea). In the Siret River basin, it was observed on mountain meadows, in old pure forests of *Picea abies* and their exploitations and in exploitations of forests of *Abies alba* and *Fagus sylvatica* (RANG, 2002). Our observations confirm its preference for mature forests of coniferous. The elevations where the birds were noted varied between 1,398 and 1,661 m (Table 1). In Rodnei Mountains, it was found between 1,200 and 1,600 m (BÉREŞ, 1977) and in the mountains of Bistriţa, between 900 and 1,600 m (MUNTEANU, 2000). A nest was met at 1,430 m, in Călimani Mountains (CIOCHIA, 1992).

It is a probable breeding species in the area. The estimated population is at least 8-12 adult males or 0.10-0.14 males/km^2 of coniferous forest. Spring densities usually range between 1 and 2 displaying cocks/km^2 (HAGEMEIJER & BLAIR, 1997). In Romania, there were cited densities of 0.4 individuals/km^2 forest or 1 individual/km^2 (MUNTEANU, 2012). In Făgăraş and Bucegi, the density is over 1 male/km^2 of forest (NEGRUŢIU, 1983); in the upper basin of Bistriţa - 0.4 individuals/km^2 (IONESCU et al., 1968).

7. Bonasa bonasia (Linnaeus, 1758).

The hazel grouse lives in mixed coniferous (rarely broad leaved), closed forests, preferring damp and densely undergrown areas with old spruces (SVENSSON et al., 2009, 2017). In Romania, it breeds in forests, mainly in the ones with *Corylus avellana* (CIOCHIA, 1992). In the mountains of Bistriţa Moldovenească River, was observed chiefly in mixed forests with rich underbush, but, also in the coniferous or beech ones (MUNTEANU, 2000). However, rarely appears in the coniferous. The population is estimated at 9,000-12,000 pairs (MUNTEANU et al., 2002).

In the researched area, the 8 individuals was seen only in the habitat 91V0 - Dacian Beech forests (Symphyto-Fagion). In the Siret Valley, it was identified in young and old forests of *Picea abies* and *Fagus sylvatica*, in young and old forests of *Abies alba* and *F. sylvatica*, in old pure forests of *Pinus sylvestris*, in young and old pure forests of *F. sylvatica* and on mountain meadows (RANG, 2002). In our case, the presence of the species was associated with the occurrence of the underwood. The spots of observations ranged between 1,002 and 1,408 m (Table 1). In Romania, it was occurred between 300 m and the level of the coniferous forest (CIOCHIA, 1992) and in other mountains from the Eastern Carpathians, it was observed between 500 and 1,600 m (MUNTEANU, 2000).

Certainly, it breeds in the Leaota Mountains. The population is estimated at 15-30 pairs or 0.12-0.24 pairs/km^2 of forest from habitat 91V0. The peak densities have been ascertained in the Polish Carpathians: broad leaved forests - 2.5 birds/km^2, mixed forest - 5.6 birds/km^2, coniferous forest - 18 birds/km^2. In Russia and Belarus: 10-15 pairs/km^2 (HAGEMEIJER & BLAIR, 1997).

8. Crex crex (Linnaeus, 1758).

The corncrake breeds on damp meadows by marshy lowland lakes, but also on lush meadowlands and hay fields with access to wetter spot with taller vegetation (SVENSSON et al., 2009, 2017). In Romania, it breeds in all wetlands, as also in agricultural terrains near the waters (CIOCHIA, 1992), where nearly 20,000 pairs live (MUNTEANU et al., 2002).

Both observed individuals were registered in the habitat 6520 - Mountain hay meadows at 821, respectively 877 m a.s.l. (Table 1). In the Siret Valley, it was seen on mountain meadows (RANG, 2002). It is known to breed in the humid glens of the mountains foots (CIOCHIA, 1992) between 350 and 900 m elevation (MUNTEANU, 2000).

The species is probably breeding in the area, although it was not found in the perimeter of focal interest, but in the immediate vicinity, where probably there are 2-4 pairs or 0.4-0.8 calling males/km^2. In the Alps, the mean density was between 0.40 and 4.11 calling males/km^2 (PEDRINI et al., 2012). In Romania, it was 0-4.6 calling males/km^2, at 600-1,800 m (DEMETER & SZABÓ, 2005) or maximum 4 calling males/5 ha, in the north – eastern part of Romania (GACHE & TRELEA, 2004).

9. Strix uralensis Pallas, 1771.

The Ural owl lives in old boreal forests interspersed with bogs, often also open water, clearfellings and small fields (SVENSSON et al., 2009, 2017). In Romania, prefers to breed in large and old broadleaf forests from Carpathians (CIOCHIA, 1992) or in woods of *Fagus* sp. and *Picea* sp., with strength of 200-800 pairs (MUNTEANU et al., 2002).

The two registered individuals were seen in the habitat 91V0 - Dacian Beech forests (Symphyto-Fagion). *Fagus sylvatica* and *Picea abies* dominated the woody vegetation in both locations, which were situated at 826, respectively 1,310 m elevation (Table 1). In the Siret Valley, it was seen in old forests of *P. abies* and *F. sylvatica*, in old forests of *Abies alba* and *F. sylvatica*, in old pure forests of *Pinus sylvestris*, in old pure forests of *F. sylvatica*, in old forests dominated by *F. sylvatica*, and in other ecosystems that not appear in our area (RANG, 2002). In the mountains of Bistriţa, it was met between 700 and 1,600 m (MUNTEANU, 2000).

It is a probable breeding species in the area. The strength is estimated at 6-12 pairs (0.04-0.09 pairs/km^2 of forest from habitat 91V0 or 0.02-0.05 pairs/km^2 of forest). The observed individuals were met on the tracks. No individuals responded to the nocturnal play-back, because of the unfavourable period of monitoring. Usually, the density is bellow 6-7 pairs/km^2 (HAGEMEIJER & BLAIR, 1997). In Romania, in old forest of *F. sylvatica*, at 830-1,100 m elevation, the density was 2 pairs/km^2 (BÉREŞ & CHERECHEŞ, 1997).

10. Picus canus Gmelin J. F., 1788.

The grey-headed woodpecker breeds in several quite different habitats, e. g. in swamp forests along river and lakeshores with plenty of insect-rich decayed deciduous trees; in open or park-like mature deciduous forest; in open woodlands in uplands (often to 600 m, at times higher) and with good coniferous element (SVENSSON et al., 2009, 2017). In Romania, it lives often in the broadleaf forests, mainly along the larger rivers. Also, it is met in the open deciduous and mixed woods and visits only the skirts of the coniferous forests (CIOCHIA, 1992). 20,000-50,000 pairs are the whole Romanian population (MUNTEANU et al., 2002).

The only individual was observed to the skirt in the habitat 91V0 - Dacian Beech forests (Symphyto-Fagion) with trees of diverse ages, at 1,105 m elevation (Table1). In the Siret Valley, it appeared in old pure forests of *Picea abies*, in young and old forests of *P. abies* and *Fagus sylvatica*, in young and old forests of *Abies alba* and *F. sylvatica*, in young and old pure forests of *F. sylvatica*, in young and old forests dominated by *F. sylvatica*, and in other ecosystems from the lower areas (RANG, 2002). Up to 900 m, it was observed in the mountains of Bistriţa (MUNTEANU, 2000), and bellow 1,400 m elevation, in Călimani Mountains (KOHL, 1983).

It is a probable breeding species in the area. The estimated population is 2-4 breeding pairs or 0.01-0.03 pairs/km^2 of forest from habitat 91V0. Typical Central European densities are c. 0.1 pairs/km^2 or 0.25 pairs/km^2 (HAGEMEIJER & BLAIR, 1997). In Romania: 15 pairs/km^2 in mountain forest Fagetum-Mercurialitosum, at 850 m elevation (KORODI, 1957), 1 pair/km^2 in forest of *F. sylvatica*, the association Fagetum carpaticum, at 700-1,000 m elevation (MUNTEANU, 2012).

11. Dendrocopos leucotos (Bechstein, 1802).

The white-backed woodpecker breeds in wet mixed forest, often by lakes and rivers, with plenty of dead and dying deciduous trees (aspen, sallow, alder, birch); thus requires areas undisturbed by forestry operations (SVENSSON

et al., 2009, 2017). In Romania, lives in the large broadleaf and coniferous forests from Carpathians (CIOCHIA, 1992) and, also, in Dobrudja. The all population ranges between 10,000 and 20,000 pairs (MUNTEANU et al., 2002).

Both registered individuals were seen in the habitat 91V0 - Dacian Beech forests (Symphyto-Fagion), at 1,044, respectively 1,078 m elevation (Table 1). In the mountains of Bistriţa Moldovenească River, it was seen in the breeding season only in the interior of the forests, between 350 and 1,400 m sea level altitude (MUNTEANU, 2000).

In the area of interest, it is a probable breeding species. The estimated population is 8-15 breeding pairs (0.06-0.12 pairs/km^2 of forest from habitat 91V0 or 0.03-0.07 pairs/km^2 of deciduous, mixed and coniferous forests). The maximum density in optimal deciduous forests is 1.0 pairs/km^2 in Northern and Central Europe (HAGEMEIJER & BLAIR, 1997). In Romania, 3 pairs/km^2 in mountain forest of *Fagus sylvatica*, at 510-850 m elevation, 15 pairs/km^2 in mixed forests, at 480-600 m elevation, 2 pairs/km^2 in forest of *F. sylvatica*, in the association Fagetum carpaticum, at 700-1,000 m elevation, 17 pairs/km^2 in forest of *F. sylvatica*, the associations Symphyto-cordati – Fagetum, Fageto drymae – Fagetum, at 900-1,200 m elevation (MUNTEANU, 2012).

12. Picoides tridactylus (Linnaeus, 1758).

The three-toed woodpecker breeds in coniferous and mixed forest with some older spruce stands and (often dying) deciduous trees (SVENSSON et al., 2009, 2017). In Romania, it breeds in the coniferous forests, where the population is 2,000-5,000 pairs (CIOCHIA, 1992; MUNTEANU et al., 2002). Rarely, it appears in the mixed forest (MUNTEANU, 2000).

In the area of Leaota Mountains, it was recorded in one type of habitat: 9410 – Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea), between 1,375 and 1,691 m elevation (Table 1). In the Siret Valley, it appeared in old forests of *Picea abies* and *Fagus sylvatica*, in old forests of *Abies alba* and *F. sylvatica*, and in old pure forests of *Pinus sylvestris* (RANG, 2002). It was found between 700 (near Braşov) and 1,550 m, in Călimani Mountains (KOHL, 1983). In the mountains of Bistriţa, it was seen between 700-800 m and 1,600 m, in winter (MUNTEANU, 2000).

It is a probable breeding species in the area. The population is estimated at 5-10 breeding pairs or 0.05-0.11 pairs/km^2 in forest of *Picea abies*. In Europe, in favoured area, the density is 1 pair/42-200 ha (HAGEMEIJER & BLAIR, 1997). In Romania: 1.2 pairs/km^2 in forest of *P. abies*, the association Piceetum montanum austrocarpaticum, at 1,300-1,500 m elevation, 3 pairs/km^2, in forest of *P. abies*, the association Hieracio rotundati – Piceetum, at 1,350-1,650 m elevation (MUNTEANU, 2012).

13. Dryocopus martius (Linnaeus, 1758).

The black woodpecker nests in mature forest, often pine and mixed forest, but also beech (SVENSSON et al., 2009, 2017). In Romania, it breeds in diverse types of woods, preferring the coniferous ones (CIOCHIA, 1992). The population is estimated at 4,000-8,000 pairs (MUNTEANU et al., 2002).

Among the 17 observed individuals, 8 (47.05% of all) were seen in the habitat 91V0 - Dacian Beech forests (Symphyto-Fagion), 7 (41.17% of all) were seen in the habitat 9410 – Acidophilous*Picea* forests of the montane to alpine levels (Vaccinio-Piceetea), 1 was seen in the habitat 9110 - Luzulo-Fagetum beech forests (5.88% of all), and 1 (5.88% of all) was seen in the mosaic of habitats on limestone – M. In the hydrographical basin of the Siret River, it was registered in old pure forests of *Picea abies*, old forests of *Fagus sylvatica* and *P. abies*, old forests of *Abies alba* and *F. sylvatica*, old pure forests of *Pinus sylvestris*, old pure forests of *F. sylvatica*, and in old forests of *Fagus* sp. and other species of trees (RANG, 2002). In our case, 11 individuals (64.70% of all) were associated with the mature forest, 3 (17.64% of all) with the young or relatively young forests interspersed with mature or old trees, 2 (11.76% of all) with the forests composed by trees of diverse ages, and 1 (5.88% of all) with rare and mature trees in a rocky area. As mentioned above, 7 individuals (41.17% of all) were registered in the coniferous forest; 9 individuals (52.94% of all) were observed in the mixed forest and 1 (5.88% of all) in the broadleaf forest. The elevation of points of observation ranged between 872 and 1,598 m (1,670 m – the nest), (Table 1). In other parts of the country, it was observed up to 1,000-1,500 (1,600) m (KOHL, 1983), or between 400 and 1,600 m (MUNTEANU, 2000).

Certainly, it breeds in the area. The population was estimated at 20-30 breeding pairs (0.09-0.14 pairs/km^2 of forest). The density in Central Europe is 1 pair/300-1,000 ha (HAGEMEIJER & BLAIR, 1997). In Romania: 0.5 pairs/km^2 in forest of *Picea abies*, the association Piceetum montanum austrocarpaticum, at 1,300-1,500 m elevation, 2 pairs/km^2 in mixed forest (*F. sylvatica*, *P. abies*, *A. alba*), the association Piceeto-Fagetum carpaticum, at 1,200 m elevation (MUNTEANU, 2012), 2 pairs/km^2 in old forest of *F. sylvatica*, at 830-1,100 m elevation (BÉREŞ & CHERECHEŞ, 1997).

14. Lullula arborea (Linnaeus, 1758).

The woodlark breeds in open forests, preferring pine on sandy soil, but also in mixed or broadleaves forests with clearings and on heatland with scattered copses (SVENSSON et al., 2009, 2017). In Romania, breeds in the hilly areas and plateaus, and also in the large valleys of the Carpathians Rivers. It prefers the open lands, with tall trees (CIOCHIA, 1992), rarely from the mountain regions. The Romanian population is estimated at 20,000-40,000 pairs (MUNTEANU et al., 2002).

Among the 4 registered individuals, 3 individuals (75.00%) were observed in the habitat 6520 - Mountain hay meadows and 1 individual (25.00%) was seen in habitat 6230 - Species-rich *Nardus* grassland, on siliceous substrates. All individuals were seen near the forest, 2 (50.00% of them) close to the coniferous one and 2 (50.00% of them) close to the mixed one. The elevation, where the individuals were noted, varied between 1,103 and 1,406 m (Table 1). In the

Oriental Carpathians, it was met frequently between 550 and 1,500 m (KALABÉR, 1982). Up to 1,400-1,500 m elevation in the mountains of Bistriţa (MUNTEANU, 2000).

Probably, it breeds in the researched area. The population was estimated at 10-20 breeding pairs or 0.06-1.23 pairs/km^2 of meadows (the habitats 6520 and 6230). In Eastern Europe, the density is 400-700 pairs/50 km square (HAGEMEIJER & BLAIR, 1997). In Romania, 10 pairs/km^2 were calculated in old forest of *Fagus sylvatica*, at 830-1,100 m elevation (BÉREŞ & CHERECHEŞ, 1997).

15. Lanius collurio Linnaeus, 1758.

The red-backed shrike breeds in open cultivated country, often on heats and pastures with hawthorn, sloe and dog-rose, also in juniper stands (SVENSSON et al., 2009, 2017). In Romania, breeds in the lands where there are bodies of forest with glades and bushes and, also, on valleys with arbustive and arborescent vegetation; met up to the subalpine areas (CIOCHIA, 1992). The maximum abundance is in the hilly and plain areas. The population numbers 400,000-800,000 pairs (MUNTEANU et al., 2002).

All the 6 individuals recorded were seen in the habitat 6520 - Mountain hay meadows. In the Siret hydrographical basin, it was observed in exploitations of forests of *Picea abies* and *Fagus sylvatica*, in exploitations of forests of *Abies alba* and *F. sylvatica*, in exploitations of pure forests of *F. sylvatica*, in exploitations of forests dominated by *F. sylvatica*, on mountain meadows and in other few types of woods from the lower areas (RANG, 2002). They preferred the meadows from the vicinity of the forest (5 individuals, 83.33% of all); 1 individual (16.66% of all) was observed in an area with scattered trees and bushes. The minimum elevation where the species was observed is 702 m, while the maximum one is 1,084 m (Table 1). In Ciucaş Mountains, it was observed bellow 1,200 m (CIOCHIA, 1992) and in Călimani Mountains, up to 1,000-1,300 (1,750) m (KOHL, 1983). In the hydrographical basin of Bistriţa Moldovenească, it was recorded until 1,200 m (MUNTEANU, 2000).

It is a confirmed breeder in the area, where the population was estimated at 10-20 breeding pairs or 2.1-4.3 pairs/km^2. The density exceeds 5,000 pairs/50 km square, in Eastern Europe (HAGEMEIJER & BLAIR, 1997). In Romania, 33 pairs/km^2 were met in some orchards from the mountain area, at 460-500 m elevation (MUNTEANU, 2012).

16. Ficedula albicollis (Temminck, 1815).

The collared flycatcher breeds in deciduous woods, in gardens and parks (SVENSSON et al., 2009, 2017). In Romania, it prefers to breed in the rich underwood forests and at the skirts of the large forests with hollow trees (CIOCHIA, 1992), from the mountain and high hilly areas, and recently from the lower ones, where the population is between 50,000 and 100,000 pairs (MUNTEANU et al., 2002). In the mountains from Oriental Carpathians, lives in deciduous forests, sporadically in the mixed one and, also, at the skirt of the coniferous plantations (MUNTEANU, 2000).

There were observed only 5 individuals, because some of the tracks were covered on the banks of streams, making difficult the hearing of the distant birds; also, the weather was rainy in some days of research, determining the birds to stop the singing. 3 individuals (60.00% of all) were observed in the habitat 91V0 - Dacian Beech forests (Symphyto-Fagion) and 2 individuals (40.00% of all) were observed in the habitat 9110 - Luzulo-Fagetum beech forests. In the Siret Valley, it appeared in old forests of *Abies alba* and *Fagus sylvatica*, old pure forests of *F. sylvatica*, young and old forests dominated by *F. sylvatica*, and in other ecosystems from the lower areas (RANG, 2002). In our situation, they were seen exclusively in well grown mixed forests. The elevation where the species was present fluctuated between 931 and 1,219 m (Table 1). In Gurghiu Mountains, it was met bellow 800 m (KALABÉR, 1982) and in the mountains of Bistriţa, between 350 and 1,350 m (MUNTEANU, 2000).

It is a probable breeder in the area. The population was roughly estimated at 150-300 breeding pairs (1.16-2.33 pairs/km^2 of broadleaf and mixed forests), but it can be much higher, considering other studies: 52 pairs/km^2 in the forest of *Fagus* sp. (MUNTEANU, 2000), 17 pairs/km^2 in the mountain forest Fagetum-Oxolidosum, at 1,250 m elevation, 32 pairs/km^2 in the mountain forest Fagetum-Mercurialitosum, at 850 m elevation (KORODI, 1957), 52 pairs/km^2 in the mountain forest of *F. sylvatica*, at 510-850 m, 20 pairs/km^2 in the mixed forest, at 480-600 m, 22 pairs/km^2 in the mixed forest (*F. sylvatica*, *P. abies*, *A. alba*), the association Piceeto-Fagetum carpaticum, at 1,200 m, 72 pairs/km^2 in the forest of *F. sylvatica*, the association Fagetum carpaticum, at 700-1,000 m (MUNTEANU, 2012), 8 pairs/km^2 in the old forest of *F. sylvatica*, at 830-1,100 m elevation etc. (BÉREŞ & CHERECHEŞ, 1997). In Polish Bialowieza National Park, the breeding densities ranged between 0.3-0.6pairs/ha, whereas 0.01 pairs/ha is representative of coniferous forest (HAGEMEIJER & BLAIR, 1997).

17. Ficedula parva (Bechstein, 1792).

The red-breasted flycatcher breeds in forests in a variety of habitats, mostly in lush, dense patches with rich undergrowth and a brook or other water, preferring deciduous woods but not shunning mixed (SVENSSON et al., 2009, 2017). In Romania, it resides the deciduous forest extended in the mountain areas, mainly of *Quercus* sp. Also, in mixed woods, with a few conifers (CIOCHIA, 1992). The population from our country is 20,000-40,000 pairs (MUNTEANU et al., 2002).

From the same motives previously exposed, in the area of research only 6 individuals were registered, all in the habitat 91V0 - Dacian Beech forests (Symphyto-Fagion). In the Siret hydrographical basin, it was identified in old forests of *Abies alba* and *Fagus sylvatica*, old pure forests of *F. sylvatica*, and in other ecosystems that are not occurred in the Leaota Mountains (RANG, 2002). Here, 5 individuals (83.33% of them) appeared in the mixed forests and 1 (16.66%) in the broadleaf ones. The occurrence of the mature or old trees was common in all. The species was observed

between 892 and 1,239 m elevation (Table1). In Călimani Mountains, it was seen up to 890 m (KOHL, 1983) and in the forests of Bistriţa Moldovenească River it ascended up to 1,300 m (MUNTEANU, 2000).

It is a probable breeder in the area. The population was roughly estimated at 30-60 breeding pairs (0.24-0.48 pairs/km^2 of forest from habitat 91V0 or 0.14-0.28 pairs/km^2 of forest). The true strength can be much bigger, if regard the density registered in other areas: 39 pairs/km^2 in the forest of *Fagus* sp., at 510-850 m elevation, 20 pairs/km^2 in the mixed forests, at 480-600 m, 6 pairs/km^2 in the forest of *F. sylvatica*, the association Fagetum carpaticum, at 700-1,000 m, 30 pairs/km^2 in the forest of *F. sylvatica*, the associations Symphytocordati – Fagetum, Fageto drymae – Fagetum, at 900-1,200 m elevation (MUNTEANU, 2000, MUNTEANU, 2012), 6 pairs/km^2 in the old forest of *F. sylvatica*, at 830-1,100 m (BÉREŞ & CHERECHEŞ, 1997). In Polish, the mean density was 1.2 pairs/10 ha, and it is supposed to be higher in primeval mountain beech-fir forest in Central Europe (HAGEMEIJER & BLAIR, 1997).

Table 1. Some data regarding the distribution of the species from the Annex I of the Birds Directive, observed in the area of Leaota Mountains.

Species	No. individuals	Toponym	Date of observation	Latitude (N)	Longitude (E)	Habitats	Mentions	A.s.l.* (m)	Mean a.s.l.* (m)	n
Aquila chrysaetos	3	Dudele-Bucşa Mountains	July 10	45° 23.211'	25° 21.597'	4060, 6150, 9410	an immature bird coming and leaving from/towards the Grohotişul Mountain from Bucegi, being driven away by the adults	1,882	1,882 in flight	3
Pernis apivorus	1	Tâncava Mountain	May 15	45° 17.990'	25° 18.506'	6230	in migration, over the ridge, toward North	1,689	1,660.62 in migration	8
	1	Iuda Valley	May 29	45° 20.634'	25° 13.084'	91V0	in flight	1,034		
	2	Albescu Mountain	May 29	45° 21.094'	25° 13.673'	91V0	over a mixed forest from Valea Caselor	1,259		
	1	Albescu Mountain	June 5	45° 21.826'	25° 12.633'	91V0	over a mixed forest	1,054		
	1	Ghimbav Valley	June 5	45° 22.490'	25° 14.325'	91V0	in flight	1,008	1,129.72 in flight, in the nesting area	11
	2	Rucăr Hill (Vârful Crucii)	June 20	45° 23.411'	25° 11.587'	91V0	in flight	962		
	1	Dealul Sasului	June 26	45° 24.555'	25° 15.377'	91V0	in flight	1,013		
	1	Albescu Mountain	July 23	45° 21.449'	25° 13.195'	6520	in flight, near the stable, carrying a honeycomb in claws	1,248		
	2	Colţii Ghimbavului	August 4	45° 23.057'	25° 13.748'	91V0	in flight	1,314	1,353.26 overall	19
	3	Ţâbra Valley	August 25	45° 16.975'	25° 16.719'	91V0, 9410	in migration, towards South	1,342		
	1	Dudele Mountain	August 28	45° 23.218'	25° 21.999'	4060	in migration, over the ridge, toward South	1,825		
	3	Leaota Mountain	September 9	45° 19.534'	25° 19.256'	4060	in migration, flying towards South	1,915		
Milvus migrans	1	Valea Bădenilor	May 15	45° 19.923'	25° 16.010'	6230, 9410	in migration, ascending over the forest of *Picea abies* from the Valea Bădenilor and flying towards North, over Cioara-Râiosu Ridge	1,584	1,584 in migration	1
Circus aeruginosus	1	Râiosu Mountain	June 5	45° 20.404'	25° 17.152'	4060, 6150, 6230	in migration, over the ridge, toward North	1,690	1,803.20 in migration	5
	2	Sântilia Mountain	August 28	45° 22.876'	25° 19.487'	4060, 6150, 6230	in migration, over the ridge, toward South	1,827		
	1	Tătaru Mountain	August 28	45° 22.637'	25° 23.359'	4060, 6150, 6230	in migration, over the ridge, toward South	1,766		
	1	Leaota Mountain	September 9	45° 19.335'	25° 18.634'	4060, 6150, 6230	in migration, over the ridge, toward South	1,906		
Falco peregrinus	1	Valea Ghimbavului	June 5	45° 22.378'	25° 13.008'	91V0	in flight	1,015	1,390.23 in flight	13
	1	Rucăr Hill	June 20	45° 23.639'	25° 11.805'	6520	in flight	988		
	1	Dealul Sasului	June 26	45° 24.428'	25° 15.010'	6520	in flight, chasing 1 individual of *Apus melba*	1,159		
	1	Dudele Mountain	July 10	45° 22.999'	25° 21.624'	4060	in flight, following 1 individual of *Falco tinnunculus*	1,875		

	1	Tătaru Mountain	July 17	45° 23.217'	25° 24.123'	6150	in flight, coming from Grohotişu Mountain	1,886	1,232.66 standing	3
	2	Rucăr (Cheia Mare)	July 23	45° 23.193'	25° 11.439'	M	juveniles, on a rocky area with *Pinus* sp. and *Picea abies*	802		
	3	Cheile Ghimbavului	July 24	45° 23.352'	25° 11.831'	M	adult with 2 juveniles, in flight over a rocky area with mixed forest	822		
	1	Frumuşelu Peak	August 25	45° 16.773'	25° 17.697'	6230	in flight, hunting	1,674		
	1	Ţâbra Valley	August 25	45° 16.884'	25° 17.247'	9410	in flight	1,539		
	1	Dudele Mountain	August 28	45° 23.235'	25° 21.469'	4060	in flight, hunting	1,848		
	1	Leaota Mountain	September 9	45° 18.910'	25° 18.852'	4060	in flight	1,937	1,360.68 overall	16
	1	Leaota Mountain	September 9	45° 19.435'	25° 18.883'	4060	1 juveniles, on a rock	2,094		
	1	Vâja Mountain	September 9	45° 19.241'	25° 17.850'	9410	1 juveniles, in flight, hunting	1,686		
Tetrao urogallus	1	Frumuşelu Mountain	May 21	45° 16.200'	25° 17.965'	9410	information from ranger, observed in a mature forest	1,415	1,555	5
	1	Marginea Domnească Mountain	May 23	45° 15.662'	25° 16.751'	9410	information from ranger, observed at the skirt, with rare and young trees, of a mature forest	1,398		
	1	Jigărea Mountain	July 10	45° 23.444'	25° 20.087'	9410	on the Northern versant, in a mature coniferous forest, near the outskirt	1,645		
	1	Sântilia Mountain	July 13	45° 23.404'	25° 17.909'	9410	observed in a mature forest	1,656		
	1	Sântilia Mountain	August 28	45° 23.756'	25° 18.731'	9410	in a relatively open mature forest, with moss, herbs and blueberries	1,661		
Bonasa bonasia	1	Jigărea Mountain	July 10	45° 23.905'	25° 19.751'	91V0	on the Northern versant, in a mixed forest with underbush	1,335	1,332.37	8
	5	Albescu Mountain	July 12	45° 21.361'	25° 13.659'	91V0	information from Monica Neblea, juveniles near a relatively recent clearance	1,408		
	1	Valea Ghimbavului	July 24	45° 22.149'	25° 13.330'	91V0	in a young mixed forest	1,002		
	1	Lespezi Mountain	August 21	45° 18.226'	25° 23.290'	91V0	in a mature forest of *Fagus sylvatica* and *Picea abies* with underwood	1,282		
Crex crex	1	Brebu (Gâlma Brebului)	June 27	45° 12.445'	25° 19.871'	6520	on the wet meadow with scattered trees, in an orchard	877	849	2
	1	Pucheni – Meişoare vicinity	July 2	45° 12.568'	25° 16.627'	6520	on the wet meadow with rows of young and mature trees (*Fagus sylvatica*, *Picea abies*, *Salix* sp., *Ulmus* sp., *Populus* sp., *Acer* sp., *Alnus glutinosa*)	821		
Strix uralensis	1	Tâncava Mountain	June 21	45° 18.248'	25° 15.824'	91V0	in an old mixed forest of *Fagus sylvatica*, *Picea abies*, and *Abies alba*	1,310	1,068	2
	1	Românescu Mountain	June 27	45° 14.113'	25° 18.879'	91V0	near the Marginea Domnească Monastery, at the confluence between Marginea Domească and Frumuşelu streams, in a mixed forest with trees of diverse ages	826		
Picus canus	1	Albescu Mountain	June 5	45° 21.416'	25° 12.437'	91V0	at the outskirt of mixed forest	1,105	1,105	1
Dendrocopos leucotos	1	Valea Fiaşului	May 23	45° 14.987'	25° 15.573'	91V0	in a relatively young forest of *Fagus sylvatica* with rare mature trees	1,044	1,061	2
	1	Albescu Mountain	June 5	45° 21.487'	25° 12.494'	91V0	at the outskirt of mixed forest with trees of diverse ages	1,078		
Picoides tridactylus	1	Marginea Domnească Mountain	May 23	45° 15.452'	25° 16.859'	9410	in a mature forest	1,375	1,533	2
	1	Sântilia Mountain	August 28	45° 23.666'	25° 18.709'	9410	in a sparsely mature forest with dead trees	1,691		
Dryocopus martius	1	Vâja Mountain	May 15	45° 18.930'	25° 16.477'	91V0	in a mixed forest, with *Fagus sylvatica*, *Picea abies*, and *Abies alba* of diverse ages	1,345	1,251.41	17
	1	Raciu Mountain	May 22	45° 17.327'	25° 20.885'	9410	observed in a mature forest	1,376		
	1	Marginea Domnească Mountain	May 23	45° 15.803'	25° 16.141'	9410	in a mature forest	1,319		

	1	Piscul Frunţii	May 23	45° 15.395'	25° 15.486'	9110	in a young broadleaf forest with rare old trees	1,207		
	1	Valea Bădenilor	May 24	45° 18.059'	25° 15.022'	91V0	in a relatively young mixed forest of *Fagus sylvatica*, *Picea abies*, and *Alnus incana*	894		
	1	Roşu Mountain	May 29	45° 20.611'	25° 12.898'	91V0	in a mature mixed forest	1,018		
	1	ValeaCaselor	May 29	45° 20.923'	25° 14.008'	91V0	in a mature mixed forest of *Fagus sylvatica*, *Picea abies*, and *Alnus incana*	1,122		
	1	Albescu Mountain	June 5	45° 21.447'	25° 12.675'	91V0	in a mixed forest with trees of diverse ages	1,094		
	1	Tâncava Mountain	June 21	45° 17.870'	25° 15.813'	91V0	in a mature mixed forest	1,075		
	1	Mitarca Mountain	June 28	45° 20.178'	25° 19.723'	9410	a nest, in a mature forest	1,670		
	1	Colţii Ghimbavului	August 4	45° 22.750'	25° 13.758'	M	in a rocky area, with debris and *Picea abies*, *Pinus* sp., and vegetation of dry meadow	905		
	1	Făgeţelu Mare Mountain	August 13	45° 19.374'	25° 15.350'	9410	in a relatively young forest	1,497		
	1	Ţâbra Valley	August 25	45° 17.008'	25° 16.522'	91V0	in a mature mixed forest	1,341		
	1	Ţâbra Mountain	August 25	45° 16.972'	25° 17.314'	9410	near the treeline of a mature forest	1,598		
	1	Românescu Mountain	August 25	45° 16.363'	25° 17.498'	9410	in a mature forest	1,483		
	1	Vâja Mountain	September 9	45° 19.083'	25° 16.840'	9410	information from Monica Neblea, observed in a mature forest	1,458		
	1	Valea Chiliilor	September 25	45° 12.983'	25° 14.514'	91V0	in a mature mixed forest	872		
Lullula arborea	1	Marginea Domnească Mountain	May 23	45° 16.011'	25° 16.253'	6230	bellow the stable, near the forest of *Picea abies*	1,406	1,210.75	4
	1	Albescu Mountain	June 5	45° 21.678'	25° 12.468'	6520	near a mixed forest	1,103		
	1	Dealul Sasului	June 26	45° 24.662'	25° 14.940'	6520	at the outskirt of relatively young coniferous forest of *Picea abies* and *Pinus* sp.	1,206		
	1	Albescu Mountain	July 23	45° 21.620'	25° 12.683'	6520	at the outskirt of young mixed forest of *Picea abies* and *Fagus sylvatica*	1,128		
Lanius collurio	1	Albescu Mountain	June 5	45° 21.758'	25° 12.531'	6520	at the outskirt of mature mixed forest	1,084	918.16	6
	1	Rucăr Hill	June 20	45° 23.394'	25° 10.934'	6520	at the outskirt of mature forest of *Fagus sylvatica*	793		
	1	Dealul Sasului	June 26	45° 24.810'	25° 14.904'	6520	at the outskirt of relatively young forest of *Picea abies* and *Pinus* sp.	1,170		
	1	Pucheni – Meişoare vicinity	July 2	45° 12.761'	25° 16.580'	6520	on the meadow with rows of young and mature trees (*Fagus sylvatica*, *Picea abies*, *Salix* sp., *Ulmus* sp., *Populus* sp., *Acer* sp., *Alnus glutinosa*)	875		
	1	Rucăr Hill	July 23	45° 23.220'	25° 10.797'	6520	in a rocky area at the skirt of a forest with mature trees of *Pinus* sp. *Picea abies*, *Fagus sylvatica* and bushes	702		
	1	Valea Chiliilor	September 25	45° 13.091'	25° 14.677'	6520	nest, in a bush of *Crataegus* sp., at the skirt of the mixed forest	885		
Ficedula albicollis	1	Vâja Mountain	May 15	45° 18.823'	25° 16.263'	91V0	in a mixed forest, with *Fagus sylvatica*, *Picea abies*, and *Abies alba* of diverse ages	1,219	1,065.6	5
	1	Valea Fiaşului	May 23	45° 14.806'	25° 15.952'	91V0	in a mature forest of *Fagus sylvatica*, with rare trees of *Alnus* sp., *Picea abies*, and *Abies alba*	931		
	1	Muchia Marginea Domnească	May 23	45° 14.896'	25° 16.094'	9110	in a mature forest of *Fagus sylvatica*, with rare trees of *Picea abies*, *Abies alba*, *Acer* sp., *Betula* sp., *Populus* sp.	968		
	1	Muchia Marginea Domnească	May 23	45° 14.981'	25° 16.155'	9110	in a mature forest of *Fagus sylvatica*, with rare trees of *Picea abies*, *Abies alba*, *Acer* sp., *Betula* sp., *Populus* sp.	1,020		
	1	Muchia Marginea Domnească	May 23	45° 15.163'	25° 16.543'	91V0	in a mature mixed forest with *Fagus sylvatica*, *Picea abies*, *Abies alba*, *Betula* sp.	1,190		
Ficedula parva	1	Vaca Valley	May 22	45° 15.797'	25° 20.528'	91V0	in a mature mixed forest with *Fagus sylvatica*, *Picea abies* and *Alnus incana*	977	1,038.33	6
	1	Rucăr Hill	June 20	45° 23.532'	25° 11.969'	91V0	in a forest of *Fagus sylvatica*	948		
	1	Tâncava Valley	June 21	45° 18.169'	25° 15.623'	91V0	in an old mixed forest of *Fagus sylvatica*, *Picea abies*, and *Abies alba*	1,197		

	1	Raciu Mountain	June 29	45° 16.681'	25° 24.012'	91V0	in an old mixed forest of *Fagus sylvatica*, *Picea abies*, *Ulmus* sp., *Abies alba*, *Acer* sp.	977		
	1	Pucheni – Meişoare	July 2	45° 12.297'	25° 16.062'	91V0	in a relatively young forest, with rare mature trees of *Fagus sylvatica* and *Picea abies*	892		
	1	Lespezi Mountain	August 21	45° 18.226'	25° 23.201'	91V0	in a mature forest of *Fagus sylvatica* and *Picea abies* with underwood	1,239		

Legend: * - sea level altitude of the species place of observation by Google Earth; n- number of individuals.

Except for the birds that were observed on the wings, which belong to 5 species (*Aquila chrysaetos*, *Pernis apivorus*, *Milvus migrans*, *Circus aeruginosus*, and *Falco peregrinus*), *Bonasa bonasia*, *Strix uralensis*, *Picus canus*, *Dendrocopos leucotos*, *Dryocopus martius*, *Ficedula albicollis* and *F. parva* were observed in the habitat 91V0 - Dacian Beech forests (Symphyto-Fagion), *Crex crex*, *Lullula arborea* and *Lanius collurio*, in the habitat 6520 - Mountain hay meadows, *Tetrao urogallus*, *Picoides tridactylus* and *Dryocopus martius*, in the habitat 9410 – Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea), *Falco peregrinus* and *Dryocopus martius*, in the mosaic of habitats on limestone (M), *Dryocopus martius* and *Ficedula albicollis*, in the habitat 9110 - Luzulo-Fagetum beech forests, *Falco peregrinus*, in the habitat 4060 - Alpine and Boreal heaths, and *Lullula arborea*, in the habitat 6230 - Species-rich *Nardus* grassland, on siliceous substrates. As a result, among these 13 species, 9 (69.23%) were observed in forests and the rest in other habitats (Table 3).

As for the age of the woods where they were identified, *Tetrao urogallus*, *Bonasa bonasia*, *Picoides tridactylus*, *Dryocopus martius*, *Ficedula albicollis*, and *F. parva* were present in the mature forests, *Picus canus*, *Dendrocopos leucotos*, *Dryocopus martius*, *Strix uralensis*, and *Ficedula albicollis* in the forests of diverse ages, *Strix uralensis*, *Dryocopus martius*, and *Ficedula parva*, in the old forests, *Dryocopus martius* and *Ficedula parva* in the relatively young forests, and *Bonasa bonasia* in the young forests (Table 2).

As for the altitude from the sea level of the places of observations of the sitting birds we have: 500-999 m – *Falco peregrinus*, *Crex crex*, *Strix uralensis*, *Dryocopus martius*, *Lanius collurio*, *Ficedula albicollis*, and *F. parva*, 1,000-1,499 m – *Tetrao urogallus*, *Bonasa bonasia*, *Strix uralensis*, *Picus canus*, *Dendrocopos leucotos*, *Picoides tridactylus*, *Dryocopus martius*, *Lullula arborea*, *Lanius collurio*, *Ficedula albicollis* and *F. parva*, 1,500-1,999 m – *Tetrao urogallus*, *Picoides tridactylus*, and *Dryocopus martius*, and over 2,000 m – *Falco peregrinus* (Table 2).

The distribution of the species on the hydrographical basins of the main rivers and rivulets from the Leaota Mountains was non-uniform. For every basin, it takes in account the quality of the habitats, meaning the availability in food resources, shelters and/or breeding places, the time reserved for field research, which was not proportionally with their size, and the area of caching. At this moment of researches, we can say that Valea Bădenilor (with 8 species), from South-West, Brătei (with 7 species), from East, Valea lui Coman, from South, and Rudăriţa, from North (each with 6 species) were the best represented from this point of view.

Table 2. The repartition of the species from the Annex I of the Birds Directive, by the type of habitat and forest and the altitude from the sea level where they were seen.

Type of habitat	Number of species	%	Type of forest	Number of species	%	Elevation range(m)	Number of species	%
91V0	7	53.85	mature forests	6	66.67	1,000-1,499	11	84.62
6520	3	23.08	forests of diverse ages	5	55.56	500-999	7	53.85
9410	3	23.08	old forests	3	33.33	1,500-1,999	3	23.08
M	2	15.38	relatively young forests	2	22.22	2,000-2,499	1	7.69
9110	2	15.38	young forests	1	11.11			
4060	1	7.69						
6230	1	7.69						

CONCLUSIONS

In the area of study, during May 15 – September 30, 2016, 17 species included in the Annex I of the Birds Directive were identified. They are species first mentioned in the Leaota Mountains.

The data confirm the distribution of the species shown in the cited scientific literature on the types of habitat, age of forest and sea level altitude. Some little exceptions related to the highest elevation where they were observed appeared: *Tetrao urogallus* was observed up to 1,661 m, *Picoides trydactilus* up to 1,691 m, and *Dryocopus martius* up to 1,670 m.

The majority of the species were observed in the habitat 91V0 – Dacian Beech forests (Symphyto-Fagion), in the mature forests and between 1,000 and 1,499 m elevation, while the less ones were recorded in the habitats 4060 – Alpine and Boreal heaths and 6230 – Species-rich *Nardus* grassland, on siliceous substrates, and, also, in the young forests and at over 2,000 m sea level altitude. It is obvious that the forests with the highest anthropogenic impact were the less attractive for the protected species, from where, it results the urgent necessity of preservation of the natural forestry habitats.

Because of monitoring circumstances, the densities were under evaluated for some species; we consider that, in the adequate habitat, the estimated densities for *Aquila chrysaetos* – 0-1 pairs/254 km^2 and *Falco peregrinus* – 0.3-0.7

pairs/100 km^2 (both species with large territories), *Crex crex* – 0.4-0.8 calling males/km^2, *Dryocopus martius* – 0.09-0.14 pairs/km^2, *Lullula arborea* – 0.06-1.23 pairs/km^2 and *Lanius collurio* – 2.1-4.3 pairs/km^2 are closer to the real ones.

By the status of breeding, 10 species (58.82% of all, *Aquila chrysaetos*, *Tetrao urogallus*, *Crex crex*, *Strix uralensis*, *Picus canus*, *Dendrocopos leucotos*, *Picoides tridactylus*, *Lullula arborea*, *Ficedula albicollis* and *F. parva*) were probably breeding in the area, 5 species (29.41% of all, *Pernis apivorus*, *Falco peregrinus*, *Bonasa bonasia*, *Dryocopus martius* and *Lanius collurio*) were certainly breeding in the area, and 2 species (11.76% of all, *Milvus migrans* and *Circus aeruginosus*) were non-breeding.

A weak migration was noted over the ridges for some species (*Pernis apivorus*, *Milvus migrans* and *Circus aeruginosus*), the birds coming along the rivulets or on North-South crests, detached from the secondary ways of migration from the region that pass through the Rucăr-Bran Corridor and Prahova Valley.

Some areas (Valea Bădenilor, Brătei, Valea lui Coman, and Rudăriţa) can be considered hot spots regarding the richness of the species from the Annex I of the Birds Directive.

The work is a preliminary study of the birds from Leaota Mountains. It must continue to establish a more accurate situation of every protected species. Also, through future researches it is expected to grow the list of protected species.

We hope that the results shown here, mainly the ones that refer to the importance of some places and habitats for the species from the Annex I of the Birds Directive, will be used by all forestry bodies that administrate the studied area in their forest arrangements. They will have to exploit the woody resources so as to favour these protected birds. Large areas with integral protection shall be imposed.

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RESEARCH REGARDING THE SUCCESS OF WHITE-TAILED EAGLE NESTING (AVES: *Haliaeetus albicilla* Linnaeus 1758) BETWEEN 2009 AND 2017 WITHIN THE DANUBE DELTA BIOSPHERE RESERVE AND ITS SURROUNDINGS (ROMANIA)

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Abstract. During the research conducted between 2009 and 2017 in the Danube Delta Biosphere Reserve and its surroundings, a total of 74 occupied nests were registered, 61 of which showed successfully completed nesting. A total of 193 chicks resulted, so the mean of the reproductive rate in all the years, was calculated to be 1.2 chicks/nest, a value that fit within the limits of the other averages in literature. From a total of 61 nests where breeding was successfully completed, the average in 2009 was 1.36 chicks/nest, in 2010 - 1.33 chicks/nest, in 2011 it was 1.3 chicks/nest, in 2012 - 1 chick/nest, in 2013 - 1.17 chicks/nest, in 2014 - 1.15 chicks/nest, in 2015 - 1.08 chicks/nest, in 2016 - 1.12 chicks/nest, and in 2017 the mean was 1.35 chicks/nest. Out of 61 nests where breeding was successfully completed from 2009 to 2017, 29 nests were used (and breeding was successfully completed) once, 8 nests were used twice, 7 three times, 4 four times, 5 five times, 4 six times, 3 were used seven times, and only 1 nest was used eight times.

Keywords: nesting, chicks number, White-tailed Eagle, DDBR.

Rezumat. Cercetări privind succesul cuibăritului la codalb (Aves: *Haliaeetus albicilla* Linnaeus 1758) în perioada 2009 – 2017, din Rezervația Biosferei Delta Dunării și împrejurimi (România). În cursul cercetărilor în perioada 2009 - 2017, în Rezervația Biosferei Delta Dunării şi împrejurimi, s-au înregistrat în total 74 de cuiburi ocupate, din care la 61 cuibăritul s-a finalizat cu succes. În total au rezultat 193 de pui, astfel, media sporului în toți anii, a fost calculată la 1,2 pui/cuib, valoare care se încadreaza în limitele altor medii din literatură. Din totalul de 61 de cuiburi la care reproducerea s-a finalizat cu succes, în 2009 media a fost de 1,36 pui/cuib; în 2010 - 1,33 pui/cuib; în 2011 a fost 1,3 pui/cuib; în 2012 - 1 pui/cuib; în 2013 - 1,17 pui/cuib; în 2014 - 1,15 pui/cuib; în 2015 - 1,08 pui/cuib; în 2016 - 1,12 pui/cuib, iar în 2017 - media a fost de 1,35 pui/cuib. Tot din cele 61 de cuiburi la care reproducerea s-a finalizat cu succes din perioada 2009 - 2017, 29 de cuiburi au fost folosite (iar reproducerea s-a finalizat cu succes) o singură dată, 8 cuiburi de două ori, 7 de 3 ori, 4 de 4 ori, 5 de 5 ori, 4 de 6 ori, 3 de 7 ori și doar 1 cuib de 8 ori.

Cuvinte cheie: cuibărit, numărul puilor, codalb, RBDD.

INTRODUCTION

Most of the Romania's White-tailed Eagle (*Haliaeetus albicilla*) population is in the Danube Delta Biosphere Reserve (DDBR) and in the neighboring forests (Romania). This species belongs to the transpalearctic fauna. It is a large diurnal bird of prey that has a vast and continuous range from the Atlantic coast to the Pacific Ocean including western Greenland in the Nearctic, where a distinct subspecies exists, recognized as *H. albicilla groenlandicus* (SALOMONSEN, 1979).

The size of the global population of *H. albicilla* is estimated at about 12,100-24,500 nesting pairs, of which 18,000-24,600 adult birds are found on our continent, representing 50-74% of the world's population (*** 2016). The largest White-tailed Eagle populations are located in Norway, Russia, Poland, Germany, Sweden, Finland and Greenland (HAGEMEIJER & BLAIR, 1997; *** 2004).

Anthropogenic factor effects between 1950 and 1960 led to an accelerated decrease of the size of the White-tailed Eagle population in Romania, but also in many other countries in Europe, the main causes being: pesticides use, poaching and habitats destruction (BIJLEVELD, 1974; BODEA et al., 1957; CĂTUNEANU, 1973; DOMBROWSKI, 1912; DRAGOMIR & KISS, 1972; KLEMM, 1973; KORNIS, 1936; LINȚIA, 1954; PUȘCARIU, 1968; RADU, 1973; ROSETTI-BĂLĂNESCU, 1957; TĂLPEANU, 1967; SCHNELL, 1936; STEINBACHER, 1957). This decline continued until the early 1990' s (DRAGOMIR & ALMĂȘAN, 1973; GRIMETT & JONES, 1989; KISS, 1982, 1985; KLEMM, 1973; STĂNESCU et al., 1985; MARINOV & KISS, 1991; MUNTEANU, 2005). Only in 1990, after the establishment of the DDBR, the White-tailed Eagle population started to recover in the Danube Delta and its surroundings. During this period, the number of breeding White-tailed Eagles pairs was estimated at 10-20 (BURFIELD & BOMMEL, 2004; CIOCHIA, 1992, 2001; DARÓCZI & ZEITZ, 2001; GÂSTESCU & ȘTIUCĂ, 2006; HAGEMEIJER & BLAIR, 1997; HEATH & EVANS, 2000; MUNTEANU et al., 1994, 2002,; MUNTEANU, 1998, 2009) in some years even falling to under 10 pairs. Some recent studies regarding the White-tailed Eagles from the DDBR and its surroundings have been made during the last few years in sub-subchapters in doctoral and dissertation papers, some of them being published (DOROȘENCU, 2011; POCORA & ION, 2005, 2006; POCORA, 2007; POCORA & POCORA, 2008; STANCIU, 2017) but a more comprehensive situation regarding the current nesting of this bird of prey within the Danube Delta Biosphere Reserve is dealt with in other recent papers (KISS et al., 2013, 2014; SÁNDOR et al., 2015).

MATERIAL AND METHODS

In the present study, the monitoring of White-tailed eagle pairs in the DDBR and the surroundings began in 2009 and was intensified starting with 2015. The number of nests varies from year to year. New nests appeared, others were destroyed by weathering or other causes. Identification of the White-tailed Eagle nests was carried out in two stages: the first was carried out during the winter period (December - March), when trees are bare of leave and the nests are visible - they can be observed even from a few kilometres, the second stage, was during the spring-summer period (from April to June), to investigate the nesting success of the White-tailed Eagles. Among the methods used to identify the White-tailed Eagle nests, we used the method of transects and fixed point (in the areas: Parcheş, Somova, Nufăru, Victoria, Baltenii de Sus, Enisala, Mandra forest (Agighiol) and Murighiol-Dunavăţ described in literature (BIBBY et al., 2000).

The effort for nest searching within the DDBR was particularly complex, especially as a rule, each pair of eagles builds several nests. The method used for locating the nests was to navigate the territory by boat on the DDBR canals and lakes. Thus, on a lake or in backwaters, the trees around the lake were scanned using binocular. When an adult bird was seen in a tree, the observer headed in the bird's direction by boat and started looking for the nest in a 300 meter radius. Usually, the adult bird (generally the male) was standing guard near the nest. This method has given good results and in this way a significant number of White-tailed Eagle nests were found.

A large part of the nests were located with the help of the ornithologists and the field workers of the Danube Delta National Institute for Research and Development (DDNIRD) and others were reported by the inspectors and the environment agents (rangers) of the Danube Delta Biosphere Reserve Authority (DDBRA) and the environment commissioners within the Danube Delta Biosphere Reserve Commissariat, but also with the help of the forestry engineers and technicians, who are assigned to on the territory of Tulcea County. At the same time, fishermen and locals from the study area were also involved, following the check of the nests by the author.

Vehicles were used for terrestrial routes and boats with engines ranging from 6 to 20 HP for aquatic routes. The identification of birds from a distance was done using optical instruments (binoculars and photo camera), from the Institute.

The GPS (Global Positioning System 62s) was used in order to locate the White-tailed Eagle nests as accurately as possible. Coordinates were taken at the tree or, where this wasn't possible, near it (maximum 100 m of nest), followed by coordinates correction using ArcGIS.

RESULTS AND DISCUSSION

The current distribution of White-tailed Eagle pairs is practically limited to the territory of the DDBR, with only two pairs located in the Babadag - Enisala and Mandra (Agighiol) forests in the western part of the DDBR (several areas from Northern Dobrogea were verified, where the species' nests have been reported previously, but currently they have not been found).

During the investigations conducted in the study area, in the 9 years of research, a total of 74 inhabited nests were registered, out of which 61 nests showed successful nesting and 193 chicks were recorded. The success of the nest is significantly influenced by a number of natural factors, as well as by the anthropic ones, even in this biosphere reserve. Therefore the mean reproductive rate for all the years was calculated to 1.2 chicks/nest (Table 1). In contrast, at the beginning of the 20th century in Romania, especially in the Danube Delta, after a suvey of 208 nests, the result was a mean of 1.955 eggs or chicks per nest (DOMBROWSKI, 1912). We do not have a mean number of eggs, lacking the actual data for Northern Dobrogea, but there is some information on the number of hatched and juvenile chicks which left the nest. Among the more recent data, regarding nests on Letea between 2004 and 2009, for the 4 nests under observation an average of 1.93 chicks nest is indicated (POCORA & POCORA, 2008; POCORA, 2010). Our mean in the same area for a period of 9 years is 1.2 chicks/nest. Another study, that refers to the situation of the White-tailed Eagle pairs on the territory of the DDBR during 2009-2011, mentions that the nesting success rate was 1.37 chicks nest (SÁNDOR et al., 2015). In this respect, our mean of 1.2 chicks/nest can be considered as having values close to those described in the reference literature.

In Table 1 we present the nesting success of the White-tailed Eagles families monitored during 2009-2017 in DDBR and surroundings.

It should be noted that some of the monitored nests within the DDBR and its surroundings territory are over 9 years old. The literature states that a single White-tailed Eagle nest can be used for more than 20 years.

Table 2 shows the number of inhabited and used nests and the nesting success, as well as the mean number of chicks from the successfully used nests between 2009 and 2017, from the study area.

Table 1. The number of White-tailed Eagle chicks (*Haliaeetus albicilla*) in the DDBR and its surroundings (Romania), which left the nest during 2009-2017 (n = 61).

No. crt.	Location of nest	No. of chicks /year									Total
		2009	2010	2011	2012	2013	2014	2015	2016	2017	
1	Partizani, north shore, Mile 33	2		1		1	1		1		6
2	Huntea S (Şontea Nouă area)	2									2
3	Grindul Cabanei (Ilganii de Sus area)				1	1	1			2	5
4	Lake Ulasova 1	1	1								2
5	Huntea N (Şontea Nouă area)	2	1					1			4
6	Head Cosburun (Holbina Gulf)							1			1
7	Periteasca Mica (between Goloviţa and Zmeica)				1	2	2	1	1	2	9
8	Lake Zmeica									2	2
9	Crişan, Torba Goală V (Incinta Ceamurlia)							1			1
10	Crişan, Torba Goală E (Incinta Ceamurlia)							1	1	1	3
11	Letea, forest margin 1	1	2		1	1	1	1			7
12	Letea, forest margin 2								1	1	2
13	Letea, Haşmacul lui Bercea	1	1	1							3
14	Letea, Haşmacul lui Bercea 2				1	1	1		1	1	5
15	Letea, Târla Popii	1		2	1	2	1	2	1	1	11
16	Letea, Cardon, Schitu area	1	1	1	1	2					6
17	Letea, Cardon, Schitu 2 area						1	1	2	2	6
18	Păpădia Veche-Şontea	2									2
19	Lake Argintiu	1				1	1	1			4
20	Lake Roşca N									1	1
21	Martinca, west shore	1								1	2
22	Pădurea Babadag, Dealul Cartalului			1	1	1	1	1	1	2	8
23	Pădurea Mandra (Agighiol)									2	2
24	Channel Taranova		2			1	2	2	2	2	11
25	Lake Merheiul Mare V		1		1	1	1	1	1	1	7
26	Pisceanei S-Arhipenco - L. Alb			2							2
27	Lake Văcaru									1	1
28	Iulia Mile 22 - 2									2	2
29	Sf. Gheorghe, cherhana 1				1	1	1		1	1	5
30	Channel Ciobănică Nou			2							2
31	Lake Leahova Mare			1	1	1	1	1	1	1	7
32	Channel Palade			1							1
33	Mile 5 Sud (br. Sulina)						1		1	1	3
34	Lake Ulasova 2							1			1
35	Channel Călugăr 1 (area L. Parcheş)					1			1	1	3
36	Channel Letieni						1	1			2
37	Sf. Gheorghe plantation N-V							1	1		2
38	Lake Nebunu E				1	1	2	1	2	2	9
39	Scaunele (Gârla Şontea)				1	1		1	1	1	5
40	Lake Obretinul Mic V							1			1
41	Lake Obretinul Mic E							1			1
42	Lake Trei Iezere						1		1	1	3
43	Lake Oaia				1						1
44	Lake Macovei						1		1	1	3
45	Lake Cuzmintii Vest								1	1	2
46	Lake Gorgova E								1	1	2
47	Chilia Branch Km 5								1	1	2
48	Ostrovul Babina								1		1
49	Channel Lejai									1	1
50	Channel Ivancia									2	2
51	Sf. Gheorghe Branch Km 80									1	1
52	Bălteni de Jos N-V									2	2
53	Păpădia incintă, northeast part		2								2
54	Lake Meşterul N									1	1
55	Lake Meşteru 1			1							1
56	Channel Ciobănică 1							1			1
57	Corciovata 1 V (Păpădia Nouă area)		1								1
58	Lake Vătafu V					1	1		1	1	4
59	Channel Sfiştofca 1							1			1
60	Sf. Gheorghe Branch Km 65									2	2
61	Channel Candura– Stipoc (L. Băclăneştii area)							1			1
Total		**15**	**12**	**13**	**13**	**20**	**22**	**25**	**27**	**46**	**193**
Mean chicks/ successfully completed nesting		**1.36**	**1.33**	**1.3**	**1**	**1.17**	**1.15**	**1.08**	**1.12**	**1.35**	**1.2**

Table 2. The evolution of White-tailed Eagle (*Haliaeetus albicilla*) nesting success between 2009 and 2017, within the DDBR and its surroundings (Romania).

Years	No. of nests visited	No. of occupied nests	No. of alternative nests (feeding, rest, etc.)	No. of successfully completed nesting	Mean no. of chicks/ successfully completed nesting
2009	36	21	15	11	1.36
2010	43	21	22	9	1.33
2011	55	20	35	10	1.3
2012	71	25	46	13	1
2013	71	26	45	17	1.17
2014	71	31	40	19	1.15
2015	63	29	34	23	1.08
2016	64	34	30	24	1.12
2017	62	38	24	34	1.35

As shown in Fig. 1, from the total number of 61 nests where the breeding nesting was successfully completed between 2009 and 2017, 29 nests were used (and breeding was successfully completed) once, 8 were used twice, 7 three times, 4 four times, 5 five times, 4 six times, 3 were used seven times, and only 1 nest was used eight times.

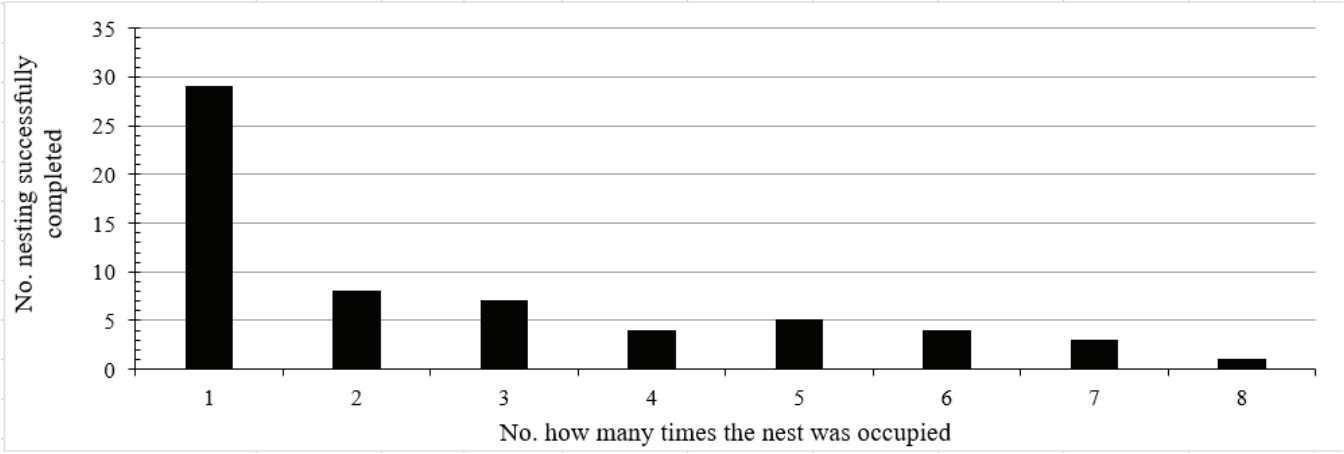

Figure 1. Numerical distribution of the White-tailed Eagle nests (*Haliaeetus albicilla*) where breeding was successfully completed in relation to the number of years in which the nest was used for breeding (n = 61), within the DDBR and its surroundings, from 2009 to 2017.

Thus, from a total of 61 nests successfully used for breeding during the above mentioned period, in 2009 the mean was 1.36 chicks/nest; in 2010 - 1.33 chicks/nest; in 2011 - 1.3 chicks/nest; in 2012 - 1 chick/nest; in 2013 - 1.17 chicks/nest; in 2014 - 1.15 chicks/nest; in 2015 - 1.08 chicks/nest; in 2016 - 1.12 chicks/nest, and in 2017 - the mean was 1.35 chicks/nest (Fig. 2).

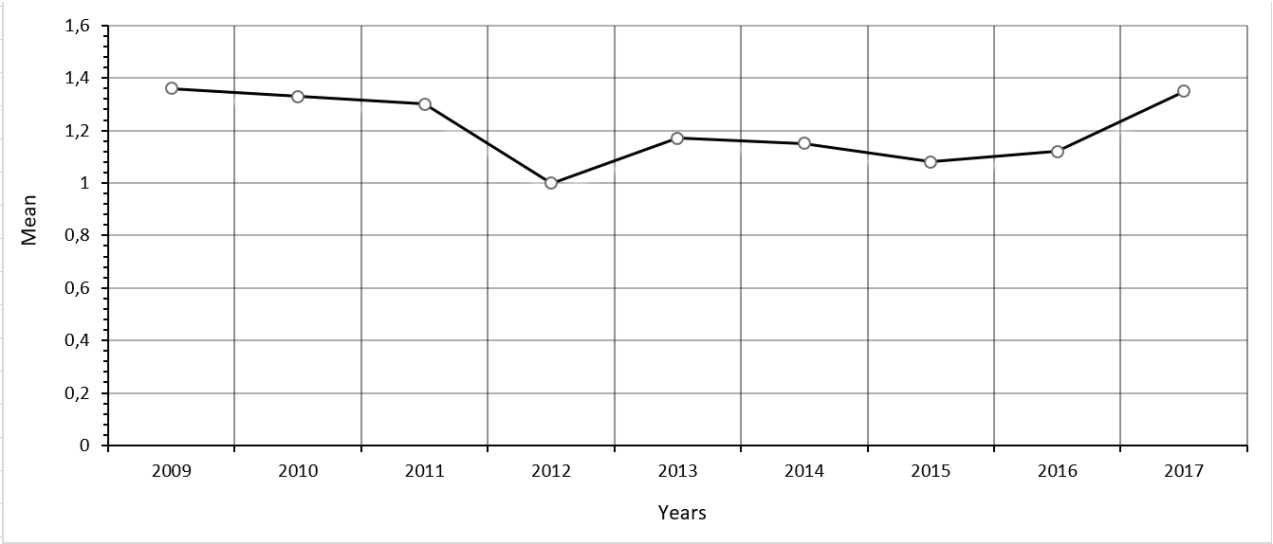

Figure 2. Annual mean of White-tailed Eagles' chicks per nest (*Haliaeetus albicilla*) (n = 61) in the DDBR and its surroundings (Romania) between 2009 and 2017.

Even after they leave the nest, the chicks stay for 1-2 months in the vicinity of their parents, learning hunting techniques. During this time, the White-tailed Eagle families with chicks can be observed around large colonies in the delta, feeding with other species' chicks still not fully confident in their own wings. Similar concentrations of White-tailed Eagles have been observed in the bird colonies of Purcelu, Nebunu, Martinca, Rosca-Buhaiova. The chicks become completely independent, capturing-food themselves, at the age of 95-100 days (BAUER & BERTHOLD, 1996; BEZZEL, 1985; CIOCHIA, 1992; LINTIA, 1954; ROSETTI-BĂLĂNESCU, 1957; PUŞCARIU, 1968; unpublished information).

In Fig. 3 we present the situation of the nesting effectiveness trend and that of the White-tailed Eagle chicks in the DDBR and its surroundings from 2009 to 2017.

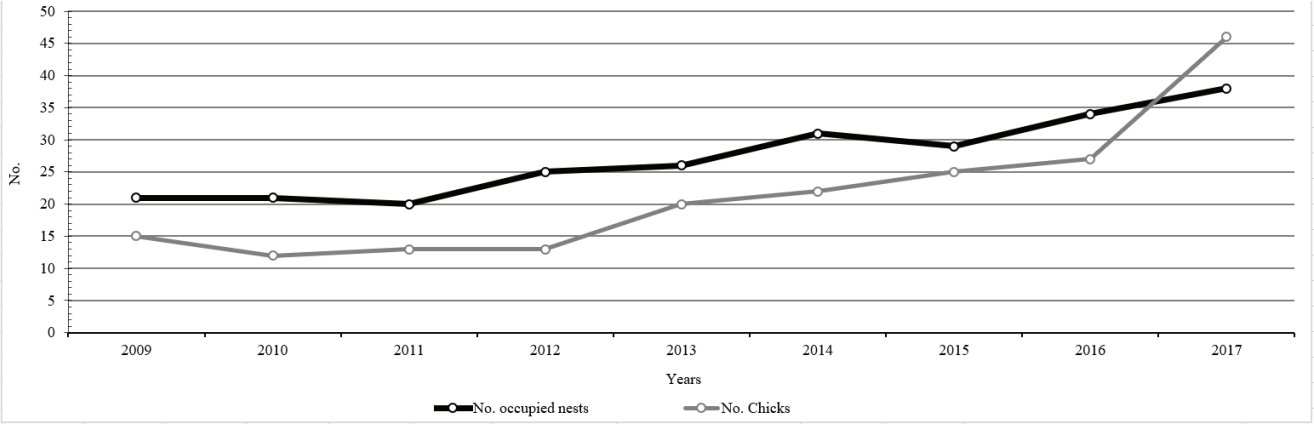

Figure 3. The trend of White-tailed Eagle (*Haliaeetus albicilla*) effectiveness in the DDBR and its surroundings from 2009 to 2017.

As can be seen in Fig. 3, the population has a slightly increasing trend over the years. Similar situation was also found in Hungary (HORVÁTH, 2007; HORVÁTH & PINTÉR, 2005).

As we have seen, the situation of the nest of the species in question is dynamic, in constant change. Considering the role of emblematic species on the territory of DDBR of White-tailed Eagle, we consider it necessary to continue the monitoring of the herds and the transmission of the results to other institutions, especially to DDBRA and forestry institutions. The presence of the nest support trees must be taken into account both in the regulations issued by the DDBRA and in the elaboration of the forest planning plans, which are found on the forestry background.

CONCLUSIONS

From the data presented above, it appears that the White-tailed Eagle population within the DDBR is increasing slightly. Limiting factors to population growth may be natural or anthropogenic.

At the moment, the anthropogenic factors that are damaging White-tailed Eagle nests in DDBR are disturbance by fishermen during the White-tailed Eagle's breeding period, the construction of fishing huts near nests, fires caused by locals, shooting at the nest during the hatching period etc., which adds to the ones caused by natural factors (falling of trees or branches which support the nest, strong winds throughout the year, rain and snow fall).

As a result of the observations regarding the nesting of White-tailed Eagle on the territory of RBDD, we consider it necessary to monitor the flocks and further.

Nesting site information has to be communicated to institutions, ARBDD and forestry.

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THE WARM WINTER OF 2017-2018 FROM SOUTH-WESTERN ROMANIA IN THE CONTEXT OF CLIMATIC CHANGES

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Abstract. The winter of 2017-2018 was warmer than normal, with a general average of 1.5°C for the area below 600 m altitude. December 2017 was warm with the general average calculated for the whole region of 2.7°C and the deviation from normal of 2.5 ° C. Winter was marked by warm months, February with average for the entire region of 0.9°C. The statistical analysis of monthly temperature averages for the last winter month revealed a significant increasing linear trend. In December, there were three hot weather intervals: 7-9 December, 12-16 December and 24-29 December 2017 (totalling 14 days). The most intense heat wave of winter was between 24-29 December and the monthly thermal peaks for December were recorded on 25 December. January was warmer than normal and two intervals with temperatures much higher than normal were recorded: 1-8 January and 29-31 January, summing up to 11 days. Monthly thermal peaks were recorded in 30 January. In February, the weather kept warm during 1-24 February, and a moderate heat wave was recorded. Climate heating over the past 58 years is also well underlined for February. Analysis of the calculated temperature averages for the whole region shows the decrease in the intensity of the February cold waves and a significant upward trend of this parameter chart for the past 58 years. The warm winter had important impacts on biotopes, crops, and fruit trees, resulting in an early spring.

Keywords: monthly temperature averages, Hellmann criterion, hot winter phenomena, heat waves, vegetative processes.

Rezumat. Iarna caldă 2017-2018 în sud-vestul României în contextul schimbărilor climatice. Iarna 2017-2018 a fost mai caldă decât normal, cu media generală de 1.5°C pentru arealul cu altitudinea sub 600 m. Luna decembrie 2017 a fost caldă cu media generală calculată pentru întreaga regiune de 2.7°C şi abaterea faţă de normală de 2.5°C. Iarna a fost marcată de toate lunile calde. Luna februarie cu media pentru întreaga regiune de 0.9°C. Analiza statististică a mediilor lunare de temperatură pentru ultima lună de iarnă a relevat un trend liniar semnificativ crescător. În decembrie, s-au înregistrat trei intervale cu vreme caldă: 7-9.XII, 12-16.XII şi 24-29.XII.2017 (însumând 14 zile). Cel mai intens val de căldură al iernii fost între 24-29.XII, iar maximele termice lunare pentru decembrie s-a înregistrat în data de 25.XII. Luna ianuarie a fost mai caldă decât normal şi s-au înregistrat două intervale cu temperaturi mult mai mari decât normalele corespunzătoare: 1-8.I şi 29-31.I însumând 11 zile. Maximele termice lunare s-au înregistrat în data de 30.I. În luna februarie vremea s-a menţinut caldă în intervalul 1-24.II şi un val moderat de căldură s-a înregistrat. Încălzirea climatică în ultimii 58 de ani este bine pusă în evidenţă şi pentru luna februarie. Analiza mediilor de temperatură calculate pentru întreaga regiune arată scăderea intensităţii valurilor de frig din luna februaurie şi o tendinţă crescătoare bine marcată a graficului acestui parametru pentru ultimii 58 de ani. Iarna caldă a avut afecte importante în cadrul biotopurilor, culturilor agricole şi pomilor fructiferi determinând premisele împrimăvărării timpurii.

Cuvinte cheie: medii lunare de temperatură, criteriul Hellmann, fenomene de iarnă caldă, valuri de frig, procese vegetative.

INTRODUCTION

Hot weather prevailed throughout 2017 except in January. The warm winter of 2017-2018 is actually a prolongation of the warm weather in 2017. *The year 2015 achieved the first global climatic record of ≥ 1.0°C above the global average of the last century and the entire period of observations from 1880-1899*. At the end of 2015 it was estimated that an average of more than 1.0°C for global average temperature will not be recorded soon. Climate developments in 2016 outweighed this hope as the global average temperature in 2016 exceeded the average of the last century by 1.03°C (http://www.ziaruldevrancea.ro/international/1588839218-temperatures-globals-au-atins-a-level record-in-2016.html, http://www.click.ro/news/national/ianuarie-2017-fost-al-treilea-cel-mai-cald-ianuarie-din-istorie). The year 2017 was ranked among the top three hottest years, achieving a true global warming record, with solar activity at its minimum and in the absence of the El Nino climatic process, being the hottest under these conditions. "*Even if we do not take into account the warming caused by the El Nino phenomenon, 2016 remains the warmest year in modern history*," according to Professor Piers Forster, director of the Priestley International Center for Climatology, affiliated with Leeds University in the UK. The year 2017 was the world's second warmest in the history of weather records, surpassing only 2016 (European Union Monitoring Center, quoted by Reuters). The Copernicus Climate Change Monitoring Program, the world's first major international meteorological agency to issue a report on global temperatures of 2017, announced that it was on average 14.7°C or 1.2°C above the preindustrial period. The year 2017 ,,was slightly cooler than the warmest year in record history, 2016, and warmer than the second hottest year previously set in 2015". (https://www.agerpres.ro/planeta/2018/01/04/2017-al-doilea-cel-mai-cald-an-din-istoria-inregistrarilor-meteorologice-dupa-2016-copernicus--31021) Globally, in the winter months of 2017-2018, average temperature deviations from the last century were positive across Atlantic to Pacific (Eurasia), and Siberia was warmer than the northern continent of America. At a regional level, in Romania, ***January 2018 was the warmest in the history of the National Meteorological Administration*** (Roxana Bojariu - Head of Climatology Laboratory NMA) (http://jurnalul.ro/stiri/vremea/luna-ianuarie-2018-cea-mai-calda-din-istoria-anm-765139.html).

This paper is part of a series of extensive studies on climate variability in the southwest of the country and the effects of climate warming, being useful to all those interested in climate developments in this part of Romania (BOGDAN et al., 2008; MARINICĂ & CHIMIŞLIU, 2008; BOGDAN & MARINICĂ, 2009; BOGDAN et al., 2010, 2014; MARINICĂ et al., 2010, 2011, 2012, 2013, 2016.

We will further analyse this exceptional climatic variability at regional level of Oltenia and its consequences on the agricultural crops, biotopes, the economy and the environment in general, characterizing the winter of 2017-2018.

MATERIAL AND METHOD

For this study I used the results of the daily data, processed with special software from the weather forecasting, the data archive of the NAM, the maps obtained in the operative activity, the ones from the internet provided by the international analysis and forecast centers and the NMA[1] Bucharest. We have used Office features to draw up tables and charts.

The paper analyses the climatic variability of the warm winter 2017-2018 in the southwest of Romania, based on the thermal and pluviometric regime of December 2017, January and February 2018 and the overall thermal and pluviometric regime of winter 2017-2018. The effects on the environment and biotopes were also analysed.

RESULTS

1a. Thermal regime of December 2017

Monthly air temperature averages ranged from 0.1°C in the Voineasa intracarpathian depression to 4.3°C in the extreme west at Drobeta Turnu Severin. Their deviations from normal were between 1.4°C in the Subcarpathian depression at Apa Neagră and 3.4°C in Caracal, leading to the classification of warm thermal (W) types in most part of Oltenia (Table 1). Warmish time (WS) was recorded on a restricted area in the Gorj Subcarpathians.

Table 1. Air temperature regime in Oltenia and minimum and maximum surface temperature in December 2017 (NXII = December normal for the period 1901-1990, MXII = monthly averages of December 2017, Δ = M-N = temperature deviation, CH = Hellmann criterion).

No	Meteorological Station	Hm	NXII	MXII	Δ=M-N	CH	air maxT		air minT		soil maxT		soil minT	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr. Tr. Severin	77	1.4	**4.3**	2.9	W	16.5	25	**-3.2**	31	**18.7**	25	-6.4	21
2	Calafat	66	1.0	3.8	2.8	W	**18.9**	25	-4.1	11	16.8	8	**-2.1**	22
3	Bechet	65	0.4	3.3	2.9	W	17.5	16	-5.4	22	15.1	8	-4.0	23
4	Băileşti	56	0.4	2.9	2.5	W	15.9	25	-5.6	22	**18.7**	25	-4.5	22
5	Caracal	112	-0.1	3.3	**3.4**	W	14.9	25	-5.7	22	11.1	25	-2.7	22;23
6	Craiova	190	0.1	3.2	3.1	W	15.7	25	-6.5	22	15.6	14	-6.2	22
7	Slatina	165	0.3	2.9	2.6	W	14.8	25	-6.9	22	*8.7*	14	-4.2	24
8	Bâcleş	309	-0.4	2.9	3.3	W	14.3	25	-6.9	22	-	-	-	-
9	Tg. Logreşti	262	0.1	2.1	2.0	W	16.3	25	-9.0	22	16.5	7	-6.8	8
10	Drăgăşani	280	0.6	3.6	3.0	W	16.3	25	-7.2	22	10.1	14	-3.0	22
11	Apa Neagră	250	0.1	1.5	***1.4***	WS	14.2	25	-7.3	23	11.2	29	-5.2	24
12	Tg. Jiu	210	0.1	1.7	1.6	WS	16.4	25	-7.0	22	13.6	29	-4.8	23;24
13	Polovragi	546	0.1	2.4	2.3	W	17.1	25	-8.0	22	16.4	12	***-10.9***	22
14	Rm. Vâlcea	243	0.5	2.9	2.4	W	15.6	25	-7.5	22	11.2	26	-5.0	22
15	Voineasa	587	-1.9	***0.1***	2.0	W	*12.7*	25	***-10.0***	22	-	-	-	-
16	Parâng	1585	-3.7	-	-	-	8.3	12	-14.5	21	-	-	-	-
17	Mean Oltenia	-	0.2	2.7	2.5	W	15.3		-7.2		14.1	-	-5.1	-
18	Ob. Lotrului	1404	-4.9	-3.3	1.6	WS	5.0	25	-16.0	20	-	-	-	-

(Source: processed data from the NMA Archive)

The monthly average air temperature, calculated for the entire Oltenia region (with an altitude below 600 m) was 2.7°C, and its deviation from normal was 2.5°C, confirming that on average December 2017 was warm (W).

Monthly air temperature minima were recorded at 22 December and were -10.0°C (recorded in 22 December) at Voineasa and -3.2°C at Drobeta Turnu Severin registered on 31 December 2017. The coldest morning was recorded on 22 December 2017 with the average for the whole region of -7.0°C, and the December-specific thermal regime was installed only on 31 December 2016. *The frost units*[2] in December 2017 were insignificant and ranged from 0.0 at

[1] NMA = National Meteorological Administration Bucharest.

[2] ***The degree of winter bitterness*** in agrometeorology (winter type) is classified according to the sum of the agrometeorological frost units (∑ of the differences between the daily minimum temperature values <-15°C and the agro-climatic critical threshold of -15.0°C in the XII-II interval) . ***Thus an agrometeorological frost unit is the difference of 1°C between the critical threshold of -15.0°C and a minimum thermal in air ≤ -1°C*** (for example for T min = -16.0°C then the difference -15.0°C - (-16.0°C) = 1, i.e. a unit of frost, (SANDU, MATEESCU, VĂTĂMANU, 2010) ***The Frost units for the whole cold season*** are calculated as ∑ average daily temperatures ≤ 0°C, between November and March. ***A cold day*** is the day when the average temperature is ≤ 0°C ***The active temperatures are ≥0°C*** and the biological minimum temperature is 0°C. It is called the winter day when the maximum air temperature is <0°C. ***Heat Units*** (∑ Daily average temperatures ≥ 0°C). For weather forecasts and diagnosis for the public, mean a temperature of ≤ -10.0°C. From the point of view of weather forecast, for people, the notion *'frost' means temperature values of ≤ -10°C*. Therefore

Drobeta Turnu Severin and 28.0 at Voineasa, and their average for the entire Oltenia region was 7.9. *The agro-meteorological frost* was not recorded. Cool weather in December fell into normal processes, and cold wave was recorded. *Heat units* ranged between 31.8 at Voineasa and 133.9 at Drobeta Turnu Severin, and their average for the whole region was 92.4, meaning a major difference between heat and frost units, ie an agrometeorological warm month. They have contributed to vegetative processes in autumn crops and generally in vegetal carpet and biotic processes in biocenoses[3]. Adaptation of plants from autumn crops to slow vegetative processes and induction of vegetative rest (preparation for wintering) was done slowly throughout December and January. *The maximum monthly temperature values* recorded the most on 25 December and were between 12.7°C at Voineasa and 18.9°C at Calafat, and their average for the whole region was 15.3°C. For 14 days in 7-9 December, 12-16 December and 24-29 December, moderate heat waves were recorded. Daily temperatures kept positive all day, combined with sunny days, keeping biotopes and vegetative processes active.

The air temperature variation chart in December 2017 shows slightly increasing trends for maximum values and slightly decreasing for average and minimum values due to the slow cooling of the weather produced mainly after 26 December (Fig. 1).

The hottest day of December 2017, according to the average temperature maxima for the whole region was 25 December, when the average for the whole region was 15.0°C, and *the coldest day* was 22 December with an average of -2.5°C. From a thermal point of view, there was no winter day, and in the mountain area only 14 days were registered in Parâng.

At the soil surface, *the minimum temperatures* were recorded most in the 21-24 December period, as well as those of the air, and were between -10.9°C at Polovragi and -2.1°C at Calafat, with the average for the whole region of -5.1°C. The processes of freeze-thaw and surface thaw have occurred since 5 December.

Maximum soil surface temperatures were recorded mostly in the period 14-29 December and ranged between 8.4°C at Slatina and 18.7°C at Băileşti and Dr. Tr. Severin and their average for the entire region was 14.1°C. At the surface of the soil, the December-specific thermal regime installed as early as 31 December.

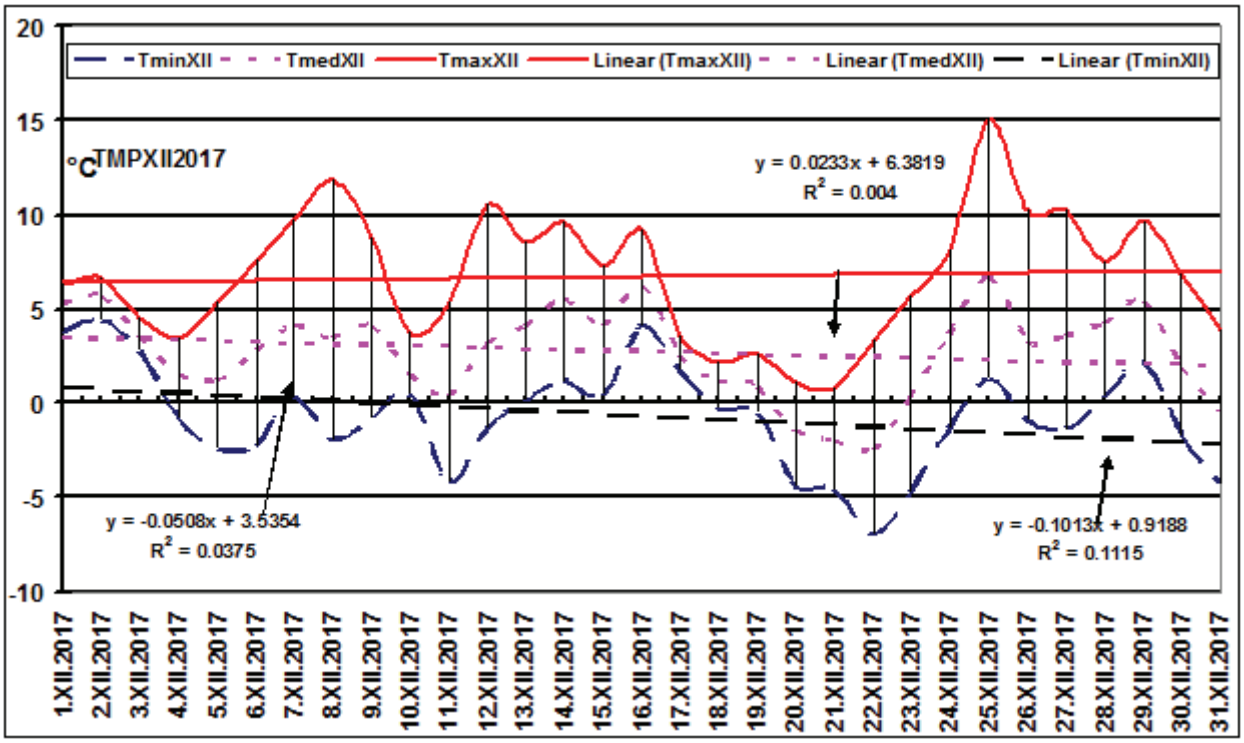

Figure 1. Air temperature variation (average daily minimum, daily average and average maximum daily) in December 2017. (Source: processed data from the NMA Archive).

the term *frost* defined by weather forecast (which are adapted to living organisms) is different from *agrometeorological frost* (temperatures of ≤ -15°C), plants being better adapted to climatic conditions (due to their cellular structure and specific biotic processes).

[3] The term ***biocenosis*** (from the Greek koinosis – to share) is an over-individual level of organization of living matter and describes the totality of living, vegetal (*phytocenosis*) organisms and animals (*zoocenosis*) interacting with each other and living in a particular environment or sector from the biosphere (*biotope*), forming with it a unitary one and that is in a dynamic dynamically dependent on that medium. It is characterized by a certain structure and function given by the model of circulation of matter, energy and information. The term biocenosis was proposed by Karl Möbius in 1877 (http://en.wikipedia.org/wiki/Biocenoz%C4%83).

1.b. The pluviometric regime of December 2017

In December 2017, the *monthly rainfall values* were between 30.7 l/m^2 at Drăgăşani and 65.2 l/m^2 at Calafat, and in the Parâng mountain area 53.3 l/m^2. The percentage deviations from normal rainfall ranged from -33.3% at Apa Neagră to 45.7% at Bechet, leading to precipitation time ranges from very rainy (FP) to Southern Oltenia to very dry (FS) for the northern half of Oltenia, with the exception of the mountain area where the percentage deviation was -2.4%, ie normal (N) (Table 2). ***The average rainfall for the entire region*** was 46.0 l/m^2, and its percentage deviation from normal was -9.8%, which determines an average rainfall month (N) for the whole region. The crop plants did not suffer since the autumn of 2017 was rainy and the ground water reserve in the arable layer of 0-100 cm thick maintained optimal or close to optimal, the drought being only atmospheric[4].

Table 2. *Amounts of rainfalls[5] recorded in the winter of 2017-2018 (Σ),* compared to normal values (N); Δ% = percentage deviation from normal, CH = Hellmann's criterion.

No	Meteorological Station	Hm	December 2017				January 2018				February 2018			
			ΣXII	N	Δ%	CH	ΣI	N	Δ%	CH	ΣII	N	Δ%	CH
1	Dr. Tr. Severin	77	38.5	61.2	-37.1	VD	45.2	51.4	-12.1	LD	88.0	47.9	83.7	ER
2	Calafat	66	**65.2**	45.5	43.3	VR	***26.8***	40.4	-33.7	VD	83.6	38.0	120.0	ER
3	Bechet	65	52.9	36.3	**45.7**	VR	29.8	33.5	-11.0	LD	***66.7***	34.8	91.7	ER
4	Băileşti	56	53.6	46.8	14.5	LR	28.8	38.5	-25.2	D	74.5	36.1	106.4	ER
5	Caracal	112	49.0	39.5	24.1	R	38.9	34.7	12.1	LR	73.2	34.5	112.2	ER
6	Craiova	190	47.2	41.8	12.9	LR	32.6	37.5	-13.1	LD	81.6	30.4	**168.4**	ER
7	Slatina	165	41.4	42.8	-3.3	N	42.8	36.0	18.9	LR	73.9	38.4	92.4	ER
8	Bâcleş	309	31.8	54.7	***-41.9***	VD	9.1	50.5	-82.0	ED	-	-	-	-
9	Tg. Logreşti	262	36.0	44.8	-19.6	LD	37.0	35.9	3.0	N	75.6	41.0	84.4	ER
10	Drăgăşani	280	**30.7**	44.6	-31.2	VD	28.6	34.1	-16.1	LD	67.5	35.4	90.7	ER
11	Apa Neagră	250	54.9	82.3	-33.3	VD	**56.7**	70.9	-20.0	LD	**115.0**	66.4	73.2	ER
12	Tg. Jiu	210	46.3	64.0	-27.7	D	28.4	53.9	***-47.3***	VD	70.2	52.0	35.0	VR
13	Polovragi	546	60.9	56.1	8.6	N	42.0	48.9	-14.1	LD	81.9	48.4	69.2	ER
14	Rm. Vâlcea	243	42.2	46.2	-8.7	N	42.8	35.5	**20.6**	R	89.6	38.4	133.3	ER
15	Voineasa	587	**32.7**	55.1	-40.7	VD	***2.8***	42.7	***-93.4***	ED	-	-	-	-
16	Parâng	1585	53.3	54.6	-2.4	N	47.7	57.7	-17.3	LD	45.9	47.7	***-3.8***	N
17	Mean Oltenia	-	46.0	51.0	-9.8	N	33.8	43.9	-23.1	D	**77.7**	42.1	66.4	ER
18	Ob. Lotrului	1404	85.6				59.7				63.5	-	-	-

(Source: processed data from the NMA Archive)

2a. The thermal regime of January 2018

Monthly air temperature averages were between 1.7°C at Voineasa and 2.4°C at Drobeta Turnu Severin, and their deviations from normal were between 2.0°C at Apa Neagră in the area of Subcarpathian depressions and 4.0°C at Craiova and Bâcleş, determining classifications of warm months (W) types throughout Oltenia (Table 3).

Table 3. Air temperature regime in Oltenia and minimum and maximum temperature at ground level in January 2018. (N = normal values calculated for the 1901-1990 interval, M = monthly average values in January 2018, CH = Hellmann criterion).

No	Meteorological Station	Hm	N I	M I	Δ=M-N	CH	Tmax aer		Tmin aer		Tmax sol		Tmin sol	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr. Tr. Severin	77	-1.1	**2.4**	3.5	W	15.1	30	**-6.3**	17	**23.2**	30	-8.2	26
2	Calafat	66	-1.8	1.7	3.5	W	**16.7**	30	-8.0	17	18.9	30	-8.2	25
3	Bechet	65	-2.2	1.1	3.3	W	16.4	30	-9.8	17	14.5	31	**-8.0**	17
4	Băileşi	56	-2.3	0.9	3.2	W	14.7	30	-8.1	17	19.5	1	-9.6	17
5	Caracal	112	-2.9	1.0	3.9	W	13.7	30	-8.9	25	11.3	31	-10.0	25
6	Craiova	190	-2.6	1.4	**4.0**	W	15.0	30	-8.4	25	17.3	7	-9.0	28
7	Slatina	165	-2.4	0.7	3.1	W	14.9	30	-11.5	25	***8.6***	30	-14.7	25
8	Bâleş	309	-3.0	1.0	**4.0**	W	13.4	30	-8.9	17	-	-	-	-
9	Tg. Logreşti	262	-2.7	0.8	3.5	W	15.2	30	-10.0	17	15.0	7	-10.4	17
10	Drăgăşani	280	-2.2	1.6	3.8	W	16.2	30	-8.6	16	15.2	29	-8.4	25
11	Apa Neagră	250	-2.6	-0.6	***2.0***	W	14.7	30	***-15.1***	16	14.3	7	-14.0	26
12	Tg. Jiu	210	-2.6	0.7	3.3	W	16.1	30	-9.2	16	16.2	7	-9.6	19
13	Polovragi	546	-3.2	0.4	3.6	W	13.6	30	-11.7	16	17.2	29	***-15.9***	17
14	Rm. Vâlcea	243	-2.2	1.4	3.6	W	16.3	30	-10.0	16	15.6	30	-7.0	17
15	Voineasa	587	-4.7	***-1.7***	3.0	W	***10.3***	30	-13.3	24	-	-	-	-
16	Parâng	1585	-	-	-	-	10.5	6	-14.5	15	-	-	-	-
17	Media Oltenia	-	-2.6	0.8	3.4	W	14.6		-10.1	-	15.9	-	-10.2	-
18	Ob. Lotrului	1404	-6.2	-4.1	2.1	W	8.9	26	-21.3	24	-	-	-	-

(Source: processed data from the NMA Archive)

[4] ***The Hellmann criterion*** is very useful for determining the types of pluviometric time and only refers to the amounts of precipitations that are fallen, so useful for determining ***atmospheric drought and excess rainfall***. ***The soil drought*** is determined using criteria that use the ***ground water reserve.***

[5] The Voineasa and Bâcleş Weather Stations because they have incomplete data, can not be taken into account nor discussed, are listed in the indicative table of these.

The monthly average air temperature for the whole region was 0.8°C, and the deviation from this normal was 3.4°C, which determines an average warm month (W) for the whole region. This overall monthly average (0.8°C) shows that January 2018 was the warmest month of the last 58 years, in decreasing order of overall temperature averages. The warmest eight months of January, over the past 58 years, were recorded in the years: ***2007*** (VW, average 4.73°C), ***1983*** (VW, average 2.62°C), ***1994*** (W, average of 1.21°C), ***1984*** (W, average of 0.96°C), ***2015*** (W, average of 0.83°C), ***2018*** (W, average of 0.80°C). ***January 2007 was the warmest winter month in all climatic data, surpassing with 2.11°C*** (almost twice) the average of the hottest ***January of the 20th century (1983), and the only January very warm (VW).***

Thus, ***in the 20th century, there was only one very warm January month (1983) which was exceeded in 2007 during the 2006-2007 Mediterranean winter with an almost double average, which indicates an increase in the climatic warming during the winter peak***. In the last 58 years (1961-2018), ***most January months were warm***, 28 cases (i.e. 48.2%), there were 19 cases of normal months (i.e. 32.8%) and with cold months - the lowest - 11 (i.e. 19.0%). The growth trend of the average monthly temperature calculated for the whole region is evidenced by a significant increase coefficient (0.0356). As a result of the increase in the average monthly temperature, the frequency, duration and intensity of cold waves in January decreased. ***Only two months of January were very warm (VW): January 1983 with an average of 2.62°C and January 2007 with a general average of 4.73°C*** (at a difference of only 0.27°C compared to an excessively warm month). As a result, climatic warming is evident even in January, which is the peak of winter In January 2018, *the frost units* registered mostly in the intervals 14-17 January and 23-28 January (totalling 10 days) and were between 19.5 at Drobeta Turnu Severin and 69.7 at Voineasa, and the average for the entire region it was 39.0, which means a mild winter month from an agrometeorological point of view. *Heat units* were significant and ranged between 16.9 at Voineasa and 93.6 at Drobeta Turnu Severin, with the average for the entire region of 64.8 surpassing the cold ones.

Monthly minimum air temperature values were recorded, most in the interval 16-25 January and were between -15.1°C at Apa Neagră and -6.3°C at Drobeta Turnu Severin, and their average for the whole region was -10.1°C. There *were two cooling periods,* between 14-17 January and 23-28 January, the duration of which amounted to 10 days. *The coldest mornings* were recorded in 16 January and 25 January, with the average for the entire region of -8.8°C, the days when the winter cold reached its peak. At 20 am, the temperature averages for the entire region were ≥ 0°C.

No agro-meteorological frost was recorded, only totally isolated in a single morning in the Subcarpathian area. *The amplitude of the air temperature* variation in January ranged from 22.3°C at Bâcleș and 29.8°C at Apa Neagră, and *for the whole region the maximum amplitude* was 31.8°C.

The maximum monthly temperature values were recorded in 30 January, when the daily maxima average for the whole region was 14.6°C, being the highest in January. Monthly thermal peaks were between 10.3°C at Voineasa and 16.7°C at Calafat, and their average for the whole region was 14.6°C.

The air temperature variation chart in January 2018 shows slightly decreasing trends for all three analysed parameters (daily minimum, daily average and daily peak) (Fig. 2). *A weak heat wave* with a duration of 6 days was recorded between 29 January - 3 February. At the surface of the soil, the minimum monthly temperature were recorded, ranging from 17-26°C, ranging from -15.9°C to Polovragi and -8.0°C at Bechet, and their average for the whole region was -10.2°C. As a result, at the soil surface in the range 14-31 January, frost / thaw alternations occurred. The value of -15.9°C, recorded at Polovragi, is the thermal minimum of the winter 2017-2018 at the surface of the soil.

The maximum temperature at the surface of the soil was recorded for the most part, in the range 29-31 January and was between 8.6°C at Slatina and 23.2°C at Drobeta Turnu Severin, and their average for the whole region was 15.9°C.

2.b. The rainfall regime of January 2018

The monthly rainfall values ranged between 26.8 l/m^2 at Calafat and 56.7 l/m^2 at Apa Neagră, and their percentage deviations from normal were between -47.3% at Tg. Jiu and 20.6% at Râmnicu Vâlcea, leading to the classification of the rainfall time types from very dry (VD) in the southwest of the region and some areas from Subcarpathian up to rainy (LR) in a restricted area in the Romanati Plain to Caracal and in the Olt River Corridor (Table 2). As a result, dry weather prevailed. *The average monthly precipitation* calculated for the entire region was 37.7 l/m^2, and its deviation from normal was -14.0%, resulting in slightly dry (LD) climate. In January there were three intervals with generally weak rainfalls: 2 January, 9-17 January and 19-23 January, and among them in one day of the last interval rainfalls were significant for agricultural crops. At first the precipitation was in the form of rain then turned into snow and a snow layer formed, starting with 14 January, which reached the maximum thickness in different data, disappeared in 19-21 January and was rebuilt in some areas between 22-25 January and then gradually melted. *The maximum thickness of the snow layer* in January was 7 cm at Calafat on 16th, Râmnicu Vâlcea in 17 January and Tg. Logreşti in 22 January and 22 cm in the Subcarpathian depressions at Apa Neagră on the 18th, and in the mountain 73 cm at Parâng and 76 cm at Obârşia Lotrului. The maximum thickness of the snow layer as well as the maximum extension was recorded on 28 February, 08 hours after ***the late winter episode*** (Fig. 3). Due to the warm weather, the snow layer lasted a few days in January, and due to compaction and slow melting it gradually decreased in thickness until disappearance. It has achieved good protection for crops in the respective intervals. *The duration of the snow layer* was between 4 days in Calafat and 18 days in the Apa Neagră. The melting of the snow layer occurred in the range 26-31.

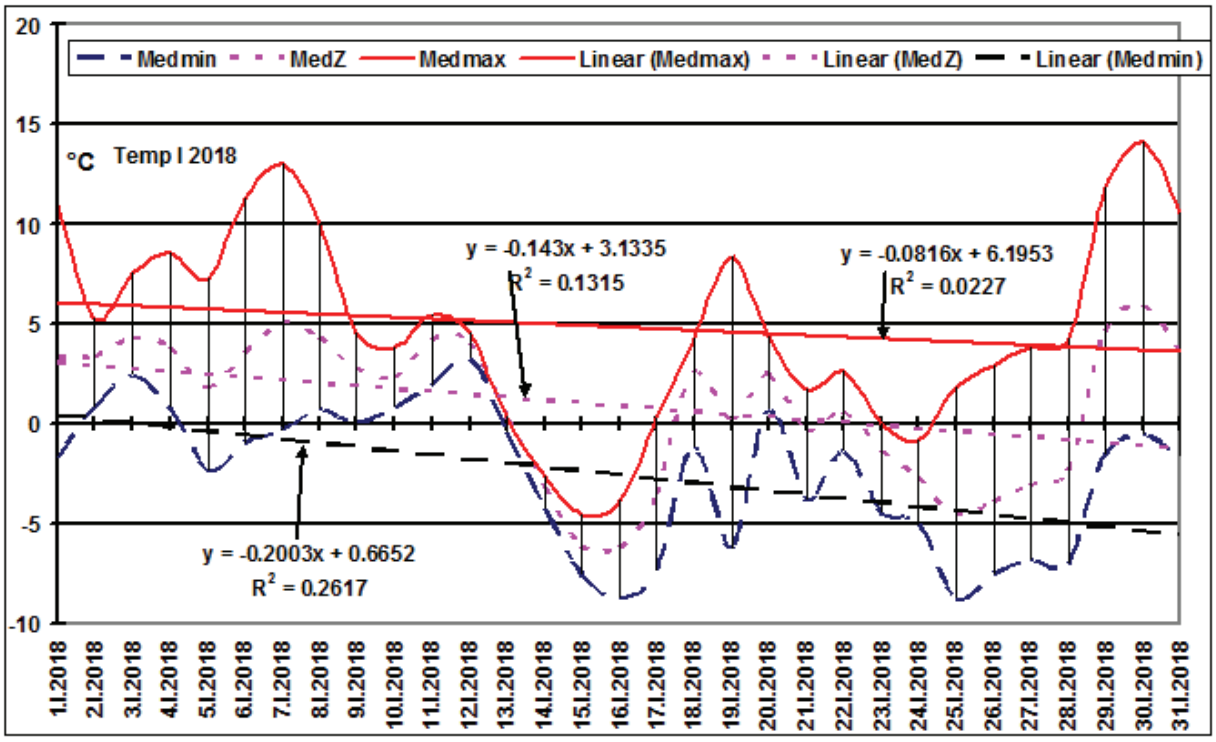

Figure 2. Air temperature variation (average daily minimum, daily average and average maximum daily) in January 2018. (Source: processed data from the NMA Archive).

3a. The thermal regime from February 2018

The statistical data on climate shows that in February, between 1901-1990 (averages considered normal values), *the average monthly temperature increases* compared to the second winter month – January, are between 1.8°C at Polovragi and 2.2°C at Calafat, Băileşti, Caracal, Craiova, Slatina, Târgu Jiu, Râmnicu Vâlcea and Voineasa, and the increase in the monthly average for the entire region is 2.0°C, ***being the first increase in the average monthly temperature during the year***, thus initiating the climatic process of spring arrival[6]. The overall average for the whole region is -0.8°C, recording a 2.0°C increase over January, being the lowest monthly increase over the course of the year. ***February 2016 was the warmest in the history of weather observations with a mean average of 6.04°C, and the monthly average in 2016 was between 3.0°C at Voineasa and 7.3°C by Drobeta Turnu Severin*** (MARINICĂ & MARINICĂ, 2016).

The coldest February in the last 58 years has been recorded in the years: ***1985*** (FR, average -5.95°C), ***2012*** (R, average -5.40°C), ***2003*** (R, with average -4.27°C), ***1965*** (R, with a mean of -3.63°C), ***1986*** (R, with a mean of -3.16°C), ***1976*** (R, with a mean of -3.08°C). ***February 1985 was the coldest winter month of the 20th Century, with the very cold month classification (FR), according to the soil temperature values*** (MARINICĂ & MARINICĂ, 2016). As a result, ***only a very cold February month (1985) was recorded in the 20th century*** (Table 4). ***The warmest February in the past 58 years*** was recorded in the years: 2016 (FC, with an average of 6.04°C), 2002 (FC, with an average of 5.93°C), 1995 (FC, with an average of 4.73°C), 1966 (FC, with an average of 4.63°C), 1977 (C, with an average of 4.40°C), 1990 (C, with an average of 3.81°C) and 1988 (C, with an average of 3.40°C). Most of the February months were hot, 31 cases (53.4%), the normal ones were the lowest, 12 cases (20.7%), and the cold months - 15 (i.e. 25.9%, i.e. less than half of the warm months). Results that in February the number of very warm months was double that of January. The growth trend of the average monthly temperature calculated for the entire region over the past 58 years is evident, with a significant growth rate (0.0283) (Fig. 4). February 2016 was the hottest winter end month (Table 4). The average February temperature, calculated for the entire region over the last 58 years, was 0.49°C, with an increase of 0.95°C over the period 1901-1990[7] (more than double that period). Most February warm months have been registered since 1988, 74.2%, which shows the acceleration of the heating process in February. As a result of the increase in the average monthly temperature, the frequency, duration and intensity of cold waves in February declined considerably. Climate warming is also demonstrated at a regional level in February, and the continuation of this climate process in 2017 and 2018 occurred ***under the conditions of the minimum solar activity and in the absence of the El Niño climate process***.

[6] *Spring day = a day with average temp. ≥ 0°C.*

[7] It is irrelevant to compare permanently with the averages of the last 30 years (as they are normal values) because the latter also increase with the sliding of the average for the next 10 years and, as a result, the comparison with these sliding averages fades the actual increase compared to the last century, lower and thus diminishing the true magnitude of climate warming. In addition, the study methodology changes once every 10 years and therefore the results are no longer comparable.

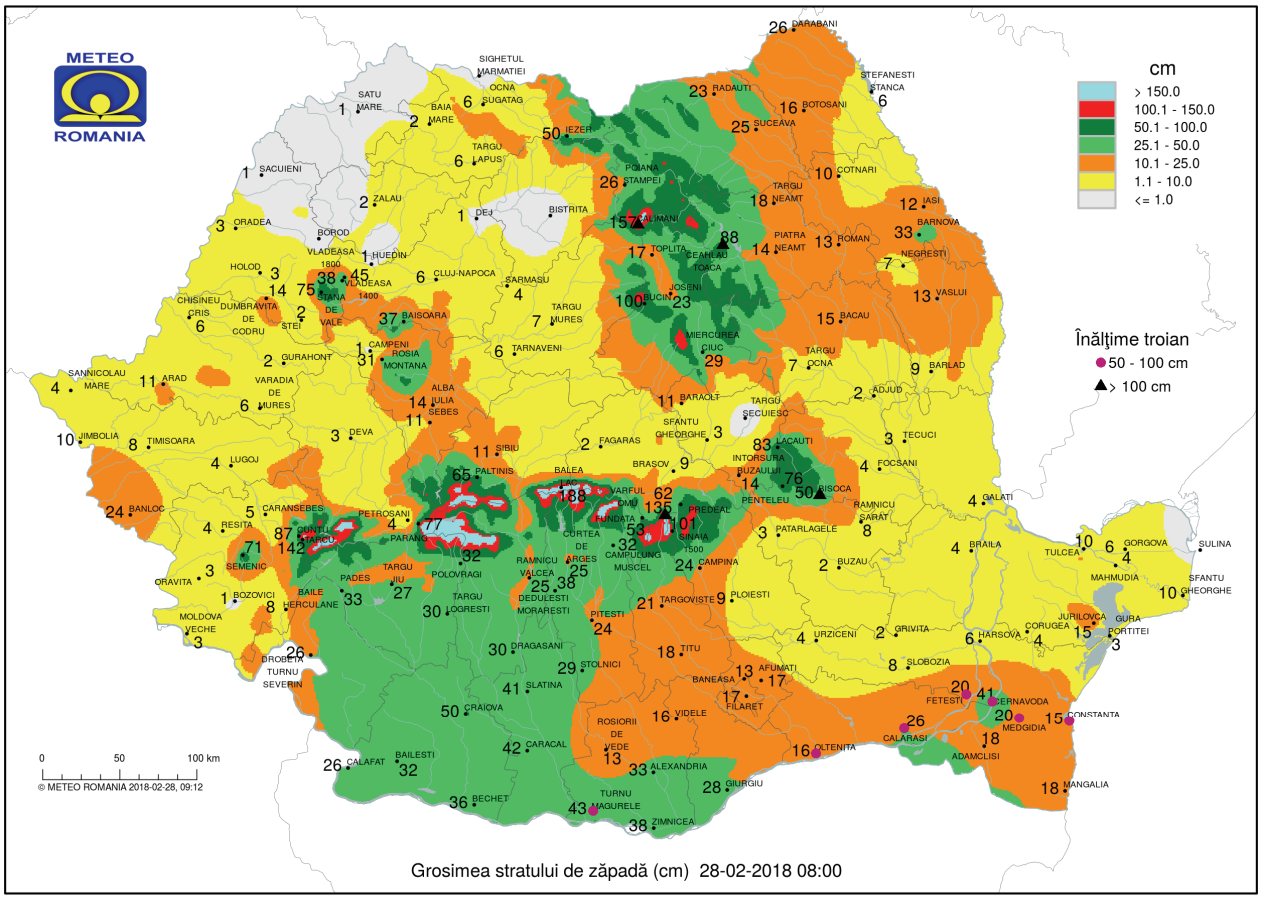

Figure 3. Spatial expansion of the snow layer, with the maximum thickness recorded in winter 2017-2018, on 28th of February 2018 at 08 o'clock. (NMA Bucharest).

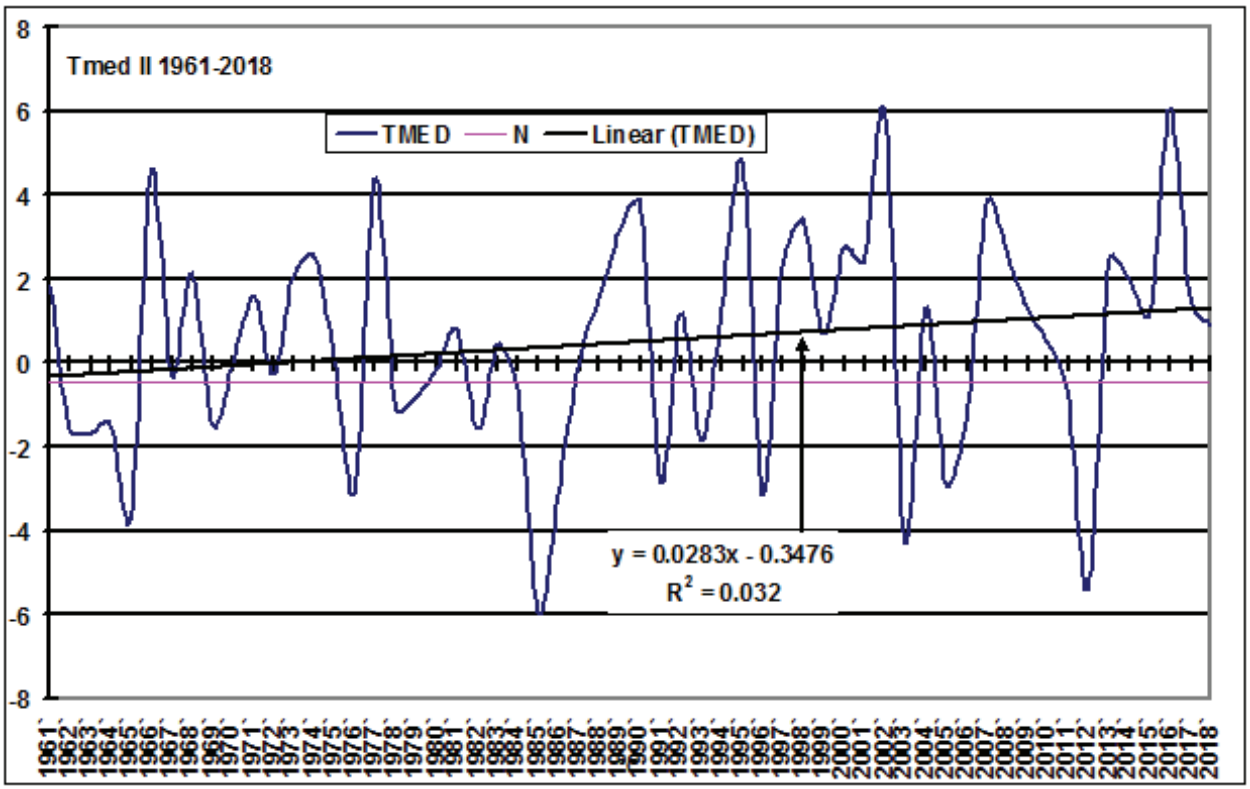

Figure 4. Monthly average air temperature variation in February calculated for the whole region (excluding the mountain range) in the period 1961-2018 (Tmed FEB = average temperature for Oltenia in February). (Source: processed data from the NMA Archive).

Table 4. The thermal classification of February in Oltenia in the last 58 years (AvgT = average temperature of February calculated for the entire Oltenia region with the area under 600 m altitude (°C), Type = thermal classification of the month according to the Hellmann criterion, Reci = number of cold winters and percentage, Normale = number of normal months and percentage, Calde = number of hot months and percentage, EC = exceptionally cold, VC = very cold, CL = cool, N = normal, WS = warmish, W = warm, VW = very warm, EW = exceptionally warm).

No	YEAR	AvgT	Type	No	YEAR	AvgT	Type	No	YEAR	AvgT	Type	No	YEAR	AvgT	Type
1	1961	1.83	W	17	1977	**4.40**	W	33	1993	-1.86	CO	48	2009	1.26	WS
2	1962	-1.59	CO	18	1978	-1.11	N	34	1994	1.34	WS	50	2010	0.50	WS
3	1963	-1.71	CO	19	1979	-0.79	N	35	1995	**4.73**	VW	51	2011	-0.86	CO
4	1964	-1.49	CO	20	1980	-0.14	N	36	1996	-3.11	CL	52	2012	**-5.40**	CL
5	1965	**-3.63**	CL	21	1981	0.78	WS	37	1997	2.29	W	53	2013	2.50	W
6	1966	**4.63**	VW	22	1982	-1.57	CO	38	1998	3.40	W	54	2014	2.03	W
7	1967	-0.32	N	23	1983	0.45	N	39	1999	0.70	WS	55	2015	1.20	WS
8	1968	2.13	W	24	1984	-0.63	N	40	2000	2.77	W	56	2016	**6.04**	VW
9	1969	-1.49	N	25	1985	**-5.95**	VC	41	2001	2.46	W	57	2017	1.40	W
10	1970	-0.04	N	26	1986	**-3.16**	CL	42	2002	**5.93**	VW	58	2018	0.90	WS
11	1971	1.59	WS	27	1987	0.06	N	43	2003	**-4.27**	CL		Reci	15	25.9%
12	1972	-0.30	N	28	1988	1.51	WS	44	2004	1.34	WS		Normale	12	20.7%
13	1973	2.06	W	29	1989	3.19	W	45	2005	-2.87	CL		Calde	31	53.4%
14	1974	2.54	W	30	1990	3.81	W	46	2006	-1.20	N				
15	1975	0.11	N	31	1991	-2.81	CL	47	2007	3.78	W				
16	1976	**-3.08**	CL	32	1992	1.19	WS	48	2008	2.71	W				

(Source: processed data from the NMA Archive)

In February 2018, the monthly air temperature averages were -0.5°C at Voineasa and 2.1°C at Drobeta Turnu Severin, and their deviations from normal were between 1.0°C on the Danube Plain at Calafat and in the Hills of Oltenia at Drăgăşani and Bâcleş and 2.0°C in the Voineasa intramontane depression, leading to the classification of the warmish thermal time (WS) in most of the region, to the warm (W) at Voineasa (Table 5).

Table 5. Air temperature regime in Oltenia and minimum and maximum soil temperature values in February 2018. (NII = normal February for the period 1901-1990, MII = monthly averages of February 2018; Δ = M-N = temperature deviation, CH = Hellmann criterion).

No	Meteorological Station	Hm	NII	MII	Δ=M-N	CH	air maxT		air minT		soil maxT		soil minT	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr. Tr. Severin	77	0.9	2.1	1.2	WS	12.4	3	**-9.1**	28	**22.0**	1	**-7.3**	28
2	Calafat	66	0.4	1.4	***1.0***	WS	14.5	3	-10.4	28	15.5	3	-12.6	28
3	Bechet	65	-0.1	1.5	1.6	WS	**21.4**	3	-10.2	28	18.9	17	-9.6	28
4	Băileşti	56	-0.1	1.1	1.2	WS	18.7	3	-10.6	28	18.3	3	-9.8	28
5	Caracal	112	-0.7	1.0	1.7	WS	17.2	3	-10.9	28	13.9	3	***-17.0***	28
6	Craiova	190	-0.4	0.7	1.1	WS	15.5	3	-10.6	28	18.0	3	-10.8	28
7	Slatina	165	-0.2	0.9	1.1	WS	16.4	3	-10.7	28	13.1	3	-10.5	28
8	Bâcleş	309	-0.9	0.1	***1.0***	WS	11.4	3	-11.0	28	-	-	-	-
9	Tg. Logreşti	262	-0.7	0.6	1.3	WS	11.3	1	-10.8	28	14.5	17	-8.4	28
10	Drăgăşani	280	-0.2	0.8	***1.0***	WS	11.8	3	-11.4	28	***10.1***	9	-9.4	28
11	Apa Neagră	250	-0.6	0.5	1.1	WS	11.2	9	-11.5	28	15.8	17	-11.4	28
12	Tg. Jiu	210	-0.4	1.3	1.7	WS	11.8	9	-9.9	28	18.2	9	-9.6	28
13	Polovragi	546	-1.4	-0.1	1.3	WS	11.0	2	***-11.9***	28	18.2	9	-10.7	27
14	Rm. Vâlcea	243	0.0	1.7	1.7	WS	12.1	2	-9.8	28	18.1	4	-12.8	28
15	Voineasa	587	-2.5	-0.5	**2.0**	W	***7.9***	8	-8.7	27	-	-	-	-
16	Parâng	1585	-	-	-	-	3.6	3	-17.4	28	-	-	-	-
17	Mean Oltenia	-	-0.5	0.9	1.4	WS	13	-	-10.9	-	16.5	-	-10.8	28
18	Ob. Lotrului	1404	-5.5	-4.7	0.8	N	5.2	2	-15.1	6	-	-	-	28

(Source: processed data from the NMA Archive)

The monthly average air temperature calculated for the whole region was 0.9°C, and its deviation from normal was 1.4°C, leading to a warmish weather (WS) on average for the entire Oltenia region. *The daily average calculated for the entire region* was -9.0°C on 28 February and 7.2°C on the 3 February. *The warmest interval in February* was between 1-19 February, when thermal maxima, totally isolated, slightly exceeded 20.0°C (on 3 February) and some thermal periods of winter 2017 -2018. After 19 February, the air temperature gradually decreased, and during the period of 25 February – 2 March 2017 there was a ***short late winter episode***. ***The late winter episode*** was marked by abundant snowfall, blizzard and a wave of Siberian cold that covered most of Europe and Asia and in Romania peaked on the morning of 1 March, when after a clear night, were recorded the lowest temperatures of the cold season 2017-2018 (-24.8°C at Apa Neagră and Târgu

Logreşti became the absolute thermal minimum of March for the latter meteorological station). The vernalization[8] took place between the 25 February and 2 March 2018.

Minimum monthly air temperature values were recorded for the most part on 28 February and were between -11.9°C in the Subcarpathian depression area at Polovragi and 9.0°C at Drobeta Turnu Severin, and their average was -10.9°C, higher by 0.2°C than in January. *The coldest morning* was recorded on the 28th February when the average for the whole region was -9.0°C. *The frost units* were modest, ranging from 22.1 at Drobeta Turnu Severin to 40.0 at Polovragi, and their average for the whole region was 31.0. These were recorded for the most part of them in the period of 25-28 February, i.e. within 4 days. *The agrometerological frost* was not registered in February and only on the 1 March with a local character. *Heat units* were recorded between 1-24 February, i.e. for 24 days, and ranged between 15.4 at Voineasa and 81.5 at Drobeta Turnu Severin, and their average for the whole region was 54.8, far exceeding the frost units, which confirms the winter warmth feature and confirms the ***translation of the spring season to the winter.***

The hottest day was on 3 February, with the average temperature for the entire region of 7.2°C. *The maximum monthly temperature values* were recorded differently in data 1, 2, 3, 8 and 9 February. They ranged between 7.9°C in the Voineasa Depression and 21.4°C at Bechet (this was the maximum winter value) and their average for the whole region was 16.5°C, exceeding the average of the other winter months. The highest daily average of the temperature peaks was 12.3°C, recorded on 3 February. A moderate wave of heat was recorded between the 29 January and 9 February, which was extended until 18 February.2018, determining the starting of the crops into vegetation, the opening of the buds to pussy willow, and the beginning of the filling and the swelling of the almond buds and apricot, etc. which signifies an early spring arrival, although the late winter episode interrupted the development of vegetative processes between the 25 February and 2 March.

The air temperature variation chart in February 2018 shows decreasing trends for all three parameters analysed (daily minima, daily averages and daily maxima) (Fig. 5), and the fastest decreasing was the maximum temperature. ***This decreasing trend is a climatic anomaly,*** because air temperature is normally on an increasing trend in February.

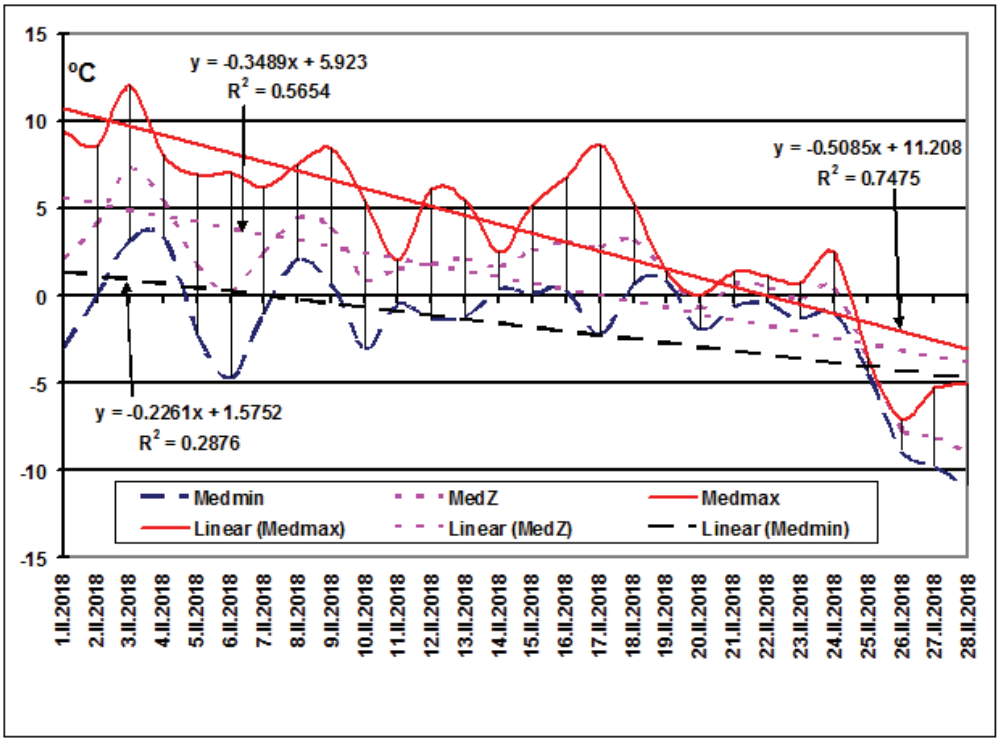

Figure 5. Air temperature variation (average daily minimum, daily average and average maximum daily) in February 2018. (Source: processed data from the NMA Archive).

As a result of the warm weather caused by the airflow on a large part of the continent Europe beginning with the end of January and maintained almost in the course of February, an early outbreak occurred, migratory birds arrived, and the starlings arrived from 2 March.2017. The bees came out to pick up pollen and propolis in many days of February. Biotopes have maintained their activity in almost all winter.

[8] Vernalization is a biochemical process that involves reaching or accelerating the flowering capacity under the influence of low temperatures. Under the influence of low temperatures immediately after germination, 4-100°C, a new plant has synthesized as a hormone that plays a role in the formation of future flowers, called vernalina. For most plant species, positive low temperatures have a profound influence on the initiation and development of reproductive organs; for this purpose annual plants require low temperatures in the first growth phases and biennial plants remain vegetative in the first year and bloom in the 2nd, if they are exposed to low-temperature treatment.

At the surface of the soil, *the monthly temperature minima* were recorded, with one exception on 28 February and ranged from -17.0°C at Caracal and -7.3°C at Drobeta Turnu Severin, and their average for the whole Oltenia region was -10.8°C. In almost all winter (with the exception of the interval between 25 February and 2 March) the superficial thawing occurred during the days and in some nights the frost (frost-thaw alternation), and then from the 2,III the soil remained defrosted. The freeze-thaw alternation can produce „***bare-root of plants*** [9]" in some areas of autumn crops, and if there is subsequent cooling or heating, they can be compromised. *Monthly temperature peaks at the soil surface* were recorded at 1, 3, 4, 9 and 17 February and were between 10.1°C in Drăgăşani and 22.0°C at Drobeta Turnu Severin and their average for the entire region was 16.5°C.

3.b. The pluviometric regime of February 2018

The highest monthly rainfall in all winter months was recorded in February. *Monthly precipitation* ranged from 66.7 l/m^2 at Bechet and 115.0 l/m^2 at Apa Neagră, and their percentage deviations from normal were between -3.8% at Parâng in the mountain area and 168.4% at Craiova, determining classification of rainwater gradient by the relief steps into exceptionally rainy Oltenia (ER) throughout Oltenia and normally in the mountain area (Table 2). *The average monthly precipitation amount* for Oltenia was 77.7 l/m^2, and its percentage deviation from normal was 66.4% which classifies February as exceptionally rainy (ER) on average for Oltenia. The largest amount of precipitation was recorded on the night of 3-4 February, when the average for the whole region was 11.9 l/m^2. February was the richest in rainfall throughout the winter.

Since 25 February, a consistent layer of snow has been formed that has reached the highest thickness in the country for the winter of 2017-2018, in the low regions of Craiova, 50 cm on the 28 February and in the whole region ranging from 25 cm at Râmnicu Vâlcea and 50 cm at Craiova. It gradually melted between 2-9 March. The snow layer formed at the end of February as well as the cooling time interval played a particularly important role in maintaining vegetative rest on the fruit trees and the vine. At the end of February, the ground water reserve was optimal across the region.

4.a. General thermal characteristics of the winter season

Average annual temperatures ranged between -0.7°C at Voineasa and 2.9°C at Dr. Tr. Severin, and their deviations from normal were between 1.5°C in the area of the Subcarpathian depressions at Apa Neagră and 3.0°C in the Romanați Plain at Caracal, leading to the classification of the very hot winter (VW) in all Oltenia (Table 6).

The winter average value for the whole region was 1.5°C, and its deviation from normal was 2.7°C, confirming that the winter of 2017-2018 was very warm (VW) on average for Oltenia. The hottest month was December with a monthly average for the entire region of 2.7°C, then February with a monthly average of 0.9°C and January with an average of 0.8°C.

Table 6. *The total rainfall and thermal regime of winter 2017-2018* (Hm = meteorological station altitude, W`17-18 = verage temperature values in winter 2017-2018 (°C), NW = normal values of the seasonal averages winter temperature (°C), Δ = W-N = average temperature deviations from normal (°C); CrH = Hellmann criterion, SW = sum of precipitation in winter 2017-2018 (l/m^2), NW = normal values of the seasonal precipitation (l/m^2), Δ = S-N = amount deviations from normal (l/m^2), Δ% = percentage amount deviations from normal).

No	Meteorological Station	Hm	Thermal Regime (°C)				Rainfall Regime (l/m^2)				
			W`17-`18	NW	Δ=W-N	CrH	SW	NW	Δ=S-N	Δ%	CrH
1	Dr. Tr. Severin	77	**2.9**	0.4	2.5	VW	171.7	160.5	11.2	7.0	**N**
2	Calafat	66	2.3	-0.1	2.4	VW	175.6	123.9	51.7	41.7	**FP**
3	Bechet	65	2.0	-0.6	2.6	VW	149.4	104.6	44.8	42.8	**FP**
4	Băileşti	56	1.6	-0.7	2.3	VW	156.9	121.4	35.5	29.2	**FP**
5	Caracal	112	1.8	-1.2	**3.0**	VW	161.1	108.7	**52.4**	**48.2**	**FP**
6	Craiova	190	1.8	-1.0	2.8	VW	161.4	109.7	51.7	47.1	**FP**
7	Slatina	165	1.5	-0.8	2.3	VW	158.1	117.2	40.9	34.9	**FP**
8	Bâcleş	309	1.3	-1.4	2.7	VW	-	149.3	-	-	**-**
9	Tg. Logreşti	262	1.2	-1.1	2.3	VW	148.6	121.7	26.9	22.1	**P**
10	Drăgăşani	280	2.0	-0.6	2.6	VW	126.8	114.1	12.7	11.1	**PP**
11	Apa Neagră	250	0.5	-1.0	***1.5***	WS	**226.6**	219.6	7.0	***3.2***	**N**
12	Tg. Jiu	210	1.2	-1.0	2.2	VW	144.9	169.9	***-25.0***	-14.7	**PS**
13	Polovragi	546	0.9	-1.5	2.4	VW	184.8	153.4	31.4	20.5	**P**
14	Rm. Vâlcea	243	2.0	-0.6	2.6	VW	174.6	120.1	54.5	45.4	**EP**
15	Voineasa	573	***-0.7***	-3.0	2.3	VW	-	141.8	-	-	**-**
16	Parâng	1585	-	-5.1	-	**-**	***146.9***	160.0	-13.1	-8.2	**N**
17	Average Oltenia	-	1.5	-1.2	2.7	VW	163.4	137.2	26.2	19.1	**P**
18	Ob. Lotrului	1348	-4.0	-5.5	***1.5***	WS	208.8	-	-	-	**-**

(Source: processed data from the NMA Archive)

[9] The term ***bare-root of plants*** due to frozen-thaw alternation means the physical process of soil removal near the roots of the plants, leaving them uncovered, which expose them to frostbite under conditions of intense frost or drying under the warm-up time after this process, therefore it is considered a dangerous process for autumn crops.

Frost units for the whole winter ranged from 41.6 to Drobeta Turnu Severin and 132.1 to Voineasa. *Heat units* for the whole winter were between 64.1 at Voineasa and 309.0 at Drobeta Turnu Severin, and the average for the whole region was 212.0, indicating a gentle agrometeorological winter.

4.b. General rainfall characteristics of the winter season

The annual rainfall ranges ranged from 126.8 l/m^2 in Olt River Corridor at Drăgăşani and 226.6 l/m^2 in the area of the Subcarpathian Depressions at Apa Neagră, and the percentage deviations from normal were between -14.7% at Târgu Jiu and 38.2% at Caracal, which results in very rainy winter classifications (FP), mostly in Oltenia Plain, Getic Piedmont and Olt Corridor in Râmnicu Vâlcea, rainy (P) in the hills, normal in the mountain area at Parâng and a slightly dry on a restricted area at Tg. Jiu (Table 6). The average annual rainfall for the winter was 163.4 l/m^2, and its percentage deviation from normal was 26.2% confirming that the winter 2017-2018 was rainy (P) on average for the whole region due to the main rainfall in September.

DISCUSSIONS

December was the warmest month of winter, with positive thermal peaks and marked by three warm weather intervals 7-9 December (3 days), 12-16 December (5 days) and 24-29 December (6 days) totalling 15 days in which the temperature peaks exceeded 10.0°C. The warmest winter range was 24-29 December when a ***moderate heat wave*** was recorded, with the maximum heating intensity at 25 December (Table 1), and the maximum monthly thermal values were recorded.

The synoptic causes of this heat wave were determined by a tropical continental movement. On 25 December.2017 at 18 UTC *at ground level* the positioning of the main atmospheric centers of action on the continent of Europe was the following: the series of Icelandic cyclones positioned in the north of the continent between the parallel of 55-75°N with more nuclei of low pressure (with center values below 990 hPa). Above Greenland, the Greenlandic Anticyclone was positioned with values in the center above 1040 hPa (Fig. 6). The southern part of the continent was dominated by a vast anti-cyclonic field made up of the union of the Azoric Anticyclone with the North African one and having a secondary center above the Asia Minor Peninsula, with atmospheric pressure values above 1030 hPa. The vast thalweg of the depression field centered on the south of the Scandinavian Peninsula, extending to northern Africa, induced a south-western (tropical continental - cT) movement for much of Europe including Romania in the lower troposphere with a warm air mass in North Africa. In the mean troposphere at 500 hPa, the geopotential field was low in the north of the continent (north of 552 damgp) and raised in the south where field values slightly passed 568 damgp. The vast geopotential thalweg field with its axis along the western and north-western shores of Europe also determines this level of tropical continental circulation (cT).

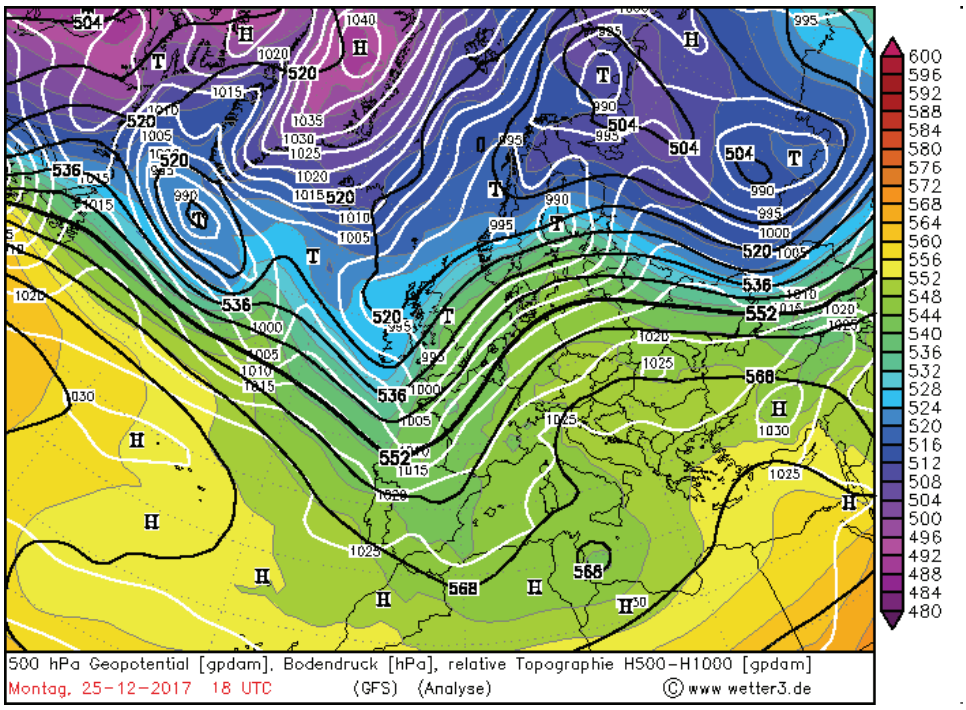

Figure 6. The synoptic situation at the ground level (pressure field, white isohypses) overlaps with the altitude synoptic situation at 500 hPa (about 5000 m altitude, geopotential field, thick black isohypses) and the relative bar topography field TR500 / 1000, thin isohypses (these are equivalent to average isotherms in the air layer between 1000 hPa and 500 hPa), on 25 December.2017 at 18 UTC (www.wetter3.de).

At 850 hPa, the hot air advection reached up to the south of the Scandinavian Peninsula (isotherm of 0°C), and above the southwest of Romania, northwest Bulgaria and Serbia was positioned on the 8°C isotherm (Fig. 7). As a result, this hot air advection across Europe had a warm air layer thickness of over 1500m. We also notice that in the period between 1 December-24 February, the air temperature deviations were positive, above the vast expanse of land formed in Europe and Asia, and in Siberia warmer than in North America, the Arctic cold air (A) was guided by the atmospheric circulation over North America. So the warm month of December 2017 confirmed the winter season's translation of the winter season across Europe and Asia.

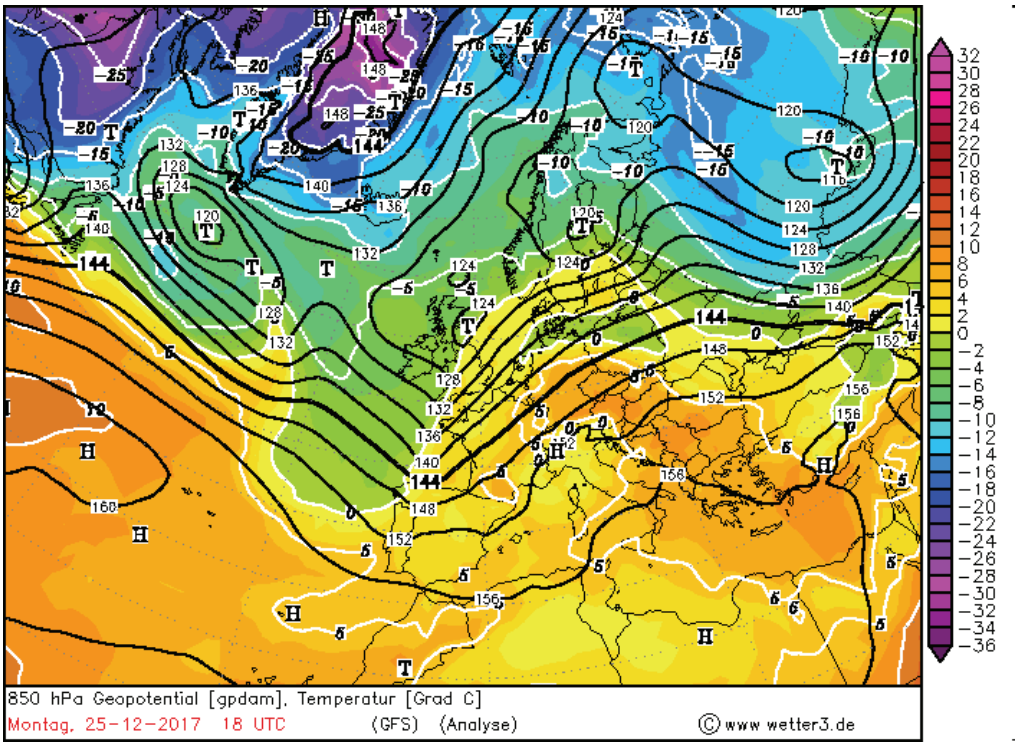

Figure 7. The thermal field (the thick white isohypses are the main isotherms, the thin isohypses that delimit the secondary isothermal colors (°C)), the black isohypses are thick with the geopotential field at 850 hPa, on 25 December.2017, 18 UTC (www.wetter3.de).

In January, two warm-day intervals were recorded, with daily thermal maximums exceeding 10.0°C: 1-8 January and 29-31 January, totalling 11 days. In January the maximum heating intensity was recorded in 30 January when the January maximum heating was recorded. The warm range was 29-31. It was extended until 3 February when most of February's thermal peaks were recorded. The warm January 2018 time was mainly due to the expansion of the Azoric anticyclone across the continent of Europe, and to the predominance of western and north-western circulation that have brought warm air over Oc. Atlantic over most of Europe.

In February, the hottest day was on the 3 February, and the maximum of this warming, characterized by the 21.4°C value at Bechet (the thermal maximum of this winter for Oltenia) was due to a south-west movement, induced by the formerly a Mediterranean Cyclone centered over the Adriatic Sea and Italy.

The coldest interval of February and the winter of 2017-2018 was between 25-28 February 2018, and this cold, gloomy weather of the night and morning extended until 2 March.2018. Frost was recorded especially on the night of 27-28 February and 28 February-1 March, when the thermal minima fell below -10.0°C on the morning of 28 February and even below -20.0°C on the morning of 1 March. ***The maximum intensity of this cold late wave*** is characterized by the lowest temperature value this winter for the whole country, -24.8°C the absolute thermal minimum of the winter recorded at two meteorological stations in Oltenia, Apa Neagră and Târgu Logreşti. ***For the Târgu Logreşti this value is an absolute climatic record of March*** being the lowest in the history of meteorological observations. Extremely intense weather cooling during the winter months had complex synoptic causes. The analysis of the synoptic situations has highlighted that the Arctic cold Siberian air (A) are brought to Europe by a vast anticyclonic field stretching across Europe and Asia, formed by the union of the regional anticyclones in the form of a large anticyclonic belt Aleksandr I Voeikov (1842-1916). The midline of this vast anticyclonic field (wind speed line 0 called the Voeikov axis) separates the west and northwest winds from the east and north east. This type of synoptic situation, due to the intense cooling it produces within a few days and the subsequent stability, determined over time the destruction of some armies considered invincible at the time, being a real terrible climate weapon of Russia, and the media called it "Beast of the East"[10]. This type of atmospheric circulation has a significant stability over time,

[10] Named the "Beast of the East" by the British press, the "Bear of Siberia" in the Netherlands, the "snow cannon" in Sweden or "Moscow-Paris" in France.

supported by the rotation of the Earth and Coriolis's deviating force that deviates cold air along a northeast trajectory, bringing it from the polar region and Siberia over Europe. The production of cooling time from the end of February 25 February-2 March.2018 was signalled by mathematical models 14 days before and then confirmed at each run.

We will analyse the synoptic situation at the moment of the maximum cooling intensity on the continent of Europe, i.e. for the night of 27 / 28 February, and in Oltenia the maximum cooling occurred on the night of 28 February-1 March because of the local causes the serene night and the presence of the thick layer of snow.

On 28th February 2018 at 00 UTC, at ground level, the vast anticyclonic field had maximum intensity above the Scandinavian Peninsula with atmospheric pressure values above 1050 hPa (Fig. 8).

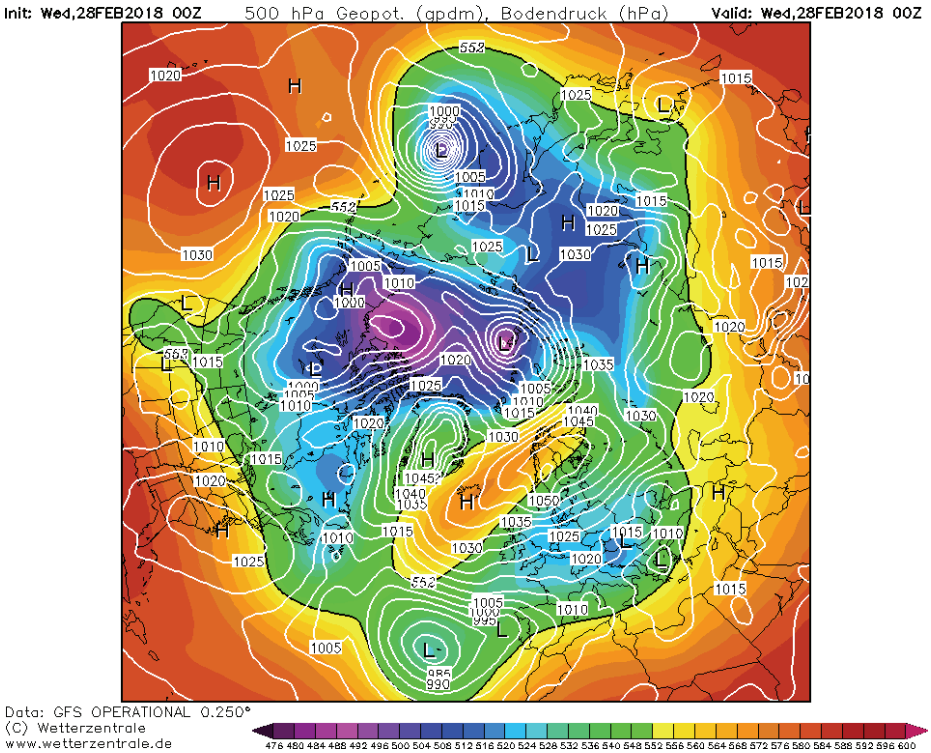

Figure 8. The synoptic situation at ground level above Europe and Asia on 28 February.2018, 00 UTC, (www.wetterzentrale.de).

For Europe, an extraordinary arctic (A) extra advection was produced over the Scandinavian Peninsula and its north polar area. The cold air reached Oltenia from the east and northeast, and during the night it continued to cool. The presence of the cyclonic field in the Mediterranean, which caused the snowy, blizzard snowfall in some time intervals, from 25-27 February accelerated the advection of cold air towards Oltenia. *At 850 hPa*, the analysis of the temperature field over the northern hemisphere highlights the massive advection of particularly cold air above Europe and Asia at temperatures between -28.0°C and -10.0°C, and even lower (Fig. 9).

As a result of the continuation of the extremely cold air, but also of the night-time cooling, with a duration of 12 hours and 53 minutes, in the presence of the snow layer the minimum air temperatures on the morning of 1 March were between -24.8°C to Apa Neagră and Târgu Logreşti and -14.4°C in Craiova and Drobeta Turnu Severin, except for the meteorological station in Calafat where the minimum was -9.4°C. Extremely low values were in the second place in descending order of the data series: Apa Neagră -24.8°C, Slatina -21.4°C, Bechet -18.4°C and Drăgăşani -16.9°C. As a result of the wave of cold and heavy snow, the school courses were stopped for one week (26 February-2 March), there was an energy crisis due to the high consumption of gas and electricity, vegetables were affected and flowers, it has been difficult to supply the markets and the shops with products, road and rail traffic has been closed in some regions, and the water of the Black Sea has frozen on the seaside. The energy crisis has affected other countries in Europe and 46 people died (AFP balance sheet on 28th February 2018) (http://www.economica.net/romania-se-pregatesste-pentru-limitarea-consumului-de-energie-electrica_131596.html#n), http://adevarul.ro/international/europa/bilantul-victimelor-valului-frig-europa-ajuns-46-morti 1_5a96e8f8df52022f75137ff7/index.html). In the 2-9 February, due to the strong, rapid warming of the weather, the snow melt quickly and floods occurred in some counties and landslides. Since 2 March.2018 the weather has been continuously warming up, which has led to the melting of the snow layer, the defrosting of the soil, the start of the vegetation of the autumn crops and initiated and supported the process of spring arrival[11].

[11] ***Spring arrival*** is the long-term climatic process that causes the gradual increase of air and soil temperature from February to 10 April. The process is complex and is mainly determined by the variation of the Earth-Sun geometry that produces an increase in the duration of the day, thus increasing the amount of heat received from the Sun from the northern hemisphere, resulting in significant changes in atmospheric circulation and increased

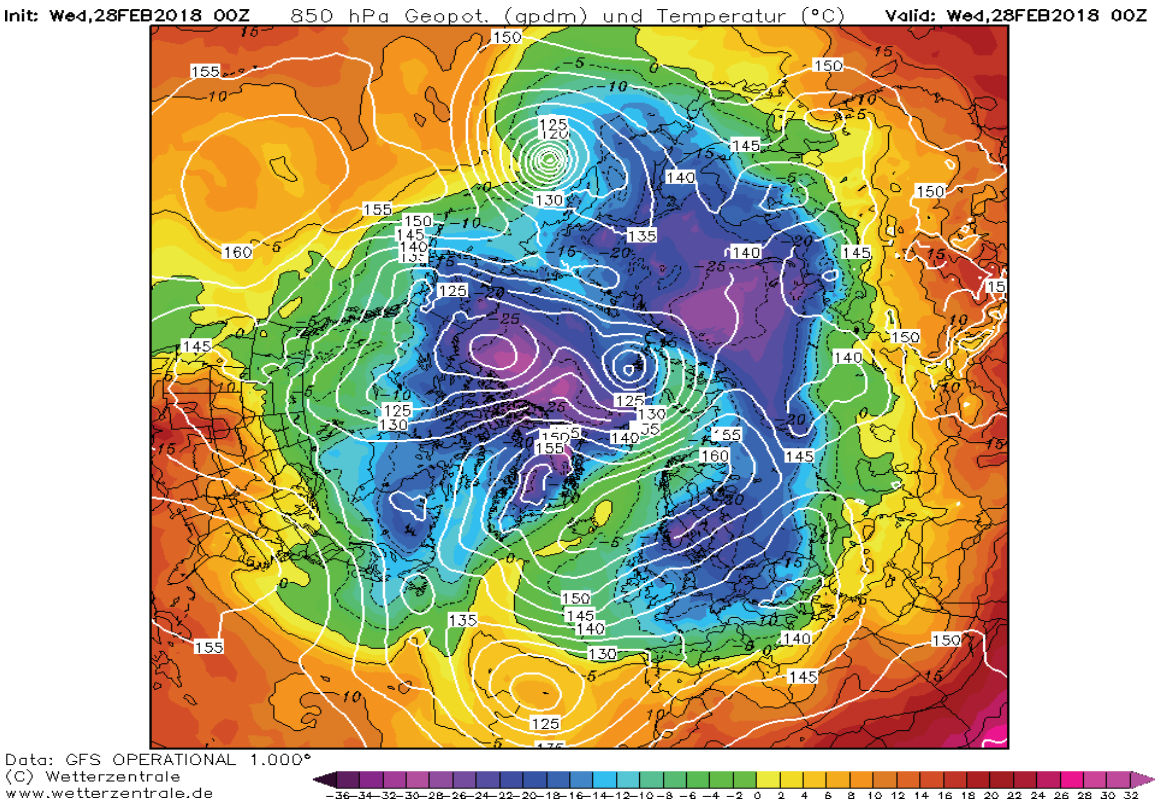

Figure 9. The geopotential and thermal field above the northern hemisphere, at 850 hPa (about 1500 m altitude) on 28 February.2018, 00 UTC (www.wetterzentrale.de).

CONCLUSIONS

Warm winter 2017-2018 was marked by a particular climatic variability due to a more pronounced variability on the Nordic Hemisphere and the continent of Europe. For Oltenia and Romania as well as for much of Europe the winter was warm, this feature was obtained by moderating the temperatures - December 2017 was the warmest (C) month of winter, January 2018 the third warmest (C) and February 2018 was the second hottest month. The soil was thawed for the most part of winter and frozen during the period 25-28. The crop protection against the frost of February was achieved due to the thick layer of snow (50 cm in the central part of Oltenia). The end of February, in just five days, caused human casualties (9 deaths in Romania and 46 in Europe) and material damage and triggered an energy crisis both in Romania and in much of Europe. All this shows that in the winter season, ***the climate risk of cold waves continues***, although global warming has continued, although solar activity has been minimized and the El Niño climate process absent, which is a climatic record for a winter warm under these conditions. We therefore conclude that national preparation for crossing the winter season must be done with great care and diligence, taking into account all the possibilities of producing energy and supply. Although a late 5-day cold wave was recorded at the end of February and the beginning of March, the startling was early, and the start of growing crops and the reactivation of biotopes occurred in the first decade of March. Migratory birds have arrived early on from the 3 March and even earlier due to the warm weather in Europe during most of the winter. ***The cold and snowy periods in the period 25 February-2 March have had important beneficial effects*** due to the maintenance of the vegetative rest on the fruit trees and vineyards, to the agricultural crops and the sanitation effect by destroying some pests, etc. Increasing climate variability is the direct consequence of climate warming, but nevertheless the seasons will never disappear due to the variability of Earth-Sun geometry. The danger of intense cold waves will be maintained and they will become more destructive by surprise the unprepared population, and the degree of adaptation to the cold and cold conditions will decrease. According to a study, "climate warming affects absolutely all aspects of life on Earth, from genetics to the whole ecosystem, and the consequences are extremely dangerous for humans. This study has shown that 80% of 94 ecological processes that ensure the normal freshwater marine ecosystem, as in the case of the land, have begun to be affected. This phenomenon leads to the emergence of harmful bacteria and disease outbreaks and affects crop yields "(Dr Brett Scheffers, University of California - http://www.descopera.ro/stiinta/15943823-incalzirea-climatica-afecteaza-deja-intreaga-viata-pe-pamant).

frequency and intensity of adventures warm from the south and southwest. The process is evaluated using ***the spring arrival index*** = ∑Positive Daily Average Temperatures in the range 1 February-10 April.

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PHENOLOGICAL ANOMALIES REGARDING THE FLOWERING OF SPONTANEOUS AND SUBSPONTANEOUS PLANTS FROM FOUR DIFFERENT PARTS OF ROMANIA

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Abstract. The paper presents observations about the phenological anomalies regarding the flowering of spontaneous and subspontaneous plants from four different parts of Romania, during the period 2000 - February 2018 (south-western, central, central-western, north-western of Romania). These anomalies are the consequences of global warming and have become more prominent particularly in the last five years (2013-2017), being observed in 100 species of spontaneous and subspontaneous plants. Both premature flowering and flowering extension were observed, sometimes even supplementary flowerings in the cold season (November-February).

Keywords: phenological anomalies, flowering, spontaneous plants, Romania.

Rezumat. Anomalii fenologice privind înflorirea plantelor spontane și subspontane din diferite părți ale României. Lucrarea prezintă observații despre anomaliile fenologice privind înflorirea plantelor spontane și subspontane din patru părți ale României în perioada 2000 - februarie 2018 (sud-vestul, centrul, central-vestul și nord-vestul României). Aceste anomalii sunt consecințe ale încălzirii globale și s-au accentuat mai ales în ultimii 5 ani (2013-2017), fiind observate la 100 de specii de plante spontane și subspontane. Au fost observate atât înfloriri premature cât și prelungirea înfloririi, uneori chiar înfloriri suplimentare în sezonul rece (noiembrie-februarie).

Cuvinte cheie: anomalii fenologice, înflorire, plante spontane, România.

INTRODUCTION

Global warming determined climatic changes in the structure of seasons: premature and shorts springs, with thermal variations, sometimes extreme, dry and sultry summers, autumns with high temperatures but sometimes with extreme thermal extreme variations, mild winters, sometimes with high temperatures for this season, the substitution of the snows with rains. Premature flowerings, its extension, the existence of some supplementary flowerings in the cold season (November – February) are only some phenological aspects observed in plants, as a consequence of global warming effects (Figs. 1-6).

This paper is a synthesis of the observations performed by the authors in four parts of Romania (south-western, central, central-western and north-western) regarding the influence of global warming on the flowering of spontaneous and subspontaneous plants (ANGHEL et al., 1971; ROMAN, 1974; IVAN, 1979; NĂSTASE, 1982; CIOBOIU, 2005).

Figure 1. *Rudbekia triloba* (photo Ilie, 2017).

Figure 2. *Erigeron annuus* (photo Ilie, 2017)

Figure 3. *Oenothera biennis* (photo ILIE, 2017).

Figure 4. *Solanum nigrum* (photo ILIE, 2017).

Figure 5. *Ranunculus sardous* (photo Ilie, 2017).

Figure 6. *Taraxacum officinale* (photo Ilie, 2017)

MATERIAL AND METHODS

The observations were made during the period 2000 – February 2018, in 15 areas, 8 counties, with the altitude ranging from 30 to 500 m, as follows: Tinca (Bihor county, the north-western part of Romania) – average altitude 130 m, hilly area; Oradea (Bihor county) – average altitude 120 m, hilly area; Maieru – Anieș (Bistrița-Năsăud county) – average altitude 500 m, hilly area; Dârmănești (Argeș county, the central part of Romania) – average altitude 400 m, hilly area; Sebeș (Alba county, the central-western part of Romania) average altitude 350 m, hilly area; Geoagiu Bai (Mureș county, the central part of Romania) – average altitude 400 m, hilly area; Drobeta Turnu-Severin (Mehedinți county, the south-western part of Romania) – average altitude 65 m, plain area; Batoți (Mehedinți county) – average altitude 70 m, plain area; Craiova, Bechet, Cârcea, Desa, Calafat (Dolj county, the southern part of Romania) – average altitude 30 – 50 m, plain areas; Racovița (Vâlcea county, the central part of Romania) – average altitude 300 m, hilly area; Caraula (Dolj County, the southern part of Romania) – average altitude 100 m, hilly area (Fig. 7).

The identification of plant species was made using different books (SĂVULESCU, 1952 -1976; TODOR, 1968; TIȚĂ I. & NĂSTASE A. 1997; CIOCÂRLAN, 2000; SÂRBU et al., 2013).

Figure 8. The map of localities where plant blooming abnormalities were found:
1. Tinca, 2. Oradea, 3. Maieru-Arieş, 4. Dărmăneşti, 5. Sebeş, 6. Geoagiu, 7. Drobeta-Turnu-Severin, 8. Batoţi, 9. Craiova, 10. Bechet, 11. Cârcea, 12. Desa, 13. Calafat, 14. Racoviţa, 15. Caraula (original).

RESULTS

During the analysed period, 2000 - 2018, phenological anomalies were observed regarding flowering in the following 100 species of spontaneous and subspontaneous plants (Table 1).

Table 1. Phenological anomalies regarding the flowering of spontaneous and subspontaneous plants from four parts of Romania.

Name of the species	Data of observations in different areas (see legend)	Temperature (Celsius degrees)	Phenological anomalies of flowering	Period of normal flowering, months
Hepatica transsilvanica Fuss, 1850	27.III.2009 , R	13	P. f.	IV – V
Ranunculus acris Linnaeus, 1758	16.XI.2017, A	7	S. f.	V – VIII
Ranunculus sardous Crantz, 1774	10.XI.2017 – 19.I.2018, T	3 – 15	S. f.	V – VII
Chelidonium majus Linnaeus, 1758	19.X – 26 XI.2017, T 10.X –11.XII 2017, Ba	3 – 15 7 – 15	S. f. –	V – IX –
Betula pendula Roth, 1828	26.I – 28.II.2018, T	5 – 15	P. f.	IV – V
Corylus avellana Linnaeus, 1758	26.XII. 2017 – 28.II.2018, T	8 – 15	P. f.	II – IV
Polygonum arenarium Waldst & Kit, 1878	10.X.2017, B, D	15	S. f.	VII – IX
Polygonum aviculare Linnaeus, 1758	19..X. – 3.XII.2017, T 21.XI.2017 B, C 13.V.2017 B, C	2 – 25 – 6 – 20	S. f. – P. f.	VI – X – –
Polygonum amfhibium Linnaeus, 1758	2.X. – 3.XII.2017, T 21.XI.2017 B, C, D 15.V.2017 B, C, D	2 – 25 6 21	S. f. – P. f.	VI – X – –
Rumex acetosa Linnaeus, 1758	25.IX. – 4.XII.2017, A	8	S. f.	VI – VII
Stellaria media Linnaeus, 1758	8.XI. – 13.XII.2017, T 4.XI.2017 – 11.I.2018, O 12.XI. – 23.XII.2017, A 28.XII.2017, S	2 -12 0 – 17 1 -13 1	S. f. – – –	III –V – – –
Fragaria vesca Linnaeus, 1758	12.XI.2017, R 18.XI. – 10.XII.2017, A	26 3 – 10	S. f. –	V – VI –
Potentilla reptans Linnaeus, 1758	1.XI.2017 – 9.I.2018, T 15.XI.2017, A	1 – 17 6	S. f. –	VI – VIII –

Potentilla leucopolitana Muller, 1862	12.XI.2017, R 23.XII.2017, T	26 3	S. f. –	V – VII –
Alchemilla vulgaris Linnaeus, 1758	20 – 25.XI.2017, A	6 - 8	S. f.	V – VIII
Agrimonia eupatoria Linnaeus, 1758	2.XI – 25.X.2017, T 14.IX -28.XI.2017, B, C 12.V.2016, B, C	12 – 25 16 – 26 23	S. f. – P. f.	VI –VIII – –
Crataegus monogyna Jacquard, 1800	28.X.2013, C	10	S. f.	V –VI
Pyrus communis Linnaues, 1758	15.X.2013, R	12	S. f.	IV – VI
Prunus cerasifera Ehrh., 1784	10.II.2017, Cv 15.III.2009, Cv 18.III.2017, Cv	5 7 10	P. f. – –	IV – V – –
Armeniaca vulgaris Lamarck, 1753	27.II.2016, Cv	3	P. f.	III – IV
Medicago sativa Linnaeus, 1758	5.XII.2017, A	1	S. f.	V – X
Medicago lupulina Linnaeus, 1758	2 – 10.XII.2017, T	2 – 8	S. f.	V – IX
Melilotus albus Medik, 1787	10 – 15.XI. 2017, A	5 – 7	S. f.	VI –IX
Melilotus officinalis Lamarck, 1753	10-15.XI 2017, A	5 – 7	S. f.	VI – IX
Trifolium repens Linnaeus, 1753	16.XII. 2017, Tr. S 2.X. – 2.XII.2017, A 11.X. – 22.XII.2017, T	9 2 – 20 1 – 23	S. f. – –	V – IX – –
Trifolium pratense Linnaeus, 1758	4.X. – 21.XII.2017, T 2.XII.2017, A 9.X – 20.XI.2017, C, R	3 – 18 0 2 – 15	S. f. – –	V – IX – –
Robinia pseudoacacia Linnaeus, 1753	20.IV.2016, Cv 26.IV.2007, Cv 25.IV.2017, Cv 16.VIII.2015, T 9.IX.2014, T	16 15 20 31 26	P. f. – – – S. f.	V – VI – – – –
Oenothera biennis Linnaeus, 1758	16.X.2009, Cv 29.XI – 3.XII.2017, T (floral buds)	1 – 4 –	S. f. –	VI – VIII –
Aesculus hippocastanum Linnaeus, 1758	20.IV.2017, Cv 16.VIII. – 7.IX.2015, T 10.IX. – 29.IX.2017, O	17 23 – 27 14 – 17	P. f. – S. f.	V – VI – –
Geranium robertianum Linnaeus, 1758	12.X – 13.XI.2017, A	8 – 10	S. f.	V – IX
Daucus carota Linnaeus, 1758	3.X – 10.XII.2017, A	3 – 9	S. f.	VI – IX
Carum carvi Linnaeus, 1758	7.X – 15.XII.2017, A	3 – 9	S. f.	VII – IX
Pimpinella saxifraga Linnaeus, 1758	1.X. – 10.XII.2017, T 12.X.2015, B, D 20.VI.2000, B, D	2 – 23 15 30	S. f. – P. f.	VII – IX – –
Aethusa cynapium Linnaeus, 1758	14.X – 12.XII.2017, T 2.IX. – 30.X.2015, B, D	2 – 21 15 – 26	S. f. –	VI – VIII –
Hypericum perforatum Linnaeus, 1758	19.X – 15.XI.2017, A	5 – 13	S. f.	VI – IX
Malva sylvestris Linnaeus, 1758	20.XI.2017, A 2.X – 13.XII.2017, T 26.IX. – 9.XII.2017, Tr. S 14.X.2017, B, C 20.V.2000, B, C	4 3 – 20 5 – 25 17 25	S. f. – – – P. f.	VI – IX – – – –
Viola odorata Linnaeeus, 1758	5.IX. – 20.XII.2017, A 20.X.2007, 3.XI.2009, 5.XII.2017, R 11.X. – 26.XII.2017, T	4 – 17 6 - 14 4 - 17	S. f. – –	III – IV – –
Sisymbrium orientale Linnaeus, 1753	20.V.2000 B, D 28.VIII. – 25.IX.2013 B, D 28.XI.2017, T	26 21 – 32 6	P. f. S. f. –	VI – VII – –
Capsella bursa-pastoris Linnaeus, 1753	10XI. – 16.XII.2017, A 16.I.2018, T 5.I.2018, O 3.IX.2017, R	1 – 11 7 4 17	S. f. – – –	IV – VII X – XI – –
Thlaspi arvense Linnaeus, 1758	14.XI.2017, A	4 –	S. f. –	IV – VI IX – X
Primula acaulis Linnaeus, 1758	18.XII.2017, G 20.XI.2017, A	1 6	S. f. –	III – IV –
Primula veris Linnaeus, 1758	9.XII.2017, A	7	S. f.	IV – V
Lysimachia numularia Linnaeus, 1758	24.XII.2017, A	5	S. f.	V – VII
Centarium erythraea Rafin, 1800	15.X.2013, R	16	S. f.	VII – IX
Gentiana asclepiadea Linnaeus, 1758	19.X.2013, R	14	S. f.	VII – IX
Asclepias syriaca Linnaeus, 1758	11.VI.2000, Ca 15.VI.2004, Ca	40 35	P. f. –	VII – VIII –
Syringa vulgaris Linnaeus, 1758	2.XII.2017, Cv	2	S. f.	IV – V
Solanum heterodoxum Dunal, 1813	15.VI.2004, Ca	27	P. f.	VII – X
Solanum nigrum Linnaeus, 1758	8.XII.2017, T 14.XI.2017, B 20.V.2004, B 26.V.2009, B	8 10 19 22	S. f. – P. f. –	VI – X – – –

Calystregia sepium Linnaeus,1758	16.X.2017, B, D	17	S. f.	VI – IX
	10.V.2004, B, D	23	P. f.	–
	29.X.2017, T	15	S. f.	–
Ipomoea purpurea Linnaeus, 1758	30.X.2017, T	12	S. f.	VI – IX
	23.X.2017, B, C	14	–	–
	9.V.2004, D	18	P. f.	–
Ajuga reptans Linnaeus, 1758	20.IX.2017, A	6	S. f.	IV – VI
Glechoma hederacea Linnaeus, 1758	16.III.2000, B	11	P. f.	IV –VI
	26.IX.2017, B	16	S. f.	–
Prunellla vulgaris Linnaeus, 1758	10.XII.2017, T	9	P. f.	IV – VI
	16.IX – 10.X.2017, C	16 – 20	S. f.	–
Lamium purpureum Linnaeus, 1758	20.X.2017, B	17	S. f.	III – IX
	25.XII.2017, A	8	–	–
	9.XII.2017 Tr. S	11	–	–
Lamium maculatum Linnaeus, 1758	21.XII.2017, T	0	S. f.	IV – VI
	20.III.2004, B	7	–	–
	3.IX.2007, B	21	–	–
Lamium album Linnaeus, 1758	25XII.2017, A	8	S. f.	IV –VI
Salvia officinalis Linnaeus, 1758	1XII.2017, A	4	S. f.	V – VII
Salvia pratensis Linnaeus, 1758	1.XII.2017, A	4	S. f.	V – VII
Origanum vulgare Linnaeus, 1758	5.IX. – 26.X.2017, B	12 – 23	S. f.	VII – VIII
Thymus vulgaris Linnaeus, 1758	3.V.2004, C	21	P. f.	VII – VIII
	19.X.2017, B	10	S. f.	–
Lycopus europaeus Linnaeus, 1758	10.XI.2017, B	12	S. f.	VI – VIII
Plantago lanceolata Linnaeus, 1758	15.XI.2017, Ba	10	S. f.	V – VIII
Veronica polita Fries, 1777	2.I.2018, O	7	S. f.	III – VI
	15.XI.2017, Ba	9	–	–
	21.II.2018, T	7	–	–
	3.VII. – 20.IX.2017 C, R	23 – 31	–	–
Veronica longifolia Linnaeus, 1758	25.XI.2017, T	13	S. f.	VI – VIII
	10.XI.2017, Car	12	–	–
Euphrasia officinalis Linnaeus, 1758	10.XII.2017, A	2	S. f.	VII – X
Campanula patula Linnaeus, 1758	20.XI.2017, A	3	S. f.	V – VII
Galium mollugo Linnaeus, 1758	6.XII.2017, A	1	S. f.	VI – IX
Sambucus nigra Linnaeus, 1758	28.IV.2017, Cv	17	P. f.	VI – VII
Lonicera tatrica Linnaeus, 1758	3.VII – 16.X.2017, Cv	9 – 26	S. f.	V – VI
	20.X.2016, Car	16	–	–
Dipsacus laciniatus Linnaeus, 1758	11.X. – 23.XI.2017, R	3 – 15	S. f.	VII – VIII
Knautia arvensis Linnaeus, 1758	25.XI.2017, A	10	S. f.	VI – VIII
Oxalis corniculata Linnaeus, 1758	13.XII.2017, T	7	S. f.	IV – V
Vinca minor Linnaeus, 1758	5.XI.2017, R	17	S. f.	IV – VI
Bellis perennis Linnaeus, 1758	26.I.2017, A	8	S. f.	III – X
	28.II.2018, T, O	7	–	–
	28.XII.2017, G	9	–	–
Aster amellus Linnaeus, 1758	13.XII.2017, T	7	S. f.	VII – IX
	5.I.2018, A	6	–	–
Erigeron annuus Linnaeus, 1758	22.XII.2017, T	1	S. f.	VII – VIII
	31.XII.2017, O	3	–	–
Erigeron canadensis Linnaeus, 1758	25.XI.2017, T	13	S. f.	VI – IX
	29.X.2017, C, R	12	–	–
Inula salicina Linnaeus, 1758	28.XI.2017, T	6	S. f.	VI – IX
Inula helenium Linnaeus, 1758	20.XI.2017, T	6	S. f.	VI – IX
	16.XII.2017, Ba	9	–	–
Ambrosia artemisiifolia Linaeus, 1758	2.I 2018, O (floral buds)	7	S. f.	VII – VIII
Galinsoga ciliata Blake, 1922	9.XII.2017, T	8,5	S. f.	VII – IX
	20.XI.2017, B, C	8	–	–
Achillea millefolium Linnaeus, 1758	20.II.2018, T	7	S. f.	VI – VIII
	26.XI.2017, Da	11	–	–
	28.XII.2017, S	9	–	–
Matricaria perforata Merat, 1753	21.XII.2017, T	0	S. f.	VI – X
	26.XI.2017, B, C	13	–	–
Tanacetum vulgare Linnaeus, 1758	28.X.2017, R	10	S. f.	VII – IX
	31.I.2018, T	8	–	–
	26.XII.2017, Tr. S	10	–	–
Tussilago farfara Linnnaeus, 1758	16.II.2007, C	4	P. f.	III - V
Senecio vulgaris Linnaeus, 1758	3.XII.2017, T	1	S. f.	III – IX
Carduus acanthoides Linnaeus, 1758	22.XII.2017, T	1	S. f.	VI – IX
	31.XII.2017, O	3	–	–
	15.X.2017, C, R	18	–	–
Cichorium intybus Linnaeus, 1758	26.XI.2017, A	9	S. f.	VII – IX
Leontodon saxatilis Lamarck, 1779	21.XII.2017, T	0	S. f.	VI – VII
Leontodon autumnalis Linnaeus, 1758	29.XI.2017, T	7	S. f.	VII – IX
	20.XI.2017, C	7	–	–

Picris hieracioides Linnaeus, 1758	8.XII.2017, T 3.XI.2017, B, D 15.VI.2004, B	8 14 25	S. f. – P. f.	VII – IX – –
Taraxacum officinale Weber, 1992	16.XII.2017, Tr. S VII – XII.2017 C, R 24.XI.2017, Da 6.I.2018, O 28.XI.2017, A 28.XII.2017, S 28.II.2018, T	7 4 -28 9 8 3 9 7	S. f. – – – – – –	IV – VI – – – – – –
Sonchus asper Linnaeus, 1758	14.X.2017 C, R	17	S. f.	VII – IX
Sonchus arvensis Linnaeus, 1758	25.XI.2017, A X – XI.2017, C, R 12.XII.2017, T	10 6 – 17 17	S. f. – –	VII – VIII – –
Hieracium umbellatum Linnaeus, 1758	9.XII.2017, Tr. S	10	S. f.	VII – IX
Rudbekia triloba Linnaeus, 1758	26.XI.2017, T	12	S. f.	VII – X
Tragopogon pratensis Linnaeus, 1758	3.I.2018, A	1	S. f.	VI – VII
Leucojum vernum Linnaeus, 1758	6.I.2018, A	9	P. f.	III – IV
Galanthus nivalis Linnaeus, 1758	3.I.2018, A 20.XII.2017, T	1 3,5	P. f. –	II – III –

Legend: R = Racovița; A = Anieș; T = Tinca; Ba = Batoți; B = Bechet; D = Desa; C = Cârcea; O = Oradea; Cv = Craiova; S = Sebeș; G = Geoagiu Băi; Ca = Calafat; Da = Dârmănești; Tr. S = Drobeta Turnu-Severin; Car = Caraula; Premature flowering = P. f..; Supplementary flowering = S. f.

DISCUSSIONS

The observed species belong to 33 families. Two families are best represented. They are: Asteraceae (24 species, 24%) and Rosaceae (9 species, 9 %), the other 31 families presented a smaller number of species, ranging from 7 to 1 species, as it follows: Fabaceae – 7 species (7 %), Lamiaceae – 5 species (5 %), Polygonaceae – 4 species (4%), Apiaceae – 4 species (4%), Ranunculaceae – 3 species (3%), Brassicaceae – 3 species (3 %), Scrophulariaceae – 3 species (3 %), Primulaceae – 3 species (3 %), Convolvulaceae – 2 species (2 %), Solanaceae – 2 species (2%), Amaryllidaceae – 2 species (2 %), Dipsacaceae – 2 species (2 %), Caprifoliaceae – 2 species (2 %), Gentianaceae – 2 species (2 %), Papaveraceae – 1 species (1 %), Oleaceae – 1 species (1 %), Oxalidaceae – 1 species (1 %), Molvaceae – 1 species (1 %), Hypocostanaceae – 1 species (1 %), Caryophyllaceae – 1 species (1 %), Onograceae – 1 species (1 %), Plantaginaceae – 1 species (1 %), Corylaceae – 1 species (1 %), Apocynaceae – 1 species (1 %), Asclepiadaceae – 1 species (1 %), Campanulaceae – 1 species (1 %), Geraniaceae – 1 species (1 %), Violaceae – 1 species (1 %), Hypericaceae – 1 species (1 %), Rubiaceae – 1 species (1 %), Betulaceae – 1 species (1 %).

Premature flowerings were registered in 25 species of plants, supplementary flowerings in 88 species of plants and both premature flowerings and supplementary flowerings in 12 species of plants. These data are preliminary, of course, since the number of vegetal species, as well as the number of families they belong to is much higher; new researches will be realised at the level of the entire country in the future.

The analysis of the table presents the phenological anomalies of plants flowering because of the positive temperatures registered in the cold season or because of the high temperatures during springtime (NĂSTASE & NĂSTASE, 2002; DRĂGULESCU, 2003).

CONCLUSIONS

During 2000 – February 2018, phenological anomalies were identified regarding the flowering of spontaneous plants in 100 species from four parts of Romania (south-western, central, central-western and north-western). The positive temperatures from the cold season and the high temperatures from spring have determined both the premature flowerings and flowering extension, sometimes even supplementary flowerings in the cold season (November – February).

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THE ASSESSMENT OF THE ATMOSPHERIC POLLUTION BY ACCUMULATION OF THE HEAVY METALS IN CENTRAL AND PERIPHERAL PARTS OF *Xanthoria parietina* (L.) Th. Fr., ROMANIA

VICOL Ioana

Abstract. This study is focused on heavy metals accumulation by *Xanthoria parietina* (L.) Th. Fr., identified on trees as components of shelterbelts. The fieldwork was performed in three counties – Călăraşi, Vaslui and Dolj – during June-December 2015. A single shelterbelt was investigated in Vaslui and Dolj, while four shelterbelts were investigated in Călăraşi. Thus, six sampling units were selected within each of the shelterbelts, with an area of 9 m^2. In the laboratory, the collected lichen thalli were shifted into two thalline components, i.e. the central and peripheral parts of the thalli. The heavy metals accumulation was analysed both in the central and the peripheral parts of the thalli. The results have indicated that heavy metals were accumulated to a higher extent in the central part of thalli than in peripheral parts. The main source of pollution with heavy metals in the studied sites is car traffic.

Keywords: shelterbelts, *Xanthoria parietina*, pollution, heavy metals, Romania.

Rezumat. Evaluarea poluării atmosferice prin acumularea metalelor grele în părţile centrale şi periferice ale speciei *Xanthoria parietina* (L.) Th. Fr., România. Acest studiu se bazează pe acumularea metalelor grele de către *Xanthoria parietina* (L.) Th. Fr., identificată pe arbori din cadrul perdelelor forestiere. Cercetările în teren s-au realizat în trei judeţe Călăraşi, Vaslui şi Dolj în perioada Iunie-Decembrie 2015. În judeţele Vaslui şi Dolj au fost investigate câte o peredea forestieră în timp ce în Judeţul Călăraşi au fost cercetate patru perdele forestiere. În cadrul fiecărei perdele forestiere au fost selectate câte şase unităţi de probă cu o dimensiune de 9 m^2. În laborator, talurile de licheni colectate au fost separate în două componente taline şi anume: părţile centrale şi periferice ale talurilor. Acumularea metalelor grele a fost analizată atât în părţile centrale cât şi periferice ale talurilor. Rezultatele au indicat că metalele grele au fost acumulate în mare măsură în partea centrală a talurilor în comparaţie cu cea periferică. În siturile studiate principala sursă de poluare cu metale grele este traficul rutier.

Cuvinte cheie: perdele forestiere, *Xanthoria parietina*, poluare, metale grele, România.

INTRODUCTION

The first data on environmental pollution assessed by heavy metals accumulation in lichens were published in 1839 (FARKAS et al., 2001). In the context of this work, the role of forest shelterbelts in the mitigation of the air pollution caused by car traffic and other anthropogenic sources is well known in Romania (GAVRILESCU & BOLEA, 2014). The role of lichens as biomonitors and bioindicators in the assessment of atmospheric quality is also well known; these organisms are efficient acumulators of chemical elements (IANOVICI et al., 2009). Lichens are useful indicators of high contamination with heavy metals caused by anthropogenic sources such as: steel works and power plants (STATE et al., 2010; 2012). In this respect, it has been seen that lichens accumulate higher concentrations of heavy metals as Fe, Pb and Cu (KÉKEDY-NAGY & BARTÓK, 2008).

Biomonitoring by using lichens is necessary for the progressive assessment of the environmental quality. Assessment of the lichens species' presence in a spatial gradient reveals a delimitation of the polluted areas (LARSEN et al., 2007). Thus, ''epiphytic lichens proved to be very effective as an early warning system to detect signs of a changing environment at forest ecosystems'' (LOPPI & PIRINTSOS, 2003).

Although policies have a significant impact on the environment health, the habitats of lichens are still affected by pollution (GIORDANI, 2007). The improvement of atmospheric quality is highlighted by the recolonisation of the lichen species in regions with a strong impact of pollution (FARKAS et al., 2001; FRIEDEL & MÜLLER, 2004).

The aim of this study is to highlight the quantity of heavy metals accumulated in the central and peripheral parts of *Xanthoria parietina* (L.) Th. Fr. The main objective of the paper is based on the identification of differences between heavy metals accumulation in the central and peripheral parts of lichen thalli. Thus, higher concentrations are moreexpected in the central parts of lichen thalli (older parts) than in the peripheral parts (juvenile parts).

MATERIALS AND METHODS

A total of six shelterbelts were investigated in the studied area (Table 1). Thus, four of them were investigated in Călăraşi County, one in Vaslui County and one in Dolj County (Fig. 1). Within each shelterbelt, six sampling units were selected, of which 3 were situated near the roadway and the other far away from the roadway, but parallel to the first ones (Table 1). A reasonable distance was kept between sampling units. Each sampling unit had an area represented by 3 m × 3 m. *Xanthoria parietina* was collected on the available trees from each sampling units at a high of 1 m above the ground.

The geographical attributes (counties, localities situated close to all investigated forest formations, altitude, GPS coordinates), metrical characteristics (the length and width of the all of them), car traffic, category of roads (Table

2), floristical composition, as well as the presence of plastic waste near each forest shelterbelts (Table 1; Table 3) were mentioned at the level of the each shelterbelt. The intensity of car traffic was assessed by counting the number of cars for ten minutes (the number of cars passing by) and the driving time (DONICA, 2007).

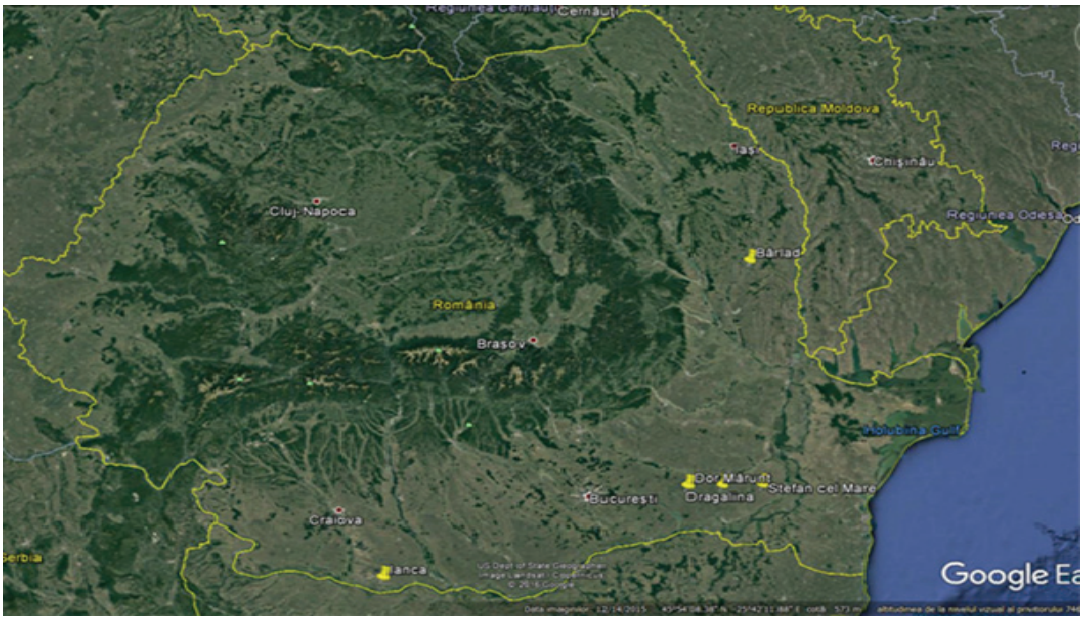

Figure 1. The geographical position of the investigated shelterbelts (https://www.google.ro/maps).

Table 1. The description of the sampling information within the studied area.

County	Locality	Number of the sampling units	Host trees of the lichen species
Călărași/1	Near Dor Mărunt	6	*Robinia pseudacacia* L.
Călărași/2	Near Dragalina	6	*Robinia pseudacacia* L.
Călărași/3	Near Dragalina	6	*Robinia pseudacacia* L.
Călărași/4	Near Ștefan cel Mare	6	*Robinia pseudacacia* L.
Vaslui	Near Bârlad	6	*Gleditsia triacanthos* L., *Robinia pseudacacia* L., *Acer negundo* L., *Juglans regia* L.
Dolj	Near Ianca	6	*Robinia pseudacacia* L.

Table 2. Geographical, metrical, traffic car and roadway characteristics for the investigated shelterbelts.

County	Locality	Altitude (m)	GPS coordinates	Metrical characteristics (km)	Car intensity	Driving time	Road category
Călărași/1	Near Dor Mărunt	48	44.43454°N 26.97512°E	L ~ 4, l ~ 0.025	-	-	NR 3A
Călărași/2	Near Dragalina	49	44.43195°N 27.11026°E	L ~ 3, l ~ 0.050	-	-	NR 3A
Călărași/3	Near Dragalina	38	44.42448°N 27.48567°E	L ~ 7, l ~ 0.025	-	-	NR 3A
Călărași/4	Near Ștefan cel Mare	46	44.42148°N 27.65607°E	L ~ 1.5, l ~ 0.006	-	-	NR 3A
Vaslui	Near Bârlad	71	46.19706°N 27.64443°E	L ~ 0.40, l ~ 0.035	57	10^{17} - 10^{27}	NR 24
Dolj	Near Ianca	38	43.78551°N 24.13971°E	L ~ 0.40, l ~ 0.035	-	-	NR 54A

Legend: L – length, l – width, NR –National Road

In the studied area *X. parietina* has not been rather abundant to be collected or in some cases has been absent on investigated trees. Lichen thalii were identified and collected on black locust only near Dragalina (Călărași County) within the third station, because *X. parietina* was somehow abundant on available trees (Table 3). The collected lichen samples were transported in laboratory and were cleaned using tweezers. The sample was not washed to avoid heavy metals loss. The third station from Călărași County is represented by **one** sample of thalli split up into two thalline components: central parts and peripheral ones. The concentration of the following heavy metals was measured: Pb, Cd, Ni, As, Hg, Al, Cs, Cr, Zn, Co, Cu, Fe and Mn (Table 4) by Energy Dispersive X-ray Fluorescence (EDXRF). The map was created using https://www.google.ro/maps.

RESULTS AND DISCUSSIONS

Of the all investigated shelterbelts *X. parietina* for heavy metals analysis was only collected in one. Due to the lowest abundance of the *X. parietina* (Fig. 2) on the tested trees, only one sample was collected within a shelterbelt situated in the third site from Călăraşi County (Table 3).

Table 3. Field observations on both host trees of the investigated lichen species and studied shelterbelts.

County	Host trees of the lichen species	Observations
Călăraşi/1	*Robinia pseudacacia* -	The cover of the lichen species was higher under a high of 1 m. The cover of *X. parietina* and *Phaeophyscia* sp. was very lower at a high of 1 m above on elms and acacias.
Călăraşi/2	*Robinia pseudacacia*	The trees were not covered with lichens!
Călăraşi/3	*Robinia pseudacacia*	*Xanthoria parietina* has been abundently on *Robinia pseudacacia*
Călăraşi/4	*Robinia pseudacacia*	The cover with *X. parietina* was rather low.
Vaslui	*G. triacanthos, R. pseudacacia, A. negundo, J. regia*	The cover of *X. parietina* and *Phaeophyscia* sp. was very low at a height of 1 m above. Lichen coverage was lower on facing the road. Plastic waste was stored near this forest formation.
Dolj	*Robinia pseudacacia*	The cover with *Physcia adscendens*, *X. parietina* şi *Evernia prunastri* was lower on trees facing the road. Plastic waste was stored near this forest formation.

Figure 2. *Xanthoria parietina* on a corticolous substrata (photo: Vicol Ioana, 01.09.2015, original).

Generally, it was observed that the central parts of lichens have accumulated higher concentrations of heavy metals than younger parts (Table 4).

Table 4. The heavy metal concentrations in collected *Xanthoria parietina* samples.

Heavy metals	Central parts	Peripheral parts
Pb	4,70	2,89
Cd	0*	0*
Ni	2,45	6,53
As	0,91	0,64
Hg	0,30	0,35
Al	674,11	514,51
Cs	0*	0*
Cr	2,47	2,43
Zn	51,56	22,09
Co	0*	0*
Cu	7,64	7,66
Fe	1046,37	893,70
Mn	31,27	32,01

Legend: *under the detection limit

The investigated site was situated near the roadway, therefore the main pollution source with heavy metals in this case is vehicular traffic. Another study revealed that the increase of distance from the roadway is correlated to a decrease of Pb, Cd, Cr and Zn (VICOL, 2014). Also, plastic waste stored near or within shelterbelts (Fig. 3) is another source of heavy metal pollution. In the present study, especially near shelterbelts from Vaslui (near Bârlad) and Dolj (near Ianca) counties, plastic waste was stored, that could represent a synergic source of heavy metals in the atmosphere.

Figure 3. *Xanthoria parietina* on its host trees (black locust) within a shelterbelt situated near Ianca in Dolj County, along NR 54A (photo: Vicol Ioana, 08.12.2015, original).

Car traffic is responsible for the release of heavy metals such as Pb, Cd, Cr, Zn, Mn, Cu into the atmosphere. Thus, by combustion of unleaded petrol and diesel oil, Pb contamination is rather obviously, especially by attrition of tyre wear and brakes. Also, Cd and Zn are found in higher concentrations in the environment (ULUOZLU et al., 2007; ASLAN et al., 2011). Other studies revealed differences between lichen species as regard heavy metal accumulation due to morpho-anatomical and eco-physiological particularities. Thus, *Parmelia sulcata* Taylor with a foliose thalli has accumulated Fe, Mn, Ni and Ti whilst *Evernia prunastri* (L.) Ach. with a fruticose thalli has accumulated Cu in natural areas from southeastern Serbia. In the same study within two polluted localities, both lichen species have accumulated Fe and Zn (Cerje locality) and Ba (Donje Vlase locality) STAMENKOVIĆ et al. (2013).

Otherwise, as regard the accumulation of heavy metals in cormophytes, in a study performed on coniferous vegetation along a roadside in Hamden (Connecticut, United States) a greater concentration of Pb was revealed in older needles than in younger needles. In this study, it was demonstrated that far away from the roadway, the shelterbelt has an important role in the mitigation of pollution (HEICHEL & HANKIN, 1976). Forested areas have a great importance for heavy metal mitigation in the atmosphere. This facts show that forest habitats act as biotic barrier against pollution (STATE et al., 2010). In a study performed in Vallombrosa (Italy), it was found that car traffic represents a risk to the health of forest ecosystems and their associated lichen species, especially by Pb contamination (LOPPI & PIRINTSOS, 2003). *Evernia prunastri* was used to monitor atmospheric pollution in Colle di Val d'Elsa (Italy). It was shown that the used lichen species accumulated Na, Cr, Cu, Fe Pb and V in higher concentrations. In this case, car traffic and a crystal factory are the main anthropic sources of environmental pollution (LOPPI & FRATI, 2006). In Romania, the assessment of environmental pollution with Pb, Cu, and Zn by using lichen species was performed in Zlatna and Baia Mare. Zlatna was revealed to be one of the strongly polluted regions on the world because of anthropogenic activities occurring for a long time (BARTÓK & RUSU, 2004).

CONCLUSIONS

It was observed that central parts of lichen thalli are prone to a higher accumulation of heavy metals than peripheral ones. This capacity to accumulate heavy metals contributes to an improvement of atmospheric quality and, consequently, to the reduction of chemical elements in environment.

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CONSIDERATIONS ON THE BIOREMEDIATION CAPABILITY OF SOME BACTERIAL STRAINS ISOLATED FROM CONTAMINATED AREAS

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Abstract. The paper is a review of the researches and experiments undertaken to assess the capability of some bacterial strains, isolated mainly from contaminated environments, to intervene in bioremediation processes. An unconventional alternative was thus attempted to reduce contaminants in various areas, not just industrial ones, by identifying the source of damage to the area under study, reducing the level of exposure of population and maintaining or restoring ecological balance in the absence of disruptive products. Laboratory research has been focused both on the analysis of soil and water samples taken from affected areas, the isolation, cultivation, testing, preservation and identification of bacterial strains of biotechnological interest, as well as the study of microorganisms under the influence of contamination stress. The paper cites only the list of papers published by the research team of the Department of Microbiology of IBB, involved in bioremediation, the results and observations recorded being a substantial contribution both in the understanding of the mechanisms of action of some physiological groups of bacteria and in demonstrating the applicability of some technologies, recognized as effective and sometimes more affordable, as compared to conventional processes.

Keywords: bioremediation, petroleum hydrocarbons, bioproducts, acidophilic chemolithotrophic bacteria, phytoremediation.

Rezumat. Consideraţii privind capacitatea de bioremediere a unor tulpini bacteriene izolate din zone contaminate. Lucrarea constituie un review al activităţii de cercetare şi experimentare, privind capacitatea unor tulpini bacteriene, izolate cu precădere din medii contaminate, de a interveni în procesele de bioremediere. S-a încercat în felul acesta aplicarea unei alternative neconvenţionale de diminuare a contaminanţilor din variate zone, nu doar industriale, prin identificarea sursei de afectare a zonei luate în studiu, reducerii nivelului de expunere al populaţiei şi menţinerii sau reinstalării echilibrului ecologic, în absenţa produşilor perturbatori. Cercetările de laborator au urmărit atât analiza probelor de sol şi apă, prelevate din zonele afectate, izolarea, cultivarea, testarea, prezervarea şi identificarea unor tulpini bacteriene de interes biotehnologic, dar şi studierea microorganismelor sub acţiunea stresului de contaminare. Lucrarea citează doar lista de lucrări publicate de colectivul de cercetare al Departamentului de Microbiologie al IBB, implicat în problematica bioremedierii, rezultatele şi observaţiile înregistrate constituind o contribuţie substanţială atât în înţelegerea mecanismelor de acţionare a unor grupe fiziologice de bacterii, cât şi în demonstrarea aplicabilităţii unor tehnologii, recunoscute drept eficiente şi uneori mai accesibile, comparativ cu procedeele convenţionale.

Cuvinte cheie: bioremediere, hidrocarburi petroliere, bioproduşi, bacterii chemolitotrofe acidofile, fitoremediere.

INTRODUCTION TO THE APPROACHED BIOREMEDIATION PROBLEM

After a long period of in-depth studies concerning the microbiology of oil, not accidentally generated by the oil crisis in the ‘70s, a group of researchers from the Center for Microbiology of the Institute of Biology of Bucharest (IBB) have approached biotechnological researches of microbial recovery of low-yield deposits of oil, in parallel with understanding and laboratory simulation of the mechanisms of oil release from porous media under the action of micro-organisms.

The areas where the bacterial samples were collected were, besides the oil and sewage water from the extraction wells, batches, tailings and oil reservoirs, sludge deposits from oil park areas or pumping stations, all that consisted of petroleum contamination generated by extraction, processing or transport of oil, but also infiltration of crude oil or its derivatives at the level of surface waters, running or standing, fresh or coastal, up to the level of the aquifer (LAZĂR et al., 1998a; b; c), with water that carries kilometers from the source of contamination, that film with rainbow reflections, called "plume", which betrays the presence of chronic, historical pollution with oil hydrocarbons (BICA et al., 2008).

It was necessary, or only attempted, to test unconventional remediation biotechnologies of the affected areas, "accidentally" contaminated, or as a result of a long exposure, as is the case of railway sleepers and other access ways soaking, in order to start the vast process of decontamination, depollution and rendering in the circuit of a clean environment of vast and varied areas ignored, forgotten or postponed to be improved, with repercussions and implications often extremely difficult to correct.

Isolation of some hydrocarbon-oxidant bacterial strains directly from the contaminated environments (LAZĂR et al., 1994; LAZĂR et al., 1995a; b; c), selection in order to obtain metabolites producing populations similar to detergents (DOBROTĂ et al., 1988; 1994; 1999a, b; 2005; DOBROTĂ & ŞTEFĂNESCU, 2005), the ability of some bacterial inocula to consume, as sole source of carbon and energy, oil hydrocarbons (DOBROTĂ et al., 1997; 2000; DOBROTĂ & ŞTEFĂNESCU, 2005) represented the basis for our laboratory researches and field experiments for testing alternative biotechnologies for cleaning and protection of the environment.

Contaminated environments can also be industrial installations, ducts and closed spaces belonging to the oil industry, clogged with paraffin deposits (LAZĂR et al., 1999a). Thus, the microbial researches, studies and experiments have expanded to the reduction of wax and paraffin deposits within the oil extraction pipelines of the marine oil platforms.

Another aspect addressed by IBB's Department of Microbiology researchers, largely the same who studied the aspects related to oil contamination and pollution, was the problem of mining waste deposits (CISMAŞIU et al., 2015)

and industrial effluents represented by the infiltration and sinking waters from the mining tailings dumps (LAZĂR et al., 1997a; KONTOPOULOS et al., 1998) and from tailing ponds with high content of heavy metals and radioactive ions. The tolerance of some bacterial strains to increased acidity conditions, the bioaccumulation capacity of some metal ions, biosorption and bioprecipitation, demonstrated under laboratory conditions, led to the setting up of treatments based on biofiltration columns that contribute both to the accumulation of metallic ions of interest, and the reduction of the contamination level of the industrial effluents (PERTIŞOR et al., 2003).

In the case of mining tailings dumps, in order to reduce the level of contamination by wind and pluvial dispersion, phytoremediation methods have been designed by covering the deposits with a vegetative layer (LAZĂR et al., 1998b; 2001a) which, by means of the roots, fixes the surface layers, contributing, together with the tolerant microbiota, to the formation of a persistent rhizosphere (LAZĂR et al., 2001a; b; ŞTEFĂNESCU et al., 2008b). The cultures made in the institute's greenhouse, with enriched soil variants and herbaceous, shrub and tree species with high resistance to high concentrations of metal ions, have been valued experiments, as well as extending the wetland type systems of decontamination and concentration of industrial waste from effluents generated by drug factories (LAZĂR et al., 2002b) or leather processing (LAZĂR et al., 2002a; IONESCU et al., 2005; 2010).

All these applicative biotechnological directions involved also advanced microbiological researches, based on molecular techniques for bacterial identification and biochemical characterization of metabolic products implicated in the decontamination processes (CÎRSTEA & ŞTEFĂNESCU, 2012).

At the same time, we tried to improve the tested technologies, by developing applicable patents (IONESCU et al., 2004) and with high adaptive capacity to the conditions enforced by the regulations regarding the pollution prevention and the environmental protection.

STUDY CASES

1. Reducing crude oil contamination

a) Soils contaminated with oil hydrocarbons. As mentioned above, contamination with crude oil and oil-based hydrocarbons includes huge areas of land, and can be expanded horizontally or vertically to the area adjacent to the surface waters, respectively, the shallow groundwater layer. The laboratory bioremediation experiments and field pilot experiments (DOBROTĂ et al., 1997) have tested the ability of some bacterial strains isolated from hydrocarbon-contaminated areas to use oil as the sole source of carbon. Laboratory simulations used both pure bacterial strains and blends or mixed cultures (LAZĂR et al., 1995a; b; c; 1996). In field applications, the test area was soiled in order to increase the contact surface with both the atmospheric air (oxygenation and evaporation) and with the applied bacterial inoculum (DOBROTĂ et al., 2000). The extraction or depositing mud extracted from the batches was preferred over impermeable tars with low permeability and wettability (LAZĂR et al., 1999c; 2002b). At laboratory level, detailed characterizations of hydrocarbon-oxidant bacterial strains (LAZĂR et al., 1994; 1998c) and selections (LAZĂR et al., 1997b) were made, considering the type of crude oil subjected to bioremediation and climatic characteristics, when actions were taken in the field (LAZĂR et al., 1999b). All these researches, related to the involvement of bacterial strains in specific biotechnologies for the remediation of oil hydrocarbon type contaminants in various areas, are widely presented in the bibliographic list (VOICU et al., 1997b; PETRIŞOR et al., 2001; 2002a; ŞTEFĂNESCU & DOBROTĂ, 2005; LAZĂR & ŞTEFĂNESCU, 2006; ŞTEFĂNESCU et al., 2009).

b) Oil hydrocarbons contaminated water and aquifers. The presence of oil contaminants in surface waters, standing or flowing, is generally the result of accidents due either to corrosion of transport pipelines or to discharge or negligence in handling. The study cases ensured sampling of water from the sea (ŞTEFĂNESCU et al., 1999) and from lakes, swamps and from the lower course of the Danube (Sulina arm). At the same time, the oil-contaminated aquifer of the Ploiesti oil extraction area (LAZĂR et al., 1998a; VOICU et al., 2000; ŞTEFĂNESCU et al., 2008b; BICA et al., 2009) was analysed, whereby micro-organisms were isolated and further selected in the laboratory (VOICU et al., 2009b).

At the laboratory level, in collaboration with researchers of the Technical University of Civil Engineering in Bucharest, pilot systems were developed for evaluation, simulation, retention and testing of the remediation capacity of some bacterial strains, using unconventional technologies applied to aquifers affected by historic pollution (BICA et al., 2008).

c) Reduction of paraffin deposits in oil pipelines. Another successful challenge was the laboratory testing of the capacity to reduce the paraffin deposits (VOICU et al., 1997c; 2002) and the use of hydrocarbon-oxidant bacterial consortia for prevention and for the cleaning of oil pipelines from offshore drilling platforms (LAZĂR et al., 1995a; VOICU et al., 1995a; b; 1997a).

d) Isolation and selection of bio-products with remedial potential. The remedial action of some isolated bacterial consortia isolated from hydrocarbon-contaminated environments on a wide variety of contaminants is due to the direct and/or synergistic activity of some emulsifying/de-emulsifying properties of several metabolites of rhamnolipid type (surfactants). Laboratory studies and researches have shown their ability to break the oil contaminant film, thus increasing the contact surface between the two phases, water/crude oil, which leads to faster metabolization of the carbon source. The obtained results (DOBROTĂ et al., 1988; 1994; VOICU et al., 1994a; ŞTEFĂNESCU et al., 1997; DOBROTĂ et al., 1999a; b; DOBROTĂ & ŞTEFĂNESCU, 2004; 2005; CÎRSTEA & ŞTEFĂNESCU, 2012) confirmed the theory, leading also to the isolation and characterization of these bacterial bioproducts with large biotech applications.

2. Others biotechnicals domains

e) Reduction in the contamination level of industrial effluents. Another issue regarding the reduction of the contamination of the spill water by bacterial technologies was the bacterial degradation of phenols in waste waters (VOICU et al., 1994a; b; LAZĂR et al., 1995b) from the chemical-pharmaceutical and leather industries. Microbial consortia capable of metabolizing a number of organic compounds (LAZĂR et al., 2002a; VOICU et al., 2003a) present in the industrial effluents were used and filtration columns (percolator batteries) were provided, supporting a wide range of porous materials such as sand quartz, montmorillonite, kaolin and shell sand, these being true biofilters, the efficiency of which has been tested in both laboratory and pilot stations, designed by our specialists, in collaboration with those from the National Institute For Chemical - Pharmaceutical Research and Development – ICCF Bucharest (IONESCU et al., 2005). Recognizing the effectiveness of the biotechnological purification processes has led to the award of medals for the patents registered with OSIM (IONESCU et al., 2004; 2010). The opportunity to isolate and select bacterial strains or consortia with bioremediation potential from contaminated waters, creates the framework for testing some alternative and unconventional ways to reduce the level of environmental damage, by self-regulation (natural remediation) without disturbing its biological balance (MACOVEI et al., 2005).

f) Intervention of some groups of acidophilic chemolithotrophic bacteria in biohidrometallurgical processes. Bioremediation applications have also covered areas affected by metal ion contamination from either mining or mobilizing these toxic ions from mining tailings dumps. The study cases were around the villages of Şesei Valley, Roşia Poieni and the Aries basin (PETRIȘOR et al., 1997; LAZĂR et al., 1999a; VOICU et al., 2009a; b; c). Water samples were taken from the tailing ponds of these operations, from which heterotrophic and acidophilic chemolithrophy bacterial strains were isolated, exhibiting biotechnological potential in leaching, bioaccumulation and bacterial bioprecipitation processes (CISMAȘIU et al., 2015). Laboratory tests have demonstrated the ability of these microorganisms to metabolize and fix some metallic ions present in excess in industrial spill waters, thus contributing to the reduction of the heavy metal pollution level (VOICU et al., 1998; PETRIȘOR et al., 2003). An interesting study was the signalling of Black Sea pollution with metal ions, brought by pluvial infiltration streams formed in the mining tailing dumps from Baia and Somova (Tulcea County) (KONTOPOULOS et al., 1998).

g) mining pits protection by phytoremediation. Concerning the same aspects of preventing the release of contaminating particles from industrial storage dumps under the action of precipitations, that generate infiltration waters and winds (wind processes) that erodes and mobilizes dust at great distances from the source of danger, we have tried to cover and plant on the heaps resistant plant species, while generating a rhizospheric layer with a rich microbiotic activity. Previous researches on phytoremediation were carried out under greenhouse conditions, on soil variants with amendments and different concentrations of chemical elements, testing the vegetal species chosen for cultivation until the flowering stage. The mining tailings dumps at Baia and the phosphogips tailings dump from Năvodari were taken into consideration. The microbiological researches focused on characterization of the microbial activity from the rhizosphere of the vegetal layer installed on the heap surface (LAZĂR et al., 2001a; c; ȘTEFĂNESCU et al., 2001) and on monitoring the development of vegetal carpet (LAZĂR et al., 1998b; 2001b; PETRIȘOR et al., 2002b).

CONCLUSIONS

Presentation of the various fields of research that have been approached give an idea on the many potential applications of microbial technologies for the remediation of environments affected by the presence of anthropogenic contaminants.

The paper, based on a several decades' work of the research team, is a synthesis of the bioremediation researches concerning the testing and implementing of widely applicable biotechnologies (VOICU et al., 2003a; b; ȘTEFĂNESCU et al., 2008a; ȘTEFĂNESCU & CÎRSTEA, 2010; 2011).

We preferred to isolate the bacterial strains directly from affected areas of (VOICU et al., 2009c), which are adapted to the local conditions, precisely because the potential application of the decontamination technologies does not destabilize the natural balance of the areas under study.

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THE IMPACT OF INVASIVE SPECIES ON URBAN ECOSYSTEMS

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Abstract. The intensive development of urban ecosystems in the last few centuries, but also the awareness of the importance of harmony between man and nature, has led to an increase of research into the factors affecting the biodiversity. Climate change, habitat fragmentation, the spread of invasive species, pollution are among the main factors harmful to the dynamics of ecosystems and their resilience. After loss of habitats, invasive alien species are the second most important cause of global biodiversity loss. Urban lakes, even if most of them have artificial origin, with a low α-diversity, meet an important role in the well-being of human population. The resilience of the urban ecosystem caused by anthropogenic impacts is much lower than in natural ecosystems due their simple structure. With the introduction of exotic species, their impact is produced by several cumulated factors, namely: new pathogens, high rates of reproduction, food competition and a weak or absent of higher consumers control. These conditions favour their expansion to the detriment of native species. Legislative and population awareness measures have to be taken, regarding access routes for invasive species, their environmental effects and economic loss and not least the application of integrated control actions.

Keywords: Bucharest lakes, non-indigenous species, *Ameiurus* genus, ecosystem services.

Rezumat. Impactul speciilor invazive asupra ecosistemelor urbane. Dezvoltarea intensă din ultimele secole a ecosistemelor urbane dar şi conştientizarea importanţei armoniei dintre om şi natură, a dus la o creştere a cercetărilor privind factorii care afectează biodiversitatea. Schimbările climatice, fragmentarea habitatelor, răspândirea speciilor invazive, poluarea, sunt printre principalii factori dăunători asupra dinamicii ecosistemelor şi a capacităţii lor de rezilienţă. După pierderea de habitate, speciile invazive reprezintă a doua cea mai importantă cauză a pierderii biodiversităţii la nivel mondial. Lacurile urbane, chiar dacă majoritatea au o origine artificială, cu o diversitate redusă, joacă un rol important în bunăstarea populaţiei umane. Datorită structurii lor simple, rezilienţa ecosistemelor urbane ca urmare a impactului antropic, este mult mai scăzută decât in cazul ecosistemelor naturale. Odată cu introducerea speciilor exotice, impactul lor este produs de mai mulţi factori cumulativi şi anume: agenţi patogeni noi, rate ridicate de reproducere, competiţia pentru hrană şi un control slab sau absent al consumatorilor superiori. Aceste condiţii favorizează extinderea lor în detrimentul speciilor indigene. Sunt necesare măsuri legislative şi conştientizarea populaţiei umane privind căile de acces pentru speciile invazive, efectele lor asupra mediului şi pierderile economice şi nu în ultimul rând aplicarea unor acţiuni de control integrat al populatiilor non-native.

Cuvinte cheie: lacuri din Bucureşti, specii non-indigene, genul *Ameiurus*, servicii ecosistemice.

THE CHARACTERISTICS OF URBAN LAKES

The intensive development of human society in the last centuries as a result of industrialization has led to a need for concentration in cities much higher than in rural areas. As a result of the expansion of the urbanization process, a new ecosystem type appeared, urban ecosystems, where energy inputs are artificial and the dominant species is taken over by man. Urban ecosystems are different from natural ones, because they als include, besides the natural component, the built-up component and the socio-economic environment (BOTNARIUC & VĂDINEANU, 1982; NASELLI-FLORES, 2008). Within these systems we find parks and water bodies that provide a range of services in the well-being of the human population such as air purification, modulation of temperature and humidity in the atmosphere.

Urban lakes are in most cases man-made and few of them are natural ecosystems in cities. Artificial ones resulted either from excavation works, or were built to be recreational parks. For this reason, urban lakes generally tend to be small in the surface (max 10 km^2) and depth (max 6 m) and are not very complex in the trophic network. Much of the water that feeds them comes from springs and rainfall. Physico- and chemical traits depend on the extent of the source of supply but also on the influence of the city on microclimate conditions (SCHUELER & SIMPSON, 2001). There are five types of urban ecosystems: nature reserves, ornamental lakes, garden pounds, drainage systems and industrial pounds (HASSALL, 2014).

POnds are much simpler in terms of α-diversity compared to large lakes or rivers, but are characterized by a greater diversity of environmental conditions, thus reflecting β-diversity. In order to preserve the biodiversity of urban ecosystems, it is not only sufficient to know the richness of species and their share in the ecosystem, but also their importance in the ecosystem function. Thus, common species are cosmopolitan and cannot serve as indicator, keystone, flagships, umbrellas species, etc. (VERMONDEN, 2010).

The resilience of ecosystems is closely related to biodiversity, the tolerance capacity of organisms and their involvement in key control processes. If the natural variations of environmental factors are characterized by normal dynamics, ecosystems have recovery mechanisms based on "*ecological memory*". The degradation of ecosystems caused by anthropogenic impacts affects the ability to recover with effects in changing the biotic component or breakdown of the food web (CARPENTER & COTTINGHAM, 1997; BENGTSSON et al., 2003). The cumulated natural and anthropogenic disturbing factors affect the resilience of ecosystems, especially in the cases with low diversity (VINEBROOKE et al., 2004). In order to reduce the anthropogenic impact on aquatic biodiversity, it is

necessary to prevent species losses including the economically less important levels, such as invertebrates or aquatic plants. Unfortunately, only a certain biotic component that can easily adapt to the pressure factors that characterize urban ecosystems is favoured, and these are often the exotic species. These anthropogenic changes of aquatic ecosystems make it difficult to preserve and protect native species (FRANKLIN, 1988).

The conscious introduction of exotic species has been accomplished for a very long time, man being tempted to bring exotic plants and animals either for economic or decorative purposes. Even though these were often kept under controlled conditions, some of them got into the environment and have changed the fate of many ecosystems.

THE FEATURES OF INVASIVE SPECIES

The Convention on Biological Diversity (CBD) considers invasive species as one of the major threats to biodiversity and natural capital and refers not only to foreign species introduced from other areas, but also to species introduced and spread *outside their natural habitat or present distribution* (HANEL et al., 2011).

In Romania, 47% of the territory is represented by natural and semi-natural ecosystems, bringing important contributions to European biodiversity (BĂNĂDUC, 2008). As in the rest of Europe, in Romania, there are many species that acclimated and became invasive, affecting the native component significantly (BĂDEANU et al., 2009).

For example, along the Snagov Lake, the most significant invasive species in this Protected Area are: *Nelumbo nucifera* (also known as Indian lotus, sacred lotus, bean of India, Egyptian bean), *Dreissena polymorpha* (Zebra mussel), *Lepomis gibbosus* (pumpkinseed, pond perch, common sunfish) and *Carassius gibelio* (Prussian carp, silver Prussian carp or Gibel carp) (*** ANPLS Mangement Plan, 2015).

"Visible" examples of invasive fish species in the urban lake ecosystems in Bucharest are bullheads species, Ameiurus (Ictalurus) found in Bucharest. In the Colentina River, the brown bullhead (*Ameiurus nebulosus*) was introduced accidentally, showing a strongly invasive character, becoming the dominant species especially in the Herăstrău, Floreasca, Tei and Plumbuita lakes (STĂNESCU & GAVRILOAIE, 2011). We consider that the anthropogenic impact produced by the fragmentation of the Colentina River has contributed to the decline of habitats, the vulnerability of the native species that have undergone also the competitive pressures, among other things, with these invasive species (BĂNĂDUC, 2008). Ictalurid genera from Siluriformes Order (Le Sueur, 1814) have also been identified in isolated lakes, such as those in the parks of Bucharest (GAVRILOAIE, 2008) or in Văcărești wetland (DRĂGAN et al., 2013).

Initially recognized as species of the genus Ictalurus and subsequently Ameiurus: *Ameiurus nebulosus*, *Ameiurus melas* and *Ameiurus natalis*, were taken from the Mississippi River basin in 1871 as decorative fish for aquariums and ponds (BÉRES et al., 2017). Subsequently, they began to develop aggressively, being thus referred to as invasive species in almost all countries of Europe. Native species prefer warmer and small depth waters being spread in ponds or shallow lakes or in the downstream sections of small and medium streams. Having reached the natural habitats, these species have spread in most European countries. *Ameiurus nebulosus* is the most widespread species, being mentioned in 23 European countries, compared to *A. melas* found in 18 of them. In the Balkan countries, Belgium, UK or Turkey, it is considered to bear a high risk of invasiveness (COPP et al., 2016). Scientific literature highlights the presence of the species *Ameiurus nebulosus* in the more cold European areas, not particularly favorable to this genus. In some cases there has been a replacement of *A. nebulosus* with *A. melas* (BÉRES et al., 2017). Due to the difficulty of taxonomic classification of species based only on morphological features, it is possible that in some ecosystems the two species coexist or produce hybrids and not be properly scientifically evaluated (MOVCHAN et al., 2014).

The studies conducted in various countries across Europe showed that *Ameiurus* species tolerate high pollution conditions with high turbidity, low oxygen concentration and high water temperatures. Their high adaptability and tolerance to precarious conditions has made this species the most widespread foreign species in Europe, with a highly invasive potential risk (RIBEIRO et al., 2008). Such conditions are common in the urban aquatic ecosystems. The success of their spread is supported not only by environmental conditions but also by the diversity of their feeding regime and reproductive strategies such as numerous multi-spawning, nest-guarding spawnings (NOVOMESKÁ & KOVÁČ, 2009; COPP et al., 2016).

Besides the high adaptability to the different types of ecosystems, bullhead species exhibit a high degree of interspecific competition for food and space resources. Bullheads have a varied feeding regime, as the following were found in their guts contents: detritus, algae, snails, fish eggs, insects, worms, fish, crayfish, etc. (*** GISD, 2015; COLLIER et al., 2018). In addition, they affect native species by changing turbidity conditions and predator-prey encounter rates. For example, in European aquatic ecosystems, the pike (*Esox lucius*) is vulnerable to competition with bullhead species (KREUTZENBERGER et al., 2008).

PATHWAYS OF INVASION

In the first phase, the introduction of alien species in Europe started from 1800 and highlighted a progressive increase of alien mammals, invertebrates and plants. A similar trend was only seen for plants in North America. The second phase of biological invasion took place in the period of Industrial Revolution (1820-1840), when the development of international trade across the continents favoured the phenomenon (HULME, 2009).

Non-native species are spread out through various ways: transportation, living industry or miscellaneous (biological control, intentional release, ecosystem disturbance). Because of global human travel, the capacity of species to disperse from natural habitats to other regions has greatly extended.

The important places for the spread of exotic species are transport hubs (shipping ports, airports) (FLOERL & INGLIS, 2005). With the increase of aquarium trade at an international level, a lot of unwanted organisms may be released into the environment, with adverse ecological and economic effects. In order to mitigate the effect on ecosystems, enhanced public education programmes, regulation of aquarium trade and improved legislation on invasive species are needed (STRECKER et al., 2011). The occurrence of non-native fishes in different regions is explained by the introductions through ballast-water exchange, and introductions from aquaria (SEMMENS et al., 2004).

In urban ecosystems, the main way of introducing exotic species is represented by trade in decorative plants and pets (VAN HAM et al., 2013). Human activities favour the colonization of some foreign species, which is not possible naturally. The colonization of species is strongly influenced by regional environmental factors. They act as filters by which the success of overtaking some species is limited (RAHEL, 2002). Urban ecosystems are more vulnerable to the impact of invasive species than natural ones due to the variability of community structure and lower diversity (HILL et al., 2016).

In aquatic ecosystems, most of the invasive species have been intentionally introduced as aquaculture and some of them accidentally. The introduction of foreign fish species began in the eighteenth century and increased later on. Their invasive character has been determined by their impact on occupied habitats, native species, especially fish, by competition for food source, parasites and exotic diseases (OLDEN et al., 2004; CROWL et al., 2008). In addition, in the case of urban water bodies, we encounter exotic plants that have been introduced for decorative purpose or abandoned exotic pet animals.

ENVIRONMENTAL AND ECONOMICAL IMPACT

Thus, the factors that lead to major changes in aquatic biota are complex and generally synergetic. In other words, the increase of pressures from global change, pollution and invasive species has led to the vulnerability of many native species and the increased risk of falling into decline. As mentioned above, as a result of cumulative anthropic pressures, the resilience capacity and supply of goods and services of the ecosystems was significantly affected (POIKANE et al., 2017). The awareness of the effects of introducing invasive species on the environment has led to the need to assess the risks and develop strategies to prevent their degradation as important and long-lasting as in the case of pollution. According to TREBITZ et al. (2017), the invasive species in the US that affected fresh water systems produced annual damage exceeding 120 billion dollars. In Europe, the costs of invasive species are estimated to EUR 12 billion per year. Thus, their effects should worry not only from an environmental point of view, but also from the economic one.

CONTROLLING MEASURES

The ecological and economic effects produced over time have led to the need to assess risk according to the stage of species invasion. The effects of the impact of invasive species on native biodiversity implies the need to establish control management plans for their expansion. It is mandatory in control measures to find effective population and to have the most comprehensive information about target species such as geographical origin, preferred environmental conditions conducive to their development, invasion paths, effects on indigenous species, direct predators.

Prevention is the best measure to control the spread of foreign species. Prevention can be achieved through both social awareness and legislative measures. In the event of a low presence of non-native species, *total eradication* is the recommended action. Another measure to reduce the invasiveness of exotic species is the *rehabilitation of degraded ecosystems* favouring the native species. As an alternative to species control, where effective, *chemical compounds* such as as insecticides and pesticides can be used. Due to the consequences on human health or the risks to other useful species, *biocontrol* can be a cost-effective measure in control of alien species, based on co-evolved natural enemies (MESSING & WRIGHT, 2006; MARTEN & MOORE, 2011). The both numeric and spatial spreading of invasive species requires *integrated measures* (REO et al., 2001; HARVEY & MAZZOTTI, 2014).

For example, in the case of *Ameiurus* species, the most well-known form of fighting it was to capture as many adult individuals as possible for a drastic reduction of its stock. On the other hand, in juvenile stages when spines are less developed, they are vulnerable to predatory fish. Largest fish predators include pike (*Esox* spp.) and pike perches (*Sander* spp.) may control the *Ameiurus* population extension (*** CABI, 2018). The strategies to eradicate these invasive species are still limited because they have not been sufficiently tested (IRIARTE et al., 2005; CUCHEROUSSET, 2006; ANASTASIU et al. 2007; ENDLICHER et al., 2007; LOUETTE et al., 2013; MANTEGHI et al., 2015).

CONCLUSION

Urban ecosystems may represent a major gateway for invasive species dispersion, as a result of high human population density and their concerns of having exotic pets and decorative plants. For this reason, the management of these ecosystems must be done responsibly and especially preventively to permit the development of these living beings in nature, which can pose high risks not only at regional level but also on extended areas.

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THE RESEARCH ON THE METABOLIC CHARACTERISTICS OF GASTROPODS AND THE ACIDOPHILIC BACTERIA TO IDENTIFY POTENTIAL TECHNOLOGICAL IMPLICATIONS

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Abstract. The study is a component part of the collaboration convention numbers 1797/20.05.2015, respectively 1402/21.05.2015 between the Institute of Biology Bucharest, the Department of Microbiology and the Museum of Oltenia Craiova, Department of Natural Sciences, on the topic: The biodiversity of the microbiota from areas with industrial contamination of Oltenia and potential biotechnological applications in order to reduce it. The researches focused on the following objectives: the structural and functional particularities of the lakeside salvation in the Preajba Valley river basin and the floodplain area of the Danube (Km 811-661); industrial pollution and biological clogging as a result of water evaporation due to climate change, as well as the accumulation of metal ions in *Viviparus acerosus* and *Radix balthica* species; desulphurization of coal from Oltenia using acidophilic bacteria of the *Acidithiobacillus* and *Acidiphilium*. The obtained results revealed the increased tolerance of the gastropods species to the presence of metal ions from the industrial activities of solid waste processing in the environment, *Viviparus acerosus* and *Radix balthica* species being bioindicators of the industrial contaminated media in Oltenia Plain because it signals early the occurrence of some negative changes within the lake ecosystems.

Keywords: Preajba Valley, Danube Delta, populations of gastropods, acidophilic bacteria, Oltenia Plain.

Rezumat. Cercetări privind caracteristicile metabolice ale gasteropodelor şi bacteriilor acidofile cu implicaţii în identificarea potenţialului tehnologic. Studiul este o parte componentă a conventiei de colaborare numerele 1797/20.05.2015 respectiv 1402/21.05.2015 dintre Institutul de Biologie Bucureşti, Departamentul de Microbiologie şi Muzeul Olteniei Craiova, Secţia de Ştiinţele Naturii, având ca temă: Biodiversitatea microbiotei din areale cu contaminare industrială ale Olteniei şi potenţiale aplicaţii biotehnologice în scopul diminuării acestuia. Cercetările au vizat următoarele obiective: particularităţile structurale şi funcţionale ale salbei de lacuri din bazinul hidrografic Valea Preajba şi zona inundabilă a Dunării (Km 811-661); poluarea industrială şi colmatarea biologică, ca urmare a evaporării apei în urma schimbărilor climatice, precum şi acumularea de ioni metalici la specii de gasteropode *Viviparus acerosus*, *Radix balthica*; desulfurizarea cărbunilor din Oltenia folosind bacterii acidofile din genurile *Acidithiobacillus* şi *Acidiphilium*. Rezultatele obţinute au evidenţiat toleranţa crescută a speciilor de gasteropode la prezenţa în mediul înconjurător a ionilor metalici proveniţi din activităţile industriale de prelucrare a deşeurilor solide, speciile *Viviparus acerosus* şi *Radix balthica* fiind bioindicatori ai mediilor contaminate industrial din Câmpia Olteniei deoarece semnalizează timpuriu apariţia unor modificări negative în cadrul ecosistemelor lacustre.

Cuvinte cheie: Valea Preajba, Lunca Dunării, populaţii de gasteropode, bacterii acidofle, Câmpia Olteniei.

INTRODUCTION

Research conducted as part of a comprehensive national program of knowledge of the representative ecosystems of Romania, makes an important contribution to defining the role and place of a system of lowlands basin - the Preajba Valley within Oltenia Plain from Dolj County and the lake ecosystems in the floodplain of the Danube.

The assessment of the biodiversity of the organism communities present in natural and anthropogenic ecosystems is of particular importance in the global context of the disappearance of many species of organisms as a result of human activity. Due to human-induced changes in natural habitats, the identification and protection of natural species is now an international priority (BREZEANU et al., 2011; CIOBOIU, 2014a; b).

This study presents more research on aquatic, lentic and loamy ecosystems in the floodplain areas of the Danube in the Oltenian sector and the Preajba Valley basin system. This research demonstrates the importance of the Danubian-Carpathian space in preserving specific biodiversity.

In the Oltenian sector, according to the results, the algae register the greatest diversity, bacillus and chlorophyll being dominant. Marsh and aquatic macrophytes have an important place in the bioeconomy of the ecosystems in the studied areas. The studies have revealed the existence of 24 fauna invertebrate groups, protozoa, rotifers, copepods, cladocerans, Oligochaeta, gastropods, bivalves, amphipods, dragonfly, Chironomidae being dominant. In these ecosystem assemblies, gastropod species play an important role among consumers, as they represent an accumulation factor and mass transfer towards higher order energy consumers, such as fish.

THE STRUCTURAL AND FUNCTIONAL CHARACTERISTICS OF THE LAKES FROM PREAJBA VALLEY UNDER THE INFLUENCE OF CLIMATE CHANGES

The research approach has started from the concept that a basin system presents a wide variety of geographic, physicochemical, and ecological relationships in particular. In these context, taking into account the Preajba Valley basin system, the study was of a priority character because it presents for the first time the structural-functional characteristics of

such a lacustrine complex. The system, enclosed in the Jiu river basin, comprises a network of terrestrial and aquatic ecosystems with an area of 30 Km^2. In this space, there is grouped a variety of ecosystems: small hills covered by pastures and meadows, farmland and a complex river system: springs, streams, rivers, marshes, small reservoirs.

The construction of dams and the formation of lakes have a double effect on a river from the ecologic viewpoint: a positive one, by enhancing the diversity of ecosystems and biodiversity types and another by the imbalance of biocoenotic structures and the deregulation of the physiology and behavior of some populations (especially fish reproduction migration or survival of fish). The same situation is encountered in the course of the Preajba Valley river: on the one hand, the enrichment of the natural environment with new elements of the landscape and the appearance of the lake ecosystem with specific population structures and, on the other, the degradation of the rheophilic ecosystem downstream the dam, as a result of the reduction of the water flow below the minimum required for the preservation and operation of the rheophilic biocoenotic structures.

Referring to the hydrographical and hydrological characteristics of the area, it was revealed that the hydrographic network is the result of the influences of the relief, the lithological structure, the climate and the soil. It should be noted that the Preajba Valley complex, consisting of the main course - the 9.6 km long Preajba river and 6.8 km of its tributary, the Bătrâna Valley, has an area of 20.2 Km^2. The main source of river supply is the 50 springs located at the morphological contact between Romanați Plain and the high terrace of the Jiu River. The 14 lakes formed through the barrage of the Preajba River and its tributary, the Bătrâna Valley, In relation to the precipitation dynamics and the use of lake water for fishery purposes, in some periods, upstream lakes (I - IV) as a result of the evaporation process have a pronounced decrease in water surface. They get the character of marshlands. The surface of the lakes is mainly determined by the width of the valley and the major bed (the former meadow), as well as by the length of the dam and its height (CIOBOIU, 2002; 2011; 2014a).

The peculiarity of this hydrographic basin consists in the fact that it runs in the east-west direction, contrary to the directions of the other hydrographic basins in Oltenia Plain. The importance of this pool derives from the fact that, being 6 km south of Craiova, this area offers a recreational area with multiple functions (watering, sport fishing, etc.). The area is not affected by strong sources of pollution; however, due to the penetration of mineral nutrients from the neighboring agricultural fields where fertilizers are used and the spillage of a small amount of domestic waste water, the lakes have a high degree of eutrophication (CIOBOIU & PLENICEANU, 2005).

The water chemistry is characteristic of the eutrophic ecosystems. In terms of surface water quality conditions, the small lakes of the Preajba river fall in the second category (bicarbonate - sulphato - calcic - magnesium) and can be used for fish farming, as well as for tourist and leisure purposes (CIOBOIU & CHICIUDEAN, 2003; CIOBOIU & BREZEANU, 2009).

THE BIOLOGICAL CLOGGING FOLLOWING WATER EVAPORATION FROM CLIMATE CHANGE AND ACCUMULATION OF METALLIC IONS IN GASTROPODS SPECIES

An important component of these industrially contaminated ecosystems is represented by microorganisms. The microbiological analysis of the affected ecosystems was focused on establishing the presence of the main physiological groups of chemioautotrophic and heterotrophic microorganisms. Chemioautotrophic microorganisms are primary producers able to use chemical energy to produce complex organic substances from inorganic substances (nitrifying bacteria, colorless sulfurous bacteria). The heterotrophic microorganisms are involved in the detritic chain by decomposing the organic residues of the primary producers (CIOBOIU & CISMAŞIU, 2016a; b; c).

In addition to industrial pollution, the lagoon ecosystems on the Preajba Valley river are subject to the anthropogenic eutrophication process. In the increasing eutrophication, lakes are in an advanced process of biological clogging due to water evaporation induced by climate change. Eutrophication effect is manifested by excessive growth of phytoplankton (78 species) and marsh and aquatic macrophytes (34 species). Bacillaryophiceae and chlorophyceae are the dominant phytoplankton groups and, in summer, cyanobacteria also have an intensive development.

The analyses performed illustrate the ability of *Viviparus acerosus* and *Radix balthica* species to accumulate metal ions Fe^{2+}, Mn^{2+} and Zn^{2+} in direct correlation with the concentration of the respective ions in the soil. Also, our studies have shown the increased tolerance of the species of snails (for example species of gills snails such as *Viviparus acerosus*) in the presence of metal ions in the environment coming from the solid waste of industrial processing (CIOBOIU, 2002; CISMAŞIU et al., 2015b; CIOBOIU & CISMAŞIU, 2016b; CIOBOIU et al., 2017). These snail species are bioindicators of industrially contaminated environments in Oltenia Plain because they signal early the appearance of negative changes in lacustrine ecosystems. Although Pb^{2+} and Cd^{2+} are not considered essential for life, they are concentrated in some aquatic organisms by leaching from the aquatic environment. Significant differences were found between the heavy metallic concentrations of water and the meat mass of the aquatic organisms present in these waters. The concentrations of Pb^{2+}, Cd^{2+}, Cu^{2+}, Zn^{2+}, Pb^{2+}, Mn^{2+} and Fe^{2+} from the Preajba lakes were found below the detection limit (0.001 – 0.01 mg/l), according to orders 756/1997 and 161/2006 (***. Ord. 756/1997; ***. Ord. 161/2006).

In this context, it has been hypothesized that such models HM transfer and accumulation in biota can be used as a fingerprint for detection and characterization of biochemical risk of environmental pollution in Oltenia Plain. Consequently, river damming and the formation of reservoirs, induce profound hydrological, geomorphological,

hydrochemical modifications of the ecosystem and in accordance with these modifications, modifications of the structures and functions of the plant and animal populations (BREZEANU & GÂŞTESCU, 1996; BREZEANU et al., 2011). Such changes are also evident in the Preajba Valley river basin, especially within its limits, the unsettled segment of the river (the one in the upper sector) being considered as a witness.

Among the microorganisms capable of removing metallic ions there are also the heterotrophic bacteria of the *Acidiphilium* sp. acidophilic bacteria that have the capability to form a polysaccharide gelatin capsule on the surface of the cells. The mechanism of attracting metallic ions by these bacteria is biosorption, retaining relatively large amounts of dissolved metals through electrical charge attraction.

The use of the heterotrophic bacteria isolated from industrial sites contaminated with metal ions to reduce the heavy metal content is substantiated by numerous publications and it is considered that the development of a technology cost of this group of microorganisms is very good for the bioremediation processes (BOONSTRA et al., 1999; BOSECKER, 1999; CISMAŞIU, 2010; CISMAŞIU et al., 2015b; 2016; 2017; CIOBOIU & CISMAŞIU, 2018a; b).

THE COAL DESULPHURIZATION PROCESSES FROM OLTENIA UNDER THE ACTION OF HETEROTROPHIC AND CHEMOLITHOTROPHIC ACIDOPHILIC BACTERIA

It is now accepted that starting with 3.5 million years ago, that is from the appearance of life on earth, some bacteria release or extract metal elements from the rock that go into solution, a phenomenon called bioleaching or biosolubilization or bio-extraction, and other groups of bacteria fix and accumulate metals, a phenomenon called biosorption, bioaccumulation or biofixation (LAZĂR & DUMITRU, 1998; BRANDL, 2001; LAZĂR, 2001).

The indigenous microorganisms are opposed to the imbalance caused by temporary environmental changes (e.g. industrial wastewater spill into soil or natural waters). To reduce the imbalance in the normal processes involved homeostasis made by consumers. The adverse effects of heavy metals on the aquatic ecosystem are manifested: (1) quantitative: reduction of water transparency and clogging of filters at capture, (2) chemical: change of O_2 level, CO_2 level, pH values and extreme conditions, (3) the modification of the biocoenosis structure (CIOBOIU & CISMAŞIU, 2016).

The acidophilic chemolithotrophic bacteria of the *Acidithiobacillus* genus, such as s sulfur- and iron-oxidizing bacteria, have a versatile metabolism because they release organic compounds in the culture medium that can accumulate in inhibitory amounts for bacterial growth. In this regard, heterotrophic bacteria of the genus *Acidiphilium* can remove this inhibition by the metabolism of organic materials. This phenomenon is the reason why mixed cultures of acidophilic iron-oxidant and heterotrophic bacteria have a higher leaching capacity compared to pure cultures. The activity of *Acidithiobacillus ferrooxidans* in the oxidation of the ferrous iron may be controlled by several parameters: H_2SO_4 production, decrease of pH, CO_2 consumption, the biomass growth or directly by measuring the passage of Fe^{2+} to Fe^{3+}. A field widely approached internationally with immediate practical applications is the use of microorganisms in microbiological recovery of metals. This method can be applied to ores and poor concentrates, as well as mining waste that accumulates over time and cannot be processed by classical hydrometallurgical methods (TOMUŞ & CISMAŞIU, 2014; GAVRILESCU et al., 2017).

The changing iron valence can be measured by changing the redox potential, which is a good indicator for determining microorganisms and allow the study of their physiology. Bacterial cultures of *Acidithiobacillus ferrooxidans* (9 populations), selected on the basis of their resistance to very high concentrations of ferrous iron (18 g/l Fe^{2+}), Cu^{2+} and Zn^{2+} (5000 ppm), were used in the desulfurization experiments (CISMAŞIU, 2010). The biooxidation processes of inorganic sulfur from lignite (Halânga mine) and coal (thermal power mind) for different values of the ratio of the solid / liquid (5 g/100 ml - 10 g/100 ml) in the presence of *Acidithiobacillus ferrooxidans* bacterial cultures under continuous stirring (KARAVAIKO, 1988; KLEIN, 1998; CISMAŞIU, 2015a).

The mutualism process has a special ecological significance because the metabolic activity and limits of physiological tolerance of the population of acidophilic bacteria involved in mutua relations are very different from those of the individual population. In the case of acidic environments the association is so close that the populations of associated microorganisms behave as a unitary population. In this context, the natural communities of microorganisms of a wide variety of common species, often as dense populations, are relatively stable and difficult to disrupt.

In the solubilization process of metal ions, an important role is played by the acidophilic heterotrophic bacteria and yeast, which is based on the elimination of organic acids in the environment, as well as metabolic products which together form soluble compounds in the water. An example of mutualism in industrial ecosystems is the iron cycle between sulfur and iron-oxidizing chemolithotrophs (using iron as an electron donor) and heterotrophic iron-reducing bacteria (using iron as an electron acceptor) in situations where oxygen concentrations dissolved varies spatially or temporarily (MURARIU, 2002; CISMAŞIU, 2012; CISMAŞIU et al., 2015a; b).

The best results of coal desulphurization have been obtained by the combined use of *Acidithiobacillus thiooxidans* and *Acidithiobacillus ferrooxidans*. The presence of other species in desulphurization cultures has proven useful in increasing the level and yield of coal desulphurization. Also, some of these species (including heterotrophic bacteria) can metabolize simple fragments of organic sulfur by removing a low percentage of organic sulfur left in the coal matrix (MONROY-FERNANDEZ et al., 1995; VIDYALAKSHMI et al., 2009).

DISCUSSION

Different studies illustrate the toxic effects of metals on living organisms and particularly effective technologies for reducing concentrations of metals in the waste water, the treatment of classical and modern systems thereof. The reduction of SO_2 in coal can have many applications in the fields of environmental protection in the former mining areas and facilities for the processing of coal, and in the zones adjacent to the bioremediation of media contaminated by sulfates and metal ions, in agriculture, food industry, in the chemical and pharmaceutical industry (BOSECKER, 1999; TOMUŞ & CISMAŞIU, 2014).

With regard to the physical-geographical, hydrological and biocoenotic factors, it can be concluded that the Preajba Valley basin system is a true *natural laboratory*, which demonstrates how anthropogenic factors cause the change of natural ecosystems and contribute to the building of other structural and functional relationships within the complex of ecosystems (FIRA & NĂSTĂSESCU, 1977; VICOL, 2011; CIOBOIU, 2014a; b).

The composition and distribution of the biocoenotic and population structures of the Valea Preajba Basin system operate in accordance with the particularities of ecosystem organization. In this regard, species of diatoms, ciliates, testos, ostracodes, gamarides, chironomides, ephemeropters, heteropters were identified in the rhitron area (including springs and small streams). In the potamon area, the structure of biocenoses is made up of representatives of all aquatic ecosystem groups (pelagial and benthic communities) in the potamon area (the hill and river sector of the Valea Preajba river basin). Thus, species of diatoms, ciliates, Testacea, ostracods, Gammaridae, Chironomidae, Ephemeroptera, Heteroptera were identified in the rhitron area (including springs and small streams). In the potamon area (the hilly sector of the Preajba Valley river basin), the structure of biocoenoses is made up of representatives of all aquatic ecosystem groups (pelagic and benthic communities). In the phytoplankton, there were identified over 70 species of algae, while in the zooplankton 65 species of ciliates, rotifers, cladocerans, copepods. Zoobenthos is composed of 13 major groups of invertebrates, some with a large number of individuals (Chironomidae 4,600 ind./m^2, ostracods 1,750 ind./m^2, Ephemeroptera 213 ind./m^2, Plecoptera 226 ind./m^2). Gastropods constitute the dominant group in the benthic structure (18 species have been identified, of which 5 are new species for the Oltenia fauna) and have an important role in the functioning of the habitats they inhabit. In the lakes of the basin, the ichthyofauna consists of a number of 14 species in which the cyprinids are dominant (CIOBOIU & NICOLESCU, 1999; CIOBOIU 2014a, b; GOGA, 2016; GAVRILESCU et al., 2017).

The research objectives are the results obtained under the collaborative convention between the Institute of Biology Bucharest of the Romanian Academy, the Department of Microbiology and the Museum of Oltenia Craiova on the topic: The biodiversity of the microbiota from areas with industrial contamination of Oltenia and potential biotechnological applications in order to reduce it. Also, some results were achieved in the project RO1567-IBB05 of the Institute of Biology Bucharest, Romanian Academy.

CONCLUSIONS

In anthropogenic environments, native microorganisms exist in the form of mixed populations, interacting with each other, both positively and negatively. Their presence is evidenced by the products of metabolism rather than by the accumulation of biomass. The accumulation of products with inhibitory activity and the phenomena of antagonism contributes together with the quantitative changes of nutrients to the emergence of new communities of microorganisms that underlie the succession of populations in an ecosystem. In this whole ecosystem, gastropod populations have an important role among consumers, representing a factor of accumulation and transfer of mass and energy towards higher order consumers - fish.

The populations of *Viviparus acerosus* and *Radix balthica* are one of the reference factors for the accumulation of Cu^{2+} and Cd^{2+} heavy metals. Bioaccumulation is strongly dependent on the amount of metal present in the living environment of sediments. The freshwater snails can accumulate higher levels of Cu^{2+} and Cd^{2+} concentrations than the average and they are generally recognized as "macroconcentrator" HMS for these species.

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MODIFICATIONS INDUCED BY ANTHROPIC ACTIVITIES UPON THE MACROZOOBENTHIC INVERTEBRATE COMMUNITIES FROM THE BRĂTCUȚEI VALLEY (BIHOR COUNTY, ROMANIA)

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Abstract. The aim of the present study was to highlight the dynamics of macrozoobenthic invertebrate communities from Brătcuței Valley, in three different areas impacted by anthropic factors in different ways. The changes occurred due to this impact were observed in spring, summer and autumn periods with the purpose to determine whether the different seasons of the year can amplify or diminish the effects of human activities upon the benthic communities. The modifications of the macrozoobenthos were correlated with the variations of certain physico-chemical parameters of water (temperature, conductivity, the dissolved oxygen content, total dissolved solids TDS). We have analysed the ecological parameters which reflect the modifications of the macrozoobenthic communities such as species richness, diversity (Shannon-Wiener index), the percent of Oligochaeta and Chironomids larvae (%OC) from the total macrozoobenthos, the percent of Ephemeroptera, Plecoptera an Trichoptera larvae (%PT) from the total macrozoobenthos. We have observed changes in the structure of the macrozoobenthic communities in the areas of the valley affected by the effluents of a trout farm, which are very obvious especially in the warm season. Also the river stretch affected by domestic waste waters has a modified macrozoobenthic community, in a greatest degree from the all investigated sampling points.

Keywords: macrozoobenthos, anthropic impact, trout farming, domestic waste waters.

Rezumat. Modificări ale comunităților de nevertebrate macrozoobentice din Valea Brătcuței (județul Bihor, România), induse de activitățile antropice. Prezentul studiu a avut drept scop urmărirea dinamicii comunităților de nevertebrate macrozoobentice din Valea Brătcuței, în trei zone ale acesteia supuse în mod diferit impactului antropic. Modificările datorate acestui impact au fost urmărite în perioadele de primăvară, vară și toamnă, pentru a urmări în ce măsură perioada anului intensifică sau diminuează efectele activității antropice. De asemenea, modificările au fost corelate și cu variația unor parametrii fizico-chimici ai apelor (temperatura, conductivitatea, conținutul de oxigen dizolvat, cantitatea totală de substanțe solide dizolvate - TDS). Parametrii ecologici care reflectă modificările comunităților macrozoobentice avute în vedere au fost bogăția de specii, diversitatea (exprimată prin indicele Shannon-Wiener - H), procentul de Oligochete și larve de Chironomide (%OC) din total macrozoobentos și procentul larvelor de Efemeroptere, Plecoptere și Trichoptere (%EPT) din total macrozoobentos. S-a constatat că există modificări ale structurii comunităților macrozoobentice în zonele afectate de funcționarea unei ferme salmonicole, ale cărei efecte sunt vizibile în special în sezonul cald. De asemenea, pe sectorul studiat, comunitatea macrozoobentică este afectată în măsura cea mai mare, în zona de deversare a apelor reziduale menajere.

Cuvinte cheie: macrozoobentos, impact antropic, salmonicultură, ape uzate menajere.

INTRODUCTION

Mcrozoobenthic invertebrates are important components of the freshwater environment. They represent an important trophic compartment for the functioning of the running water ecosystems, elements of the biodiversity and biological indicators of water quality (FABRIZI et al., 2010; GUILPART et al., 2012).

The structure and dynamics of the macrozoobenthic invertebrate community is determined by the hydrological characteristics of the watershed they inhabit, its trophicity and degree of pollution (MUNOZ, 1989; STOIANOVICI et al., 2017).

One of the most widespread sources of pollution are domestic waste waters. These are especially present in the area of small localities where the sewage plants are lacking, so some of the domestic waste waters reach the surface waters (ATASOY et al., 2006; BADRUZZAMAN et al., 2012; CAREY et al., 2013). The pollution with domestic waste waters is characterised by a high organic content, the presence of the detergents and microorganisms (HELGESON & MCNEAL, 2009; BADRUZZAMAN et al., 2012). These pollutants modify the physico-chemical parameters of the waters they flow in and influence the structure of the macrozoobenthic community.

The increased quantity of the organic content intensifies the activity of the microorganisms from water sediments. This increased metabolic activity of microorganisms consumes the oxygen from the water and can generate hypoxia (VITOUSEK et al., 1997). The detergents contained in these waste waters add a significant quantity of nutrients and create favourable conditions for algal bloom (BADRUZZAMAN et al., 2012).

Another source of pollution of anthropic origin are waste waters from trout farms situated near small mountainous water courses. These farms use water from the nearby streams and their effluents are periodically released in these surface waters. The effluents from the farms have a high content in N and P compounds, generated by the metabolism of the fishes or by food and drugs remains in the water. There are several studies in Europe concerning the effects of these waste waters from trout farms upon the quality of the receiving waterbodies and on the macrozoobenthic invertebrate communities (MUNOZ, 1989; CAMARGO, 1992; HARRISON et al., 2007; SINDILARIU et al., 2008; MESA et al., 2013; STOIANOVICI et al., 2017). These studies underline the impact of these waste waters loaded with nutrients and microorganisms upon the macrozoobenthic invertebrate communities.

During our study we have examined the macrozoobenthic community from Brătcuței Valley, tributary of Crișul Repede River. The valley is a mountainous stream which has an upper course on a stony riverbed, with a high speed, passing a beech forest and with no localities in the area or evident anthropic activity with a negative impact on the water quality. In the middle course the valley passes an area with some week-end houses and a trout farm. In this area it is possible that domestic waste waters from the houses and trout farm effluents might be spilled in the valley, especially in the warm season of the year. In the inferior course, the valley flows through Bratca village before it reaches the Crisul Repede River. In this portion the pollution with organic wastes and garbage, especially PET bottles, is obvious.

Considering these facts, we analysed the effects of these types of anthropic impact factors upon the macrozobenthic community in the analysed portions of the valley in different periods of the year (spring, summer and autumn).

MATERIAL AND METHODS

The samples were collected from Brătcuța Valley, tributary of Crișul Repede River, from three sampling sites chosen to be different from a hydrological point of view and with a different anthropic impact intensity.

The samples were collected in the spring, summer and autumn from each sampling site, in order to follow the dynamics of the macrozoobenthic communities due to life cycle particularities.

The samples were collected with a Surber dredge, with a surface of 0,9 m^2, and a mesh size of 250 μm. The samples were preserved in the field in 4% formaldehid solution and transported to the lab. In the lab the samples were sorted under a 40X magnification stereomicroscope, the different invertebrate groups were transferred into 80% ethylic alcohol and determined using specific keys for each group.

The samples were collected from the following sites:

- **Brătcuței Valley upstream** (B1) – situated 6 km upstream from Bratca village. The valley passes through a beech forest, near a road, in a hilly region. The valley is 2-3 m wide, with fast flowing portions. The riverbed is covered by pebbles and boulders. The aquatic macrophysics vegetation is absent and the phytobenthic is very scarce, located only on the slow flowing portions. The allochthonous debris is present in small quantities because the fallen leaves are washed away by the current. No localities or human activities are performed in this area or upstream.
- **Brătcuței Valley downstream the trout farm** (B2) – situated at 4 km upstream Bratca village. The valley passes a more flat region, there is a trout farm and some week-end houses in the area. The valley is 3-4 m wide, 20-50 cm deep, the riverbed is covered by boulders, rocks and pebbles and near the banks with gravels and sand. The macrophytic aquatic vegetation lacks, the phytobenthos is scarce, but there are greater allochthonous material accumulations.
- **Brătcuței Valley at Bratca** (B3) – the sample site is located in Bratca village. The banks of the valley are dammed, on the shore there is a treeline of genus Alnus and Salix, and also a rich herbaceous vegetation. The valley is 6-8 m wide, the phytobenthos on the rocks is scarce, but the riverbed includes a lot of allochthonous material, including domestic waste (vegetable debris, plastic waste, glasses and others).

The physico-chemical parameters were measured with a Hanna HI 9829 multimeter. The following indexes were calculated: species richness, Shannon-Wiener diversity index, percent of Ephemeroptera, Plecoptera and Trichoptera larvae from total macrozoobenthos (%EPT) and percent of Oligochaeta and Chironomids larvae from total macrozoobenthos (%OC).

RESULTS AND DISCUTIONS

From the collected samples in the three sampling points, we have identified a number of 12 systematic groups of invertebrates including worms, crustaceans and also aquatic insect larvae such as: Ephemeroptera, Plecoptera, Coleoptera larvae, as well as imago, Chironomids, Trichoptera, Simuliids and other Diptera. The best represented insect larvae in terms of number of species were the Coleoptera, Trichoptera and Ephemeroptera.

The measured values of the physicochemical parameters showed a great variation of the dissolved oxygen content between the three sample sites, with their greatest values at B1 (23.9 to 265%). The variation tendency is for the concentration to raise at lower temperature and vice-versa, because the solubility of oxygen in water is negatively correlated to water temperature (Fig. 1). The values at the sampling site B2 are much smaller at comparable temperatures. These lower values show an anthropic impact due to waste waters released in the valley from the houses and also from the trout farm. These waste waters have high microbial content, these microorganisms consume the oxygen in their metabolism (ALABASTER, 1982; MUNOZ, 1989). The recorded values for the dissolved oxygen at this sample site were between 4.7 and 6.6% (Fig. 1).

At the sample site B3, the measured values of the dissolved oxygen were even lower because in this sector of the valley the human impact is the greatest from all investigated sites. The valley passes through Bratca village, where a significant amount of domestic waste waters reach the water course. Also, the values of the water temperature measured at this sampling site were the highest, so the solubility of the oxygen was the lowest. The high temperature and the great organic content from the waste waters were the causes of the severe oxygen content drop to 0. 9 - 1% (Fig. 1).

The temperature had seasonal variations according to the air temperature, so the greatest values were measured in July, smaller in October and the smallest in March. Between the three sampling sites there were significant variations of the water temperature. At site B1 between 3.21^{0}C and 7.08^{0}C, at B2 between 5.83^{0}C and 9.03^{0}C, and at B3 between 15.38^{0}C and 19.4^{0}C (Fig. 1).

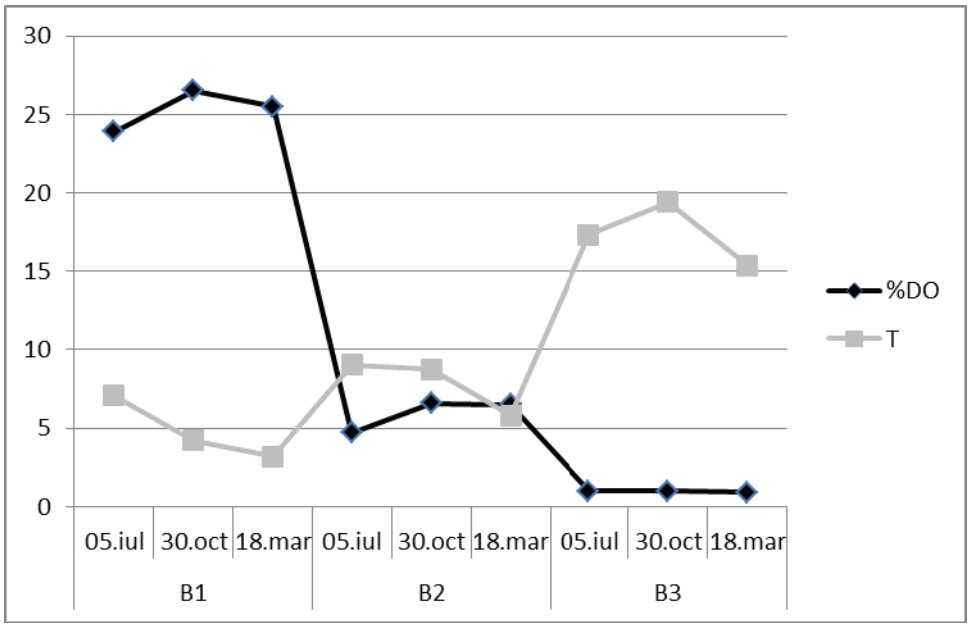

Figure 1. The values of temperature and dissolved oxygen in each sample site and period.

These differences between the water temperatures in the three sampling sites are due to the different microclimate of the sites and the particularities of the terrain. At B1 the valley is narrow, shaded almost all day long, at B2 the valley is broader and not so shaded during the day, and at B3 there is an open area with lot of sun shine and less shade.

The values of the conductivity and total dissolved solids (TDS) show no significant differences between the three sample sites (Fig. 2). The greatest values were measured in all three sampling sites in March and the smallest in July. We consider that the dissolved substances were consumed by the aquatic organisms, in the warm season, when they have the greatest density and a high metabolic rate.

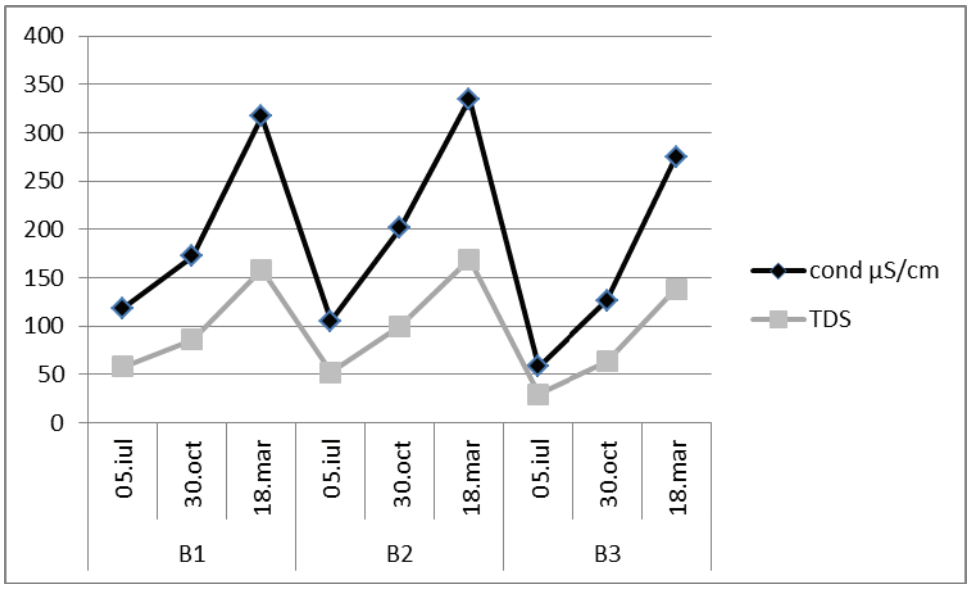

Figure 2. The values of conductivity and total dissolved solids in each sample site and period.

The species richness have the greatest values in all three sampling sites in July, because during summer most of the species with aquatic larval stage can be found in the water. During autumn some specimens of insects emerge, leaving the aquatic environment, so the richness of species decreases. In the spring period, the richness of species had

the lowest values, because water is cold and a small number of species and individuals are active after the winter diapause. Also, some of them do not survive winter, because the valley has a small water volume along its course and most of it can freeze during winter (Fig. 3).

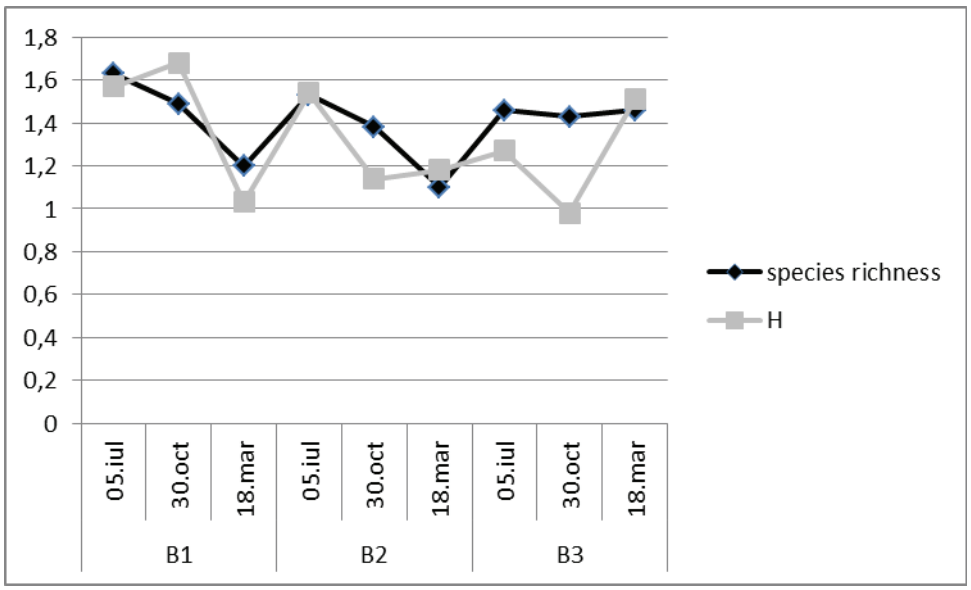

Figure 3. The values of species richness and Shannon-Wiener diversity index in each sample site and period.

The diversity (H) has the greatest values at site B1 excepting March, when due to the very cold water a small number of species are active. At sites B2 and B3 the lowest values of H index were reached in October because the species richness drops due to the emergence of adults for many species. At sample site B3 the greatest diversity was reached in March when water temperature was the lowest so the microbial activity was minimal. In the absence of the decomposing action of bacteria the oxygen consumption remained low and other toxic metabolites produced by microorganisms had low concentration and they did not affect the macrozoobenthic community (CAREY et al., 2013). The differences between H index in the three sampling sites are not too high, and this situation was observed also in other rivers affected by pollution with fish farming waste waters (STOIANOVICI et al., 2017) or with domestic waste waters (BADRUZZAMAN et al., 2012).

At site B1 the macrozoobenthic community is made up mostly by Plecoptera larvae which have a density of over 200 specimens/m^2 in March (Fig. 4). Also abundant were the Ephemeroptera larvae, which have the most constant effectives in all investigated seasons compared to Plecoptera. With a smaller density we also found Coleoptera imagos and Trichoptera larvae, but also well represented in the community.

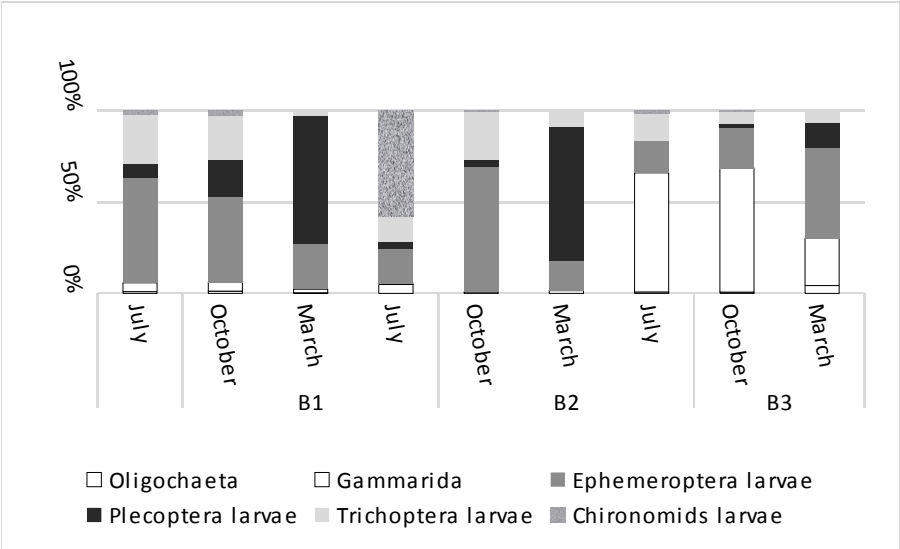

Figure 4. The proportion of the main macrozobenthic groups in each sample site and period.

Gamarida had small densities because the quantity of debris in the riverbed is small, so they lack the required nutrients to develop big populations. The Diptera larvae (Chironomids, Simuliids and other Diptera groups) have very small densities, they are not characteristic for this altitudinal and hydrographic sector. Oligochaeta as detitivorous group are present with very low densities at this sampling site.

The structure of the macrozoobenthic community at this site is characteristic for this mountainous area being dominated by Plecoptera, Ephemeroptera and Trichoptera larvae; this structure indicates good water quality, also confirmed by the values of the physico-chemical parameters.

The general structure of the macrozoobenthic community in this sampling site by its taxonomic structure and number of specimens characterises good water quality, without a significant human impact, characteristic for the mountainous sector.

At site B2 the macrozoobenthic community is dominated by Ephemeroptera, Chironomids and Plecoptera larvae. Ephemeroptera larvae have the greatest abundance in October, probably due to the presence of a new larvae generation resulted from the summer reproduction. In March their abundance decreases especially due to mortality in the winter season and their consumption by predators.

Plecoptera reach the greatest abundance in March and are less abundant in the rest of the investigated periods. This fact is due to their preference to live in cold, well oxygenated waters, and they have this condition in the early spring period. Trichoptera larvae have a similar dynamics of abundance with the Ephemeroptera, because they are influenced by the same environmental factors.

Chironomids larvae have small abundancies except July when they are the most abundant in the community. This phenomenon can be caused by the warm water in the summer period together with the increase of the organic decomposition process and a probable human impact represented by a high quantity of water discharge from the houses and the trout farm. The nearby houses are inhabited especially during the summer period, these are not connected to a sewage plant so they discharge their waste waters in the valley. The domestic and trout farm effluents have a high organic content, so they ensure a very good nutritive support for Chironomids larvae. Also the waste waters from the trout farm have a high organic content so they create favourable conditions for Chironomids larvae development (MUNOZ 1989; MESA et al., 2013; STOIANOVICI et al. 2017).

We can′t know for sure which is the exact cause of the Chironomids population explosion, but we suppose it occurred as a result of a short term impact, because their density dropped in autumn and the abundance of Grammarian, which are indicators of high organic content is low. If the organic substances would be present permanently in high load the abundance of Gammarida would be much higher.

At this sample site we also found relatively high abundance of Coleoptera and low abundance of Turbelariata, Oligochaeta, Coleoptera larvae, Simuliids larvae and other Diptera larvae.

The structure of the macrozoobenthic community at sample site B2 shows a water with good physico-chemical quality which allow the existence of sensitive groups with high abundancy, but the increased abundance of Chironomids larvae in July shows an anthropic impact, which even if it is localised can threat for the investigated community.

At site B3 Gammarida are highly dominant in the community. Their maximum abundance was observed in july, when the water temperature was the highest and the organic load the greatest. The high abundance of the Gammarida during the whole studied period suggests a long term human impact seen especially in a high organic load resuted from discharge of domestic waste waters and vegetal debris directly into the valley.

Ephemeroptera larvae had a relatively hig abundance, but lower compared to the previous sample sites. Plecoptera larvae were present in very low number because they represent the most sensitive group to the depreciation of the water quality. The hydrological conditions of the valley offer the possibility for Plecoptera to populate this area, but their absence confirm the presence of the human impact which affects the water quality, by its high organic content and oxygen deficiency.

Trichoptera larvae also have smaller populations than in the former sample sites, emphasizing the decrease in water quality. Turbelariata, Oligochaeta, Coleoptera (larvae and imago) Simuliids and Chironomids larvae have small abundancies comparable with the first two sample sites. Their sensitivity to water quality change is lower than those of the former groups.

The anthropic impact at sample site B3 is the highest and longest in time from all three investigated sites. Together with the increase of human impact from site B1 to B3 we can also observe a modification of the valley hydrography, the slope of the terrain decreases, the valley is wider and it is less shaded during the day. These factors modify the temperature of water in the three sites, from cold to warmer ones as we move downstream along the valley. These modifications associated with the constant human impact at B3 modify significantly the macrozoobenthic community structure compared to the other two sampling sites.

The proportion of EPT in the three sampling sites during the investigated period shows important differences. At the sample site B1, %EPT is over 70% (Fig. 5) for the entire period, and in the spring is even over 90%. At site B2 the proportion of EPT is over 80% except July when it drops under 40%. This decrease is due to the enrichment of the water environment in organic content caused by waste water discharge in the valley. At sample site B3, the proportion of EPT is under 30%, except March when it reaches values over 60%. This increased value in

March is due to lower water temperature, higher oxygen content and lower microbial activity, factors which create conditions for the development of the EPT group in the waterbed.

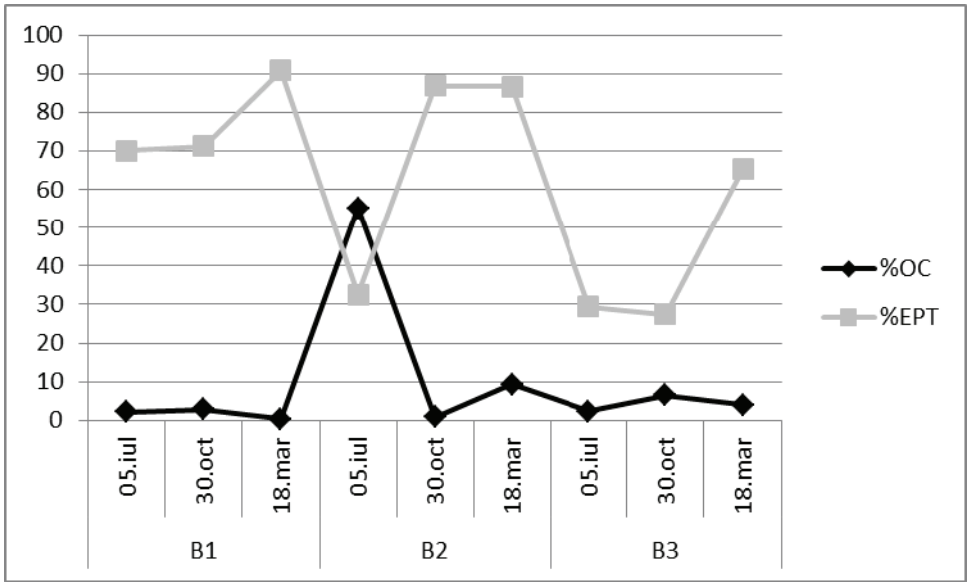

Figure 5. The values of %OC and %EPT in each sample site and period.

%OC have very low values at B1, a site where the environmental conditions are not favourable to these groups. At B2 the values are also low except July when due to the high organic charge the proportion of OC increases spectacularly. The general conditions for the development of Oligochaete and Chironomids larvae at this sample site are not favourable, they only develop larvae populations under human impact.

At B3, %OC are low and very similar during the study period, unless water has a high organic load. The riverbed made up by stones is not very favourable for these groups and probably the domestic wastes contain detergents and other chemicals which can be tolerable by these groups which are otherwise expected to be found in high proportion in these kind of sectors (ROSENBERG & RESHT, 1993; DOBSON et al., 2002; HARRISON et al., 2007).

CONCLUSIONS

The invertebrate macrozoobenthic community living in the sample site B1 from Brătcuței Valley is made up mostly by Ephemeroptera, Plecoptera and Trichoptera larvae, characteristic to waters from mountainous regions, with high flowing speed, high oxygen content, with low temperatures and a rocky riverbed. At this site the human impact is minimal so we can say that these waters are in natural state and can represent reference conditions for the upstream sector.

At B2, the hydrological conditions are slightly modified, the physico-chemical parameters are also different, the oxygen content is lower, the pH has lower values, the conductivity increases as well as TDS. The structure of the macrozoobenthic community does not change very much, except July when we have observed a significant increase of the Chironomids larvae abundance. Their increase, together with the alteration of the physico-chemical parameters is caused by an anthropic impact caused by waste water discharge.

At B3 we have observed an alteration of the physico-chemical parameters as the valley passes through Bratca village. At this site the human impact is permanent and lasting for a long period. This impact is reflected in the modifications of the physico-chemical parameters values. The structure of the macrozoobenthic community at this site is very modified, comparing to the former two sites. The community is dominated by Gammarida, represented by very dense populations in these waters with a high detritus content.

We can observe along the valley a gradual modification of the physico-chemical parameters and of the macrozoobentic community structure due to the different antropic impact from the point of view of its frequency and intensity.

We consider that Brătcuței Valley is a water body which in the upstream sector has a good water qualiy which allow the development of a macrozoobenthic community made up by sensitive species. The middle and downstream sectors are affected by human impact which affects the macrozoobenthic communities, and for that reason we consider that it is important to monitorize the evolution of the intensity of the impact in the places where already happens.Also it is important to monitorize the whole valley to follow if other sectors will be affected by the anthropic impact as there is a tendency to extend the built area and the human activity upstream on the valley.

We recomend to monitorize the valley sector which is not affected in order to detect any modifications of the physico-chemical parameters and of the macrozoobenthic community structure as soon as the water quality decrease in time to stop the irreversible depreciation of the quality of aquatic environment.

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VARIATIONS OF THE STRUCTURE OF BIOLOGICAL COMMUNITIES RELATED TO SALINITY IN SOME SALINE LAKES FROM ROMANIA

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Abstract. The study was conducted in several natural saline lakes from the Buzău and Brăila counties (Romania). The Lakes Câineni, Balta Albă and Amara are hyposaline, only the Lake Movila Miresei can be considered as hypersaline according to mineral content. The aim of the study was to have an quantitative approach to the biological structure of the lakes in relationship with abiotic factors, mainly salinity. Using the Principal Component Analysis (PCA), the Lake Movila Miresei was associated with salinity and conductivity, the Lake Câineni with temperature, while Balta Albă and Amara were influenced mainly by DO, pH, TDS, ORP, turbidity. The level of primary producers was represented by four groups of phytoplankton and the highest species richness was registered in Lake Amara (38 species), with low salinity. The zooplankton community showed a species richness significantly smaller than phytoplankton, even if it presented species belonging to several taxonomic groups (9). The high zooplankton diversity of the Lake Amara was correlated with low salinity. The Shannon index decreasead with the reduction of salinity in the other three lakes. It is noteworthy the presence of *Artemia salina* Linnaeus 1758, both in the Lakes Amara and Movila Miresei, known as indicator species of therapeutic mud. The additional technique applied for investigating the diversity of the phytoplankton confirmed the values of Shannon's diversity index and infirmed the values of the species richness trend. Thus, the Lake Câineni (with high salinity, second after Movila Miresei) held the first place in terms of diversity, the second was Balta Albă, and the less diverse were Amara and Movila Miresei. The Amara Lake experienced an cyanobacterial bloom event, with *Oscillatoria tenuis* Agardh 1813. We conclude that salinity not always is the main factor shaping the diversity of saline lakes. Other factors, such as temperature, DO, pH, TDS, ORP, turbidity can influence the biological communities of these lakes.

Keywords: salt lakes, phytoplankton, zooplankton, bacterioplankton, saline ecosystems, salinity.

Rezumat. Variaţii în structura comunităţilor biologice în relaţie cu salinitatea în câteva lacuri saline din România. Studiul a fost realizat în câteva lacuri saline naturale din județele Buzău și Brăila (România). Lacurile Câineni, Balta Albă și Amara sunt hiposaline, numai lacul Movila Miresei poate fi considerat hipersalin în funcție de conținutul de minerale. Scopul studiului a fost de a avea o abordare cantitativă a structurii biologice a lacurilor, în relație cu factorii abiotici, în principal salinitatea. Folosind Analiza Componentelor Principale (PCA), lacul Movila Miresei a fost asociat cu salinitatea şi conductivitatea, lacul Câineni cu temperatura, în timp ce Balta Albă şi Amara au fost influenţate, în principal, de turbiditate DO, pH, TDS, ORP. Nivelul producătorilor primari a fost reprezentat de patru grupe de fitoplancton, iar cea mai mare bogăție de specii a fost înregistrată în lacul Amara (38 specii), cu salinitate scăzută. Comunitatea zooplanctonică a prezentat o bogăție de specii semnificativ mai mică decât fitoplanctonul, chiar dacă speciile prezente aparţin mai multor grupe taxonomice (9). Diversitatea ridicată a zooplanctonului din lacul Amara a fost corelată cu o salinitate scăzută. Indicele Shannon scade cu reducerea salinității în celelalte trei lacuri. Este de remarcat prezența speciei *Artemia salina* Linnaeus 1758, cunoscută ca specie indicator de nămol terapeutic, în lacurile Amara şi Movila Miresei. Tehnica suplimentară aplicată pentru investigarea diversității fitoplanctonului a confirmat valorile indicelui de diversitate Shannon şi a infirmat valorile bogăției de specii. Astfel, lacul Câineni (cu salinitate ridicată, după Movila Miresei) se află pe primul loc în ceea ce privește diversitatea, al doilea fiind Balta Albă, lacurile Amara şi Movila Miresei fiind cele mai puțin bogate din punct de vedere al diversității biologice. Lacul Amara a cunoscut un eveniment de înflorire cianobacteriană, cu *Oscillatoria tenuis* Agardh 1813. Se observă astfel că salinitatea nu este întotdeauna principalul factor care modelează diversitatea lacurilor saline. Alți factori, ca temperatura, DO, pH, TDS, ORP, turbiditatea pot influența comunitățile biologice ale acestor lacuri.

Cuvinte cheie: lacuri sărate, fitoplancton, zooplancton, bacterioplancton, ecosisteme saline, salinitate.

INTRODUCTION

Saline lakes have a more simple biological structure than freshwater ecosystems (HAMMER, 1986; COMÍN et al., 1992). Salt lakes are geographically widespread, being mostly inland aquatic ecosystems. These natural systems have considerable aesthetic, cultural, economic, recreational, scientific, conservation and ecological values (WILLIAMS, 2002). In such systems, diversity, ecological factors driving biological components, biogeography and evolution in the microbial world can be investigated much more easily than in complex freshwater and marine systems (MA et al., 2010; ENACHE et al., 2017).

Differences in the composition and biological structure of freshwater and saltwater ecosystems are very visible and easy to study. Instead, these differences are harder to investigate between waters with different salinity values. Salty waters are classified according to salinity in several categories: (over 3 g L^{-1}) as hyposaline, (over 20 g L^{-1}) as mezosaline and over 50 g L^{-1} as hypersaline (HAMMER, 1986; ENACHE et al., 2017).

In lakes a certain degree of salinity, most authors consider that this factor is the one that structures the entire biological composition of the ecosystem (KIPRIYANOVA et al., 2007). However, some authors have shown that the species richness and diversity can be significantly influenced by other factors such as oxygen, ionic composition, pH, hydrological patterns, geographic position, palaeoclimatic events, anthropogenic influences, and biological interactions (WILLIAMS, 1998).

The present work represents the continuation of the pilot research conducted in 2013 in some saline lakes from România published by MOLDOVEANU et al., in 2015. This time, we intend to have an quantitative approach to the biological structure of lakes in relationship with abiotic factors, mainly salinity. We keep sampling in our study the Lakes Movila Miresei and Balta Albă, from Brăila county, and in addition, we sampled the Lakes Amara from Buzău county (another lake with the same name is located in the Ialomița county) and Câineni from Buzău county.

Multivariate analysis is less used in literature to highlight the relationships in the saline lakes, between habitat and communities, habitat and physicochemical factors that characterize it, or the relationship between biological communities and measured physicochemical factors. We have used multivariate statistics techniques as Principal Component Analysis, Diversity Indices and Diversity Profiles to investigate these relationships.

The novelty degree of the present study is revealed by the biological complexity approach for communities' evaluation in relation with other physico-chemical parameters than salinity, seen in terms of content in sodium chloride considering the chemical composition in some investigated sites where sodium was not detected.

MATERIAL AND METHODS

Sampling sites. The investigated saline lakes have a natural origin and are located in the Romanian plain (Fig. 1).

Figure 1. The map of sampling points (modified after Google Maps, accessed March 5, 2018).

The water samples have been taken from several salt lakes namely: Amara, located in Buzău county, Balta Albă (White Pool) located at the border between Buzău and Brăila counties, Movila Miresei (Bride's Hill) and Câineni, situated in the Brăila county. The Câineni Lake is the fourth important lake of the site, is surrounded by agricultural land and is located in the village of Câineni, a former spa resort. It has a high salinity, and one of the best sapropelic sludge is extracted from here.

The samples were collected in summer 2016, in July, as folowing: 2 sampling points from Movila Miresei (45º13'14.62"N, 27º38'31.58"E and 45º13'15.46"N, 27º38'19.6"E) and Amara (45º14'43.32"N, 27º18'7.29"E and 45º13'44.70"N, 27º16'52.25"E) and 1 sampling point from Balta Albă (45º17'38,99"N, 27º20'54,56"E) and Câineni (45º10'56.39"N, 27º19'29.41"E). The warmest season was selected for sampling in order to reveal the high values of salinity in relation with biological composition of lakes. In summer, due to an aride climate of the region, the evaporation processess are intense and the salinity of the water increase.

In situ physicochemical measurements. Using a portable water multiparameter system HI 9828 from Hanna Instruments, the dissolved oxygen (DO), the oxygen saturation (%), conductivity, pH, redox potential ORP, total dissolved solids TDS, salinity were measured in the field for each lake.

Also, the geographical coordinates for all lakes were established using a GPS device. Water turbidity was measured with a Hanna Instruments turbidimeter in the field, avoiding sample alteration.

The light intensity was determined with a lightmeter, at the moment of water sampling.

Laboratory analyses. The chemical composition of the water samples (10 mL) was determined using a Supermini X-Ray Fluorescence Spectrometer (Rigaku Corporation, Japan), following the semi quantitative method for light elements analysis in helium atmosphere.

Bacterioplankton density. The total colony forming units (c.f.u.) were estimated by incubation of the samples on MH culture medium at 30^0C for 7 days as previously described (COJOC et al., 2009; MOLDOVEANU et al., 2015).

Extracellular enzymatic activities were estimated as previously described (COJOC et al., 2009) in terms of the presence of enzymes which degrading starch, cellulose, inulin, Tween 80, pectin, xilan, casein and olive oil.

Phyto and zooplankton samples. The phytoplankton and zooplankton samples were taken on the water column with a Patalas Schindler plankton device at the same moment with the *in situ* measurements. Immediately, all samples

were filtered through a plankton net mesh with 50 µm Ø and preserved in 4% formalin solution. The species identification was made using a Zeiss inverted microscope according to the method described by UTERMÖHL (1958) and specific taxonomic keys.

Statistical analyses. Data processing was performed using PAST software (HAMMER et al., 2001). The Principal Component Analysis (PCA) was used in order to reveal the relationship between lakes, biological components and environmental factors. As PCA is a non-parametric method of classification, there is no need to transform the data for a normal distribution (VEGA et al., 1998; HELENA et al., 2000).

RESULTS AND DISCUSSION

Though the site ROSCI0005 Balta Albă-Amara-Lacul Sărat Câineni-Jirlău has a Community importance (Habitats Directive), it is subjected to riverine activities: household waste discharges into the lakes, significant water volume fluctuations due to weather conditions, natural and artificial water composition changes, intensive agriculture, uncontrolled tourism (http://ananp.gov.ro). The Movila Miresei Lake does not have a conservational status and the occasional use of water for bathing by local population may be a disturbance factor for the saline system.

The waters of the lakes are different in terms of salinity, turbidity, total dissolved solids (TDS), oxido-reduction potential (ORP), dissolved oxygen and saturation. The order of classification of the lakes according to salinity and conductivity is: Movila Miresii > Câineni > Balta Albă > Amara (Table 1). According to HAMMER, 1986, the Lakes Câineni, Balta Albă and Amara are hyposaline, only the Movila Miresei Lake can be considered as hypersaline.

The Principal Component Analysis showed which environmental factors describe significantly (PC 1 = 51.34 %, PC 2 = 28.35 %, PC1 and PC2 reached 79.69 %) the studied lakes (Fig. 2). Thus, the Movila Miresei Lake was associated with salinity and conductivity, the Câineni Lake with temperature, while Balta Albă and Amara were influenced mainly by DO, pH, TDS, ORP, turbidity. Our findings were in agreement with the results of WILLIAMS, 1998. In the past (early 70s), the Amara Lake has been flooded with fresh water and salinity never increased at a high level, affecting the therapeutic quality of water (https://www.agerpres.ro).

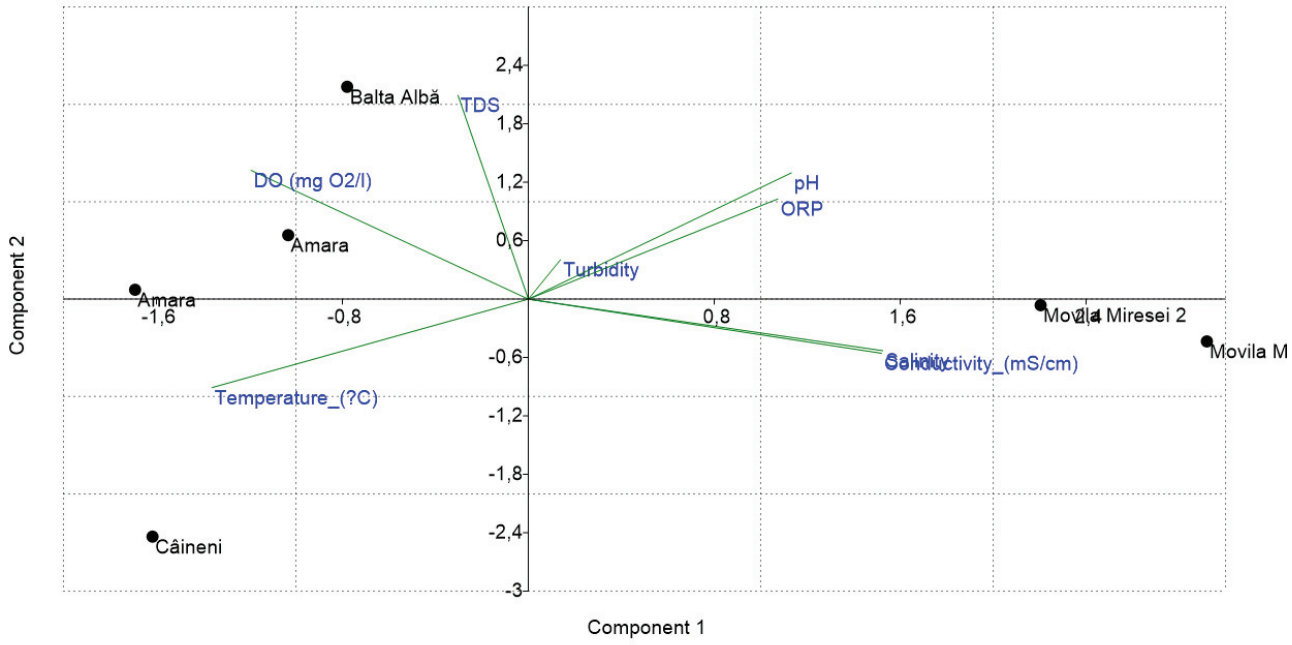

Figure 2. The PCA biplot of the environmental factors caracterising sampled lakes.

The turbidity ranged widely, from 9.21 FNU in Lake Câineni to 216 FNU in Lake Amara. All lakes can be considered alkaline having a pH over 8.45. The lower ORP value was registered in the Balta Albă and Amara Lakes, while the highest value was measured in the Movila Miresei Lake (152) (Table 1).

Salinity has a significant impact on biological communities, like phyto and zooplankton, because it requires them to adjust the saline concentrations in their bodies to the surrounding environment. (PATUREJ et al., 2017). Thus, any changes in salinity can lead to the disappearance of some species and their replacement with others, more well adapted (OJAVEER et al., 2010).

The cultivable colony forming units (C.F.U) numbers varying from 9 x10^2 (Lake Câineni) until to 64 x 10^2 (in Lake Movila Miresei) (Table 2). The numbers are relatively close to previous reports from other saline lakes from România (MOLDOVEANU et al., 2015) but is relatively low if compared with data for the Dead Sea or the Great Salt

Lake inhabited by halophiles until to 10^6 cells/g with seasonal fluctuation (OREN, 1993; NEAGU et al., 2014). On the other hand, the C.F.U. numbers appear to be related to the salinity and increase with its content (Table 2). In terms of the presence of NaCl, the recorded data (Tables 1 and 2) revealed the absence of a correlation between C.F.U. numbers and this compound.

Table 1. The environmental factors of the salt lakes.

Lake	St.	Light intensity	Depth (m)	Turbidity FNU	Temp. (ºC)	pH	Cond. (mS/cm)	DO (mgO2/l)	DO %	ORP	Salini-ty	TDS
Movila Miresei	st1	1056X100	1.00	90.90	27	9.38	78.82	1.17	9.17	152	54.9	31.41
Movila Miresei	st2	1056X100	1.00	86.40	27	9.48	78.74	4.58	80	50.6	55	39.31
Balta Albă	st1	1135X100	1.00	11.10	28	9.56	15.42	10.96	156	28	8.97	75.71
Amara	st1	1151X100	0.50	84.40	30.76	8.65	10.08	8.03	114.9	55	5.64	50.52
Amara	st2	1180X100	1.00	216.00	28.55	8.77	10.64	7.82	106.5	32	5.59	50
Câineni	st1	1108X100	1.00	9.21	30.68	8.45	27.47	5.48	80	124	16.82	13.78

Table 2. The bacterioplankton density and XRF analysis results in salt lakes.

Lake	Sampling point		Bacterioplankton density CFU ml $^{-1}$	Na_2O	SO_3	K_2O	Cl	MgO
Movila Miresei	st1		$64x10^2$	17.10	15.55	3.27	62.39	0
Movila Miresei	st2		$64x10^2$	24.59	15.17	2.88	56.37	0
Balta Albă	st1		$39 x10^2$	20.40	11.19	12.88	50.08	4.12
Amara	st1		-	0	14.17	11.33	28.53	3.04
Amara	st2		-	0	12.07	10.10	24.45	1.96
Câineni	st1		$9 x10^2$	17.56	22.37	4.78	39.64	7.37

The species number of phytoplankton ranged from 3 species in Movila Miresei, to 38 species in the Amara Lake. The dominating taxonomic groups were Bacillariophyceae (19 species in Amara) and Cyanobacteria (8 species in Lake Amara and Câineni) (Table 3).

The zooplankton community showed a species richness significantly smaller than phytoplankton, even if it presented species belonging to more taxonomic groups (9). The highest number of zooplanktonic species is recorded in the Amara Lake (13), of which five are rotifers (Table 3). It is noteworthy the presence of *A. salina*, belonging to the Artemiidae family, Branchiopoda class, both in the Amara and Movila Miresei lakes. The species is known to tolerate salinity values between 3-50 g L^{-1} (BANISTER, 1985). Also, this species is considered an indicator of the therapeutic quality of mud in salty lakes in which it is present, especially if the abundance is high, as is the case of the Movila Miresei Lake (509 ind L^{-1}). In the meantime, it contributes, by its microbial degradation and sediment deposition, to the enrichment of the organic matter of the sludge, becoming a sapropelic mud (MUNTEANU & DUMITRAȘCU, 2011).

Table 3. The species richness of phytoplankton (cell L^{-1}) and zooplankton (ind.L^{-1}) in salt lakes.

Phytoplankton/zooplankton groups	Balta Albă	Câineni	Amara	Movila Miresei
Cyanobacteria	5	8	8	1
Euglenophyceae	2	3	3	0
Bacillariophyceae	12	11	19	2
Chlorophyceae	0	0	8	0
Total phytoplankton	**19**	**22**	**38**	**3**
Ciliata	1	0	1	0
Testacea	1	0	1	1
Rotifera	2	1	5	2
Ostracoda	0	0	1	0
Cladocera	0	1	1	0
Copepoda	2	2	3	0
Branchiopoda (Artemiidae)	0	0	1	1
Total zooplankton	**6**	**4**	**13**	**6**

Regarding the abundance of the total phytoplankton, an inverse upward trend was seen with the decreasing of the salinity gradient in the lakes. The only system with a high abundance of phytoplankton at a relatively high salinity (17 g L^{-1}) was the Câineni Lake (Figs. 3; 4).

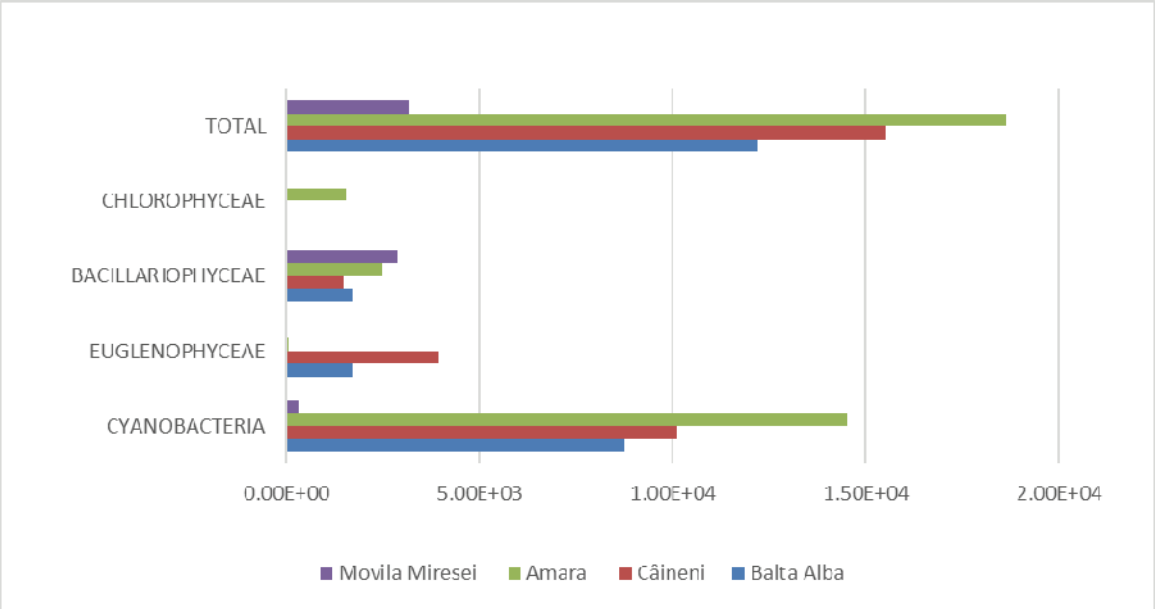

Figure 3. The variation of phytoplankton density (cell L^{-1}) in the sampled lakes.

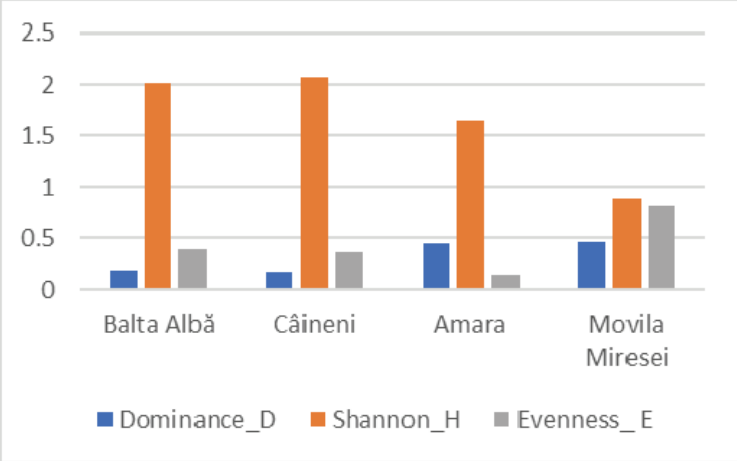

Figure 4. Diversity indices of phytoplankton in saline lakes.

In order to assess the degree of the plankton diversity in the four studied lakes, indices of diversity (Shannon, index of dominance, evenness) were calculated. Although these indices are often used in ecology to analyse and compare the spatial and temporal diversity of a lake or several lakes, they do not always have the necessary precision (HELLMANN & FOWLER, 1999). Therefore, a good statistical technique was chosen for shaping diversity profiles (Figs. 5; 7) to compare the four lakes from this point of view. The test is based on the calculation of the alpha index, an index that encompasses in point 0, the species richness, in point 1, the Shannon diversity and in point 2, the dominance index. The curve that is above the other lines, in the range 0-2, is interpreted to have the greatest diversity.

The diversity of plankton in these types of ecosystems, with a simpler organization than those of fresh water, is very important (GHEORGHIEVICI et al., 2015). Most times, the phytoplankton community provides the primary production of the lake, because the aquatic plant community is poor or even absent, especially at high salinity. The phytoplankton community is the only one to support the entire trophic network of salty lakes, which is limited to primary consumers (zooplankton) and microbial communities that are mainly the organic matter decomposers.

The diversity curves of the phytoplankton confirmed the values of Shannon's diversity index, with the Câineni Lake holding the first place, Balta Albă the second, and the less diverse were Amara and Movila Miresei (Fig. 5).

As it can be seen both in Figure 4 and Figure 6, the Shannon index varies inversely with the dominance index, suggesting that, for example, although the Movila Miresei Lake Amara recorded the highest abundance, it is accumulated only by one species, *O. tenuis*. For this reason, in the Amara Lake, evenness showed the lowest value (0.136) (Fig. 4).

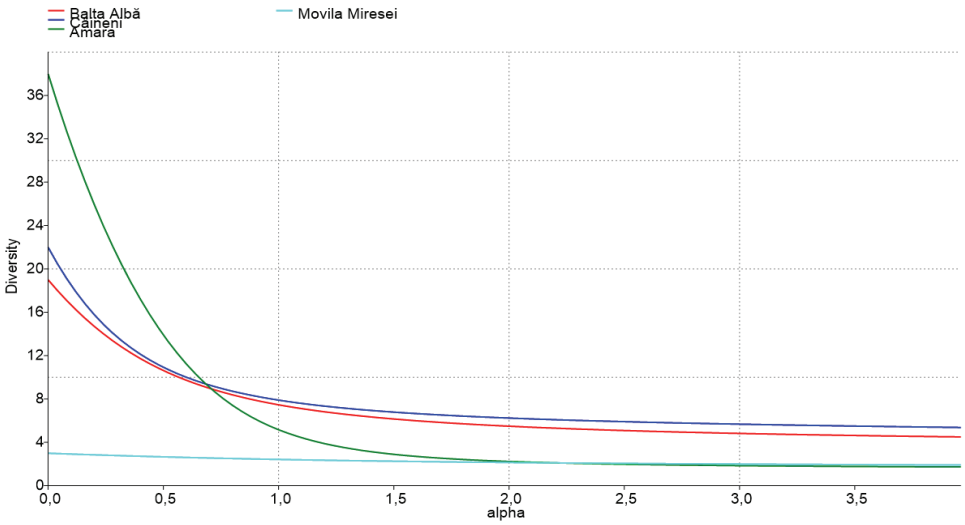

Figure 5. The diversity profile of saline lakes based on phytoplankton abundance.

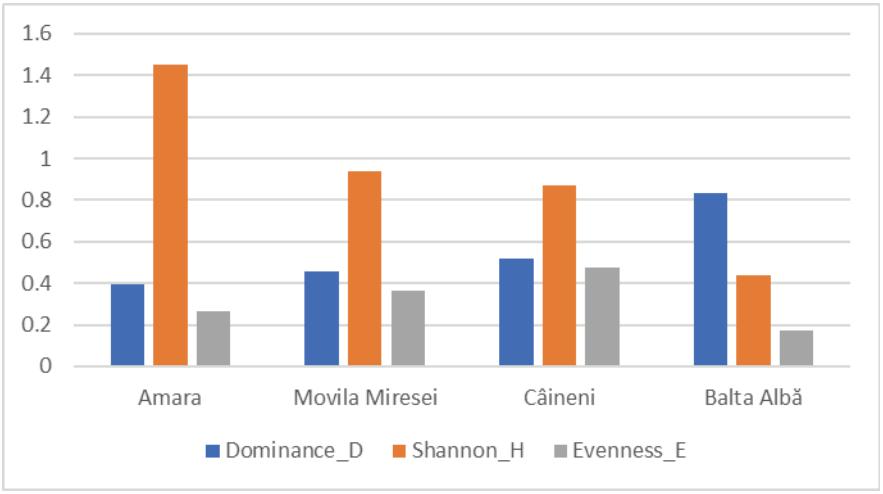

Figure 6. Diversity indices of zooplankton in saline lakes.

The high zooplankton diversity of the Lake Amara was correlated with a low salinity. The Shannon index decreased with the reduction of salinity in the other three lakes (Fig. 6).

The zooplankton diversity curves confirmed this analysis, the lake with the most zooplanktonic species being Amara (Fig. 7). The high diversity of species is related to the low salinity level, the species found here being species found in freshwater and tolerant to oligohaline waters.

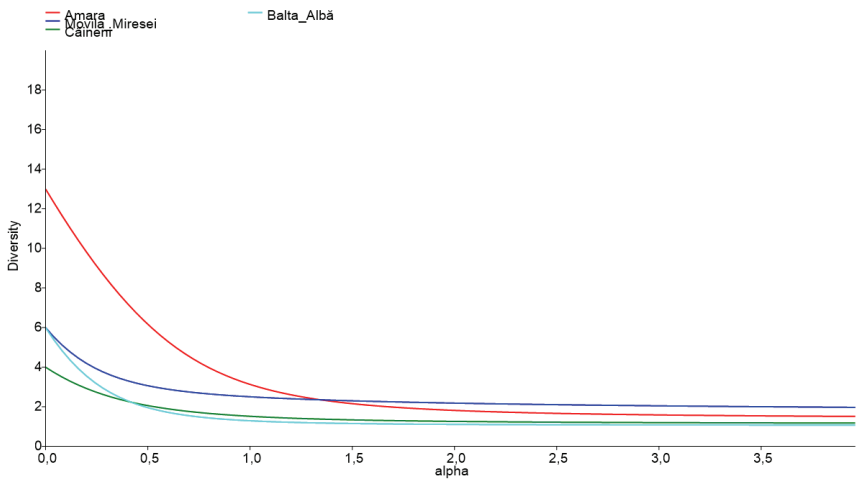

Figure 7. Diversity profiles of the saline lakes based on zooplankton abundance.

In order to find out the preference of the plankton groups for a particular lake, a multivariate statistical technique, Principal Component Analysis (PCA) was applied.

Ffigure 8 shows that *A. salina* belonging to the Artemiidae family preferred higher salinity conditions, such as those of Movila Miresei, while in the Câineni Lake, which ranked second in salinity, species of the Copepoda group are found. The lakes with lower salinity, such as Amara and Balta Albă, are preferred by the Rotifera group, where most of the species in this group were found. The degree of association of these groups with the studied lakes is 85.39%, combined percentage of the two PC1 and PC2 component axes of the analysis.

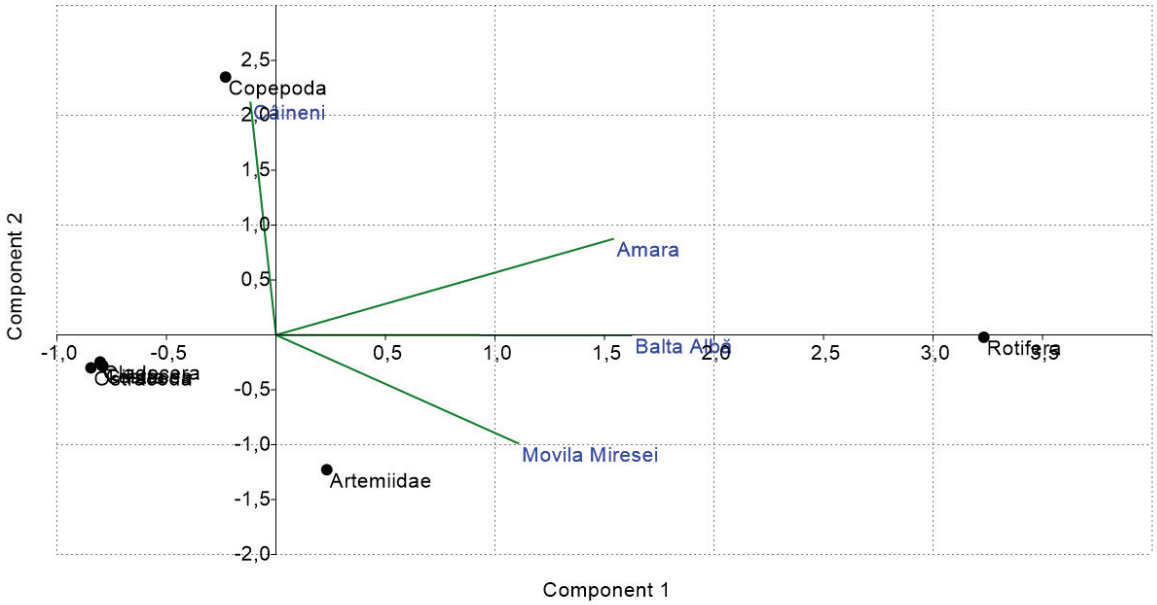

Figure 8. PCA biplot of the correlation between zooplankton groups and saline lakes.

Figure 9 shows the degree of preference of the phytoplankton groups for the studied lakes. Thus, the diatoms were found in the conditions of the high salinity that characterized the Movila Miresei Lake. Species belonging to the Cyanobacteria group preferred lower salinity conditions, from Câineni, Balta Albă and Amara. In the Lake Amara was registered a blooming episode of the cianobacterial filamentous species, *O. tenuis*.

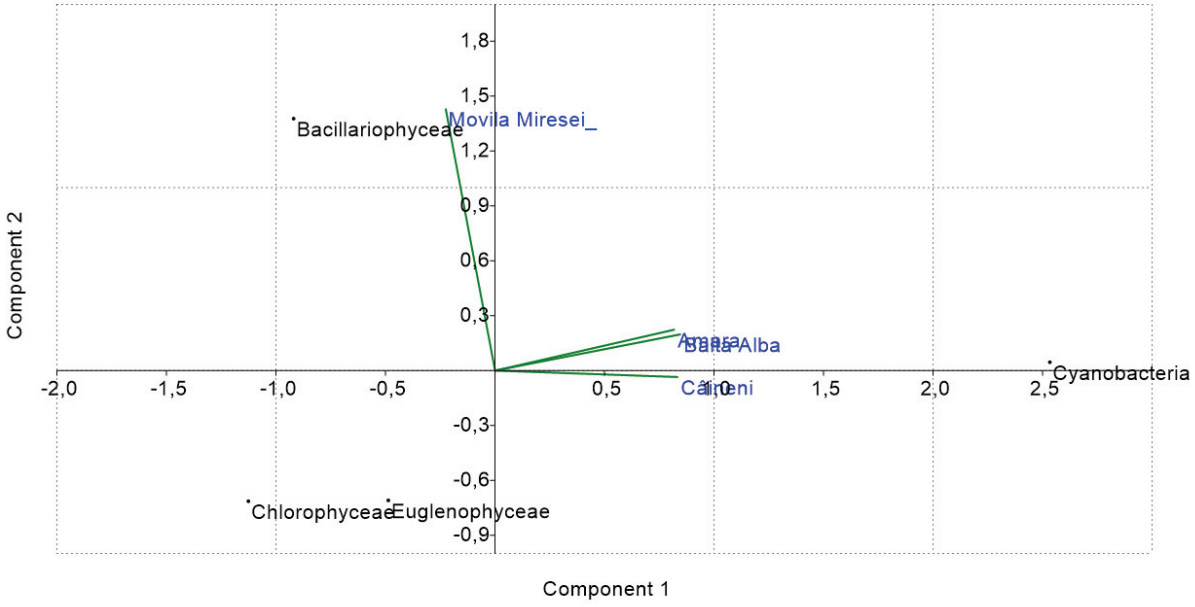

Figure 9. PCA biplot of the correlation between phytoplankton groups and saline lakes.

54 bacterial strains were randomly selected from the investigated sites, which showed halotolerant behaviour considering their ability to grow on culture media supplemented with NaCl up to 5M. From the investigated strains, 25 harbour ability to grow well on media having a NaCl concentration from 0 to 5M. A lot of them, namely 20 strains, were isolated from the sapropelic mud sample from the Movila Miresei hypersaline lake. In terms of the presence of extracellular enzymatic activities, seven strains showed capacity to degrade casein, eight strains degrading starch, four strains harbour lipolysis activities, another four hydrolyzing Tween 80, three strains used pectin as substrate, one strain degrading xylene and another one carboxy-methyl cellulose (CMC). Inulin was not degraded by the investigated strains. Two strains isolated from sapropelic mud from Movila Miresei harbour ability to degrade three tested substrates. Other seven strains degraded two tested substrates. The recorded data revealed that two extracellular activities were predominant, namely amylase and protease. The less used substrates testes in our investigations were xylene and CMC.

CONCLUSIONS

Using the Principal Component Analysis PCA), the Movila Miresei Lake was associated with salinity and conductivity, the Lake Câineni with temperature, while Balta Albă and Amara were influenced mainly by DO, pH, TDS, ORP, turbidity. The additional technique applied for investigating diversity of the phytoplankton confirmed the values of Shannon's diversity index and infirmed the values of species richness. Thus, the Câineni Lake (with high salinity, after Movila Miresei) was on the first place in terms of diversity, the second was Balta Albă, and the less diverse were Amara and Movila Miresei. Salinity is not always the main factor shaping the diversity of saline lakes. Other factors, as temperature, DO, pH, TDS, ORP, turbidity can influence the biological communities of these lakes.

Salinity is not always the main factor shaping the diversity of saline lakes. Other factors, as temperature, DO, pH, TDS, ORP, turbidity can influence the biological communities of the investigated lakes.

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ECOLOGICAL IMPLICATIONS OF BIODIVERSITY SPECIFIC TO INDUSTRIALLY CONTAMINATED ECOSYSTEMS IN NORTHWESTERN OLTENIA

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Abstract. Both chemical and biological analyses, which aim at rendering water quality have advantages and disadvantages. If the chemical analysis provides information on the chemical characteristics valid only for sampling, the biological analysis provides information that reflects the situation for a long, retrospective period. This advantage is due to the fact that organisms, do not generally have an immediate response to the change in environmental factors but in a longer time, depending on the ecological valence of the species. Therefore, the biological and ecological analysis of water is based on the total response of organisms to environmental conditions. This is reflected in the qualitative and quantitative composition of biocoenosis in the ecosystem. Our research carried out within a national program of knowledge of industrially contaminated ecosystems in northwestern Oltenia has highlighted the presence of certain physiological groups of organisms (plants, invertebrates) adapted to different living environments, which have acquired perfect tolerance for ecological characteristics of substrates. In this respect, Mehedinţi County is a reference area in determining the influence of physico-chemical conditions on the dynamics of the biodiversity evolution of industrially contaminated ecosystems in southwestern Romania.

Keywords: Oltenia, microorganisms, gastropods, ecological valence.

Rezumat. Implicații ecologice ale biodiversității specifice ecosistemelor contaminate industrial din nord-vestul Olteniei. Analiza chimică, cât şi cea biologică, care au în vedere stabilirea calităţii apei, au avantaje şi dezavantaje. Dacă analiza chimică dă informaţii asupra unor caracteristici chimice valabile numai pentru momentul prelevării probei, analiza biologică furnizează informaţii ce oglindesc situaţia pe o perioadă îndelungată, având un caracter retrospectiv. Acest avantaj este consecinţa faptului că organismele, în general, nu au un răspuns imediat la schimbarea factorilor de mediu, ci într-un timp mai îndelungat, în funcţie de valenţa ecologică a speciei. Aşadar, analiza biologic-ecologică a apelor se bazează pe totalitatea reacţiilor de răspuns ale organismelor faţă de condiţiile de mediu. Acest fapt se reflectă în componenţa calitativă şi cantitativă a biocenozei din ecosistemul respectiv. Cercetările noastre efectuate în cadrul unui program național de cunoaștere a unor ecosisteme contaminate industrial din nord-vestul Olteniei au evidențiat prezența cu pregnanță a anumitor grupe fiziologice de organisme (plante, nevertebrate) adaptate la diferite medii de viață, care au dobândit o perfectă toleranță la caracteristicile ecologice ale substratelor. În acest sens, județul Mehedinți reprezintă un areal de referință în stabilirea influenței condițiilor fizico-chimice asupra dinamicii evoluției biodiversității ecosistemelor contaminate industrial din sud-vestul României.

Cuvinte cheie: Oltenia, microorganisme, gasteropode, valența ecologică.

INTRODUCTION

Among the pollution factors pollution generated by chemical mineral substances and organic matter are particularly common. In case of organic substances, water is characterized by low levels of oxygen, the occurrence of toxic hydrogen sulfide, methanol, changes in pH and in organoleptic properties, increased turbidity. By virtue of their ability to adapt, some species live in waters polluted with organic matter and feed on these resources. Such organisms are called indicators of the organic load or water saprobity. At the same time, it is known that another category of organisms lives in clean waters with a very low load of organic substances. These species are biological indicators of the degree of water cleaning.

Considering that organisms in general have a certain plasticity to environmental conditions, in water quality assessment it is taken into account that only if the number of indicator species is very high and this happens in very polluted areas or, on the contrary, in very clean areas, a safe diagnosis on the water quality can be made. The main role in the process of self-purification of water is played by bacteria, the rest of the organisms continuing the transformations started by the bacteria. Some bacteria in the water develop in the presence of oxygen (the aerobic bacteria) and others in the absence of oxygen (the anaerobic bacteria). The aerobic bacteria play a major role in the process of self-purification, but the process involves both categories, as the activity of a category is conditioned by the activity of the others; they succeed, depending on the quantity and quality of organic substances, hydrological conditions and temperature.

Along with bacteria, which they always accompany, protozoa have a major role in the self-purification of contaminated water with organic substances. Among them, the most important are ciliates. Protozoa alone (without bacteria) cannot perform the cleaning, but as they are debris consumers, they contribute to the clarification of water and influence the development of microbial communities, which are ingested by them. Macro vertebrates are of multiple importance. Sponges, braziers, bivalves fulfill the role of water filtration, retaining the organic suspension they feed on. The swan mussel (*Anodonta cygnea* Linnaeus, 1758) can filter 40 liters of water in 24 hours.

Our research carried out within a national program of knowledge of industrially contaminated ecosystems in north-west Oltenia has revealed the presence of certain physiological groups of organisms (plants, invertebrates) adapted to different living environments that have acquired a perfect tolerance to the ecological characteristics of the substrates. In this respect, Mehedinti County located in the Western Plain of Oltenia, interfering with Banat, belonging to the Moesica province (Banat-Oltenia) represents a point of reference in determining the influence of physic-chemical influences on the dynamics of biodiversity evolution of industrially contaminated ecosystems from the south-west of Romania (Fig. 1).

Figure 1. The map with the delimitation of Mehedinți County in southwestern Romania (Google Earth, accessed: March 5, 2018).

The analysed territory is covered with sedimentary formations originating in the Lower and Upper Holocene, consisting of alluvial deposits, wind-shaped, such as sand dunes, and sedimentary formations made up of clay, clays and loess, belonging to the upper terrace of the Danube and the plain area, constituting the parental material for chernozems, on which Quercus vegetation has installed: Turkey oak (*Quercus cerris*), Hungarian oak (*Q. frainetto*), pedunculate oak (*Q. robur*), with intercalated plots of acacia plantations (*Robinia pseudoacacia*) (BERCEA, 2009; ADAM et al., 2012). The climate is temperate continental with Mediterranean influences (VLADUȚ et al., 2017). In the area, there are specific terrestrial ecosystems: dunes, meadows, forests, meadows integrated aquatic ecosystems represented by lakes, ponds, swamps. According to this ecosystem diversity, structures are characteristic floristic and faunistic (FIERA & OROMULU-VASILIU, 2009; BREZEANU et al., 2011; VICOL, 2015; CIOBOIU & BREZEANU, 2017).

MATERIALS AND METHOD

The case study refers to Halânga Thermal Power Plant, located 9 km from Drobeta Turnu Severin, in the northern region of Mehedinţi County, on the territory of Puţinei village, on the left slope of the Topolniţa at the confluence with its tributary, the Pleşuva. It produces electricity based on lignite excavated in the Husnicioara quarry (Fig. 2).

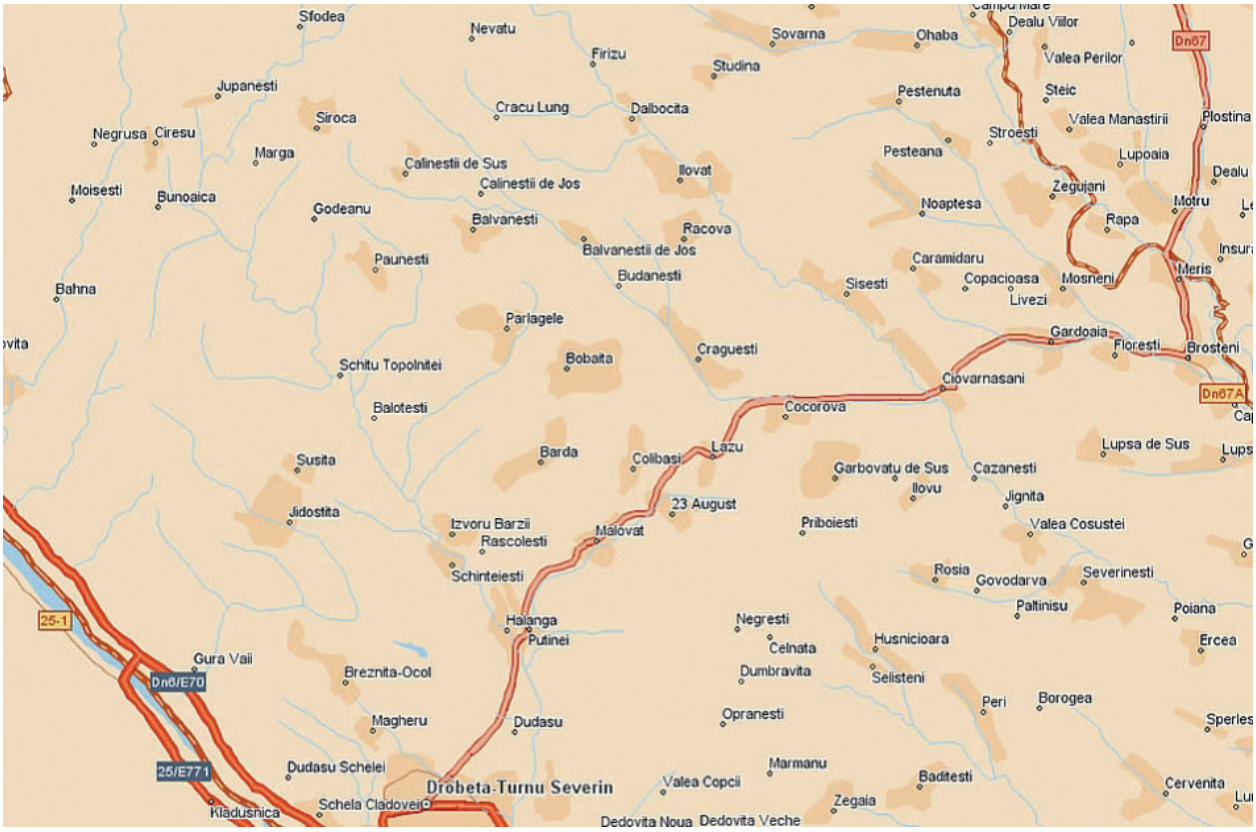

Figure 2. Map rendering the position of Halânga power plant to Drobeta Turnu Severin (Google Earth, accessed: March 5, 2018).

In this context, knowing the ecological mechanisms of adaptation and change in the structure of populations and biocoenoses, biological-ecological analysis can give information on the degree of the ecosystem intoxication chemical analysis can highlight it only if measurements are repeated frequently and over a long period of time. The limits of biological analysis are that it cannot provide information on the quantitative and qualitative values of the pollutants. Therefore, the two methods complement one another without giving partial information (GAVRILESCU & OLTEANU, 2003; GAVRILESCU, 2007; CISMAŞIU, 2009; CISMAŞIU et al., 2010; VICOL, 2011).

RESULTS AND DISCUSSIONS

In general, the acute pollution of the water with mineral substances is highlighted by the total absence of organisms. There are species that have a certain resistance to heavy metal ions, which does not mean they can achieve large numerical densities under such conditions. Because of this, they are not considered as indicator species. In this respect, there are known signaling organisms for the pollution with iron, calcium, sodium chloride, hydrogen sulphide and sulfur compounds, and oil pollution. Coal waste deposited in various places has a high content of pyrite. The most important issue related to environmental pollution is the oxidation of the pyrite and the generation of acidity. The waste is deposited and constitutes an active source of acid (H_2SO_4), which generates soil contamination at the surface, and groundwater, endangering ecosystems. Pyrite oxidation results in Fe^{2+}, SO_4^{2-} and H^{+}. Drainages of coal mines are characterized by low pH, a highly varied composition that prevails in high concentrations of sulphate, iron, manganese, aluminum and other toxic and radioactive ions, as well as solid particles in excess. This drainage is one of the oldest problems arising from coal mining (Fig. 3).

Figure 3. Map rendering the localization of Halânga Thermal Power Plant in northern Oltenia (Source: http://www.nationsonline.org/oneworld/map/google_map_romania.htm; Google Earth Software, accessed March 3, 2018).

Desulphurization techniques are physical, chemical, thermal or biological. These techniques are applicable to the desulphurization of coal before it is subjected to combustion. Many studies undertaken in the last decades on the desulphurization of coal have focused on the removal of pyritic sulfur (inorganic), which is half of the total sulfur content in coal. Organic sulphide is more difficult to remove by conventional processes as there are to strong organic bonds.

The physical treatment of inorganic sulfur removal involves magnetic separation or hydrocyclone use, while the elimination of organic sulfur is carried out in most cases by chemical and/or microbiological treatment. Chemical treatment involves the use of strong acids, bases or salts. This treatment is commonly performed at elevated temperatures (200-300 ºC) and is characterized by high selectivity. Leaching with nitric acid at high pressure and temperature (up to 90 °C) is an effective treatment, almost completely removing sulfur. Leaching with sodium carbonate, sodium hydroxide or potassium hydroxide is effective, removing 90% of organic and inorganic sulfur. Although these techniques can be considered feasible, they have high cost and negative environmental impact. The heat treatment involves the use of hydrolysis or steam-air mixture. These two processes operate at high temperatures: 350-500 °C, considered being quite complicated, and the degree of desulfurization depends on a number of parameters, such as temperature, particle size, composition of the air-steam-gas mixture, type of coal, heating and type of reactor used.

The biological desulfurization has been established as a laboratory technique by the use of bacteria with high capacity to oxidize pyrite, thus implicitly removing sulfur from coal. Recent studies on coal desulphurization have highlighted the successful application of biological techniques. The removal of sulfur from coal is a feasible process. The elimination of the pyrite in higher percentage leads to a reduction in the acidity of the waste. Physical, chemical or biological techniques can be applied with a double effect: removing sulfur on the one hand and decreasing the degree of susceptibility of the waste to oxidation.

Choosing the most feasible techniques requires extensive experimental studies, while their application requires the use of advanced techniques whose primary objective is environmental protection. In this context, the species of plants, invertebrates and microorganisms in contaminated areas are biomarkers for pollution with metal ions, sodium and calcium chloride, and sulfur compounds.

From the observations made in our country, *Helix pomatia* grows mainly in anthropogenic ecosystems, being an indicator of industrially contaminated areas (GROSSU, 1983; NEACŞU & CIOBOIU, 1999; 2000). In natural ecosystems, the species is mainly found in the bright forests, located in the plain, hilly or mountain areas. The best lands for the development of this snail are limestone, mobile and preferably dry soils. In general, acidic, sandy, clayey and marshy soil are avoided.

In these ecosystems, it occupies abiotic microhabits (vegetal remains, old wood or cement fences, soil, stones, cartons, metal vessels, concrete slabs, etc.) and biotic microhabits represented by various plant organs: leaves, stems and branches.

Helix pomatia Linnaeus 1758 is an euribiont species (widespread in a wide range of biotopes: gardens, forests and generally shady and humid places). The shell is globular, grayish-brown, with darker longitudinal stripes and a size of 38-40 mm. In cross section, the shell is made up of three parts: periostracum, ostracum and hypostracum. The body consists of head, foot and trunk. It is ovipar, deposits a few tens of eggs in June and July, in a pit with a foot and a shell.

The development is direct, without metaphorphosis, due to adaptation to terrestrial life and as a consequence of the constitution of relatively rich vitelus eggs. All stages of embryonic development occur in the egg shell from which the individual stands ready to provide. *Helix pomatia* buries to 25-35 cm in soil and closes its aperture with a limestone lid, isolating itself from the external environment and leading a latent life. It is a phytopathic species that feeds on mushroom hay and the green parts of the superior plants. It lives through bushes, orchards, lush and humid forests, under 500 m altitude, and up to 1800 m is a ubiquist species.

In case of terrestrial gastropods, hibernation is generally done in a sheltered place or in the ground. The nature of the soil is of great importance for terrestrial gastropods. They prefer limestone substrates because they provide material for building the shell, retaining water, having some moisture, allowing the development of a rich vegetation. Other terrestrial species belonging to the family Helicidae, common in natural (orchards, forests, bushes in hilly and flat) and anthropogenic ecosystems or cultivated (kitchen gardens, orchards, fields wine) and ruderal areas are *Helicella obvia* (Menke 1821), *Cepaea vindobonensis* (Ferussac 1821), *Helix lutescens* (Rossmassler 1837), *H. lucorum* (Rossmassler 1837).

In natural ecosystems (especially in orchards and forests), the species *Succinea putris* Linnaeus 1758 and *S. oblonga* (Draparnaud 1801), belonging to the Succineidae family, have a low frequency; they live near water, in wet orchards (GROSSU, 1993). *Arion hortensis* (Ferussac 1819) belonging to the Arionidae family is a European species present in all the provinces of Romania, the preferred habitat being represented by forests, meadows, orchards in both mountain and plains.

Originally from Spain, *Lehmania valentiana* (Ferussac 1823) belonging to the Limacidae family, is a cosmopolitan species, frequent in anthropogenic ecosystems (greenhouses, botanical gardens), where it produces significant damage. A harmful species belonging to the same family is *Deroceras reticulatum* (O. F. Muller 1774), frequent in large-scale vegetable gardens, but also in forests and orchards (GROSSU, 1993; CIOBOIU, 2005).

The ability of natural or artificial aquatic ecosystems to self-propel depends on a complex of environmental factors (physical, chemical, and biological) that interact in this process simultaneously or in a certain succession. It is understood, however, that if pollution is strong and occurs suddenly (in case of spills of large quantities of pollutants) the death of organisms can be instantaneous. Following the gradual change in the physicochemical characteristics of water as a result of pollution, a change in the ecological balance occurs: some species gradually disappear, changing the ratio of the populations constituting the biocoenosis; those adapted to the new conditions will multiply. There is a selection, depending on their ecological valence, forming another type of biocoenosis characteristic of polluted water (CIOBOIU, 2005; MANU & ONETE, 2014; TEODORESCU & MAICAN, 2014; MANU et al., 2017).

Water and soil contamination by both inorganic (e.g., metals) and organic (e.g., petroleum) pollutants is a major issue in several European countries. Petroleum and petroleum products (complex mixture of hydrocarbons) are the major source of energy for industry and daily life. Accordingly, petroleum hydrocarbons are one of the most important pollutants of the water and soil in Romania. Furthermore, there several approaches were performed for the isolation and characterization of new bacterial strains able to survive in the presence of different toxic hydrocarbons. These bacteria belong to several genera, such as *Vibrio*, *Rhodococcus*, *Lysinibacillus*, *Shewanella*, *Serratia* and *Pseudomonas* (VOICU et al., 2005; ŞTEFĂNESCU & CÎRSTEA, 2010; STANCU, 2014; 2015; 2016).

CONCLUSIONS

Increasing the efficiency of bacteriochemical solubilization techniques of industrial wastes is interconnected with the direct interaction between microorganisms and solid coal surfaces subjected to the action of the microbiological method of removal of inorganic sulfur. In addition, the obtained results have highlighted the ecological characteristics of the Helicidae family, which have an important role in the biogeochemical circuit, being indicators of Oltenia's contaminated industrial environments, as well as metal ion bioaccumulators from natural and anthropogenic ecosystems.

The studies conducted showed the increased tolerance of plant and invertebrate species to the presence in the environment of bivalent metallic ions from the industrial activities of solid coal waste processing. Biological methods are not particularly precise and they cannot be included in absolute mathematical formulas or specify the quantity and quality of the pollutant, but only their effect and not when sampling, but as a result of a long period of pollution, on the contrary, the decrease or elimination of this pressure. Therefore, in order to have a more accurate picture of the quality of ecosystems (and therefore the type and quantity of pollutants), biological methods must be accompanied by chemical determinations.

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2006-2012 LAND COVER AND USE CHANGES IN ROMANIAN NATURAL PROTECTED AREAS

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Abstract. The literature shows that, despite of the 'sustainability' concept, conservation and development are still in a conflicting relationship. In Romania, natural protected areas were declared during the accession to the European Union, but their status was not always enforced. The aim of this study is to look at the spatial distribution of land cover and use changes occurring in Romanian natural protected areas during 2006-2012 in relationship to their underlying transitional dynamic. The methodology consists of geo-spatial analyses of CORINE land cover and use data and data on the Romanian natural protected areas. The results attest the presence of land cover and use changes in the Romanian natural protected areas. Furthermore, nearly 50% of all deforestations occurred within their perimeter. The findings reflect the consequences of an unplanned development, disregarding the long-term consequences for the short-term benefits.

Keywords: sustainability, deforestation, floods, CORINE, conservation.

Rezumat. Modificări în acoperirea şi utilizarea terenului din ariile naturale protejate din România în perioada 2006-2012. Literatura de specialitate arată că, în pofida apariţiei conceptului de „dezvoltare durabilă", relaţia dintre conservare şi dezvoltare rămâne una conflictuală. În România, ariile naturale protejate au fost declarate în timpul procesului de aderare la Uniunea Europeană, dar statutul lor nu a fost întotdeauna supus controlului implementării legislaţiei. Scopul acestui studiu a fost analiza distribuţiei modificărilor acoperirii şi utilizării terenului din ariile naturale protejate din România în perioada 2006-2012 pe baza dinamicilor de tranziţie. Metodologia a constat în analize geo-spaţiale pe baza datelor CORINE privind acoperirea şi utilizarea terenului şi acelor referitoare la ariile naturale protejate. Rezultatele atestă prezenţa modificărilor acoperirii şi utilizării terenului în ariile naturale protejate. Mai mult, 50% din defrişări s-au produs în acest perimetru. Aceste rezultate reflectă consecinţele unei dezvoltări neplanificate, ce sacrifică consecinţele pe termen lung pentru beneficii imediate.

Cuvinte cheie: dezvoltare durabilă, defrişare, inundaţii, CORINE, conservare.

INTRODUCTION

The conservation status limits the usage of natural resources (JAMES et al., 2001; CHOMITZ et al., 2005; PETRIŞOR et al., 2016), but results in benefits such as ecosystem services (ADAMS & HUTTON, 2007; TALLIS et al., 2008; ANDAM et al., 2010; BUSCH & GRANTHAM, 2013), tourism revenues (ANDAM et al., 2010; FERRARO et al., 2011) and an improvement of the infrastructure (ANDAM et al., 2010; FERRARO et al., 2011).

In developing countries and/or during economic crises, conservation and socio-economic development develop a confliction relationship (BENNETT et al., 2007; PETRIŞOR et al. 2016); this could be a consequence of the association between the lack of environmental awareness and poverty (REICHEL-DOLMATOFF, 1982; ROZELLE et al., 1997; JEHAN & UMANA, 2003; TALLIS et al., 2008), especially in the developing countries (LEONARD & DAVID, 1981; IANOŞ et al., 2011) which do not use the natural resources to reduce poverty (SAYER et al., 2012).

The potential benefits of conservation are debatable (WILKIE et al., 2006; ANDAM et al., 2010; ANTHONY & SZABO, 2011). Some authors consider conservation a solution for reducing poverty (KUŠOVÁ et al., 2005; KOTHARI, 2006; ADAMS & HUTTON, 2007; TALLIS et al., 2008; ANDAM et al., 2010; FERRARO et al., 2011), whilst others consider it a cause of poverty (DE SHERBININ, 2008), because conservation does not have this aim (ANDAM et al., 2010). The conflict may be rooted in the long-term goals of conservation, which do not account for the present challenges (OHL et al., 2008). Generally, the relationship might differ by scale (UPTON et al., 2008).

The most conflicting activities are the economic ones (FRYS & NIENABER, 2011), especially agriculture (ANDAM et al., 2010; ANTHONY & SZABO, 2011; FRYS & NIENABER, 2011). Conflicts are determined by the limited access to resources (BELL et al., 2001; CERNEA & SCHMIDT-SOLTAU, 2003; BROWMAN et al., 2004; ADAMS & HUTTON, 2007; DHAKAL et al., 2007; OHL et al., 2008; ANDAM et al., 2010; IOJĂ et al., 2010; ANTHONY & SZABO, 2011; FERRARO et al., 2011), restrictions to the ownership (CERNEA & SCHMIDT-SOLTAU, 2003; WILKIE et al., 2006; ADAMS & HUTTON, 2007; PETRIŞOR et al., 2016), ignoring the local culture in the management process (WALPOLE & GOODWIN, 2001; CAMPBELL & VAINIO-MATTILA, 2003; KOTHARI, 2006; SINGH et al., 2012, 2014; SUGANDI, 2014) or unfair distribution of revenues (KOTHARI, 2006; WILKIE et al., 2006; OHL et al., 2008). Political causes include the opposition to top-down approaches (ADAMS & HUTTON, 2007; KUŠOVÁ et al., 2008; MACKELWORTH & CARIC, 2010; ANTHONY & SZABO, 2011; GRODZINSKA-JURCZAK & CENT, 2011), especially in an international context (NELSON & VERTINSKY, 2005), but also by low accessibility (ANDAM et al., 2010), lack of funding (SHULTIS, 2005; IOJĂ et al., 2010) of planning (SINGH et al., 2014) and tourism (SHULTIS, 2005).

Land cover and use changes reflect socio-economic issues through their underlying transitional dynamics (PETRIŞOR et al., 2010; 2014). Previous studies (PETRIŞOR, 2015b; 2016) aimed to assess human impacts in the Romanian natural protected areas through the land cover and use changes occurred in the Romanian natural protected areas, but due to the age of the datasets it was hard to assess causality (i.e., whether changes occurred before of after the

acquisition of the protection status). Romanian natural protected areas were declared in relationship with joining the European Union, but their status was not really enforced always, as some missed either a managing authority and a management plan or at least the second. For these reasons, the protection status was questioned, and resulted into Romania being sued by the European Union (COJOCARIU et al., 2010), as: (1) if changes occurred before, the protection status is questionable because the areas were no longer in a pristine state, and (2) if changes occurred after, the efficiency of enforcing the protection status is at stakes.

This study aims at looking at the spatial distribution of land cover and use changes occurred in the Romanian natural protected areas during 2006-2012 in relationship to their underlying transitional dynamic.

DATA AND METHODS

The study used several datasets, freely available from European and international sources, presented in Table 1. Data processing consisted of re-projecting and sub-sampling subsets for Romania, clipping the polygons affected by land cover and use changes by the natural protected areas, and ultimately computing areas using the X-Tools extension of ArcView GIS 3.X. The analyses aimed to assess the distribution of land cover and use changes by the natural protected areas by computing their total areas.

The following transitional dynamics were defined combining the classification schemes used in the previous studies (IANOŞ et al., 2011; PETRIŞOR, 2012a, b, c, 2015a, b, 2016, 2017b, c; PETRIŞOR & PETRIŞOR, 2015, 2017; PETRIŞOR et al., 2010, 2014), based on the occurrence of changes at the first level of classification – C1, corresponding to land cover, or at the third – C3, corresponding to land use (PETRIŞOR et al., 2010):

1. Urbanization – C1 transformation of other classes into 'urban' or C3 change indicating that urban development occurred within the city
2. Forestation – C1 transformation of other classes into 'forest', including the colonization of abandoned agricultural land into forests (AGNOLETTI et al., 2011; PETRIŞOR et al., 2014), C3 transformation into forest; 'forest' corresponds to C3 classes 311 – coniferous forests, 312 – broadleaved forests, 313- mixed forests) (DE LIMA, 2005)
3. Deforestation – C3 transformation of 'forest' (see above) into other classes
4. Development of agriculture – C1 transformation of other classes into 'agricultural' or C3 transformations indicating the development of agriculture
5. Abandonment of agriculture – C3 transformations indicating the abandonment of agriculture
6. Floods – C1 transformation of other classes into 'wetlands' or 'waters'.

The natural protected areas considered in this study, based on the availability of data from the Romanian Ministry of the Environment and Sustainable Development, were:

1. National parks and natural parks (IUCN: protected landscapes
2. Scientific reserves, natural reserves and natural monuments with an area exceeding 10 ha
3. Ramsar Sites (derived by the authors)
4. Reserves of the biosphere (derived by the authors)
5. Natura 2000 SCIs, SPAs and SACs
6. A consolidated dataset, which joined all protected areas, accounting for their overlap (IOJĂ et al., 2010)
7. The Romanian territory of the Carpathian Convention, although not a genuine protected area (simply assumes measures for conserving the biodiversity).

Table 1. Specifications on the data used in the study: dataset, provider, URL, remarks and transformations.

Dataset	Provider	URL	Remarks	Transformation
Land cover and use changes data	Copernicus Land Monitoring Services	http://land.copernicus.eu/pan-european/corine-land-cover/lcc-2006-2012/view	ArcView GIS 3.X	Project into Stereo 1970, sub-sample for Romania
Natural protected areas	Romanian Ministry of the Environment and Sustainable Development	http://www.mmediu.ro/departament_ape/biodiversitate/	ArcView GIS 3.X; only several categories are available	No transformation needed

RESULTS AND DISCUSSION

The analysis aimed to look at the spatial distribution of land cover and use changes by their underlying transitional dynamic in the Romanian natural protected areas. The results are presented for each analysis separately: the overall situation in all natural protected areas (Table 2), in the Carpathian Convention area (Table 3), and in each type of natural protected area (Table 4).

Table 2 compares the distribution of land cover and use changes by their underlying transitional dynamic in all natural protected areas and the overall situation of Romania, looking at the area affected and its share in the total. The results reveal the existence of some differences; deforestation seems to be more prominent (69% compared to 57%); this is due to the fact that a significant number of natural protected areas are situated in the mountain region and include forests. It has to be stressed out that 48% of the areas Romanian affected by deforestation during 2006-2012 are situated in natural protected areas. However, forestations total a lesser share (5% compared to 9%), and only 26% of the total

Romania forested area is situated within the natural protected areas. Also, floods have a higher importance (21% compared to 8%); this is due to the fact that wetlands make up an important share of the natural protected areas, and significant floods occurred during the analyzed period.

Table 2. Land cover and use changes in all Romanian natural protected areas, compared to all changes in Romania.

Transitional dynamic	Area affected per region			
	Romania		All protected areas	
	Area (km^2)	% of the category	Area (km^2)	% of the category
Abandonment of agriculture	30	4	4	1
Deforestation	408	57	196	69
Development of agriculture	26	4	1	0
Floods	60	8	59	21
Forestation	62	9	16	5
Other	6	1	6	2
Urbanization	128	18	3	1

Table 3 compares the area of the Carpathian Convention with the national territory with respect to land cover and use changes by their underlying transitional dynamic. The Convention on the protection and sustainable development of the Carpathians, known as the Carpathian Convention, was signed in Kyiv, Ukraine in 2003 and aims to turn into a policy the special interest paid by the European Union to the mountain regions due to their vulnerability to environmental and special characteristics, such as the inclusion of fragile ecosystems, harsh climate, isolation, political and economic isolation (POPESCU & PETRIŞOR, 2010). The results emphasize the importance of deforestations (89% compared to 57%) – 82% of the whole deforested areas, explained by the fact that most Romanian forests lie within the Carpathians, covered by the Carpathian Convention. However, only 26% of the forested area is situated within this perimeter. Another difference consists in the lesser importance of urbanization (3% compared to 18%), explained through the fact that low accessibility prevented urban development (POPESCU & PETRIŞOR, 2010).

Table 3. Land cover and use changes in the area of the Carpathian Convention, compared to all changes in Romania.

Transitional dynamic	Area affected per region			
	Romania		Carpathian Convention area	
	Area (km^2)	% of the category	Area (km^2)	% of the category
Abandonment of agriculture	30	4	2	0
Deforestation	408	57	335	89
Development of agriculture	26	4		
Floods	60	8	1	0
Forestation	62	9	25	7
Other	6	1		
Urbanization	128	18	12	3

Table 4. Land cover and use changes in different types of natural protected areas, compared to all changes in Romania and in all the natural protected areas.

Transitional dynamic	Area affected per region																								
	Romania		All protect-ted areas		Parks (1)			Ramsar			Reserves of the biosphere			Reserves (2)			SCIs			SPAs			SACs		
	Area	% (3)	Area	% (3)	Area	% (3)	% (4)	Area	% (3)	% (4)	Area	% (3)	% (4)	Area	% (3)	% (4)	Area	% (3)	% (4)	Area	% (3)	% (4)	Area	% (3)	% (4)
Abandonment of agriculture	30	4	4	1							12	18	4	0	2	0	1	0	0	3	2	1			
Deforestation	408	57	196	69	62	53	22	13	19	5				8	90	3	176	69	62	122	60	43	4	100	2
Development of agriculture	26	4	1	0	0									1	7	0	1	0	0	1	0	0			
Floods	60	8	59	21	54	46	19	54	80	19	54	82	19				59	23	21	58	29	20			
Forestation	62	9	16	5	2	1	1	1	1	0				0	0	0	12	5	4	12	6	4			
Other	6	1	6	2													6	2	2	6	3	2			
Urbanization	128	18	3	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	2	1	1			

1 – includes national parks, natural parks (IUCN: protected landscapes); 2 – includes scientific reserves, natural reserves and natural monuments; 3 – percentage from the total area affected per category; 4 – percentage from the total area affected by changes in all natural protected areas

Table 4 compares the different types of Romanian natural protected areas with respect to land cover and use changes by their underlying transitional dynamic. Comparisons are carried out between the different types of natural protected areas, but also between them and the national situation or all protected areas together, accounting for their overlap (IOJĂ et al., 2010). The results vary across the different natural protected areas and transitional dynamics. The abandonment of agriculture is important only in Ramsar sites, but their large share is explained by the fact that other changes are not present. More exactly, since the Ramsar sites are wetlands, the share of forests is reduced within their perimeter, and deforestations and forestations are missing; also, they include lesser human settlements, and urbanization is not important. However, they are affected by floods to a greater extent. Deforestations affect all natural protected areas, and especially the Special Areas of

Conservation (SACs), where they are the only driver of change. The development of agriculture, urbanization and other causes are misrepresented; this is because most protected areas include natural ecosystems, and to a lesser extent man-dominated ecosystems, and, therefore, the transitional dynamics characteristic to socio-economic systems are less important, and host lesser human communities, reducing the impacts resulting from demographic factors (population and density), such as urbanization (PETRIŞOR, 2017a, b), extensive agriculture or deforestations. Floods are prominent in many categories, especially the Ramsar sites discussed above, but also the biosphere reserves; this is due to the share of the area of the Danube Delta Biosphere Reserve in the category of biosphere reserve.

The study is subject to limitations characteristic to CORINE data, including misclassification of satellite data, as well as different classification schemes and resolutions from one period to another (JANSEN, 2007; PELOROSSO et al., 2011; VERBURG et al., 2011; PETRIŞOR et al., 2010, 2014).

CONCLUSION

This study aimed to look at the relationship between conservation and development by analyzing the land cover and use changes occurred in Romania during 2006-2012 based on their transitional dynamics, which are conditioned by socio-economic factors. One of the most important factors is that changes occurred within these areas despite their protection status. Furthermore, nearly 50% of all deforestations occurred within this perimeter, but they were not compensated by forestation to a similar extent. Overall, the findings reflect the consequences of an unplanned development, where the protection status was not enforced, disregarding the long-term consequences for the short-term benefits.

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THE PLACE AND THE ROLE OF THE URBAN OXYGENATING AREAS IN THE URBAN LANDSCAPE RENATURATION

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Abstract. The green-blue infrastructure or urban oxygenating areas represent regions of particular importance in the urban ecosystem due to the benefits provided and positive implications for the inhabitants' state of health. This issue has gained particular importance as compared with the ascending dynamics of urban residents, thereby causing changes in the way land is used inside the urban area. The present study underlines the importance of oxygenating areas in the urban renaturation process, with the objective of maintaining the balance between the ecological systems and achieving the urban sustainability. The identification of the oxygenating areas categories and their functions is the method chosen in order to highlight the role and the place of the green-blue infrastructure at the level of the urban landscape, and the established area of study is represented by the Development Region of South-West Oltenia. The functions of urban oxygenating infrastructure (cultural, ecological, recreational and improving health) are the guarantor of the urban sustainability, therefore the structural and functional conservation of these areas is a binding approach that may only be achieved by conjugating the will of the political decision-makers to the existence and implementation of an appropriate legislation, but also by involving the residents.

Keywords: oxygenating areas, renaturation, urban landscape, South-West Oltenia Development Region.

Rezumat. Locul și rolul suprafețelor oxigenante urbane în renaturarea peisajului urban. Infrastructura verde-albastră sau suprafețele oxigenante urbane reprezintă areale cu importanță deosebită la nivelul ecosistemului urban prin beneficiile oferite și implicațiile pozitive asupra stării de sănătate a locuitorilor. Această problematică a dobândit o importanță deosebită în raport cu dinamica ascendentă a rezidenților urbani, fapt ce cauzează schimbări în modul de utilizare a terenului în interiorul intravilanului. Prezentul studiu evidențiază importanța suprafețelor oxigenante în procesul de renaturare urbană, având drept obiectiv menținerea echilibrului ecosistemic și atingerea durabilității urbane. Identificarea categoriilor de suprafețe oxigenante și a funcțiilor acestora este metoda aleasă spre a reliefa rolul și locul infrastructurii verzi-albastre la nivelul peisajului urban, iar zona de studiu stabilită este reprezentată de Regiunea de Dezvoltare Sud-Vest Oltenia. Funcțiile infrastructurilor oxigenante urbane (culturale, ecologice, recreative și de îmbunătățire a sănătății) reprezintă garantul durabilității urbane, de aceea conservarea structurală și funcțională a acestor suprafețe este un demers obligatoriu ce poate fi realizat doar prin conjugarea voinței decidenților politici, cu existența și implementarea unei legislații corespunzătoare, dar și prin implicarea rezidenților.

Cuvinte cheie: suprafețe oxigenante, renaturare, peisaj urban, Regiunea de Dezvoltare Sud-Vest Oltenia.

INTRODUCTION

Urban oxygenating areas have been timidly addressed in the scientific geographic research in Romania, thereby circumventing their structural and functional assessment in relation to the inhabitants' state of sanogenesis and quality of the urban living. Identifying and applying a complex and objective methodology to quantify the ecosystem services and benefits provided by the urban oxygenating infrastructure may lead to the achievement of a vast database that integrates both the theoretical values and the way residents refer to these natural regions. The studied issue is a current and important one through the relationship developed with the urban topoclimate and its changes (the urban heat island phenomenon, the air and water pollution, etc.) in the sense of understanding the influence of the green-blue infrastructure on such phenomena having negative effects on the quality of life and living in the urban environment.

The importance of the study is also attached to the need for updated data which will help local and regional decision-makers to design and implement policies and good practices, with a view t achieving the objectives of the programme *Horizon 2030 for Sustainable Development*. These administrative and legislative measures may be integrated into urban planning projects, thereby maximizing the ecosystem services provided by the urban oxygenating infrastructure.

METHODS

Considerations on the concept of renaturation of the urban landscape

The European Landscape Convention defines *landscape* as *part of the territory perceived by the population, the characteristics of which derive from the action of natural and / or human factors and their interrelationships. The urban landscape*, on the other hand, is defined as the *object and subject of the human-nature interactions within a given area*, according to human needs (LOISEAU et. al., 1993). The term of *renaturation* is used in urbanism, architecture and ecology and should be understood as a process, an action modifying a portion of area, neighbourhood, landscape, parcel or territory by extending the natural elements of flora, fauna, surface water flows (MURATET et. al., 2007). This process follows the anthroposis and in the context of the urban landscape, it means a sort of planning in such a way that it is effectively perceived as an element contributing to the functioning of the urban system (PENONE et. al., 2012; PECH, 2013). MURATET et al. (2007) consider *renaturation* as capable of creating new ecosystems, perceived as islands of biodiversity in the urban tissue.

Urban oxygenating areas and the process of urbanization

The renaturation of the urban landscape is often achieved by expanding or creating new urban oxygenating areas. The green infrastructure, together with the blue one, form the *urban oxygenating areas*, whose role is to improve the quality of the urban life, people's state of health (NIȚĂ, 2016) and urban environment. This category must include, on structural, functional and aesthetic levels, all the elements of a natural and semi-natural landscape (DEMUZERE et al., 2014) such as lakes, urban rivers, parks, forest vegetation, gardens that are private and public property, sports fields and street alignments, as well as riparian vegetation. The extent and quality of these oxygenating areas is conditioned by the size of the city, but also by the period in which it has achieved this rank.

The urbanization process in Romania has, in many cases, been made by the political decision-makers who decided to change the status of the rural settlements in urban areas (BADIU, 2016). This phenomenon took place immediately after the change of the governance regime in 1989, when the transition from communist authority to democratic freedom was accomplished. In the case of this transition from rural to urban, no account has been taken of the existence of a specific infrastructure or the capacity to adapt to the changes imposed by the new status. In this respect, a very important aspect is represented by the land-use change (*** UNITED NATIONS, 2008), in response to the need of expanding the residential, industrial or commercial areas, most often at the expense of the green areas and blue infrastructure (KUEMMERLE et al., 2009; GAVRILIDIS et al., 2015).

There are many ecological aspects of the use and change of urban lands with direct implications for the climate change (BLANCO et al., 2011), the level of the land sealing and major changes in storm drains (KAMMEN & SUNTER, 2016). The use of land at the urban level shall be subject to the approval of many decision-makers such as: the existing legal, planning, administrative and fiscal systems, and the land estate markets enabling transactions by regulating the demand and supply (BLANCO et al., 2011). Through the accepted and agreed treaties and norms both internationally and nationally, it is currently desirable to implement coherent and holistic measures in order to promote the achievement of the urban environment sustainability standard (***. UNITED NATIONS, 2016).

The analysed area, involving case studies, coincides with the historical region of Oltenia, which is located in the South-West of Romania and comprises 5 counties (Mehedinti, Dolj, Gorj, Olt, Vâlcea) and 40 cities (Fig. 1). To establish the role of oxygenating areas in the urban landscape renaturation, we identified the categories of such areas existing at the level of each administrative-territorial unit by vectoring on the orthophotoplan for the year 2008 and we compared the results with the General Urbanistic Plans of each city. Then, we determined the ecosystem functions of the green-blue infrastructures and their impact on the urban ecosystem and residents.

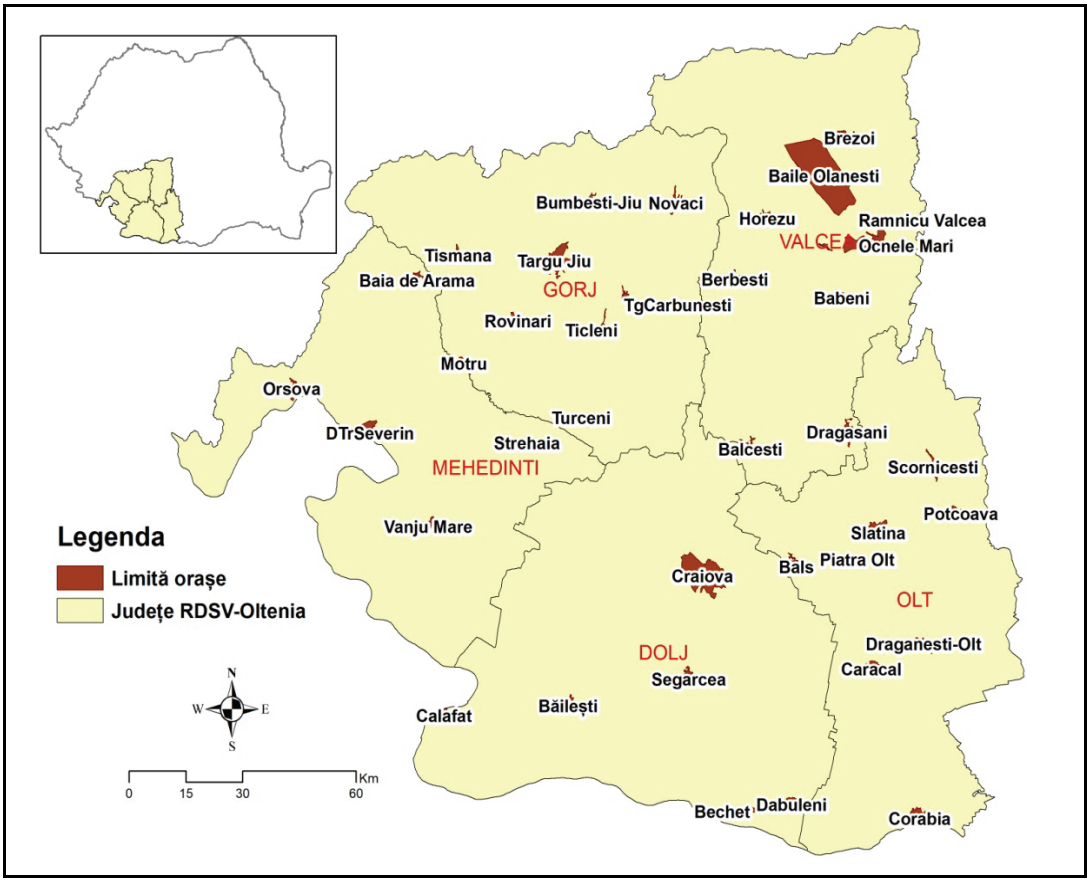

Figure 1. Spatial distribution of selected cities within the SV Oltenia Development Region for the assessment of urban oxygenating areas (original).

RESULTS AND DISCUSSIONS

The urban green infrastructures include, structurally, the following green areas*: urban parks, gardens of public institutions, squares, street alignments, gardens that are private or public property, cemeteries, sports fields, riparian vegetation, green roofs, green vertical walls, urban forest*. On the basis of the legislation in force, we have established 11 categories of urban oxygenating areas having a role in the urban topoclimate. These categories may be identified at the level of the cities in the Development Region of South-West Oltenia (Table 1).

Table 1. Categories of the urban oxygenating areas identified within the cities of the S-W Oltenia Development Region.

City name	Lake	River	Private property gardens	Urban forest	Public gardens	Parks	Riparian vegetation	Cemetery	Gardens of public institutions	Squares and street alignments	Sports fields
1. Băbeni	x	-	x	x	x	x	-	x	x	x	-
2.Baia de Aramă	x	x	x	x	x	-	x	-	x	-	-
3.Băile Govora	-	-	x	x	x	x	-	x	x	x	x
4.Băile Olăneşti	x	x	x	x	x	x	x	x	x	-	x
5.Băileşti	x	x	x	-	x	x	x	x	x	x	x
6.Bălceşti	-	-	x	x	x	-	-	x	x	-	-
7.Balş	x	x	x	x	x	x	x	x	x	x	x
8.Bechet	-	x	x	x	x	x	x	x	x	x	-
9.Berbeşti	-	x	x	x	x	-	x	x	x	x	x
10.Brezoi	x	x	x	x	x	x	x	x	x	x	x
11.Bumbeşti-Jiu	x	x	x	x	x	-	x	x	x	x	x
12.Calafat	x	x	x	x	x	x	x	x	x	x	-
13.Călimăneşti	x		x	x	x	x	x	x	x	x	-
14.Caracal	x	-	x	x	x	x	-	x	x	x	x
15.Corabia	x	x	x	x	x	x	x	x	x	x	x
16.Craiova	x	x	x	x	x	x	x	x	x	x	x
17.Dăbuleni	x	x	x	x	-	-	-	x	x	x	-
18.Drăgăneşti	x	-	x	x	x	x	-	x	x	x	x
19.Drăgăşani	x	x	x	x	x	x	x	x	x	x	x
20.Drobeta Turnu Severin	x	x	x	x	x	x	x	x	x	x	x
21.Filiaşi	x	-	x	x	x	x	x	x	x	x	-
22.Horezu	-	x	x	x	x	x	x	x	x	x	x
23.Motru	x	x	x	-	x	x	x	-	x	x	x
24.Novaci	x	x	x	x	-	-	x	x	x	x	x
25.Ocnele Mari	x	x	x	x	-	x	x	x	x	-	-
26.Orşova	x	x	x	x	x	x	x	x	x	x	x
27.Piatra Olt	x	x	x	x	x	x	-	x	x	x	x
28.Potcoava	x	x	x	x	x	-	x	x	x	x	-
29.Râmnicu Vâlcea	x	x	x	x	x	x	x	-	x	x	x
30.Rovinari	-	x	x	-	x	x	x	x	x	-	x
31.Scorniceşti	x	x	x	x	x	-	-	-	x	x	x
32.Segarcea	x	x	x	-	-	x	-	x	x	x	-
33.Slatina	x	x	x	x	x	x	-	x	x	x	x
34.Strehaia	x	x	x	x	x	x	x	x	x	x	x
35.Târgu Cărbuneşti	x	x	x	x	x	x	x	x	x	x	-
36.Târgu Jiu	x	x	x	x	x	x	x	x	x	x	-
37.Ticleni	x	x	x	x	x	x	x	x	x	x	x
38.Tismana	x	x	x	x	-	-	x	x	x	-	-
39.Turceni	x	x	x	x	x	-	-	-	x	x	-
40.Vânju Mare	x	x	x	x	x	x	-	x	x	-	-

x=presence, -=absence, Source: the processing of the Ortophotos 2008

The lack of a certain category of oxygenating areas is not only an absence at the structural level but also at the functional level, with direct implications on the urban metabolism and the residents' health state. To this end and to highlight the role of the green-blue infrastructure at the urban level, we carried out an assessment of their ecosystem functions by categories of oxygenating areas.

The importance of the ecosystem functions of the urban green infrastructure

A complex analysis concerning the perception of the ecosystem functions generated by the green categories which are components of the urban green infrastructure in our country highlights the importance of the *urban parks* and *forests*, recognizing the ability of trees to absorb from 60 to 90% of the radiation received (LESIUK, 2000). The urban parks in the Development Region of South-West Oltenia are populated with thermophilic and meso-thermophilic shrub and arboreal species, to which grass vegetation is added, fulfilling *recreational functions* in all seasons of the year. This

category of green area has multifunctional valences, such as: *increasing the value of the urban landscape, representing an area for recreational and sports activities* (PĂTROESCU & IOJĂ, 2004; McCORMACK et al., 2010), *a social area* and an informal setting to perform cultural activities.

The *urban forests* depend, in terms of surface and species, on the location of the urban settlements at the level of the relief units in our country and they have mainly ecological functions: reducing the land surface erosion, improving the climate, shading (BOLUND & HUNHAMMAR, 1999), ensuring the habitat for local fauna, filtering the suspended particulate matter and exhaust emissions. The *squares and street alignments*, populated with native arboreal species, but also with acclimated ornamental vegetation, provide benefits related to the air quality, climate and landscape aesthetics (BADIU, 2016). Ornamental plants are characteristic of the gardens belonging to public institutions (schools, kindergartens, churches, cultural institutions having administrative functions), as they offer a certain aesthetics to the urban landscape, tolerating a very large temperature range and being easy to maintain. The ecosystemic importance of these green structures lies in preserving a good physical and mental state of health of the inhabitants (OZER, 2006), contributing, at the same time, to the connectivity of the green infrastructures as a whole (IOJĂ et al., 2014), but also to the relationship with the vegetation in the urban and extra-urban peripheries.

As regards the gardens that are public and private property, it must be underlined that their arrangement depends on the degree of interest of the holder, and there may even be situations of soil pollution. The role of these green areas in the urban landscape is to *preserve the biodiversity* (DAVIES et al., 2009) and *recreational environment*. Cemeteries are considered to be valuable green areas in the urban infrastructure with a role in *preserving native arboreal species*, but without performing social or aesthetic functions (NIȚĂ et al., 2014), being perceived even as having negative connotations (TUDOR et al., 2013). Moreover, the location of such areas near residential areas causes a decrease in the value of buildings, being considered a restrictive factor in increasing the value of the urban landscape aesthetics. The biodiversity at the level of cemeteries is proportional to their age (BARRETT & BARRETT, 2001).

The importance of the ecosystem functions of the urban blue infrastructures

The urban blue infrastructure or the hydraulic system (DUCHESNE, 2000; BRUN, 2011) include the urban rivers and lakes, and their existence at the level of the urban metabolism has an optional value. The urban lacustrine ecosystems are distinguished by their recreational, educational, fishing, water supply and flood control benefits that they perform at the level of the city (HENNYA & MEUTIAB, 2014).

The importance of urban lakes also results from improving the air quality, managing waste, regulating the urban microclimate, supporting physical, intellectual or spiritual interactions (***. CCMESI, 2018), and the degradation of the urban aquatic ecosystems poses a serious threat to the sustainable urban development (CHEN, 2017). The vulnerability of lakes to environmental changes is directly proportional to the impact of the urban development in the surrounding areas (HENNYA & MEUTIAB, 2014), through actions such as the land-use change or landfill.

The rivers, through the provision of food and water resources, represented the forger and the catalyst of urban areas. At present, the urban aquatic landscape is positively perceived by residents due to its naturalness and high accessibility (STEPNIEWSKA & SOBCZAK, 2017), but also through the recreational benefits that it offers: walking, cycling (KONDOLF & PINTO, 2017), the pursuit of sporting or contemplative activities. The practice of sport fishing, diving and canoeing (KONDOLF & PINTO, 2017) or other water sports should also be added, depending on the water quality level. The urban rivers also fulfil ecosystemic functions with ecological benefits such as the adjustment of the air temperature, as a natural source of cooling (DUA & LI, 2017).

With all these ecosystemic functions, the rivers located in the urban areas have been associated with water quality problems due to the practice of dumping untreated domestic and industrial waste into the water bodies (AlINOORHOSSEINI et al., 2017) or storing the waste in water or on shore.

CONCLUSIONS

Urban oxygenating areas represent important pawns in the effort to provide durability and sustainability to the urban environments, but also have a direct impact on the people's health state. In this respect, ensuring the thermal comfort inside the dwellings and diminishing the phenomenon of urban heat island are strategic objectives at the level of the urban metabolism, the fulfilment of which may only be achieved by conjugating the will of the political decision-makers to the existence and implementation of an appropriate legislation, but also by involving the residents.

The functions of the urban oxygenating infrastructures (cultural, ecological, recreational and improving health) are the guarantor of the urban sustainability, therefore the structural and functional conservation of these areas represents a binding approach. Although there is complementarity between the ecosystem functions of some categories of green-blue infrastructures, we consider the lack of any of these areas not only a structural absence, but also a functional one. Another aspect to be highlighted is the quality of the oxygenating areas. Pollution of any kind or at any level affects the green-blue areas and diminishes their ecosystem functions.

Understanding the importance of these areas at the urban level is considered to be a proof of an optimal level of education for the decision-makers and residents with favourable effects on the cities' attractiveness now and in the future.

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A LIFE DEVOTED TO MUSEOGRAPHY: ZOE APOSTOLACHE STOICESCU

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Abstract. With a significant number of books and over 100 publications, as well as numerous academic achievements, including the ”Emil Racoviță Award” of the Romanian Academy certifying the quality of her work, Dr. Zoe Apostolache Stoicescu can easily be regarded as a prominent figure in Romanian science and culture. Between 1978 and 1983 she develops a unique project for Romanian museography, a museum of man, inaugurated in Ploiești in 1984 as the Museum of Human Biology. Spiritual and patrimonial heir of the painter Rudolf Schweitzer–Cumpăna, as his niece, she ventures for two decades in a complex of activities such as seminars, exhibits and monographs, in order to underline the role and place of Schweitzer–Cumpăna in the Romanian fine arts.

Keywords: Zoe Apostolache Stoicescu, ecology, interdisciplinarity, human biology, art collector.

Rezumat. O viață închinată muzeografiei: Zoe Apostolache Stoicescu. Cu un număr semnificativ de cărți scrise și peste 100 de publicații, precum și numeroase distincții academice, incluzând „Premiul Emil Racovită” al Academiei Române drept certificare a calității muncii sale, dr. Zoe Apostolache Stoicescu se remarcă drept o figură proeminentă în știința și cultura românească. În perioada 1978 și 1983, elaborează un proiect unic în muzeografia românească, un muzeu al omului, inaugurat la Ploiești în 1984 sub titulatura de Muzeu de Biologie Umană. Moștenitoare spirituală și patrimonială, în calitate de nepoată a pictorului Rudolf Schweitzer – Cumpăna, realizează timp de două decenii un complex de activități (seminarii, expoziții, monografii) care au ca scop reliefarea rolului și locului pictorului în arta plastică românească.

Cuvinte cheie: Zoe Apostolache Stoicescu, ecologie, interdisciplinaritate, biologie umană, colecționar de artă.

On the warmest day of 2017, on Friday the 27th of July, the flame that had burnt so close to us, bearing a destined name, Zoe Apostolache Stoicescu, was fading with its last flickers.

Born in Ploiești on the 22nd of September 1936 and guided since middle school by the two brilliant minds of Prahova's museography, Nicolae Simache and Margareta Moșneaga, Zoe Apostolache Stoicescu moved forward in this profession, with notable achievements, worthy of recognition and remembrance.

After attending middle school and high school in Ploiești, she graduates in 1959 from the University of Bucharest, Faculty of Natural Sciences, with a major in biology and she returns to her hometown. Here, she goes through her postgraduate preparation as a biochemist researcher for the Epidemiological Center. In 1962, she enters the Museum of Natural Sciences from Ploiești as a museographer, only six years after the museum had been founded. In this institution, Zoe Apostolache Stoicescu begins an intense research activity, immerses herself in the museum's activities and gets involved in various cultural and educational projects. All of her endeavors are comprised in numerous scientific papers published in academic journals.

In 1965 she begins her activity within the Romanian Academy's Commission for Natural Monuments as an honorary custodian, thus commencing a quarter of century contribution to the protection of the existing natural reservations and their expansion in the sub Carpathian area.

In 1970, she takes over Margareta Moșneaga's legacy by becoming the director of the Museum of Natural Sciences in Ploiești. In this position, she contributes to the development of the museum by adding new exhibition spaces in the cities of Cheia, Slănic and Sinaia.

In 1976, Zoe Apostolache Stoicescu receives the title of doctor in biology after presenting the paper ”Taxonomic, zoogeographic and ecologic study on populations of terrestrial gastropods from the basin of Teleajen”, coordinated by the scholar Nicolae Botnariuc.

In 1982, she collaborates with Dr Petre Neacșu for the first ”Dictionary of Ecology” published by the Scientific and Enciclopedic Publishing House in Bucharest (Editura Științifică și Enciclopedică București). The dictionary is a referential monographic work in Romanian science, being awarded the “Emil Racoviță Award” of the Romanian Academy on the same year.

After founding the Museum of Man in Ploiești, in 1984, Dr. Zoe Apostolache Stoicescu impregnates, for almost a decade, her multicultural and multidisciplinary approach on the entire museum patrimony of the Prahova County, while also running the Departmental Office for the National Cultural Patrimony. As a general manager of the Departmental Museum Complex (that includes the Art Museum, the History and Archaeology Museum, the Museum

of Natural Sciences, memorial homes etc.) between 1982 and 1990, she shines a light on this local thesaurus, both nationally and internationally, through hundreds of permanent and temporary exhibitions, symposiums and conferences, articles and scientific papers, books and monographs.

More than 100 titles that can be found in prestigious volumes and academic publications account for Dr. Apostolache - Stoicescu's lifetime work. Her most important external endeavors were accomplished in partnership with the National Museum of Prague – Czechoslovakia (1972, 1976, 1979, 1985), the National Museum of Berlin and the German Hygiene Museum – Germany (1980), the Lomonosov University of Moscow – Russia (1978), the Museum of Man in Paris – France (1973, 1981) and the Smithsonian Institute in Washington DC – USA (1982). Having been granted a scholarship by this prestigious institution in the programme for the Office of Museum Programs, she gives an impressive lecture on the wildlife in the natural park of the Natural Sciences Museum in Ploiești on the 3rd of June, in what can be regarded as one of the highlights of her career.

Her official retirement in 1990 was far from bringing her well-deserved peace. On the contrary, Zoe Apostolache Stoicescu began a second youth, becoming for 25 years one of the trademark figures in non-governmental activities by participating in dozens of interdisciplinary cultural programs with an extraordinary energy. As the niece of the painter Rudolf Schweitzer–Cumpăna, she became his spiritual and patrimonial heir. In this sense, for two decades she organized seminars and exhibitions and worked on monographs with prestigious art critics with the sole purpose of revealing the role and place that the painter who mentored generations of students had in the Romanian and universal fine arts.

A simple review of the more than 100 published articles paints the picture of a complex scientist, of a woman of culture with extensive preoccupations in various domains and with an interdisciplinary overall vision on the material and spiritual world. The same portrait of Dr. Zoe Apostolache Stoicescu's complex personality emerges from the titles of her most important books, written during five decades of scientific, museistic and cultural activity:

1981 – *Monografia județului Prahova* (*Monograph of the Prahova County* - collective work);
1982 – *Dicționar de Ecologie* (*Dictionary of Ecology* - co-written with Petre Neacșu);
2003 – Zooterapie – leacuri cu animale (*Zootherapy – Cures with Animals* - sole author);
2003 – *Album – Pictorul Rudolf Schweitzer-Cumpăna* (*Album – Painter Rudolf Schweitzer-Cumpăna* - co-written with Radu Ionescu);
2005 – *Dicționarul Enciclopedic al Mediului* (*The Encyclopedic Dictionary of the Environment* - co-written with Contanstin Pârvu);
2005 – *Terminologie populară românească în medicină* (*Popular Romanian Terminology in Medicine* – co-written with Ion Georgescu Vâște);
2005 – *Stihuri peste generații* (*Verses across generation*s – co-written with Liana Dupont, Sabina Popa and Eliza Tomescu);
2007 – *Margareta Moșneaga, sensul unei vieți* (*Margareta Moșneaga, the meaning of a life* – sole author);
2014 – *Frânturi de viață. Monografie Rudolf Schweitzer-Cumpăna* (*Shards of life. The monograph of Rudolf Schweitzer-Cumpăna*);
1998-2006 – *Caietele Fundației Rudolph Schweitzer-Cumpăna* (Five volumes of the *Notebooks of Rudolf Schweitzer-Cumpăna Foundation*).

The ruthless destiny steals her from this world on the 27th of July 2017. Her family, disciples, collaborators, colleagues and scientists from our country and abroad who knew and appreciated her, now bring Dr.. Zoe Apostolache Stoicescu a pious homage, forever keeping her in their memory as she was for her entire lifetime: a living flame on the altar of knowledge.

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APOSTOLACHE-STOICESCU ZOE. 2007. *Margareta Moșneaga – Sensul unei vieți*. Edit. Fundației Cumpăna. București. 205 pp.

APOSTOLACHE-STOICESCU ZOE & NEACȘU P. *Dicționar de ecologie*. Edit. Științifică și Enciclopedică București. 678 pp.

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RECOMMENDATIONS
regarding the elaboration of the papers for the scientific journal
"*Oltenia. Studii şi comunicări. Ştiinţele Naturii*"

The journal is edited by the Oltenia Museum Craiova and it publishes original papers in the fields of vegetal and animal biology, ecology-environment protection, mineralogy-palaeontology, as well as scientific reports, reviews, anniversary or commemoration papers.

It appears annually, it is ISI indexed (http://science.thomsonreuters.com/cgi-bin/jrnlst/jlresults.cgi?PC=MASTER &Word=oltenia**) and accredited by CNCSIS as a B+ Journal.**

I. Structure (format) for original papers, scientific reports and reviews:

A	***Original papers***	will be structured according to the information rendered in the Table 1.
B	***Scientific reports***	will be structured according to the author's (authors') preferences, but it has to include abstract and key words, both in English and Romanian.
C	***Reviews***	there will be mentioned: author (authors) of the book (name and first name – CAPITAL LETTERS), comma, the title of the book, lowercase letters (Italic), publishing house, publishing location, year, number of pages. Use a free space and then render the text of the review with as fewer paragraphs as possible and the same characters as in the case of original papers.

Table 1.

STRUCTURE OF THE PAPER	CHARACTERISTICS	OBSERVATIONS
TITLE	capital letters, 12 pt., bold, centred	
two spare rows (12 pt.) between the title and the name of the author/s		
Author/Authors	name, capital letters, first name, noncapital, 11 pt., bold, normal, aligned right	between two or many authors, use comma
One spare row, 10 pt.		
Abstract (English)	from the beginning of the line, without tab, 9 pt., bold, normal	the abstract will be written with 9 pt., normal, maximum 300 words
One spare row, 9 pt.		
Keywords (English)	from the beginning of the line, without tab, maximum 5 words, 9 pt., normal	
One spare row, 9 pt.		
Rezumat (Romanian)	from the beginning of the line, without tab, 9 pt., bold, normal	**Complete translation of the title in Romanian** (no capital letters, except for the first letter of the title; 10 pt., bold). The content of the abstract – 9 pt., normal, maximum 300 words
One spare row, 9 pt.		
Cuvinte cheie (Romanian)	from the beginning of the line, without tab, maximum 5 words, 9 pt., normal	
One spare row, 14 pt.		
INTRODUCTION	10 pt. (capital letters, bold)	content – 10 pt., normal
One spare row, 10 pt.		
MATERIAL AND METHODS	10 pt. (capital letters, bold)	content – 10 pt., normal
One spare row, 10 pt.		
RESULTS	10 pt. (capital letters, bold)	content – 10 pt., normal
One spare row, 10 pt.		
DISCUSSIONS	10 pt. (capital letters, bold)	content – 10 pt., normal
One spare row, 10 pt.		
CONCLUSIONS	10 pt. (capital letters, bold)	content – 10 pt., normal
One spare row, 10 pt.		
ACKNOWLEDGEMENTS	10 pt. (capital letters, bold)	content – 10 pt., normal
One spare row, 10 pt.		
REFERENCES	10 pt. (capital letters, bold)	content – see bibliographical references
One spare row, 10 pt.		
Bibliography enumeration	see the detailed explanations at the references heading	
Personal data	Name and surname – 8 pt., bold, normal, centred Institution and e-mail address – 8 pt., normal, centred	

Other details related to the papers:

Publishing language	English
Page format	A4 (21 x 29.7 cm), margins: top – 2.5 cm; bottom – 2.0 cm; left – 2.0 cm; right – 2.0 cm; gutter – 0 cm; header, footer – 1.27 cm. The papers will be elaborated in Microsoft Word, justified; font: Times New Roman, 10 pt., normal; single space.

- Latin names (genus, subgenus, species, subspecies) will be written with italic characters; - Suprageneric names are **not** written with italic characters. The same procedure is used when they are mentioned within figures, graphs and tables.
The first mention of a taxon in the text will be followed by the taxon author's name and the publishing year of the description, according to the zoological nomenclature code (e.g.: *Cossus cossus* (Linnaeus 1758), afterwards, it will be used abbreviated.
The name of the authors quoted in the text will be written **normal, capital letters,** while the names of the authors of the taxa will be written **normal, lowercase letters**
For the names of Romanian authors and settlements diacritics must be used.
The materials sent for publication (printed and in electronic format) has to be between 2 and 8 pages (the number of pages must be **even**).

II. References

- **References** in the text (quotation) includes only the author's/authors' names (CAPITAL LETTERS) and publishing year. For example:
  - when it is a single author: IONESCU (1965) or (IONESCU, 1965);
  - when there are two authors, it is used "&": RĂDULESCU & SAMSON (1990) or (RĂDULESCU & SAMSON, 1990);
  - when there are more than two authors: IONESCU et al., (1992) or (IONESCU et al., 1992);
  - in case there are many papers written by the same author/authors, published in the same year, use the letters a, b, c, etc. after the year (e.g.: IONESCU, 2000; IONESCU, 2000a, …, 2000g);
  - authors are rendered alphabetically and, in case there are many papers written by the same author, they are introduced chronologically.

- **References** will include **only** the papers quoted in the text (10 pt.), alphabetically rendered, without numbers, as it follows:

- author (CAPITAL LETTERS), publishing year (normal), (**do not use** comma between the author and the publishing year or between the name and first name of the same author; use comma between different authors, when there are more than two), *the title of the paper* (*italic*), name of the journal, publishing house, volume number (bold), the number of fascicle (normal), number of pages (normal). When there are two authors, use "**&**"; if there are many authors, mention **all** of them. The ladies' first name is completely written; for gentlemen, use only the first letter.

The reference titles will be aligned as it follows: the first line from the beginning (no tab), the second at 1.27. For example**:**

EXEMPLE
Book reference:
BOŞCAIU N. 1971. *Flora şi vegetaţia Munţilor Ţarcu, Godeanu şi Cernei*. Edit. Academiei R. S. R. Bucureşti. 300 pp.
Paper published in a journal:
GULII V. *&* PAMUJAC M. 1994. Elemente ale protecţiei integrate a culturilor agricole de dăunători şi boli. *Protecţia integrată a plantelor*. Edit. „Ştiinţa". Chişinău: 112-118. STAN MELANIA & BACAL SVETLANA 2006. New contributions to knowledge stafilinidelor (Coleoptera: Staphylinidae) of the landscape reserve "Codrii Tigheci" (Moldova). *Oltenia. Studii şi comunicări. Ştiinţele Naturii*. Muzeul Olteniei Craiova. **22**: 155-159.
Reference to a part of a collective paper; volume (with editors):
IFTIME Al. 2005. Amfibieni şi Reptile. In: Botnariuc & Tatole (Eds.) *Cartea Roşie a Vertebratelor din România*. Edit. Academiei Române. Bucureşti: 1-325.
Papers presented at scientific manifestations and published in a volume without editors:
CIOCHIA V. & STANCĂ-MOISE CRISTINA. 2001. Contributions to the knowledge of the Macrolepidoptera from natural complex "Dumbrava Sibiului". *Sesiunea Ştiinţifică dedicată împlinirii a 75 de ani de la înfiinţarea Staţiunii Biologice Marine „Prof. Dr. I. Borcea"*. Agigea-Constanţa. 19-20 octombrie 2001: 125-131.
Official publications (laws, decrees, official reports):
***. România. Legea nr. 13 / 1993 pentru aderarea României la Convenţia privind conservarea vieţii sălbatice şi a habitatelor naturale din Europa, adoptată la Berna la 19 septembrie 1979. *Monitorul Oficial al României*. An V, nr. 62/25 martie 1993. Bucureşti: 1-20.
PhD thesis:
COSTACHE I. 2005. *Flora and vegetation Motru River Lower Basin.* Ph. D. Thesis, University of Bucharest. Romania. 290 pp., 8 Pl.
Web pages:
Muzeul Olteniei Craiova. Secţia Ştiinţele Naturii. *Oltenia. Studii şi comunicări. Ştiinţele Naturii.* (onlline). 2011. Publisher: Museum of Oltenia Craiova, Romania. www.olteniastudii.3x.ro (accessed: May 8, 2012).

Entire electronic document or service (data base):
***. Fauna Europaea: Chironomidae. In: *Fauna Europaea: Chironomidae, Diptera, Nemathocera*. (Ed. H. de Jong) Fauna Europaea version 1.5, http://www.faunaeur.org. (accessed: June 23, 2012).
E-book:
AHMADJIAN V. 1967. *The Lichen Symbiosis*. Blaisdell Publishing Company. Massachusetts. Available from: http://books.google.ro/books?id=at7uXMn8iMC&printsec=frontcover&hl=ro&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false. 152 pp. (accessed: January 15, 2013).
Electronic publication (papers):
DANILEVSKY M. L. 2007. A check-list of Longicorn Beetles (Coleoptera, Cerambycoidea) of Europe. Available online at: http://www.coleoptera-literatura.ic.cz./literatura/checklist_cerambycidae_2007.doc. (accessed: May 20, 2009).
Note: The papers published with other characters than the Latin ones, will be re-written with Latin characters, both in the text and at references, mentioning the original language of publication between square brackets at the end:
ALEXANDROVICH O. R. 1995. Reconstruction of the ways of the ground beetles (Coleoptera, Carabidae) fauna forming at the West of the Russian plain. In: I. K. Lopatin, Pisanenko A. D., Shklyarov L. P. (Eds.). *Fauna and taxonomy: Proceedings of Zoological Museum of the Byelorussian University*, Minsk: Nauka Tekhnika. **1**: 52-68. [In Russian].

III. Illustration

▪ Images (white/black or colour), tables, graphs and maps are inserted into the manuscript, but **the original versions have to be sent also separately**: high contrast photographs, electronic images in TIFF format at a minimum resolution of 300 dpi.	
▪ The references to the illustrations (tables, images, photographs) will be made in the text as it follows: (Fig. 1), (Figs. 1a, b), (Figs. 3; 5); (Table 1); (Photo 1).	
▪ **Graphs must be achieved in Microsoft Excel.**	
The title of a table (in English) will be placed above the table (aligned right), 9 pt., normal.	The title of a figure, photo, map (in English) will be placed below, centred, 9 pt., normal.
▪ For photographs and maps: - It will be mentioned the word 'original' in case it is achieved by the author/'s of the paper; - It will be mentioned the name of the author/'s between brackets in case it is achieved by another or other persons; - It will be mentioned the web source (if it is the case), which has to be entirely rendered at references, also mentioning the access date.	
Legend is placed below a table, graph, etc., 8 pt., normal (English)	
!!!!!!For graphs and diagrams, use white, black, grey, different tones and textures. **They will not be published in colours.**	

Illustrations references (tables, images) (in English), will be made in the text as it follows: (Fig. 1), (Fig. 1a, b), (Figs. 3; 5); (Table 1). The title of a figure (in English), will be centered below the figure; as for tables, put it above (aligned right), both 9 pt., normal. Examples: a) Table 1. List of the identified staphylinids from the Lower Dniester. b) Figure 1. Distribution of the butterfly *Papilio machaon* L.

The paper will be accepted for publishing if:

- **it respects** the aforementioned **requirements**;
- **it acquires a favourable review** from the scientific reviewers of the journal;
- **it is sustained** within the framework of the International Conference "*Museum and scientific research*";
- **the publication fee is paid**;
- **it is respected** the deadline, **March 31** of the current year.

The editorial board *has the right to reduce the number of figures and photos (if there are too many as compared to the text of the paper or if they do not correspond to the requirements) and not to accept papers sent after deadline*, **March 31, 2019**.

With all the respect for the authors, papers that do not correspond to the recommendations will be sent back.

The responsibility of the scientific content of the papers depends entirely on the authors. Authors must revise the papers reviewed by the reviewers.

The Editorial Board