

MUZEUL OLTENIEI CRAIOVA

OLTENIA
STUDII ȘI COMUNICĂRI
ȘTIINȚELE NATURII

Vol. XXXIII/2



CRAIOVA 2017

OLTENIA

STUDII ȘI COMUNICĂRI ȘTIINȚELE NATURII

Oltenia Journal for Studies in Natural Sciences

(Proceedings of the 24th International Conference of the Oltenia Museum)

Tom. XXXIII, No. 2 / 2017

MUZEUL OLTENIEI CRAIOVA

Oltenia. Studii și comunicări. Științele Naturii

ISSN 1454 – 6914

2017, Tom. 33, no. 2

Cover Image: *The Building of the Section of Sciences of Nature of the Museum of Oltenia Craiova*

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Available On-line:

Oltenia. Studii și comunicări. Științele Naturii with full text articles available on-line: <http://biozoojournals.ro/oscsn/>;
<http://www.olteniastudii.3x.ro/>; <http://biozoojournals.ro/>

Publisher: Museum of Oltenia Craiova, Str. Popa Șapcă, No. 8 – 200 410, Craiova, Romania

Financial Support by: The Council of Dolj County, Romania

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INTRAMoesian FAULT IN THE FĂGĂRAȘ MOUNTAINS AREA

STELEA Ion

In memoriam Mircea Săndulescu

Abstract. It is considered that the Intramoesian Fault on the Romanian territory is not topographically expressed. Although there is evidence that the fault plane is close to the surface in the Moesian Platform area, the assumption that the fault does not cross-cuts the upper crust in the orogenic area of the Făgăraș Mountains is currently accepted. The geophysical fault trace in this region coincides with the geological trace of the Scara Fault. The tectonic movements along the two (?) faults during the Cretaceous and the Miocene contributed to the achievement of the Alpine structures in the eastern part of the South Carpathians, connected to Vrancea bend of the Carpathian orogen. Both faults are seismically active, the earthquakes hypocenters in the Făgăraș Mountains area being localized both in the upper and middle crust. Accordingly, the presence of the Intramoesian Fault at the topographic surface in the Făgăraș Mountains, on the NW-SE direction of the Scara Fault, is taken into account.

Keywords: Intramoesian Fault, Scara Fault, Făgăraș Mountains.

Rezumat. Falia Intramoesică în aria Munților Făgăraș. Se consideră că Falia Intramoesică nu apare la zi pe teritoriul României. Deși există dovezi că planul faliei este aproape de suprafață în aria Platformei Moesice, în prezent este acceptată ipoteza neargumentată că falia nu traversează crusta superioară din aria orogenică a Munților Făgăraș. În această regiune, traseul geofizic al Faliei Intramoesice coincide cu traseul geologic al Faliei Scara. Mișcările tectonice în lungul celor două (?) falii în timpul Cretacicului și Miocenului au contribuit la realizarea structurilor alpine din partea estică a Carpaților Meridionali, conectată la curbura Vrancea a orogenului carpatic. Ambele falii sunt active seismic, focarele cutremurelor din aria Munților Făgăraș fiind localizate atât în crusta superioară cât și în crusta medie. În consecință, prezența la zi a Faliei Intramoesice în fundamentul cristalin al Munților Făgăraș, pe direcția NW-SE a Faliei Scara, este luată în considerație.

Cuvinte cheie: Falia Intramoesică, Falia Scara, Munții Făgăraș.

INTRODUCTION

The Intramoesian Fault (IMF) separates the eastern sector of the Moesian Platform with low-grade metamorphic basement, of Dobrogea type, from the western one with granitic and medium-grade metamorphic basement, of Danubian type according to the petrographic drilling data (BARBU & DĂNEȚ, 1970). The fault stretches on NW-SE direction from the Black Sea continental platform to the Făgăraș Mountains area. VISARION & SĂNDULESCU (1991) consider that the fault does not cross the upper level of the crystalline basement in this region, the fault plane being buried under the Getic Nappe body, at 10 km depth.

On the territory of Bulgaria, the IMF is clearly expressed in the surface topography by two subparallel branches at 5-6 km away from each other on the Silistra Town-Shabla Cape lineament. Both branches are represented by en echelon fault sets, morphologically expressed by linear and narrow valleys with the slopes affected by active landslides (ROGOZHIN et al., 2009). The tectonic block between the two branches suffered recent downward movements of 8-12 m, the resulted graben being filled with tectonically disturbed Quaternary loams.

For the Romanian territory, there are no cartographical data regarding the IMF occurrence at surface, perhaps because detailed geological maps lack in the Moesian Platform area. It is known that, after the subcrustal earthquake of March 4, 1977 in Vrancea, hot water emerged from the depth on the fault plane at Fierbinți, near Urziceni Town (CORNEA & POLONIC, 1979). This is a proof that the fault plane is very close to the surface.

The geophysical IMF trace in the Făgăraș Mountains (SOCOLESCU et al., 1964; VISARION & SĂNDULESCU, 1991) is coincident with the lineament of an active dextral strike-slip fault which cross-cuts the crystalline basement on the NW-SE direction (DIMITRESCU et al., 1985; GHEUCA, 1988; STELEA, 1992), called herein Scara Fault, after the saddle name through which the fault crosses the main crest of the mountains. The dextral movement on this fault has contributed to the Alpine regeneration of the basement on the northern border of the Făgăraș Mountains. In this paper, we bring into question geometrical, kinematical and seismic arguments, in order to demonstrate that the Scara Fault actually is the Intramoesian Fault correspondent at the topographic surface.

INTRAMoesian FAULT

History of knowledge. Kinematically undefined, the Intramoesian Fault appears for the first time on the tectonic map of Romania at scale 1:1000000 (DIMITRESCU & SĂNDULESCU, 1970), as a short tectonic line crossing the Moesian Platform and the outer foredeep between the localities Călărași and Fierbinți. Based on seismic data, RĂDULESCU et al. (1976) prolonged the fault over the inner foredeep up to Câmpulung Muscel Town. In order to explain the subduction of the eastern sector of the Moesian Platform beneath the Carpathian orogen in Vrancea bend,

the authors deduced a sinistral slip on the Călărași-Fierbinți Fault, correlated with the dextral slip on the Peceneaga-Camena Fault.

Investigating the seismicity of the eastern sector of the Moesian Platform, CORNEA & POLONIC (1979) found that almost the entire seismic activity of the region is localized on the Călărași-Fierbinți Fault, which they define as active transcurrent fault. The sinistral slip on the fault plane was argued by the more rapid movement of the eastern compartment due to its sinking beneath the orogen. SÂNDULESCU (1984) is the author of the name Intramoesian Fault, with dextral slip during the Cretaceous followed by sinistral slip from the Miocene till now.

Intramoesian Fault kinematics. SÂNDULESCU (1984, 1994) argued the important geodynamic role played by the Intramoesian and Peceneaga-Camena faults in the achievement of the Carpathians geometry and structure during the Cretaceous phases of the Alpine orogenesis. According to the author, the two sectors of the Moesian Platform separated by IMF moved toward northwest with different motion rates, the higher motion rates of the western sector inducing a relative dextral displacement on the fault plane.

During the Miocene, only the eastern platform sector moved toward the orogen, the displacement on the fault plane becoming sinistral as it is today (SÂNDULESCU, 1984, 1994). The western sector immobility would explain the lack of the Neogene magmatism related to the subduction process in the South Carpathians, as well as the narrowing of the Miocene nappes west of the IMF. The nappes inside the Miocene thrusts belt gradually disappear west of the Dâmbovița Valley so that, west of the Olt Valley, only the Subcarpathian Nappe appears.

Even less developed, the Miocene thrusts in front of the central South Carpathians show that the western IMF compartment also moved toward the orogen during the Miocene. In our opinion, the Miocene thrusts narrowing and thinning in the central South Carpathians area reflects a change in the tectonic regime on the contact between platform and orogen, induced by the collision angle reduction with the progressive double bending of the orogen. As the two Carpathians bends had already formed at the end of the Cretaceous (SÂNDULESCU, 1984, 1994), the drift direction of the western platform sector was no longer perpendicular to the orogen during the Miocene, but oblique. Consequently, the Miocene tectonic regime at the contact between the Moesian Platform and the orogen in the Făgăraș Mountains area became transpressive.

At the same time, the tectonic regime on the platform/orogen contact east of the IMF remained compressional, proof being the large development of the Cretaceous and Miocene thrusts belts, as well as the current platform subduction beneath the orogen in Vrancea bend. The compressional regime in this region is the result of the Moesian Platform drift to west and northwest synchronous with the Foreapulian crustal block drift to east and its subsequent clockwise rotation (SÂNDULESCU, 1984, 1994).

Both the Miocene nappes and the covering Mio-Pliocene molasse in front of the Făgăraș Mountains are dextral displaced along the IMF. The subsequent down dip movement of the western fault compartment (SÂNDULESCU, 1984) took place during the Upper Miocene, after the nappes emplacement.

Seismic activity of the Intramoesian Fault. The IMF is seismically active, the focal depth of earthquakes covering the entire thickness of the crust (CORNEA & POLONIC, 1979). After the subcrustal earthquake of March 4, 1977 in Vrancea region, an intense seismic activity was recorded on this fault in the region localized northeast of Bucharest, where 13 earthquakes occurred between March 26 and June 6, 1977 (CORNEA & POLONIC, 1979).

Historical earthquakes related to IMF in the Moesian Platform took place at Urziceni on November 25, 1897 and October 26, 1898, both at depth of 2 km (CONSTANTINESCU & MĂRZA, 1980). Most earthquakes on the territory of Bulgaria is related to the tectonic activity of the Intramoesian Fault (ROGOZHIN et al., 2009). The current crustal earthquakes along the fault are concentrated on the Black Sea coastal area and 30-100 km offshore.

SCARA FAULT

Scara Fault geometry. The Scara Fault is in fact a fault zone consisting of parallel or braided vertical faults which crosses the Făgăraș Mountains on the same direction with the Intramoesian Fault between the localities Sebeșul de Jos (Sibiu County) on the northern slope and Nucșoara (Argeș County) on the southern one. The fault zone has a width of 1-2 km on the southern slope and branches northwestward reaching a width of 6-7 km on the northern slope (Fig. 1). The lithological markers show dextral fault displacements of 1.5-4.5 km on the southern slope (DIMITRESCU et al., 1985; GHEUCA, 1988) and of 0.5-3 km on the northern one.

In its western compartment, the Scara Fault is accompanied by NW-SE secondary fractures (Fig. 1) probably representing the surface expression of a deep arborescent structure, asymmetrically branched (half flower structure). Many sectors of rivers valleys in this tectonic compartment are oriented on NW-SE fractures direction (e.g. Jibra, Moașa Sebeșului, Tătaru, Strâmba, Scara, Cumpenița). Such fractures also affect the Cretaceous and the Tertiary sedimentary formations within the Brezoi-Titești Basin and Călimănești Basin (e.g. ȘTEFĂNESCU et al., 1982).

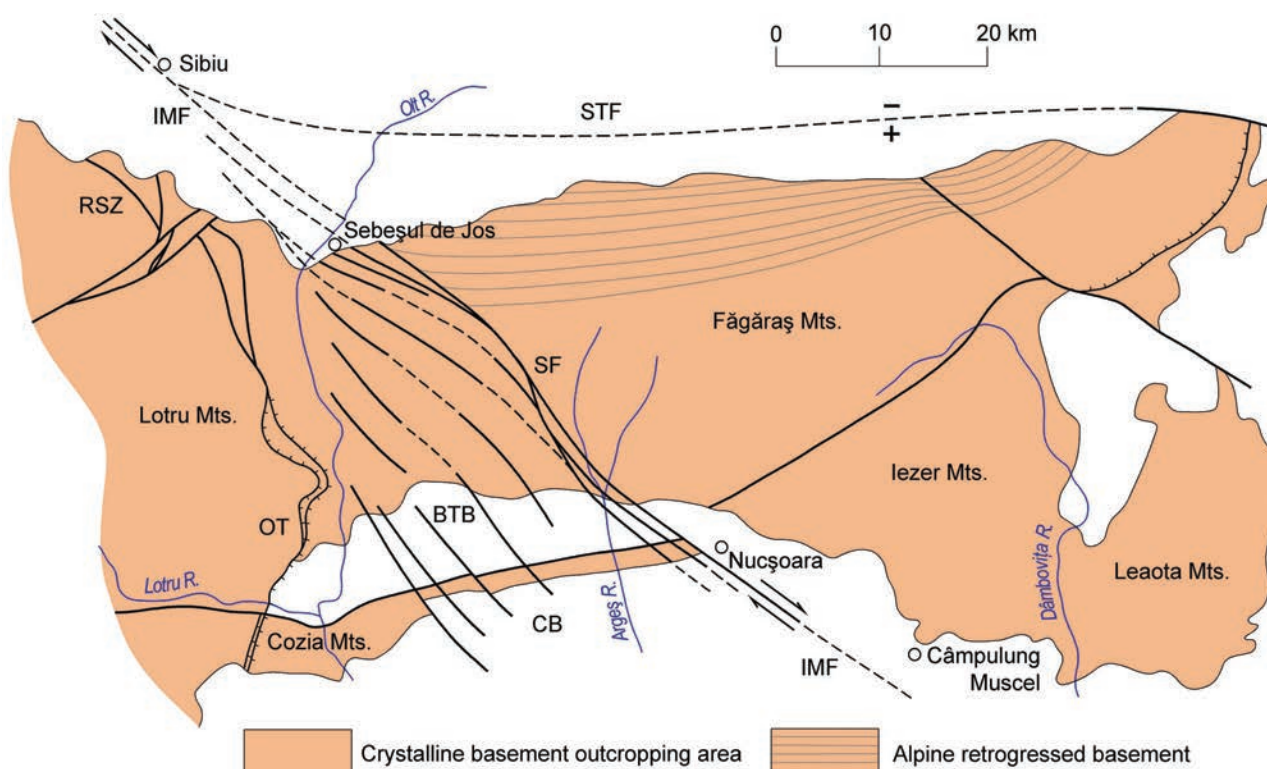


Figure 1. Scara Fault (SF)/Intramoesian Fault (IMF) in the Făgăraș Mountains area and related secondary faults suggesting a deep half flower structure in the western compartment. Abbreviations: STF-South Transylvanian Fault; RSZ-Rășinari Shear Zone; OT-Olt Valley thrust faults; BTB-Brezoi-Titești Basin; CB-Călimănești Basin.

At the present erosion level, the metamorphic rocks along the Scara Fault are deformed through frictional sliding and cataclastic flow. The deformation is homogeneous in the gneissic rocks, large volumes of rock being brecciated (Fig. 2a). Strain concentrations locally occur, marked by planes of cataclastic flow and hydrothermal fluids circulation (Fig. 2b). In the micaceous rocks, the deformation usually is localized on the foliation planes transposed on the fault direction (Figs. 2c, d).

Scara Fault kinematics. The Scara Fault corresponds to a major structural discordance in the crystalline basement of the Făgăraș Mountains, obvious on their northern slope especially. The eastern tectonic compartment was tightly folded, strongly retrogressed and completely restructured during the Cretaceous phases of the Alpine orogenesis. The Pre-Alpine (Hecynian) foliation was transposed on a penetrative axial plane cleavage associated with low-grade mineral parageneses (chlorite). This compartment has a monoclinical general structure with northern dip close to the vertical. By contrast, the basement in the western fault compartment is not affected by penetrative Alpine deformations so that it preserves the Pre-Alpine foliation associated with medium-grade mineral parageneses (staurolite, kyanite). The general structure of the western compartment on the northern slope is that of a large antiforme with western plunge.

These field data show the Scara Fault accommodated the isoclinal folding of the crystalline basement in the Făgăraș Mountains area during the Cretaceous. The fault limited to the west the Alpine retrograde metamorphism of the basement in the manner in which the Intramoesian Fault limited the westward development of the Miocene thrusts in the foredeep area (SÂNDULESCU, 1984). Situated next to Vrancea bend, the eastern fault compartment was folded under the action of the compressional forces exerted by the southeastward drift of the Foreapulian crustal block. At the same time, the tectonic regime in the western compartment was transpressive, with en echelon dextral displacements on the secondary faults related to the Scara Fault and non-penetrative deformations, strictly localized on them.

According to SÂNDULESCU (1984, 1994), the Carpathians bend in Vrancea region is the result of the southeastward movement of the Foreapulian block in concurrence with the northwestward movement of the Moesian Platform during the Cretaceous, accommodated by dextral displacements on the IMF and sinistral displacements on the Peceneaga-Camena Fault. Therefore, the movements along the IMF during the Cretaceous had the same sense with the movements on the Scara Fault, which accommodated the crust shortening in the crystalline basement on the northern border of the Făgăraș Mountains.

Land instability along the Scara Fault. In the southern area of the Făgăraș Mountains, the present-day tectonic movements on the Scara Fault are manifested through the permanent instability of the Argeș Valley slopes in Vidraru Lake area, as well as the active landslides in the eastern extremity of Cozia Mountains (Nușoara-Slatina region). Landslides frequently occur on the related fractures in the western fault compartment in the Brezoi-Titești Basin (Perișani-Titești-Boișoara region). Toward southeast, the landslides affect the sedimentary cover in Poiana-Priopare region, as well as the crystalline horst of Cozia Mountains, strongly brecciated and almost completely eroded in this area.

Not far from the northwestern Făgăraș Mountains, in Aciliu-Apoldu region, there are active landslides with detachment surfaces on NW-SE tectonic planes representing prolongations of the Scara Fault. These are visible in the Pannonian sedimentary deposits on the Transylvania Depression southwestern border. In this region, where the Intramoesian Fault intersects the South Transylvanian Fault, the land instability seriously affect the road infrastructure.

Here are also mentioned recent phenomena of mud volcanoes type, on the NW-SE lineament Apoldu-Sibiu-Avrig (CIUPAGEA et al., 1970).

SEISMIC ACTIVITY IN THE FĂGĂRAȘ MOUNTAINS AREA

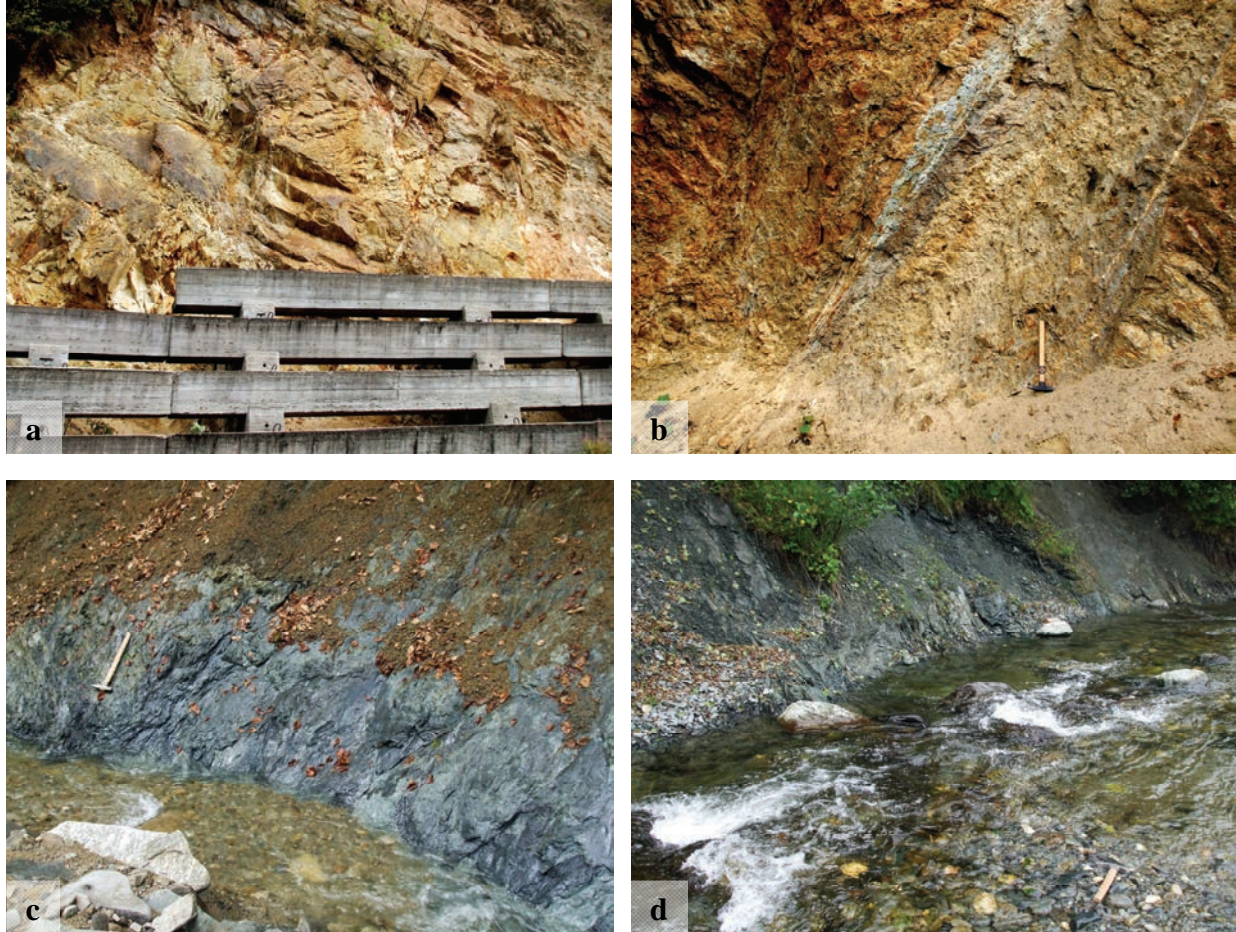


Figure 2. The Scara Fault in outcrops. a, b) Brecciated augen gneisses on the Argeș Valley (Vidraru Lake area) with hydrothermal circulation on cataclastic flow planes (b). Support structure for the slope are seen in (a). c, d) Chloritized biotite gneisses and fault gouge on the Cumpenița (c) and Moașa Sebeșului valleys (d).

The active character of the NW-SE fault zone in the Făgăraș Mountains area is reflected in the high crustal seismicity of the region. In this region, there are registered numerous earthquakes aligned on the NW-SE direction, with hypocenters localized in the middle crust, as well as in the upper crust. The earthquakes along the Intramoesian Fault are concentrated in the western fault compartment (VISARION & SÂNDULESCU, 1991), namely in Vidraru Lake and Câmpulung Muscel areas (VISARION et al., 1988). Vidraru Lake area is located exactly on the Scara Fault lineament. If we accept two different faults on the same tectonic lineament in the orogen area, the earthquakes with depths greater than 10 km should be assigned to the IMF plane and those with depths less than 10 km to the Scara Fault plane, which is a nonsense.

A destructive earthquake was registered in the Făgăraș Mountains area on January 26, 1916, at 21 km depth, followed by a long series of aftershocks, from January to May, with hypocenters at depths of 10-15 km (CONSTANTINESCU & MÂRZA, 1980). According to the macroseismic data synthesized by ATANASIU (1961), the replies from January were recorded at Titești (Brezoi-Titești Basin), Cumpăna and Piscu Negru (Argeș Valley), the following replies migrating to the southeast at Arefu, Mușetești and Nucșoara, localities on the southeastern border of the Cozia Mountains. By correlating these seismic data with the tectonics of the region, it is found that most replies have occurred along two NW-SE lineaments, i.e. Cumpăna-Nucșoara along the Scara Fault and Titești-Arefu-Mușetești along the fault branches in its western compartment.

Another shallow earthquakes was recorded in the Câmpulung Muscel region January 5, 1940 at 5 km depth (ATANASIU, 1961), on November 21, 1943 at 2 km depth and on April 12, 1969 at 8 km depth (CONSTANTINESCU & MÂRZA, 1980). A question arises: if the Intramoesian Fault plane lies at 10 km depth not far to the northwest, on which fault these earthquakes occurred?

DISCUSSIONS AND CONCLUSIONS

The data presented in the text, some of them contradictory, can be summarized as follows:

- a) in the Moesian Platform area, the Intramoesian Fault is active from the Cretaceous until the present, with dextral displacement during the Cretaceous and sinistral displacement starting with the Miocene (e.g. SÂNDULESCU, 1984, 1994);
- b) in the Făgăraș Mountains area, the Scara Fault is active with dextral displacement from the Cretaceous until the present, which means that the Scara Fault kinematics was identical to the Intramoesian Fault kinematics during the Cretaceous;
- c) starting with the Miocene, the horizontal displacements on the two faults become contrary, sinistral on the Intramoesian Fault in the platform and dextral on the Scara Fault in the orogen;
- d) both faults played a determinant role in achieving the Alpine structures in the eastern part of the South Carpathians, connected to Vrancea bend of the Carpathian orogen;
- e) the seismic activity of the Intramoesian Fault in the Făgăraș Mountains area cannot be separated from the seismic activity related to the Scara Fault.

The movement toward the orogen of the eastern IMF compartment from the Cretaceous until the present was conjugated with the movement in the same sense of the western fault compartment from the Cretaceous until the Sarmatian, when there took place the last thrusts on the inner flank of the foredeep. The higher dextral movement rate of the western compartment (SÂNDULESCU, 1984) explains the large Cretaceous thrusts in the western South Carpathians. The Cretaceous dextral fault displacement has also made possible the crust shortening by folding in the eastern South Carpathians basement on the northern border of the Făgăraș Mountains.

Starting with the Miocene, the displacement on the IMF became sinistral in the Moesian Platform area, the eastern fault compartment moving faster due to its subduction under the orogen in Vrancea region (RÂDULESCU et al., 1976; CORNEA & POLONIC, 1979; SÂNDULESCU, 1984, 1994). But the horizontal fault displacements in the inner foredeep and the Făgăraș Mountains basement are dextral. How is it explained?

Our explanation is that the current sinistral movement on the IMF in the Moesian Platform area disappears at the contact with the orogen by the subduction of its eastern compartment. Starting with the Miocene, the subduction plane splits the eastern fault compartment into two blocks with opposite movements, the platform block sinking below the orogen and the orogen block overthrusting the platform. The eastern IMF compartment moving toward NW does not collide with the eastern Scara Fault compartment moving toward SE on the same vertical tectonic plane. Therefore, the horizontal movement sense on the Intramoesian Fault-Scara Fault lineament can be simultaneously sinistral in the platform area and dextral in the orogen area.

In the western IMF compartment corresponding to the central-eastern South Carpathians there is no subduction plane. The platform comes in contact with the orogen through vertical and subvertical faults, possible thrust faults, related to the Tertiary foredeep subsidence (SÂNDULESCU, 1984). The Moesian Platform presses the orogen at low angle inducing en echelon dextral displacements in the crystalline basement. The tectonic instability of the western compartment in the Făgăraș Mountains is evidenced by its high crustal seismicity (VISARION & SÂNDULESCU, 1991) and the land instability. The seismic activity of the Intramoesian Fault in this region coincides with that of the Scara Fault. The depth range of earthquakes focus covers both the upper and middle crust, being localized on the same transcrustal tectonic plane belonging to the same fault, i.e. the Intramoesian Fault.

Now we can understand why ATANASIU (1961) could not explain why the earthquake of October 31, 1894 was simultaneously felt in the localities Căineni, Câmpulung Muscel and Brăila. The line Căineni-Câmpulung Muscel coincides with the Intramoesian Fault, active in conjunction with the Peceneaga-Camena Fault, where Brăila Town is seated. At that time, the author did not know about these geodynamic connections at regional scale.

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Received: March 10, 2017

Accepted: August 9, 2017

THE EVALUATION OF THE PETROLEUM POTENTIAL IN DUMRE REGION (ALBANIA) BASED UPON DUMRE-7 WELL RESULTS

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Abstract. Dumre diapir is one of the largest in Albania. It meets Kuçova and Rasë-Pekisht oilfields in its west and south parts, with Messinian sandstones as reservoirs. In the diapir area, several wells have been drilled. These wells are mostly oriented on its periphery. The object of petroleum exploration has been the sedimentary section tectonically supported by the diapir body. Most of the wells stopped in the evaporate deposits. Dumre-7 well is the only one which passed beyond the diapir body at the depth of 6,101 m. Its end is in the Lower Oligocene flysch. During the drilling, hydrocarbon gas shows occurred, with the gas stream going up to the top of the drilling tower. Similar performances appeared in other wells too. The geochemical study was conducted during and after the drilling process, on coaly shales and on hydrocarbon gas that emerged during the drilling of Dumre-7. The geochemical study is based on the following methods: Rock-evaluation studies of coaly shale in the evaporate deposits; the petrologic study of coaly shale; gas chromatography study of hydrocarbon gases; isotopic determination of carbon methane. The total organic carbon of coaly shale ranges up to 38.73%. The volume of hydrocarbons that formed during the thermal pyrolysis is lower than 103.8 mg HC/ g rock. The type of organic matter is III-II (HI <319). Type III-II is confirmed by petrologic study, where gelinite macerals predominate. Based on vitrinite reflectivity (R_o < 0.446%), T_{max} (T_{max} < 427°C) and the productivity index (PI < 0.141), it was confirmed that the organic matter is immature. In Dumre-7 well, there predominate wet and dry hydrocarbon gases (C_1/C_2 < 100; C_1/C_{2+} < 50). Based on carbon isotope ratio of methane ($\delta^{13}C-CH_4$ > -35.49‰) it was indicated that the hydrocarbon gases are more matured than the ones in the around oilfields. Hydrocarbon gas shows of evaporate formation do not represent gas trap, but "imprisoned" gases during the penetration of the diapir body. In this study, one cannot present well logs for three reasons: a. The diapir evaporate formation is chaotic; b. The logs are confidential; c. The region is in an international tender for petroleum exploration. Based on the geochemical indicators interpretation, relevant conclusions to oil exploration in the region have emerged.

Keywords: free hydrocarbon gas, thermal vacuum gas, evaporate formation, wetness ratio.

Rezumat. Evaluarea potențialului petrolifer în regiunea Dumre (Albania) pe baza rezultatelor forajului Dumre-7.

Diapirul Dumre este unul dintre cele mai mari din Albania. În partea sudică și vestică întâlnește câmpurile petroliere Kuçova și Rasë-Pekisht cu gresii de vârstă messiniană în bază. În zona diapirului au fost efectuate câteva foraje. Aceste foraje sunt în mare parte la periferia sa. Explorarea pentru rezervele de petrol a fost făcută mai ales în secțiunea sedimentară susținută tectonic de corpul diapirului. Mare parte a forajelor s-au oprit în depozitele de evaporite. Forajul Dumre-7 este singurul care a trecut de corpul diapirului și a atins adâncimea de 6.101 m. Acesta s-a oprit în flișul care datează din Oligocenul inferior. Pe parcursul forării au apărut scăpări de hidrocarburi gazoase. Astfel de cazuri s-au înregistrat și la alte foraje. Studiul geochimic a fost efectuat în timpul și după finalizarea procesului de forare, pe șisturile cărbunoase și hidrocarburile gazoase care au apărut în timpul forării la Dumre-7. Studiul geochimic se bazează pe următoarele metode: studii de evaluare a șisturilor cărbunoase din depozitele de evaporite; studiul petrologic al șisturilor cărbunoase; studiu prin cromatografie în fază gazoasă a hidrocarburilor gazoase; determinarea izotopică a metanului. Carbonul organic total din șisturile cărbunoase ajunge la 38.73%. Volumul hidrocarburilor format în timpul pirolizei termice este mai redus de 103.8 mg HC/ g rocă. Tipul de materie organică este III-II (HI < 319). Tipul III-II este confirmat de studiul petrologic prin predominarea gelinitelor macerale. Pe baza vitritului de reflexie (R_o < 0.446%), T_{max} (T_{max} < 427°C) și a indicelui de productivitate (PI < 0.141) s-a stabilit că materia organică este imatură. În forajul Dumre-7 predomină hidrocarburile gazoase umede și uscate (C_1/C_2 < 100; C_1/C_{2+} < 50). În funcție de raportul de izotopi de carbon ai metanului ($\delta^{13}C-CH_4$ > -35.49‰) s-a stabilit faptul că hidrocarburile gazoase sunt mai maturizate decât în jurul câmpurilor petroliere. Hidrocarburi gazoase din formațiunea evaporitelor nu reprezintă punji de gaze, ci gazele „închise” în timpul penetrării corpului diapir. În acest studiu nu se pot prezenta bine jurnalele din trei motive: a. Formațiunea evaporitelor din diapir este haotică; b. Jurnalele sunt confidențiale; c. Regiunea face obiectul unei licitații internaționale pentru explorarea rezervelor de petrol. Pe baza interpretării indicatorilor geochimici, s-a ajuns la o serie de concluzii cu privire la explorarea petrolului din regiune.

Cuvinte cheie: hidrocarburi gazoase libere, vacuum gazos termal, formațiunea evaporitelor, raportul de umiditate.

INTRODUCTION

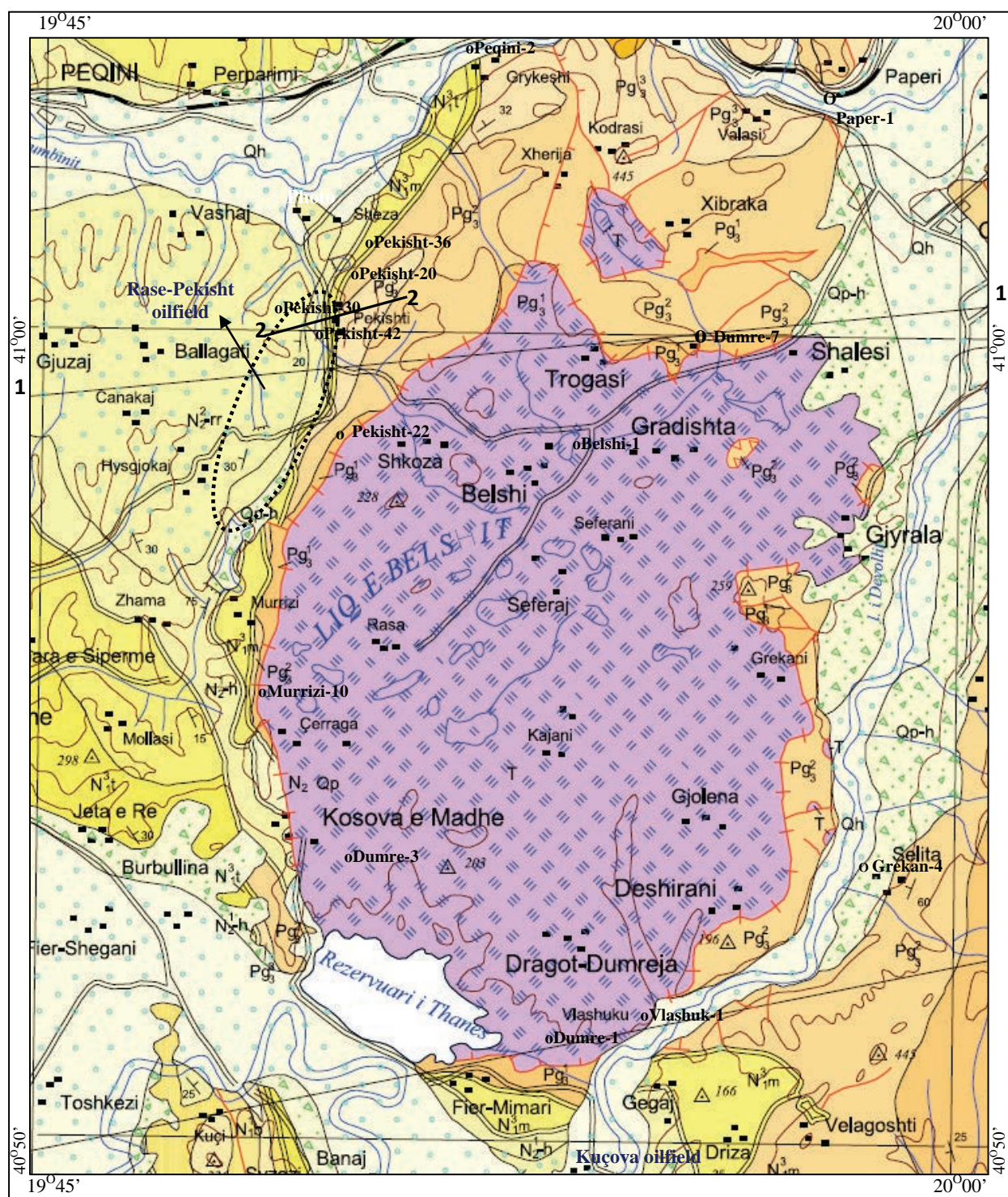
Dumre region (Fig. 1) presents a high interest for the exploration of hydrocarbons in Albania. This refers to the geological construction and results of Dumre-7 well.

The geochemical characteristics of the region were identified during the drilling of the well and then studied based on cuttings, as well as on the geochemical properties of crude oil of Rase-Pekisht and Kucova oilfields and relations with them. Hydrocarbon gases are not mainly generated by evaporate section, but in deeper sedimentary section.

The lower contact body diapir represents an anomaly only by C_2H_6/C_3H_8 ratio, while the other indicators do not reflect any anomaly. The Miocene tectonic block located west of the diapir and the anticline covered by evaporate formation are important in terms of oil exploration.

Dumre diapir is placed in the continuation of the northern part of the anticline belt of Berati subzone. The evaporate formation of Dumre is of an earlier age than the Upper Triassic or the Permian-Triassic periods (DIAMANTI et al., 1998; Albanian Geological Survey, 2002).

GEOLOGICAL SETTING



Legend

Qp - Holocene

Qp-h - Pleistocene - Holocene

N₂^{2-rr} - Middle Pliocene (Rrogozhina formation)N₂^{1-h} - Lower Pliocene (Helmesi formation)N₁^{3m} - MessinianN₁^{3t}N₁^{2s} - SerravallianN₁^{2l} - LanghianPg₃³ - Upper OligocenePg₃² - Middle OligocenePg₃¹ - Lower Oligocene

- Geological boundary

- Unconformity boundary

-- Tectonical line

- Over thrust

- Tectonic block

Figure 1. Geological map of Dumre region (based on geological map of Albania, sc: 1/200 000).

The rising of the diapir occurred on the western part of Maraku anticline (northern anticline of Berati subzone), with greater intensity, expressed as the most advanced westward diaper (Fig. 2). The current form is shown after the Pliocene tectonic phase (PRIFTI et al., 2013; VELAJ, 2015). This was confirmed by seismic studies and the drilling of Dumre-7 well (PRIFTI et al., 2014).

In Dumre region, many wells were drilled for oil exploration and minerals (gypsum, salts in the evaporate deposits). Only nine wells met evaporate deposits, which are shown on the geological map. The deeper well passed beyond the body of the diapir is Dumre-7 (File of Dumre-7 well; BANDILLI et al., 2003).

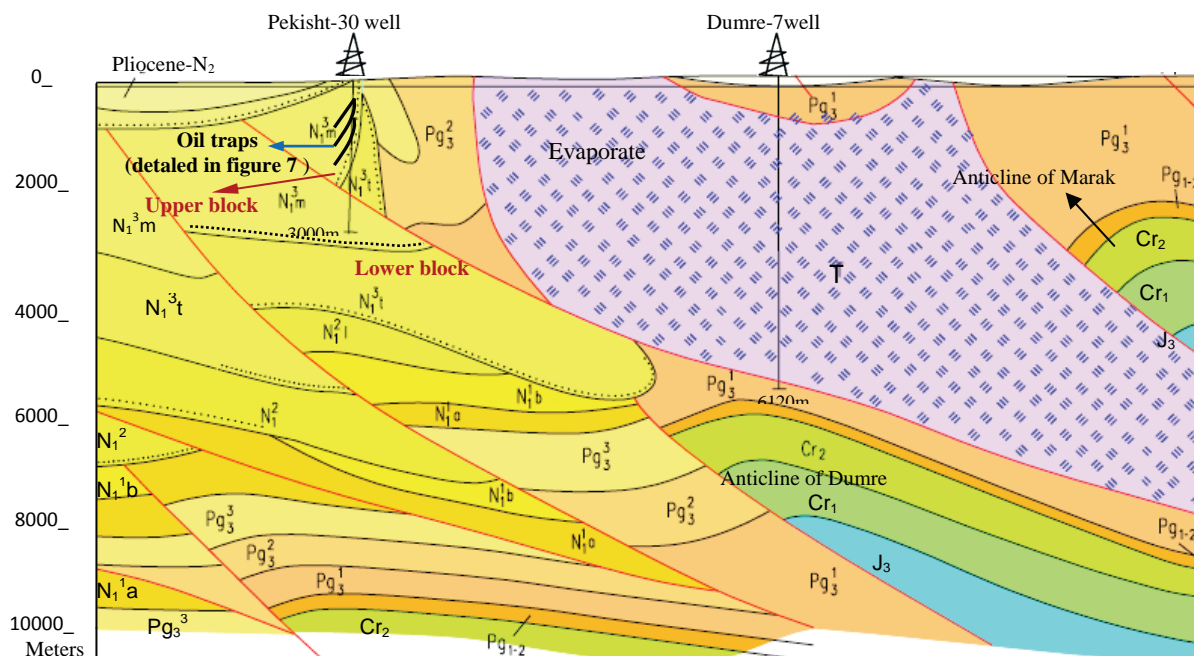


Figure 2. Diapir of Dumre crossed by Dumre-7 well (PRIFTI et al., 2013).

The well Dumre-7 was designed to detect oil trapped in Dumre anticline (under the diapir body). During the drilling, there were many technological problems caused by the lithological nature of evaporates, which are represented by anhydrides, salts, clays, dolomites, tectonic blocks with different orientations and displays of hydrocarbon gases.

The well penetrated this geological section:

0 ÷ 450m, Lower Oligocene flysch (Pg_3^1);

450m ÷ 6,101m, Upper Triassic (T_3);

6,101m ÷ 6,120m, Lower Oligocene flysch (Pg_3^1).

During the drilling geochemical determinations of hydrocarbon gases (free hydrocarbon gases, thermal vacuumed hydrocarbon gases and mud logging gas) were conducted.

Recently, we have studied some coal samples that were taken from the stored cuttings. Their level does not seem clear in the chart logs because they are thin layers of coal and coaly shale.

MATERIAL AND METHODS

The geochemical study was carried out at the depths 4,458-5,290 m and 5,673-5,980 m, while the interval 5,290 m-5,673 m was not studied because it coincided with the time of signing contracts related to exploration companies and exchanging of operators. Also, in specific intervals, pyrolysis (Rock-Eval) and petrologic studies of coaly shale were conducted. The geochemical interpretation of the well is realised by the experience of the Oil and Gas Geological Institute of Albania (OGGI) as methane/ethane (C_1/C_2), methane/homologues of methane (C_1/C_{2+}) and ethane/propane (C_2/C_3) ratios.

The geochemical study was based on the geochemical determinations:

1. Pyrolysis result of coal and coaly shale identified in cuttings.
2. Organic petrology of coal and coaly shale (maceral analysis and vitrinite reflectivity).
3. Geochemical method of gaseous hydrocarbons definitions by gas chromatography.

Method and carbon isotope ratio of methane ($\delta^{13}C-CH_4$).

Pyrolysis results of coal samples from Dumre-7 well (evaporate formation, Table 1).

Table 1. Rock-eval data of coal and coaly schist in Dumre-7 well.

Depth (meters)	Type of samples	Lithology	S ₁ , Fre HC (mgrHC/gr.rock)	S ₂ , generated (mgrHC/gr.rock)	T _{max}	PI	TOC	HI
4,745-4,750	Sample	Coal schist	10.0	60.90	425	0.141	36.56	166
4,750-4,755	"	"	6.29	43.79	421	0.126	33.53	130
4,785-4,790	"	"	11.3	72.4	423	0.135	37.2	194
4,790-4,795	"	"	10.89	70.19	427	0.134	31.12	225
4,830-4,835	"	"	8.75	78.87	412	0.100	36.82	212
4,905-4,910	"	"	3.8	87.82	409	0.041	29.29	299
5,230-5,235/1	Cuttings	Coal schist	0.45	103.8	407	0.004	32.47	319
5,230-5,235/2	"	"	10.5	69.4	416	0.131	38.73	179

The study of hydrocarbon gases in the well was conducted in the three forms of their occurrence:

- Free hydrocarbon gases appearing during drilling.
- Hydrocarbon gases in mud, isolated by the thermal vacuum degassing scheme.
- Hydrocarbon mud logging and evaluation of gas hydrocarbon and its constituents.

The pyrolytic study of coal and coaly shale samples identified in cuttings were performed by "Oil Show

Analyzer" equipment. By means of this method, there are defined:

- S₀ (mg HC/g rock) for free gas hydrocarbons present in the sample before the analysis;
- S₁ (mg HC/g rock) - The free hydrocarbons present in the sample before the analysis;
- S₂ (mg HC/g rock) - The volume of hydrocarbons formed during the thermal pyrolysis of the sample;
- T_{max}(°C)-Temperature of peak S₂ maximum;
- TOC-Total organic carbon;
- HI (Hydrogen index)-S₂/TOC*100;
- PI (petroleum index)- S₁/(S₁+S₂);

The petrologic study of coal and coaly shale was conducted by means of "Microphotometer MPV3", using the reflected light method. Through this method, the separation of the maceral groups (liptinite, vitrinite and inertinite) and the measurements of vitrinite reflectivity (Ro) were carried out.

Gas chromatography studies are conducted for free hydrocarbon gases, thermal vacuumed hydrocarbon gases and results from hydrocarbon mud logging (ABLANDET al., 2012). By means of the first two methods, the series of methane up to C₇H₁₆ (heptanes) by "Carlo Ebra STRUMENTAZIONE" were defined. By means of the hydrocarbon mud logging, gas hydrocarbons are set up to butane (C₄H₁₀). This does not mean that there are no more heavy gas hydrocarbons, but the method is designed to record up to C₄ (butane). Taking into consideration this statement, the following geochemical indicators were examined: C₁ / C₂, C₂ / C₃ and i-C₄ / n-C₄.

It should be noted that in the depths where hydrocarbon gases appeared, samples were taken from the mud.

The study of different forms of the gas occurrences requires different analytical techniques of gas extraction and individual hydrocarbon gas composition (PRIFTI et al., 1994; SHKURTAJ & BITRI, 2008).

By this method, the maturity of hydrocarbon gases is estimated through isomerisation ratio (iC₄H₁₀/nC₄ H₁₀).

Also, in free hydrocarbon gas samples, it is defined the carbon isotope ratio of methane (δ¹³C-CH₄). These determinations were carried out by the laboratories of the oil companies in accordance with the ISO standard.

Based on the methods of study, on the geological structure, on the results of wells, on the presence of Rasë-Pekisht oilfield and bituminous sandstones at the base of the Messinian deposits, one arrives at some opinions regarding the petroleum potential of Dumre-region.

DISCUSSION

1. Properties of organic matter. Based on the above mentioned geochemical determinations, we could not prepare the geochemical logs of evaporate formation because the diaper body is in a chaotic situation.

In the evaporate formation of wells, there are identified coal and coaly shale. In Dumre-7 well, there are three levels of coal and coaly shale at the depths of 4,745÷4,795 m, 4,905÷4,910 m and 5,230÷5,235 m.

Total organic carbon (TOC) ranges from 29.29% to 38.73%, which is typical for coaly schists (Table 2). The type of organic matter is determined by the hydrogen index (HI), which is typical for III-II type (HI=130÷319). This is due to the high content of free lipid compounds (S₁ = 0.45 to 11.30 mg HC/g rock) and residual genetic potential (S₂ =43.79÷103.8 mg HC/ g rock).

Type III-II is confirmed by petrologic study, where gelinite macerals predominate (Table 2), which derived from inferior plants in wetland environments (PRIFTI, 2014).

Table 2. Groups of macerals and reflectance of vitrinites of coaly schists met at Dumre-7 well.

Depth (m)	Liptinite (%)	Vitrinite (%)	Inertinite (%)	Reflectance of vitrinites, Ro (%)	Remarks
4,745-4,750	5.94	86.14	7.92	0.446	Gelinite (predominate in coal schists)
4,750-4,755	2.12	72.79	25.09	0.412	Semifusinite (coal schists)
4,775-4,780	15.84	84.16	trace	-	Are gelinite, no Ro (coal schists)
4,780-4,785	5.17	91.38	3.45	-	Are gelinite, no Ro (coal schists)
4,785-4,790	15.68	80.39	3.92	-	Are gelinite, no Ro (coal schists)
4,790-4,795	18.36	70.97	10.67	0.402	Gelinite (predominate incoalschists)
4,790-4,795	10	90	trace	0.402	Gelinite (predominate in coalschists)
4,830-4,835	9.04	90.96	trace	-	Are gelinite, no Ro (coalschists)
4,845-4,850	7.79	91.21	trace	-	Are gelinite, no Ro (coalschists)
4,850-4,855	7.04	92.96	trace	-	Are gelinite, no Ro (coalschists)
4,905-4,907	7.01	90.07	2.92	0.423	Gelinite (predominate in coalschists)
5,230-5,235	trace	100	trace	-	Are gelinite, no Ro (coalschists)

The maturity of organic matter was evaluated by the vitrinite reflectance (Ro). This indicator varies in the range of $0.402 \div 0.446\%$. So, the organic matter is immature and is included in subbituminous coal rank (mixed hydrocarbon gas generation).

The low level of maturity of the organic matter of the evaporate formation confirms the information received from pyrolytic data. So, Tmax is less than 435°C , which indicates immature organic matter (Fig. 3).

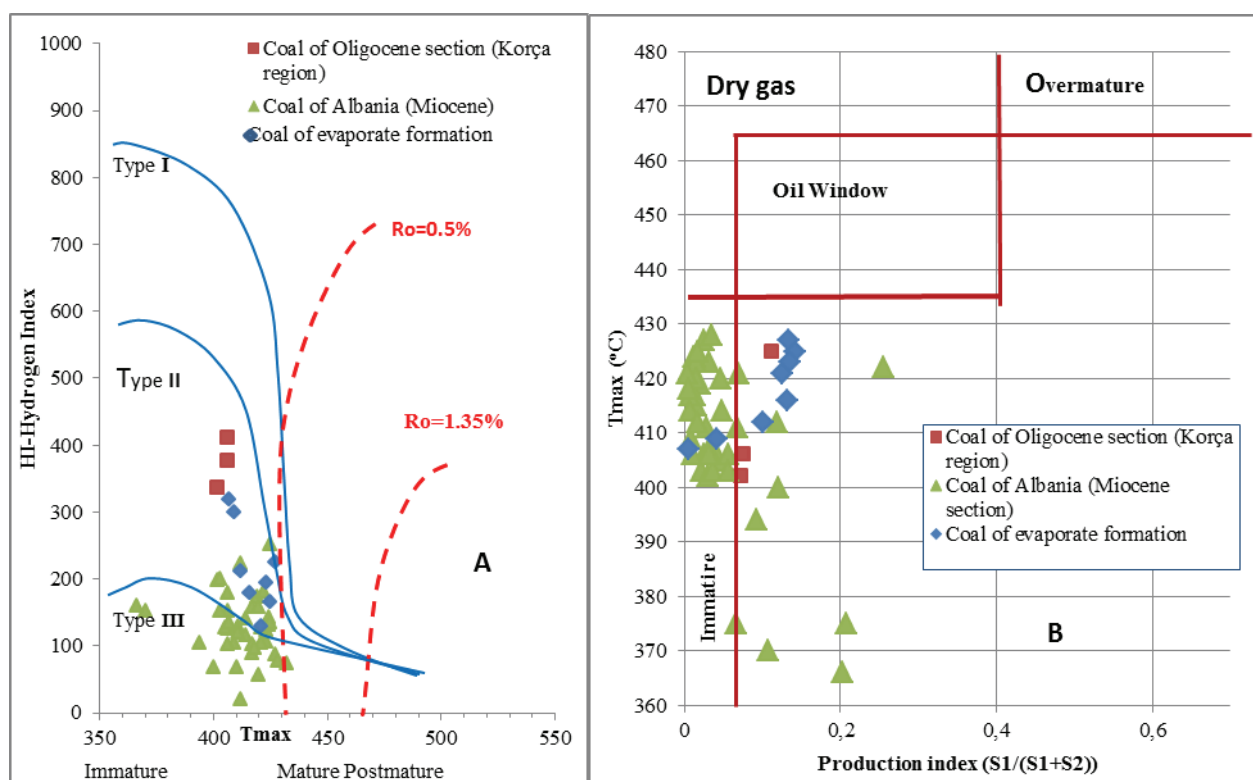


Figure 3. Type of organic matter (A) and maturity (B) from rock-eval data of coaly matter in Albania.

The maturity of the organic matter is also interpreted by the productivity index ($PI = S_1 / (S_1 + S_2)$). By different authors, this indicator has been interpreted in different ways. So, matured organic matter is included in the oil window in the limits $0.1 \div 0.3$; $0.2 \div 0.4$. We accept $0.1 \div 0.4$ as the limits of the oil window. In the coal and coaly shale of the evaporate formation, there is noted that the productivity index (in most samples) that is included in the range between $0.1 \div 0.4$. The high values of PI are related to the free lipid in coaly matter and not to their maturity level.

The low level of maturity is due to the high thermal permeability of the evaporate section, which, also, has a low thermal capacity. Evaporate deposits are very good thermal conductors, so they increase the maturity of cover rocks. When the diapir emerges, the cooling of the basin begins (PRIFTI et al., 2014).

This is the only reason that the drilled wells on the Dumre diapir have lower temperatures. The phenomenon of low gradients in evaporate section is proven in Grekan-4 well.

During the drilling of Dumre-7 well hydrocarbon gases were met in the evaporate formation. The geochemical types of hydrocarbon gases are determined according to the experience of Oil and Gas Geological Institute (OGGI) as C_1/C_2 (CH_4/C_2H_6), C_1/C_{2+} (CH_4/C_2H_{6+}).

The geochemical type of hydrocarbon gases is given in Figure 4. The hydrocarbon gases were studied by means of three methods:

A) Free gases are taken during the drilling, manoeuvres and the circulation (4,524÷5,290 m). Their composition included the full range of gaseous hydrocarbons (C_1 ÷ C_7). The main component is methane, which represents 62.768% to 97.328% (relative percentage). Based on the geochemical indicators (C_1/C_2 , C_1/C_{2+}), free hydrocarbons gases are mostly dry gas type, two samples are wet gas type (4,684 and 5,256 m) and one sample is dry gas (5,290 m). Free hydrocarbon gases in the Rasë-Pekisht oilfield are wet hydrocarbon gases (Fig. 4).

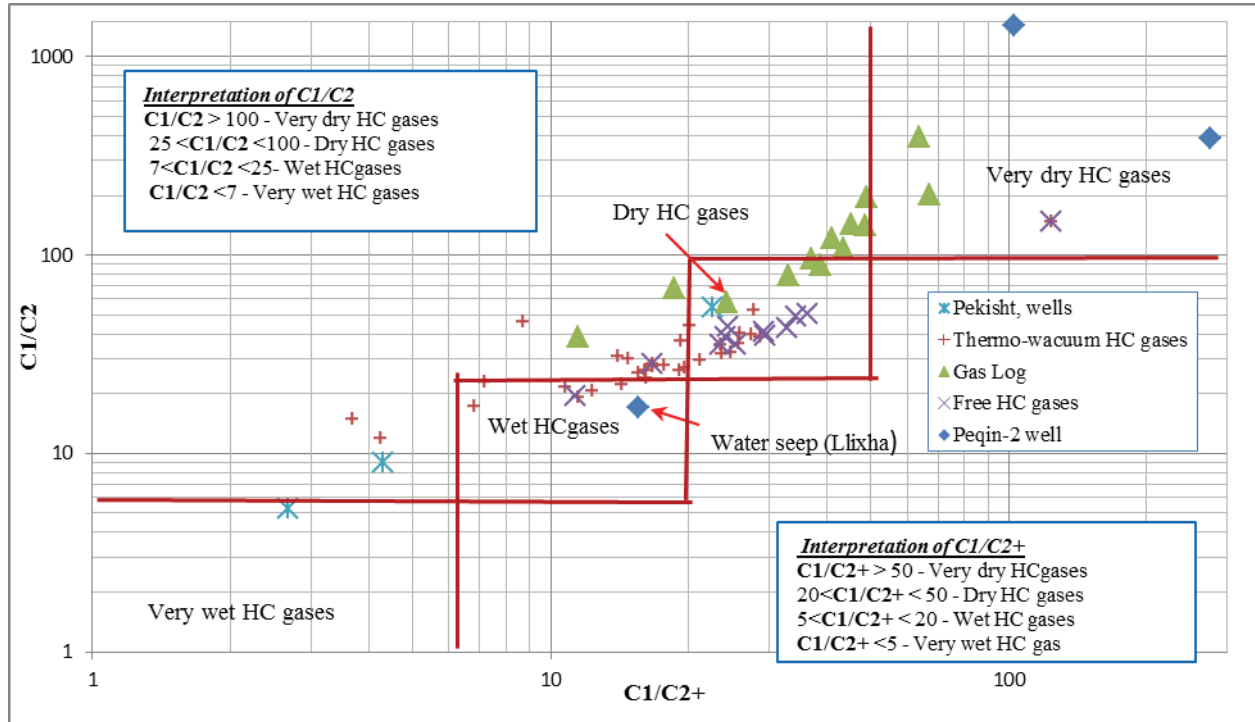


Figure 4. Geochemical type of hydrocarbon gases (HC) by OGGI indexes.

Table 3. Geochemical gaseous hydrocarbons indexes of Dumre-7 well (diapasons).

Type of Gas	C_{2+}	OGGI geochemical indexes			$i-C_4/n-C_4$	$i-C_5/n-C_5$	Wh	Bh	Ch	$\delta^{13}C$ (‰)
		C_1/C_2	C_1/C_{2+}	C_2/C_3						
ThVG	0.8-19.05	11.48-148	4.25-124	1.01-12.64	0.44-0.92	1.30-2.36	0.78-18.84	6.48-933.6	0.58-3.97	-35.49 ÷ -32.5
Free Gas	0.44-10.0	11.46-147.72	8.96-123.6	2.59-12.3	0.53-0.92	1.51-3.03	0.78-10.04	35.76-914.63	0.52-1.08	
GasLog	0.54-3.22	38.86-396	11.46-67.27	0.68-4.15	0.48-1.14					

As it regards the composition of hydrocarbon gases related to lithology, there is observed that they belong to the dry and very dry types ($C_1/C_2 = 16.68 \div 201.81$, $C_1/C_{2+} = 6.14 \div 78.05$). Two gas samples are included in the wet type.

Considering as a whole the composition of hydrocarbon gases (free hydrocarbon gases, thermal vacuumed hydrocarbon gases and mud hydrocarbon gases), there is observed the tendency that with the increase of the depth, hydrocarbon gases pass from wet and dry types into the dry and very dry types (DIAMANTI et al., 1998; PRIFTI, 2014).

The maturity of hydrocarbon gases. The degree of maturity of hydrocarbon gases is evaluated by two indicators: carbon isotope ratio of methane ($\delta^{13}C-CH_4$) and isomerisation ratio ($i-C_4H_{10}/n-C_4H_{10}$).

The Carbon isotope ratio of methane ($\delta^{13}C-CH_4$) ranging from -32.4‰ to -35.49‰ indicates that the hydrocarbon gases are more matured (DIAMANTI et al., 1998; SHKURTAJ et al., 2002).

Hydrocarbon gases with high level of maturity are generated by the source rocks that passed the oil window, or more precisely, that generated condensate and wet hydrocarbon gases. The highest value of this indicator ($\delta^{13}C = -25.23\%$) characterises the hydrocarbon gas of thermal water sources in Llixha. Water sources appear in northeast of the diapir body and are influenced by it.

The carbon isotope ratio of methane ($\delta^{13}C-CH_4$) is defined in the hydrocarbon gases of two oilfields; one in the Rasë-Pekisht oilfield ($\delta^{13}C-CH_4 = -53.887\%$), and the other in Kuçova oilfield ($\delta^{13}C-CH_4 = -44.43\%$). This difference speaks out of:

- Different levels of maturity of crude oils;

• Crude oil of Rasë-Pekisht oilfield is not affected by the new generation of the Pliocene - post-Pliocene time (GJOKA et al., 2002).

Isomerisation ratio has mainly the value of $i\text{-C}_4\text{H}_{10}/n\text{-C}_4\text{H}_{10} < 1$, also the ratio ($i\text{-C}_5/n\text{-C}_5$) has a low value, which indicates the matured hydrocarbon gases. Only two samples of mud hydrocarbon gases, where isomeric forms prevail over normal ones, are an exception; they are immature and are generated by organic matter of the evaporate formation.

Geochemical correlation is carried out taking into account the following criteria:

- a. Geochemical features and maturity of fluids (oil, gas),
- b. Geochemical features and maturity of the source rocks.

In the evaporate formation crossed by Dumre-7 well, mainly matured hydrocarbon gases are met. Also, there are met coaly shale, which are not matured. Given the different levels of their maturity, it is concluded that hydrocarbon gases are not generated by evaporate section but by another sedimentary section, which passed the "oil window" and contacted the diapir body in depth, while hydrocarbon gases that have high isomerisation ratio ($i\text{-C}_4/\text{C}_4n > 1$) are generated from the coaly shale of the evaporate formation.

Earlier studies determined that crude oils of Rasë-Pekisht oilfield (as all crude oils of the Ionian zone) are generated by the source rocks of carbonate section where the Triassic-Jurassic source rocks are the main contributors (PRIFTI & MUSKA, 2013). The low value of the carbon isotope ratio of methane of crude oils of Rasë-Pekisht oilfield indicates the early stages of hydrocarbon generation (GJOKA et al., 2002).

So, the oilfield of Rasë-Pekisht is not affected by the new generations and migration stages, as a result of the interruption of relations with the source of supply. However, detailed studies are needed to determine the origin of the crude oils of Rasë-Pekisht oilfield.

The accumulation of gas hydrocarbons. Manifestations of hydrocarbon gases are met almost in the evaporite section of the Dumre-7 well. Their origin is related mainly to older sedimentary section that passed the "oil window".

The diapirism of evaporate formation included gaseous hydrocarbons, which are stored within the body of the diapir. These hydrocarbons are stored in the tectonic blocks of dolomites, limestones and other rocks that have porosity.

The main task of the organic geochemistry science is to determine whether these rocks represent gaseous hydrocarbons traps. To this purpose six geochemical indicators are calculated, three indicators (the first) are under World experience, while the other indicators have been interpreted by the experience of Oil and Gas Geological Institute of Albania (OGGI):

1. Hydrocarbon Wetness Ratio (Wh),

$$\text{Wh} = (\text{C}_2 + \text{C}_3 + i\text{C}_4 + n\text{C}_4 + i\text{C}_5 + n\text{C}_5) / (\text{C}_1 + \text{C}_2 + \text{C}_3 + i\text{C}_4 + n\text{C}_4 + i\text{C}_5 + n\text{C}_5) * 100$$

2. Hydrocarbon Balance Ratio, $\text{Bh} = (\text{C}_1 + \text{C}_2) / (\text{C}_3 + i\text{C}_4 + n\text{C}_4 + i\text{C}_5 + n\text{C}_5)$,

3. Hydrocarbon Character Ratio, $\text{Ch} = (i\text{C}_4 + n\text{C}_4 + i\text{C}_5 + n\text{C}_5) / \text{C}_3$,

4. Methane/Ethane Ratio = C_1/C_2 ,

5. Ethane/Propane Ratio = C_2/C_3 ,

6. Ethane/ iso butane Ratio = $\text{C}_2/i\text{-C}_4$

The accumulation of hydrocarbons will be examined by determining all the above indicators.

The definitions of hydrocarbon gases carried by the station unit (mud logging unit) are limited up to butane, so we cannot calculate the first three indicators. By consequence, instead of these determinations, other indicators shall be interpreted.

According to "Wh", in the evaporate section there exist accumulations of hydrocarbon gases. These accumulations are actually called "imprisoned gases" by the diapirism of the evaporate formation. This term is included for the first time in the science of organic geochemistry. Although such accumulations have some reserves, they are unusable.

There is not a trend of geochemical indicators (Wh, Bh, Ch) in the evaporate formation section. Geochemical indicators do not show any anomaly of oil trap covered by the evaporate formation (Fig. 5).

Ethane/Propane ratio ($\text{Ep} = \text{C}_2/\text{C}_3$) is interpreted as an index of maturity and biodegradation of crude oils by foreign researchers (ABLAND et al., 2012).

Therefore, its growth is related to the maturity of hydrocarbon gases. In the studies carried out at the Oil and Gas Geological Institute of Albania (OGGI), this indicator is interpreted for the purpose of evaluating the anomaly of oil and gas traps.

So, high values are characteristic for the aureole of gas hydrocarbons traps; $2 < \text{C}_2/\text{C}_3 < 3$ is characteristic of the aureole of condensation traps and $\text{C}_2/\text{C}_3 < 2$ is a peculiar feature of the aureole of oil traps (the increase of propane). This model is appropriate for hydrocarbon traps in the carbonate section of the Ionian Zone (PRIFTI et al., 1994). The Ionian Zone is made up of sedimentary rocks from the Triassic up to the Miocene age and was affected by many tectonic phases.

Based on Ethane/Propane ratio there must be remaining oils on special intervals of the section (4,500m÷4,700m and 5,700m÷6,000m).

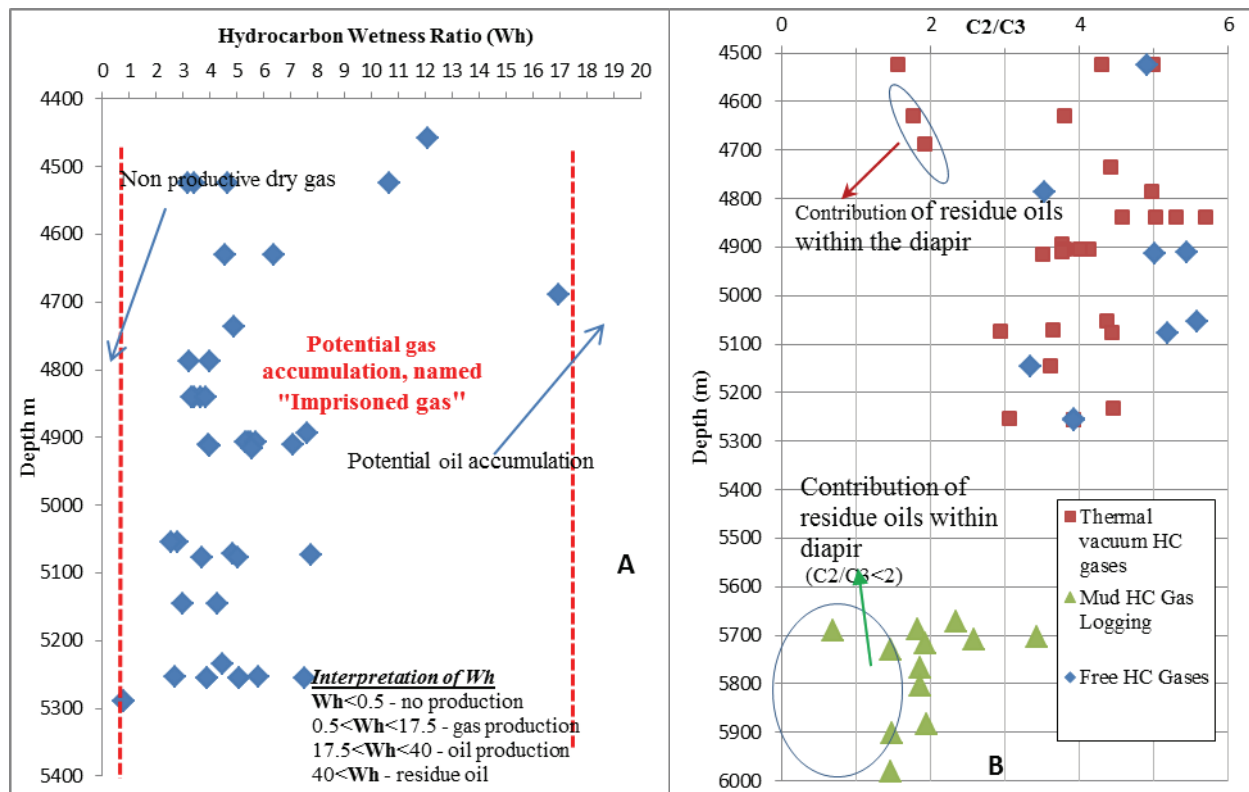


Figure 5. Gas accumulation of Dumre-7 well based on Hydrocarbon Wetness (A) and C_2/C_3 ratio (B).

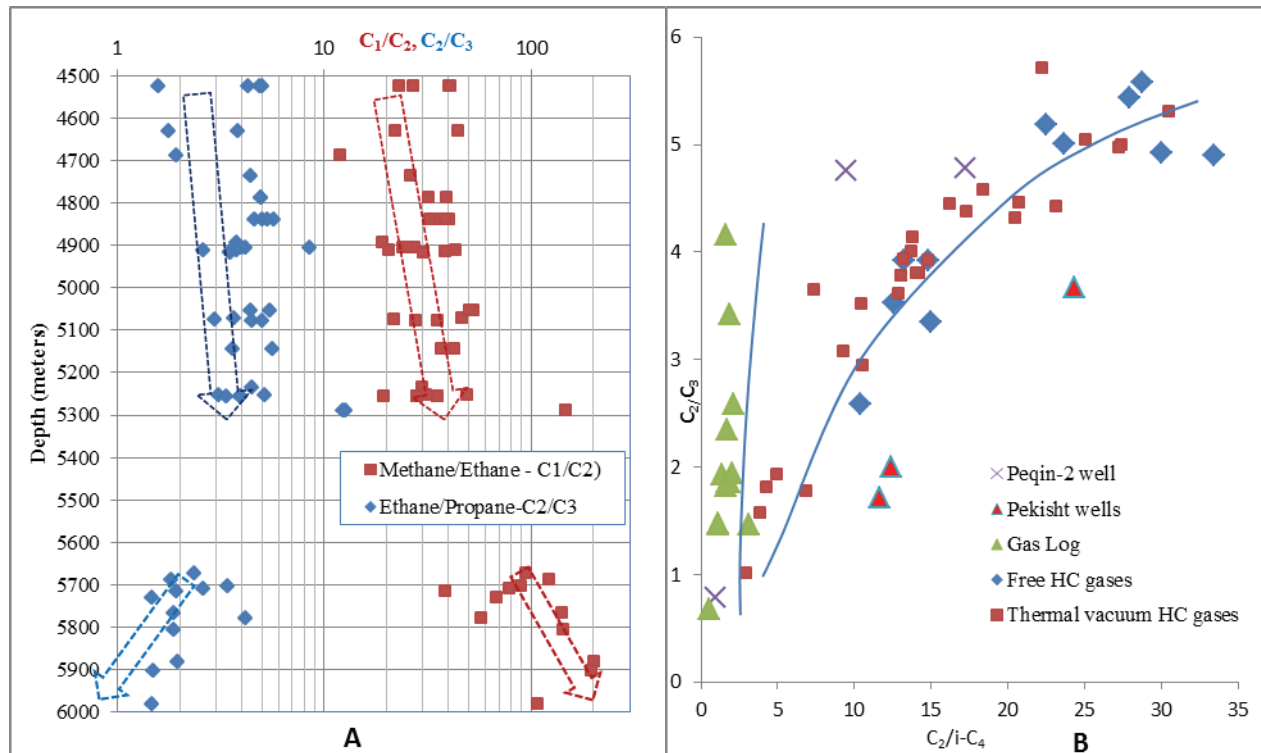


Figure 6. Correlation of C_2/C_3 , C_1/C_2 with depth (A) and C_2/C_3 with $C_2/i-C_4$ (B) in section of Dumre-7 well.

There is an interesting correlation of this ratio with $C_2/i-C_4$ ratio (ethane/iso-butane). There were observed two trends (Fig. 6):

- Major changes of C_2/C_3 associated with small changes of $C_2/i-C_4$ in mud logging gases.

- In the other forms of hydrocarbon gases there is aregular correlation between indicators.

In the geochemical study of the SH2-well in the southwest of the diapir, a concordance of hydrocarbon gases of the anomaly with those of the oil trap is observed (DUKAJ et al., 2014).

Based on the geochemical experience, there is observed a right correlation between the C_2/C_3 and C_1/C_2 . In the hydrocarbon gases studied by means of Mud gas logging (5,673m÷5,980m), this trend is not observed. This means that the lower section of evaporates currently do not serve as seal rocks. We consider that the high values of C_2/C_3 (characteristic of gas anomalies related to oiltrap), could denote two possibilities:

- That they are influenced by any oiltrap on the eastside and the diapir body shifted it westward. This is because the diapir body is always in a westward motion.
- Or the lower tectonic contact of the diapir serves as a hydrocarbon migration route.

In these conditions, we think that the evaporate section do not serve as seal rocks for any oil trap. For the oil traps in the Ionian zone, this role is performed by flysch deposits. There have not been conducted geochemical determinations on the flysch section of Dumre-7 well under the tectonic contact of the diapir. In the SH2 well the two parameters reflect the oil traps in the reservoir rocks and the anomaly in the seal rocks (flysch formation).

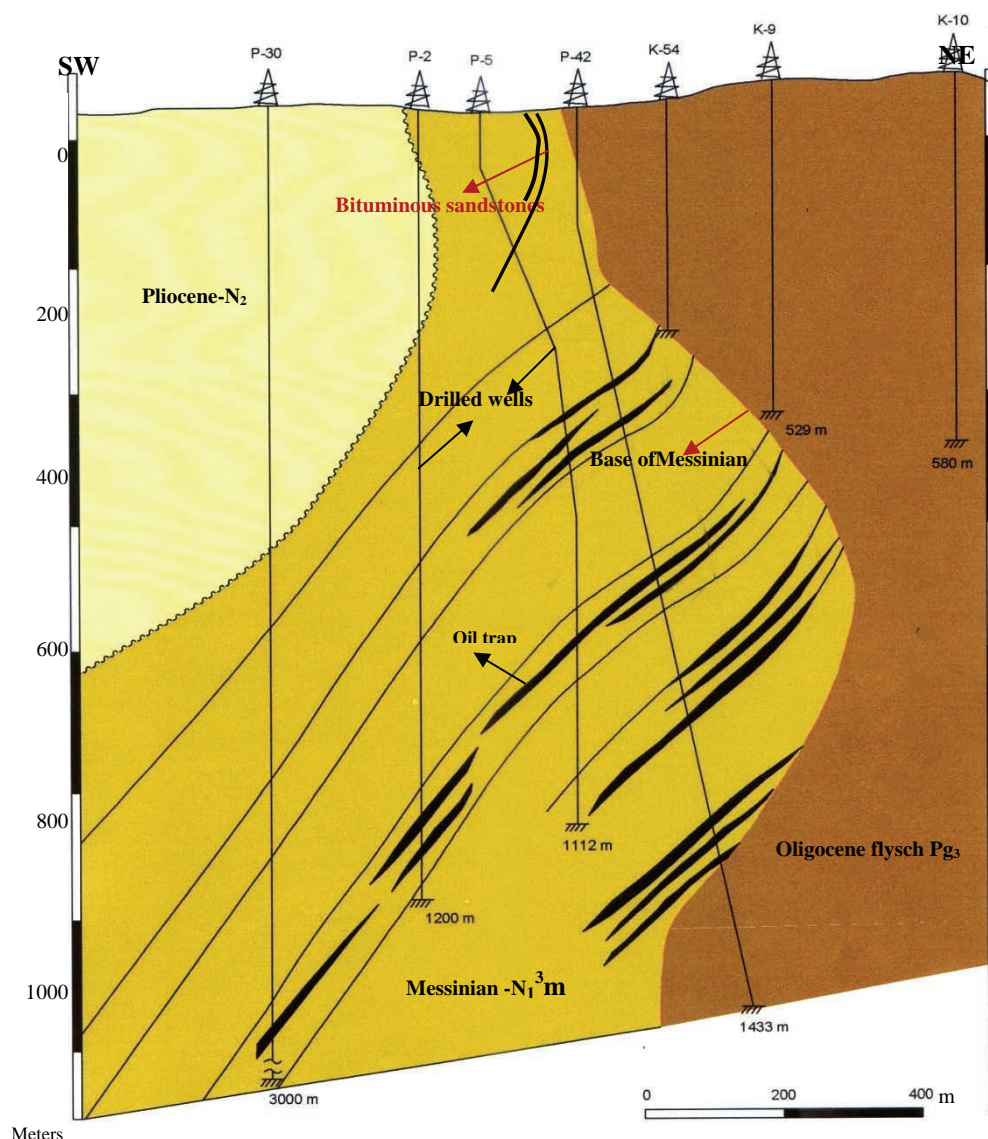


Figure 7. Geological profile of Rase-Pekisht oilfield (Gjoka et al, 2002, modified Prifti).

The presence of oil trap in the limestone reservoirs causes a decrease of the geochemical parameters, such as C_2/C_3 and C_1/C_2 in the seal rocks and has the same tendency. This phenomenon does not occur at the lower section of the evaporate formation.

The accumulation of liquid hydrocarbons. Along the tectonic contact that encompasses the diapir, up to now, there are not observed traces of oil. The diapir body may have remaining oil in the depth, where the ratio C_2/C_3 presents low values. These oils are supposed to be involved in the evaporate section during the outbreak of the diapir through the carbonate section of the Ionian zone.

In western side of the diapir, bituminous sandstones at the base of the Miocene transgression are met on the eroded Oligocene flysch. Southwards it lies Kuçova oilfield.

Rasë-Pekisht oilfield lies in the north-west of Dumre diapir. Its reservoir rocks are the Messinian sandstones (Fig. 7). The proximity of the oil trap to the transgression base of Messinian is linked with the westward pressure of Dumre diapir. The vertical position of the oil trap is in direct relation to the force of this pressure.

Crude oils of Rasë-Pekisht oilfield are lighter compared with those of Kuçova. Scientific debate about the origin of crude oils of the Rasë-Pekisht oilfields is in these directions:

a. The oil has migrated from the eroded carbonate anticline of Kuçova through a nearly horizontal secondary migration of sandstone reservoirs. Along the distances there happened a natural chromatographic effect, so in Rasë-Pekisht oilfield, lighter oils occur (PRIFTI, et al, 2014).

This questionable opinion may be discussed. Conducted studies have justified this conclusion with the same depth of the oilfields (GJOKA et al., 2002). For this opinion there are some discrepancies:

- Rasë-Pekisht oilfield presents a tectonic block (overhead block), while the lower block, where oil traps can be found, is hidden by the diapir. Thus, current depth of oil traps is the result of Dumre diapir.
- Sandstone reservoirs of both oilfields are different, finer grained and more carbonate cement in case of Rasë-Pekisht oilfield.
- Sedimentation environment was the same, but we think they represent two different deltas.

b. Crude oils of Rasë-Pekisht oilfield are more naphthenic than those of Kuçova. This indicates either natural chromatography or there existed different supply sources. The oil of Rasë-Pekisht oilfield is characterized by higher content of the distillation fractions (PRIFTI et al. 2015).

- The presences of different types of crude oils is also supported by hydrocarbon composition of bituminous sandstones (sandstone of Kuçova: Saturate hydrocarbon=16.9%; Aromatics=58.4%; NSO=18.8%; Asphalt=7.9%, sandstone of Pekisht: Saturate hydrocarbon=25.33%; Aromatics=39.47%; NSO=15.57%; Asphalt=8.02%).
- Based on these discussions, the crude oil of Rasë-Pekisht oilfield migrated from other eroded anticline hidden by the diapir. This may be Dumre anticline. Erosion could have occurred during the Tortonian. So, the oil migrated from the carbonate section to the Tortonian and Messinian section.
- The carbon isotope ratio of methane of Rasë-Pekisht oilfield is low ($\delta^{13}\text{C-CH}_4 = -53.887\text{‰}$, lower value). These values were interpreted as related with the earlier generation of oils and Rasë-Pekisht oilfield was not affected by new phases of migration during the Pliocene-post-Pliocene stages (GJOKA et al., 2002). This could be a strong reason that the Tortonian and Messinian sandstones of the lower tectonic block may present large oil reserves.

CONCLUSIONS

Kuçova and Rasë-Pekisht oilfields were discovered in the diapir southern and western parts. The natural reservoirs are the sandstones of the Messinian section.

In Dumre region, many wells have been drilled so far, but only nine of them were drilled in evaporate deposits. One of them, Dumre-7 well, crossed the diapir body at 6,101m depth.

Three levels of coaly shale at depths of 4,745m÷4,795m, 4,905m÷4,910m and 5,230m÷5,235m, in evaporate section were met. A coaly shale was studied by petrologic and pyrolysis methods. Based on their data, organic matter is of the third and second types. Its maturity level is low ($R_o = 0.4\%$).

During the drilling of Dumre-7 well, hydrocarbon gases appeared and were studied by the gas chromatography methods. Through this method three types of hydrocarbon gases were studied: free hydrocarbon gases, thermal vacuumed hydrocarbon gases from mud and mud logging gases. By geochemical indicators, hydrocarbon gases are of dry and wet types. Based on the carbon isotope ratio of methane ($\delta^{13}\text{C-CH}_4$), hydrocarbon gases are mature, generated by the source rocks that passed the oil window. So, they are not generated by the section of the diapir evaporates.

As it regards the isomerisation ratio ($i\text{-C}_4/n\text{-C}_4$), only two gas samples are generated from the organic matter of the evaporate formation. Hydrocarbon gas shows of the evaporate formation do not represent gas trap, but "imprisoned" gases during the penetration of the diapir body through the carbonate formation. Lower values of C_2/C_3 ratio of the diapir body (4,524 m, 4,630 m, 4,689 m, 5,687 m ÷ 5,980 m) may be the result of oil remaining in the depth during the diapirism process. Rasë-Pekisht oilfield is assumed to be formed by the petroleum migration from the eroded Kuçova anticline or the eroded Dumre anticline (the conclusion of the authors).

Rasë-Pekisht oilfield is not affected by the new migration phase of the Pliocene-post-Pliocene time. This indicates that the lower tectonic block must have petroleum reserves.

Given the importance of the petroleum exploration in Dumre region, a geological and geochemical study in western front of the diapir is recommended.

ACKNOWLEDGES

We thank to the National Agency of Natural Resources, Faculty of Geology and Mining, Albanian Geological Service that enabled us to refer to their archived studies.

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Received: March 01, 2017

Accepted: July 20, 2017

THE IMPORTANCE OF FISH IN THE SPREAD OF THE ROMANIAN UNIONIDS

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Abstract. The spread throughout the whole Dacian basin of the „carved” Romanian unionids has been attributed to the attachment of glochidia (larvae of unionids) to the gills or fins of the fish from the hydrographical network. From the analysis of the parasitosis process with glochidia at current freshwater fish, it results that this is the propagation mechanism of unionids, but it mostly occurs in stagnant waters and to a lesser extend in rivers.

Keywords: Romanian, „carved” unionids, *Glochidium*, the importance of fish in the spread of unionids.

Rezumat. Importanța peștilor în răspândirea unionidelor romaniene. Răspândirea în tot Bazinul Dacic a unionidelor „sculptate” romaniene a fost pusă pe seama atașării glochidiilor (larve de unionide) de branhiile sau aripioarele peștilor din rețeaua hidrografică. Din analiza procesului de parazitoză cu glochidii la peștii dulcicoli actuali, rezultă că acesta este mecanismul de înmulțire a unionidelor, dar că el se realizează cel mai mult în ape stătătoare și mult mai puțin în fluvii și râuri.

Cuvinte cheie: Romanian, unionide „sculptate”, *Glochidium*, importanța peștilor în răspândirea unionidelor.

INTRODUCTION

The last stage of the Pliocene (Romanian), which lasted almost 2 My, from 4.5 to 2.5 My ago, is characterized by the presence of fossil-bearing levels with so-called ‘carved’ unionids and viviparids with decorated shells, characteristic to this stage within the whole Dacian Basin. Spreading bivalves in the Dacian Basin was explained by the attachment of glochidia (larvae of Lamellibranchiata) to the gills of fish, which carried them through the major hydrographical network, represented by rivers, on long distances (from Oltenia in the west to Slobozia in the east).

By explaining the mechanisms the parasitosis caused by the freshwater fish spread, we try to clarify the importance but also the limits of this phenomenon in the Dacian Basin within the whole spreading area of the Romanian.

MATERIAL AND METHOD

Starting from the life environment of current unionids from the hydrographic network of Romania and from the analysis of their reproductive way, we extrapolated these findings to the Romanian unionids. We also analysed the possible spreading areas of the fluvial and lagoon deposits during the Romanian, based on the facial analysis of these deposits and their extent.

RESULTS AND DISCUSSIONS

There is evidence in references (ROMAN, 1955; GROSSU, 1961; BOGATU & MUNTEANU, 2008) that *Glochidium*, larvae of bivalves as *Unio* and *Anadonta*, constitutes the etiological agent of glochidiosis (parasitosis observed at freshwater fish caused by *Glochidium*). Glochidia are under 1 mm in size and present 2 valves prolonged with a sharp peak bent on the ventral edge, with the aspect of a hook (Fig. 1), with which they attach to the fins or gills of fish.

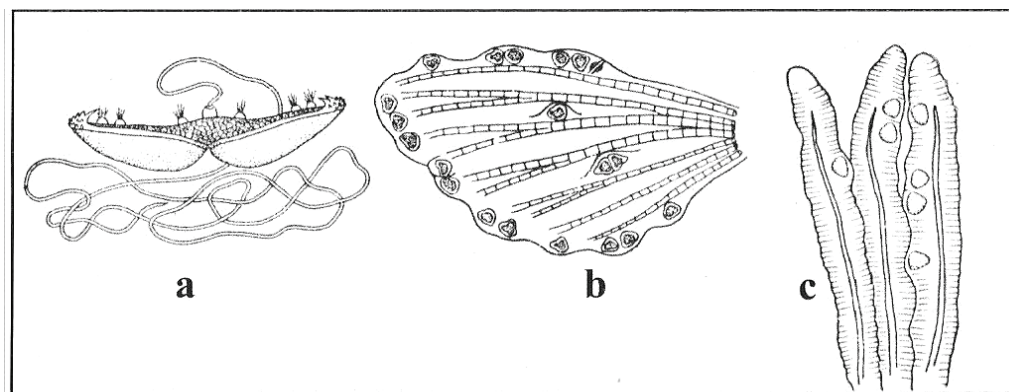


Figure 1. Glochidia of unionids
a – general aspect; b – fixed on the fins of fish; c – fixed on gills (after BOGATU & MUNTEANU, 2008).

The analysis of the habitats of current freshwater fish leads to the conclusion that most of them live not only in rivers, but also in lakes, ponds, pools and even swamps. Some of them prefer lakes and ponds, as it is the case of bream, perch, sun perch (called the king of ponds), pike, catfish and zander.

The actual unionids from the fauna of Romania (*Unio tumidus*, *U. crasus*, *U. pictorum*) live, apart from flowing watercourses, in lakes, ponds, pools or swamps (GROSSU, 1961).

In the paper “Research of the parasite-fauna of the fish from the Danube”, ROMAN (1955) argues that the parasitic larvae of unionids or anodontines (*Glochidium* sp.) were found at the following fish species: rudd, bream, sichel, perch, sun perch, located at level of the gills. These larvae parasitize only in spring and in the first half of summer. Formed in autumn, *Glochidium* sp. larva spends winter in the gills of the mothers’ shell and, in spring, it gets out and falls to the bottom of the water; here, it can attach to fish with the help of the hooks of the valves. It detaches from the fish gills 2-3 months later and falls on the riverbed (GROSSU, 1961). There, in 4-5 years, they get sexually mature. If in two weeks they do not get attached to a fish body, glochidia die. Although the unionids produce about 200,000 eggs, most of the encysted glochidia in fish tissues degenerate (BOGATU & MUNTEANU, 2008).

The spread of the unionids through the glochidia caught on the gills of fish occurs at random, as well as the spreading distance. It cannot be too long, fish usually staying within their habitat (lower course of the river, lake, pond).

Continuing the analysis of the possible habitat of the Romanian ‘carved’ unionids from the Dacian Basin, it can be said that they could have lived not only in rivers, but also in lakes and ponds. Moreover, their spreading through glochidia, which parasite fish for some time, was also at random and occurred only under certain conditions.

From the research done by ROMAN (1955), it results that out of 100 species of parasitized fish from the Danube, which were analyzed, only 0.92% were affected by *Glochidium*. Thus, it results that the parasitosis generated by *Glochidium* at the fish from the Danube is extremely reduced.

From the analysis of the outcrops and the drilling cores with Romanian deposits, it results that the lumachelles with ‘carved’ unionids, 1-5 m thick or even more, are found in the whole area in which these deposits exist. This spread cannot be explained only by the presence of fluvial bars.

Moreover, there are places where the shells are chaotically spread, in a stack of sandy deposits more than 20 m thick, as it is the case at Bălta (Fig. 2) and Smadovița in Oltenia, with quasi horizontal deposits specific to lakes and not to fluvial bars in which the deposits are oblique. The predominance of a certain species, the chaotically spreading and the predominant vertical position of the shells in thick stack of sand arranged in horizontal layers cannot be assigned to a fluvial deposition, but to a quiet deposition on the bottom of the lake.



Figure 2. Bălta outcrop with lamellibranchiate chaotically spread in horizontal sand deposits (photo C. Enache).

ENCIU (2007), a supporter of the theory of the lack of lacustrine deposits during the Romanian, mentions nevertheless the Romanian deltaic deposits in the area between Busu and Cernătești (Dolj), while Dan Jipa, even if he states that the Romanian deposits were placed in fluvial environment, remarks the possibility of the existence of a collector of the waters transported by the fluvial network (LUBENESCU, 2008).

The above mentioned findings lead us to the conclusion that the discordant and transgressive layout in the western, southern and eastern extremities of the Dacian Basin of the ‘carved’ unionids deposits was possible through the ingression of a lacustrine domain (ENACHE, 2004). The existence of some deltas at the western extremity of the mouth of a river indicates the presence of a lake, in which they flowed; this entitles us to say that during the Romanian, there occurred a fast flooding at least in the southern part of the Dacian domain and a progressive formation of a lacustrine domain, through the invasion of the Dacian relief.

We consider also that during the Romanian (Pelendavian sub-stage), while within the northern part of the Dacian Basin, westwards of the Jiu, palustral cycles with the formation of lignite layers took place (ENACHE, 1976), south of Strehaia-Craiova line, there was a lake (Fig. 3) that gradually advanced westwards, southwards and eastwards.

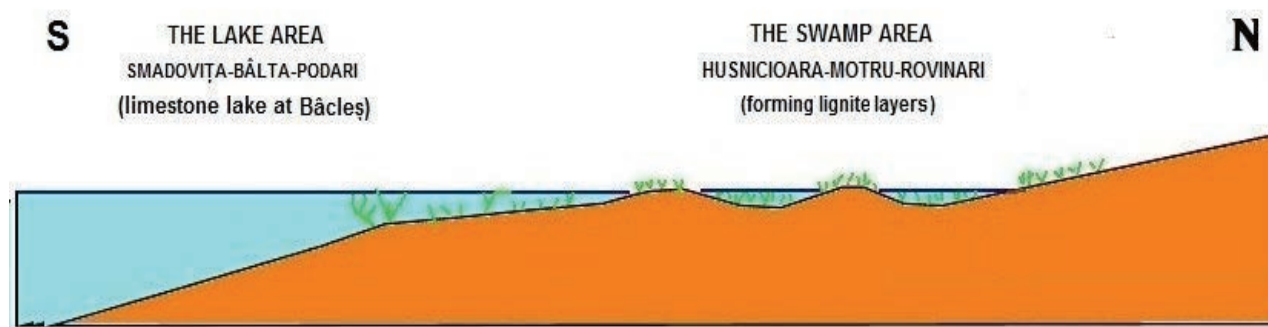


Figure 3. S – N section through the region west of the Jiu River during the Pelendavian stage.

CONCLUSIONS

The research regarding the importance of fish in the spreading of the Romanian unionids leads us to the conclusion that the shallow lacustrine environment, formed through the invasion of some plains, presents the most favorable environment for the massive spreading of these bivalves, because fish are forced to swim closer to the bottom, being more vulnerable to the *Glochidium* infection, which can easily attach to their gills or fins.

A confirmation of the link between the lacustrine fish and bivalves during the Pleistocene from Oltenia comes from the discovery of some fish remains in the Romanian lacustrine deposits with 'carved' unionids from Podari: *Esox* sp., *Tinca* sp., *Scardinius* sp., *Silurus* sp., which proves the existence of the Pliocene lake in southern Oltenia (TRIF et al., 2016).

Their current descendants also prefer stagnant waters.

The pike (*Esox lucius*) is a freshwater or blackish water predatory fish, spread in the stagnant or slowly flowing waters, with plenty of vegetation.

The tech (*Tinca tinca*) is a freshwater fish species that usually lives at the bottom of slowly flowing waters.

The rudd (*Scardinius erythrophthalmus*) is a fish that lives in groups, in stagnant freshwaters as lakes, ponds, pools or slowly flowing waters.

The catfish (*Silurus glanis*) is a large predatory fish, which frequently lives in ponds, lakes, lower course of large rivers, preferring deep places with mud and turbid waters.

In conclusion, it can be said that without the existence of fish, unionids cannot spread on large areas because their larvae need an intermediary host to carry them. The most favorable environment for the perpetuation of unionids is represented by shallow lakes and ponds, where fish are forced to swim near the bottom, being vulnerable to the parasitosis with *Glochidium*. This explains the excessive spread of unionids at Balta, where their valves do not form piles on river banks.

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Received: March 12, 2017

Accepted: July 6, 2017

SEPARATION OF GRAVIMETRIC ANOMALIES WITH DIFFERENT DEGREES OF REGIONALITY

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Abstract. The anomaly separation operation consists in determining the number of sources, the characteristics of each (depth, density, shape, and dimensions) so as to result in cumulative total anomaly, measured at the Earth's surface. This separation has to be done in the context of the fundamental ambiguity of gravimetric information, based on the cause-effect ratio. There are various methods for achieving this separation of gravimetric anomalies. This paper presents some examples of the use of the moving average method and the polynomial trend surfaces. In particular, we presented the results of the mobile mediation with different windows compared to the trend surfaces with different degrees, for a case study in Vrancea seismogenic area. For this study we used data from the International Gravimetric Bureau for geoglobal model WGM2012: Bouguer anomaly for density 2.67 g/cm^3 , Free Air anomaly, isostatic anomaly, gravity disturbance and altitude. The moving average is a direct method for separating regional effects and local (residual) effects. Polynomial trend surfaces analysis contributes to the recognition, isolation and measurement of trends that can be calculated and represented by analytical equations, thus achieving a separation in regional and local variations. The analytical expressions of the polynomial trends based on the least squares method were calculated, highlighting the regional trend caused by the deep structures. Then, by calculating the residual values resulting from the difference between the initial values and the trend values from the network nodes used, we highlighted the superficial local effects. We also obtained information about the regional trend caused by geological structures at medium and large depths, by calculating the difference between gravity parameters, obtained with different moving average windows or tendency surfaces with different degrees, interpolated in same network.

Keywords: trend surfaces, Moving average, Bouguer anomaly, Free Air anomaly, gravity disturbance.

Rezumat. Separarea anomaliilor gravimetrice cu grade diferite de regionalitate. Operația de separare a anomaliilor constă în determinarea numărului de surse, a caracteristicilor fiecăreia (adâncimea, densitatea, forma și dimensiunile) astfel încât să rezulte o anomalie totală cumulată, măsurată la suprafața Pământului. Această separare trebuie făcută în contextul ambiguității fundamentale a informațiilor gravimetrice, bazată pe raportul cauză-efect. Există diferite metode pentru realizarea acestei separări a anomaliilor gravimetrice. Această lucrare prezintă câteva exemple de utilizare a metodei mediei mobile și a suprafețelor de tendință polinomiale. În particular, am prezentat rezultatele medierii mobile cu ferestre diferite comparativ cu suprafețele de tendință de diferite grade, pentru un studiu de caz în zona seismogenă Vrancea. Pentru acest studiu am folosit date de la Biroul Internațional de Gravimetrie pentru modelul geoglobal WGM2012: anomalia Bouguer pentru densitatea $2,67 \text{ g/cm}^3$, anomalia Free Air, anomalia izostatică, perturbația gravitațională și altitudinea. Mediarea mobilă este o metodă directă de separare a efectelor regionale și a efectelor locale (reziduale). Analiza suprafețelor polinomiale de tendință contribuie la recunoașterea, izolarea și măsurarea tendințelor care pot fi calculate și reprezentate prin ecuații analitice, realizând astfel o separare a variațiilor regionale și locale. Au fost calculate expresiile analitice ale tendințelor polinomiale pe baza metodei celor mai mici pătrate, evidențiind tendința regională cauzată de structurile profunde. Apoi, prin calcularea valorilor reziduale rezultate din diferența dintre valorile inițiale și valorile de tendință din nodurile de rețea utilizate, am subliniat efectele locale superficiale. De asemenea, am obținut informații despre tendința regională cauzată de structurile geologice la adâncimi medii și mari, prin calcularea diferenței dintre parametrii gravitaționali, obținuți cu diferite ferestre medii mobile sau suprafețe de tendință cu grade diferite, interpolate în aceeași rețea.

Cuvinte cheie: suprafețe de tendință, mediere mobilă, anomalia Bouguer, anomalia Free Air, perturbația gravitației.

INTRODUCTION

The observed gravity is given both by the topographic surface and the density variations of the geological formations in the basement. Thus, in the regions with a positive altitude (e.g. mountainous areas) the average density of Earth Crust is lower than in the ocean basins, where the basaltic layer is predominant and implicit, the average density is higher. The Free Air anomaly is positive on high altitude and negative in depressions. The Bouguer Anomaly is opposite (in the mirror) to the topographic surface. The thickness of the Earth's Crust, determined by seismic methods, varies considerably, being thin under the oceans and thick under the continents. Density suddenly increases at the Crust / Mantle interface (density is $2.800 - 2.900 \text{ g/cm}^3$ in the lower Crust, density $3.200 - 3.300 \text{ g/cm}^3$ in the upper Mantle). This means that under the high altitude regions of the continent, Crust is thicker and compensates the isostatic balance through the size of its thickness, while Crust under the oceans is much thinner and heavy materials in Mantle are closer to the surface.

The Crust usually behaves as a rigid layer capable of withstanding stress, but at a certain depth, with increasing of temperature and pressure, it has a plastic deformation under the influence of the stress caused by the adjacent environment.

Thus, the notion of modern tectonic plates requires the existence of a deformation region in Mantle under the effect of tensions applied at the geological time, favoring the movement of the tectonic plates in relation to the Deep Mantle.

Isostasy concept arose a century ago as a result of gravitational observations, seismic measurements and rheology responses that competed with the theory of compensation for the gravitational effect of topographic masses.

Thus, the importance of separating gravitational anomalies with different degrees of regionality for deciphering deep geological structures appears. This can be done by many methods, among which we mention the moving average method with different windows, the tendency surface method, upward continuation (Laplace equation) and downward continuation (Poisson equation), spectral analysis method, multispectral methods, wavelet, etc.

An important role in deciphering the profound geological structure is the filtration of gravimetric data of the "low pass filter" type. In this paper we conducted filtering of this type based on programs we have developed according to the least squares methodology. In this regard, we mention the results obtained by Unwin D (1978), where the algorithm for the calculation of the trend surfaces up to the second degree is presented, as well as examples. About the least squares method, which underlies the calculation of the coefficients of the analytical expressions of the trend surfaces, there are many works, among which we can mention: FARHANG-BOROUJENY (2013), DUMITRIU et al. (1972), HARBAUGH (1972), POULARIKAS & RAMADAN (2006), where various techniques of this method and examples are presented. Trends of hypersurfaces were mentioned by authors such as KARAKUS et al. (2011), DUMITRIU et al. (1972), etc.

Parameters processed in this way are: Bouguer anomaly, Free Air anomaly, isostatic anomaly, gravity disturbance, and elevation of the terrain. All these parameters are described in HEISKANEN & MORITZ (1967), VAJDA et al. (2004), BARTHELMES & KÖHLER (2016), PAVLIS et al. (2008) and many others.

The "low pass" filters we have made in this paper are mobile medials with windows of various sizes and polynomial surfaces of various degrees. In the case of mobile environments, the used window is larger (it contains several values), the more information obtained is relevant for larger depths. In case of polynomial trends, the higher the polynomial degree of the surface, the more information is relevant for smaller depths.

Residual anomalies calculated for both mobile average and trend surfaces reflect the shallow structure and local effects. These residual abnormalities are filtered data with "high pass" filters.

We also calculated the filtered data with "band pass" filters, represented by the difference between mobile averages with different windows. These data reflect the mean depth, without the depth being quantified. However, their interpretation in relation to depth, allows us to correctly input the parameters into the modeling program.

DATA USED

The information and data used in gravimetric anomalies maps (Bouguer, Free-Air, isostatic) are related to the EGM 2008 geopotential model (Pavlis et al., 2008) / DTU 10 gravity field (ANDERSEN, 2010). The Free Air anomaly was calculated in the context of the Molodensky theory (HEISKANEN & MORITZ, 1967) and includes corrections for atmospheric mass. The reference density used for the Bouguer and isostatic maps was $2,670 \text{ kg} / \text{m}^3$ and the spatial resolution of $1' \times 1'$.

The World Gravity Map (WGM) denotes the use of a large-scale gravity resolution set in digital grids on a global scale from the available Earth gravity and digital terrain models. WGM 2012 is the first global map of gravity anomaly maps (free air anomaly, complete Bouguer anomaly, isostatic anomaly) derived from the EGM 2008 geopotential model and the ETOPO 1 model - the overall relief model; WGM2012 also takes into account the contribution of atmospheric masses, earth, oceans, inland seas, lakes and glaciers, providing maps of the scale of gravity on a regional or global scale, also available in digital format.

The used gravimetric data were derived from Earth Geopotential Model EGM 2008 through spherical harmonics development to 2190 degree by the National Geospatial Intelligence Agency (NGA) (PAVLIS et al., 2008). The EGM 2008 model includes surface gravimetric (land, sea and air) measurements, satellite altimeters and satellite gravity (Grace mission).

METHODS

The mobile averages method is a direct technique for leveling anomalies, which highlights wide anomalies and removes small anomalies. The residual map retains and localizes local anomalies, their value depending directly on the size of the used window.

Another method, similar to the mobile averages applications, which is also a data filtering system, is the analysis of the polynomial trends. These surfaces contribute to the recognition, isolation and measurement of trends, by separating large-scale variations and local variation trends. This separation is done by adjusting the trend function to different degrees. Tendency analysis is part of the field of regression analysis satisfying the smallest squares criterion. The difference between the calculated value of the trend surface at a certain point and the value observed in that point is the residual value. The sum of the squares of these residual values must be minimal according to the smallest squares criterion. If the trend area is considered to be a regional or large scale component, then the residual value should be considered as the local or small scale component. Removing the regional trend has the effect of highlighting local components represented by residual values. Also, the principles of trend analysis are applicable for hypersurfaces in any number of dimensions. A surface occupying a three-dimensional space is a mathematical function with a dependent variable and two independent variables. We can operate mathematically and with functions of four or more variables (in hyperspace) that have great importance in some applications.

An efficient analyzing method of data using trend surfaces is based on the progressive application of this method, starting with the smallest degree of surface, then going to higher degrees. Thus, in the first place, the residual to the trend plan can be calculated. Then, for these residual values, upper-order trend surfaces (for example: for grade 3 or 6) can be calculated. In this way, successive residues can be calculated from which components that reflect certain degrees of regionality and depth of anomalous sources will be removed.

RESULTS AND DISCUSSIONS

Map of the Bouguer anomaly in Romania, was based on data from BGI (Fig. 1), on a latitude grid of 43° to 49° and longitude from 20° to 30° , obtaining a number of 54480 data in geographic coordinates. We transformed these in coordinates STEREO 70 to have the dimensions in km.

We used a grid of 210 lines x 250 columns = 52500 nodes (values) for each map. The mesh density has 3.25 km x 3.20 km, i.e. approx. 10 km².

The studied area (Vrancea seismological extended zone) is marked by a rectangle and has an extension of 155.33 Km in the East-West direction and 164.64 Km in the North-South direction, representing an area of 25,573.5 Km².

On the map, we overlaid the isobates at the base of the Crust, as well as the main tectonic elements in the detail area (Peceneaga-Camena Fault and Capidava-Ovidiu Fault). These isobaths at the Moho surface were obtained by RĂDULESCU (1988) from the seismic prospecting. There were represented on the map the isobath interval for 40 km to 52.5 km, with the increment of 2.5 km from the study zone.

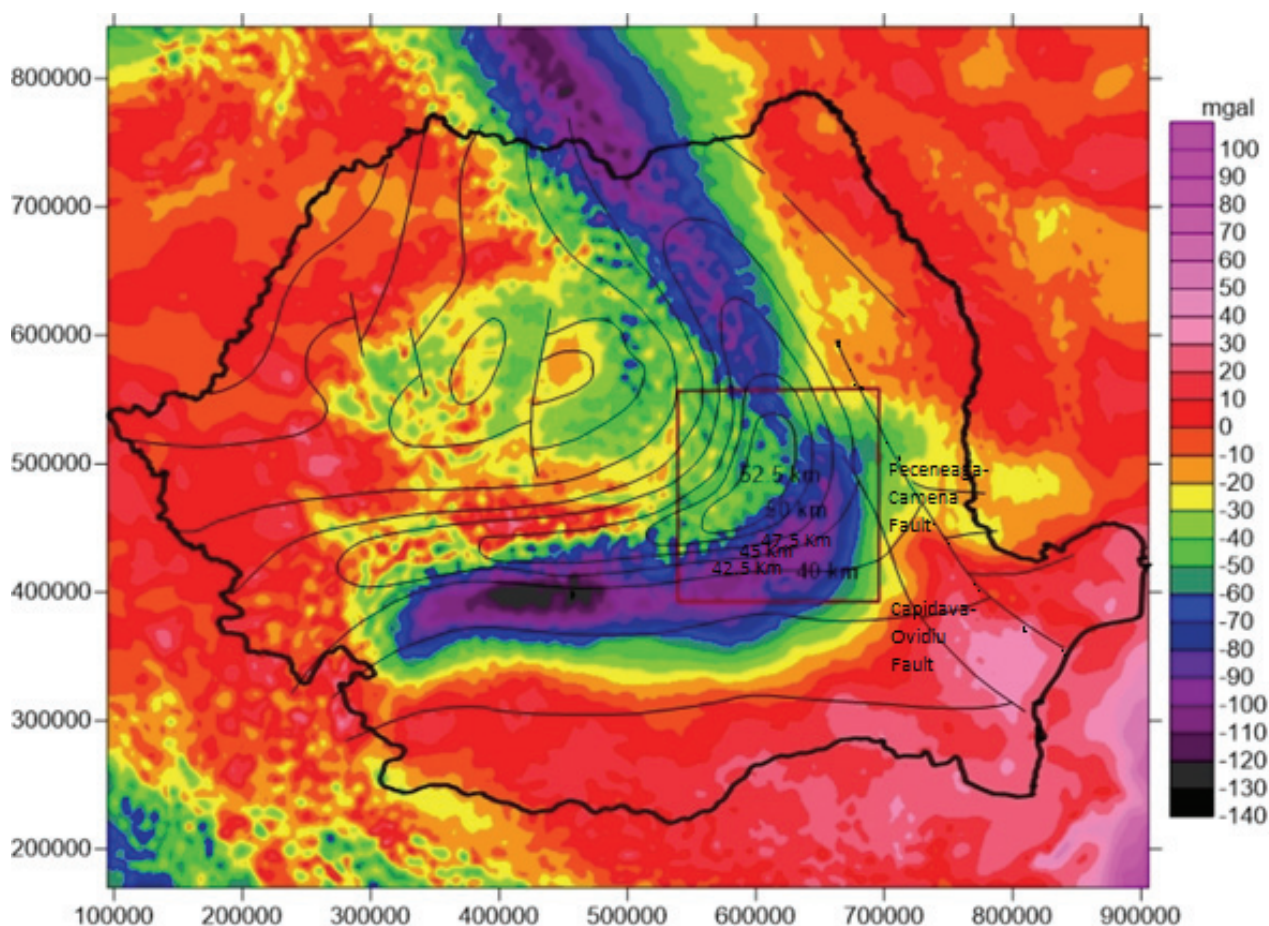


Figure 1. WGM2012 - Complete spherical Bouguer gravity anomaly, with Moho isolines of deep and main fault.

Peceneaga - Camena Fault and its prolongation to NV and SE is found both in the Crust and under Crust, being a major active fracture.

Along Peceneaga - Camena fracture, as well as its prolongation to the NW, two continental lithospheric portions with different particularities come into contact. Close to it, alongside contact, seismological data show that there have been earthquakes, both normal and deep.

Vrancea area is affected by a crustal and mantle fracture system, NE-SV orientation, delineating between Focsani and Covasna a submerged area that can be traced to Bucharest and Ploiesti.

In Vrancea region, there exist both compressive and extensional events, with focal planes having different directions. This can be attributed to the possibility of the coexistence of several physical, geodynamic and rheological processes, each acting at various scales of time and space gravitational diving, phase transitions and dehydration of rocks (ZADEH et al., 2005) thermal barriers (BEŞUTIU, 2006), etc.

The seismicity of Vrancea region, the crumbly deformations and the lack of volcanism usually associated with the subduction zones have been channeled in three directions in the conception of various scientists: subduction of the ocean crust "in place", rupture of the ocean Crust and its roll-back, respectively lithospheric delamination (Fig.2).

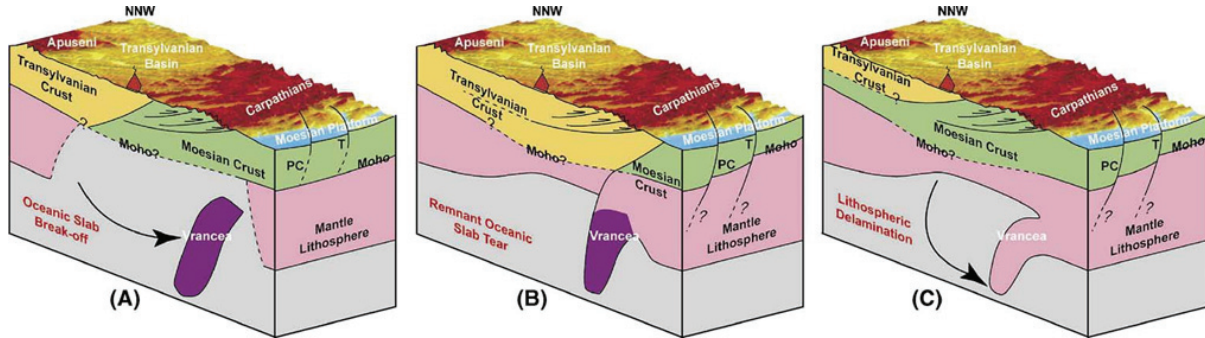


Figure 2. The main geodynamic scenarios are: (A) the subduction of an ocean plate and its break-off, B) the subduction of an ocean plate, and (C) progressive lateral tearing under the Carpathian vortex and delamination of the continental lithosphere (after KNAPP et al., 2005)

We used 3 windows of mobile average (with: 3x3 values, 5x5 values and 7x7 values) with which we traveled the entire network from point to point of the selected area with 50x50 values. The length of mesh on the X axis of the grid (in the West-East direction) are 3.17 km and the length of the Y axis of the grid (in the North-South direction) are 3.36 km, resulting a surface of network mesh about 10.65 km². This grid was chosen to have a similar resolution with the initial data used (from BGI) for Romania.

For tendency surfaces, we have developed programs for calculating analytical expressions for the following types of surfaces: plan (first degree): $Z_{\text{tend}} = A + Bx + Cy$,
 2nd degree: $Z_{\text{tend}} = A + BX + CY + DX^2 + EXY + FY^2$,
 3rd degree: $Z_{\text{tend}} = A + BX + CY + DX^2 + EXY + FY^2 + GX^3 + HX^2Y + IXY^2 + JY^3$, și
 6th degree: $Z_{\text{tend}} = A + BX + CX^2 + DX^3 + EY + FXY + GX^2Y + HX^3Y + IY^2 + JXY^2 + KX^2Y^2 + LX^3Y^2 + MY^3 + NXY^3 + OX^2Y^3 + PX^3Y^3$, where X and Y represent the independent variables (in the coordinates system STEREO 70 in the directions W-E, respectively N-S) and Z represents the variable dependent on X and Y.

The residual value is $Z_{\text{rez}} = Z_{\text{obs}} - Z_{\text{tend}}$ highlights the local aspects of anomalies.

In Fig. 3 (A, B, C), there are rendered the residual Bouguer anomalies. From the initial values we lowered the values of the mobile averages with different windows. These anomalies are the result of "high pass" filters, so it refers to causes from the surface to a certain depth that is proportional to the size of the used window.

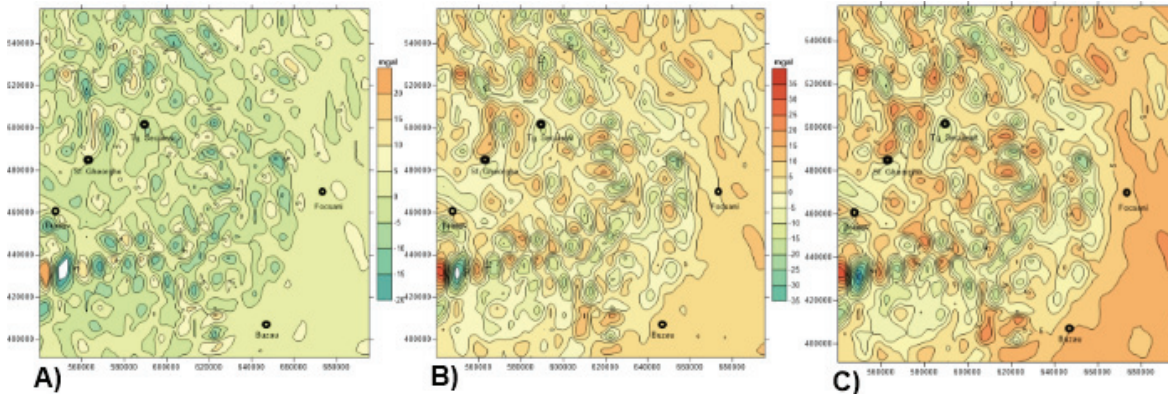


Figure 3. Residual Bouguer anomaly calculated with the mobile averages of 3 different square windows:

- A) Residual Bouguer anomaly calculated with the mobile averages of 9 values;
- B) Residual Bouguer anomaly calculated with the mobile averages of 25 values;
- C) Residual Bouguer anomaly calculated with the mobile averages of 49 values.

Figs. 4 and 5 (A, B, C, D, E, F) show the effects of mobile averages and tendency surfaces for Bouguer and Free Air anomalies. These images in each figure are presented in the order of the degree of averages (the size of the window used), which is reflected in the extension and depth to which the information refers.

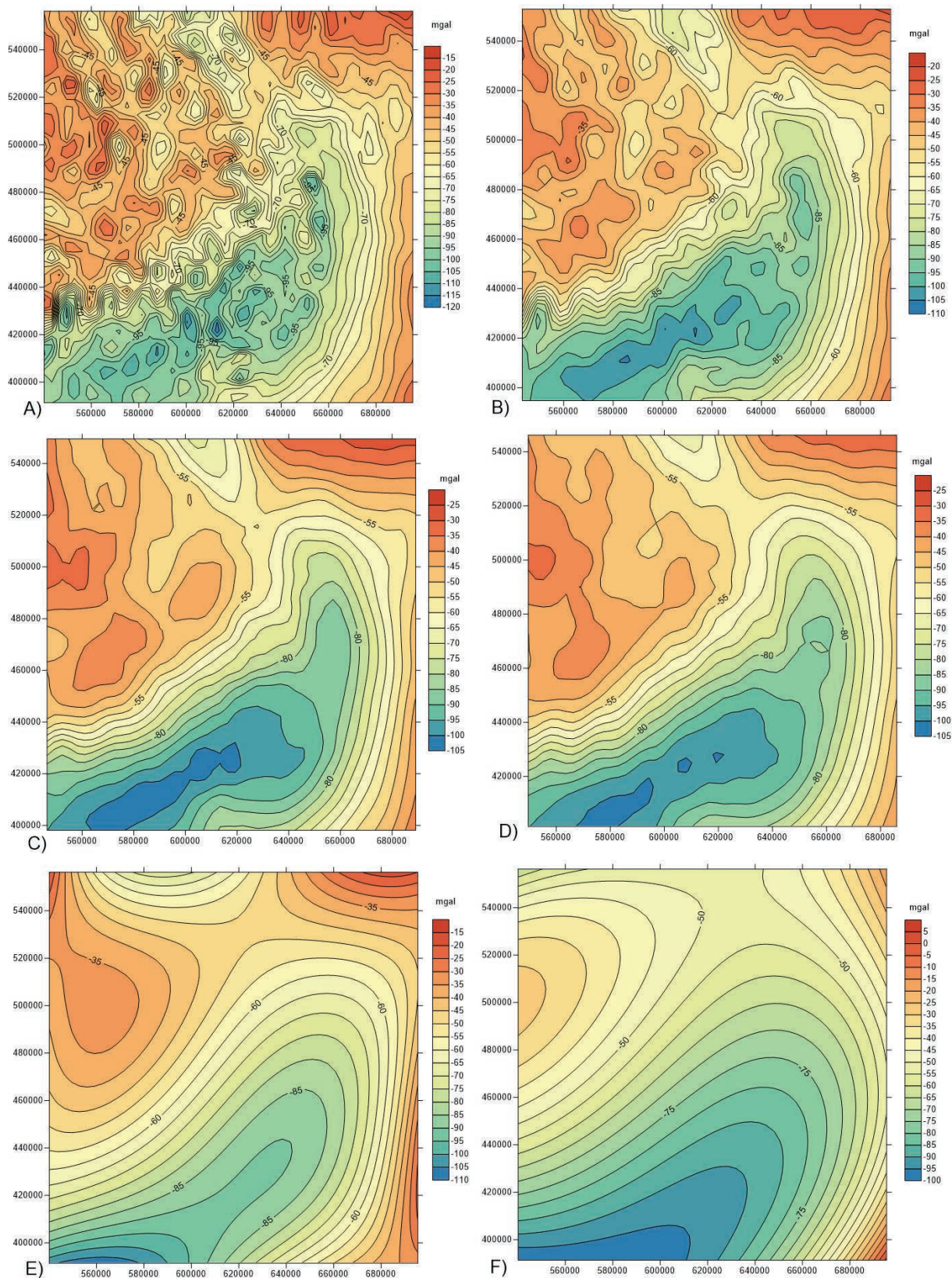


Figure 4. Bouguer Anomaly in the studied area (marked in fig.1; from BGI data):

- A) The representation of unfiltered data;
 B) Representation of the data averaged in moving windows of 9 values (3 lines * 3 columns);
 C) Representation of the data averaged in moving windows of 25 values (5 lines * 5 columns);
 D) Representation of the data averaged in moving windows of 49 values (7 lines * 7 columns);
 E) The tendency surface with 6th order; F) The tendency surface with 3rd order.

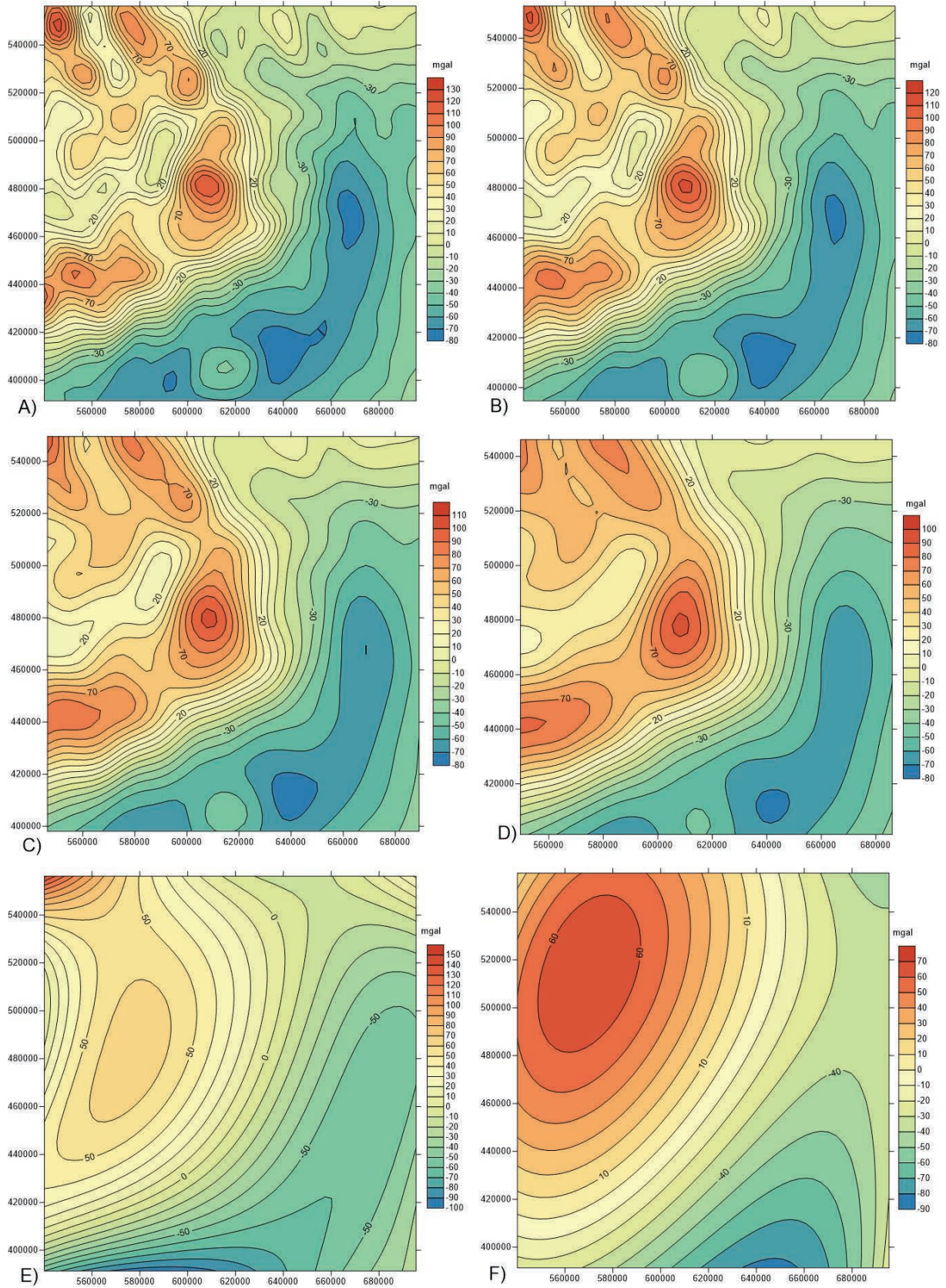


Figure 5. Free Air Anomaly in the studied area (marked in Fig.1 ; from BGI data):

- A) The representation of unfiltered data;
 B) Representation of the data averaged in moving windows of 9 values (3 lines * 3 columns);
 C) Representation of the data averaged in moving windows of 25 values (5 lines * 5 columns);
 D) Representation of the data averaged in moving windows of 49 values (7 lines * 7 columns);
 E) The tendency surface with 6th order; F) The tendency surface with 3rd order..

The data was interpolated with the Surfer program, the Kriging method. Figs. B, C and D show the mobile averages with 9 values, 25 values and 49 values respectively, reflecting an increase in the wavelength, the regionality of the anomalies and the depth of their causes. In Figs. 4 and 5 (E and F), there are tendency surface for Bouguer and Free Air anomaly (6th degree and 3rd degree). They reflect anomalies with a higher degree of regionality, greater wavelength and deeper causes. In fig.4E, it is the tendency surface with 6th order, the coefficients being: A=499438.5000000000; B=-373202.3671875000; C=81600.5175781250; D=-5520.4898071289; E=-19053.6718750000; F=91387.8554687500; G=-28282.2333984375; H=2245.9517211914; I=-63199.0019531250; J=13665.5058593750; K=619.8403320313; L=-186.4072189331; M=9255.7174072266; N=-3328.0280761719; O=342.1310119629; P=-7.7146945000. In fig. 4F, it is the tendency surface with 3rd order, the coefficients being: A=-11938.42251006; B=4797.3673020601; C=1487.1852331124; D=-652.9127963639; E=-438.9016750949; F=0.0000125275; G=45.8620878794; H=-31.7580106317; I=85.5197506216; J=-37.4263031660.

The tendency plan of Bouguer anomaly has the following equation: $Z = -188.707147163 \cdot X - 0.1554708098 \cdot Y + 27.0513680505$.

Also, for Free Air anomaly, in fig. 5E, it is the tendency surface with 6th order, the coefficients being: A=652400.357; B=-573419.16; C=130655.106; D=-8890.1671; E=-13391.961; F=176664.462; G=-53988.576; H=4163.66569; I=-84321.436; J=3692.53278; K=5022.64747; L=-550.96074; M=11806.3857; N=-3037.9968; O=81.2227445; P=16.2677661. In fig.5F is the tendency surface with 3rd order, the coefficients being: A=-17470.82; B=9726.1603; C=-1795.333; D=-1851.304; E=694.84799; F=7.129E-05; G=123.81737; H=-93.70176; I=46.332052; J=-23.12028.

The tendency plan of Free Air anomaly has the following equation: $Z = 187.9363 \cdot X - 66.7992 \cdot Y + 47.01299$.

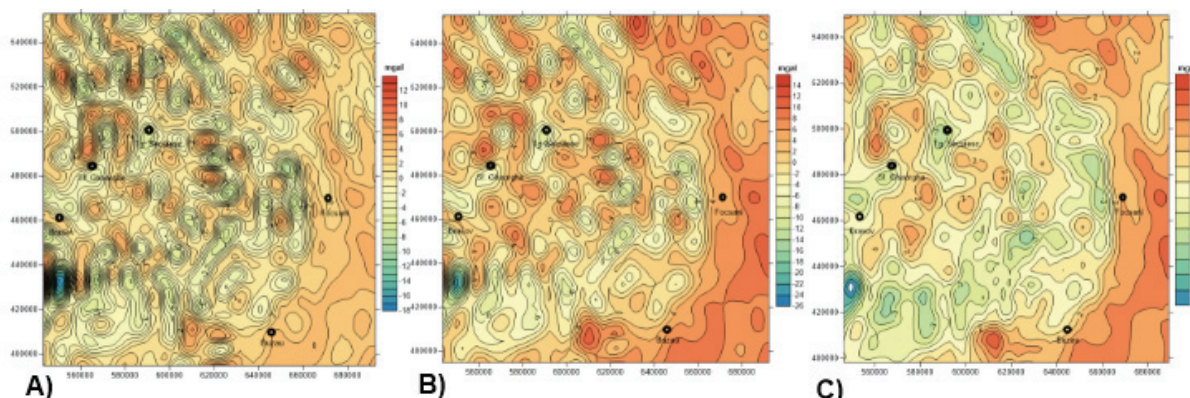


Figure 6. Differences between the moving averages of the Bouguer anomaly, calculated with two different windows;

- A) The difference between the moving averages of the Bouguer anomaly, calculated with the windows of 9 values and 25 values;
- B) The difference between the moving averages of the Bouguer anomaly, calculated with the windows of 9 values and 49 values;
- C) The difference between the moving averages of the Bouguer anomaly, calculated with the windows of 25 values and 49 values.

Fig. 6 shows Bouguer anomalies as a result of the application of "band pass" filters. We made the difference between two averages made with two different windows, in every point of the network. These anomalies refer to causes from a certain depth range that is proportional to the dimensions of the two used mobile windows.

CONCLUSIONS

In the present paper we presented as filtering methods only the mobile mediation with windows of different dimensions and polynomial tendencies of different degrees. These types of filters were compared with the results of other types of filtration that I did not present in this paper (Fourier 2D analysis, Wavelet analysis with different window types, analytical continuation up and down), given the volume, both theoretical and methodological, the programs used and the results of the processes, as well as their geological significance.

The results of all types of filtering can be matched with 2D models (for which we have developed the data profiles and sketched the structure in depth based on the results obtained by various methods and various authors).

Also, the variation of the correlation factor between two sets of parameters brings information for geological and tectonic assumptions. This correlation factor between two sets of data can be calculated, similarly as in mobile averages with windows of different sizes, passing through the entire network of points, bringing information from different depths. The correlation between two sets of parameters may be some indicators that they are dependent on common causes. Contrast of densities juxtaposed in areas with different petrophysical properties at suture zones, usually cause gravimetric anomalies. However, some of the anomalies of gravity that have deep causes may be masked by the presence of geological formations of a very different density compared to deep formations. Anomalies of gravity caused by small-scale formations can be easily recognized in residual maps after regional trends are eliminated.

In conclusion, referring only to the types of filters presented in the paper, we can say that they provide us with information with different degrees of regionality and from different depths, which of course cannot be quantified until all the geological and geophysical information has been corroborated. These filters can bring both information about local and surface effects (residual maps, through "high pass" filters), mid-depth structures (through "band pass" filters), and deep structure (tendency maps, through "low pass" filter).

ACKNOWLEDGEMENT

We address our thanks for scientific publications, reports and gravity data, to: Bureau Gravimétrique International (BGI), International Association of Geodesy (IAG) and International Centre for Global Earth Models (ICGEM).

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Received: March 12, 2017

Accepted: July 26, 2017

VARIABILITY OF SOME BIOCHEMICAL CHARACTERISTICS IN THE PERSPECTIVE TOMATO VARIETIES

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Abstract. There are presented the results of the test of some perspective varieties created at the Institute of Genetics, Physiology and Plant Protection based on some biochemical characteristics of the fruit. The varieties with a high content of vitamin C and a high ratio sugar / acidity, which is an indicator of the quality of the fruit, were selected. The varieties Jubiliar, Elvira, Prestij are characterized by the highest indexes of studied biochemical characters and can be successfully used as the initial material in breeding to improve the quality of tomato fruits.

Keywords: tomato, varieties, biochemical characters.

Rezumat. Variabilitatea caracterelor biochimice la soiurile de tomate de perspectivă. Sunt prezentate date despre rezultatele testării soiurilor de perspectivă create în Institutul de Genetică, Fiziologie și Protecție a Plantelor în baza caracterelor biochimice ale fructului. Au fost selectate soiuri cu un conținut înalt de vitamina C și un raport înalt a zahărului / aciditate, care este un indicator al calității fructelor. Soiurile Jubiliar, Elvira, Prestij se caracterizează prin indici mai înalți ai caracterelor biochimice luate în studiu și pot fi cu succes utilizate ca material inițial în ameliorarea calității fructelor de tomate.

Cuvinte cheie: tomate, soiuri, caractere biochimice.

INTRODUCTION

The high quality of tomato fruits is one of the main aims of this culture improving, i.e. the improving of the characters of production as well as other characteristics of the variety is important. In this context, taking into account the widespread use of tomato products, enhance of research in this direction in national programs is fully justified (MIHNEA et al., 2007). Varieties with high solid content, sugar, vitamins, pigments, and other characters are required for the canning industry. These characters are not often found in approved varieties (BOTNARI, 2015). Fruits quality characteristic has two main aspects: biochemical and morphological. From the biochemical point of view, they must be rich in vitamins. The highest level in tomato has vitamin C. Vitamins, solid content, acidity, sugar / acid ratio determine the taste and aroma of fruits. Morphological aspects as quality factors are shape, color and fruit size. The shape and color depend on the consumer's preferences. High diversity of shapes and colors constitutes the base of attraction for consumers. The request regarding fruit size is determined by final destination: large fruits are preferred for the consumption as fresh, paste and juice, and the smaller ones are required by the food service sector and preserving of fruits at home.

Taking into account that most characters which obtain the productivity have a polygenic determinism, it is not possible to make analysis and description of each polygenic effect separately. This is an entire complex of genes that control the respective character. Thus, it is important for the practical improvement that the phenotypic expression of a quantitative character does not depend on the effect of individual gene. It depends on the cumulative effect of genes and their interactions with the environment.

The breeding is a sure way to improve the biochemical composition of tomato fruits: the solid content, the gluco-acidic ratio, sugar, vitamin C, etc. Creating new varieties, hybrids, lines with a high level of dry matters is one of the main requirements in modern agriculture and intensive technologies implementing. Therefore, the test of selective material based on this character is very important in breeding (ANDRIUSCHENKO, 1987; GRATI, 2007.).

Biochemical and aesthetic quality of tomato fruits is often a priority for middle-income consumer's decision, even more important than price (GÓMEZ et al. 2001, SEYMOUR et al. 2002). Taste, appearance, color of tomatoes *L. esculentum* Mill. are decisive for fresh fruits, while consistency, sugar, acidity, solid content are important for processing tomato industry. The amount of solid content in the fruit on rare occasions exceeds 6%, this is known from many literature data (MORENO et al. 2014). Yield and quality of tomato fruits are not only depending on optimization of the conditions for plants growth but on the use of varieties with high genetic performance. This factor is a link that is decisive for the innovational progress in agriculture and ensures obtaining of big productions with highest quality and required organoleptic properties (ALPATIEV, 1981; CARLI et al. 2011; ERCOLANO et al., 2008; SEYMOUR et al., 2002).

For the last 50 years, intensification of tomato breeding programs, aimed initially to the increase of the production yield, in many cases led indirectly to the considerable decrease of the biochemical characteristics of fruits, such as flavor and nutrient content. Mostly, the deterioration of the taste is directly determined by genetic and biochemical complexity of this character that erects serious impediments on the way of creating tomato genotypes with successful qualitative associations. Moreover, the lack of fundamental knowledge about the specificity of synthesis of biochemically valuable substances, as well as about genes involved in the control and regulation of metabolic pathways may often impede the right and directed strategy in creating perform tomato genotypes that maintain high gustatory and aromatic qualities for a long time after harvesting. This currently presents a major challenge (KLEE & TIEMAN,

2013). First of all, classical breeding of plants requires the use of the initial material with high biological value (SIMINEL, 1998), the determination of genetic variation and selection of those forms that are of interest from segregating or natural populations with subsequent and directed conservation of valuable genetic sources (BARRERO & TANKSLEY, 2004; GEPTS, 2002; 2006). The general efficiency of tomato breeding, strategic planification of selection and its future realization depends mainly on the choice or correct use of the original material.

The research goal is to evaluate new varieties of tomatoes on the base of biochemical characteristics of the fruit for subsequent use in breeding schemes.

MATERIAL AND METHODS

Three varieties created by interspecific crosses (Tomis, Mihaela, Milenium) and three – by intraspecific crosses (Jubilee 60/20, Prestij, Elvira) were used as a material for research. The determination of the solid content in a fruit was carried out according to the author Tretiakova (TRETIAKOVA, 1982), the sugar – Valter, Pinevug, Varasova (VALTER, 1957), the acidity and vitamin C – Pleshkov (PLESHKOV, 1967). The processing of the obtained data was performed by descriptive statistical analysis, the software package STATISTICA 7.

RESULTS AND DISCUSSION

In terms of chemical composition, the studied varieties in the compared crops demonstrate the value and high quality of the fruit (Table 1). The results of the solid content in tomatoes show significant differences between the studied genotypes. It has been found that the solid content ranged within the limits of 5.2- 6.2%. Analysis of the results revealed varieties Prestij, Elvira, Mihaela, in which the solids content reached of 6.0 - 6.2%.

In the created varieties there were established differences in the sugar content in the fruit that varied within the limits of 4.3- 5.5%. The varieties Jubiliar 60/20, Prestij and Elvira were recorded as having the highest sugar content.

The content of ascorbic acid is also important for the quality of the fruit. The results show that a high variability of vitamin C was registered in the studied varieties: from 27.3 mg% (Tomis) to 52.0 mg% (Prestij). The crucial importance for the variety performance has the ratio sugar / acid that determines many gustative properties of the fruit (BALDWIN et al. 2000; BALDWIN et al., 2008; GEORGELIS et al., 2004; GOFF & KLEE, 2006; RONEN et al., 2000). As a result of the research, it has been found relatively high variation – within the limits of 6.6 - 10.8. . Based on this character, the varieties Jubiliar 60/20 (10.8), Tomis (8.6), Milenium (8.3), Elvira (8.2) were highlighted.

Table 1. Chemical composition of the tomato fruit in the created varieties.

Variety	Solid content, %	Sugar total, %	Vitamin C, mg/%	Acidity, %	Index sugar / acidity
Jubiliar 60/20	5.5	5.4	46.0	0.50	10.8
Prestij	6.2	5.5	52.0	0.78	7.1
Elvira	6.0	5.4	47.6	0.66	8.2
Mihaela	6.0	4.5	35.2	0.58	7.8
Milenium	5.8	4.0	37.9	0.48	8.3
Tomis	5.2	4.3	27.3	0.5	8.6
Solearis (martor)	5.7	5.0	52.0	0.80	6.6

Some dependences (r) between the biochemical characteristics of the created tomato varieties were found by the correlational analysis. Some of them had no statistical significance. For example, the relationships between *the solid content and vitamin C* $r = 0.66$ ($p > 0.05$), *the solid content and acidity* $r = 0.77$ ($p > 0.05$), *total sugar and acidity* $r = 0.67$ ($p > 0.05$). This pattern reflects a tendency of associations rather than a true dependence. However, it has been found a strong relationship between *vitamin C content and total sugar*: $r = 0.85^*$ ($p \leq 0.05$), regression equation is shown in Figure 1.

The analysis of the dendrogram distribution of varieties on the base of biochemical characters demonstrated their separation into two large clusters. The first cluster consists of the genotypes Jubiliar, Elvira, Prestij, Solearis (standard), and cluster 2 is composed of Mihaela, Milenium and Tomis (Fig. 2). It must be mentioned that the first cluster, compared with cluster 2, is characterized by the highest indexes of the studied biochemical characteristics.

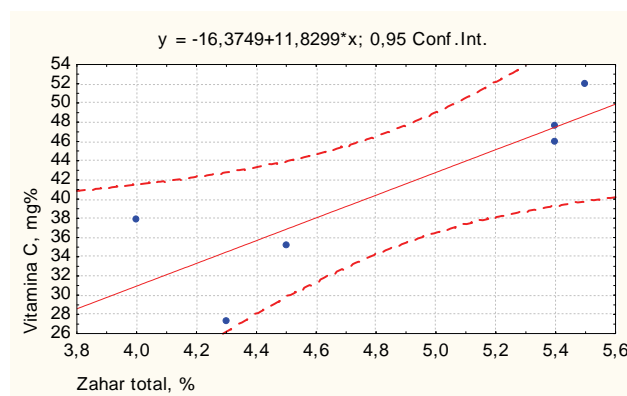


Figure 1. Regression equation of the dependence *vitamin C* content - total sugar in the created tomato varieties.

The analysis of inter- and intracluster variance (k-means method) showed that the most powerful factor discriminating the analyzed genotypes was vitamin C content, followed by the decreasing ratio gluco-acid, total sugar, acidity. Intercluster differences on the basis of solid content had no statistical significance ($p > 0.05$), namely this factor was not relevant to establish differences between the studied genotypes (Table 2).

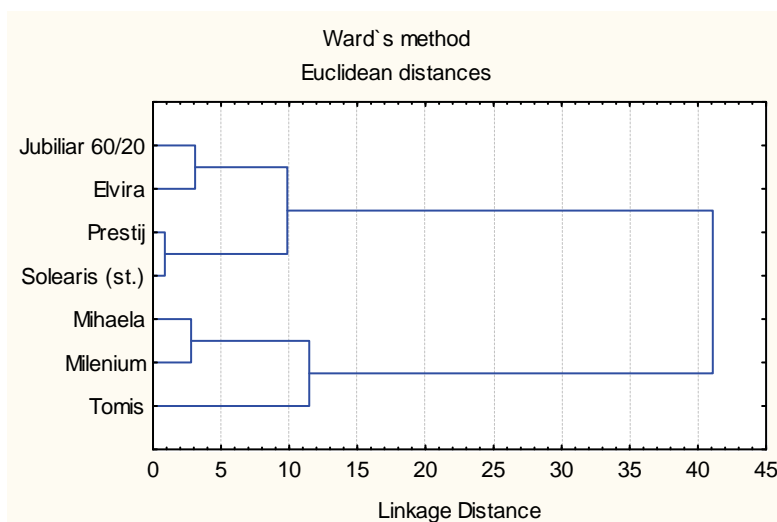


Figure 2. Dendrogram distribution of tomato varieties based on biochemical characteristics of the fruit (2008).

Thus, the created varieties are distinguished from the control with their appreciated biochemical indexes. It must be mentioned that all created varieties exceeded the standard variety in terms of the ratio sugar / acidity, which is an indicator of fruit quality. So, the created varieties manifest increased productivity as well as high gustative properties.

Table 2. Analysis of inter- and intracluster variance (k-means method) based on the biochemical characteristics of the tomato varieties.

Indicator	Intercluster variance	Degree of freedom	Intracluster variance	Degree of freedom	F	Significance p
Solid content	0.0976	2	0.5967	4	0.3272	0.7386
Sugar total	1.9426	2	0.2517	4	15.4380*	0.0132
Vitamin C	462.2476	2	61.9667	4	14.9192*	0.0140
Acidity	0.0908	2	0.0186	4	9.7604*	0.0289
Ratio gluco-acid	7.0283	2	3.8317	4	3.6686*	0.1245

Legend: $p \leq 0,05$.

CONCLUSIONS

1. The biochemical analysis of fruits shows that the varieties Prestij, Elvira, Jubiliar due to high indicators of studied biochemical characteristics can be successfully used for fresh production, as well as for the processing and may be applied like the initial material in breeding to improve the quality of tomato fruits.

2. The dendrogram distribution of the studied tomato varieties has demonstrated that they showed pronounced differences taking into account their distribution in clusters at different levels of aggregation.

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Received: March 12, 2017

Accepted: August 12, 2017

BEHAVIOR OF VINE VARIETIES WITH BIOLOGICAL TOLERANCE UNDER GIURGIU AREA CONDITIONS

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Abstract. Technological, biochemical and agrobiological studies have been carried out on varieties of vines with biological tolerance in the climatic conditions of Giurgiu area, Romania. The determinations focused on the phenology of varieties, fertility coefficients and productivity indices, the behavior of these varieties on the main diseases of vines, the physical-mechanical characteristics and the technological indices; also, the musts have been analyzed biochemically, including the main flavoring compounds. For the determination of aromatic compounds in grape must, gas chromatography/mass spectrometry methods were used. The studied vine varieties were: *Perla de Zala* and *Moldova* (table vine varieties) and *Radames* (variety of wine). In ecopedoclimatic terms from Giurgiu area, varieties mature in the ages III (*Perla de Zala*) and VI (*Moldova* and *Radames*). The results showed that under the conditions of the analyzed area the varieties entered faster in vegetation and had a slightly higher percentage of fertile shoots than the average recorded in other areas of culture. Fertility coefficients and productivity indices have also been higher in this area. Regarding the tolerance to the main diseases of the vine, the varieties behaved somewhat similarly to other areas of culture, *Perla de Zala* registering a higher degree of attack compared to the other 2 analyzed varieties. Chromatographic gas analysis revealed 28 volatile grape compounds that determine the variety of the analyzed varieties. The results showed a lower number of esters compared to those identified in *vinifera* varieties; in higher concentrations, for all 3 varieties, there were identified: 1-hexanol, caprylic acid, ethyl acetate and 2-pentanones. Among the terpenes, limonene was found in the highest concentration.

Keywords: gas chromatography/mass spectrometry methods, downy mildew, grey mold.

Rezumat. Comportamentul soiurilor de viță-de-vie cu rezistență biologică în condițiile zonei Giurgiu. Au fost realizate studii agrobiologice, tehnologice și biochimice asupra unor soiuri de viță de vie cu toleranță biologică, în condițiile climatice ale zonei Giurgiu, România. Determinările au vizat fenologia soiurilor, coeficienții de fertilitate și indicii de productivitate, comportamentul acestor soiuri la principalele boli ale viței de vie, caracteristicile fizico-mecanice și indicii tehnologici; deasemenea, musturile au fost analizate din punct de vedere biochimic, inclusiv privind principalii compuși de aroma varietală. Pentru determinarea compușilor aromatici din mustul de struguri s-a utilizat metoda gaz cromatografică cuplată cu spectrometria de masă. Soiurile de viță de vie studiate au fost: *Perla de Zala* și *Moldova* (soiuri de masă) și *Radames* (soi de vin). În condițiile ecopedoclimatice ale zonei Giurgiu, soiurile se maturează în epocile III (*Perla de Zala*) și VI (*Moldova* și *Radames*). Rezultatele au arătat că în condițiile zonei analizate soiurile au intrat mai repede în vegetație și au avut un procent ușor mai ridicat de lăstari fertili decât media înregistrată în alte zone de cultură. Coeficienții de fertilitate și indicii de productivitate au avut, deasemenea valori crescute în această zonă. În ceea ce privește toleranța la principalele boli ale viței de vie soiurile s-au comportat oarecum asemănător ca în alte zone de cultură, *Perla de Zala* înregistrând un grad de atac mai mare în comparație cu celelalte 2 soiuri analizate. Analiza gaz cromatografică a pus în evidență 28 de compuși volatili din struguri care determină aroma varietală a soiurilor analizate. Rezultatele au arătat un număr mai mic de esteri în comparație cu cei identificați în soiurile *vinifera*; în concentrații mai ridicate, în cazul tuturor celor 3 soiuri au fost identificați: 1-hexanolul, acidul caprilic, etil acetatul și 2-pentanone. Dintre terpene, limonenu s-a regăsit în concentrația cea mai ridicată.

Cuvinte cheie: metoda cromatografie gazoasă/spectrometrie de masă, mana viței de vie, putregaiul cenușiu.

INTRODUCTION

Vine varieties with biological tolerance are interspecific hybrids, resulted by hybridization between the European varieties of vine *Vitis vinifera* and hybrids directly producers, coming from the American species (ROBINSON, 1986). The interspecific hybrids divided by generation, in the American old hybrids (first generation), were represented by varieties brought from the American continent, created before the invasion of phylloxera in Europe: *Noah*, *Isabelle*, *Lidia*, *Delaware*, *Othello*, etc.; Euro x American hybrids (second generation, result of crossing between hybrids from the first generation with noble vines): *Seibel 1*, *Seibel 1000*, *Terras 20*, *Rayon d'or*, etc. and the varieties with biological resistance, resulted from multiple crossings between *vinifera* vines with American hybrids (GALET, 1979).

The vine varieties with biological resistance, named by some authors, varieties with biological tolerance, have a lower resistance to the main diseases and pests of vines compared with the old hybrids, but much higher than the *vinifera* noble varieties, thus requiring a much smaller number of phytosanitary treatments (CATTELL, 1979; VIȘAN et al., 2014).

Although their quality does not equal the noble varieties, these varieties have their importance in winemaking, both in improving vine and obtaining green products (juice, alcoholic and non-alcoholic drinks, in different types of food industry).

In many countries in Europe, but especially in the US, they get natural juices of grapes, various foods, as well as nutritional supplements from hybrid grapes (ELFVING, 1992; VIȘAN et al., 2015).

MATERIALS AND METHODS

Vine varieties with biological tolerance *Perla de Zala*, *Moldova* and *Radames* were studied under the ecopedoclimatic conditions of Giurgiu area. The study, conducted over a period of three years, referred to determining phenology variety, fertility, the agrobiological characterization of varieties (percentage of fertile shoots, the fertility coefficients, productivity indices, reaction to major diseases and pests of the vine) and technological characterization of variety (total production grapes/ha, physical and mechanical characteristics of the grapes, technological indices).

The fertility of the shoots was determined by counting the inflorescences, total shoots and fertile shoots. Absolute and relative fertility coefficients were calculated using computation formulas. The productivity of varieties was determined at full grape maturation, using absolute and relative productivity indices (TARDEA & DEJEU, 1995).

The average grape weight at full maturity was calculated by weighing 50 grapes and calculating the average. The production of grapes per hectare was calculated according to the production of grapes on the hub and the number of hubs per hectare (OȘLOBEANU, 1980).

In order to assess the behavior at the main diseases of the vine, the degree of attack was determined (DA), calculated according to the relation: (frequency of attack x intensity) / 100 (TOMOIAGĂ, 2006).

Grape musts were analyzed under sugar and total acidity terms (after the standardized methods in effect) and characterized in terms of concentration in volatile compound by gas chromatography method coupled with mass spectrometry.

Gas Chromatography/Mass Spectrometry (GC/MS):

Juice Preparation.

The grapes from the three studied vine varieties were harvested at full maturity. Maturity was estimated by content in sugars (g/L), titrable acidity (g/L sulfuric acid) and berry size. After harvesting, grapes were crushed and pressed with a laboratory winepress. The must was homogenized, filtered and stored at -18°C prior to extraction of volatile compounds.

Extraction of Volatile Compounds.

At the extraction of the volatile compounds, it was used a continuous extractor liquid-liquid. Two hundred milliliters of juice (containing internal standard IS: 1-heptanol) placed in a conical flask, were extracted with 5 mL of distilled dichloromethane (Merck, Darmstadt, Germany) by stirring for 30 min at 0°C and then centrifuged for 15 min at 10000 g. The extract was dried with 4 g sodium sulfate and stored at -18°C until analysis (SEROT et al., 2001; BAEK et al., 1997; VIȘAN et al., 2007).

Gas Chromatography/Mass Spectrometry (GC/MS)

The GC/MS system includes a Hewlett Packard 5890 Series II gas chromatograph and a Hewlett Packard 5971 mass spectrometer. Each extract was injected 1 µl in the spitless mode (200°C injector temperature, 60 sec valve delay) into a capillary column (DB-Wax, 30 m length x 0.32 mm internal diameter x 0.5 µm film thickness). The flow rate of helium (carrier gas) was 1 mL/min. Oven temperature was programmed from 50 to 200°C at a rate of 3°C/min with initial and final hold times of 5 and 50 min (GUTH et al., 1997).

In case of mass spectrometer, the conditions were: ion source temperature: 280°C; ionization energy: 70 eV; mass range: 30-350 a.m.u.; electron multiplier voltage: 2100 V; scan rate: 2.2 sec⁻¹.

The identification of volatile compounds was based on comparison of GC retention indices (RI), mass spectra (comparison with MS spectra database and internal library of the laboratory) and odor properties (TRANCHANT, 1995; LE GUEN et al., 2000).

RESULTS AND DISCUSSIONS

Perla de Zala table variety (synonyms: *Zala Göngye*, *Egri Csillagok 24*, *Perle von Zala*, *Zala Dende*), genitors (Villard blanc x SV 12 375) x *Perla de Csaba* (*Vitis vinifera* variety), breaking leaf buds in Giurgiu area around April 20 (Table 1) and has the shortest vegetation of 172 days (Fig. 1) fits in III maturation era.

Regarding the phenology of *Perla de Zala* variety, under the conditions of Giurgiu area, the phenophases begin 5-7 days earlier than in Dealu Mare area, for example, and the vegetation period is reduced by 4-5 days (GRECU, 2010).

Moldova table variety (hybrid obtained in the Republic of Moldova in 1974), genitors *Guzali kara* x *Villard blanc*, breaking leaf buds in Giurgiu area around May 1 (Table 1) has a vegetation period of 182 days and fits in the VI maturation era.

In the studied area, *Moldova* variety behaves similarly to *Perla de Zala*, in the sense that the variety enters the vegetation faster than in case of Dealu Mare vineyard, and the vegetation is shorter by 5 days (182 days compared to 187 in Dealu Mare (GRECU, 2010).

Radames variety, genitors *Traminer Pink* x descendant *Villard blanc* x *Queen vineyards* (obtained by Moldovan St. in 1993) breaking leaf buds in Giurgiu area on April 6 and but has the longest vegetation period (200 days) thus sweeping later, in the VI maturation era.

In the case of *Radames* variety, it is noticeable that in Giurgiu area, the entrance to vegetation is much faster compared to other vineyards, and the vegetation period is shorter by about 9 days compared to Dealu Mare area (MOLDOVAN et al., 1994; GRECU, 2010).

Fertility and productivity of varieties with biological tolerance in the conditions of Giurgiu area:

The 3 analyzed varieties under the ecopedoclimatic conditions of Giurgiu area recorded an average percentage of fertile shoots, ranging between 60.2 and 68.2%, higher than in other areas of culture (VIȘAN et al., 2015).

Table 1. Phenology biological resistant varieties.

Variety	Average data of phenophases				
	breaking leaf buds	flowering	first fruits	maturation	fall leaves
<i>Perla de Zala</i>	20.04	1.06	3.08	28.08	18.10
<i>Moldova</i>	1.05	3.06	12.08	1.10	5.11
<i>Radames</i>	6.04	30.05	15.08	8.10	5.11

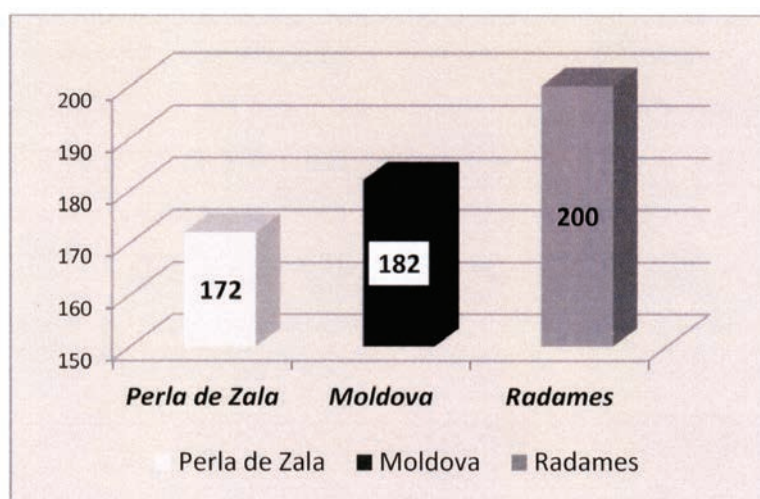


Figure 1. The vegetation period of the vine varieties with biological resistance in the conditions of Giurgiu area (days).

Of the two mass varieties, Moldova has a higher percentage of fertile shoots (68.2%), a higher weight of grape (260 g) and higher productivity indices. Perla de Zala variety has a small grain weight (for a table wine) of 178 g, the lowest percentage of fertile shoots of the analyzed varieties and an average production of 9.6 t / ha (Table 2). Radames variety shows a percentage of 64.5% fertile shoots (Fig. 2) and has an average production of 11 t/ha (Table 2).

Table 2. Fertility and productivity of varieties with biological tolerance.

Variety	fertility			average weight of a grape g	index of productivity		Production of varieties t/ha
	fertile shoots %	fertility coefficients			absolute g	relative g	
		absolute	relative				
<i>Perla de Zala</i>	60.2	1.7	1.1	178	303	196	9.6
<i>Moldova</i>	68.2	1.9	1.2	260	494	312	13.8
<i>Radames</i>	64.5	1.7	1.0	179	305	179	11

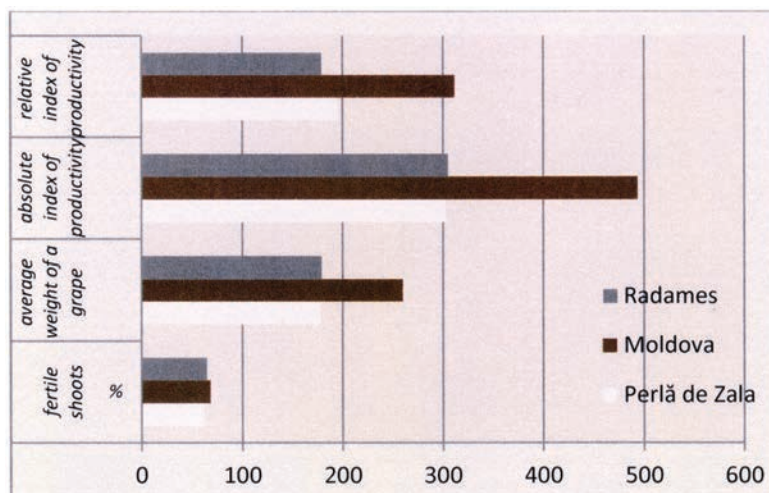


Figure 2. Fertility and productivity of the vine varieties with biological tolerance in the conditions of Giurgiu area.

Regarding the behavior of the varieties with biological tolerance to the main diseases of the vine, it can be noted that is a big difference between the three hybrids, *Perla de Zala* having a lower resistance to most diseases, the degree of attack ranging between 4% (downy mildew) and 12% (powdery mildew on the grapes). Also *Perla de Zala* showed the highest degree of mold attack. The hybrids of *Moldova* and *Radames* recorded a low degree of attack, especially in downy mildew and grey mold (Fig. 3).

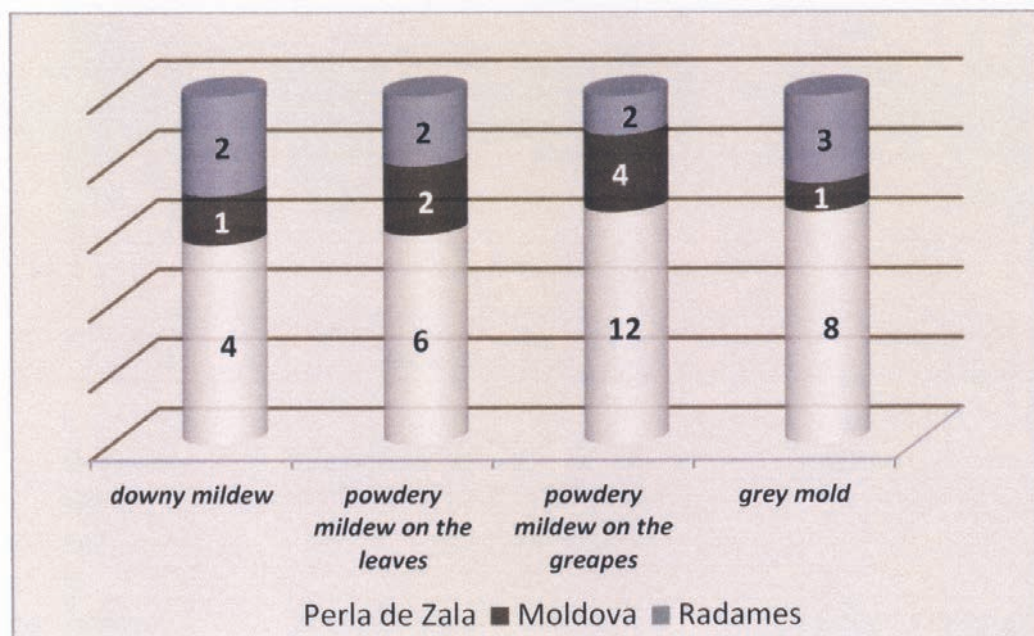


Figure 3. Behavior of vine varieties with biological tolerance to major diseases and pests of the vine (attack degree %).

However, from the point of view of disease tolerance, the hybrids behaved better than in other studied areas, the degree of attack being lower for all diseases (Fig. 4). Physical-mechanical characteristics and technological indices are presented in Table 3.

At the table varieties *Moldova* shows a grain weigh of 975 g and in terms of yield indices *Radames* recorded the lowest value of 1.6.

In terms of sugar content, *Perla de Zala* accumulates a high amount of sugars, of 183 g/L, but it has a glucoacidimetric index of 42, higher than the optimal value. *Moldova* variety recorded the lowest sugar content (158 g/L), but a normal glucose index of 32.9. *Radames* variety has moderate sugar content, especially for a variety of wine and a high acidity of 5.8 g/L of sulfuric acid.

As for the sugar content of grapes, under the same climatic conditions all three varieties recorded slightly higher values than Dealu Mare (GRECU, 2010; VIȘAN et al., 2014).

Table 3. The physico-mechanical and technological indices of biological resistant varieties.

Characteristics	Variety		
	<i>Perla de Zala</i>	<i>Moldova</i>	<i>Radames</i>
	Mechanical composition / kg grapes (g)		
Grain weight	972	975	965
Weight of must	759	725	632
Skin and pulp	172	218	288
Rahis	28	25	37
Seeds	41	32	45
Marc	241	275	370
<i>The composition of 100 grains (g)</i>			
grain weight	231	390	160
Skin weight	34	46	36
pulp weight	193	328	114
seed weight	9	16	10
<i>Technological indices</i>			
Index structure of the grape	34.7	39.0	26.1
Index grain	38.0	28.0	40.0
Index composition of grain	4.7	5.3	2.6
Yield index	3.1	2.6	1.6

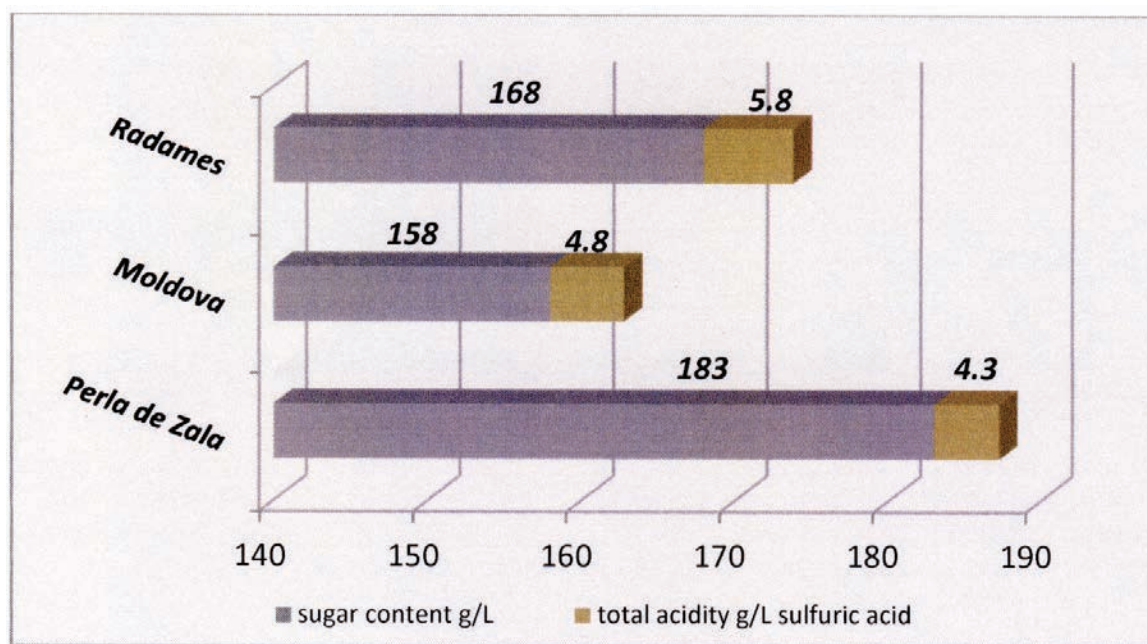


Figure 4. Composition characteristics of grapes.

The GC/MS analysis of volatile compounds revealed a number of compounds that characterize the studied varieties; some of these compounds can be found in higher concentration in comparison with the other identified compounds (Table 4).

Table 4. Volatile compounds from the analyzed musts.

No.	Volatile compounds	Perla de Zala	Moldova	Radames
		ppm		
1	ethyl acetate	2300	2250	3785
2	2-pentanone	1230	1425	1856
3	ethyl butyrate	39	75	144
4	n-propanol	487	119	245
5	ethyl 2-methyl butanoate	122	58	75
6	2-methyl 3-buten-2-ol	54	65	39
7	3-pentanol	85	70	115
8	hexanal	125	89	76
9	(Z)-2-hexenal	258	896	345
10	ethyl hexanoate	75	253	85
11	ethyl caproate	296	387	128
12	1-octene-3-ona	12	-	3
13	methyl hexanoate	25	45	14
14	1-hexanol	1230	985	605
15	ethyl 3-hidroxy butanoate	230	445	120
16	phenylacetaldehyde	2	45	15
17	cis 3-hexen-1-ol	85	64	59
18	ethyl caprylate	758	450	589
19	ethyl 2-hydroxy 4-methyl pentanoate	72	90	28
20	phenyl acetate	75	112	89
21	ethyl-2-hydroxy-3-phenylpropanoate	125	154	115
22	2-phenylethanol	57	81	15
23	caprylic acid	4620	3560	1250
24	delta-3-carene	1.2	1.1	0.3
25	β-myrcene	0.5	0.2	trace
26	limonene	6.8	21.2	8.5
27	p-cymene	1.2	1.4	trace
28	β-pinene	0	0.1	trace

Esters are formed in grape fermentation process in large quantities by enzymatic esterification and in the process of maturation and aging of wine by chemical esterification (VIȘAN, 2015). Thus, regarding esters, there were identified: Ethyl acetate, Ethyl butyrate, Ethyl 2-methyl butanoate, Ethyl hexanoate, Ethyl caproate, Methyl hexanoate, ethyl 3-hidroxy butanoate, Ethyl caprylate, Ethyl 2-hydroxy 4-methyl pentanoate, Phenyl acetate and Ethyl-2-hydroxy-3-phenylpropanoate (Fig. 5).

Among aldehydes, there were identified: Hexanal, (Z)-2-hexenal, phenylacetaldehyde. The higher alcohols were represented by: n-Propanol, 2-methyl 3-buten-2-ol, 3-pentanol, 1-Hexanol, Cis 3-hexen-1-ol and 2-phenylethanol. (Fig. 6). The identified terpenes were, in order of concentration at studied varieties: limonene, p-cymene, delta-3-carene, β -myrcene, β -pinene (Fig. 7).

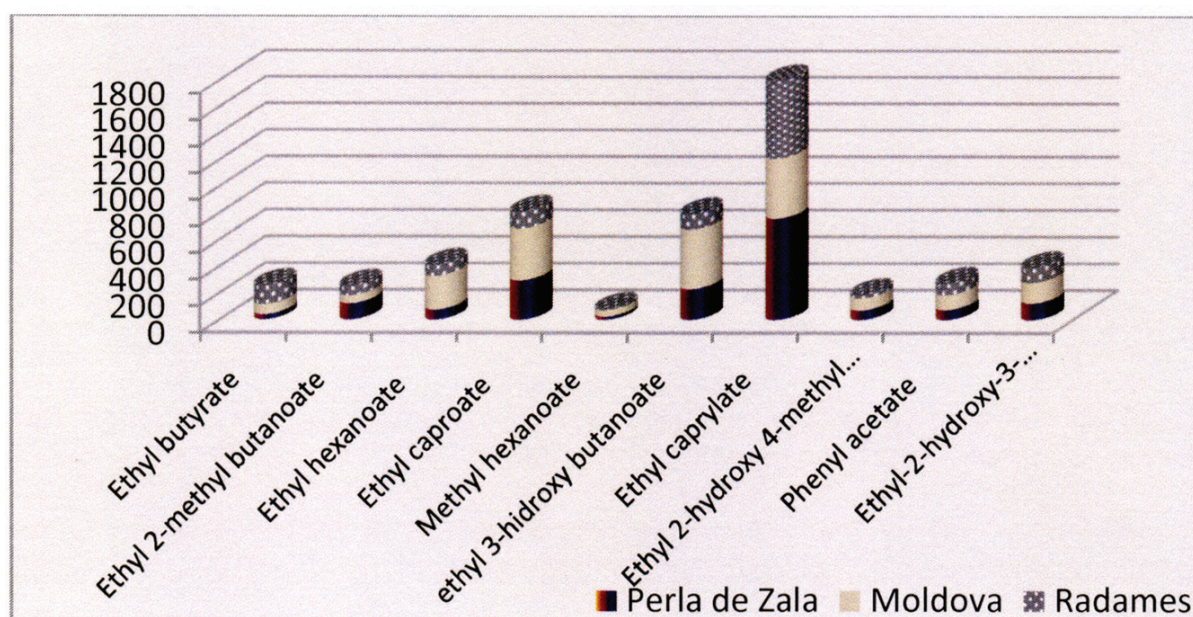


Figure 5. The main esters of analyzed musts, ppm.

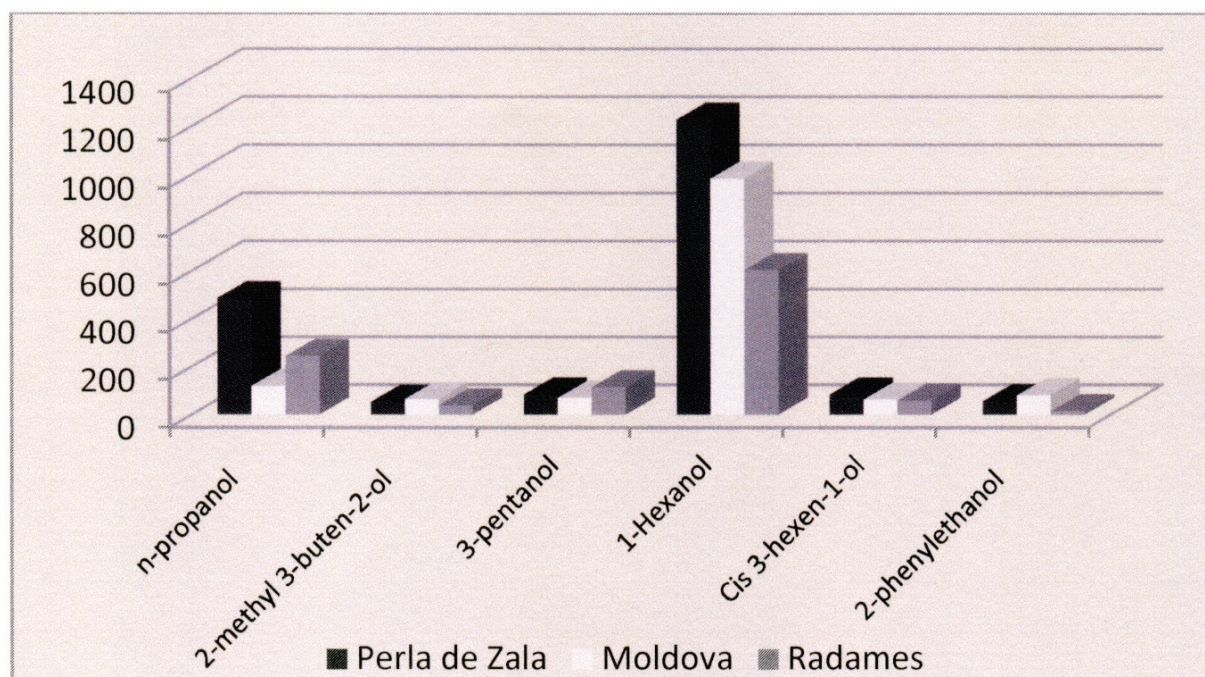


Figure 6. Concentration of higher alcohols, ppm.

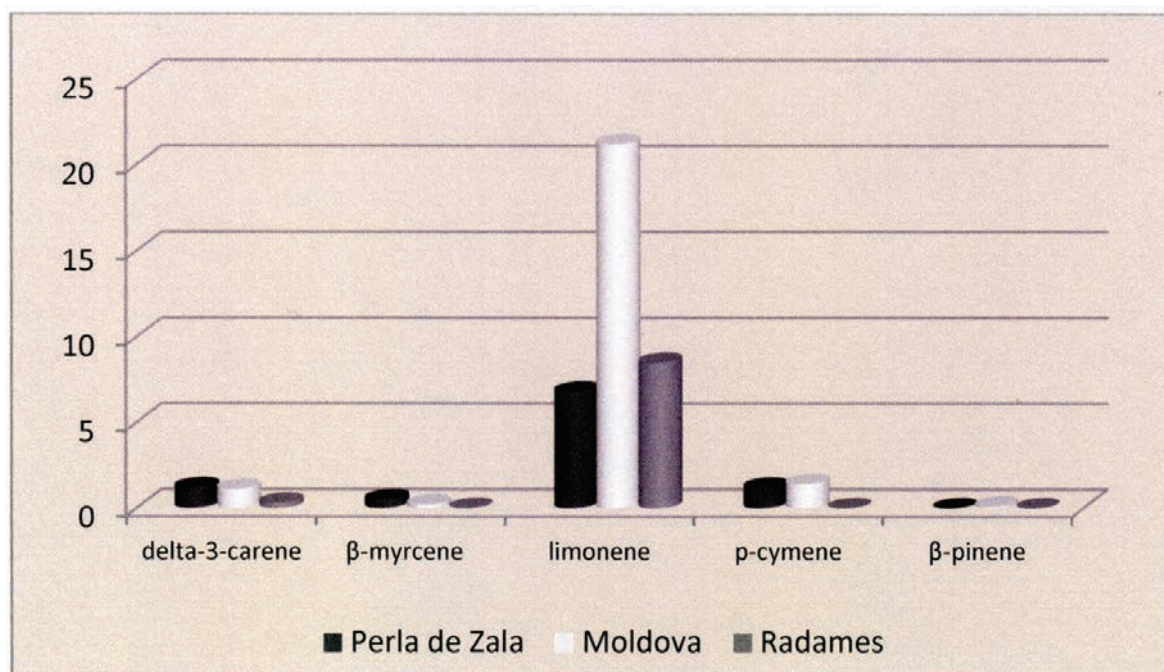


Figure 7. Concentration of terpenes, ppm.

CONCLUSIONS

The beginning of the vegetation period for the vine varieties with biological tolerance analyzed under the conditions of Giurgiu area was advanced by 7-10 days compared to other areas of culture.

The longest vegetation period was recorded by *Radames*, 200 days.

The varieties show a medium fertility, with a percentage of fertile shoots between 60.2% (*Perla de Zala*) and 68.2% (*Radames*).

The highest values of the indices of productivity (absolute and relative) were registered by *Moldova* variety, the average yield of the variety being 13.8 t / ha.

Perla de Zala variety accumulates a high sugar content of 183 g/L, but records a gluco-acidimetric index of 42, higher than the optimal value. *Moldova* registered the smallest sugar content in grapes (158 g/L).

By GC/MS analysis 28 volatile compounds were identified and dosed: esters, aldehydes, higher alcohols, terpenes, etc.; in high concentrations, there were identified 1-hexanol and n-propanol, ethyl caprylate and ethyl 3-hydroxy butanoates, as well as limonene, terpene in higher concentration as compared to the other identified terpenes.

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Received: March 31, 2017

Accepted: August 12, 2017

EFFECTS OF BIOLOGICAL AND CHEMICAL TREATMENTS ON THE MORPHOLOGY AND PRODUCTIVE PERFORMANCE OF SOME *Camelina sativa* L. VARIETIES

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BOIU-SICUIA Oana-Alina, VIȘAN Valerica Luminița

Abstract. *Camelina sativa* is an oleaginous plant of economic perspective, with major importance in the production of biofuels. In addition, camelina oil has several nutritional benefits and valuable uses in many industrial branches. The aim of this study was to evaluate the effect of biological and chemical seed treatments on six varieties of camelina. The morphological and technological characteristics of seed treated and untreated plants were evaluated during vegetation up to full maturity. Positive results were recorded at the camelina genotypes G1- Mădălina, G3-GP 204, G4-GP 202 and G6-Camelia when seeds were treated with plant beneficial bacteria. Therefore, biologically seed treated plants expressed an increased biomass weight /plant (g), seed weight/plant (g) and a higher percentage of seed weight from the total biomass weight (%).

Keywords: *Camelina sativa*, seed production, controlled conditions.

Rezumat. Efectul unor tratamente biologice și chimice asupra caracterelor morfologice și performanțelor productive ale unor soiuri de *Camelina sativa* L. Această specie reprezintă una dintre plantele oleaginoase de perspectivă și cu importanță majoră în obținerea biocombustibililor. Pe lângă aceasta, ea are multiple recomandări nutriționale și de valorificare în multe ramuri industriale. Obiectivul acestui studiu a fost evaluarea efectului a două tratamente (biologic și chimic) aplicate la semințele a șase genotipuri de camelina. În cadrul studiului au fost evaluate caracterele morfologice și proprietățile tehnologice ale plantelor tratate la sămânță și netratate, până când acestea au atins maturitatea deplină. Rezultate pozitive au fost înregistrate la genotipurile de *Camelina sativa* G1-Mădălina, G3-GP 204, G4-GP 202 și G6-Camelia când semințele au fost tratate cu bacterii benefice. Astfel, semințele plantelor tratate biologic au evidențiat o creștere a parametrilor de productivitate analizați: greutate biomasă/plantă (g), greutate semințe/plantă (g) și procentul de semințe raportat la greutatea totală a biomasei (%).

Cuvinte cheie: *Camelina sativa*, producerea de semințe, condiții controlate.

INTRODUCTION

Camelina sativa (L.) Crantz, popularly known as false flax, wild flax, Siberian oilseed, German sesame or gold-of-pleasure, is an ancient cultivated oilseed species (ZUBR, 1998) that occurs mostly as accompanying flax. It is an annual or winter annual plant that belongs to *Brassicaceae* family (*Cruciferae*).

Its history goes back to the Bronze Age (PUTNAM et al., 1993). Although widely cultivated up to the early 1940's, the commercial production ceased with the introduction of oilseed rape. The lower cost of hydrogenating rape oil and the lack of knowledge on the value of oils containing a high percentage of polyunsaturated fatty acids were the main causes of the lack of interest in *C. sativa* (BUDIN et al., 1995; SHUKLA, 2002; JOHNSON et al., 2010; DOBRE et al., 2014a,b). The revival of interest in camelina oil now is due to its high linolenic acid content (up to 38%) (ZUBR, 1992). Linolenic acid is one of the OMEGA-3 fatty acids, which are only found in linseed and edible fish oils (ZUBR, 1997; CROWLEY & FRÖHLICH, 1998; DRUMEA et al., 2016).

C. sativa (L.) Crantz, has favourable agronomic traits and potentially large number of uses. It has a short growing season (PAVLISTA et al., 2011) and can be cultivated as an annual summer crop or as annual winter crop. It has good potential for non-irrigated crop production systems (DOBRE et al., 2014b), the seasonal water consumption ranging from 333 to 423 mm (FRENCH et al., 2009). It is a cold and drought tolerant crop (MATEI et al., 2014). The chemical fertilizers requirement is moderate to low (100 kg/ha of N; 30 kg/ha of P; and 40 kg/ha of S) (DOBRE et al., 2014a). Minimal management practices are required after seeding to crop maturity (TONCEA, 2014). Camelina can be grown in environmentally friendly way with oat, without excessive applications of herbicides and pesticides, due to its allelopathic effects against weeds and its high resistance to blackleg disease of cruciferous plants (PUTNAM et al., 1997). It can be grown on marginal land as a low input biofuel crop, except for heavy clay and organic soils. This specie is self-pollinating and the seeds do not have seed dormancy. It has negligible potential as an invasive weed if grown on a large-scale as a biofuel crop (SHONNARD et al., 2010; FRÖHLICH & RICE, 2005). Camelina oil could offer excellent health benefits to consumers and has nutritional value to humans and animals (DRUMEA et al., 2016). The oil is rich in tocopherols, which confers a good oxidative stability and a reasonable shelf life. Some co-products like glycerin and camelina meal are used in animal diet (PETRE et al., 2015; GIURESCU et al., 2016). The oil is also used in biodiesel production (via transesterification) and for renewable jet fuel (through hydrogenation/hydrocracking) (TONCEA, 2013); it can be also used to obtain biobased industrial products such as: polymers, varnishes, paints, cosmetics and dermatological products, and after epoxidation could be used for lubricants, resins, coatings, adhesives, soaps etc. Moreover, it is compatible with the existing agricultural and fuel infrastructure (WALSH et al., 2012; VOLLMANN & LAIMER, 2013). The life-cycle assessment (LCA) showed a reduction of C emissions by 75-80% when using camelina bio-fuel (PETRE et al., 2015).

Recent interest for the use of renewable sources of raw materials for biofuel production requires the identification of effective solutions to pursue the principles of sustainable development. This approach is the one that meets the needs of the present without compromising the ability of future generations to meet their own requirements.

Numerous studies have been carried out to maximize seeds performance at sowing, in order to control plant pests and diseases through biological and chemical means (CONSTANTINESCU & SICUIA, 2013; SICUIA et al., 2015).

It has been noticed that, in field conditions, camelina is frequently affected by some diseases, the most frequent being the downy mildew produced by *Peronospora parasitica* (VOLLMANN et al., 2001). In the spring, the oospores of the pathogen germinate and cause the primary infection, from which conidia are spread on the host plants. After the first symptoms of disease, the pathogen attack can proliferate on the leaves, stems and fruits (silicles) of camelina due to more conidia production, which causes secondary infections (SPENCER, 1981). In Romania, the first report of downy mildew on camelina was made by CRISTEA & MANOLE (2014) on a Romanian variety cultivated at "Moara Domneasca" farm of the University of Agricultural Sciences and Veterinary Medicine of Bucharest.

Moreover, the incidence of phytopathogenic infections caused by *Phytium* spp. and *Phytophthora* spp. is increasing in greenhouse conditions, as it also happens at legume and ornamental plants.

The purpose of this study was to evaluate some morphological traits and the productive performance of six camelina varieties cultivated in greenhouse, when using some biological and chemical seed treatments, based on *Bacillus amyloliquefaciens* and Dithane M 45 fungicide. The experimental study was carried out in automated controlled greenhouse conditions.

MATERIAL AND METHODS

The experiment was developed in the greenhouse automation unit for research of the Center for Quality Research of the Agro-Food Products (HORTINVEST), from UASVM-Bucharest. The camelina plants were grown in pots, on 160 m² greenhouse with heating, shading, air-conditioning, assimilation lighting, tide type irrigation system and microaspiration facilities. The provenance of the biological material was assured from - NARDI Fundulea Romania for the seeds of camelina genotypes.

Six varieties of *Camelina sativa*, were used in this study: G1- Mădălina hybrid, (Romanian genotype, registered in 2014); G2- Fundulea local population of wild camelina, (Romanian genotype); G3-GP 204 (Spanish genotype); G4-GP 202; G5-Calena (Austrian genotype); G6-Camelia variety, (Romanian genotype, registered in 2011).

As a working method we have resumed in this experiment the conditions of camelina cultivation in protected areas according to the protocol developed and reported in an earlier publication (PODGOREANU et al., 2015).

Camelina was seeded in black plastic, square-shaped pots of 11x11x11 cm in size, placed in water collecting trays of 60 x 40cm. Each pot was filled with 1L of Kekkila DSM 2 W growth substrate, which is a light, aerated peat (well milled) with additional perlite, pre-fertilized with NPK 14-16-18, with the pH adjusted to 5.5/5.9. Before use, the growth substrate was sterilized by autoclaving at 100° C for 20 minutes, and soaked in water after cooling.

For the present study, the trials were conceived as a bifactorial experiment, where the **A Factor** involved two experimental seed treatments compared to an untreated control:

- "M" = Untreated control, where seeds were moistened for 20 minutes in distilled water;
- "B" = Biological treated experimental variant, where seeds were immersed for 20 minutes in bacterial suspension based on *Bacillus amyloliquefaciens* BW strain, at 10⁸UFC/ml concentration, supplemented with 2% carboxymethyl cellulose;
- "D" = Chemical treated experimental variant, where seeds were immersed for 20 minutes in 0.2% solution of Dithane M 45, a contact fungicide (80% mancozeb).

The **B Factor** involved the morphological characteristics and productive parameters were recorded in the six Camelina genotypes: **G1**-Madalina, **G2**-Fundulea local population of wild camelina, **G3**-GP 204, **G4**-GP 202, **G5**-Calena and **G6**-Camelia.

The bacterial bio-preparation was obtained at the Biotechnology department of UASVM Bucharest. Liquid bacterial culture of 48h was used to prepare the inoculum.

The *Bacillus amyloliquefaciens* BW strain was grown in Luria Bertani broth at 28°C in a rotary shaker, at 150 rpm. The bacterial culture was centrifuged for 15 minutes at 3500xg and the pellet was washed and resuspended in phosphate saline buffer. To increase the bacterial adherence to seeds tegument during inoculation (as seed treatment) the aqueous suspension was amended with 2% carboxymethyl cellulose. The bacterial cell concentration in the formulated product was 10⁸UFC/ml.

The biological treatment based on *B. amyloliquefaciens* BW strain was selected to be used due to the beneficial properties of the strain. The BW strain expressed activity both *in vitro* and *in vivo* against a wide spectrum of plant pathogens and improved plant growth of several leguminous species (CORNEA et al., 2008; SICUIA, 2013).

Dithane M45 is a contact fungicide with a wide spectrum of pathogen control in field crops, potato, vegetables, flowers, orchards and vineyards, as well as seed treatment. Due to its multisided mode of action, it prevents pathogen resistance. The active substance mancozeb 80%; inhibits spore germination and interrupts six enzymatic pathways.

Ten seeds of camelina from each genotype were sowed /pot under two replications in each experimental variant and the plants were examined during the 5 months of culture - from February (the 2nd decade) to July (the 1st decade) (Table 1).

Table 1. Experimental scheme used to evaluate performance on six camelina genotypes cultivated in the HORTINVEST greenhouse unit (spring, 2016).

GENOTYPE (HYBRID)	Number of plants/ Variant "M"		Number of plants / Variant "B"		Number of plants / Variant "D"		Total evaluated plant/ genotype
	Repetition MR1	Repetition MR2	Repetition BR1	Repetition BR2	Repetition DR1	Repetition DR2	
G1 - Mădălina	10	10	10	10	10	10	60
G2-Fundulea local population of wild camelina	10	10	10	10	10	10	60
G3-GP 204	10	10	10	10	10	10	60
G4-GP 202	10	10	10	10	10	10	60
G5-Calena	10	10	10	10	10	10	60
G6-Camelia	10	10	10	10	10	10	60

Legend: "M" = Untreated control, "B"= Experimental variant of biocontrol treatment based on plant beneficial bacteria, "D" = Experimental variant with chemical control treatment based on Dithane M 45 contact fungicide.

The following morphological characteristics and productive parameters were recorded during the bifactorial experiments: plant height (cm); it was measured periodically during vegetation and at harvest time from the soil surface to the highest point of the plant; days to flowering; it was measured periodically during the number of days from date of seeding to approximately 20%, 40%, 60% and 80% of the plants having open flowers; days to maturity; it was estimated visually as the date when approximately 90% of pods were brown; biomass weight (g); seed weight/plant (g); the difference between seed weight/total biomass (%).

RESULTS AND DISCUSSIONS

The greenhouse experiment conducted in the spring of 2016, at HORTINVEST research centre, Bucharest, revealed some morphological and productivity performances in six genotypes of *Camelina sativa* plants, with or without chemical or biological seed treatments.

The growth conditions registered during camelina cultivation were as follows: 4700 to 6000 lx naturally provided 14 hours/day. However, during cloudy periods, the lighting was supplemented with four halogen lamps placed on each corner of the growing area. The temperature was maintained between 24 and 40°C during daylight and at 20°C during night, while the relative humidity was adjusted between 55 and 80% (Fig. 1).



Figure 1. Registered values for Temperature - T°C (A) and Atmospheric humidity-U% (B) in the HORTINVEST greenhouse unit during of camelina genotypes studies (spring, 2016). (Original photo-in the HORTINVEST greenhouse unit, spring 2016).

In order to prevent the pest attack, yellow sticky traps were used, and curatively, a 0.5% of ORTHUS solution was applied 2-3 times, each 7-day. The germination of the seeds of all six genotypes of camelina, treated and untreated, was analyzed at 3 to 10 days after sowing. The germination rate after the first 3 days from sowing was relatively moderate.

In all replicates of the treated experimental variants (BR1, BR2 and DR1, DR2) the germination rate was 55%, compared to the control (MR1, MR2). For all six genotypes (G1 to G6), full germination (100%) was recorded after 8 days in the biological treated variant "B" and the control "M", and after 10 days in the chemical treated variant "D". All germinated camelina plants showed normal germline characteristics (Fig. 2).



Figure 2. Germination of camelina plants 10 days after sowing. "M" = Untreated control, "B" = Experimental variant of biocontrol treatment based on plant beneficial bacteria, "D" = Experimental variant with chemical control treatment based on Dithane M 45 contact fungicide. (Original photo-in the HORTINVEST greenhouse unit, spring 2016).

To determine the dynamics of plant growth (cm) for all six camelina genotypes (G1-G6) in the control and treated variants, three measurements were performed: after 35 days from sowing, and at 20 days intervals (Table 2). In the first growth stages, plants height at 35-day and 55-day after sowing was higher in the control variants than in the biologically and chemically treated variants (Fig. 3).

Table 2. Morphometric determinations of plant height (cm) for six camelina genotypes (G1-G6) cultivated in greenhouse conditions, in three experimental variants. (Average values/ plants/2 repetition).

GENOTYPE	Variant "M"			Variant "B"			Variant "D"		
	Average of plants height (cm)								
	after 35 days	after 55 days	after 105 days	after 35 days	after 55 days	after 105 days	after 35 days	after 55 days	after 105 days
VARIANTS									
G1-Mădălina	24.5	32.5	54.0	15.5	22.5	50.5	21.0	26.0	48.0
G2-Fundulea local population of wild camelina	22.5	30.5	60.0	19.0	26.0	59.0	21.5	27.0	57.0
G3-GP 204	13.5	27.5	52.5	17.0	22.5	60.0	15.0	22.5	46.0
G4-GP 202	25.5	32.8	55.5	14.5	19.6	58.0	21.0	29.0	47.0
G5-Calena	24.5	31.5	56.0	15.0	20.0	57.0	18.5	30.0	53.0
G6-Camelia	19.5	29.0	57.0	13.5	18.5	61.0	11.0	28.0	51.0

Legend: "M" = Untreated control, "B" = Experimental variant of biocontrol treatment based on plant beneficial bacteria, "D" = Experimental variant with chemical control treatment based on Dithane M 45 contact fungicide.

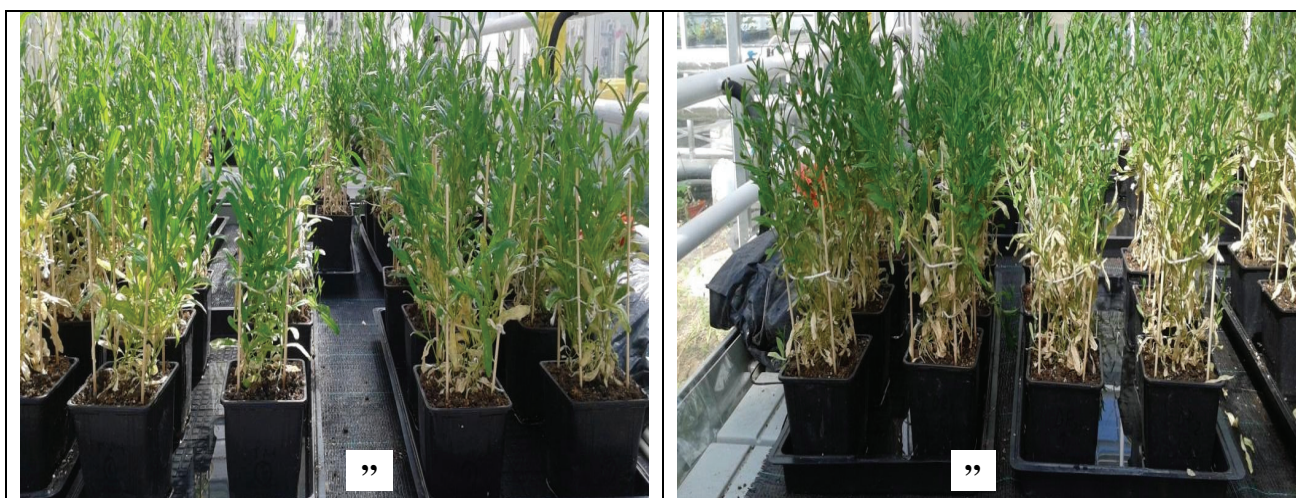


Figure 3. Camelina seedlings aspect of experimental variants (M, B, D), after 55 days from sowing: "M" = Untreated control, "B" = Experimental variant of biocontrol seed treatment based on plant beneficial bacteria, "D" = Experimental variant with chemical seed control treatment based on Dithane M 45 contact fungicide. (Original photo-in the HORTINVEST greenhouse unit, spring 2016).

However, as the camelina plants approached maturity, plants vigour improved. Morphometric analyzes revealed that plants height increased 10 to 20 cm/30 days and the number of leaves increased to 30-40 leaves/plant.

Thus, at the 3rd determination of plants height (after 105 day from sowing), in four camelina genotypes: **G3-GP 204**, **G4-GP202**, **G5-Calena** and **G6-Camelia**, biologically seed treated with *B. amyloliquefaciens* BW strain, it was found that the height of the plants exceeded with 7-14% the untreated control. The emergence of the first flower buds was revealed after 40 days from sowing; and extended for another 20 to 40 days. The flowers blossomed at first on the main stem of the plants and then on the lateral branches (Table 3).

Table 3. Time estimation of vegetative and generative stages, in no. of Days until flowering and no. of Days until maturity, for six camelina genotypes (G1-G6) cultivated in greenhouse conditions, in three experimental variants. (Average values/ plants/2 repetition).

GENOTYPE VARIANTS	Variant "M"		Variant "B"		Variant "D"	
	Days to flowering	Days to maturity	Days to flowering	Days to maturity	Days to flowering	Days to maturity
G1 - Mădălina	62	108	68	120	72	115
G2 - Fundulea local population of wild camelina	63	105	66	115	70	126
G3-GP 204	63	125	64	115	77	126
G4-GP 202	62	105	76	125	69	121
G5-Calena	66	115	64	115	72	126
G6-Camelia	68	108	80	133	72	121

Legend: "M" = Untreated control, "B"= Experimental variant of biocontrol treatment based on plant beneficial bacteria, "D" = Experimental variant with chemical control treatment based on Dithane M 45 contact fungicide.

No significant differences were found between the genotypes regarding the time period needed for plants to bloom and mature their silicles in the untreated/control variants. The only differences were noticed at the blooming of G6-Camelia genotype, where the plants biologically treated (variant "B") blossomed 12-18 days after the first flowers appeared in the control ("M"), and 3-11 days after the plants chemically treated (variant "D"). The generative stage, from the time of the first fructification (silicles) to full maturity, another 40 days were required, for all six studied genotypes, in both control "M" and "D" experimental variants. Similar results were also registered in "B" experimental variant (biologically treated), however at **G1 – Mădălina** genotype, from the end of blooming to silicles maturity plants staggered over 50 days.

The *C. sativa* plants from all three experimental variants, "M", "B" and "D", at the beginning of the maturing of silicles (80 days old plants) and prior to the harvest time (plants aged 120-125 days) are illustrated in Fig. 4.

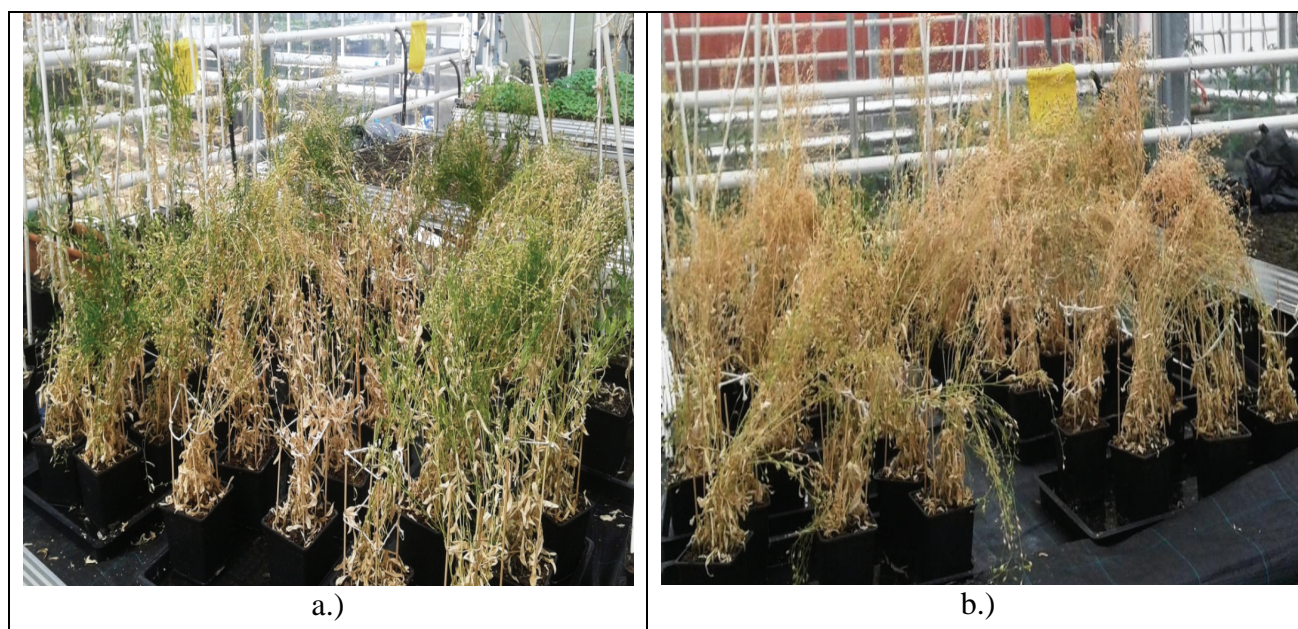


Figure 4. Camelina plants from all three experimental variants ("M", "B", "D"):
a) after 80 days and b) after 120 days from sowing (original photo-in the HORTINVEST greenhouse unit, 2016).

Plants productivity of all six camelina genotypes (G1- Mădălina, G2- Fundulea local population of wild camelina, G3-GP 204, G4- GP 202, G5-Calena and G6-Camelia) cultivated in greenhouse condition, in seed treated and untreated experimental variants were evaluated after harvest and presented in Table 4.

Table 4. Plants productivity parameters of six camelina genotypes (G1-G6) cultivated in greenhouse conditions in seed treated and untreated experimental variants. (Average values/ plants/2 repetition).

GENOTYPE VARIANTS	Variant "M"			Variant "B"			Variant "D"		
	Biomass weight (g)	Seed weight/ plant (g)	Total seed weight/ biomass %	Biomass weight (g)	Seed weight/ plant (g)	Total seed weight/ biomass %	Biomass weight (g)	Seed weight/ plant (g)	Total seed weight/ biomass %
G1-Madalina,	10.15	0.76	7.48	17.55	1.13	6.44	12.64	0.54	4.27
G2-Fundulea local population of wild camelina	16.30	0.91	5.58	14.63	0.76	5.19	12.44	1.53	12.29
G3-GP 204	11.23	0.45	4.00	14.36	1.24	8.63	11.46	0.24	2.09
G4-GP 202	14.78	0.94	6.35	17.20	2.20	12.80	14.66	0.70	4.77
G5-Calena	12.65	2.58	20.39	14.36	1.30	9.05	12.25	0.44	3.60
G6-Camelia	14.64	1.12	7.65	17.52	2.32	13.24	11.78	0.56	4.75

Legend: "M" = Untreated control, "B" = Experimental variant of biocontrol treatment based on plant beneficial bacteria, "D" = Experimental variant with chemical control treatment based on Dithane M 45 contact fungicide.

Analyzing plants productivity (table 4), it was found that the biological seed treatment of *Camelina sativa* genotypes G1 - Mădălina, G3-GP 204, G4-GP 202 and G6-Camelia increased the productivity potential of the plants, compared to the untreated control (M), regarding: biomass weight / plant (g), seed weight / plant (g) and the difference between weight of seeds and total biomass weight.

CONCLUSIONS

This experiment was carried out in 2016, during 5 months. Six *Camelina sativa* genotypes were analyzed for their morphometric and productivity potential, after being seed treated with biological and chemical products, compared with untreated controls. All plants were grown in automatic greenhouse, in the same climatic conditions and agronomic maintenance. The chemical seed treatment with Dithane M 45 contact fungicide provided higher morphometric characteristics like: plant height and number of shoots / plant. However, after harvest, the biological seed treatment with *Bacillus amyloliquefaciens* BW beneficial bacteria improved plants productivity of four genotypes (G1-Mădălina, G3-GP 204, G4-GP 202 and G6-Camelia) compared with the control and chemically treated variants.

ACKNOWLEDGEMENTS

This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CNCS/CCCDI – UEFISCDI, project number PN-III-P2-2.1-PTE-2016-0166, contract 21-PTE, within PNCDI III. Authors would like to thank staff from HORTINVEST - Center for Quality Research of the Agro-Food Products, Bucharest for the greenhouse technical assistance, and to NARDI Fundulea Romania for the seeds of camelina genotypes provided for this study.

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Received: March 30, 2017
Accepted: July 24, 2017

TERRESTRIAL ISOPODS IN A SMALL TOWN IN WESTERN ROMANIA (PÂNCOTA, ARAD COUNTY): WITNESSES OF THE PAST HUMAN IMPACT OF THE REGION?

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Abstract. In Pâncota town from western Romania (Arad County) we identified 13 terrestrial isopod species, the most common being *Trachelipus nodulosus*. The species number registered in Pâncota was lower than in other towns which borders with forests, but was higher than in a previously studied town surrounded by agricultural areas in western Romania. Some species common in other towns from western Romania are not present in Pâncota. Most of the identified species are native, common and generalists. Nevertheless, the wet areas situated in the town and its surroundings are populated by species with narrow ecological demands, even forest species. They probably survived in the wet areas following the deforestations of the region. In Pâncota, there are less non-native species than in other towns from the Western Romanian Plain.

Keywords: plain, wet areas, forests, common species, urban area.

Rezumat. Izopodele terestre dintr-un oraș mic din vestul României (Pâncota, județul Arad): martorii impactului antropoc al regiunii din trecut? În orașul Pâncota din vestul României (județul Arad) am identificat 13 specii de izopode terestre, cea mai comună fiind *Trachelipus nodulosus*. Numărul de specii din Pâncota a fost mai mic decât în alte orașe, care sunt înconjurată cu păduri, dar a fost mai mare decât într-un oraș înconjurat de terenuri agricole, studiat anterior în vestul României. Specii comune în alte orașe din vestul României lipsesc din Pâncota. Majoritatea speciilor identificate sunt native, comune și generaliste. Cu toate acestea, zonele umede situate în oraș și în apropiere sunt populate de specii cu cerințe ecologice înguste, chiar specii de pădure. Acestea probabil au supraviețuit în zonele umede după defrișările din regiune. În Pâncota sunt prezente mai puține specii non-native decât în alte orașe din Câmpia de Vest.

Cuvinte cheie: câmpie, zone umede, păduri, specii comune, zonă urbană.

INTRODUCTION

In Romania, over 80 terrestrial isopod species were confirmed to be present (e.g. RADU, 1983, 1985; TĂBĂCARU & GIURGINCA, 2013). Nevertheless, most of them populate natural areas, even restrictive habitats, having narrow habitat requirements, some being endemic or cave species (e.g. RADU 1983, 1985, TĂBĂCARU & GIURGINCA, 2013; TOMESCU et al., 2015). On the contrary, in human affected, and especially in urban areas, the species number is reduced (BODIN et al., 2013; FERENȚI et al., 2015; HERLE et al., 2016). Even more, there are obvious differences between towns surrounded by relatively natural habitats and towns surrounded by human affected, like agricultural, areas; until now, the smallest species number in the country was registered in a plain town surrounded by agricultural areas (FERENȚI et al., 2015). The species number and composition in urban areas seem to be influenced also by the geographic location (VILISICS et al., 2012). In the last years, in western Romania, some studies upon urban terrestrial isopods were performed with the direct collecting method (BODIN et al., 2013; FERENȚI et al., 2015; HERLE et al., 2016), and revealed the poverty of the isopod fauna once with the degradation of the areas surrounding the town (FERENȚI et al., 2015). Moreover, natural areas near towns, even in the industrialized ones, determined the isopod fauna recovery (HERLE et al., 2016). Taking into account this strong influence of the surroundings upon the urban fauna, we supposed that if a plain town is in contact with natural areas, the isopod fauna will be richer than in a town exclusively surrounded by flat plains exploited for agriculture. To test this hypothesis we chose Pâncota, a town that borders in three parts with flat agricultural plains, but in one side it is in contact with the lower limit of the first hills. As Pâncota is also situated in western Romania and we also used the direct collecting method, the results are comparable with the previous studies (BODIN et al., 2013; FERENȚI et al., 2015; HERLE et al., 2016). Our objectives were the following: **1.** to establish the terrestrial isopod species at Pâncota, **2.** to identify the differences between the isopod fauna from different habitat types in the town.

MATERIAL AND METHODS

Pâncota is a small town situated in the central-western part of Arad County, at the contact between the Lower Crișuri Plain and Zărand Hills (POSEA & BADEA, 1984). According to the last population census from 2011, the town has 6946 inhabitants (<http://www.recensamantromania.ro/rezultate-2/>), a decreasing population, like in Arad County generally (VERT & ANCUȚA, 2011). In its southern, northern and western parts, the town borders with flat pain areas, used for cereal cultivation, but also vegetables in the northern region (OKROS et al., 2015). Only in the eastern part the aspect is different, the town bordering with the first heights of Zărand Hills, which are mostly used as vineyards, characteristic for this region (e.g. GRECU, 2008; MĂLĂESCU et al., 2014). Even if the landscape is agriculturally modified, zones with shrubs or grasslands are still present. The town is crossed by a small stream which springs from the south-eastern high areas. In the town, the

stream is heavily polluted, mostly arranged and drained. At the western limit of the town, there are some larger ponds. The town is crossed by a main and some secondary driveways from north to south, with many perpendicular branches. Pâncota contains mostly traditional houses and streets with green spaces. There are only few residential blocks and some massive old official buildings. The industrial activity in the town is reduced. The fieldwork was conducted on March 8, 2017. We collected 33 samples from 24 collecting points, because the large and small sized isopods were separated in different tubes. Isopods were captured directly by hand from under different shelters, as well as in other studies in Romania (e.g. HERLE et al., 2016). As in the previous cases, at each sampling point, we spent approximately 20 minutes. Isopods were found generally under debris and more rarely in the humid soil near wetlands. The sampled individuals were conserved in test tubes with alcohol; the species were determined in the laboratory. By the sampling points we tried to cover relatively uniformly the entire surface of the town, collecting from its most representative zones (both downtown and outskirts). The 24 sampling points matched with 6 habitat types: grasslands, wetlands, abandoned buildings, houses from the centre, houses from the town edge, public zones. The obtained data were analyzed both for the total and for the habitat types. We calculated the percentage abundance and frequency of occurrence for each species. We also calculated the percentage abundance for the individuals from each collecting point. These two parameters were given for habitat types too. The similarity of species was estimated by Jaccard and Bray-Curtis indexes, the species diversity by the Shannon-Wiener index. The affinity of the species to different habitat types was estimated by the Principal Component Analysis (PCA). The significance of the differences between the species composition of different habitat types was tested by the Kruskal-Wallis (for all habitat types) and Mann-Whitney (for habitat type pairs) indexes. All calculations were realized with the PAST 3x software (HAMMER et al., 2001).

RESULTS

In Pâncota town, we found 233 individuals belonging to 13 terrestrial isopod species: *Trichoniscus* sp., *Hyloniscus riparius* (C. Koch, 1838), *Haplophthalmus danicus* Budde-Lund, 1880, *H. mengii* (Zaddach, 1844), *Platyarthrus hoffmannseggii* Brandt, 1833, *Cylisticus convexus* (De Geer, 1778), *Porcellionides pruinosus* (Brandt, 1833), *Protracheoniscus politus* (C. Koch, 1841), *Porcellium collicola* (Verhoeff, 1907), *Trachelipus arcuatus* (Budde-Lund, 1885), *T. nodulosus* (C. Koch, 1838), *Armadillidium versicolor* Stein, 1859 and *A. vulgare* (Latreille, 1804). *Trichoniscus* sp. could not be determined to species level, because we found only 9 females. *T. nodulosus* had the highest percentage abundance. It was followed by *H. riparius* and *A. vulgare* (Table 1). Regarding the frequency of occurrence, the top is occupied by *T. nodulosus*, identified in 91.66% of the collecting points from Pâncota. *T. nodulosus* was followed in frequency by *A. vulgare*, and then by *H. riparius* and *P. pruinosus* (Table 1). In three sampling points, we identified only one species. The maximum number of species / sampling point was seven, registered in only one collecting point. In 10 sampling points, we identified two terrestrial isopod species (Table 1). In Pâncota town, the diversity of terrestrial isopod assemblages was $H=1.84$.

Table 1. The distribution of the terrestrial isopod species in the sampling points in Pâncota town (N - number of species, P% - percentage abundance, f% - frequency of occurrence, Tri – *Trichoniscus* sp., Hr – *H. riparius*, Hd – *H. danicus*, Hm – *H. mengii*, Ph – *P. hoffmannseggii*, Cc – *C. convexus*, Ppr – *P. pruinosus*, Ppo – *P. politus*, Pco – *P. collicola*, Ta – *T. arcuatus*, Tn – *T. nodulosus*, Ave – *A. versicolor*, Avu – *A. vulgare*).

	Tri	Hr	Hd	Hm	Ph	Cc	Ppr	Ppo	Pco	Ta	Tn	Ave	Avu	N	P%
1. Park, high school	-	-	-	-	-	-	-	-	-	-	X	-	-	1	2.57
2. Stream bank, northern town	X	X	-	-	-	X	-	X	-	-	X	-	X	6	6.43
3. Park, town hall	-	-	-	-	-	-	-	-	-	-	X	-	X	2	4.72
4. Stream bank, eastern town	X	X	X	X	-	-	-	-	-	-	-	-	-	4	5.15
5. Houses, near railway station	-	-	-	-	-	-	-	-	-	-	X	-	X	2	3.00
6. Stream bank, centre	-	-	-	-	-	-	-	-	-	X	X	X	-	3	3.43
7. Houses, eastern town	-	-	-	-	-	-	-	-	-	-	X	-	X	2	1.28
8. Houses/pasture, eastern town limit	-	-	-	-	X	-	-	-	-	-	X	-	-	2	1.71
9. Narrow gauge railway station	-	-	-	-	-	-	X	-	-	-	X	-	-	2	2.57
10. Abandoned storehouse, town centre	-	-	-	-	-	-	X	-	-	-	X	-	X	3	2.14
11. Houses/grassland, eastern town limit	-	-	-	-	-	X	-	-	-	-	X	-	-	2	3.00
12. Old abandoned house, northern town	-	X	-	-	-	X	X	-	-	-	X	-	X	5	3.43
13. Large street with old houses	-	-	-	-	-	-	-	-	-	-	X	-	-	1	1.28
14. Cellar entrance, eastern town	-	-	X	-	-	-	-	-	-	-	-	-	-	1	2.57
15. Houses, northern town	-	-	-	-	-	-	X	-	-	-	X	X	X	4	5.57
16. Houses, to the railway station	-	-	-	-	X	-	-	-	-	-	X	-	X	3	5.15
17. Pond, railway station	-	X	-	-	-	-	-	-	X	-	X	-	X	4	18.88
18. Green space, gas station	-	-	-	-	-	-	-	-	-	-	X	-	X	2	2.14
19. Graveyard, eastern town	-	-	-	-	X	-	-	-	-	-	X	-	X	3	3.86
20. Houses, northern town limit	X	X	-	X	-	X	X	-	-	-	X	-	X	7	6.00
21. New block residential area	-	-	-	-	-	-	-	-	-	-	X	-	X	2	7.29
22. Green space, centre	-	-	-	-	-	-	-	-	-	-	X	-	X	2	3.43
23. Abandoned factory, railway station	-	X	-	-	-	-	X	-	-	-	X	-	X	4	2.57
24. Abandoned railway station	-	-	-	-	-	-	-	-	-	-	X	-	X	2	1.71
P%	3.86	20.60	3.86	1.28	3.86	5.15	2.57	0.42	2.57	0.42	39.05	0.85	15.45		
f%	12.50	25.00	8.33	8.33	12.50	16.66	25.00	4.16	4.16	4.16	91.66	8.33	66.66		

Grasslands presented the lowest species number and the public zones the fewest individuals. Humid zones registered the highest species and individual number (Table 2). The most frequent species were *T. nodulosus* and *A. vulgare*, they being present in all 6 habitat types (Table 2). The species *P. politus*, *T. arcuatus* and *P. collicola* were present in only one habitat type, near wetlands (Table 2). According to the Jaccard index, the most resembling isopod assemblages were found in the central house areas and public zones ($J=0.8$), but grasslands and wetlands presented the most different species composition ($J=0.18$) (Fig. 1a). Likewise by the Bray-Curtis similarity, the most distinct assemblage was sheltered by wetlands and the closest by central house areas and grasslands ($BC=0.06$) (Fig. 1b). According to PCA analysis *H. riparius* showed affinity towards wetlands; *A. vulgare* and *T. nodulosus* seem to prefer the central houses area (Fig. 2).

According to Kruskal-Wallis index, there were significant differences between the isopods from different habitat types from Pâncota ($p=0.020$). Analyzing the differences between the habitat type pairs with the Mann-Whitney index, these were significant only in some cases. Thus, significant differences were registered between grasslands and wetlands ($p=0.004$), grasslands and houses from the town edge ($p=0.025$), and wetlands and public zones ($p=0.011$).

Table 2. Terrestrial isopod species distribution in different habitat types in Pâncota town (N - number of species, P% - percentage abundance, f% - frequency of occurrence, Tri – *Trichoniscus* sp., Hr – *H. riparius*, Hd – *H. danicus*, Hm – *H. mengii*, Ph – *P. hoffmannseggii*, Cc – *C. convexus*, Ppr – *P. pruinosis*, Ppo – *P. politus*, Pco – *P. collicola*, Ta – *T. arcuatus*, Tn – *T. nodulosus*, Ave – *A. versicolor*, Avu – *A. vulgare*).

Habitats	Tri	Hr	Hd	Hm	Ph	Cc	Ppr	Ppo	Pco	Ta	Tn	Ave	Avu	N	P%
1. Grasslands															
2. Wetlands	x	x	x	x		x		x	x	x	x	x	x	11	33.91
3. Abandoned buildings		x				x	x				x		x	5	8.15
4. Houses, town centre					x		x				x	x	x	5	21.03
5. Houses, town edge	x	x	x	x	x	x	x				x		x	9	15.88
6. Public zones					x		x				x		x	4	8.15
f%	33.33	50.00	33.33	33.33	50.00	50.00	66.67	16.67	16.67	16.67	100	33.33	100		

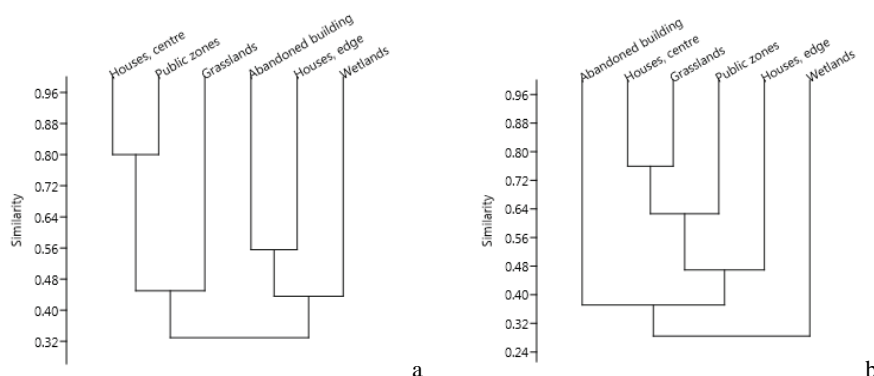


Figure 1. The Jaccard (a) and Bray-Curtis (b) similarity of the species from different habitat types.

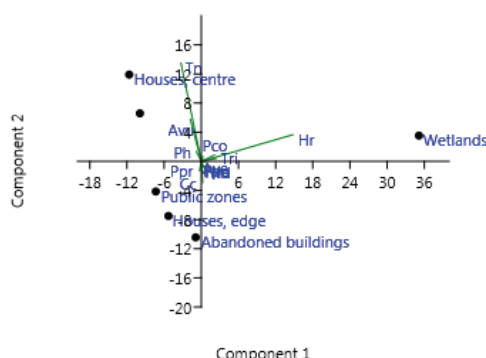


Figure 2. Principal component analysis (PCA) biplot between habitat types and species.

DISCUSSIONS

The presence of the 13 terrestrial isopod species identified in Pâncota is not surprising in the context of their ecological requirements and distribution pattern in Romania (RADU, 1983, 1985; TOMESCU et al., 2011). The number of the identified species in Pâncota is situated between the one registered in Romanian urban areas surrounded by

relatively natural, humid and forested habitats (BODIN et al., 2013; HERLE et al., 2016) and the one situated on plain (Salonta) surrounded by agricultural areas without forests, where only 11 terrestrial isopod species were identified (FERENȚI et al., 2015). Thus, the presence of the additional two species is a consequence of the fact that Pâncota is neighbored partially by a hilly area. Also, it can be attributed to the presence of some permanent wetlands, even if, as well as in Salonta (FERENȚI et al., 2015), the town is surrounded mostly by agricultural areas. Most of the sampling points presented only few species, the remaining species being added by the wetland areas sampling points, especially at the eastern limit of the town, situated in contact with the hilly area.

The isopods identified only in Pâncota, which were not previously found in Salonta, are native, generally linked to wetland and forested areas. The presence of *P. politus*, a typical sylvan species (RADU, 1985; TOMESCU et al., 2011, 2016), is unusual in a locality without forests. *P. politus* was previously identified in urban areas surrounded by forests, but only inside forests (e.g. VILISICS & HORNUNG, 2009; HERLE et al., 2016). However, the species was sometimes observed in disturbed sylvan habitats, like plantations (FARKAS et al., 2013; IANC & FERENȚI, 2014). At Pâncota, *P. politus* was identified on the bank of a small permanent stream, surrounded by willows and shrubs, situated at the eastern part of the town, with higher relief. Probably in the recent past, there were forests near Pâncota. Crișuri Plain was covered by forests in the past, which were clear cut (BERINDEI et al. 1977). The species survived these clearings in the immediate vicinity of the stream, a zone which is still surrounded by shrubbery, like in other cases (TOMESCU et al., 2010). The same explanation was given in the case of the presence of sylvan species in open wetland areas, in north-western Romania (TOMESCU et al., 2010; FERENȚI & DIMANCEA, 2012). This is the case of *T. arcuatus*, which is rare in urban habitats (BODIN et al., 2013; HERLE et al., 2016) and is considered a forest species (e.g. TOMESCU et al., 2015). At Pâncota, *T. arcuatus* was found on the bank of the same stream, the explanation of its presence being the same as in the case of *P. politus* or the other areas of northwestern Romania. Both species are survivors of the past forests, which were replaced by vineyards; at some kilometers distance from Pâncota, there are forests in the hilly area. Other isopods, considered characteristic for mountain forested habitats, were previously identified in humid zones without forests, where they were considered relict species (FERENȚI & COVACIU-MARCOV, 2014).

If the isopod species present in Pâncota were generally expectable, in our case the absence of some species is more curious. Firstly, this is the case of *Porcellio scaber* Latreille, 1804, a common species in other urban areas of Romania (e.g. BODIN et al., 2013; HERLE et al., 2016) or other countries (e.g. JĘDRYCKOWSKI, 1981; VILISICS & HORNUNG, 2009; VILISICS et al., 2012; PRECIADO & MARTINEZ, 2014). *P. scaber* is a synanthropic species (RADU, 1985), which was introduced in many places over the world (e.g. SCHMALFUSS, 2003; PARKER & MINOR, 2015). For all that, in Pâncota we did not identify any individual of this species, even if it was mentioned in urban areas from the northernmost Europe (JĘDRYCKOWSKI, 1981; VILISICS & TERHIVUO, 2009; ŠATKAUSKIENĖ et al., 2016), thus zones with harsher environmental conditions. Taking into account the fact that the collecting points covered relatively uniformly the town surface, targeting its representative habitats, probably the species is really missing from Pâncota. Also, in Pâncota we collected more individuals than previously in Ștei town, where 16 species were present and *P. scaber* was common (HERLE et al., 2016). The absence of the species is even more surprising, because in Romania *P. scaber* was frequently identified in rural areas and even in seminatural and natural habitats (e.g. FERENȚI & COVACIU-MARCOV, 2012, 2015; IANC & FERENȚI, 2014). *P. scaber* absence from Pâncota probably indicates that this species was truly introduced in other urban areas, not being native in this region, and by chance it was not introduced in Pâncota. This seems plausible, because another non native species in Europe like *Protracheoniscus major* (Dollfus, 1903) (COCHARD et al., 2010), were not identified in Pâncota, even if it was introduced in some localities from western Romania (e.g. TOMESCU et al., 2016). Unfortunately, data upon terrestrial isopods are very few in Arad County (TOMESCU et al., 2015); thus, we cannot know the status of *P. scaber* in the surrounding regions. Even more, this species is considered an indicator of metal urban pollution (e.g. HOPKIN, 1986; DALLINGER et al., 1992; UDOVIC et al., 2009), and the vegetables grown on soils from Arad region have a reduced concentration of heavy metals (MUNTEANU et al., 2011).

The terrestrial isopod fauna in Pâncota, although poor, contains mostly native species, characteristic to the region, but common and tolerant species, frequent in urban areas. The most common species, *T. nodulosus*, is native, considered typical for open and dry plain areas (FARKAS, 2010), being frequently mentioned in western Romania (TOMESCU et al., 2015). *T. nodulosus* was encountered also in other localities with high frequency and percentage abundance (e.g. BODIN et al., 2013; FERENȚI et al., 2015). The wet areas are the most important habitats for isopods in Pâncota, like in other towns (FERENȚI et al., 2015; HERLE et al., 2016) and also in natural areas (e.g. FERENȚI et al., 2012, 2013). The species mostly linked with wet areas was *H. riparius*, a species known to be related with such habitats (e.g. RADU, 1983). Related with wet and relatively natural habitats are also *P. collicola* and *T. arcuatus*, like in other regions from western Romania (e.g. FERENȚI et al., 2012). In the same time, the non-native species, frequent in other urban areas (e.g. VILISICS & HORNUNG, 2009; FERENȚI et al., 2015) generally lack from Pâncota. Nevertheless, *P. pruinosus* is present, a Mediterranean species (RADU, 1985), which was frequently mentioned in localities (JĘDRYCKOWSKI, 1981; VILISICS & HORNUNG, 2009; BODIN et al., 2013), but also in natural xeric habitats (FERENȚI et al., 2012).

The majority of habitat types in Pâncota shelters a poor and uniform terrestrial isopod fauna, with few species on a collecting point. The town is populated by native tolerant species, related to open areas. The town small dimension generally protected it from the entrance of non-native species, as in the case of another small town from western

Romania (BODIN et al., 2013). The vicinity of this plain town with higher and wet areas increased the species richness compared to a plain town surrounded only by agricultural areas (FERENȚI et al., 2015). The vineyards from Pâncota vicinity do not seem to influence the isopod fauna. The few native species with narrow habitat requirements are very rare, being survivors of the region's ancient natural habitats.

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Received: March 31, 2017

Accepted: May 27, 2017

STUDY REGARDING THE EVOLUTION OF LYME DISEASE MONITORED FOR A PERIOD OF FOUR YEARS IN OLTENIA, FROM 2013 TO 2016

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Abstract. Lyme disease (Lyme borreliosis) groups the clinic manifestations due to the infection with *Borrelia burgdorferi*. Lyme disease, caused by infection with *Borrelia burgdorferi*, is the most frequently reported arthropod-borne disease in the United States. In Europe, the vector of transmitting the disease is represented by the tick *Ixodes ricinus*. In Romania, there have been identified 27 species of ticks, 25 species of ixodids and 2 species of argasids. Not all ticks are infected with *Borrelia burgdorferi*. The incriminated stages in transmitting Lyme borreliosis are the nymphs and adults. The epidemiologic analysis regarding the supervised cases of Lyme disease from Oltenia taken into consideration for 2010-2012 period when the number of supervised Lyme disease progressively increased, on one side, but also the increase of confirmed cases made us continue the analysis for the next years. In the year 2013, the number of supervised cases of Lyme disease from Oltenia decreased very much and the period 2014-2016 shows variations: increase of cases in the year 2014, their decrease in 2015 followed by an increase in 2016. The lowest number of cases was recorded in 2014, a single case. We notice then a progressive increase of Lyme disease cases in the period 2015-2016. The highest number of Lyme disease cases confirmed in Oltenia was recorded in 2012, and the lowest number in the year 2013.

Keywords: Lyme disease, *Borrelia burgdorferi*, tick, epidemiologic analysis, confirmed cases.

Rezumat. Studiu privind evoluția cazurilor de boală Lyme luate în supraveghere în Oltenia pentru o perioadă de patru ani, din 2013 până în 2016. Boala Lyme (borrelioza Lyme) grupează manifestările clinice datorate infecției cu *Borrelia burgdorferi*. Boala Lyme, cauzată de infecția cu *Borrelia burgdorferi*, este cea mai frecventă boală transmisă de artropode în Statele Unite ale Americii. În Europa, vectorul de transmitere al bolii îl reprezintă căpușa *Ixodes ricinus*. În România, au fost identificate 27 specii de căpușe, 25 specii ixodide și 2 specii argaside. Nu toate căpușele sunt infectate cu *Borrelia burgdorferi*. Stadiile incriminate în transmiterea borreliozei Lyme sunt: nimfele și adulții. Analiza epidemiologică privind cazurile de boală Lyme luate în supraveghere din Oltenia realizată pentru perioada 2010-2012 când numărul de cazuri de boală Lyme intrate în supraveghere în Oltenia a crescut progresiv, pe de o parte, dar și creșterea numărului de cazuri confirmate, ne-a determinat să continuăm analiza pentru anii următori. În anul 2013 numărul de cazuri de boală Lyme intrate în supraveghere în Oltenia a scăzut foarte mult, iar perioada 2014-2016 prezintă fluctuații: creșterea numărului de cazuri în anul 2014, scăderea lor în 2015, urmată de o creștere în anul 2016. Cel mai mic număr de cazuri de boală Lyme intrate în supraveghere în Oltenia s-a înregistrat în anul 2014, un singur caz. Se remarcă apoi o creștere progresivă a numărului de cazuri de boală Lyme confirmate în Oltenia în perioada 2015-2016. Cel mai mare număr de cazuri de boală Lyme confirmate în Oltenia, s-a înregistrat în anul 2012, iar cel mai mic număr în anul 2013.

Cuvinte cheie: boala Lyme, *Borrelia burgdorferi*, căpușă, analiză epidemiologică, cazuri confirmate.

INTRODUCTION

The syndrome known today under the generic denomination of Lyme disease was reported in many regions from Asia, Australia, England, Europe, Mexico, North America, Russia and South Africa (WHITE, 2005). Lyme disease, caused by infection with *Borrelia burgdorferi*, is the most frequently reported arthropod-borne disease in the United States. (DAVID et al., 1998). Lyme disease (Lyme borreliosis) groups the clinic manifestations caused by the infection with *Borrelia burgdorferi* (CIOLPAN, 2008). Many of the researches done to identify the etiological agent of the disease coincided with the efforts to determine the potential vector and the natural cycle of the disease (WHITE, 2005).

In Europe, the vector of the disease transmission is the tick *Ixodes ricinus*. In Romania, 27 species of ticks, 25 species of ixodids and two species of argasids were identified (COIPAN et al., 2011). Not all the ticks are infected with *Borrelia burgdorferi*. The incriminated stages in transmitting the Lyme borreliosis are the nymphs and adults (VLADIMIRESCU, 2012). According to the researches done by COIPAN & VLADIMIRESCU, 2011 approximately 18% of the ticks analyzed through molecular methods presented *Borrelia burgdorferi* *sensu lato* and the prevalence of infection did not differ significantly between nymphs (19.1%) and adults (15.4%). The borrelioses persist in the *Ixodes* ticks genus also through trans-stages and transovarian transmission (CIOLPAN, 2008).

Lyme borreliosis, present also in Romania, is a part of the supervised transmissible diseases. The epidemiologic analysis regarding the supervised cases of Lyme disease from Oltenia taken into consideration for 2010-2012 period when the number of supervised Lyme disease progressively increased, on one side, but also the increase of the confirmed cases, made us continue the analysis for the next years. In the year 2013, the number of the supervised Lyme disease cases decreased very much and the period 2014-2016 shows variations - increase of the cases in the year 2014, their decrease in 2015 followed by an increase in the year 2016. The lowest number of the supervised Lyme disease was recorded in the year 2014, a single case. We notice then a progressive increase of Lyme disease confirmed cases in the period 2015-2016. The highest number of Lyme disease cases confirmed in Oltenia was recorded in 2012, and the lowest number in the year 2013.

MATERIAL AND METHODS

The used data for this analysis are extracted from the yearly *Reports regarding The Analysis of the transmissible Supervised Diseases Evolution* from 2013-2016 period and *Lyme disease - The descriptive epidemiologic analysis of Lyme diseases supervised* for 2013-2016 period, realized by the National Institute for Public Health Romania/ National Center of the Surveillance and Control of Transmissible Diseases. The data extracted were registered in tables. The data processing was done through mathematic methods, and the graphs were realized using Microsoft Excel.

RESULTS AND DISCUSSIONS

Stage II. The analysis of the supervised Lyme disease cases in Oltenia in 2013-2016.

The cases of the supervised Lyme disease in the year 2013 in Oltenia represent 25% of the total number of cases from 2012, their significant decrease being pointed out (Table 1). Regarding the number of cases confirmed in the year 2013, we notice a significant decrease, representing 38.09% from the number of cases confirmed in 2012. As a consequence of the supervised cases reported in Oltenia compared to the supervised cases at the national level (2013) we notice the next aspects: supervised cases: 1.71% from the cases at the national level; confirmed cases: 1.95% from the ones at the national level; infirmed cases: 1.74% from the ones at the national level.

Table 1. Lyme disease cases supervised in Romania in 2013-2016 period.

Years	Confirmed	Infirmed	Probable	Suspected/possible	Total
2013	409	572	70	1	1052
2014	248	441	17	52	758
2015	330	386	27	30	773
2016	250	392	20	26	688

In the next year, 2014, the supervised Lyme disease cases in Oltenia represent 83.33 % from the number of 2013 year cases, a slow decrease being pointed out. Speaking about the number of the confirmed cases in the year 2014, we notice a significant decrease, these representing 12.5 % from the number of cases confirmed in the year 2013. As a result of the analyses of the supervised cases reported in Oltenia compared to the ones at the national level (2014) we observe the following aspects: supervised cases: 1.97 % from the ones at the national level; confirmed cases: 0.40 % from the ones at the national level; infirmed cases: 2.97 % from the ones at the national level; probable cases: 5.88 % from the ones at the national level.

In Oltenia, the supervised Lyme disease cases in 2015 represent 73.33 % from the number of cases in the year 2014, a slow decrease being noticed. The number of cases confirmed in the year 2015 in Oltenia, shows a significant increase, four times higher than the number of the confirmed cases in 2014. Thus, the number of the confirmed cases in the year 2015 in Oltenia represents 36.36 % from the supervised Lyme disease cases in that year at Oltenia level. Analyzing the supervised reported cases compared to the ones at the national level (2015), we underline the following aspects: supervised cases: 1.42 % from the ones at the national level; confirmed cases: 1.21 % from the ones at the national level; probable cases: 3.33 % from the ones at the national level; infirmed cases: 1.55 % from the ones at the national level.

In the year 2016, in Oltenia, the supervised Lyme disease cases increased with 36.36 % compared to the ones from 2015. Speaking of the confirmed cases in the year 2016 in Oltenia, we also notice here a significant increase, 75 % compared to the confirmed cases in the year 2015. The number of the confirmed cases in the year 2016 in Oltenia represents 46.66 % from the supervised cases in that year at the level of Oltenia. As a conclusion of the supervised cases reported from Oltenia compared to the ones at the national level, we notice the following aspects: supervised cases: 2.18 % from the ones at the national level; confirmed cases: 2.8 % from the ones at the national level; infirmed cases: 1.78 % from the ones at the national level; possible cases: 5% from the ones at the national level.

For the period 2013-2016 the supervised Lyme cases in Oltenia is presented in the below table (Table 2).

Table 2. Lyme disease cases supervised in Oltenia in 2013-2016 period.

Years	Confirmed	Infirmed	Probable	Suspected/possible	Total
2013	5	0	0	0	5
2014	1	13	0	1	15
2015	4	6	1	0	11
2016	7	7	0	1	15
Total	17	26	1	2	46

After the analysis of these data we notice the fact that the lowest number of supervised cases was in 2013 and the highest in 2014 and 2016. Speaking of the number of confirmed cases, the highest number was recorded in 2016 and the lowest number in 2014, when, at the level of Oltenia, only one case of Lyme disease was confirmed.

In the period 2013-2016, the number of the supervised Lyme disease cases in Oltenia was 46, and the number of the confirmed cases was 17 that represents 36.95 % from the total supervised cases. We notice a variation in this period of the supervised cases in Oltenia, with the decrease of the number in the years 2013 and 2015 on one side and the increase of the cases in the years 2014 and 2016 on the other side.

We shall further analyse the distribution on counties of the supervised Lyme disease cases in Oltenia for the period 2013-2016. From the analysis of the graph (Fig.1), we notice that the highest number of the confirmed Lyme disease cases in the year 2013 was recorded in Vâlcea County, followed by Olt and Gorj Counties. We also notice that there was no case in Dolj and Mehedinți counties. In Vâlcea County, there were not infirmed, probable or possible cases, and in the counties Olt and Gorj there were not any probable or possible Lyme disease cases.

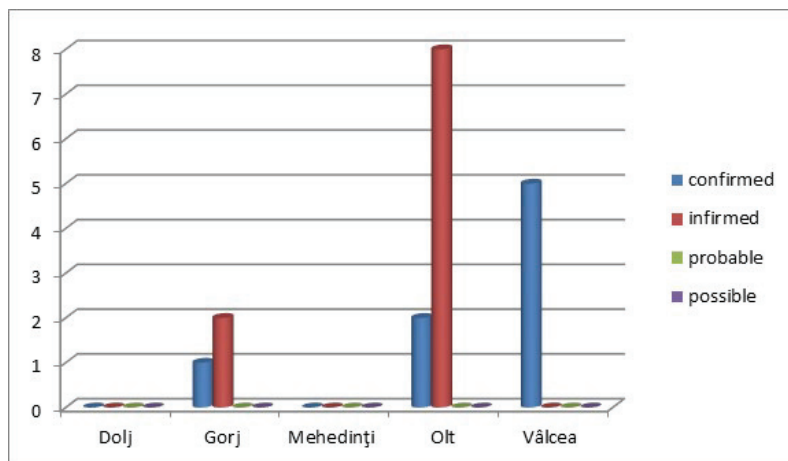


Figure. 1 The distribution on counties of the supervised Lyme disease cases in Oltenia 2013.

In 2014, we notice the fact that the highest number of the confirmed Lyme disease cases was recorded in Vâlcea County, being in fact the only county in Oltenia where there were confirmed cases. In the graph below (Fig. 2), we also notice that there was no case of Lyme disease in Dolj County and in the counties Gorj, Mehedinți and Olt there were not confirmed cases.

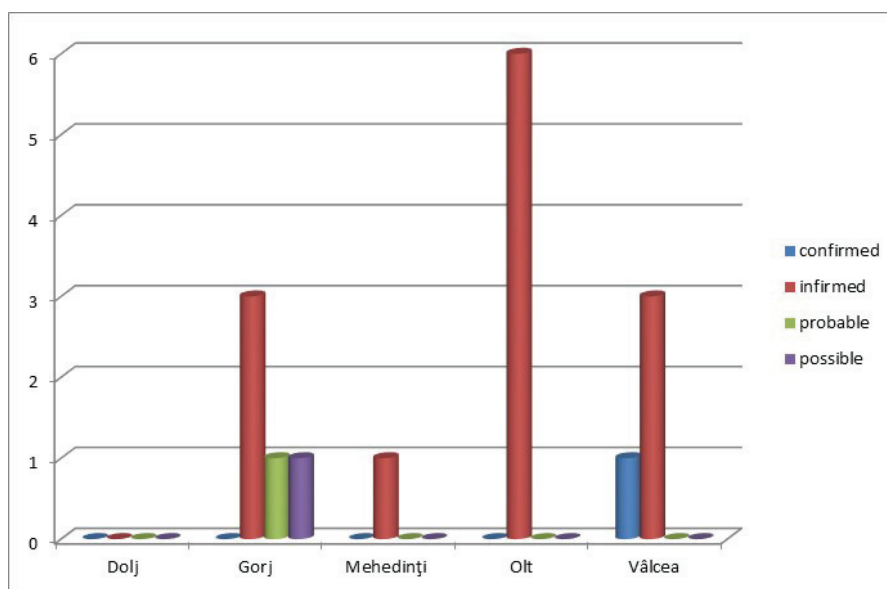


Figure 2. The distribution on counties of the supervised Lyme disease cases in Oltenia 2014.

For the next year, 2015, in Gorj County, it is remarked the highest number of confirmed Lyme disease cases in Oltenia. From the analysis of the graph (Fig. 3), we notice the fact that the number of cases is equal in Olt and Vâlcea counties. We notice that in Mehedinți County there was not recorded any case and in Dolj County there were not confirmed cases. In Gorj County, there were not infirmed, possible or probable cases.

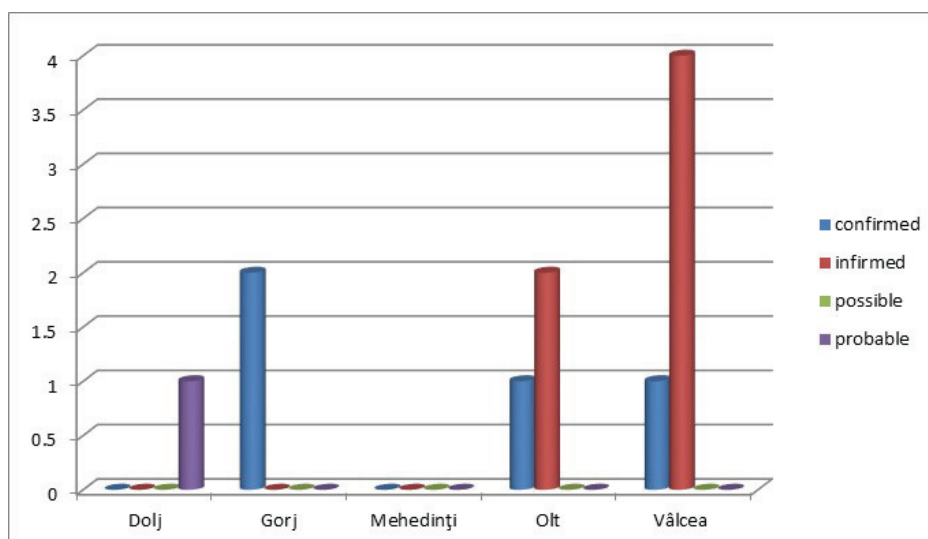


Figure 3. The distribution on counties of the supervised Lyme disease cases in Oltenia 2015.

In Oltenia, in 2016, there were supervised Lyme disease cases, in all the counties. Thus, according to the graph (Fig. 4), we notice that the highest number of the confirmed Lyme disease cases in the year 2016 was recorded in Mehedinți County followed by the counties Dolj, Olt, Gorj and Vâlcea that had the same number of cases. In Vâlcea County, there were infirmed most of the cases, followed by Olt and Gorj counties. In the counties Dolj and Mehedinți, there were not any infirmed, probable or suspected Lyme disease cases.

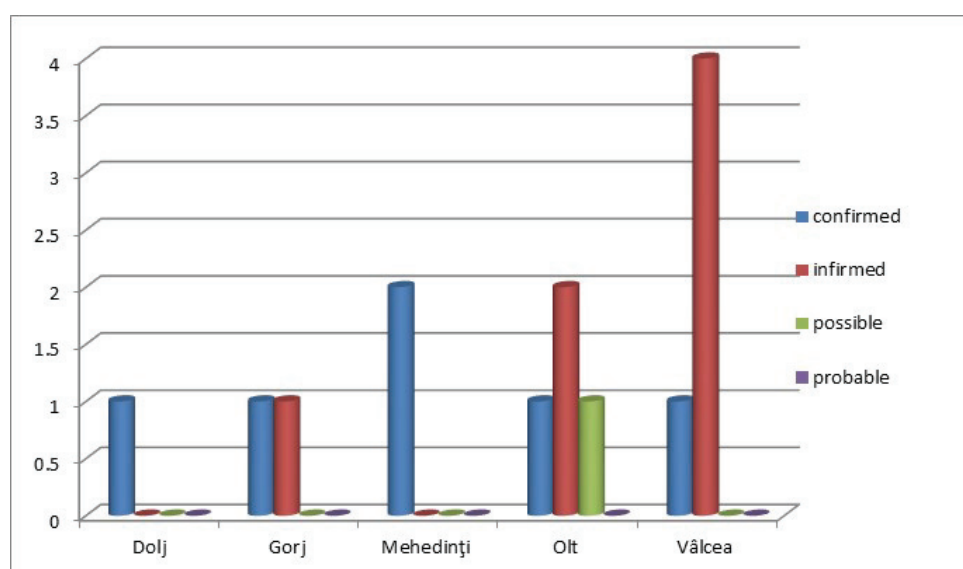


Figure 4. The distribution on counties of the supervised Lyme disease cases in Oltenia 2016.

From the graph (Fig. 5) we notice that the highest number of the confirmed Lyme disease cases in the period 2010-2016 was recorded in the year 2012 (21 cases). In the period 2010-2012, the number of confirmed cases in Oltenia progressively increased and in the period 2013-2014 the number of confirmed cases decreased. We notice then a progressive increase of the confirmed cases in Oltenia in the period 2015-2016. The lowest number of confirmed cases was recorded in 2013 that is 5 cases.

In the period 2010-2012, (Fig. 6) the number of the supervised cases progressively increased and in 2013 the cases decreased very much. We noticed the period 2014-2016 with variations, an increase of the cases in the year 2014, their decrease in 2015 followed by an increase in 2016. The lowest number of the supervised cases in Oltenia was in 2014 that is a single case.

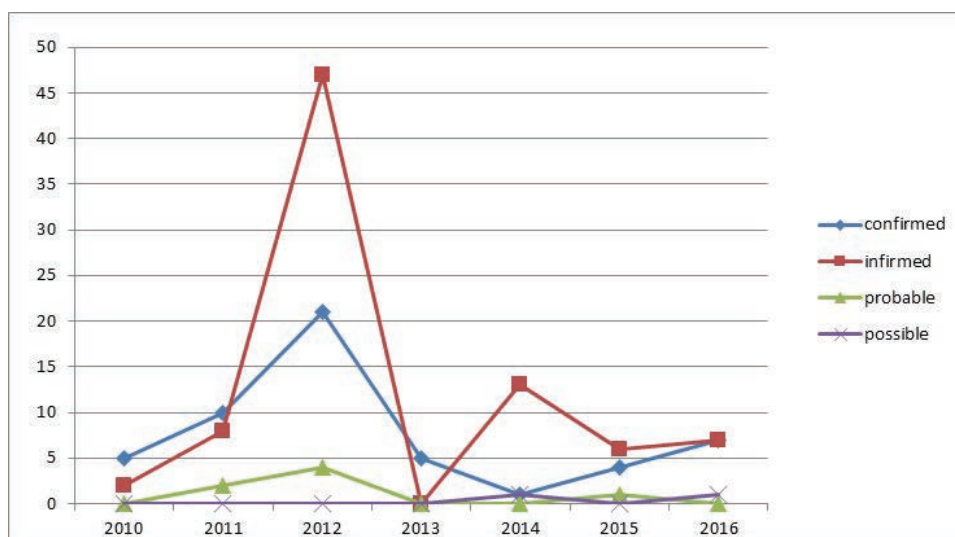


Figure 5. The evolution of the supervised Lyme disease cases in Oltenia (2010-2016).

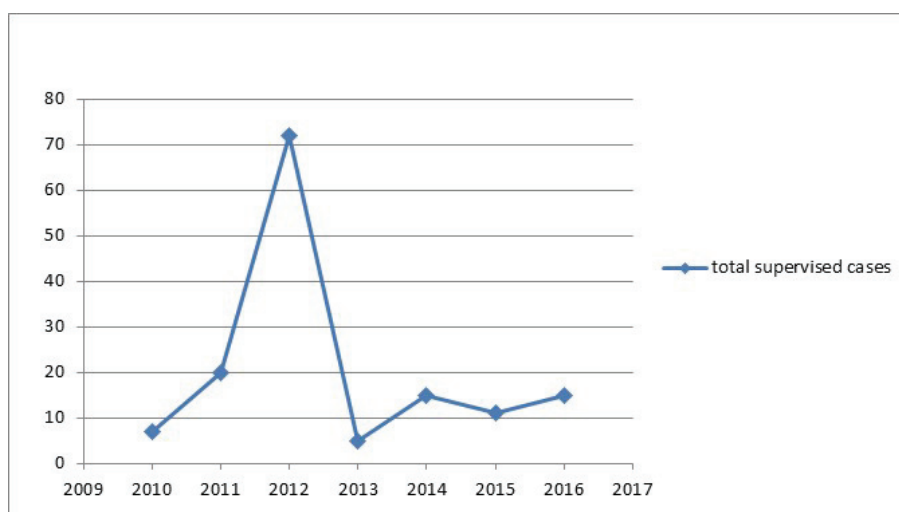


Figure 6. The evolution of the supervised Lyme disease cases in Oltenia (2010-2016).

CONCLUSIONS

The epidemiologic analysis regarding Lyme disease cases supervised in Oltenia, is realized for the 2010-2016 period, in two stages: the first one for the 2010-2012 period and the second stage, 2013-2016 period.

In conclusion, we underline some important aspects related to Lyme borreliosis for the 2010-2016 period in Oltenia region. The number of the supervised cases in Oltenia in 2011 is 2.85 times higher than in 2010 and in the next year, 2012, the number of the supervised cases in Oltenia is 3.6 times higher than in 2011. But in the year 2013, the number of the supervised cases in Oltenia is 14.4 times lower than in 2012. In the next year, 2014, the number of the supervised cases in Oltenia is three times higher than in 2013. The number of the supervised cases in 2015 is 1.36 times lower than in 2014. The number of the supervised cases in Oltenia in 2016 is 1.36 times higher than in 2015.

Taking into consideration the continuous increase of Lyme disease cases in the period 2010-2012, in the second stage of the study, the period 2013-2016, when the supervised Lyme disease cases were analyzed, we started to collect ticks from pets, especially dogs, stray dogs or from shelters, domestic animals (goats), as well as from the people present at the emergency room of the Hospital no.1 from Craiova. The collected ticks were preserved in ethyl alcohol 96 degrees for further studies in order to identify the pathogens transmitted by them.

The ticks *Ixodes ricinus* are recorded in Romania with two peaks of activity: a maximum in spring (March-May) and another one of a lesser intensity in the fall (September-November) (VLADIMIRESCU, 2012). The development of the ticks is highly depended on the climate conditions. The rainfalls are important in the expansions of the vectors and/or the increase of their populations (CODREANU-BĂLCESCU & CODREANU, 2010). As a result, the years in which temperatures abruptly increased and abundant rains from March-May were followed by high temperatures gave a fast development of the vegetation and the appearance of a great number of ticks. The recreational areas, the parks and the places with rich vegetation, the forested areas are good places for the spreading of ticks.

Thus, a walk in the park or a picnic can be very annoying or even dangerous; in order to protect the population present in parks, playgrounds and recreational areas, disinsectization is advisable on one side and on the other side, for individual protection, suitable clothes and different repellents for ticks are recommended.

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Received: March 29, 2017
Accepted: June 22, 2017

PRELIMINARY DATA REGARDING BEETLE PARASITE SPECIES COLLECTED FROM DIFFERENT ECOSYSTEMS MET IN DOLJ COUNTY IN 2017

LILA Gima

Abstract. The research studies on the diversity of parasite beetles from Dolj County exposed in this paper were achieved in 2017. The beetle biological material (32 specimens, 4 of which displaying various parasite forms) was collected from terrestrial ecosystems - Radomir, Bistreț, Valea Stanciului, Bâlta. The hosts, from the systematic viewpoint, belong to the order Coleoptera, respectively to 2 subfamily- Dynastidae and Scarabaeinae, from Scarabaeidae family. The species on which parasites were found are *Onthophagus* (*Palaeonthophagus*) *vacca* (Linnaeus 1758); *Onthophagus taurus* (Schreber, 1759); *Oryctes nasicornis* Linnaeus 1758 and *Copris lunaris* (Linnaeus 1758). From the systematic viewpoint, the identified parasites are mites and grouped as follows: *Macrocheles* sp. (Mesostigmata: Dermanyssina: Eviphidoidea: Macrochelidae) and *Hypoaspis* sp. (Mesostigmata: Laelapidae). The dominant species is represented by mites, *Macrocheles* sp., identified in *O. vacca* and *O. taurus*, new for Dolj, Romania. In this paper we expose the results of research conducted in two species of parasites (*Macrocheles punctillatus*, identified in *O. vacca* and *Hypoaspis* sp. to *Copris lunaris*); the other will be set out in a forthcoming paper.

Keywords: mites, beetles, ecosystems.

Rezumat. Date preliminare privind specii de paraziți la coleoptere din diferite ecosisteme din județul Dolj colectate în 2017. Cercetările privind diversitatea paraziților la coleoptere din județul Dolj expuse în lucrarea de față au fost realizate în anul 2017. Materialul biologic de coleoptere (32 exemplare din care 4 exemplare au diverse forme parazite) a fost colectate din ecosisteme terestre (Radomir, Bistreț, Valea Stanciului, Bâlta). Gazdele, din punct de vedere sistematic, aparțin ordinului Coleoptera încadrându-se în 2 familii: Dynastidae și Scarabaeidae. Speciile pe care s-au găsit paraziți sunt: *O. (Palaeonthophagus) vacca* (Linnaeus 1758); *O. taurus* (Schreber, 1759); *O. nasicornis* Linnaeus 1758 și *C. lunaris* (Linnaeus 1758). Paraziții identificați în urma cercetărilor de specialitate, din punct de vedere sistematic, sunt acarieni și sunt încadrați astfel: *Macrocheles* sp. (Mesostigmata: Dermanyssina: Eviphidoidea: Macrochelidae) și *Hypoaspis* sp. (Mesostigmata: Laelapidae). Specia dominantă ca și parazit este reprezentată de către acarieni, *Macrocheles* sp., identificați la *O. vacca* și *O. taurus*. În lucrarea de față vom expune rezultatele cercetărilor efectuate la două specii de paraziți (*Macrocheles punctillatus* identificat la *O. vacca* și *Hypoaspis* sp. la *Copris lunaris*), celelalte urmând a fi expuse într-o lucrare viitoare.

Cuvinte cheie: acarieni, coleoptere, ecosisteme.

INTRODUCTION

The purpose of this paper is to present some contributions to the knowledge of the diversity of parasites, 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 (32 specimens, 4 of which displaying various parasite forms) was collected from terrestrial ecosystem - Radomir, Bistreț, Valea Stanciului, Bâlta. The hosts, from the systematic viewpoint, belong to the order Coleoptera, respectively to 2 Dynastidae and Scarabaeidae. The species on which parasites were found are *O. vacca* (Linnaeus 1758); *O. taurus* (Schreber, 1759); *Oryctes nasicornis* Linnaeus 1758 and *Copris lunaris* (Linnaeus 1758). From the systematic viewpoint, the identified parasites are mites and grouped as follows: *Macrocheles* sp. (Mesostigmata: Dermanyssina: Eviphidoidea: Macrochelidae) and *Hypoaspis* sp. (Mesostigmata: Laelapidae).

MATERIALS AND METHODS

The material used in this paper consisted in 32 specimens found in the field, which were identified, analysed and studied, three species having parasites.

The species of beetles are presented in systematic order according to the year they were collected and there are mentioned the species of parasite identified for each of them.

The material was collected in 2017. Collections were made at different dates, in May, June and July. Collection date is mentioned for each species. Moreover, for every locality, there are rendered the geographical coordinates, flora and fauna information. Collection methods were different according to the analysed host species.

1. Collection methods for *O. vacca*, *O. taurus*, *Oryctes nasicornis* and *Copris lunaris*.

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 museum, entomology 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

Each of the four specimenes examined contained mites that was stored in separate glass jars at room temperature until they were carefully transported and examined under the microscope. Using tweezers, mites were collected from *O. vacca*, *O. taurus*, *Oryctes nasicornis* and *Copris lunaris* females, more precisely from the feet and the ventral side of the abdomen. For identification, the mites were prepared in paraffin.

To determine the collected material there were used the works of PANIN (1957), in the entomology laboratory of the Department of Natural Sciences Museum of Oltenia Craiova. For the some species of mites, the determination was performed by Mr. Ismail Babaiean, University of Tehran, College of Agriculture. From the systematic viewpoint, the species of Spirocercidae was determined by Mrs. analyst Claudia Mirela Fimon, who will further determine the exact species.

Some of the photos were made with Mr. Cristi Boicea and Mrs. Marilena Boicea - chemist in the laboratory of Restoration - Oltenia Museum Craiova by means of the stereomicroscope OLYMPUS 3D and another category were made by DMC-FZ62 Panasonic FullHD digital camera by Lila Gima.

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

RESULTS AND DISCUSSIONS

The analysed material was represented by 44 specimens of which 7 specimens had parasites. The material was collected in 2017 in the following locations: Radomir, Bistreț, Valea Stanciului, Bâlta. There are rendered the collection sites, the species of collected beetles and the identified parasites (Table 1).

Table 1. Material collected and their parasites.

No.	Host	Parasites	Collection site	Date of collection
1	<i>Onthophagus (Palaeonthophagus) vacca</i> (Linnaeus 1767)	<i>Macrocheles punctillatus</i> (Willmann, 1939)	Radomir	May 17, 2017
2	<i>Onthophagus taurus</i> (Schreber, 1759)	<i>Macrocheles</i> sp.	Bistreț	May 17, 2017
3	<i>Oryctes nasicornis</i> Linnaeus 1758 ♀	<i>Hypoaspis</i> sp.	Valea Stanciului	May 30, 2017
4	<i>Copris lunaris</i> (Linnaeus 1758) ♀	<i>Uropoda</i> sp.	Bâlta	June 6, 2017

Host: *Onthophagus (Palaeonthophagus) vacca* (Linnaeus 1767)

Parasite: *Macrocheles punctillatus* (Willmann, 1939).

Collection site: Radomir

***O. (Palaeonthophagus) vacca* (Linnaeus 1767)**

Scarabaeoidea: Scarabaeidae: Scarabaeinae: Onthophagini: *Onthophagus*: *Palaeonthophagus*

The genus *Onthophagus* is represented in the fauna of Oltenia by 16 species, out of the 24 reported for the fauna of Romania (CHIMIȘLIU, 2004). All 16 species were identified in Dolj County entomofauna.

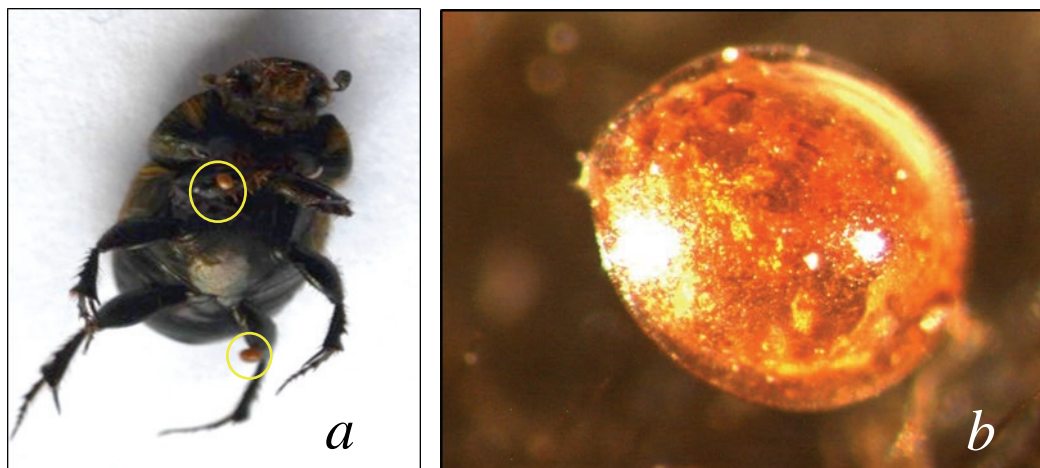


Figure 1. Deuteronymphs on the legs (a) fixed with pedicel (b) at *O. vacca* (orig).

O. vacca is a species with coprophagous trophic regime, encountered in all climatic conditions, except for the alpine steppes, being more common in the area of oak forests and ante-steppes (PANIN, 1957). This species is present in most of Southern Europe, Western Asia and North Africa.

The species of the genus *Onthophagus* Latr. are hosts for *Rhabditistretzeli* Sachs., *Ascarops strongylina* Rud. and *Gongylonema scutatum* Auct. (Nematoda, Secernentea, Spirurida, Gongylonematidae), *Macrocheles punctillatus* (Willm.), *Anoetus ferroniarum* (Duf.) (Acari, Mesostigmata, Dermanyssoidea, Scheloribatidae).

The material was found in an area where the locals leave their cattle for grazing. The identified mite species is *Macrocheles punctillatus* (Willmann, 1939) and Radomir locality is a new site for this species.

The species *M. punctillatus* is described by Bregetova and Koroleva (1959) (in COSTA, 1966) and Bregetova (1960) at *Onthophagus* sp.; the species is common in Israel in manure stacks (in COSTA, 1964) and reported by BALTHASAR (1963) (Figs. 1a, b).

***Macrocheles punctillatus* (Willmann, 1939)**

Arachnida: Micrura: Acari: Anactinotrichida: Mesostigmata: Dermanyssina: Eviphidoidea: Macrochelidae: *Macrocheles*: *M. punctillatus*.

The species of the genus *Macrocheles* fall into two main categories, for ecological reasons, which correlate with certain morphological features. There are those species usually found in leaves, garbage, moss, bird nests and small mammals and other habitats that are not predominantly associated with coprophagous insects and there are species that are usually coprophilic, in association with coprophagous insects, but also found in piles of compost, rotting grass, dung, generally loose soil that favors the reproduction of synanthropic flies (KRANTZ, 1981).

The species in the aforementioned group are often forezia species; mostly females can be found on coprophagous and necrophagous insects, for example garbage bugs and synanthropic flies. Their males are rarely found.

Some species of the two categories have certain common characters: *M. penicilliger* is found on coprophagous insects and *M. matrius*, which is very often associated with chicken manure and compost heaps, is not usually found on coprophagous insects. Both species have a strong preponderance.

It is interesting to note that KRANTZ (1981) showed that the group of glabra species and *M. robustulus* do not share the ambulacral characters in the immature stages found in other *Macrocheles* species and that *M. penicilliger* is an intermediate between the two main types of ambulacral structures (in KEITH HYATT & EMBERSON, 1988).

Most species have been found out to be predators specialized on eggs and young larvae of flies, coleopterans and also on small nematodes and small worms of Enchytraeidae found in their habitat, although biological data are much more fragmented for these species (KEITH HYATT & EMBERSON, 1988).

Host: *Oryctes nasicornis* Linnaeus 1758 (The European rhinoceros beetle) ♀

Parasite: *Hypoaspis* sp.

Collection site: Valea Stanciului

***Oryctes nasicornis* Linnaeus, 1758**

Coleoptera: Scarabaeidae: Dynastinae: *Oryctes*

It is the only representative of the Dynastinae subfamily found in Northern Europe. It is widespread in the Mediterranean basin up to Pakistan, the Near East and North Africa.

Oryctes is the most economically important genus of rhinoceros beetles in the subfamily Dynastinae (family: Scarabaeidae), since is insect pest. It is a sexually dimorphic species. The male's head is topped by a long curved horn (hence its common name), while the females have no horns (Fig. 3).

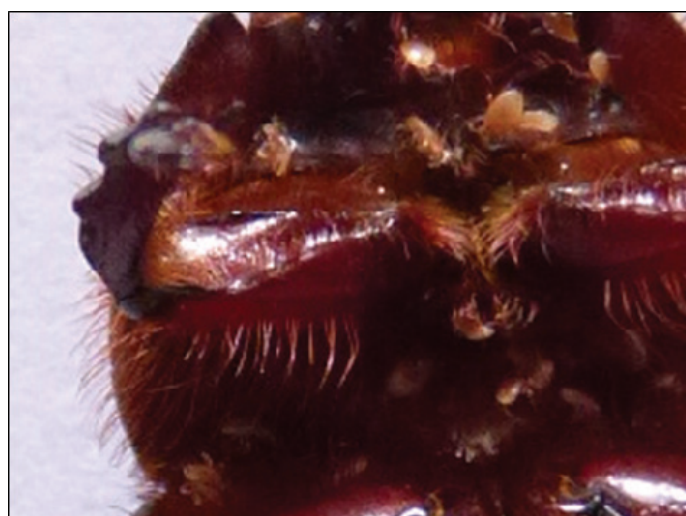


Figure 3. Deuteronymph of *Hypoaspis* sp. on *O. nasicornis*, female (original).

***Hypoaspis* sp.**

Arthropoda: Arachnida: Acari: Mesostigmata: Laelapidae: *Hypoaspis*

Fifteen species considered as belonging to *Hypoaspis* sp. have been reported from Iran so far, including new species. Almost all species of *Hypoaspis* sp., which appear in Iran, are associated with Coleoptera, especially with species belonging to the Scarabaeidae family, while few have been collected in the soil (JOHARCHI & SHAHEDI, 2016).

The Laelapidae family includes about 800 species of dermanyssoid 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 & 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.

The family of Laelapidae mites includes many species that are ectoparasites of small mammals, birds, annelids, insects and myriapods, as well as predators in the soil, living freely in the leaf and moss bedding (EVANS & TILL, 1979; KHANJANI & UECKERMANN, 2005; FARAJI & HALLIDAY, 2009; KRANTZ & WALTER, 2009 in MOHAMMAD KHANJANI et al., 2013).

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)

Many species of *Hypoaspis* sp. which appear in Iran are associated with Coleoptera, especially with the species of the Scarabaeidae family (JOHARCHI & SHAHEDI, 2016).

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

It is difficult to determine the species, because they are not yet trained specialists. 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.

Laelapidae species are associated with a variety of insects, including the beetles belonging to the Scarabaeidae family, which they also use to disperse (JOHARCHI et al., 2017).

The members of the genus *Hypoaspis* Canestrini (Fig. 4) and the related genera are predators found in soil, litter and moss (EVANS & TILL, 1979 in MOHAMMAD KHANJANI et al., 2013).

Some of these species are used as biological control agents in greenhouse crops against spiders and thrips, and in fungus cultures such as *Rhizoglyphus* and *Tyrophagus* spp. (ENKEGARD et al., 1997, LESNA et al., 2000, VANNINEN & KOSKULA 2004, BEAULIEU, 2009 in MOHAMMAD KHANJANI et al., 2013).

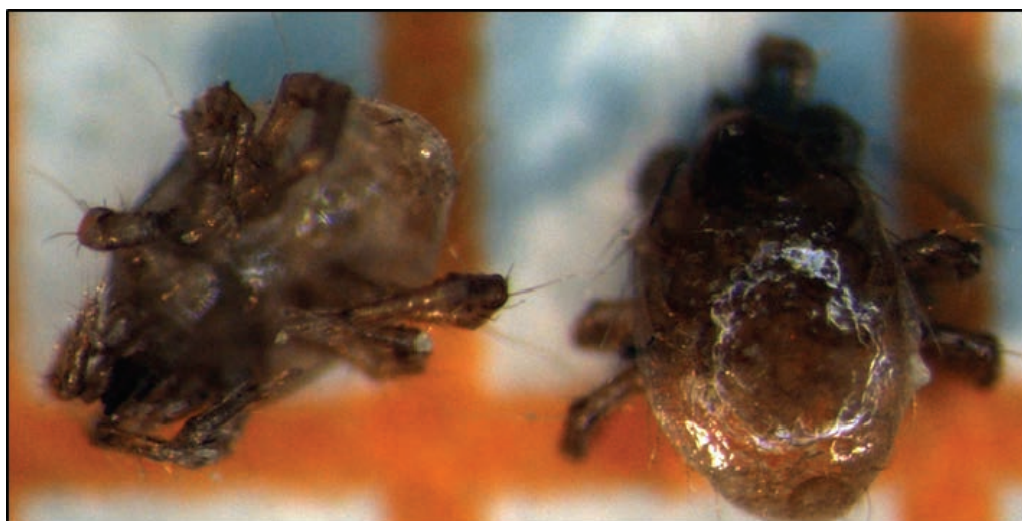


Figure 4. Deuteronymphs of *Hypoaspis* sp. ventral and dorsal side (orig.).

They can cause significant reductions in the number of fungus and thrips attacks on flowers (BEAULIEU, 2009 in MOHAMMAD KHANJANI et al., 2013).

At the same time, *Hypoaspis calcuttaensis* Bhattacharya significantly reduced the number of root-knot nematode, *Meloidogyne Javanica* (Treub), a pest of the plant *Hibiscus esculentus*.

Hypoaspis rhinocerotis Oudemans feeds on the eggs of the coconut rhinoceros beetle *Oryctes rhinoceros* L., a serious pest of coconut palm trees.

Hypoaspis athiasae Costa, originally associated with *O. monocerus* Oliver, from Côte d'Ivoire, feeds on *O. rhinoceros* eggs (COSTA, 1971; GERSON et al., 2003 in MOHAMMAD KHANJANI et al., 2013).

Besides *Hypoaspis athiasae*, Costa (1971) described yet another species collected from Coleoptera from Israel, Côte d'Ivoire and Western Samoa. Khanjani & Ueckermann (2005) described *Hypoaspis polyphyllae* from *Polyphylla olivieri* (in MOHAMMAD KHANJANI et al., 2013).

Polyphylla olivieri (Scarabaeidae) is a serious pest of horticultural crops in western Iran. Its larvae cause serious damage to the roots of apple and cherry trees, as well as of potatoes, and adults occasionally attack apple and cherry leaves (in MOHAMMAD KHANJANI et al., 2013).

CONCLUSIONS

The work joins the efforts of specialists who contribute to the knowledge of entomofauna diversity.

Of the identified parasite species, we publish only the results for 7 species that we studied, the next ones being part of another paper. Cernătești, Craiova, Mogoșești, Radomir, Bistreț, Valea Stanciului, Bălta localities represent new collection sites for each species of Coleoptera.

The species of mites identified in the studied beetles are species reported by foreign authors, but there are no mentions of them in the Romanian specialized literature.

It is difficult to determine the species, because they are not yet trained specialists. 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.

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Received: March 31, 2017
Accepted: September 2, 2017

INSECT ECTOPARASITES ON THE WHITE STORK, *Ciconia ciconia* (L.) (CICONIIFORMES: CICONIIDAE), DURING THE BREEDING PERIOD IN THE EXTREME EAST OF ALGERIA

BOUGUESSA-CHERIAK Linda, DOUMANDJI Salaheddine,
OULD MESSAOUD Sadek, MARNICHE Faiza

Abstract. Avian and other migratory fauna are strongly exposed to different forms of parasites in their feeding and breeding areas; the white stork is a good model for the study of this phenomenon. This study was carried out in the region of Tebessa, which is located in the extreme east of Algeria, at an altitude of 896 m and which belongs to the semi-arid bioclimatic stage. Two colonies of white stork are chosen for this study, one nesting in urban areas and the other in a natural environment. The results obtained revealed the presence of ten ectoparasite species found on the feathers of the white stork. They belong to 4 orders: Phthiraptera, Heteroptera, Hymenoptera and Diptera, 4 suborders and 5 families. A total of 246 specimens were collected: 67 specimens of *Ardeicola* sp., 63 specimens of *Colpocephalum* sp. and 46 specimens of *C. zebra*. On the storks from the urban area, 50 specimens were collected; they belong to 7 different species. *Ardeicola ciconiae* is the most abundant species, accounting for 38% of the total fauna, followed by *Ciconiphilus quadripululatus* (Burmeister, 1838) with 28%, *Ardeicola* sp., with 14%. On the storks from the natural area, 117 specimens were collected; they belong to 4 different species. *Ardeicola* sp. is the most abundant species, accounting for 38% of the total ectoparasitic fauna, followed by *Colpocephalum* sp., with 36% and *C. zebra* with 26%.

Keywords: ectoparasites, feathers, *Ciconia ciconia*, urban environment, natural environment.

Rezumat. Insectele ectoparazite ale berzei albe, *Ciconia ciconia* (L.) (Ciconiiformes: Ciconiidae), în timpul perioadei de reproducere, în estul extrem al Algeriei. Păsările și alte specii migratoare sunt puternic expuse diferitelor forme de paraziți în zonele de hrănire și reproducere; barza albă reprezintă un bun model pentru studiul acestui fenomen. Acest studiu a fost realizat în regiunea Tebessa, situată în extremitatea estică a Algeriei, la o altitudine de 896 m, care aparține zonei bioclimatice semi-aride. Două colonii de barză albă au fost alese pentru acest studiu, una care a cuibărit în zona urbană și cealaltă într-un mediu natural. Rezultatele obținute au evidențiat prezența a 10 specii ectoparazite găsite pe pene la barza albă. Acestea aparțin la 4 ordine: Phthiraptera, Heteroptera, Hymenoptera și Diptera, 4 subordine și 5 familii. Au fost colectate 246 de exemplare: 67 de exemplare de *Ardeicola* sp., 63 de exemplare de *Colpocephalum* sp. și 46 de exemplare de *Colpocephalum zebra*. Pe berzele din zona urbană au fost colectate 50 de exemplare; acestea aparțin la 7 specii diferite. *Ardeicola ciconiae* este cea mai abundentă specie, reprezentând 38% din fauna totală, urmată de *Ciconiphilus quadripululatus* (Burmeister, 1838) cu 28%, *Ardeicola* sp., cu 14%. Pe berzele din mediul natural, au fost colectate 117 exemplare care aparțin la 4 specii diferite. *Ardeicola* sp. este cea mai abundentă specie, reprezentând 38% din fauna ectoparazică totală, urmată de *Colpocephalum* sp. cu 36% și *C. zebra* cu 26%.

Cuvinte cheie: ectoparaziți, pene, *Ciconia ciconia*, mediu urban, mediu natural.

INTRODUCTION

Birds as parasite hosts provide a large mosaic of habitats for several groups of parasitic arthropods adapted to life in specific types of such microhabitats. Two basic groups of organisms can be distinguished: one group includes ectoparasites of the bird hosts, the second includes members of an accompanying fauna, which is associated with the microenvironment of the nest (BAJERLEIN et al., 2006), in wild animals that are pathogenic vectors responsible for important zoonosis (COLEBROOK & WALL, 2004).

The parasitic arthropods of birds are an extremely varied group showing both taxonomic and ecological diversity. There are fleas (Insecta: Siphonaptera), bugs (Insecta: Hemiptera), and flies (Insecta: Diptera), but the chewing lice (Insecta: Phthiraptera), which are specific to birds and mammals, are probably the most important insects; they are stationary on birds and mammals, live on feathers or hairs, on the surface of the skin or inside, in body cavities or internal organs (FRYDERYK & IZDEBSKA, 2009). In the world, the works that treat birds-ectoparasites relationships are numerous; however, the number of studies related to chewing louse species among the white stork have been carried out in certain regions like Turkey (DIK & USLU, 2006), Romania (ADAM, 2007) and Poland (FRYDERYK & IZDEBSKA, 2009). In Algeria, this type of study is limited to BACIR & BOUSICIMO (2006) on *Turdus merula mauritanicus*, ROUAG-ZIANE et al. (2007) on *Fulica atra*, ROUAG-ZIANE & CHABI (2008) on *Cyanistes caeruleus ultramarinus*, and MAMMERIA et al. (2014) on *Ciconia ciconia* in the north east of Algeria.

MATERIALS AND METHODS

Presentation of the study area: the study is conducted in Tebessa region, located in the far east of Algeria, which covers 13,878 km² and belongs naturally to the immense steppe expanse of the country; geographically, it is limited: at the north by the wilaya of Souk-Ahras, at the west by the wilayas of Oum El-Bouaghi and Khenchela, at the south by the wilaya of El-Oued and at the east by the Tunisia (Fig. 1).



Figure 1. Geographical location of the study area - Lambert coordinates: 35° 29'N, 08° 08'E (NEFFAR, 2012).

Two populations of white storks were selected for this study; the first nested in an urban area (El Merdja Station) northeast of Tebessa (35° 29'N, 08° 08'E), and the second population nested in a rural area (Ain Zaroug Station).

Sampling techniques

The sampling lasted for 3 months, from April to July, coinciding with the breeding period of the chicks.

Specimens were collected from young and adults by either enclosing only their bodies (not the head) in a bag by shaking them, rubbing the feathers, or spraying the body on white cloth with a suitable insecticide.

The obtained individuals were stored in ethyl alcohol (70%) and transported to the laboratory with labels indicating the collecting data and the study station and then, they were identified and confirmed at the National School of Veterinary Sciences in El Harrach (Algiers, Algeria).

Methods of exploitation of the results

After the identification of the samples, we used ecological indices for calculating the relative abundance (AR%), which is defined by the percentage of individuals of a species (ni) to the total number of individuals (Ni) (DAJOZ, 1971) Equation: $AR\% = (ni / Ni) \times 100$.

RESULTS

The faunal community of ectoparasites found on white stork *Ciconia ciconia* (Linnaeus, 1758) in the region of Tebessa (Algeria) and sampled during the breeding period of chicks consists of nine (09) species, which belong to the order Phthiraptera, family Menoponidae, suborder Amblycera as *Colpocephalum zebra* Burmeister, 1838, *Colpocephalum* sp., *Ciconiphilus quadripustulatus*; family Philopteridae, suborder Ischnocera like *Neophilopterus incompletus* (Denny, 1842), *Ardeicola ciconiae*, *Ardeicola* sp.; and other insects: Rhopalidae sp. Ind., *Protocalliphora* sp. Ind.

The study of the richness of white stork ectoparasites revealed that the urban station (El Merdja) presents a higher number of species (seven species) than the rural one (Ain Zaroug), which contains only four species (Table 1).

Table 1. Richness, abundance, and relative abundance of the faunal ectoparasites in the study stations.

Taxa	Study stations					
	El Merdja			Ain Zaroug		
	R	A	R.A.%	R	A	R.A.%
Menoponidae	01	09	22.89	02	119	60.71
<i>Colpocephalum zebra</i>	-	00	00	+	51	26.02
<i>Colpocephalum</i> , sp.	-	00	00	+	68	35.59
<i>Ciconiphilus quadripustulatus</i>	+	09	22.89	-	00	00
Philopteridae	03	45	54.20	01	72	36.73
<i>Ardeicola ciconiae</i>	+	24	28.91	-	00	00
<i>Ardeicola</i> sp.	+	11	13.25	+	72	36.73
<i>Neophilopterus incompletus</i>	+	10	12.04	-	00	00
Rhopalidae	01	06	7.22	-	00	00
<i>Rhopalidae</i> sp. ind.	+	06	7.22	-	00	00
Hymenoptera	01	08	9.63	01	05	2.55
<i>Apocrita</i> sp. ind.	+	08	9.63	+	05	2.55
Calliphoridae	01	05	6.02	-	00	00
<i>Protocalliphora</i> sp.	+	05	6.02	-	00	00
Total	07	83	99.97	04	196	99.99

Legend: + Presence, - absence; R - richness, A - abundance, R.A. % - relative abundance.

Total Abundance was higher at Ain Zaroug station where 196 individuals were counted; however 83 specimens were captured at El Merdja station (Table1). With a relative abundance of 54.20%, Philopteridae was more abundant than Menoponidae (22.89%) at El Merdja, in Ain Zaroug the relative abundance of Menoponidae was more important (60.71%) followed by Philopteridae 36.73%. Other taxa are very low or absent (Fig. 2).

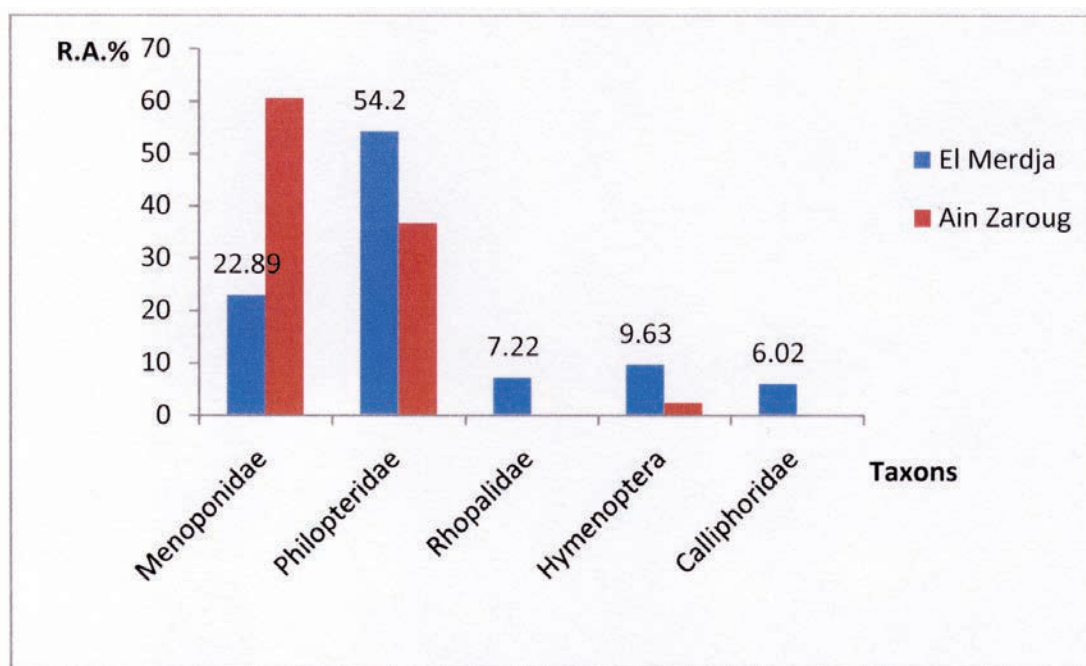


Figure 2. Relative abundance of ectoparasites in the study stations.

Ardeicola ciconiae was the most abundant ectoparasite on white stork at El Merdja representing 32.88% of the total number of fauna ectoparasite, followed by *Ardeicola* sp. 15.06%, then *Neophilopterus incompletes*, *Ciconiphilus quadripustulatus* and *Apocrita* sp. ind. With respectively 13.69%, 12.34%, 10.97%. *Rhopalidae* sp. ind. and *Protocalliphora* sp. were the least important ectoparasites on white stork in this station (Fig. 3).

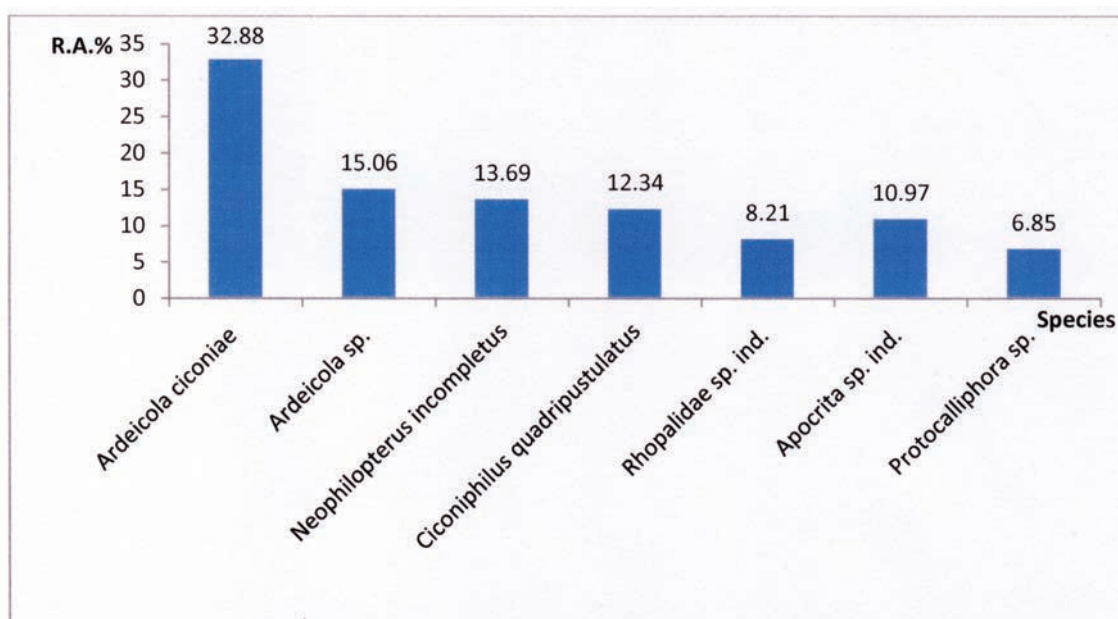


Figure 3. Relative abundance of ectoparasite species on white stork at El Merdja station.

The most abundant species at Ain Zaroug were *Ardeicola* sp., which represented 36.74 % followed by *Colpocephalum* sp. (34.69%) and *C. zebra* with 26.02%. *Apocrita* sp. ind. were weakly represented (Fig. 4).

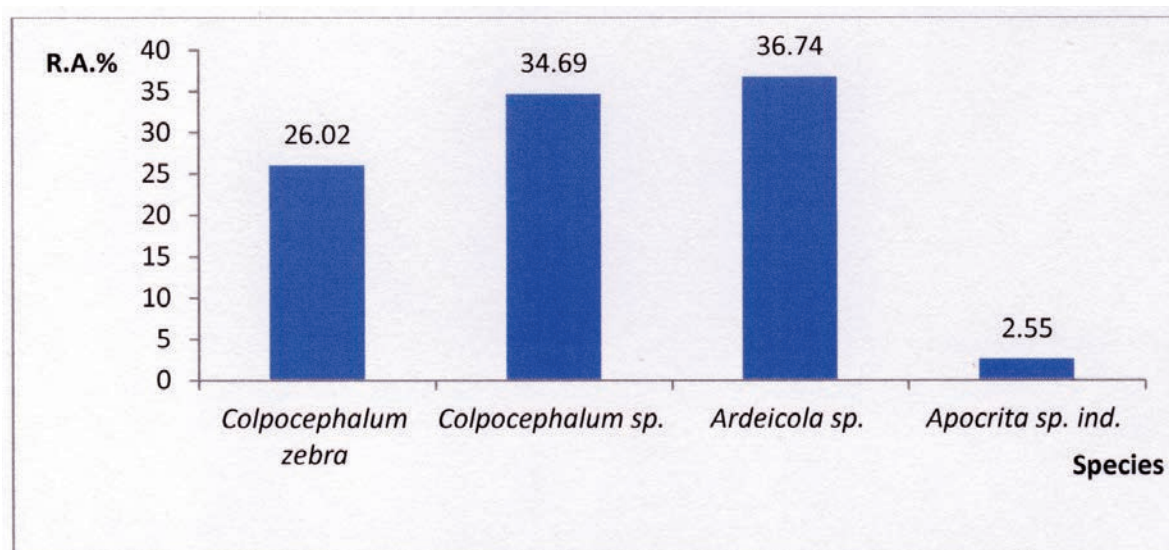


Figure 4. Relative abundance of ectoparasite species on white stork at Ain Zaroug station.

Ectoparasites on white stork from El Merdja station were abundant in May as in June; *Ardeicola ciconiae* was more dominant in May with 47.37% followed by *Ardeicola* sp. with 18.42%, while *Neophilotheus incompletus* was only present in June (27.77%) and *Ciconiphilus quadripustulatus* was more abundant in June (19.45%) than in May (Fig. 5).

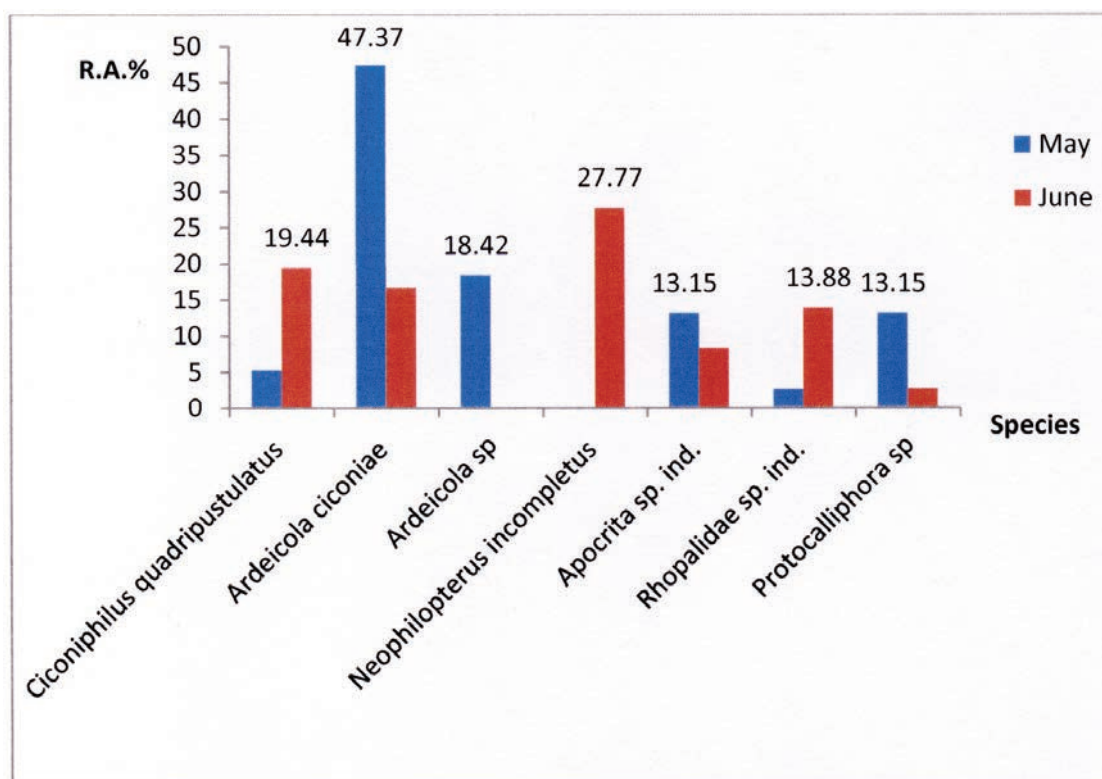


Figure 5. Phenology of ectoparasites on white stork at El Merdja station.

The ectoparasites on the white stork at Ain Zaroug station were more abundant in June (92 specimens), followed by May 79 specimens, then April 25 specimens. *Colpocephalum zebra* was predominant in May (39,24%) whereas *Ardeicola* sp. and *Colpocephalum* sp. with 44.56%, respectively 39.13% were more abundant in June (Fig. 6).

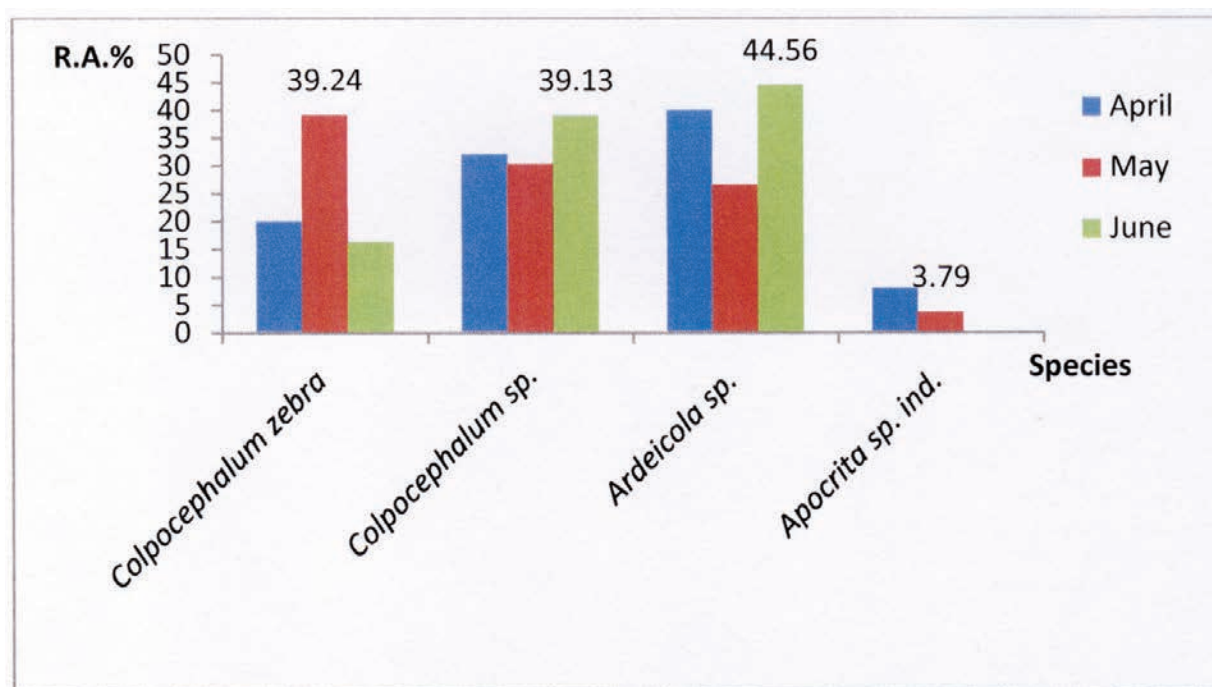


Figure 6. Phenology of ectoparasites on white stork at Ain Zaroug station.

DISCUSSION

The chewing lice from the white stork identified in the Tebessa region are *Colpocephalum zebra*, *Colpocephalum* sp., *Ciconiphilus quadripustulatus*, *Ardeicola ciconiae*, *Neophiloaterus incompletus*, and *Ardeicola* sp. In many regions in the Algerian littoral, two species were found on different avian hosts: *Menacathus stramineus* on *Luscinia megarhynchos*, *Columba livia* and *Columbicola columbae* on *Alectoris chukar* (BAZIZ-NEFFAH et al., 2015).

In north-east of Algeria, MAMMERIA et al. (2014) found only one species belonging to Laemobothriidae in the nest of a White stork.

In his first study on chewing louse insect pests of white storks in Turkey, DIK & USLU (2006) reported the presence of four species: *Colpocephalum zebra*, *Neophiloaterus incompletus*, *Ardeicola ciconiae* and *Ciconiphilus quadripustulatus*, which is confirmed later by DIK et al. (2011). Similar result is obtained by GIRISGIN et al. (2013) in the north-west of Turkey.

In Hungary, species reported on *Ciconia ciconia* are: *Ardeicola ciconiae*, *Ciconiphilus quadripustulatus*, *Colpocephalum zebra*, *Neophiloaterus incompletus* and *N. tricolor* (REKASI, 1993), while in Belgium HELLENTAL et al. (2004) found only two species on *Ciconia ciconia*, which are: *Ciconiphilus quadripustulatus* and *Neophiloaterus incompletus* and in Bulgaria, ILIEVA (2005) notes the presence of a single species *N. incompletus*. On the other hand, *N. incompletus*, *Colpocephalum zebra*, *Ciconiphilus quadripustulatus* and *Ardeicola ciconiae* are found on *Ciconia ciconia* in Romania (ADAM, 2007).

According to PRICE & BEER (1965), the genus *Colpocephalum* includes 43 species specific to Ciconiiformes, including 19 newly described with their hosts, and some species of *Colpocephalum* that are morphologically divergent from *C. zebra* that is specific to *Ciconia ciconia ciconia*.

FRYDERYK & IZDEBSKA (2009) show that parasites have preference to sites on their host *Ciconia ciconia*: most specimens (91%) of *C. zebra* were found on the wings, while *N. incompletus* and the rest of *C. zebra* were observed on other parts of the body (neck, breast, flanks, back).

The abundance of chewing louse fauna is more important on the white storks at Ain Zaroug than on those of El Merdja. The most abundant species at Ain Zaroug is *Ardeicola* sp. followed by *Colpocephalum* sp. and *C. zebra*; at El Merdja, the most abundant species is *Ardeicola ciconiae* followed by *Ardeicola* sp., and *Neophiloaterus incompletus*.

In the north western of Turkey, the most abundant species is *Ciconiphilus quadripustulatus* with 441 individuals, followed distantly by *Ardeicola ciconiae* with 11 individuals, *Neophiloaterus incompletus* with 6 individuals and *Colpocephalum zebra* with 3 individuals (GIRISGIN et al., 2013). FRYDERYK & IZDEBSKA (2009) also reported

the presence of a large number of lice on white storks in Poland, dominated by *C. zebra* with 237 specimens, while *N. incompletus* is less numerous.

Monthly fluctuations in the abundance of the ectoparasites species on *Ciconia ciconia* at El Merdja and Ain Zaroug stations show a variation in the abundance of species over the months.

The peak of infestation of the white stork at Ain Zaroug occurred in June by *Ardeicola* sp.; *Colpocephalum* sp. is very abundant in June and *C. zebra* in May. At El Merdja *Ardeicola ciconiae*, *Ardeicola* sp. are very abundant mainly in May; however, *Ciconiphilus quadripustulatus* and *Neophilopterus incompletus* are very recorded.

ASH (1960) reported that chewing lice appear on young birds from 1-15 days and Menoponids are the first to be present on birds as they are able to find food before feathers appear. In the Danube Delta in Romania, *Neophilopterus incompletus* and *Colpocephalum zebra* are more abundant on *Ciconia ciconia* in August (REKASI et al., 1996).

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Received: March 30, 2017

Accepted: September 04, 2017

PARASITES ENCOUNTERED IN CAPTIVITY BIRDS: CASE OF INFESTED BLUE PEACOCK - *Pavo cristatus* Linnaeus, 1758 (AVES: PHASIANIDAE) IN DIFFERENT LOCALITIES FROM ALGERIA

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Abstract. For our study, sampling of the Blue Poppy droppings of *Pavo cristatus* in captivity, February and March 2016 from two zoos (El Hamma Test Garden and the Ben Aknoun) of 24 individuals were collected. The flotation technique allowed us to identify the parasites found in our samples. Our results revealed the presence of a 50% rate of the genus *Capillaria* and a rate of 50% of the genus *Ascaridia* at the Reghaia marsh. In the Ben Aknoun National Park, we recorded a total of 179 individuals of hosted parasites, including *Eimeria* sp. (AR% = 7.26%) and *Capillaria* sp. (5.03%) are the dominant in the Blue Peacock droppings. Finally 77 parasite specimens from 24 samples of this bird's droppings were recorded at the El Hamma test garden with a relative abundance recorded for *Capillaria* sp. (AR% = 7.79%), *Eimeria* sp. (AR% = 6.49%), and *Amidostomum* sp. (AR% = 5.19%). The ectoparasites encountered in both *Pavo cristatus* are *Amyrsidea minuta* and *Colpocephalum tausi* in the Ben Aknoun National Park.

Keywords: *Pavo cristatus* in zoos, ecto- and endoparasites, relative abundance, dominant species.

Rezumat. Paraziți întâlniți la păsările din captivitate: studiu de caz păunul albastru - *Pavo cristatus* Linnaeus, 1758 (Aves: Phasianidae) în diferite grădini zoologice din Algeria. Pentru studiul nostru au fost prelevate probe din excrementele a 24 indivizi de păun albastru (*Pavo cristatus*) în februarie și martie 2016 din diferite grădini zoologice (El Hamma Test Garden și Ben Aknoun). Prin tehnica flotației au fost separați paraziții din probe. Identificarea lor a relevat prezența a 50% din genul *Capillaria* sp. și de 50% din genul *Ascaridia*. Din fecalele păunilor din grădinile zoologice au fost în total identificați 179 de paraziți – 77 fiind din El Hamma. Abundența relativă (AR) este pentru *Eimeria* sp. = 7,26%, iar pentru *Capillaria* sp. = 5,03%, aceste două genuri fiind dominante. Separat, pentru El Hamma, AR a genului *Capillaria* = 7,79%, pentru *Eimeria* = 6,49% și pentru *Amidostomum* = 5,19%. Ectoparaziți întâlniți la *Pavo cristatus* din Ben Aknoun sunt *Amyrsidea minuta* și *Colpocephalum tausi*.

Cuvinte cheie: *Pavo cristatus* în grădinile zoologice, ecto- și endoparaziți, abundența relativă, specii dominante.

INTRODUCTION

Parasitoses are diseases of particular importance in animal health. The status of animals in zoos remains quite singular, which differentiates them, particularly in terms of parasites, from the species mentioned above. Nevertheless, they can not be likened to pets because they live in an often closed environment, sometimes coexist with others within their enclosure and evolve in a large animal density of varied nature. Nevertheless, parasites remain a notable issue in birds in animal parks. Unfortunately, the scientific data concerning the parasites of animal park birds remain few. The purpose of this study is therefore to identify the main parasites found on wild birds in captivity. Of a very wide distribution, we are based precisely on the Blue Peacock as an example of the Phasianidae, to make our study. The diseases and health of peacocks are about the same as those of domestic poultry, especially those of turkeys. The Peacocks are Phasianids and can therefore be affected by the same diseases as other Pheasants. For enthusiasts, getting closer to an avian pathologist is a good option to get the necessary information on the health of the Peacock. Since many of the bird diseases can cross the species line, mixing peacocks with other birds or domestic poultry will increase their risk of becoming infected with endemic diseases.

MATERIALS AND METHODS

We harvested 50 fresh droppings from 10 Blue Peacocks (*Pavo cristatus*) from January to February 2016 from two different zoological parks Ben Aknoun (36 ° 45 '34.19 "N, 3 ° 0' 33.36" E) El Hamma (36 ° 44 '53 "N, 3 ° 04' 34" E) and only two at the Marais de Réghaia (36 ° 46 '17 "N, 3 ° 20' 38" E). These samples of fecal matter were identified and quantified. These samples were analyzed at E. N. S. V by the total flotation technique is the most widely used enrichment technique in veterinary medicine. Its purpose is to concentrate the parasitic elements from a very small quantity of excreta. It is based on the use of solutions whose density is higher than that of most parasite eggs ($d = 1.2$). The aim is to bring up the parasitic elements while letting the faecal debris flow (BUSSIERAS & CHERMETTE, 1991). Ectoparasites are collected from 6 Blue Peacocks in Ben Aknoun Park. For the exploitation of the coprological results we used a statistical analysis method of endoparasites are parasitological analysis such as host status, prevalence and mean intensity. These tests were performed using the Quantitative Parasitology V 3.0 software. (ROZSA et al., 2000).

RESULTS

- **Coprology of the Peacock droppings (*Pavo cristatus*)**

The identification of the parasites was based on morphological criteria of the eggs / oocysts, observed under a microscope. To go further and be more precise, it would have been necessary to use molecular methods leading to the

identification of parasites. For lack of means, this could not be achieved (Table 1, Figs. 1, 4). Table 1 shows the different parasitic species present in the Blue Pawn droppings listed in the three study stations cited above by means of the Flotation technique.

Table 1. Systematics of the parasites present in the droppings of the Peacocks in the 3 stations.

Branches	Classes	Orders	Families	Species
Protozoaires	Sporozoa	Eimeriida	Eimeriidae	<i>Eimeria</i> sp.
	Mastigophora	Diplomonadida	Giardiidae	<i>Giardia</i> sp.
		Retortamonadida	Retortamonadidae	<i>Chilomastix</i> sp.
Plathelminthes	Nematoda	Strongylida	Trichostrongylidae	<i>Cooperiasp.</i>
			Strongylidae	<i>Strongyloides</i> sp.
			Syngamidae	<i>Cyathostoma bronchialis</i>
			Amidostomatidae	<i>Amidostomum</i> sp.
		Ascaridida	Ascaridae	<i>Ascaridia</i> sp.
		Trichocephalida	Capillariidae	<i>Capillaria</i> sp.

The prevalence and intensity of endoparasites of the Blue Peacock in both stations only are noted in Table 2 below - Parasitology V 3.0.

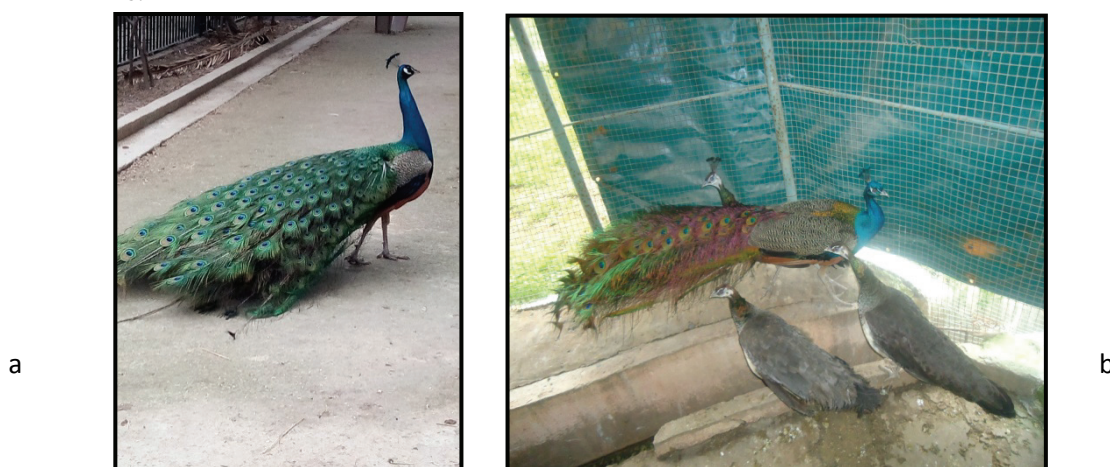


Figure 1. Blue Peacock a, Zoological Park of the Garden of Trial El Hamma; B, male and female Ben Aknoun National Park (Original photo).

According to (Table 2, Fig. 5) a total of 24 samples of Ben Aknoun Blue Peacock droppings have been identified. Only 14 droppings are infested with *Eimeria* sp. (Egg) with a rate of 58.30%. Followed by 6 droppings infested by *Capillaria* sp. With a rate of 25%. Then 5 droppings are infested with *Amidostomum* sp. with a rate of 20.80%. A prevalence of 16.70% on 4 droppings infesting the two species of parasites *Chilomastix* sp. and *Strongyloides* sp. And for the other species have a prevalence ranging from 4.20% to 8.30% on 1 and 2 droppings. It is observed that 58.30% are infested by *Eimeria* sp. belongs to the class of the dominant species, then *Capillaria* sp. And *Amidostomum* sp with a rate ranging from 20.80% to 25%. These species belong to the class of satellite species. And for the other species belong to the class of rare species. The mean intensity increases gradually between 1 and 6.43 (very low) for *Giardia* sp., *Chilomastix* sp., *Strongyloides* sp., *Amidostomum* sp. and weak for the value 8.67 for *Capillaria* sp. (Fig. 2). Similarly, 6 specimens of El Hamma Blue Peacock droppings are infested with two parasites *Amidostomum* sp. and *Capillaria* sp. With a prevalence of 25%, whereas on 8 droppings are infested with *Eimeria* sp. (Egg) with 33.33% (Table 3). It also appears that the three satellite species are *Eimeria* sp. *Capillaria* sp. et *Amidostomum* sp. (Table 2). The average intensity is weakly marked for the *Eimeria* sp species of 3.5 and a low value of 3.5 for the two species *Amidostomum* sp. and *Capillaria* sp. (Fig. 3).

Table 2. Endoparasites found in Blue Peacock droppings in both stations with host status, prevalence and intensity.

Stations	Host	Species	Host Condition		Prevalence	Intensity	
			Total	Infested		Medium	Median
Ben Aknoun	Paon bleu	<i>Amidostomum</i> sp.	24	5	20,80%	2,6	2
		<i>Capillaria</i> sp.	24	6	25%	8,67	8,5
		<i>Chilomastix</i> sp.	24	4	16,70%	2	2
		<i>Cooperia</i> sp.	24	1	4,20%	2	2
		<i>Cyathostoma branchialis</i>	24	2	8,30%	1,5	1,5
		<i>Eimeria</i> sp.	24	14	58,30%	6,43	5,5
		<i>Giardia</i> sp.	24	1	4,20%	1	1
		<i>Strongyloides</i> sp.	24	4	16,70%	2,5	2
Jardin d'essai d'El Hamma	Paon bleu	<i>Amidostomum</i> sp.	24	6	25%	3,5	3,5
		<i>Capillaria</i> sp.	24	6	25%	3,5	3,5
		<i>Eimeria</i> sp.	24	8	33,30%	3,38	4,5

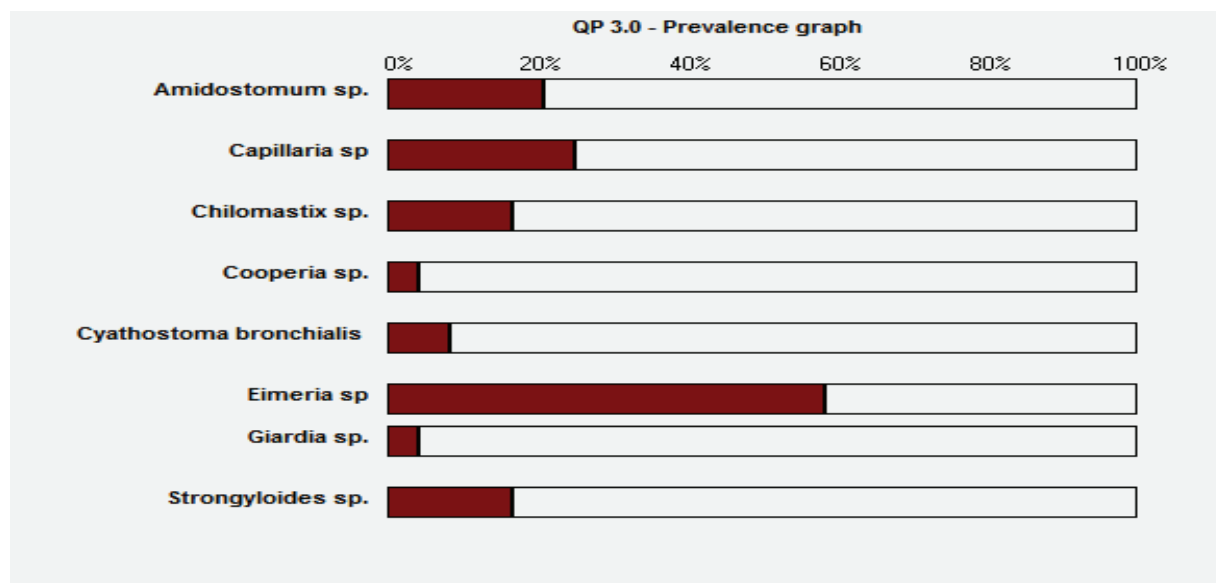


Figure 2. Graph of prevalences of endoparasites found in Ben Aknoun peacen droppings with the software (Quantitative Parasitology V 3.0.).

• Inventory of ectoparasites of animals in the zoo of Ben Aknoun.

In Table 3, we have represented an inventory of ectoparasite species of the blue peacocks of the Zoological Park of Ben Aknoun.

Table 3. Inventory of bird ectoparasites in the Ben Aknoun Zoo in 2016.

Phylums	Classes	Ordres	Familles	Espèces	ni	AR %
Arthropodes	Insectes	Phtiraptera	Menoponidae	<i>Menopon sp.</i>	1	7,14
				<i>Menacantus sp.</i>	4	28,57
				<i>Colpocephalum tausi</i>	7	50,00
				<i>Amyrsidea minuta</i>	1	7,14
			Philopteridae	<i>Lipeureus caponis</i>	1	7,14
			Totale	5 espèces	14	100,00

Chez les Paons bleu du zoo de Ben Aknoun en 2016, nous avons identifié 2 genres et 3 espèces d'ectoparasites, appartenant à un seul phylum les arthropodes, une classe, un ordre et 2 familles.

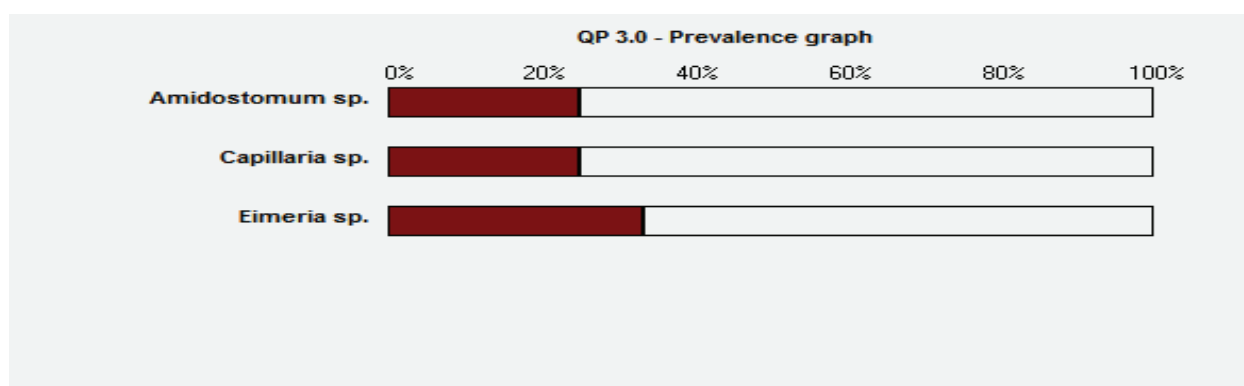


Figure 3. Graph of prevalences of endoparasites found in El Hamma peacock droppings with software (Quantitative Parasitology V 3.0.).

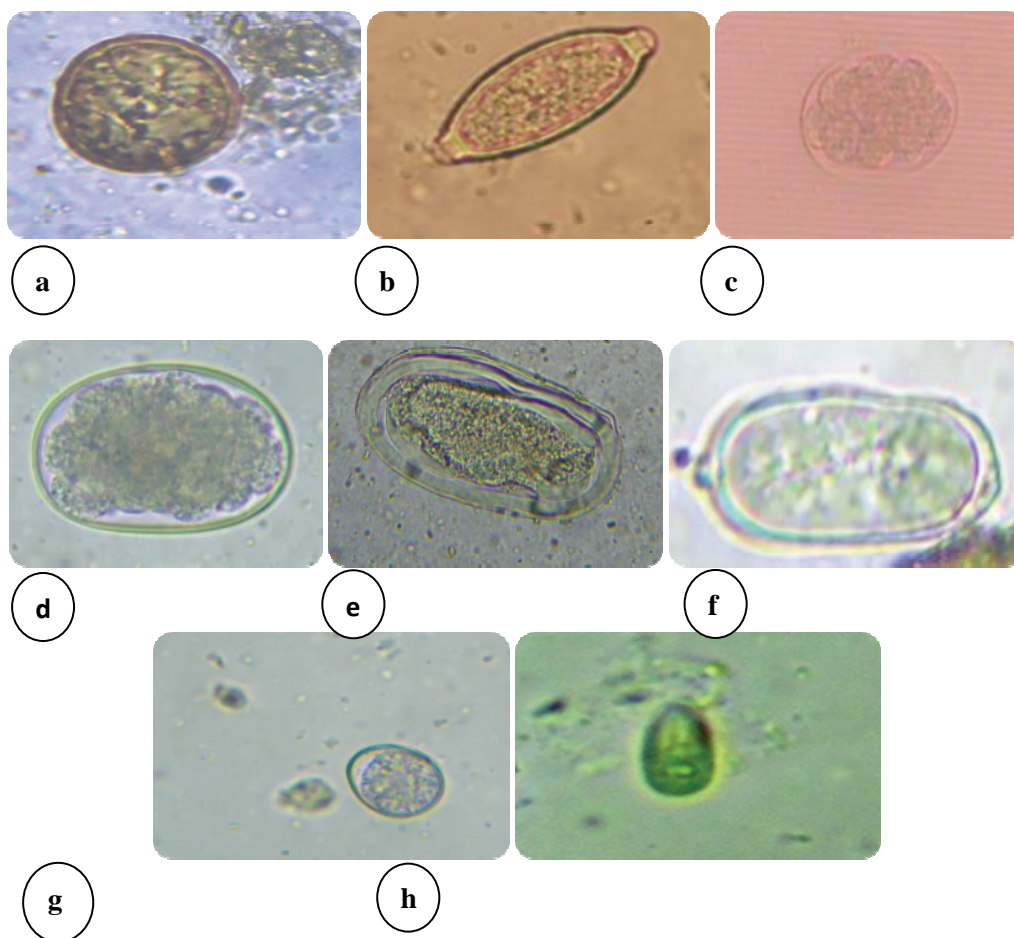


Figure 4. The different parasites found in the droppings of the Peacocks (Original Photo). a. Kyste *Giardia* sp.; b. *Capillaria* sp.; c. *Cyathostoma branchialis*; d. *Amidostomum* sp.; e. *Strongyloides* sp.; f. *Cooperia* sp.; g. *Eimeria* sp.; h. *Chilomastix* sp.

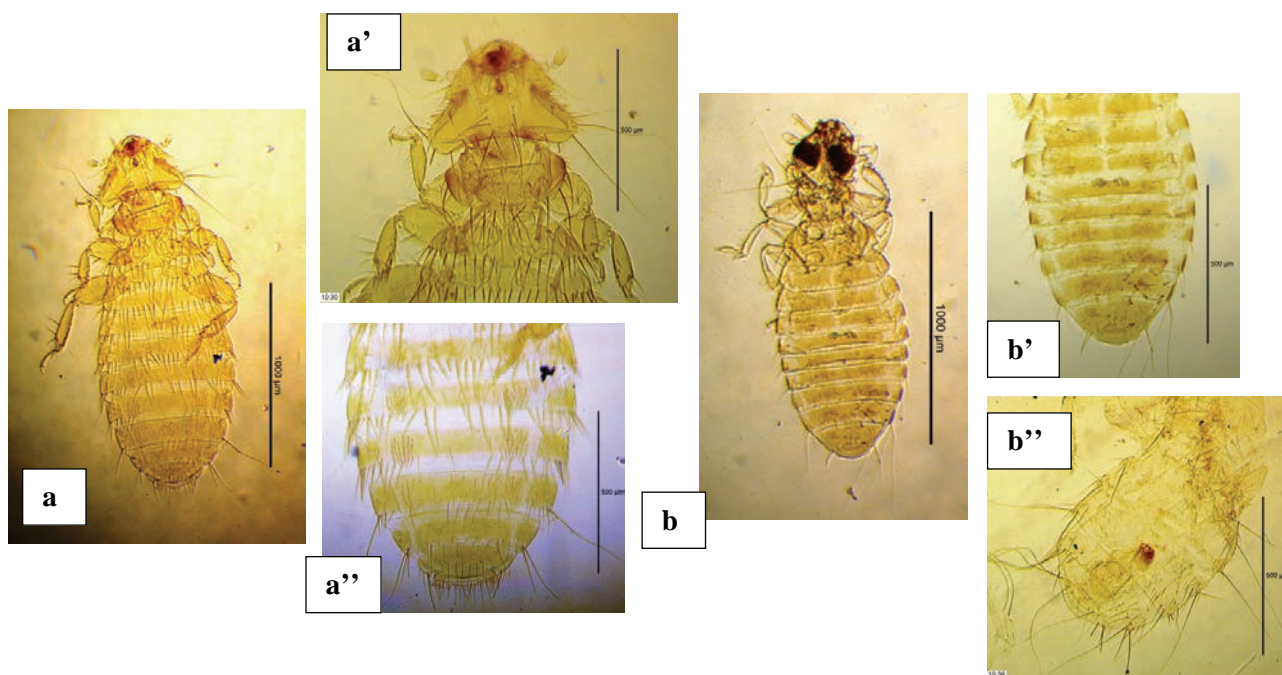


Figure 5. Ectoparasites of the blue peacock (Original Photo).a. *Amyrsidea minuta* female; a'. *Amyrsidea minuta*; a'' abdomen *Amyrsidea minuta*; b. *Colpocephalum tausi* female; b'. *Colpocephalum tausi* female abdomen; b''. *Colpocephalum tausi* male.

DISCUSSIONS AND CONCLUSION

50 droppings were collected from 10 peacocks (*Pavo cristatus*) from January to February 2016, from two different zoo parks (Ben Aknoun and El Hamma). These feces have been identified and quantified. We carried out another study of two blue peacocks in captivity in the Reghaia marsh which revealed the presence of 50% of the genus *Capillaria* and 50% of the genus *Ascaridia*. In Algeria, there are no studies on the intestinal parasites of the Blue Peacock, so we will refer to previous work carried out in other countries in order to compare it with the parasitic diversity of this captive bird in Algeria. In our study, the coprological examination of droppings revealed a 49% rate of the genus *Eimeria* sp between January and February, which is higher than that found by (QAMAR et al., 2013) conducted in Pakistan. Reported a rate of 18% in January and 22% in February (MUSAEV et al., 1991) found an *Eimeria* sp infestation rate of 53.3% in Azerbaijan, but noted that this rate decreased in February 26.6% due to climatic conditions.

The identification of the species in our case was not possible. However, several species of Blue Peacock species have been reported. In Romania (TITILINCU et al., 2009) reported 90 species with a presence of three species of *Eimeria* with different rates: *E. pavonis* with 16.7%, *E. pavonina* with 48.3% and *E. patnaiki* with 32.3% and a total of 64.4%. In Saudi Arabia, (ALYOUSIF et al., 1999) isolated four species of *Eimeria* (*E. pavonina*, *E. pavonis*, *E. mayinai*, *E. pellesdy*) from a peacock with diarrhea. In our study, the high infestation of the peacock by the genus *Eimeria* is revealed in Ben Aknoun station, this difference in infestation may be due to management conditions in the two localities.

Another parasite found in our study is a *plathelminth* worm of the genus *Capillaria*, with a rate of 29% which is lower than that observed by (TITILINCU et al., 2009). (35.3%), but SAKAMOTO & YAMASHTA (1970) reported its presence in peacocks with diarrhea and in those with loss of appetite. It is noted that many Galliformes can host this species, PINTO et al., (2008) in Brazil reported that a representative of the order Galliformes: Turkey harbors this species with a rate of 82.5%. However, *Capillaria anatis* in the latter is not pathogenic. However, they also reported the presence of *Capillaria phasiania* in the Pheasant. *Strongyloides* have had parasites reported in our study, but their rates are very low (4%) when compared to TITILINCU et al., (2009) which is 51% knowing that these results are obtained by the same method (flotation).

The identification of the species has not been carried out. But (TITILINCU et al., 2009) reported the presence of the species *Strongyloides pavonis* in the Blue Peacock (*Pavo cristatus*). This kind was also found in Galliformes species in a recent study of the quail of wheat in Algeria carried out by ZOUBIRI & IDRIS-BAY (2015) with a prevalence of 28%, and in another study that of WETZEL & RIECKEN (1966). On the game bird that harbors the genus *Strongyloid*. Another representative of protozoa of the genus *Chilomastix* with a low rate of 3%, no study reported its presence in the Blue Peacock. Nevertheless, two studies have been carried out on representatives of the Galliformes, the first one on ZOUBIRI & IDRIS-BAY (2015) on the Quail of the wheat, which harbors this protozoan at a very high rate compared with that observed in our study (65, 77%). And the second one of on the chicken which signals its presence but without any pathogenic effect. In addition, three other parasitic platyhelminths and a protozoan of the genus *Giardia* were found in the peacock during our experiment, but no study reported their presence in *Pavo cristatus*. The first plathelminth is that of the genus *Amidostomum* recorded with a prevalence of 36% in the El Hamma station and 7% in Ben Aknoun, this difference is significant so that the El Hamma Blue Peacock are very infested by these parasites. The genus *Cooperia* and genus *Cyathostoma branchialis* as well as the protozoan *Giardia* was only found in the peacocks of Ben Aknoun with low rates of 1%, 2%, and 1% respectively in faecal samples. Except that (GARAPIN, 2014) in France declares that in captive birds the genus *Cyathostoma* sp. Can cause high mortality and affects a number of different species. This parasitic variation and variation between the two stations studied during our experiment on the Blue Peacock (*Pavo cristatus*). Concerning the ectoparasites taken from the 6 Blue Peacocks of Ben Aknoun shows that our results are similar to those found by (SEGUY, 1944), that he described the Blue Peacock as the host of *Menopon phaeostomum*, *Goniodes parviceps*, *Goniodes pavonis*, *Goniocotes rectungulatus* and *Lipeurus pavo*. On the other hand (LAKSHMINARAYANA, 1979) cites for the Blue Peacock 09 lice *Goniocotes mayuri*, *Goniocotes parviceps*, *Goniocotes rectangulatus*, *Goniocotes yngarejsuf*, *Goniodes meinertzhageni*, *Goniodes pavonis*, *Amysidea minuta*, *Amysidea phaestoma* and *Colpocephalum tausi*. According to (PRICE et al., 1997) the Blue Peacock is a host for *Goniocotes rectangulatus* and *Goniocotes parviceps* (cosmopolitan species) and *Goniocotes mayuri* a subspecies of the Indian subcontinent. Our work has revealed a great diversity of parasites in the Blue Peacocks of animal parks in Algeria. The majority of these parasites are direct-cycle parasites. Indeed, these parasites can more easily infest their host even if it is not in its natural environment, since they do not require intermediate hosts. Considering the disparities between parks, the numbers of the different orders and the number of samples sent, it is difficult to identify general trends regarding parasitism in these parks. The overall prevalence of positive colposcopy remains moderate.

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Received: March 21, 2017

Accepted: June 9, 2017

FAUNAL AND ECOLOGICAL DATA ABOUT THE LEAF-BEETLES (COLEOPTERA, CHRYSOMELIDAE) FROM THE MOUNTAINOUS AREA OF BIHOR COUNTY (ROMANIA)

ILIE Lorena Cosma

Abstract. The paper presents the faunal and ecological data of the leaf-beetles from the mountainous area of Bihor County studied during a period of five years (2010-2015). There were identified 63 species belonging to 30 genera and 6 subfamilies. The majority of the chrysomelid species were identified in Bihor Mts. and are oligophagous species. The list includes Carpathian endemic species restricted only to the Romanian Carpathians, recorded along the entire chain of the Carpathian Mts. Four species are rare at national level.

Keywords: Chrysomelidae, mountainous area, Bihor County.

Rezumat. Date faunistice și ecologice despre gândacii de frunze (Coleoptera, Chrysomelidae) din zona montană a județului Bihor (România). Lucrarea prezintă fauna și date ecologice ale gândacilor de frunze din zona montană a județului Bihor studiată în perioada 2010-2015. S-au identificat 63 de specii aparținând la 30 de genuri și 6 subfamilii. Majoritatea speciilor de crisomelide au fost identificate în munții Bihorului și sunt oligofage. Lista include specii endemice carpatine, cunoscute doar în Carpații românești, întâlnite de-a lungul întregului lanț Carpatic. Patru specii sunt rare la nivel național.

Cuvinte cheie: Chrysomelidae, zona montană, județul Bihor.

INTRODUCTION

Bihor County belongs to the historical province Crișana and is located in the north-western part of Romania. The mountainous area is located in all the eastern part of this county, from south to north and includes the following mountainous groups: Bihor Mountains, Codru-Moma Mountains, Pădurea Craiului Mountains and Plopiș (Șes) Mountains.

Bihor Mountains are located in the south-eastern part of Bihor County, having the biggest altitudes, between 1160 m (Vârtopeș peak) and 1848 m (Cucurbăta Mare peak).

Codru Moma Mountains are located in the southern extremity of Bihor County having altitudes up to 1112 m (Pleșu peak).

Pădurea Craiului Mountains are located in the central-eastern part of Bihor County, having altitudes between 600 and 800 meters.

Șes Mountain is located in the north-eastern part of Bihor County, having more reduced altitudes, between 500 and 900 meters (BERINDEI & POP, 1972).

Data about the leaf-beetles from the mountain area of Bihor County were published by seven different authors (MOCSARY, 1875; PETRI, 1912; PANIN, 1944; MARCU, 1957; 1961; KASZAB, 1962; GRUEV & MERKL, 1993).

MATERIALS AND METHODS

The coleopterans were collected for seven months during April – October, 2010-2015. There was used an entomological net, sweeping the vegetation (bushes and herbs).

The identification of the species was made in the laboratory, using some sources mentioned in specialized literature (KASZAB, 1962; WARCHALOWSKI, 2003). There were used the nomenclature and the classification of LOBL & SMETANA, 2010.

RESULTS AND DISCUSSIONS

In the mountain area of Bihor County, there were identified six subfamilies and 63 species belonging to the family Chrysomelidae:

Subfamily Criocerinae Latreille, 1807

1. *Lilioceris merdigera* Linnaeus, 1758 – Codru-Moma Mts (collected Ilie, 2013). Oligophagous.
2. *Oulema melanopus* Linnaeus, 1758 – Bihor Mts (collected Ilie, 2012-2014). Oligophagous.

Subfamily Cryptocephalinae Gyllenhal, 1813

1. *Labidostomis tridentate* Linnaeus, 1758 – Codru Moma Mts (collected Ilie, 2011). Polyphagous.
2. *Labidostomis humeralis* Schneider, 1792 – Șes Mountain (collected Ilie, 2013). Oligophagous.
3. *Clytra laeviuscula* Linnaeus, 1758 – Bihor Mts (collected Ilie, 2012-2015). Polyphagous.
4. *Smaragdina salicina* Scopoli, 1763 – Șes Mountain (collected Ilie, 2015). Polyphagous.
5. *Smaragdina xanthaspis* Germar, 1824 – Bihor Mts (collected Ilie, 2014). Polyphagous.

6. *Pachybrachys sinuatus* Mulsant et Rey, 1857 – Bihor Mts (collected Ilie, 2012). Polyphagous.
7. *Cryptocephalus ocellatus* Drapiez, 1819 – Şes Mountain (collected Ilie, 2013). Polyphagous.
8. *Cryptocephalus bipunctatus* Linnaeus, 1758 – Bihor Mts (collected Ilie, 2011). Polyphagous.
9. *Cryptocephalus hipochaeridis* Linnaeus, 17758 – Codru-Moma Mts (collected Ilie, 2010). Oligophagous.
10. *Cryptocephalus moraei* Linaeus, 1758 – Codru-Moma Mts (collected Ilie, 2011), Bihor Mts (collected Ilie, 2012). Polyphagous.
11. *Cryptocephalus octacosmus* Bedel, 1891 – Bihor Mts (collected Ilie, 2013). Polyphagous.
12. *Cryptocephalus flavipes* Fabricius, 1781 – Bihor Mts (collected Ilie, 2012). Polyphagous.
13. *Cryptocephalus quadripustulatus* Gyllenhal, 1813 – Bihor Mts (collected Ilie, 2012). Oligophagous.
14. *Cryptocephalus schaefferi* Schrank, 1789 – Bihor Mts. (collected Ilie, 2013). Polyphagous.

Subfamily Chrysomelinae Latreille, 1802

1. *Timarcha goettingensis* Linnaeus, 1758 – Şes Mountain (collected Ilie, 2012). Oligophagous.
2. *Timarcha gibba* Hagenbach, 1825 – Bihor Mts. (KASZAB, 1962). Oligophagous.
3. *Chrysolina aurichalcea* Linnaeus, 1758– Codru-Moma Mts. (collected Ilie, 2013). Oligophagous.
4. *Chrysolina haemoptera* Linnaeus, 1758 – Bihor Mts. (collected Ilie, 2013). Oligophagous.
5. *Chrysolina biharica* Breit, 1919 – Bihor Mts. (KASZAB, 1962). Oligophagous
6. *Chrysolina umbratilis* Weise, 1887 –Bihor Mts. (KASZAB, 1962). Monophagous.
7. *Chrysolina sturmi* Westhoff, 1882 – Codru-Moma Mts. (collected Ilie, 2012). Polyphagous.
8. *Chrysolina polita* Linnaeus, 1758 – Codru-Moma Mts. (collected Ilie, 2013), Bihor Mts. (ILIE, 2012; PANIN, 1944). Oligophagous.
9. *Chrysolina graminis* Linnaeus, 1758 – Bihor Mts. (MARCUS, 1957). Polyphagous.
10. *Chrysolina fastuosa* Scopoli, 1763 – Bihor Mts. (collected Ilie, 2011-2015). Polyphagous.
11. *Chrysolina olivieri* Bedel, 1892 –Şes Mountain, (collected Ilie, 2012). Oligophagous.
12. *Chrysolina sanguinolenta* Linnaeus, 1758 –Şes Mountain (collected Ilie, 2013). Monophagous.
13. *Chrysolina weisei* Frivaldszky, 1883 –Şes Mountain (collected Ilie, 2013). Unknown
14. *Chrysomela populi* Linnaeus, 1758 – Bihor Mts. (collected Ilie, 2013). Oligophagous.
15. *Gastrophysa viridula* De Geer, 1775 – Bihor Mts. (collected Ilie, 2013; MARCUS, 1963). Oligophagous.
16. *Oreina coerulea* Olivier, 1790 – Bihor Mts. (MARCUS, 1961). Oligophagous.
17. *Oreina bidentata* Bontems, 1891 – Bihor Mts. (collected Ilie, 2013). Oligophagous.
18. *Oreina intricata* Germar, 1824 – Bihor Mts. (KASZAB, 1962) Monophagous.
19. *Oreina virgulata* Germar, 1824 – Codru-Moma Mts. (collected Ilie, 2012). Oligophagous.
20. *Oreina bifrons* Fabricius, 1792 – Bihor Mts. (PETRI, 1912). Oligophagous.
21. *Sclerophaedon carpathicus* Weise, 1875 – Codru-Moma Mts. (KASZAB, 1962). Oligophagous.
22. *Goniocetena fornicata* Brugemann, 1873 – Bihor Mts. (collected Ilie, 2012-2014). Polyphagous.

Subfamily Galerucinae Latreille, 1802

1. *Lochmaea capreae* Linnaeus, 1758 – Bihor Mts. (collected Ilie, 2012-2013). Polyphagous.
2. *Galerucella calmariensis* Linnaeus, 1758 – Bihor Mts. (collected Ilie, 2013). Monophagous.

Subfamily Alticinae Kutschera, 1859

1. *Phyllotreta vittula* Redtenbacher, 1849 – Bihor Mts. (collected Ilie, 2012-2015). Polyphagous.
2. *Aphthona ovata* Foudras, 1861 – Bihor Mts. (collected Ilie, 2013). Oligophagous.
3. *Longitarsus melanocephalus* De Geer, 1775 – Codru-Moma Mts. (collected Ilie, 2014). Oligophagous.
4. *Longitarsus ganglbaueri* Heikertinger, 1912 – Codru-Moma Mts. (collected Ilie, 2014). Monophagous.
5. *Mniophila muscorum* Koch, 1803– Codru-Moma Mts. (collected Ilie, 2013), Bihor Mts. (MOCSARY, 1875). Polyphagous.
6. *Orestia carpathica* Reitter, 1880 – Bihor Mts. (GRUEV & MERKL, 1993). Oligophagous.
7. *Minota carpathica* Heikertinger, 1911 – Bihor Mts. (GRUEV & MERKL, 1993). Oligophagous.
8. *Minota halmae* Apfelbech, 1906 – Bihor Mts. (GRUEV & MERKL, 1993). Oligophagous.
9. *Neocrepidodera ferruginea* Scopoli, 1763 – Codru-Moma Mts. (collected Ilie, 2013), Bihor Mts. (MOCSARY, 1875). Polyphagous.
10. *Dibolia carpathica* Weise, 1893 – Şes Mountain (collected Ilie, 2013). Monophagous.
11. *Chaetocnema hortensis* Geoffroy, 1785 – Şes Mountain (collected Ilie, 2014). Oligophagous.
12. *Crepidodera aurata* Marsham, 1802 –Bihor Mts. (collected Ilie, 2011-2015). Oligophagous.
13. *Crepidodera plutus* Latreille, 1804 – Bihor Mts. (collected Ilie, 2011-2013). Oligophagous.
14. *Crepidodera aurea* Geoffroy, 1805 – Bihor Mts. (collected Ilie, 2012). Oligophagous.
15. *Podagrica fuscicornis* Linnaeus, 1766 – Codru-Moma Mts. (collected Ilie, 2012), Bihor Mts. (MOCSARY, 1875). Oligophagous.
16. *Podagrica malvae* Hliger, 1807 – Bihor Mts. (MOCSARY, 1875), Codru-Moma Mts. (collected Ilie, 2012). Oligophagous.

17. *Psylliodes frivaldszky* Weise, 1888 – Bihor Mts. (GRUEV & MERKL, 1993). Oligophagous.
18. *Psylliodes hyosianus* Linnaeus, 1758 – Bihor Mts. (MOCSARY, 1875). Monophagous.
19. *Psylliodes subaeneus* Kutschera, 1867 – Bihor Mts. (GRUEV & MERKL, 1993). Oligophagous.

Subfamily Cassidinae Gyllenhal, 1813

1. *Hypocassida subferruginea* Schrank, 1776 – Șes Mountain (collected Ilie, 2013), Bihor Mts. (collected Ilie, 2012-2014). Monophagous.
2. *Cassida sanguinolenta* Müller, 1776 – Codru-Moma Mts. (collected Ilie, 2012). Monophagous.
3. *Cassida vibex* Linnaeus, 1767 – Șes Mountain (collected Ilie, 2013), Codru-Moma Mts. (collected Ilie, 2014-2015). Oligophagous.
4. *Cassida viridis* Linnaeus, 1758 – Șes Mountain (collected Ilie, 2013), Codru-Moma Mts. (collected Ilie, 2014), Bihor Mts. (collected Ilie, 2011-2013). Polyphagous.

Those 63 collected species of chrysomelids belong to 6 subfamilies and 30 genera. Three subfamilies are best represented: Chrysomelidae (22 species, 34.92%), Alticinae (19 species, 30.15%), Chryptocephalinae (14 species, 22.22%). Other subfamilies presents a smaller number of species: Cassidinae - 4 species (6.4%), Galerucinae 2 species (3.17%) and Criocerinae – 2 species, 3.17%.

Out of the 63 mentioned chrysomelid species, 49 have been identified by the author (marked in round brackets with “Ilie” and the years when the author collected the chrysomelid species), the rest of them being recorded from literature.

The identified chrysomelid species present the following distribution in the mountain area of Bihor County: 35 were found in Bihor Mts., 9 – in Șes Mountain, 8 – in Codru-Moma Mts., 8 are common in Codru-Moma Mts. and Bihor Mts., 1 is common in Șes Mountain and Bihor Mts., 1 is common in Șes Mountain and Codru-Moma Mts. and 1 is common in Codru-Moma Mts., Șes Mountain and Bihor Mts.

Some of the mentioned species (14) are widely distributed in Romania: *Oulema melanopus*, *Clytra laeviuscula*, *Pachybrachys sinuatus*, *Cryptocephalus hypochaeridis*, *Cryptocephalus moraei*, *Chrysolina polita*, *Chrysolina fastuosa*, *Chrysomela populi*, *Gonioctena fornicata*, *Crepidodera aurea*, *Podagrica malvae*, *Hypocassida subferruginea*, *Cassida vibex* and *Cassida viridis*.

The list includes two certain Carpathian endemics restricted only to the Romanian Carpathians: *Chrysolina biharica* and *Chrysolina weisei*. Other species are Carpathian endemics, being recorded along the entire Carpathian Mts. chain: *Sclerophaedon carpathicus* and *Psylliodes frivaldszky*.

Five chrysomelid species are distributed within the Alpine - Carpathian chain: *Chrysolina olivieri*, *Chrysolina umbratilis*, *Oreina intricata*, *Sclerophaedon carpathicus* and *Minota carpathica*.

Depending on the nutritional spectrum, the chrysomelids of Bihor County belong to three groups: oligophagous species (33, 52.38%), polyphagous species (20, 31.74%), monophagous species (9, 14.28 %) and one (1.58 %) with host-plant unknown.

Four chrysomelid species (*Timarcha gibba*, *Chrysolina aurichalcea*, *Chrysolina umbratilis* and *Oreina bifrons*) are rare at national level.

CONCLUSIONS

The list of the mountainous leaf-beetles of Bihor County includes 63 species belonging to 30 genera and 6 subfamilies.

The majority of chrysomelids were recorded in Bihor Mts. and 14 species are widely distributed in Romania.

The oligophagous species predominate in the collected chrysomelid species.

Four species are rare at national level, six species are distributed within the Alpine-Carpathian chain and along the entire Carpathian Mts. chain and two species are endemic in the Carpathians, restricted only to the Romanian Carpathians.

ACKNOWLEDGEMENTS

Special thanks to Mr. Professor Mircea Varvara, “Al. I. Cuza” University of Iasi, for his constructive comments and publishing advice.

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Received: January 23, 2017

Accepted: March 31, 2017

DATA REGARDING THE DIVERSITY OF SCARABAEOIDEA SUPERFAMILY (INSECTA, COLEOPTERA) FROM THE PROTECTED AREA JIU-DANUBE CONFLUENCE (ROSPA0023) (I)

CHIMIȘLIU Cornelia

Abstract. The work is a synthesis of the species from ten families: Cetoniidae, Dynastidae, Glaresidae, Hybosoridae, Lucanidae, Melolonthidae, Ochodaeidae, Orphnidae, Rutelidae and Trogidae, the Scarabaeoidea superfamily, signaled during 1954-2017 in this area of Romania. The data comes both from previously published papers and from the observations made by the author. There have been identified 41 species and subspecies, included in 25 genera, 6 subfamilies. In the fauna of this protected area, there have been reported the protected species of Community interest *Lucanus* (*Lucanus*) *cervus*, as well as some rare and very rare species: *Protaetia* (*Cetonischema*) *aeruginosa*, *Protaetia* (*Eupotosia*) *affinis*, *Protaetia* (*Netocia*) *ungarica*, *Tropinota* *squalida*, *Pentodon* *bidens*, *Glaresis* *rufa*, *Hybosorus* *illigeri*, *Monotropus* *nordmanni*, *Chaetonyx* *robustus*, etc. The species *Protaetia* (*Liocola*) *lugubris* and *Ochodaeus* *chrysomeloides* are now reported for the first time in the analyzed area.

Keywords: diversity, Scarabaeoidea, Jiu-Danube Confluence, rare and very rare species.

Rezumat. Date privind diversitatea suprafamiliei Scarabaeoidea (Insecta, Coleoptera) din fauna ariei protejate Confluența Jiu-Dunăre (ROSPA0023) (I). Lucrarea este o sinteză a speciilor din zece familii: Cetoniidae, Dynastidae, Glaresidae, Hybosoridae, Lucanidae, Melolonthidae, Ochodaeidae, Orphnidae, Rutelidae și Trogidae, suprafamilia Scarabaeoidea, semnalate în perioada anilor 1954-2017 din această zonă a României. Datele provin atât din lucrări de specialitate publicate anterior cât și din observații efectuate de către autoare. Au fost identificate 41 de specii și subspecii, incluse în 25 genuri, 6 sufamilii. În fauna ariei a fost semnalată specia protejată de interes comunitar *Lucanus* (*Lucanus*) *cervus*, precum și specii rare și foarte rare: *Protaetia* (*Cetonischema*) *aeruginosa*, *Protaetia* (*Eupotosia*) *affinis*, *Protaetia* (*Netocia*) *ungarica*, *Tropinota* (*Tropinota*) *squalida*, *Pentodon* *bidens*, *Glaresis* *rufa*, *Hybosorus* *illigeri*, *Monotropus* *nordmanni*, *Chaetonyx* *robustus*, etc. Speciile *Protaetia* (*Liocola*) *lugubris* și *Ochodaeus* *chrysomeloides*, sunt semnalate acum pentru prima dată în zona analizată.

Cuvinte cheie: diversitate, scarabaeoidee, Confluența Jiu-Dunăre, specii rare și foarte rare.

INTRODUCTION

The protected area of the Jiu-Danube Confluence (ROSPA0023) is part of the SPA list (Special Areas of Avifaunistic Protection) according to the Government Decision no.1284/2007 regarding the declaration of special protection areas for avifauna. It is an integral part of the European ecological network Natura 2000 in Romania.

The territory has an area of 19,800 ha and is located on both sides of the Lower Jiu, downstream of Craiova, to the confluence of the Jiu and the Danube, being about 50 km long.

The area is valued not only due to the important herds of protected bird species but also to the great diversity of the entomofauna.

The purpose of this paper is to render the stage of knowing the diversity of Scarabeoids in the Jiu-Danube Confluence Area. In the present study, there have been analyzed the families with phytophagous, saprophagous and necrophagous species (Cetoniidae, Dynastidae, Glaresidae, Hybosoridae, Lucanidae, Melolonthidae, Ochodaeidae, Orphnidae, Rutelidae and Trogidae). The families with coprophagous species will be analyzed in another paper.

Since the work is the first of its kind, it can be a reference point for further research on this superfamily.

MATERIAL AND METHOD

The paper is elaborated both on the basis of data from specialized papers published during 1960-2014 (BOBÎRNAC, 1960, 1974; BOBÎRNAC & SANDA, 1964; BOBÎRNAC & MATEI, 1985; CHIMIȘLIU, 1999, 2000a,b,c, 2001, 2003, 2005; CHIMIȘLIU & MOGOȘEANU, 2011; MATEI & BOBÎRNAC, 1975, 1978; MATEI et al., 1974, 1976, 1997; NEȚOIU & CHIMIȘLIU, 2004) and on the personal observations made in various sites in the protected area Jiu-Danube confluence. The previously published personal results on the Scarabeoids in Oltenia are summarized in the paper published in 2014 (CHIMIȘLIU, 2014).

The personal data from this paper were obtained following the observations made between 2007 and 2017.

The following methods for identifying the species presented in this paper have been used: collecting, direct observation and/or photographing the coleopterans.

To determine the species we used the works: PANIN (1955).

For each species we mentioned: previous entries in the literature (in chronological order of publication of the papers) and personal data.

The collecting/observation sites are presented in alphabetical order and the collection data in the chronological order of the years and months of collecting.

The species are presented in phylogenetic order, according to Fauna Europaea ([http // www.faunaeur.org](http://www.faunaeur.org)).

RESULTS

The analyzed material was collected from 21 collecting sites: Bechet, Bratovoești, Căciulătești, Dăbuleni, Făcăi, Ghindeni, Gura Văii, Lake Victoria, Lișteava, Malu Mare, Mărășani, Piscu Sadovei, Preajba, Prunet, Rojiște, Sadova, Segarcea, Secui, Tâmburești, Zăval.

After processing the material, we identified 41 species, included in 25 genera, six subfamilies, ten families. The distribution of the species in the ten families is shown in Table 1.

Table 1. Taxonomic spectrum of Scarabeoids in the Protected Area Confluence Jiu-Danube.

No	Families	Subfamilies	Tribe	No. of genera	No. of subgenera	No. of species	No. of specimens
1.	Cetoniidae	Cetoniinae	Cetoniini	4	6	10	335
		Valginae		1		1	70
2.	Dynastidae	Dynastinae	Oryctini	1		1	26
			Pentodontini	1		2	
3.	Glaresidae			1		1	
4.	Hybosoridae			1		1	1
5.	Lucanidae			2		2	63
6.	Melolonthidae	Melolonthinae	Melolonthini	3		7	89
			Rhizotrogini	3		3	17
		Sericinae		1		1	12
7.	Ochodaeidae			1		1	3
8.	Orphnidae			1		1	
9.	Rutelidae	Rutelinae	Anisopliini	2		4	
			Anomalini	2		4	110
10.	Trogidae			1		2	
Total		6	7	25		41	726

Superfamily SCARABAEOIDEA

Family CETONIIDAE

Subfamily CETONIINAE Distant, 1900-1911

Tribe *Cetoniini* Seidlitz, 1875

Genus *Cetonia* Fabricius, 1775

Cetonia aurata (Linnaeus, 1761)

Previous reports: BOBÎRNAC & SANDA (1964) - Bechet; BOBÎRNAC (1974) - Bechet; CHIMIȘLIU (1999) - Segarcea, Zăval; CHIMIȘLIU & MOGOȘEANU (2011) - Bratovoești, Secui, Segarcea.

Personal data - 30 specs.: Zăval 9 specs. - April 30, 2010; Secui 1 spec. - July 16, 2011; 1 spec. - May 25, 2013; 1 spec. - June 7, 2014; 1 spec. - April 26, 2015; 1 spec. - April 28, 2015; 10 specs. - April 20, 2016; 6 specs. - April 15, 2017.

Genus *Protaetia* Burmeister, 1842

Subgenus *Cetonischema* Reitter, 1898

Protaetia (Cetonischema) aeruginosa (Linnaeus, 1767)

Previous reports: BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești.

Personal data - 5 specs.: Bratovoești 1 spec. - June 19, 2015; 3 specs. - June 23, 2015; 1 spec. - July 8, 2015.

Subgenus *Eupotosia* Miksic, 1954

Protaetia (Eupotosia) affinis (Andersch, 1797)

Previous reports: BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; CHIMIȘLIU & MOGOȘEANU (2011) - Secui.

Subgenus *Liocola* Thomson, 1859

Protaetia (Liocola) lugubris (Herbst, 1786)

Personal data: Bratovoești 1 spec. - June 19, 2015.

Subgenus *Netocia* Costa, 1852

Protaetia (Netocia) cuprea metallica (Herbst, 1782)

Previous reports: CHIMIȘLIU & MOGOȘEANU (2011) - Bratovoești, Segarcea.

Protaetia (Netocia) cuprea obscura (Andersch, 1797)

Previous reports: CHIMIȘLIU (1999) - Bratovoești; CHIMIȘLIU & MOGOȘEANU (2011) - Secui, Segarcea.

Personal data - 14 specs.: Bratovoești 4 specs. - July 8, 2015; Dăbuleni 2 specs. - April 30, 2010; Secui 2 specs. - May 24, 2010; 2 specs. - July 10, 2011; 1 spec. - April 15, 2017; Teasc 1 spec. - August 9, 2013; 1 spec. - June 7, 2014; 1 spec. - May 20, 2015.

Protaetia (Netocia) ungarica (Herbst, 1790)

Previous reports: CHIMIȘLIU (1999) - Făcăi.

Genus *Tropinota* Mulsant, 1842

Subgenus *Epicometis* Burmeister, 1842

Tropinota (Epicometis) hirta (Poda, 1761)

Previous reports: BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; MATEI & BOBÎRNAC (1975) - Tâmburești; MATEI et al. (1975) - Bechet, Dăbuleni, Tâmburești; MATEI & BOBÎRNAC (1976) - Malu Mare, Rojiște, Tâmburești; CHIMIȘLIU (1999) - Bechet, Segarcea, Tâmburești; CHIMIȘLIU & MOGOȘEANU (2011) - Bratovoești, Secui, Segarcea.

Personal data - 234 specs.: Secui 25 specs. - April 15, 2010; 15 specs. - May 5, 2010; 4 specs. - April 2, 2011; 8 specs. - April 20, 2011; 13 specs. - June 5, 2011 50 specs.- May 24, 2010; Dăbuleni 12 specs. - April 30, 2010; 1 spec.- April 21, 2012; 7 spec.- April 17, 2013; 11 specs.- May 11, 2013; 1 spec.- May 25, 2013; 4 specs. - April 21, 2014; 2 specs. - May 3, 2014; 2 specs. - May 11, 2014; 4 specs. - May 31, 2014; 8 specs. - June 7, 2014; 2 specs. - June 14, 2014; 28 specs. - April 26, 2015; 1 spec. - April 28, 2015; 8 specs. - May 1, 2015; 1 spec. - May 10, 2015; 1 spec. - April 20, 2016; 26 specs. - April 15, 2017.

Subgenus *Tropinota* Mulsant, 1842

Tropinota (Tropinota) squalida (Scopoli, 1783)

Previous reports: CHIMIȘLIU & MOGOȘEANU (2011) - Segarcea.

Subtribe Leucocelina

Genus *Oxythyrea* Mulsant, 1842

Oxythyrea funesta (Poda, 1761)

Previous reports: BOBÎRNAC & SANDA (1964) - Mârșani, Tâmburești; BOBÎRNAC (1974) - Mârșani Tâmburești; MATEI & BOBÎRNAC (1975) - Tâmburești; MATEI et al. (1975) - Bechet, Dăbuleni, Tâmburești; MATEI et al. (1976) - Dăbuleni, Sadova; CHIMIȘLIU (1999) - Bechet; CHIMIȘLIU (2000c) - Secui; CHIMIȘLIU & MOGOȘEANU (2011) - Bratovoești, Secui, Segarcea.

Personal data - 51 specs.: Dăbuleni 6 specs. - April 30, 2010; Secui, 10 specs. - May 5, 2010; 2 specs. - May 24, 2010; 1 spec. - July 10, 2011; 1 spec.- May 25, 2013; 11 spec. - May 10, 2015; 2 specs. - March 22, 2016; 2 specs. - April 20, 2016; 16 specs. - April 15, 2017.

Subfamily VALGINAE Mulsant, 1842

Genus *Valgus* Scriba, 1790

Valgus hemipterus (Linnaeus, 1758)

Previous reports: BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; MATEI & BOBÎRNAC (1975) - Tâmburești; MATEI et al. (1975) - Bechet, Dăbuleni, Tâmburești; CHIMIȘLIU & MOGOȘEANU (2011) - Bratovoești, Gura Văii, Secui; Segarcea.

Personal data - 70 specs.: Dăbuleni 20 specs.- April 30, 2010; Secui 1 spec. - May 11, 2013; 1 spec. - May 25, 2013; 2 specs. - April 21, 2014; 1 spec. - April 26, 2015; 14 specs. - April 28, 2015; 2 specs. - May 1, 2015; 1 spec. - May 10, 2015; 12 specs. - April 20, 2016; 16 specs. - April 15, 2017.

Family DYNASTIDAE

Subfamily DYNASTINAE Kolbe, 1897

Tribe *Oryctini* Mulsant, 1842

Genus *Oryctes* Illiger, 1798

Oryctes nasicornis (Linnaeus, 1758)

Previous reports: BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; CHIMIȘLIU (2005) - Bratovoești, Făcăi, Teasc.

Personal data: Bratovoești 1 spec. - July 8, 2015; Secui 3 specs. - July 4, 2010; 4 specs. - June 19, 2011; 2 specs. - April 07, 2011; 1 spec. - July 10, 2011; 1 spec.- July 16, 2011; 3 specs. - June 22, 2013; 1 spec. - June 26, 2013; 1 spec. - July 3, 2013; 1 spec. - May 31, 2014; 1 spec. - July, 20, 2014; 2 specs. - June 15, 2017; 3 specs. July 10, 2017.

Tribe *Pentodontini* Mulsant, 1842

Genus *Pentodon* Hope, 1837

Pentodon bidens bidens (Pallas, 1771)

Previous reports: CHIMIȘLIU (2005) - Dăbuleni.

Pentodon idiota (Herbst, 1789)

Previous reports: MATEI et al. (1976) - Bechet, Dăbuleni, Tâmburești; MATEI & BOBÎRNAC (1978) - Preajba; CHIMIȘLIU (2005) - Dăbuleni, Segarcea, Zăval.

Family **GLARESIDAE** Semenov & Medvedev, 1932

Genus *Glaresis* Erichson, 1848

Glaresis rufa Erichson, 1848

Previous reports: CHIMIȘLIU (2003) - Dăbuleni.

Family **HYBOSORIDAE** Erichson, 1847

Genus *Hybosorus* MacLeay, 1819

Hybosorus illigeri (Reiche, 1853)

Previous reports: PANIN (1957) - Sadova.

Personal data: Secui 1 spec.- June 7, 2014.

Family **LUCANIDAE**

Subfamily **LUCANINAE** Latreille, 1804

Genus *Dorcus* MacLeay, 1819

Dorcus parallelipipedus (Linnaeus, 1785)

Previous reports: CHIMIȘLIU (2008) – Bratovoesti, Tâmburești.

Personal data: 29 specs.: Bratovoesti 2 specs. - June 19, 2015; Secui 2 specs. - May 30, 2010; 1 spec. - June 24, 2010; 2 specs.- July 16, 2011; 1 spec. - June 7, 2014; 3 specs.- July 24, 2011; 1 spec.- July 30, 2011; 1 spec. - June 24, 2013; 4 specs. - May 31, 2014; 1 spec. - July 7, 2014; 8 specs. - June 23, 2015; 1 spec. - July 8, 2015; 2 specs. - June 15, 2017.

Genus *Lucanus* Scopoli, 1763

Subgenus *Lucanus* Scopoli, 1763

Lucanus (Lucanus) cervus (Linnaeus, 1758)

Previous reports: CHIMIȘLIU (2008) - Bratovoesti, Segarcea, Tâmburești.

Personal data - 34 specs.: Bratovoesti 14 specs.- June 19, 2015; 6 specs. June 23, 2015; 7 specs. - July 8, 2015; Secui 2 specs.- July 24, 2011; 2 specs. - June 5, 2014; 2 specs. - June 10, 2017; 1 spec. - July 28, 2017.

Family **MELOLONTHIDAE**

Subfamily **MELOLONTHINAE** Reitter, 1902

Tribe **Melolonthini** MacLeay, 1819

Genus *Anoxia* Laporte de Castelnau, 1833

Subgenus *Anoxia* Laporte de Castelnau, 1833

Anoxia (Anoxia) pilosa (Fabricius, 1792)

Previous reports: BOBÎRNAC (1960) - Bratovoesti, Căciulătești, Lișteava, Piscu Sadovei, Sadova, Tâmburești; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; BOBÎRNAC & MATEI (1985) - Căciulătești, Sadova, Tâmburești; MATEI et al. (1997) - Tâmburești; CHIMIȘLIU (2000a) - Segarcea; CHIMIȘLIU (2000c) - Ghindeni, Preajba, Prunet, Secui; NEȚOIU & CHIMIȘLIU 2004 - Sadova, Segarcea.

Personal data 9 specs.: Secui 3 specs. - June 17, 2015; 2 specs. - July 2, 2016; 4 specs. - June 24, 2017.

Anoxia (Anoxia) villosa (Fabricius, 1781)

Personal data: Secui 2 specs. - July 5, 2014.

Subgenus *Protanoxia* Medvedev, 1951

Anoxia (Protanoxia) orientalis (Krynicky, 1832)

Previous reports: BOBÎRNAC (1960) - Dăbuleni, Mârșani, Tâmburești; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; MATEI & BOBÎRNAC (1975) - Tâmburești; MATEI & BOBÎRNAC (1978) - Dăbuleni, Sadova, Tâmburești.

Personal data: Secui 3 specs. - July 10, 2011.

Genus *Melolontha* Fabricius, 1775

Melolontha hippocastani Fabricius, 1801

Previous reports: BOBÎRNAC (1960) - Dăbuleni, Mârșani, Sadova, Tâmburești; BOBÎRNAC & MATEI (1985) - Dăbuleni, Lișteava, Sadova, Tâmburești; MATEI et al. (1997) - Tâmburești.

Melolontha melolontha (Linnaeus, 1758)

Previous reports: BOBÎRNAC (1960) - Segarcea; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; MATEI & BOBÎRNAC (1975) - Tâmburești; MATEI & BOBÎRNAC (1978) - Dăbuleni, Tâmburești.

Personal data - 59 specs.: Secui 4 specs. - April 20, 2010; 1 spec. - May 5, 2010; 2 specs. - May 9, 2010; 13 specs. - April 17, 2013; 6 specs. - May 11, 2013; 16 specs. - May 10, 2014; 1 spec. - April 26, 2015; 2 specs. - April 5, 2016; 12 specs. - April 20, 2016; 2 specs. May, 2017.

Melolontha pectoralis Megerle, 1812

Previous reports: BOBÎRNAC (1960) - Tâmburești.

Genus ***Polyphylla*** Harris, 1842
Subgenus ***Polyphylla*** Harris, 1842

Polyphylla (Polyphylla) fullo (Linnaeus, 1758)

Previous reports: BOBÎRNAC (1960) - Dăbuleni, Lișteava, Piscu Sadovei, Tâmburești; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC et al. (1972); MATEI & BOBÎRNAC (1975) - Tâmburești; MATEI & BOBÎRNAC (1976) - Dăbuleni, Malu Mare, Tâmburești; BOBÎRNAC & MATEI (1985) - Dăbuleni, Lișteava, Piscu Sadovei, Tâmburești; MATEI et al. (1997) - Tâmburești; CHIMIȘLIU (2000c) - Prunet, Secui; NEȚOIU & CHIMIȘLIU (2004) - Sadova.

Personal data 16 specs.: Secui 1 spec. - July 10, 2011; 5 spec. - June 24, 2013; 3 spec. - June 17, 2015; 7 spec. - July 6, 2017.

Tribe **Rhizotrogini**

Genus ***Amphimallon*** Berthold, 1827

Amphimallon solstitiale (Linnaeus, 1758)

Previous reports: BOBÎRNAC (1960) - Piscu Sadovei, Tâmburești; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; MATEI et al. (1975) - Bechet, Dăbuleni, Tâmburești; BOBÎRNAC & MATEI (1985) - Piscu Sadovei, Tâmburești; MATEI et al. (1997) - Dăbuleni, Mârșani; CHIMIȘLIU (2000b, 2000c) - Făcăi; NEȚOIU & CHIMIȘLIU (2004) - Segarcea.

Personal data 17 specs.: Secui 14 specs. - June 19, 2013; 3 spec. - June 24, 2013.

Genus ***Holochelus*** Reitter, 1889
Subgenus ***Miltotrogus*** Reitter, 1902

Holochelus (Miltotrogus) aequinoctialis (Herbst, 1790)

Previous reports: BOBÎRNAC (1960) - Piscu Sadovei, Tâmburești; MATEI et al. (1975) - Bechet, Dăbuleni, Tâmburești; MATEI & BOBÎRNAC (1978) - Dăbuleni, Malu Mare, Tâmburești.

Genus ***Monotropus*** Erichson, 1848

Monotropus nordmanni Blanchard, 1850

A very rare species in Romania's coleopteran fauna.

Previous reports: PANIN (1940) - Sadova.

Subfamily SERICINAE
Genus ***Maladera*** Mulsant & Rey, 1871
Subgenus ***Maladera*** Mulsant & Rey, 1871

Maladera (Maladera) holosericea (Scopoli, 1772)

Previous reports: CHIMIȘLIU (2000b) - Secui.

Personal data 12 specs.: Secui 1 spec. - October 10, 2010; 3 spec. - April 17, 2013; 2 spec. - May 3, 2014; 5 spec. - May 1, 2015.

Family **OCHODAEIDAE** Mulsant & Rey, 1871

Genus ***Ochodaeus*** Dejean, 1821

Ochodaeus chrysomeloides (Schrank, 1781)

Personal data - 3 specs.: Secui 1 spec. - June 19, 2013; 1 spec. - June 24, 2013; 1 spec. - May 31, 2014.

Family **ORPHNIDAE**
Genus ***Chaetonyx*** Schaum, 1862

Chaetonyx robustus Schaum, 1862

Previous reports: CHIMIȘLIU (2003) - Gura Văii.

Family **RUTELIDAE**

Subfamily RUTELINAE (Reitter, 1903)

Tribe **Anisopliini**

Genus *Anisoplia* Schoenherr, 1817

Subgenus *Anisoplia* Schoenherr, 1817

Anisoplia (Anisoplia) agricola (Poda, 1761)

Previous reports: BOBÎRNAC (1960) - Rojiște, Tâmburești; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC et al. (1972); BOBÎRNAC (1974) - Tâmburești.

Anisoplia (Anisoplia) deserticola Fischer von Waldheim, 1824

Previous reports: CHIMIȘLIU (2000b) - Dăbuleni; CHIMIȘLIU (2000c) - Ghindeni.

Subgenus *Autanisoplia* Medvedev, 1949

Anisoplia (Autanisoplia) austriaca (Herbst, 1783)

Previous reports: BOBÎRNAC (1960) - Mârșani, Piscu Sadovei, Segarcea, Tâmburești; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; MATEI & BOBÎRNAC (1976) - Dăbuleni, Sadova; MATEI et al. (1974) - Tâmburești; CHIMIȘLIU (2000c) - Secui.

Genus *Chaetopteropia* Medvedev, 1949

Anisoplia (Chaetopteropia) segetum Herbst, 1783

Previous reports: BOBÎRNAC (1960) - Lișteava, Mârșani, Piscu Sadovei, Tâmburești; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești; MATEI et al. (1976) - Mârșani, Rojiște, Tâmburești; MATEI et al. (1974); CHIMIȘLIU (2000c) - Secui.

Anisoplia (Anisoplia) lata Erichson 1847

Previous reports: CHIMIȘLIU (2000c) - Ghindeni, Secui.

Tribe **Anomalini**

Genus *Anomala* Schoenherr, 1817

Anomala dubia (Scopoli, 1763)

Previous reports: BOBÎRNAC (1960) - Dăbuleni, Tâmburești; BOBÎRNAC & SANDA (1964) - Bechet, Căciulătești, Lișteava, Sadova, Tâmburești; BOBÎRNAC (1974) - Tâmburești; MATEI et al. (1975) - Bechet, Dăbuleni, Tâmburești; MATEI & BOBÎRNAC (1975) - Tâmburești; MATEI & BOBÎRNAC (1978) - Dăbuleni, Tâmburești; BOBÎRNAC & MATEI (1985); CHIMIȘLIU (2000b) - Dăbuleni, Prunet; CHIMIȘLIU (2000c) - Ghindeni, Prunet, Secui.

Anomala errans (Fabricius, 1775)

Previous reports: BOBÎRNAC & SANDA (1964) - Tâmburești; CHIMIȘLIU (2000b) - Tâmburești.

Anomala solida Erichson, 1847

Semnări anterioare: PANIN (1955); BOBÎRNAC (1960) - Bechet, Căciulătești, Lișteava, Piscu Sadovei, Tâmburești; BOBÎRNAC & SANDA (1964) - Bechet, Căciulătești, Dăbuleni, Dobrești, Lișteava, Piscu Sadovei, Sadova, Tâmburești; BOBÎRNAC (1974) - Bechet, Dăbuleni, Sadova, Tâmburești; MATEI et al. (1975) - Bechet, Dăbuleni, Tâmburești; MATEI & BOBÎRNAC (1978) - Dăbuleni, Malu Mare, Rojiște, Sadova, Tâmburești; MATEI et al. (1997) - Dăbuleni, Mârșani; CHIMIȘLIU (2000b) - Bechet, Dăbuleni, Gura Văii, Lac Victoria; CHIMIȘLIU (2000c) - Făcăi, Preajba, Prunet, Secui; NEȚOIU & CHIMIȘLIU (2004) - Sadova.

Personal data - 110 specs.: Bratovoești 2 specs. - June 23, 2015; 7 specs. - July 8, 2015; Secui 3 specs. - June 24, 2010; 2 specs. - July 4, 2011; 2 specs. - July 10, 2011; 14 specs. - June 19, 2013; 22 specs. - June 22, 2013; 20 specs. - June 24, 2013; 10 specs. - July 3, 2013; 1 spec. - June 07, 2014; 6 specs. - July 5, 2014; 3 specs. June 17, 2015; 15 specs. June 26, 2016; 7 specs. - July 6, 2017.

Anomala vitis (Fabricius, 1775)

Previous reports: BOBÎRNAC (1960) - Lișteava, Tâmburești; BOBÎRNAC & SANDA (1964) - Tâmburești; BOBÎRNAC (1974) - Tâmburești.

Genus *Phyllopertha* Stephens, 1830

Phyllopertha horticola (Linnaeus, 1758)

Previous reports: MATEI et al. (1974) - Tâmburești; MATEI & BOBÎRNAC (1978) - Preajba.

Family **TROGIDAE** Péringuey, 1901Genus ***Trox*** Fabricius, 1775Subgenus ***Trox*** Fabricius, 1775***Trox (Trox) hispidus*** Pontoppidan, 1763**Previous reports:** CHIMIȘLIU (2003) - Rojiște, Zăval.***Trox (Trox) scaber*** (Linnaeus, 1767)**Previous reports:** CHIMIȘLIU (2003) - Dăbuleni, Zăval.

DISCUSSIONS

The area has been declared protected for the conservation of wild birds due to the special species of wild birds living in this territory, but the physico-geographic conditions have also determined the existence of a great variety of entomofauna.

We mention that although, systematic studies have not been carried out in this area for the knowledge of entomofauna diversity, the data obtained from the analyzed materials in this paper attest to the great diversity of scarabaeoid fauna. Thus, out of the 83 species of the ten analyzed families present in the fauna of Romania, 41 species have been reported up to now in the fauna of the area (Table 2).

The protected species of Community interest *Lucanus (Lucanus) cervus* is present in the area and is quite common.

We now report for the first time in the area two rare species in the fauna of the country: *Protaetia (Liocola) lugubris* and *Ochodaeus chrysomeloides*.

Table 2. Species of scarabaeoids signaled in the protected area Jiu-Danube Confluence, compared to species reported in Romania.

No.	Families	No. of species in Romania	No. of species in the protected area Jiu-Danube confluence
1	Cetoniidae	16	11
2	Dynastidae	4	3
3	Glaresidae	1	1
4	Hybosoridae	1	1
5	Lucanidae	7	2
6	Melolonthidae	27	11
7	Ochodaeidae	3	1
8	Orphnidae	1	1
9	Rutelidae	19	8
10	Trogidae	4	2
Total		83	41

Other rare and very rare species present in the fauna of the Area are: *Protaetia (Cetonischema) aeruginosa*, *Protaetia (Eupotosia) affinis*, *Protaetia (Netocia) ungarica*, *Tropinota (Tropinota) squalida*, *Pentodon bidens bidens*, *Glaresis rufa*, *Hybosorus illigeri*, *Monotropus nordmanni*, *Ochodaeus chrysomeloides*, *Chaetonyx robustus* etc.

CONCLUSIONS

Considering the surface of the area compared to the surface of Romania, the identification of about fifty percent of the species of Romania fauna attests the great diversity of scarabaeoidea species in the area

Given the physico-geographical features of the area and the specificity of the climate, surely the diversity of this group of insects is much bigger.

The presence of protected, rare or endangered species increases the scientific value of Oltenia scarabaeoidea fauna.

In order to know the diversity of this group and to reconfirm or invalidate the presence of the species mentioned in the literature, systematic studies are required.

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Received: March 8, 2017
Accepted: June 2, 2017

STUDY ON THE MACROLEPIDOPTERA COLLECTED FROM PĂLTINIȘ (SIBIU COUNTY), EXISTING WITHIN THE COLLECTION OF DR. VIKTOR WEINDEL

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Abstract. The present paper is an important contribution to the knowledge of Lepidoptera heritage in Romania, thus, completing literature data fauna of great interest for the natural heritage. In Dr. Viktor Weindel's collection of Lepidoptera, containing a total of 573 species and 3,490 specimens, after analyzing all the material, we identified 49 species belonging to 10 families, collected during 1905-1955 from Păltiniș-Sibiu. At present, 2017, this collection of Lepidoptera is in the collection of the Museum of Natural History in Sibiu, being invaluable from the historical, documentary and scientific, national and even global point of view. The systematic classification is updated according to the lepidoptera catalog in Romania.

Keywords: Lepidoptera, Dr. V. Weindel collection, Păltiniș.

Rezumat. Studiu asupra macrolepidopterelor colectate din Păltiniș (județul Sibiu), existente în Colecția lui Dr. Viktor Weindel. Prezenta lucrare reprezintă o contribuție importantă la cunoașterea patrimoniului lepidopterelor din România, completând astfel literatura de specialitate cu datele faunistice de mare actualitate pentru valoarea patrimoniului natural. În colecția de lepidoptere a Dr. Viktor Weindel, care conține 573 specii, totalizând 3490 de exemplare, am identificat după analiza întregului material 49 de specii, aparținând la 10 familii, colectate în perioada 1905-1955 din stațiunea Păltiniș. În prezent această colecție de lepidoptere a Dr. V. Weindel se găsește în cadrul patrimoniului Muzeului de Istorie Naturală din Sibiu, fiind de o valoare inestimabilă din punct de vedere istoric, documentar-științific, național și chiar mondial. Încadrarea sistematică este actualizată conform Catalogului lepidopterelor României.

Cuvinte cheie: lepidoptere, colecție Dr. V. Weindel, Păltiniș.

INTRODUCTION

Previous decades were very important for the development of lepidopterological research in the town of Sibiu and Transylvania, in the postwar years. The richness of fauna and, in particular, the great number of Lepidoptera species, the knowledge of this Order of insects raised the curiosity of many researchers since the mid-19th century.

Since the establishment of the "Transylvanian Society of Natural Sciences" in 1849, Sibiu has become a center of naturalistic research activity in Transylvania, Carpathian area and surrounding areas. The company, with its members and network of relations with institutions of Natural Sciences and personalities from around the world, favoured cultural exchange and scientific research for the development of local and regional naturalists. In the first half of the last century, it was developed an entomological research, especially for Lepidoptera and Coleoptera species because of their wealth and multitude of forms, but also for their appearance.

In 1849, there was established "The Transylvanian Naturalist Society of Sibiu" (Siebenbürgischer Verein für Naturwissenschaften zu Hermannstadt), a scientific structure that contributed, in a decisive way, to the affirmation of the city as a scientific center (VLAD ANTONIE & CIOBANU, 2004a). As a pressorgan was the publication "Debates and Communications of the Transylvanian Society of Natural Sciences in Sibiu" (Verhandlungen und Mitteilungen des siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt) (ANTONIE, 2016).

Dr. Viktor Weindel (3.XI.1887- 27.V.1966) is closely linked to the history of medicine in Sibiu. After graduating the medical school in Cluj-Napoca, Budapest, Munich, he was especially chosen as secondary physician in Franz-Joseph hospital. He took part in the war between 1914 and 1918, from the first to the last day, as an army doctor, while continuing also his work at the hospital. He worked for nine years in the Medicine Department of the Transylvanian Society of Natural Sciences, being one of the last members during 1942-1945. He had an extremely varied activity both in medicine and in the Society of Natural Sciences. Born in Sibiu, he graduated the Evangelical gymnasium in the city. As a lepidopterist collector, he began as a child. The oldest specimens of the collection come from the century. Although not a large collection that was born in Sibiu, containing specimens of an extended period of time (60 years) and many gathering places in the surroundings remotest of Sibiu in Transylvania southern and eastern part from Pasul Turnu Roșu to the hills area. In a note entitled "Source of my butterfly" he says: "The cardinal points of my work collection are: Sibiu, Gușterița vineyards of Sibiu, Cisnădioara, Sibiu Forest Grove, Sadu, Cisnădie, Păltiniș, Măgura Cisnădiei".

After his retirement due to a serious illness, he did not have time to order and process his collection. Thus, it arrived at the Museum in a less ordered state. Here, there were ordered 4,322 specimens of Macro- and Microlepidoptera that were collected between 1900 and 1959 from Transylvania (Sibiu and its neighbourhoods), but also from other geographical regions of Romania and published as a list (SCHNEIDER, 1996). In a manuscript of Weindel, there are listed over 42 species in his paper. This collection (Table 1) contains rare and very interesting species in terms of collecting biogeographical areas. The Microlepidoptera collection still waits for processing, updating and publication.

Table1. Lepidoptera collection of Dr. Viktor Weindel.

Superfamily	Family	No. sp.	No. ex.
I. BOMBYCOIDEA	Lasiocampidae	11	62
	Lemoniidae	1	9
	Saturniidae	3	9
II. DREPANOIDEA	Drepanidae	3	12
	Thyatridae	4	9
III. GEOMETROIDEA	Geometridae	170	773
IV. SPHINGOIDEA	Sphingidae	19	52
V. NOTODONTOIDEA	Notodontidae	17	49
	Dilobidae	1	1
	Thaumatopoeidae	1	2
VI. NOCTUIDEA	Lymantriidae	10	62
	Arctiidae	26	102
	Ctenuchidae	2	16
	Nolidae	1	2
	Noctuidae	178	634
VII. HESPERIOIDEA	Hesperiidae	12	117
VIII. PAPILIONOIDEA	Papilionidae	6	88
	Pieridae	13	307
	Nymphalidae	38	420
	Satyridae	22	359
	Riodinidae	1	12
	Lycaenidae	34	393
TOTAL 8		573	3,490

MATERIAL AND METHODS

The entomologic collection was studied by many specialists, entomologists, such as: ANTONIE, 2007, 2015, 2016; MOISE, 2011a, b, c, d; RÁKOSY, 2003, 2005; SCHNEIDER, 1996; STANCĂ-MOISE, 2015a, b, c, d, e, 2016a, b; SZÉKELY, 1994, 1996, 1999a, b, 2003, 2008, 2010, 2011, 2014; VLAD-ANTONIE, 2000, 2004b; VLAD – ANTONIE & CIOBANU, 2004a;

The species in this study were collected from the mountains, Păltiniș Resort (Cindrel), located 35 km South-West of Sibiu, at an altitude of 1,440 m. The nomenclature is given according to the systematic list from The Catalog of Lepidoptera of Romania (RÁKOSY et al., 2003). For each species, there are written collecting data, (date, month and year), as it was found in Dr. Viktor Weindel Collection.

RESULTS

The following presentation is a systematic list of the species of Lepidoptera collected between 1904 and 1955 from Păltiniș Sibiu, present in Dr. Victor Weindel's Lepidoptera collection.

Family LASIOCAMPIDAE

1. *Lasiocampa quercus quercus* (Linnaeus, 1758): July 3, 1913; July 8, 1913 (3323 Ro, 6752 K & R).
2. *Cosmotriche lunigera* Esper, 1784: October 12, 1922 (3331 Ro, 6769 K & R).

Family HESPERIIDAE

3. *Ochlodes venatus* (Bremer & Grey, 1853): August 22, 1955 (3444 Ro, 6930 K & R).

Family PAPILIONIDAE

4. *Leptidea sinapis sinapis* (Linnaeus, 1758): July 2, 1950 (3464 Ro, 6966 K & R)
5. *Pieris rapae* (Linnaeus, 1758): March 7, 1922 (3 ex.), March 14, 1922, August 17, 1922, July 2, 1950 (3478 Ro, 6998 K & R).
6. *Pieris napi napi* (Linnaeus, 1758): March 14, 1922, August 15, 1922, July 3, 1950 (3480 Ro, 7000 K & R).
7. *Colias hyale* (Linnaeus, 1758): August 7, 1922 (3492 Ro, 7021 K & R).
8. *Colias croceus* (Fourcroy, 1785): August 1, 1925 (3489 Ro, 7015 K & R).

Family LYCAENIDAE

9. *Lycaena phlaeas phlaeas* (Linnaeus, 1761): August 16, 1922 (3502 Ro, 7034 K & R).
10. *Polyommatus icarus* (Rottemburg, 1775): August 15, 1922 (3578 Ro, 7163 K & R).

Family NYMPHALIDAE

11. *Issoria lathonia* (Linnaeus, 1758): July 3, 1950 (3600 Ro, 7210 K & R).
12. *Nymphalis polychloros* (Linnaeus, 1758): July 13, 1923 (3629 Ro, 7258 K & R).
13. *Nymphalis xanthomelas* (Esper, 1781): August 8, 1922 (3630 Ro, 7259 K & R).
14. *Nymphalis vaualbum* ([Denis & Schiffermüller], 1775): August 8, 1922 (3631 Ro, 7260 K & R).
15. *Vanessa cardui* (Linnaeus, 1758): August 12, 1922 (3617 Ro, 7245 K & R).
16. *Aglais urticae* (Linnaeus, 1758): July 21, 1922, July 32, 1922, July 8, 1923, July 2, 1930 (3621 Ro, 7250 K & R).
17. *Polygonia c-album* (Linnaeus, 1758): July 22, 1922 (3623 Ro, 7252 K & R).
18. *Apatura iris* (Linnaeus, 1758): August 4, 1923 (3658 Ro, 7299 K & R).

Family SATYRIDAE

19. *Lasiommata maera* (Linnaeus, 1758): July 14, 1908 (3668 Ro, 7312 K & R).
20. *Erebia ligea carthusianorum* Fruhstorfer, 1909: July 22, 1922 (2 spm.), July 7, 1950, July 2, 1950, (3689 Ro, 7360 K & R).
21. *Erebia euryale syrmia* Fruhstorfer, 1919: July 18-27, 1922 (2 spm.), July 7, 1950, July 2, 1950 (3690 Ro, 7361 K & R).
22. *Erebia medusa posodea* (Hübner, [1804]): July 8, 1922.

Family GEOMETRIDAE

23. *Macaria signaria* (Hübner, 1809): July 6, 1923 (3778 Ro, 7541 K & R).
24. *Alcis repandata* (Linnaeus, 1758): July 18, 1922 (3897 Ro, 7777 K & R).
25. *Alcis maculata* Staudinger, 1892, nec Moore, 1868 (August 13, 1904) (3898 Ro, 7778 K & R).
26. *Campaea margaritata* (Linnaeus, 1767): July 21, 1922 (3937 Ro, 7836 K & R).
27. *Hylaea fasciaria fasciaria* (Linnaeus, 1758): August 4, 1923 (3939 Ro, 7839 K & R).
28. *Puengeleria capreolaria* ([Denis&Schiffermüller], 1775): August 14, 1904 (3941 Ro, 7844 K & R).
29. *Parietaria sordaria mendicaria* Herrich-Schäffer, 1852: July 2, 1923 (3968 Ro, 7893 K & R).
30. *Scopula ternata* (Schränk, 1802): July 22, 1922, July 1, 1923 (5 spm.) (4063 Ro, 8067 K & R).
31. *Idaea ochrata* (Scopoli, 1763): July 22, 1922 (4077 Ro, 8099 K & R).
32. *Scotopteryx chenopodiata* (Linnaeus, 1758): July 22, 1922 (2 ex.) (4128 Ro, 8236 K & R).
33. *Xanthorhoe montanata* ([Denis&Schiffermüller], 1775): July 21, 1922, July 22, 1922, July 1-4, 1923 (4143 Ro, 8255 K & R).
34. *Xanthorhoe incursata* (Hübner, 1813): May 2, 1923 (4146 Ro, 8259 K & R).
35. *Entephria flavicinctata* (Hübner, 1813): July 3, 1923 (4166 Ro, 8299 K & R).
36. *Entephria caesiata* ([Denis&Schiffermüller], 1775): July 22, 1922 (6 spm.), July 31, 1922, August 7, 1922, July 1-4, 1923 (16 spm.) (4168 Ro, 8302 K & R).
37. *Eulithis populata* (Linnaeus, 1758): August 14, 1904, August 4, 1922 (5 spm.), August 10, 1922, August 15, 1922, August 16, 1922, August 27, 1922 (4192 Ro, 8332 K & R).
38. *Thera variata* ([Denis&Schiffermüller], 1775): July 5, 1925 (4211 Ro, 8357 K & R).
39. *Thera stragulata* Hübner, [1809]: July 18, 1922, July 23, 1922 (4213, 8360 K & R).
40. *Hydromena furcata* (Thunberg, 1784): August 4, 1923 (4228 Ro, 8391 K & R).
41. *Spargania luctuata* ([Denis&Schiffermüller], 1775): July 1, 1923 (4247 Ro, 8417 K & R).
42. *Rheumaptera hastata* (Linnaeus, 1758): July 14, 1923 (4249 Ro, 8419 K & R).
43. *Eupithecia icterata icterata* (Villers, 1789): July 3, 1950 (4337 Ro, 8538 K & R).
44. *Aplocera plagiata* (Linnaeus, 1759): August 4, 1922 (4386 Ro, 8620 K & R).
45. *Venusia cambric* Curtis, 1839: July (4403 Ro, 8652 K & R).
46. *Minoa murinata* (Scopoli, 1763): July 1, 1923 (4413 Ro, 8663 K & R).

Family SPHINGOIDEA

47. *Macroglossum stellatarum* (Linnaeus, 1758): July 27, 1922, August 15, 1922 (3388 Ro, 6843 K & R).

Family NOTODONTIDAE

48. *Hypena proboscidalis* (Linnaeus, 1758): July 3, 1950 (4633 Ro, 8994 K & R).

Family ARCTIIDAE

49. *Parasemia plantaginis* (Linnaeus, 1758): July 4, 1925 (2 spm.), (5554 Ro, 10557 K & R).

CONCLUSIONS

Transylvania, according to its geographical location, is a region where flora and fauna are well defined, whereby, in addition to many elements in common with its neighboring areas, there are also some characteristic species, which, so far, continue to maintain the status of "endemic".

At present, 2017, Dr. V. Weindel's collection of Lepidoptera is in the collection of the Museum of Natural History in Sibiu, being of priceless from the history, documentary and scientific, national and even global point of view.

In terms of history, the value lies in the fact that it is among the oldest entomological collections in Romania, some of the specimens dating from 1827 (PASCU & SCHNEIDER, 1998). Documents and scientific value is exceptional for this collection of bio-geographical nature of Transylvania, which illustrates Lepidoptera, in general, and Paltinis resort, in particular, where the species presented in this paper were collected.

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Received: March 30, 2017

Accepted: June 12, 2017

INFLUENCE OF STERILIZATION OF *Sitotroga cerealella* Ol. EGGS AND OF PASSAGES ON BIOLOGICAL INDICES AND EFFICACY OF *Trichogramma* spp.

GAVRILIȚA Lidia

Abstract. According to available data, the variant where *Sitotroga cerealella* Ol. eggs were irradiated with gamma rays of 150 Gy dose and kept within one month, the state quality criterion was 2.6 higher, irradiated and stored in within two months – 1.8 times greater, held within three months - 1.5 times higher, held within four months - 1.5 times higher, held within five months 1.34 times higher, compared to the control sample. The higher the terms of storage, the lower the biological indices of *Trichogramma* spp. Mathematical processing, analysis of variance indicated that, according to the criterion – T., statistics are accurate at 95%. Static quality criterion *Trichogramma* spp. difference, multiplied by *Sitotroga cerealella* Ol. irradiated eggs kept for five months, for further propagation of *Trichogramma* compared to the control is essentially higher.

Keywords: biological indices, prolificacy, *Trichogramma* spp., *Sitotroga cerealella*, biological efficacy.

Rezumat. Influența sterilizării ouălor de *Sitotroga cerealella* Ol. și a pasajelor asupra indicilor biologici și a eficacității *Trichogramma* spp. Conform datelor obținute, în prima variantă, unde ouăle de *Sitotroga cerealella* Ol. au fost iradiate cu raze gama cu doza de 150 Gy (Grey) și păstrate în decurs de o lună, criteriul static al calității a fost de 2,6 mai mare, iradiate și păstrate în decurs de două luni – de 1,8 ori mai mare, păstrate în decurs de trei luni – de 1,5 ori mai mare, păstrate în decurs de patru luni – de 1,5 ori mai mare, păstrate în decurs de cinci luni – de 1,34 ori mai mare, decât în martor. Cu cât termenii de păstrare sunt mai mari, cu atât mai mici sunt indicii biologici a *Trichogramma* spp. Prelucrarea matematică, efectuarea analizei disperse indică faptul, că conform criteriului – T – datele statistice sunt veridice la nivelul de 95%. Deosebirea criteriului static al calității *Trichogramma* spp. înmulțită pe ouă *Sitotroga cerealella* Ol. iradiate, care s-au păstrat cinci luni, pentru înmulțirea ulterioară a *Trichogramma* în comparație cu martorul este esențial mai mare.

Cuvinte cheie: indicii biologici, prolificitatea, *Trichogramma* spp., *Sitotroga cerealella*, eficacitatea biologică.

INTRODUCTION

One of the procedures to increase *Trichogramma* vitality is obtaining biological material of sterile insect eggs. There are several factors of host eggs' sterilization that allow improving insect development oofage: using low temperatures, thermo procedure, ultraviolet irradiation (VOEGELE & DAUMAL, 1974), irradiation with gamma rays (GAVRILIȚA, 1993, 1995, 1996, 2002; GAVRILIȚA & GREENBERG, 1996; BUTNARU & GAVRILIȚA 2011; LYSIKOVA, 1985; FIRU et al., 2003), etc. At our discretion obtaining anytime host eggs as a result of their longer storage has favored settling the issue. Agnomen grain moth (*Sitotroga cerealella* Ol.) cannot be stored for a long time in a refrigerator. This problem is particularly acute in biological laboratories where it is necessary to prepare big quantities of host eggs parasitized by *Trichogramma* (BURZINSKI & KOT, 1963; MENCHER et al., 1980) and it has been shown that the irradiation of *Sitotroga cerealella* Ol. eggs has a positive effect on the reproductive indices of *Trichogramma* developing on them. Similar indices have been obtained when *Trichogramma* developed on cabbage moth eggs irradiated with X-rays (dose of 15 krad) (DEGTYAREV & YANISHEVSKAYA, 1985).

Special prolongation of shelf life for irradiated eggs for their parasitizing by *Trichogramma* (up to 12 days) as compared to 2-3 days of non-irradiated eggs allowed reducing the number of eggs required for parasitization with *Trichogramma* (GAVRILIȚA, 1995). There still lack data on the usage of fresh *Sitotroga cerealella* Ol. eggs, gamma irradiated, with the aim of their long – term storage and possibility of subsequent *Trichogramma* spp. development on them.

Scientific research conducted at the Institute of Genetics, Physiology and Plant Protection allowed us to establish that a technique for improving *Trichogramma* spp. quality and it consists in rearing it on gamma irradiated eggs of *S. cerealella* (GAVRILIȚA & GREENBERG, 1996). Taking into consideration research tasks, the developed technique demonstrated prospects of rearing the entomophage on gamma radiated eggs of the *S. cerealella*. In this connection, rearing the parasitoid on gamma irradiated eggs of *S. cerealella* improved biological indices of the entomophage 1.5-2 times. The obtained research results showed that gamma irradiation of *S. cerealella* eggs at the age of 24 hours allows increasing the term of host eggs storage at the temperature of 3⁰C up to 4-5 months for subsequent *Trichogramma* rearing. Such rearing of *Trichogramma* on gamma radiated eggs of *S. cerealella* contributed to the improvement of its biological indices 1.5-2 times. Sex ratio played an important role in regulating population density. Bibliography on the showed that changing *Trichogramma* spp. sex ratio impacts a number of factors such as temperature, humidity, a number of developing larvae per egg, host species and their age, the term of storing *Trichogramma* in diapause and many others (GAVRILIȚA & GREENBERG, 1996).

Bibliography on the subject proves that biological indices of the parasitoid are directly proportional to the host species, its age and egg number (GAVRILIȚA, 1996). Each species has a high capacity for selecting the host to develop on them. Some differences were revealed in one and the same *Trichogramma* species from different hosts. *Trichogramma* successfully develops with high biological indices when rearing is made on host eggs in early stages of embryonic development. Biological and ecological research has been conducted and the results are evaluated using traditional methods.

For specific experiences, the *Trichogramma* species were collected, multiplied and identified, then the biological indices and biological effectiveness of the entomophagus were determined.

MATERIALS AND METHODS

Determination of shelf life of irradiated *Sitotroga cerealella* Ol. eggs in plastic bags. Mathematical data processing was done using variance analysis method (MENCER & ZEMSHMAN, 1986). In the experiments, there were used fresh eggs of the Angoumois grain moth (*S. cerealella* Ol.) at the age of (24-28 hours), if possible, under mass rearing conditions, gamma irradiated at the dose of 150 Gy.

After a certain term of storing eggs of the *S. cerealella* in the refrigerator at the temperature of $3^{\circ}\text{C} \pm 1$, biological indices were determined for *T. evanescens* (prolificacy, hatching, females' rate) reared on these eggs. The best results with prolificacy of *Trichogramma* spp. were obtained when applying the irradiation dose of 150 Gy to the eggs of the *S. cerealella*. After determining the optimal dose for irradiating the eggs of *S. cerealella*, in subsequent experiments, the dose of 150 Gy was applied to eggs.

Collection, identification, storage and accumulation of *Trichogramma* species were done according to DIURICI (2008). Rearing of the laboratory host – grain moth (*Sitotroga cerealella* Ol.), for *Trichogramma* production was done by (ABASCHIN et al., 1997) authors' methods.

RESULTS AND DISCUSSIONS

In Table 1 and Fig. 1 shows the results of storing *Sitotroga cerealella* irradiated eggs for 157 days in plastic bags (5 x 5 cm) and the control, where the eggs of *S. cerealella* Ol., were neither irradiated nor stored.

After irradiating the eggs of the *S. cerealella* at the dose of 150 Gy and placing them into plastic bags to be stored for 32, 65, 102, 136, and 157 days, biological indices of *T. evanescens* were determined.

Prolificacy of *Trichogramma* spp. reared on *S. cerealella* eggs soon after irradiation constituted 43.0 eggs per female, in the – 24.7, prolificacy in the trial with irradiation was two times higher than in the. It eloquently explains that irradiated eggs of the Angoumois grain moth contributed to improving *Trichogramma* prolificacy. In 32 and 65 days of storing eggs of the *S. cerealella*, prolificacy of *Trichogramma* spp. remained at almost the same level as at the beginning (41.8; 38.5), though considerably higher than in the (21.7; 21.3). According to criterion T., static data were accurate to the level of 95 %. In 102 days, no essential differences were revealed between the irradiation variant and the. In 136-157 days, *Trichogramma* prolificacy in the variant with essential irradiation was much lower than in the and equaled respectively to 17.8 and 4.76 eggs per female, in the – 22.2 and 18.0 eggs per female.

The obtained results showed that the eggs of the *S. cerealella* at the age of 24 hours, gamma irradiated to accumulate eggs, can be stored up to 102 days (3-4 months) in the refrigerator at the temperature of $T=3^{\circ}\text{C}$. The embryo in the irradiated Angoumois grain moth died and this allowed parasitizing and rearing of *Trichogramma* spp. for a longer time, thus increasing its prolificacy. It was found that female longevity increased 2-3 times (Table 2) in the variant, where *Trichogramma* was reared on irradiated eggs as compared to the when *Trichogramma* was reared without radiation.

When *Trichogramma* developed on irradiated *S. cerealella* eggs and stored in the refrigerator, its average longevity equaled to 7 days, in the – to 2.1 days, when stored for 82 days, respectively – to 4.8 days in the variant, in the – to 2.2 days, when stored for 103 days – 2.2 days in the variant and 1.7 days, respectively. Table 3 shows the biological indices of *Trichogramma* reared on irradiated Angoumois grain moth eggs stored for 2 months in plastic bags (5 x 10 cm). *Trichogramma* stock generation (F_0) was reared on irradiated *S. cerealella* eggs, while subsequent six generations were reared on non-irradiated eggs. When comparing F_0 , F_1 , F_2 , F_3 , F_4 , with the, an increase by 1.5-2 times was found in the static criterion and quality, in general, while generations F_5 , F_6 demonstrated no essential differences. *Trichogramma* quality increased in generations (F_1 to F_6) reared on irradiated eggs compared to F_0 , that may be explained by physiological changes in *S. cerealella* eggs caused by gamma irradiation at the dose of 150 Gy.

Determining storage period of the Angoumois grain moth (*Sitotroga cerealella* Ol.) eggs.

Irradiated *Sitotroga cerealella* eggs were stored for five months in small glasses with the volume of 50 ml. Every month irradiated and stored eggs were exposed to parasitizing by *Trichogramma* followed by determining biological indices in order to reveal optimal terms for storage of irradiated eggs. Table 4 shows static criterion of *Trichogramma* quality reared on the stored irradiated *S. cerealella* (variant) and on non-stored Angoumois grain moth eggs.

According to the obtained data, quality static criterion of eggs irradiated and stored for one month was 2.6 times higher and when storing for two months – 1.8 times higher, for three months – 1.5 times higher, for four months – 1.5 times higher, for 5 months – 1.34 times higher. The longer the storage period, the lower the biological index of *Trichogramma*. Mathematical processing and analysis of variance showed that, according to T – criterion, data were accurate at the level of 95 %. The difference of quality was essential and $T_{0.05}=2.23 < T_F=6.587-15.428$. Irradiated *S. cerealella* eggs can be stored in glasses for five months with essential differences as compared to the.

Determining efficacy of *Trichogramma* generations

Table 5 and Fig. 2 give graphical representation of the biological indices of *T. evanescens* reared on irradiated and non – irradiated *Sitotroga cerealella* Ol. eggs. While comparing the biological indices of *Trichogramma*, reared on *S. cerealella* eggs from the stock generation (F_0) with 12 consecutive generations reared on irradiated and non-stored

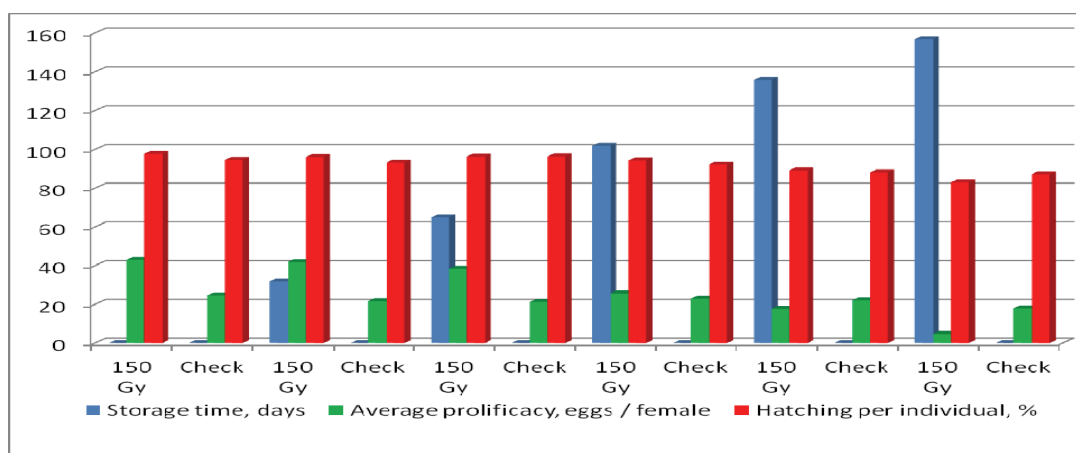
eggs, it was shown that they are two times higher in the variant with radiation than those in the check. Prolificacy has varied in 12 generations from 31.1 to 42.1 in the variant with radiation and from 19 to 22 in the check and the static criterion of quality in the variant with irradiation from 15.5 to 19.6 and from 8.7 to 9.8 in the check. The comparison of variant generations $F_1 - F_{12}$ with those in the check showed considerable difference, where $T_{0,05} = 2.78$; $T_{1-12} = 5.9-50.9$ at the level of 95% accuracy $F_{\text{practical}} = 58 > F_{\text{theoretical}} = 7.7$.

Table 1. Influence of gamma radiation of the *Sitotroga cerealella* Ol. eggs on biological indices of *T. evanescens*.

Ref. No.	Variants, gamma radiation, Grey	Storage time, days	Average prolificacy, eggs / female	Hatching per individual, %	Confidence interval	Student comparison criterion - T
1.	150 Gy	0	43.0±14.8	97.7±13.8	(36.38; 49.52)	$t_f = 4.13 > t_{0,05} = 2.04$
2.	Check	0	24.7±10.4	94.7±12.8	(19.37; 30.04)	
3.	150 Gy	32	41.8±12.6	96.1±10.8	(36.53; 47.2)	$t_f = 6.40 > t_{0,05} = 2.04$
4.	Check	0	21.7±3.4	93.2±9.8	(20.01; 23.38)	
5.	150 Gy	65	38.5±9.9	96.3±10.6	(33.84; 43.16)	$t_f = 6.52 > t_{0,05} = 2.04$
6.	Check	0	21.3±3.8	96.4±10.7	(19.44; 23.16)	
7.	150 Gy	102	25.7±5.6	94.4±9.8	(23.13; 28.27)	$t_f = 1.3 > t_{0,05} = 2.02$
8.	Check	0	23.0±4.5	92.2±9.3	(21.10; 24.80)	
9.	150 Gy	136	17.8±3.1	89.2±9.2	(16.56; 9.03)	$t_f = 2.31 > t_{0,05} = 2.01$
10.	Check	0	22.2±6.4	88.2±8.8	(19.47; 24.92)	
11.	150 Gy	157	4.7±1.36	83.0±7.2	(3.84; 4.96)	$t_f = 2.89 > t_{0,05} = 2.01$
12.	Check	0	18.0±6.3	87.2±7.8	(15.45; 20.55)	

Table 2. Longevity of *Trichogramma* females reared on irradiated and stored eggs of the *Sitotroga cerealella* Ol.

Variant	Storage period	Female longevity (days)
150 Gy	48±2.36	7.0±0.8
Check	0	2.1±0.1
150 Gy	82 ±3.32	4.8±0.6
Check	0	2.2±0.2
150 Gy	103±3.36	2.1±0.1
Check	0	1.7±0.3

Figure 1. Influence of gamma radiation of the *Sitotroga cerealella* Ol. eggs on biological indices of *Trichogramma evanescens*.Table 3. Biological indices of *T. evanescens* reared on eggs of the *Sitotroga cerealella* Ol. stored for 2 months.

Biological indices	Value of biological indices by generations														
	F ₀	M	F ₁	M	F ₂	M	F ₃	M	F ₄	M	F ₅	M	F ₆	M	
Prolificacy, egg/female, (P)	30.0	22.0	34.2	22.1	35.8	22.1	28.6	20.0	32.4	20.0	25.7	20.0	18.7	18.0	
Individual hatching, % (α_1)			85.0	85.5	87.6	85.0	88.1	85.5	84.6	80.0	81.3	80.0	80.6	81.0	
Error	1.1	0.001	0.9	4.6	2.6	4.6	2.8	0.43	2.0	0.43	0.88	0.43	6.5	0.51	
Females hatching, % (α_2)			53.0	53.0	53.4	52.9	52.5	51.0	53.6	53.7	54.0	53.7	54.0	52.0	
Static criteria of quality (γ_1)			15.4	10.0	17.2	10.0	13.2	8.6	14.2	8.6	11.2	8.6	8.0	7.6	
Error			0.68	0.001	0.19	0.002	0.9	0.17	0.2	0.17	0.41	0.1	0.17	0.2	
Searching capacity, % (γ_2)			33.4	20.4	33.0	22.8	28.0	20.8	22.0	20.4	24.0	20.4	25.0	21.0	
General criteria of quality, (D)			0.55	0.25	0.59	0.26	0.44	0.24	0.31	0.24	0.34	0.24	0.33	0.23	
Error			0.006	0.001	0.01	0.03	0.2	0.005	0.1	0.005	0.005	0.005	0.01	0.003	

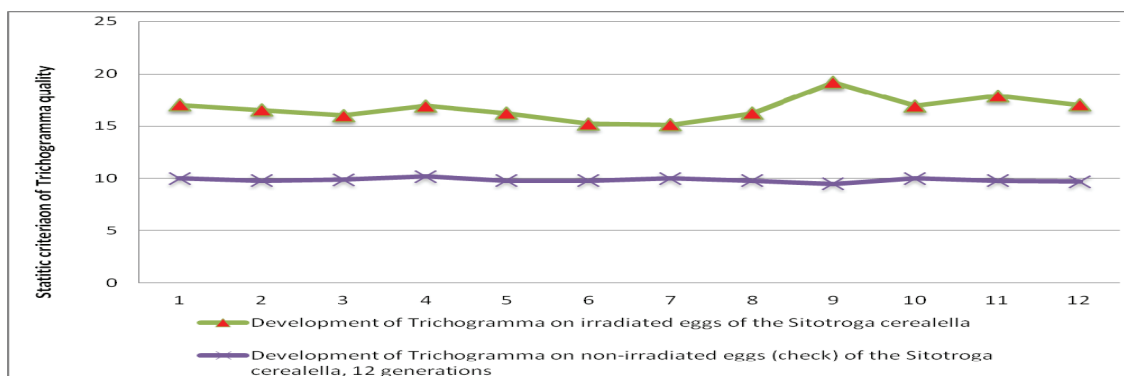
Legend: F₀ – storage of eggs of the *S. cerealella* irradiated for 2 months; F₁–F₆ – *Trichogramma* reared on non-irradiated *S. cerealella* eggs, six generations; M – check.

Table 4. Static criteria of quality of *Trichogramma evanescens* reared on irradiated eggs of *Sitotroga cerealella*.

Variant	Storage term (months)				
	1	2	3	4	5
<i>T. evanescens</i> reared on irradiated eggs of <i>Sitotroga cerealella</i>					
Static criteria of quality of <i>Trichogramma evanescens</i> reared on irradiated eggs	23.4	17.1	13.5	12.7	11.6
Error	1.74	0.94	0.29	0.25	0.20
Dispersion	9.60	2.63	0.26	0.19	0.12
Check (on non-irradiated eggs)	1	2	3	4	5
Static criteria of quality of <i>Trichogramma evanescens</i> reared on non-irradiated non-stored eggs	9.02±0.8	9.2±0.9	8.6±0.7	8.4±0.8	8.7±0.8
Error	0.005	0.10	0.45	0.025	0.10
Dispersion	0.0001	0.02	0.40	0.001	0.02

Table 5. Static criteria of *Trichogramma evanescens* quality.

Static criteria of quality	Generations											
	1	2	3	4	5	6	7	8	9	10	11	12
Development of <i>Trichogramma</i> on irradiated eggs of the <i>Sitotroga cerealella</i>	17.0 ±1.8	16.5 ±1.3	16.0 ±1.1	16.9 ±1.2	16.2 ±1.4	15.2 ±1.2	15.1 ±1.1	16.2 ±1.0	19.2 ±1.8	16.9 ±1.5	17.9 ±1.2	17.0 ±1.4
Development of <i>Trichogramma</i> on non-irradiated eggs (check) of the <i>Sitotroga cerealella</i> , 12 generations	10 ±1.4	9.8 ±1.0	9.9 ±1.1	10.2 ±1.5	9.8 ±1.0	9.8 ±1.1	10 ±1.3	9.8 ±1.2	9.5 ±1.1	10 ±1.0	9.8 ±1.3	9.7 ±1.2

Figure 2. Static criteria of *Trichogramma* quality (Y₁) by generations.

Field verification of *T. evanescens* and *T. pintoi*, Costești village, Hincești region, Moldova.

Testing *T. evanescens* and *T. pintoi* with different passages was effectuated in cabbage field against the second generation of the cabbage moth in Costesti village, Hincesti region, Moldova, in the year 1978, within an area of 4 hectares. Three releases of *Trichogramma* were made. After each record, *Trichogramma* species was identified and the share of eggs parasitized by *T. evanescens* and *T. pintoi* from nature and laboratory populations. In variant I, one passage of the entomophage was made on eggs of *M. brassicae* and subsequently released into the field, where biological efficacy after three releases of *T. evanescens* varied from 77.9 to 90.7% and after three releases of *T. pintoi* – from 64.1% to 80.7% (Table 6).

Table 6. Percentage of *Mamestra brassicae* eggs parasitized by *Trichogramma* in the field of Costești village, Hincesti region, Moldova.

Variant	Percentage of parasitized eggs of <i>Mamestra brassicae</i>					
	<i>Trichogramma evanescens</i> Westw.			<i>Trichogramma pintoi</i> Vegele		
	First release, 25.07	Second release, 02.08	Third release, 08.08	First release, 25.07	Second release, 02.08	Third release, 08.08
Variant I Passage on eggs of <i>M. brassicae</i>	77.9 ± 2.9	84.6 ± 3.0	90.7 ± 3.4	64.1 ± 2.0	70.4 ± 2.2	80.7 ± 3.3
Variant II Passage on eggs of <i>Sitotroga cerealella</i>	62.4 ± 2.3	79.7 ± 2.9	82.7 ± 2.9	54.1 ± 1.6	66.0 ± 1.6	72.7 ± 2.5
Average day temperature (T, °C)	20.1	20.2	19.8	20.1	20.2	19.8
Average daily humidity (W, %)	61.0	61.2	62.0	61.0	61.2	62.0

In variant II, *T. evanescens* and *T. pintoi* were reared on eggs of *Sitotroga cerealella* after diapause, then three releases were made into the field on late cabbage. Biological effectiveness after three releases of *T. evanescens* varied from 62.4 to 82.7% and for *T. pintoi* – from 5.1% to – 72.7%. Pest density records revealed the presence of *Trichogramma* in the field from nature, hence, the result took into account the percentage of parasitizing by laboratory *T. evanescens* together with *Trichogramma* from nature. In the check, the density of parasitized eggs varied from 3.2 to 6.0%. During pest development and verification of *Trichogramma* efficacy in the field, the average temperature per 24 hours varied from 19.8 to 20.2°C and relative air humidity from 61.0 % to 62.0%. The density of pest eggs during this period varied from 1.0 to 4.0 eggs/sq.m

Observations have shown that *T. pintoi* in cabbage field is low active, does not aggregate and gradually disappears. The picture is different when rearing *T. evanescens* and *T. pintoi* on eggs of the Angoumois grain moth (*Sitotroga cerealella*) under laboratory conditions. At mass rearing of both entomophage species there has taken place their mixture and subsequent substitution of *T. evanescens* by *T. pintoi*.

Average temperature and humidity during experiments have positively influenced ovipositing of the pest and the process of parasitizing cabbage moth eggs in the field (Table 6). The average temperature and humidity during this period have varied, from 19.8 to 20.2°C, and from 61.0 to 62.0%.

CONCLUSIONS

1. According to available data, the get variant where *Sitotroga cerealella* Ol. eggs were irradiated with gamma rays of 150 Gy dose and kept within one month, the state quality criteria was 2.6 higher, irradiated and stored in within two months – 1.8 times higher, held within three months – 1.5 times higher, held within four months – 1.5 times higher, held within five months – 1.34 times higher, compared to the control sample. The higher the terms of storage, the smaller the biological indices of *Trichogramma* spp.

2. Mathematical processing, analysis of variance indicated that the criterion – T– statistics are accurate at 95%. Static quality criterion *Trichogramma* spp. difference, multiplied by *Sitotroga cerealella* Ol. eggs irradiated were kept five months, further propagation of *Trichogramma* compared to control is essentially higher.

3. In variant I, one passage of the entomophage was made on eggs of *M. brassicae* and subsequently released into the field, where biological efficacy after three releases of *T. evanescens* varied from 77.9 to 90.7% and after three releases of *T. pintoi* – from 64.1% to 80.7%. In variant II, *T. evanescens* and *T. pintoi* have been reared on eggs of *Sitotroga cerealella* after diapause, then three releases were made into the field on late cabbage. Biological effectiveness after three releases of *T. evanescens* varied from 62.4 to 82.7% and for *T. pintoi* – from 5.1% to – 72.7%.

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Received: March 8, 2017

Accepted: June 2, 2017

ECOFAUNISTIC RESEARCHES ON SOME TAXONOMIC INVERTEBRATE GROUPS OF THE EDAPHIC FAUNA (SHALE LITHOSOL) FROM LEAOTA MOUNTAINS, 2014 -2015

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Abstract. The areal represented by Leaota Mountains has not been researched nearly at all until 2014-2015 from the perspective of the invertebrate fauna; thus, it still represents a white spot from this point of view. For this reason, our research has focused on the north-western sector of the massif, on the contact area with Bran-Rucăr Corridor and Piatra Craiului Massif, where the geological diversity of the substratum, limestone and crystalline schists, can represent a premise for the installation of some favourable conditions for the fauna biodiversity in the edaphic soil. This study presents the results of the distribution of taxa of invertebrates (Araneae, Isopoda, Collembola, Coleoptera, Diplopoda, and Chilopoda) in the edaphic soil with a substratum of meso-metamorphic crystalline schists. The variation of this distribution was analyzed both depending on the ecological stationary and on the month of the year. The monitoring process was carried out on a monthly basis, in 2014 and 2015.

Keywords: invertebrate fauna, Leaota, edaphic soil, shale lithosol.

Rezumat. Cercetări ecofaunistice asupra unor grupe taxonomice de nevertebrate din fauna edafică (litosol șistos) din Munții Leaota. Arealul reprezentat de Munții Leaota nu a fost aproape deloc cercetat până în anii 2014-2015, din punct de vedere al faunei de nevertebrate, reprezentând încă o pată albă din acest punct de vedere. Din acest motiv, cercetările noastre s-au concentrat pe sectorul de nord-vest al masivului, la zona de contact cu Culoarul Bran-Rucăr și cu Masivul Piatra Craiului, unde diversitatea geologică a substratului, calcare și sisturi cristaline pot constitui o premisă pentru instalarea unor condiții favorabile unei biodiversități faunistice în mediul edafic. Studiul nostru prezintă rezultatele în ceea ce privește distribuția taxonilor de nevertebrate (Araneae, Isopoda, Collembola, Coleoptera, Diplopoda și Chilopoda) în mediul edafic cu substrat format din șisturi cristaline mezometamorfice. Variația acestei distribuții a fost analizată atât în funcție de staționarul ecologic, cât și în funcție de luna din an. Monitorizările au fost efectuate lunar, în anii 2014 și 2015.

Cuvinte cheie: fauna de nevertebrate, Leaota, mediu edafic, litosol șistos.

INTRODUCTION

This paper displays the results of the research regarding the distribution of some important fauna taxonomic groups in schistic lithosol (meso-metamorphic) in the north-western area of Leaota Massif. Lithosol is an undeveloped soil, with skeletal soil with fine material < 20% of the quantity, reaching a 75cm depth (FLOREA & MUNTEANU, 2012), featured by the presence, at its surface, of the parental rock, consisting of pieces of centimeters or decimeters. Parental rocks display, in case of the lithosol, a general feature: they are hard, consolidated rocks (DUMITRIU, 2003). The fertility of this soil type is reduced due to the low quantity of humus it contains. Lithosol frequently appears in many areas in Leaota, being specific both to the areas with limestone substratum and to the ones with schist substratum. Lithosol represents a type of soil with litho-clast particles of different sizes, which allow the existence of some free spaces that are populated with different invertebrate species. The lithosol is also included in this category of special habitats as a type of endogenous environment (RACOVITĂ, 1989; DECU et. al., 1991), featured by particularities of some ecological factors, which determine the temporary or permanent population with certain species.

The ecological significance of this type of habitat comes from the fact that it represents a shelter for a series of invertebrates and small mammals, when the weather conditions become unfavorable for the biocoenosis components at the surface of the soil, such as a draught period or lower temperatures. Considering all of these, the distribution of these invertebrate species in the lithosol is directly influenced by the ecological factors, such as temperature, relative humidity and also, at least in an indirect manner, by the lithological nature of the substratum; the lithological types of clasts determine the chemistry of the soil, the disintegration and alteration speed of the parenting rock and its transformation in clay (solification process) (RĂDOANE & RĂDOANE, 2007). This is the reason why we made research on the distribution of some significant taxonomic groups in schistic lithosol (Araneae, Isopoda, Collembola, Coleoptera, Diplopoda, Chilopoda).

The studies in this paper are a component of some wider research, which analyze the way in which different types of geological substratum of the SSHs influence the distribution of some invertebrate taxonomic groups in Leaota Massif. Such research is a premiere for Leaota.

MATERIALS AND METHODS

We chose three ecological stationaries, where we placed Barber traps in order to collect the fauna in the edaphic soil with a substratum formed of crystalline schists. The stationaries were placed in areas in which the anthropogenic influence would be minimum or non-existent.

Thus, the ecological stationary no. 1 was placed at the foot of the southern slope of Zăbava Mountain, at its limit with Berbece's Brook (Pârâul lui Berbece) (a right side tributary of the Ghimbav River) (Fig. 1), on the left bank of the brook.

The position was determined through the GPS coordinates: N 45°22'18.1"; E 25°15'57.2", at an altitude of 1060 meters. The geological substratum consists of schist scree, covered in soil (lithosol), on which one can find a layer of litter, the thickness of the soil stratum and of the litter reaching a total of approximately 10-11 cm. In this ecologic stationary, we have placed five Barber traps in order to collect the edaphic fauna, disposed according to the collecting method that is described below (Fig. 2). The gathering of edaphic fauna was carried out on a periodical basis, the Barber traps functioning for ten days each month.

The second stationary on schist substratum was placed in Popii Valley (Valea Popii), on the left bank of the brook. The ecological stationary no. 2 – Popii Valley (Fig. 1) was placed on a plane surface, on the right bank of Popii Brook, where we placed five Barber traps, in order to collect the edaphic fauna. The GPS coordinates of the stationary are: N 45° 21'41.2"; E 25°16'37.9", at an altitude of 1079 meters. The geological substratum is also formed of crystalline schists like in the previous case, covered in soil and litter (lithosol), with a thickness of approximately 10-12 cm. The placement method of the Barber traps is the same one as in case of stationary 1. The stationary functioned from May to November (we have not installed Barber traps in April, as there was snow in the area).

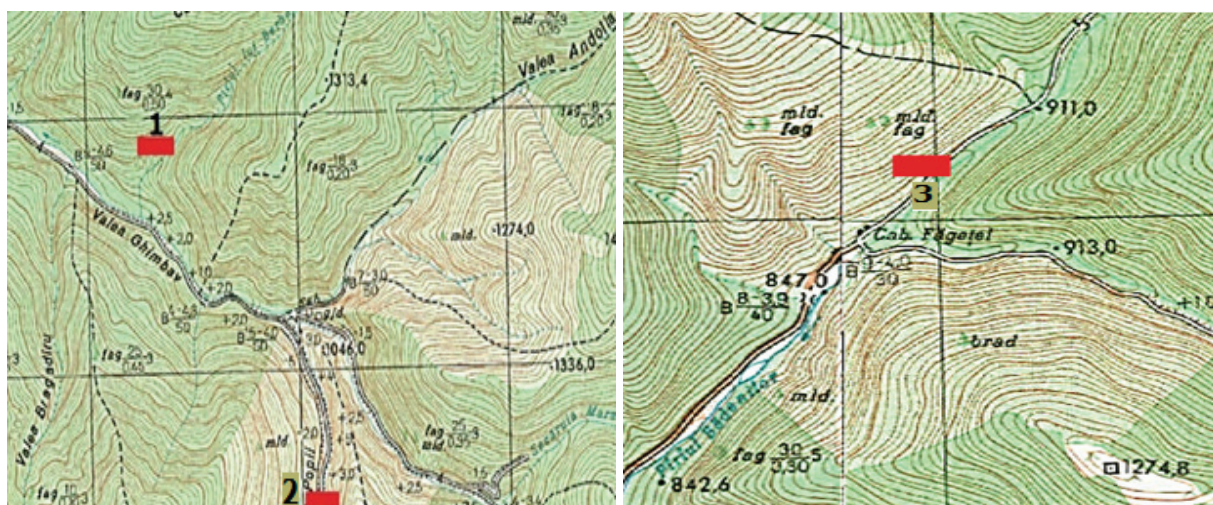


Figure 1. Location of the ecological stationary: 1 – Pârâul lui Berbece, 2 – Valea Popii, 3 – Valea Bădenilor (Bădeanca) (<http://limite.opengov.ro/leaota>)

The ecological stationary no. 3 on Bădeni Valley (Valea Bădenilor) had a temporary functioning, between July 17th and 26th 2015. We installed it in order to see if there is a potential of finding new species of invertebrates, different from the already-identified species in the two stationaries we mentioned before, 1 and 2. Samples were collected only once from Barber traps. GPS location: N 45° 17' 52.4", E 25° 14' 47.9", 863 meters altitude, on the right side of the forest road (from Leaota Peak to the village) parallel to Bădeni Valley (Fig. 1). The substratum is formed of metamorphic rocks (covered in lithosol).

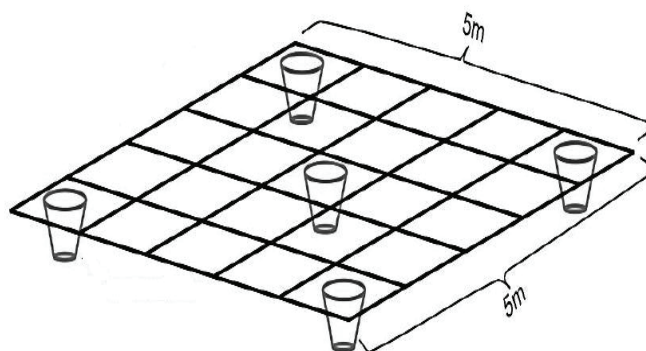


Figure 2. Barber traps layout (from NAE, 2010)

RESULTS AND DISCUSSIONS

Subsequently to the processing and the centralization of the data registered on a continuous basis, from 2 to 2 hours, regarding the main ecological factors T and RH, we drew tables 1 and 2, for a more accurate presentation, which displays the centralized values of temperature and relative humidity parameters registered at the level of the soil in the stationaries placed in the edaphic environment (lithosol).

Table 1. The monthly average temperature (°C) in stationaries.

STATIONARIES	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1. Pârâul lui Berbece	6.85	11.1	17.03	18.62	21.46	18.25	10.25	8.3	-
2. Valea Popii	-	16.07	12.12	12.23	12.64	12.15	8.57	5.05	-0.5*

* - only for the first 5 days of December 2015 (the average of the registrations for the respective month of 2014 and 2015).

Table 2. The average monthly relative humidity (%) in stationaries.

STATIONARIES	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1. Pârâul lui Berbece	85.80	79.02	92.29	87.38	75.35	80	80.50	81	-
2. Valea Popii	-	84.24	92.57	96.65	93.14	97.93	98.40	94.20	80*

* - only for the first 5 days of December 2015 (the average of the registrations for the respective month of 2014 and 2015).

Regarding the fauna results, in the above mentioned stationaries, we have identified the following numerical distribution of the invertebrate species on stationaries and superior taxonomic categories (Table 3).

Table 3. Distribution of the invertebrate species on stationaries, within taxa.

No. of order*	Taxonomic group	Stationary 1 (Pârâul lui Berbece)	Stationary 2 (Valea Popii)	Stationary 3 (Valea Bădenilor)
1.	Ord. Araneae	10	4	2
2.	Ord. Isopoda	4	4	2
I.	Cls. Colembolla	43	21	12
3.	Ord. Coleoptera	43	37	5
II.	Cls. Diplopoda	12	10	4
III.	Cls. Chilopoda	3	2	2
	Total/stationary	115	78	27

*The orders have been numbered with Arabian and the classes with Roman numerals.

The centralized results on environmental factors T and RH (Tables 1, 2) lead to more discussions. Regarding temperature (T), its average value for the whole monitoring period was 13.61 °C for the Berbece's Brook stationary and 11.26 °C for the Popii Valley stationary. It is an evident result that the average annual temperature is higher at Berbece's Brook stationary, with $\Delta t = 2.35$ °C than at Popii Valley stationary. In May only, T had higher values in the last stationary compared to the first one.

We notice that the relative humidity ecologic factor (RH) had a notable higher value in Popii Valley compared to Berbece's Brook, during the entire monitoring period (Table 2). The annual average RH is 93.87% at the Popii Valley stationary and 82.69% in Berbece's Brook stationary (in order not to distort the results, we did not included the average value for the 5 days in December 2015).

Taking into account the faunistic results, if we analyze the total number of species on taxonomic categories in all the three ecologic stationaries with a substratum of crystalline schists, together with the number of captured individuals, than we have: 13 species of Araneae (64 individuals); 5 species of Isopoda (184 individuals); 47 species of Collembola (1,911 individuals); 61 species of Coleoptera (513 individuals); 17 species of Diplopoda (321 individuals); 5 species of Chilopoda (13 individuals).

The total number of species in the edaphic soil with schist substratum was 148 and the total number of individuals was 3,006.

The most numerous species in the edaphic soil in the two stationaries that functioned for a long time (stationaries 1 and 2) were Coleoptera: 43 species in stationary 1 (the same number as Collembola) and 37 species in stationary 2. Only in stationary 3 – Bădeni Valley, where we collected just once, the situation is opposite, as the collected fauna material is dominated by Collembola (12 species, representing almost 45%).

As number of collected individuals, Collembola leads by far, with 1,911 individuals of the total; next comes Coleoptera, with 513, Diplopoda with 321 and Isopoda with 184, and far away, Araneae, 64 and Chilopoda, with only 13 individuals (Table 3).

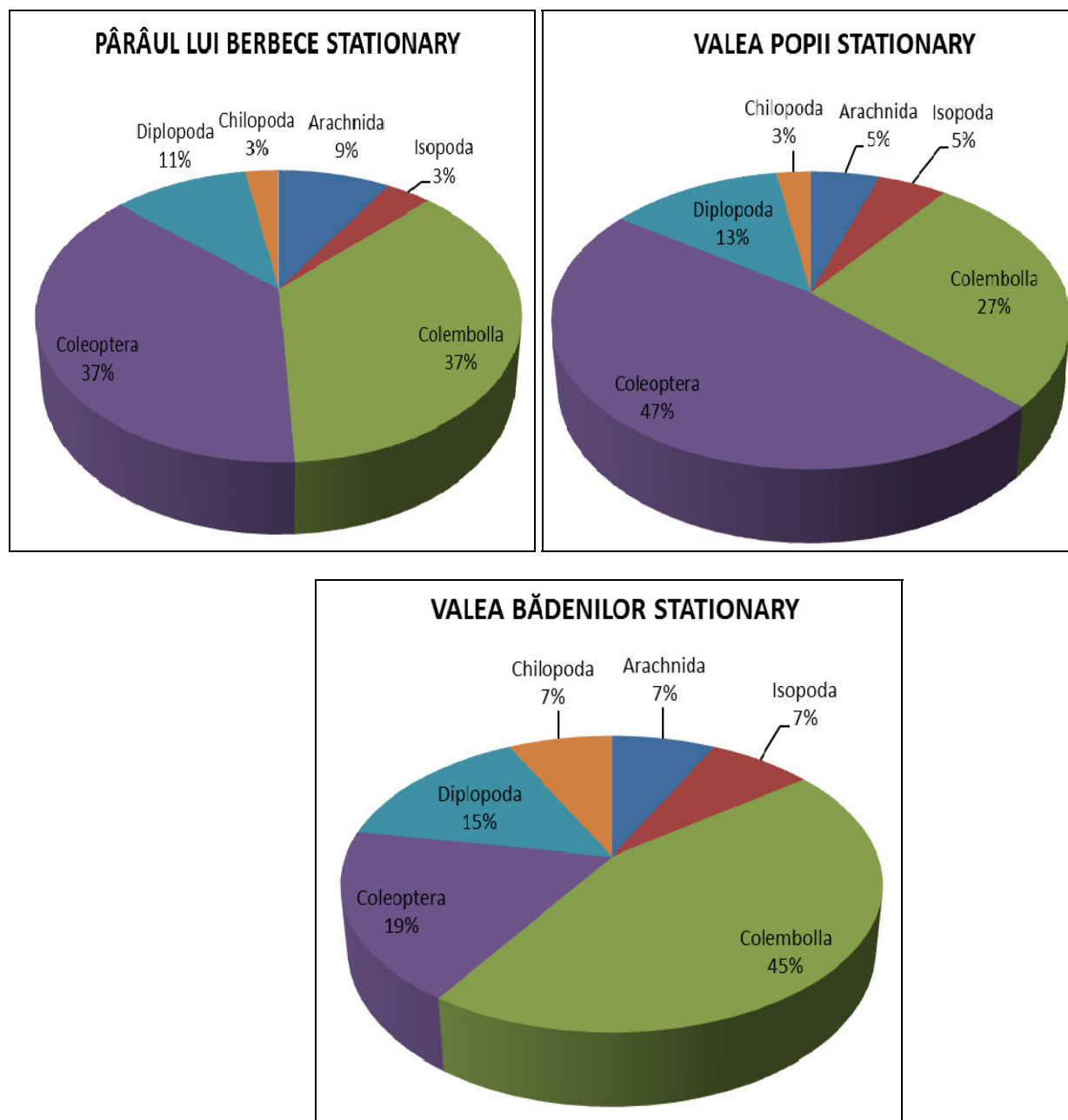


Figure 3. The percentage distribution of the six invertebrate taxa in the edaphic soil on the stationaries they were collected from.

We noted the small percentage values for Isopoda, Chilopoda and Arachnida determined in all three stationaries. Also, in the same stationaries, the relatively high values for Collembola and Coleoptera are observed (Fig. 3).

On the stationary 1 – Pârâul lui Berbece, the diversity of the species had the highest values for all six invertebrate taxa (Fig. 4).

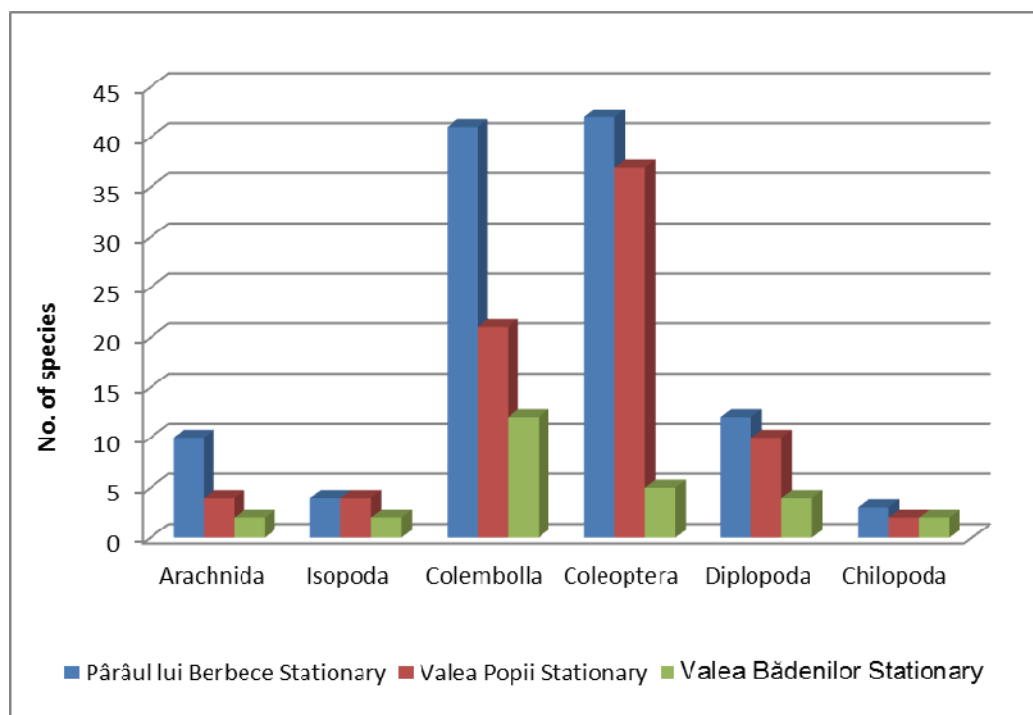


Figure 4. The comparative distribution of the six invertebrate taxa in the edaphic soil on the stationary they were collected from.

To analyze the way in which the fauna distribution fluctuates depending on the period of the year and stationary, we created, for the two ecologic stationaries 1 - Berbece's Brook and 2 - Popii Valley (Stationary 3 being used for a single data collecting), radar diagrams, which we used for the analysis of the monthly variation of the cumulated abundance and the specific diversity (Figs. 5 - 16).

In case of Araneae, at station 1 Berbece's Brook, we registered the peak of the specific diversity in July (10 species) (Fig. 5), contrary to the rest of the months. Though, the cumulated abundance had higher values for July and September, when the maximum number of individuals was reported (Fig. 6).

At station 2 - Popii Valley, both the specific diversity and the cumulated abundance of the Araneae registered very low values. In August, we noticed both the highest number of individuals and species.

As for Collembola, as well as for the Araneae, the highest specific diversity in case of the stations in the edaphic soil was also reported for stationary 1 - Berbece's Brook (Fig. 7), in July. At stationary 2 - Popii Valley, the peak of the specific diversity was reached in August, but at a much lower value. The cumulated abundance in case of Collembola species reached its peak in July for stationary 1 - Berbece's Brook and barely in September for stationary 2 - Popii Valley, with a much lower number (Fig. 8). We ascribe this delay of the maximum of the cumulated abundance for stationary 2 to the colder micro-climate, as Popii Valley is a narrower and more shadowed valley compared to the one where stationary 1 was placed, which clearly resides from table 1. Thus, in July, T reached an average value of 18.62 °C in Berbece's Brook stationary and only 12.23 °C in Popii Valley stationary. By analyzing the radar diagram of Coleoptera species on stationaries (Fig. 9), we notice that the specific diversity is the highest, with the peak in August (when factor T reached the highest monthly average value 12.64 °C) for stationary 2 - Popii Valley and with a lower, yet relatively constant number of species for July-September, in stationary 1 - Berbece's Brook. We underline that, in stationary 2 - Popii Valley, the increase and decrease of the diversity of species is sudden, compared to the peak registered in August. Though, watching the diagram in figure 10, we can notice that for the two stationaries, the cumulated abundance reached low values, compared to the specific diversity. Only in July, at stationary 1 - Berbece's Brook, we registered a significant maximum. The maximum number was lower for the other schist stationary, 2- Popii Valley, which can be explained through the colder micro-climate.

The specific diversity of the Isopoda is emphasized in case of the two stationaries located on schists in Fig. 11. For the stationary Berbece's Brook, we notice a maximum in July.

The cumulated abundance in case of Isopoda had low values for stationary 2, compared to stationary 1, with a maximum in August, which is clearly emphasized (Fig. 12).

We also reached a maximum of the cumulated abundance in August for the stationary 2, but at a much lower level compared to stationary 1, with the micro-climate and the habitat type as possible causes that generated these differences.

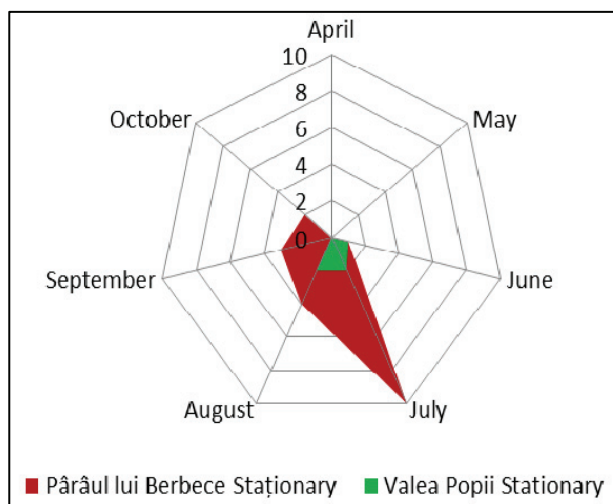


Figure 5. The radar diagram of the diversity of Araneae species from the edaphic soil on stationaries and months.

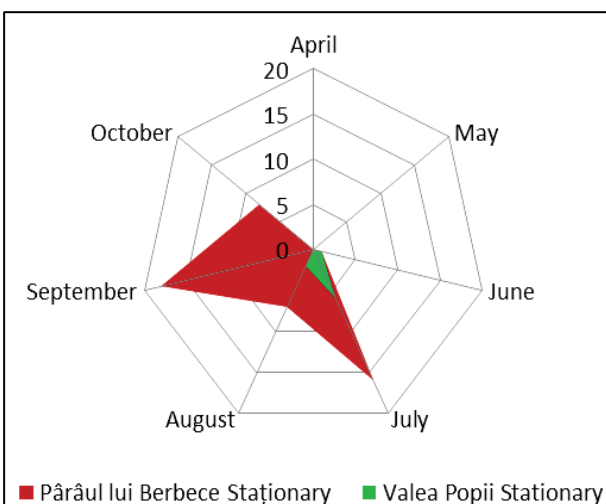


Figure 6. The radar diagram of the cumulated abundance of Araneae species from the edaphic soil on stationaries.

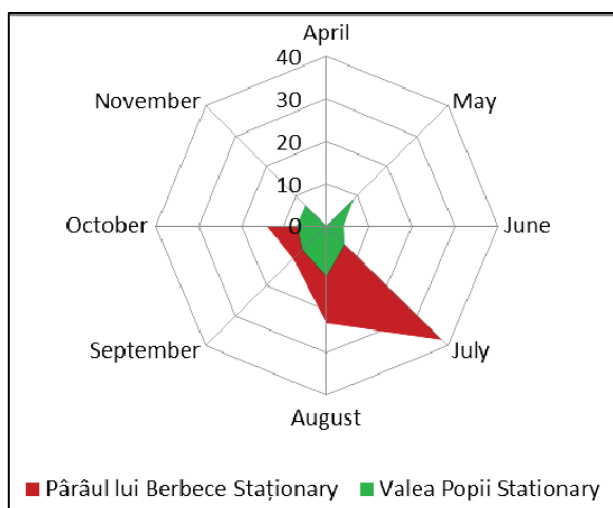


Figure 7. The radar diagram of the diversity of Collembola species from the edaphic soil on stationaries and months.

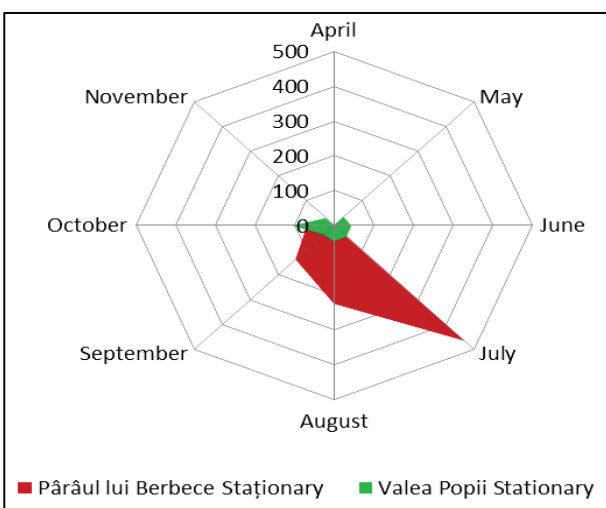


Figure 8. The radar diagram of the cumulated abundance of Collembola species from the edaphic soil on stationaries.

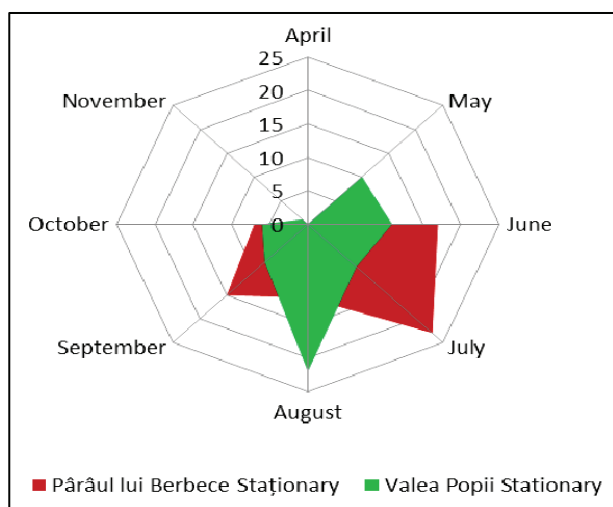


Figure 9. The radar diagram of the diversity of Coleoptera species from the edaphic soil on stationaries and months.

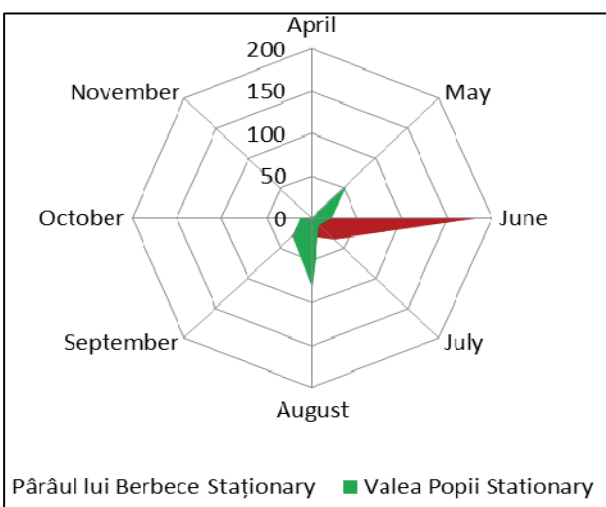


Figure 10. The radar diagram of the cumulated abundance of Coleoptera species from the edaphic soil on stationaries.

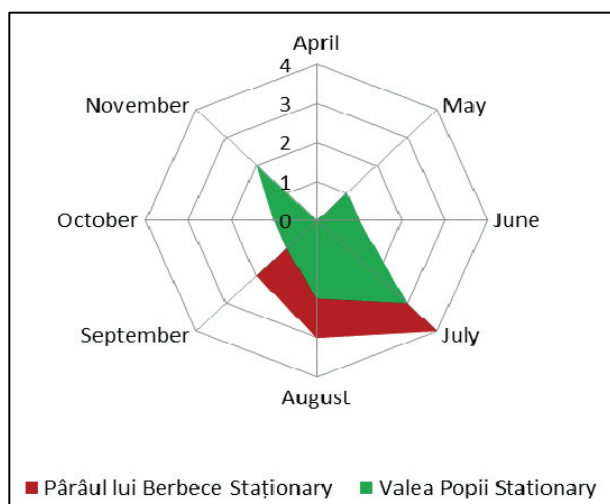


Figure 11. The radar diagram of the diversity of isopod-species from the edaphic soil on stationaries and months.

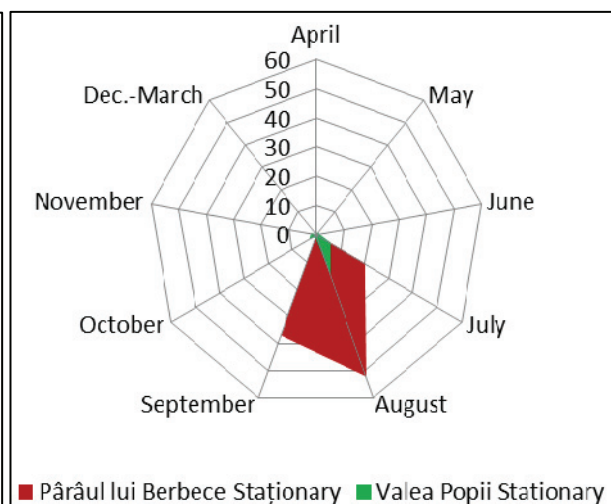


Figure 12. The radar diagram of the cumulated abundance of the isopod species from the edaphic soil on stationaries.

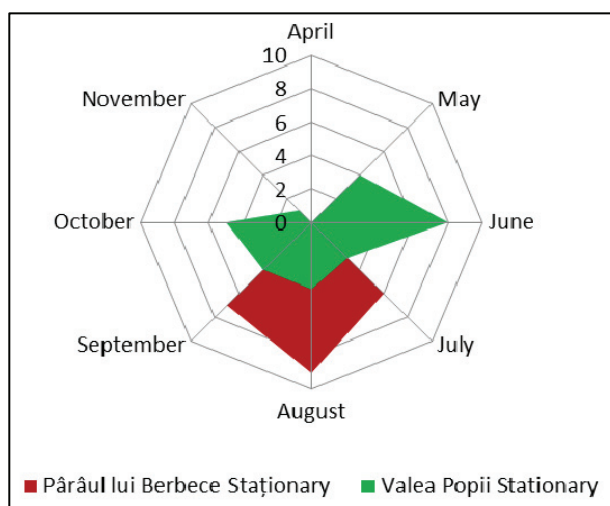


Figure 13. The radar diagram of the diversity of Diplopoda species from the edaphic soil on stationaries and months.

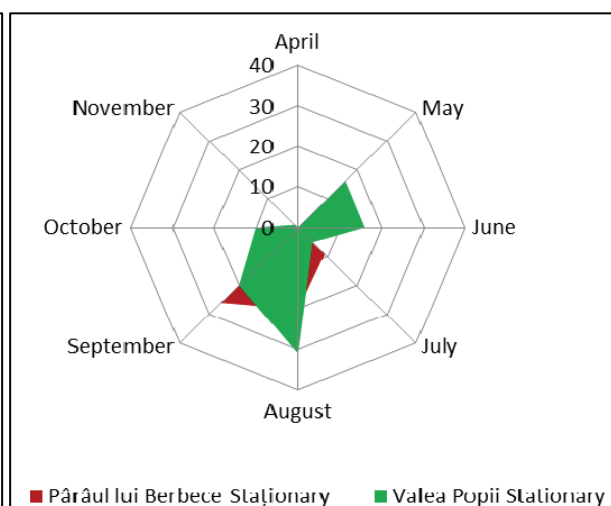


Figure 14. The radar diagram of the cumulated abundance of Diplopoda species from the edaphic soil on stationaries.

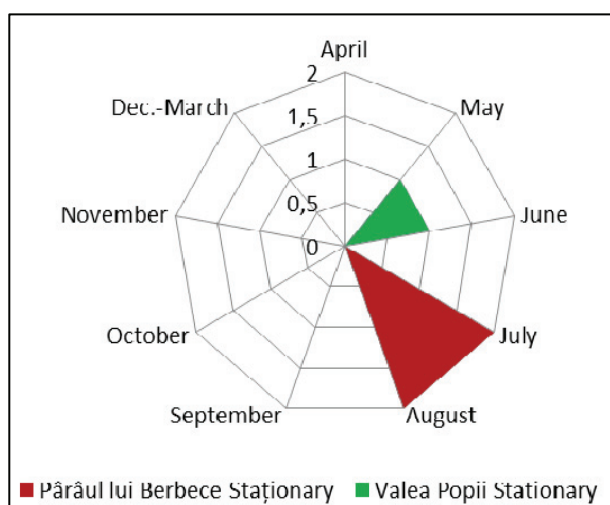


Figure 15. The radar diagram of the diversity of Chilopoda species from the edaphic soil on stationaries and months.

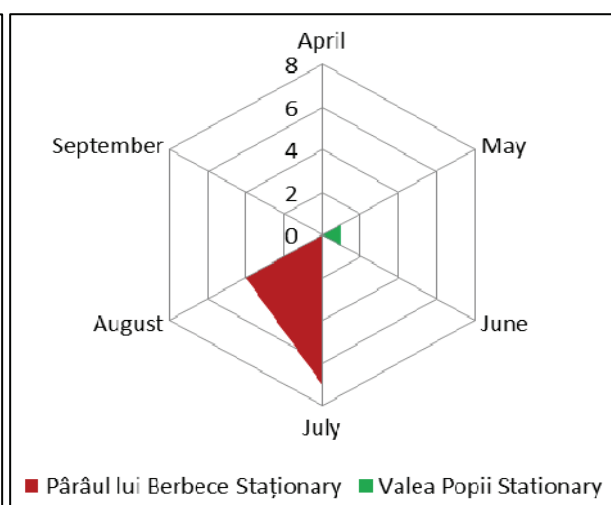


Figure 16. The radar diagram of the cumulated abundance of Chilopoda species from the edaphic soil on stationaries.

By analyzing the radar diagrams in case of Diplopoda (Figs. 13, 14), we notice that, in August, we have the highest number of species in stationary 1 – Berbece's Brook, with a slight decrease in September. What is interesting is the maximum in June in stationary 2 – Popii Valley, followed by a stiff decrease in July and a slight increase in August. As for the cumulated abundance, for stationary 2 – Popii Valley, the maximum number of individuals is in August, and, for the other stationary, Berbece's Brook, barely in September. We link this observation to the fact that, in August, in Berbece's Brook stationary, the average T reached 21.46 °C, significantly higher than 12.64 °C, the average value in Popii Valley stationary.

Chilopoda diagrams (Figs. 15, 16) show a specific diversity and a low abundance for both stationaries. At stationary 1 – Berbece's Brook, we have the highest specific diversity and also cumulated abundance. Regarding the ecologic stationary 3 in Bădeni Valley, this only functioned in July 2015, when we collected fauna elements, in order to explore the area and see if there are any chances of finding new species. Our intuition was confirmed by the fact that, after the determination of the collected fauna material, we identified 3 species we did not meet in the other two stationaries.

CONCLUSIONS

The microclimate is essential for the differentiation of the distribution of the analyzed taxonomic groups; the ecological factor temperature (T) is the most important from this perspective, but the relative humidity also plays a significant role.

Lower values of the average temperature lead to lower values of the specific diversity and also of the cumulated abundance, as well as a gap, a delay of the month when the maximum cumulated abundances is reached.

The habitat type also has a significance regarding the percentage distribution of the taxonomic groups in the stationaries.

Thus, in Popii Valley stationary, Coleoptera represents 47% of the total species, compared to 37%, which was registered in Berbece's Brook stationary, and the distribution of Collembola is the opposite, with only 27% in Popii Valley and 37% in Berbece's Brook, which can be explained by the differences between the average values of the ecologic factors T and RH.

It is a higher potential to discover new species of invertebrates in Leaota Massif, compared to the ones we have already identified.

In order to reach a higher efficiency regarding the collecting of the fauna material, we need combined capturing methods, the Barber traps being less efficient in case of Araneae or Chilopoda.

ACKNOWLEDGMENTS

This paper of Magdalin Leonard Dorobăț was supported by the strategic grant POSDRU/159/1.5/S/138963 - PERFORM, co-financed by the European Social Fund – Investing in People, within the Sectorial Operational Programme Human Resources Development 2007-2013.

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Received: March 29, 2017

Accepted: May 9, 2017

ASSESSMENT OF ICHTHYOFAUNA ALONG THE LOWER SECTOR OF THE OLT RIVER

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Abstract. The complex works for obtaining hydroelectric power of the Olt River included the construction of a series of reservoirs; among these reservoirs, there are no longer sectors with flowing water. This situation generated even more important changes in aquatic fauna than pollution (BĂNĂRESCU, 1964). One of the significant effects is the disappearance of the indigenous species living in flowing water, as most of the remaining specimens are old and cannot reproduce, thus leading eventually to the their total disappearance (IONESCU, 2001). For the ecological characterization of the ichthyofauna of the Olt River, especially based on the diversity and heterogeneity of the biotope, there were established four study sectors, three in the area of the reservoirs and one in the rheophilous sector of the Olt River.

Keywords: fish, rheophilous sector, stagnant sector, the Olt River.

Rezumat. Evaluarea ihtiofaunei din sectorul inferior al râului Olt. Amenajarea hidroenergetică complexă a râului Olt a creat o serie de lacuri, între care nu mai există practic porțiuni cu apă permanent curgătoare. Aceasta a condus la modificări ale faunei acvatice mai importante chiar decât poluarea (BĂNĂRESCU, 1954). Unul din efectele deosebite este cel al dispariției speciilor autohtone iubitoare de apă curgătoare, în marea lor majoritate rămânând doar exemplare bătrâne, care nu se mai pot reproduce conducând în final la dispariția totală a acestora (IONESCU, 2001). Pentru caracterizarea ecologică a ihtiofaunei râului Olt, mai ales pe baza varietății și heterogenității biotopului, au fost stabilite 4 sectoare de studiu, trei în lacurile de baraj și unul pe sectorul reofil al râului Olt.

Cuvinte cheie: pești, sector reofil, sector stagnofil, râul Olt.

INTRODUCTION

The hydrographical basin of the Olt modified a lot after the construction and commissioning of the chain of reservoirs located along its course, starting from Brașov County downstream to its mouth (BREZEANU et al., 1993; BREZEANU, 1999; BREZEANU & SIMON-GRUIȚA, 2002).

The Olt is one of the four largest rivers in Romania. The harnessing of the Olt River was based on a chain of hydroelectric power plants of dam type. After the system was achieved, a series of modifications of the morphology of the riverbed and banks of the Olt River occurred, as well as important changes in the flow regime of surface and groundwater, soil cover and biotic environment (SCUTELNICU & DRUȚĂ, 1990).

In the studied areas, there are currently noticed some changes and an interesting evolution of the ecosystems (GÂȘTESCU, 1971; MIRON & MIRON, 1997). Thus, some new biotopes have emerged and expanded, namely the lentic biotopes, the physicochemical properties of the water have changed, the water temperature and conditions of oxygenation have changed and others, which have influenced the pre-existent species (BURIAN, 2002; DIACONU, 1999). The construction of the reservoirs led to the quantitative reduction of a number of species, as a consequence of the reduction of their habitat and thus, it led to the decrease of their functional contribution to the biological production; it also affected the genofund and the ecofund of the Olt River (NISTREANU & NISTREANU, 1999).

Instead of native species living in flowing water, there rapidly developed species adapted to stagnant water, which, prior to the construction of reservoirs, appeared accidentally or at a very low percentage, and which have currently become dominant (BUȘNIȚĂ & ALEXANDRESCU, 1963).

If the presence in the reservoirs of large quantities of fish species characteristic to stagnant water (significantly more specimens than those living in the proper river) meets the requirements of recreational fishing, it does not meet the requirements of nature protection (CIOBOIU, 2005).

One of the main objectives of nature protection is precisely to ensure the survival of most indigenous species and populations, which is not possible under these circumstances (NICOARĂ, 2002).

However, there is a surprisingly rich fauna, and in the area between Izbiceni and the Danube, species of significant scientific and economic value have been identified.

MATERIAL AND METHODS

The research objective was rendering the dynamics of fish populations in the lower sector of the Olt River.

The sampling for fish study was carried out by fishing by means of cork, lead on the bottom of the water and fishing nets.

In order to establish the structure of fish population, there were made the following operations:

- grouping of fish according to the species
- grouping of the specimens of each species according to their dimensions
- measurement of specimens
- weighing specimens of each species by size groups

In order to make the ecological characterization of the ichthyofauna of the Olt River, especially based on the variety and heterogeneity of the biotopes, there were established 4 study sectors, three in the area of Strejești, Ipotești, Izbiceni reservoirs and one along the rheophilous sector from Izbiceni to Islaz.

RESULTS AND DISCUSSIONS

The study of the composition and structure of fish populations presents certain difficulties related to sampling, which are, on the one hand, due to the nature of the aquatic environment, and, on the other hand, to that fact that fish are organisms with extremely varied sizes and a high degree of mobility.

In 1909, GRIGORE ANTIPA in 'Ichthyologic Fauna of Romania' mentioned 72 fish species present in the Olt River, fish also mentioned by BĂNĂRESCU in 1964. The number of species decreased a lot, and, now there are about one third of the species mentioned by Antipa in 1909.

In 2006, along the rheophilous sector of the Olt, there were identified 7 fish species (Table 1).

Table 1. Fish species identified along the rheophilous sector of the Olt River in 2006.

No.	Fish species	Number of specimens	Average dimension (cm)	Average weight (g)
1.	<i>Carassius gibelio</i> (Prussian carp)	18	14	115
2.	<i>Lepomis gibbosus</i> (pumpkinseed)	5	5	10
3.	<i>Alburnus alburnus</i> (common bleak)	2	5	5
4.	<i>Chondrostoma nasus</i> (common nase)	6	8	23.5
5.	<i>Abramis brama</i> (common bream)	3	10	34
6.	<i>Silurus glanis</i> (wels catfish)	1	12	80
7.	<i>Lota lota</i> (burbot)	1	19	80

Analyzing Figure 1, it can be noticed that the dominant species is the Prussian carp, followed by pumpkinseed and common nase, the rest of the species having a reduced share.

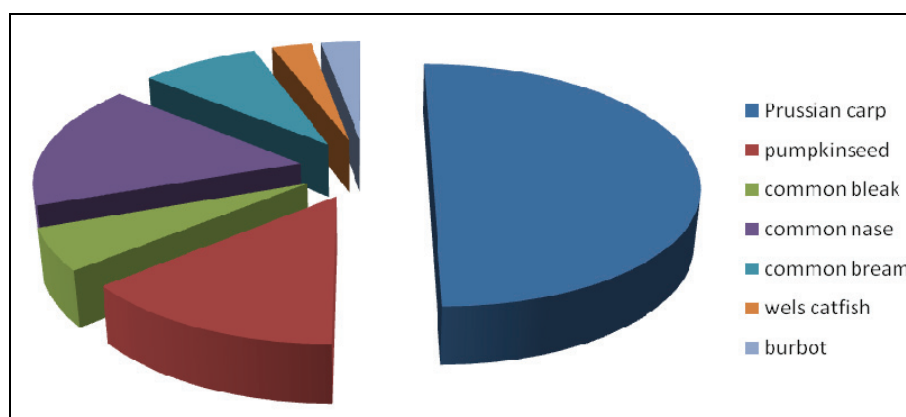


Figure 1. The share of fish species identified along the rheophilous sector of the Olt River in 2006.

In 2009, there were identified 12 fish species (Table 2). The dominant specie are: Prussian carp, common nase, common bleak and common bream (Fig. 2).

Table 2. Fish species identified along the rheophilous sector of the Olt River in 2009.

No.	Fish species	Number of specimens	Average dimension (cm)	Average weight (g)
1.	<i>Carassius gibelio</i> (Prussian carp)	14	17	195
2.	<i>Lepomis gibbosus</i> (pumpkinseed)	3	7	13
3.	<i>Alburnus alburnus</i> (common bleak)	5	8	10
4.	<i>Chondrostoma nasus</i> (common nase)	4	7	21
5.	<i>Abramis brama</i> (common bream)	5	12	37
6.	<i>Silurus glanis</i> (wels catfish)	2	17	125
7.	<i>Scardinius erythrophthalmus</i> (rudd)	3	10	65
8.	<i>Lota lota</i> (burbot)	3	18	78
9.	<i>Aspius aspius</i> (asp)	2	15	145
10.	<i>Cyprinus carpio</i> (carp)	5	18	250
11.	<i>Stizostedion lucioperca</i> (zander)	2	22	365
12.	<i>Perca fluviatilis</i> (European perch)	4	12	135

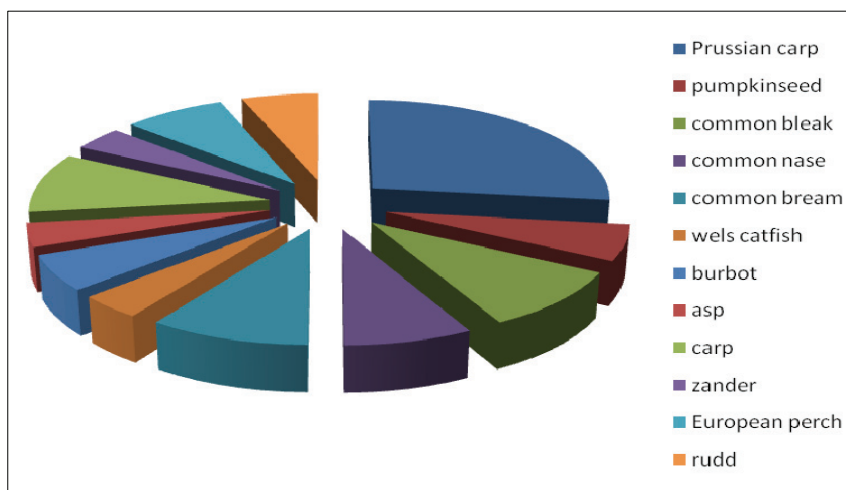


Figure 2. The share of fish species identified along the rheophilous sector of the Olt River in 2009.

The dominant fish species identified in 2012 (Table 3) are the Prussian carp, common nase, common bleak and common bream as well as in 2009 (Fig. 3).

Table 3. Fish species identified along the rheophilous sector of the Olt River in 2012.

No.	Fish species	Number of specimens	Average dimension (cm)	Average weight (g)
1.	<i>Carassius gibelio</i> (Prussian carp)	15	19	225
2.	<i>Esox lucius</i> (pike)	3	25	315
3.	<i>Alburnus alburnus</i> (common bleak)	5	7	9
4.	<i>Chondrostoma nasus</i> (common nase)	4	7	21
5.	<i>Abramis brama</i> (common bream)	4	10	36
6.	<i>Silurus glanis</i> (wels catfish)	2	21	210
7.	<i>Scardinius erythrophthalmus</i> (rudd)	3	11	70
8.	<i>Lota lota</i> (burbot)	1	17	69
9.	<i>Aspius aspius</i> (asp)	4	13	127
10.	<i>Cyprinus carpio</i> (carp)	4	16	228
11.	<i>Stizostedion lucioperca</i> (zander)	3	20	292
12.	<i>Perca fluviatilis</i> (European perch)	4	13	147
13.	<i>Barbus barbus</i> (common barbel)	2	20	300
14.	<i>Leuciscus cephalus</i> (chub)	1	15	230
15.	<i>Gobio gobio</i> (gudgeon)	1	10	23

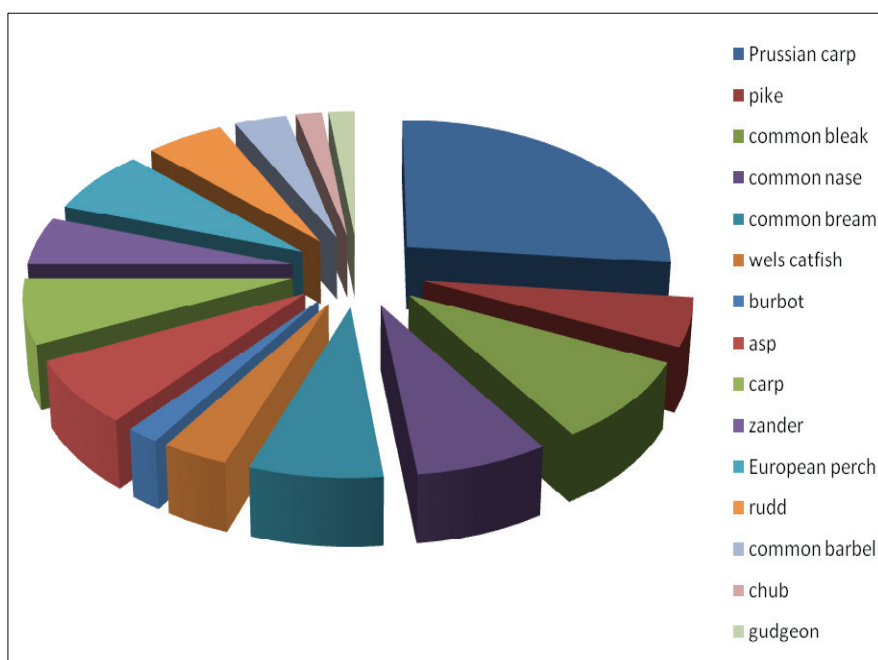


Figure 3. The share of fish species identified along the rheophilous sector of the Olt River in 2012.

Within the stagnant sectors, the dominant species are: Prussian carp (35%), carp (20%), wels catfish (10%), European perch (10%), zander (10%), pike (5%), common bream (5%) and rudd (5%) (Fig. 4).

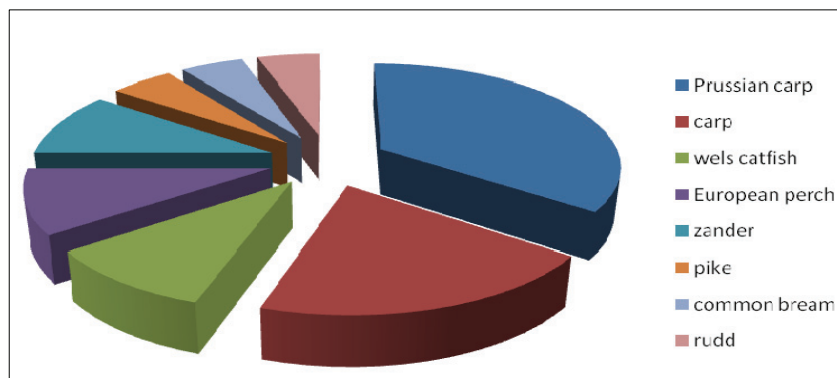


Figure 4. The share of fish species identified along the stagnant sector of the Olt River.

From the data, it can be noticed that the most numerous specimens are registered by the Prussian carp (*Carassius gibelio*) – present in all the studied sectors, to the mouth of the river, as it had been expected.

Cyprinus carpio (carp) is mainly present in the stagnant sectors, the number of specimens in case of this species being more reduced than in case of the Prussian carp, but greater compared to the rest of the fish species.

The highest number of specimens was captured in stagnant sectors, while along the rheophilous sector the number is lower and the dimensions of the specimens smaller.

CONCLUSIONS

The structure of the fish populations has been deeply affected; the complex harnessing of the Olt River in order to obtain hydroelectric power had a great impact on the fish populations living in the river, as well as on the fish population from the Danube that used to migrate on the Olt River to Drăgănești Olt to lay eggs as it changed the water flow regime; of the total fish species identified by Antipa in 1909, presently, there are about one-third left.

Thus, the Olt River transformed from a natural ecosystem to an anthropogenic ecosystem. Downstream Izbiceni, the impact of the constructions is reduced and the Olt River still preserves its natural aspect, thus ensuring optimum conditions for the development of the autochthonous ichthyofauna of the Olt and even of certain species characteristic to the Danube; consequently, in this sector, there is a greater variety of species of scientific and economic importance.

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Received: March 29, 2017

Accepted: June 17, 2017

THE CENSUS OF THE WHITE STORK (*Ciconia ciconia* Linnaeus, 1758) FROM ARGEȘ COUNTY, IN 2014

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Abstract. The situation of the white stork (*Ciconia ciconia* Linnaeus, 1758) breeding in Argeș County, in 2014, is showed in this paper. The data were collected during the White Stork Census in Romania, which was coordinated at the national level by the Romanian Ornithological Society, "Milvus Group" Bird and Nature Protection Association. It was focused on getting of information about the area, population size and breeding of the species in Romania. Some considerations regarding a number of indicators (uH, HPo, HPm, Hpa, H, JZG, JZa, JZm, and StD) that characterise the breeding as well as other facts about the distribution and the type of supports, where the nests were placed, are made. The results are compared with the ones obtained through the previous census of the white stork from Argeș County, carried on in 2004. Information of tendency type emerged. So, it was noticed that, although the number of the nests, the total number of the chicks, and the number of the localities with nests increased, the average number of chicks/nest decreased. A little decrease was also observed with regard to the average altitude the nest is placed. From the nest support point of view, an increasing of the number of nests installed on the artificial holders and a decreasing of the number of nests installed on the natural holders were remarked.

Keywords: white stork, breeding, Argeș, Romania.

Rezumat. Recensământul berzelor albe (*Ciconia ciconia* Linnaeus, 1958) din județul Argeș, în 2014. În această lucrare este prezentată situația cuibăritului berzei albe (*Ciconia ciconia* Linnaeus, 1758) în județul Argeș, la nivelul anului 2014. Datele au fost colectate cu ocazia realizării Recensământului berzei albe în România, recensământ coordonat în țara noastră de Societatea Ornitologică Română și Asociația pentru Protecția Păsărilor și a Naturii „Grupul Milvus”. Acesta urmărește obținerea de informații privind arealul, mărimea populației și cuibăritul speciei în România. Au fost considerați mai mulți indicatori ai cuibăririi (uH, HPo, HPm, Hpa, H, JZG, JZa, JZm și StD), dar și alte date referitoare la distribuția și tipul suportului de amplasare a cuiburilor. Rezultatele sunt comparate cu cele obținute la precedentul recensământ al berzelor albe din județul Argeș, realizat în 2004, reieșind unele informații tip tendință. Astfel, s-a constatat că, deși numărul de cuiburi, numărul tuturor puilor și numărul localităților cu cuiburi au crescut, media numărului de pui/cuib a scăzut. De asemenea, o mică descreștere a fost observată și în privința mediei altitudinii locului de cuib. În ceea ce privește suportul cuibului, s-a remarcat o creștere a numărului de cuiburi instalate pe suporturi artificiale și o scădere a numărului de cuiburi instalate pe suporturi naturale.

Cuvinte cheie: barza albă, cuibărire, Argeș, România.

INTRODUCTION

The white stork (*Ciconia ciconia* L.1758) breeding in Romania was discussed in many papers. These research-studies were performed mainly in Transylvania, Banat, Crișana and Maramureș – the South-Eastern part of Transylvania (KOVÁCS, 1968), the Western part of Romania (KISS, 1998), the Criș Rivers basin (BECZY, 1970), the Crișul Repede basin (IONCIO, 2004), the Târnava Rivers basin (KÓSA & PAPP, 2005), the Hârtibaciu River basin (KÓSA & PAPP, 2007), the Upper and Middle Olt River basin (KÓSA et al., 2002a), the Someș River basin (KÓSA et al., 2002b), the Burzenland, Hârtibaciu Valley and Târnavale Land (KLEMM, 1975a), the vicinities of the Harghita Mountains (WEBER & ANTAL, 1978), Satu Mare – Șieu – Măgheruș range (CRISTEA, 1993), Sibiu area (KLEMM, 1975b; PHILIPPI & POPA, 1990), Cluj area (BÉLDI, 1959, KÓSA et al., 1998a, b; KÓSA, 2015), Brașov County (LUTSCH, 1990; LUTSCH et al., 1990), Covasna County (DAMÓ, 1984, 1985; KOVÁCS, 1975, 1976; MOLNÁR, 1990), Timiș County (KISS, 1979, 1989, 1992, 2000), Mureș County (SÁRKÁNY-KISS & KÓNYA, 1991; PAPP, 1995; PAPP & SZABÓ, 1996), Harghita County (SZABÓ & PAP, 1996), etc. There are two papers dedicated especially to this subject from Moldavia and Bukovina (BALTAG & BOLBOACĂ, 2008; BALTAG et al., 2009), two from Oltenia (MUNTEANU, 1991; TÂNĂSESCU, 1993), one from Muntenia (MESTECĂNEANU et al., 2012) and three from Dobruja and the Danube Delta (KISS & MARINOV, 1990; MUTULICĂ & CAZACENCU, 1997; MESTECĂNEANU et al., 2014). There are few articles regarding the global situation, resulted from national censuses (KLEMM, 1982; SÁRKÁNY-KISS, 1990, 1991; WEBER, 1996; KÓSA, 2005, 2013 etc.). This is a succinct inventory, and an exhaustive writing on the theme presented into “The Fauna of Romania” (PETRESCU, 2015).

The white storks lay eggs in the first days of April. After an incubation of 31 – 34 days, the young hatch. They can fly after 33 – 35 days, when they are almost identical with the adults, except the darker bill and the undefined colour of the legs (RADU, 1984).

Except the North, it is a common species in Europe where there are 105,000 – 120,000 breeding pairs (ARAÚJO & BIBER, 1997) or 224,000-247,000 pairs, by IUCN, 2015 (<http://www.iucnredlist.org>). In Romania, it is broadly spread in rural localities and, also, in some towns, the number varying between 4,000 and 6,000 pairs (CIOCHIA, 1992; MUNTEANU et al., 2002) or 5,000 – 6,000 pairs (by Romanian Ornithological Society / BirdLife International, "Milvus Group" Bird and Nature Protection Association, 2015). However, in the Western and Central Europe a decline was noticed, because of modern agriculture, combined with the feeding habitat loss. The conditions from the winter quarters or from the migration routes (i.e. the long-term rainfall decreasing in the Western Sahel) may

also represent some reasons (ARAUJO & BIBER, 1997). By IUCN, it is Least Concern, the trend of the global population increasing (<http://www.iucnredlist.org>).

Taking these into account, the white stork is a protected species. In this regard, in Romania there are some laws: Law 13/1993 (<http://biodiversitate.mmediu.ro>), Law 13/1998 (<http://www.lexex.ro/>), Law 462/2001 (<http://legislatie.just.ro>), and Law of hunting (<http://agvps.ro>). It is mentioned in the Red Book of the Romanian Vertebrates (MUNTEANU, 2005). Certain measures were applied, one of the most important being the supporting of the nests built on the top of the electrical poles with artificial platforms and the isolation of the wires against electric shock.

The goals of the present work were to establish the distribution of the white storks, to determine the number of breeding pairs and to obtain other information about the species breeding in Argeş County.

MATERIALS AND METHODS

Argeş County is one of the counties from the Southern part of Romania. Localised in Muntenia historical province, it is 6,826.3 km². Its relief is very diverse. In the North, there is Făgăraş Massif (East-West oriented) with many heights over 2000 m (Moldoveanu Peak, 2544 m, the highest), Piatra Craiului and Leaota Mountains, that totalise together 25% of the county area. They continue southwards with the Getic High Hills (the Subcarpathians) and Getic Piedmont (55% of the county area) – an ancient plain eroded by streams in narrow crests, composed of Cotmeana Piedmont, to the West (between the Olt and the Argeş Rivers), Argeş Piedmont, to the Centre (between the Argeş and the Argeşel Rivers), and Căndeşti Piedmont, to the East (between the Argeşel and the Dâmboviţa Rivers). To the South, there is the Romanian Plain, 20% of the county area (BARCO & NEDELCU, 1974, <http://www.arges.insse.ro/main.php>), where it is the lowest altitude of the county – 131 m, in the Cotmeana valley (Fig. 1).

The temperate-continental climate, with mountain character in the North and plain feature in the South, is beneficial to wild life (chiefly in the North, for the former, where the anthropogenic influence is lower) and humans. In the mountains, the snow is abundant and sometimes it can persist year round in the sheltered spaces. The annual average temperature is below 0°C and the average of the precipitations is over 1400 mm/year. In the hilly area, the climate is milder (the annual average temperatures are 6 – 9°C and the average of precipitation amount is 700 – 1000 mm/year). In the plain, the average of the annual temperatures is over 10°C and the average of the precipitations is below 700 mm/year (BARCO & NEDELCU, 1974). The year 2014, when this research was performed, has been one of the warmest years in Romania lately, because the annual air temperature average was 10.2°C (1.4°C bigger than the temperature average for 1961-2014). Also, it was a rainy year, with 807.7 l/m² (637.8 l/m², the mean for 1961-1990). The spring and the summer of 2014 were characterised by abundant precipitation amounts, mainly registered in short periods of time. So, by comparison with 1961-1990, generally, the months when the storks cover the eggs or raise the young were rainy: 83.2 mm – April (+31.7 mm), 115.8 mm – May (+40.1 mm), and 123.5 mm – July (+45.3 mm). Only June was a normal month: 88.8 mm (-0.4 mm), (SANDU, 2015).

Argeş County has a rich hydrographic system (Fig. 1). From West to East, it includes: the Topolog River (tributary to the Olt River), the Vedeia River (including the Cotmeana and the Teleorman Rivers), the Argeş River (including the Vâlsan, the Râul Doamnei, with the Bratia, the Râul Târgului and the Argeşel, then the Cărcinov, the Neajlov, with the Dâmboviţa and the Glavacioc, and, finally, the Dâmboviţa River). The area of drainage of the Râul Doamnei is 1822 km², the surfaces of the other main hydrographical basins that overlap Argeş County area being unknown (UJVÁRI, 1972). There are numerous lakes: some of them are reservoirs (Vidraru – 870 ha, Vâlcele – 442 ha, Zigoneni – 165 ha, Vâlcele – 442 ha, Budeasa – 643 ha, Bascov – 140 ha and Goleşti – 680 ha, on the Argeş River, Pecineanu – 182 ha, on the Dâmboviţa River, and Râuşor – 190 ha, on the Râul Târgului), others, much smaller (below 2.2 ha), of natural origin: Învărtita, Buda, Capra, Călţun, etc. (the three latest in the mountain region). Also, there are many artificial ponds, from the submountain region to the plain one. The phreatic waters emerge to the surface mainly where the Getic Piedmont meets the Romanian Plain and, also, in Găvanu-Burdea Plain, the Southern subunit of the Romanian Plain (BARCO & NEDELCU, 1974; <http://www.arges.insse.ro/main.php>).

Because of the wide-ranging relief, Argeş County has a large biodiversity. The vegetation is gradually modified from the top of the mountains, covered by grasslands, to the plain, used for agriculture. The forests occur in the mountain, submountain and hilly area, where there are vast woodlands of spruce (*Picea abies*), beech (*Fagus sylvatica*), and oak (*Quercus* sp.). The arable land (about 30 % of the county) is cultivated with cereal plants: maize (*Zea mays*), wheat (*Triticum* sp.), oat (*Avena sativa*), barley (*Hordeum vulgare*), forage: alfalfa (*Medicago sativa*), white clover (*Trifolium repens*), ryegrass (*Lolium perenne*) and edible plants: cabbage (*Brassica oleracea*), potato (*Solanum tuberosum*), onion (*Allium cepa*), etc. (ALEXIU, 2011). Moreover, there are many species of animals, some of them being food for the storks: insects, molluscs, fish, frogs, snakes, young and unfledged birds, mice, etc. They are caught often in short vegetation (CIOCHIA, 1992).

The number of localities from Argeş County is 102: three municipalities, four cities and 95 villages (Fig. 1, Fig. 2) and the population density is 89.7 inhabitants/km² (cf. <http://www.arges.insse.ro>).

The census was performed between July 1 and 31, 2014. It was part of the 7th International White Stork Census that was achieved in all European countries in 2014-2015. The Ornithological Romanian Society, the Milvus Group for the Birds and Nature Protection carried it out through the project “Sistemul naţional de gestiune si monitorizare a speciilor de păsări din România în baza articolului 12 din Directiva Păsări” – **SMIS-CSNR 36586**, which was

implemented in Romania by the National Centre for Sustainable Development, Bucharest in partnership with the Ministry of Environment, Water and Forests (<http://monitorizareapasarilor.cndd.ro>).

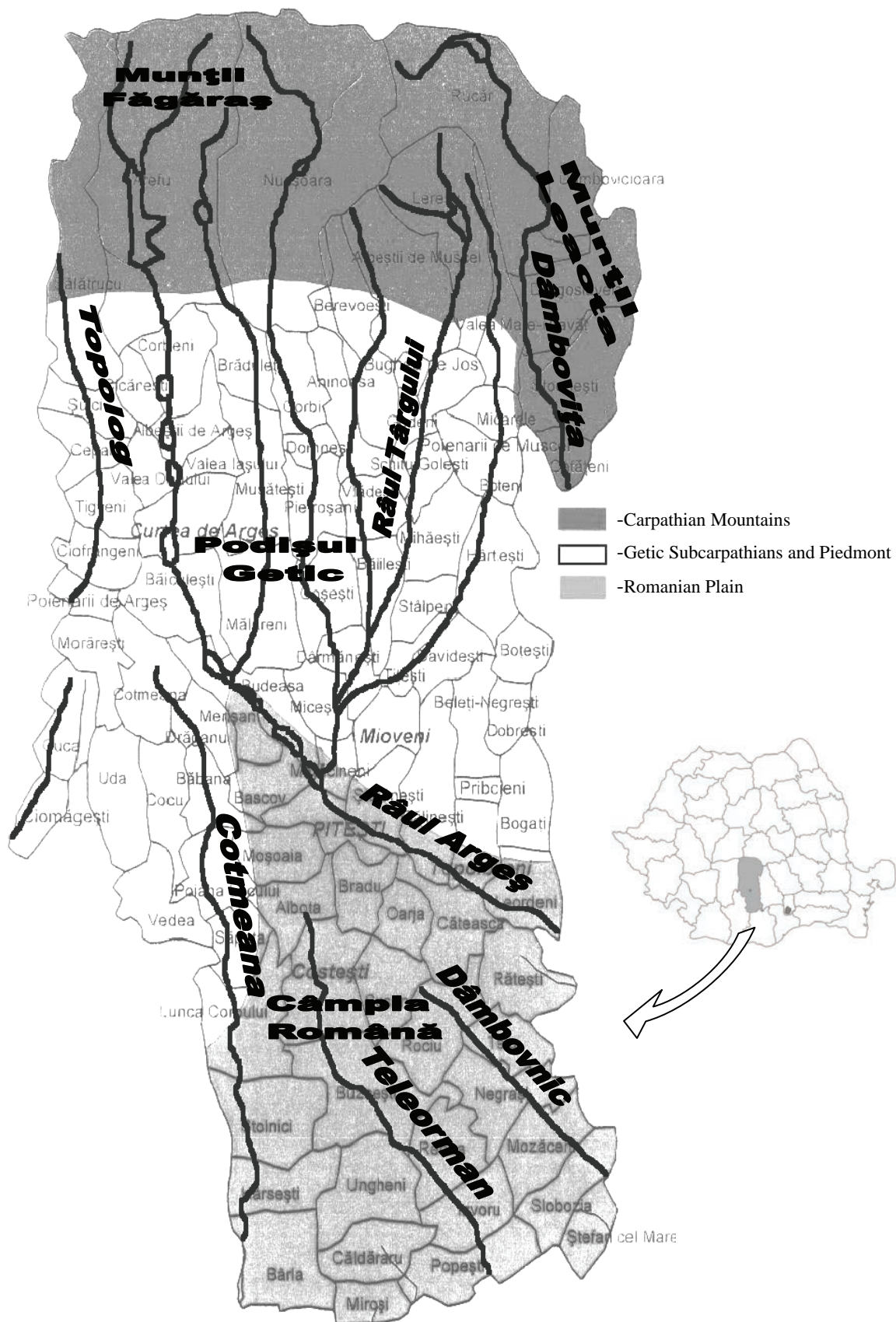


Figure 1. The administrative and physical map of Argeș County (original map – www.arges.insse.ro/main.php, modified).

favourable nest places and food resources assurance. Because there are some localities without nests in the plain area (Hârsești, Izvoru, Mozăceni, Râca, and Suseni), other factors like the pollution and the chemistry of the water, the intensive agriculture etc. can be taken into discussion in the distribution, too. It is known that the monotonous crops on large scale decrease diversity of habitats and, consequently, the available preys for the birds (LOVÁSZI, 2012).

Table 1. The white stork breeding parameters by localities (n=74).

Parameter		Number of nests (H)	Pairs with chicks (HPm)	Pairs without chicks (HPo)	Number of pairs (HPa)	Solitary stork	Unoccupied nests (uH)	JZG	JZa	JZm	Nests on simple electric poles	Nests on electric poles with support for nest	Nests on chimneys	Nests on trees	STD	STD built-up area (- - unknown situation)
Localities	Aninoasa	2	1	0	1	0	1	3	3	3	1	0	0	0	1.74	16.58
	Bârla	2	2	0	2	0	0	7	3.5	3.5	1	1	0	0	1.93	16.23
	Berevoești	1	1	0	1	0	0	3	3	3	1	0	0	0	0.98	20.83
	Brad	1	0	1	1	0	0	0	-	-	1	0	0	0	2.48	15.17
	Budeasa	2	2	0	2	0	0	6	3	3	1	0	0	0	4.73	-
	Buzoesti	4	3	1	4	0	0	9	2.25	3	2	0	0	0	2.50	17.96
	Căldăraru	2	1	0	1	0	1	2	2	2	1	0	0	0	8.55	-
	Căteasca	7	5	1	6	0	1	17	2.83	3.4	1	1	0	0	1.66	-
	Câmpulung	1	1	0	1	0	0	2	2	2	0	0	1	1	7.36	100.00
	Ciofrângeni	1	1	0	1	0	0	3	3	3	2	1	1	1	2.31	14.53
	Corbeni	2	1	0	1	0	1	3	3	3	0	1	0	0	1.62	46.08
	Corbi	1	1	0	1	0	0	4	4	4	1	1	0	0	1.90	19.92
	Costești	1	1	0	1	0	0	4	4	4	1	0	0	0	1.10	6.39
	Coșești	5	2	1	3	0	2	7	2.33	3.5	1	0	0	0	4.89	36.59
	Curtea de Argeș	1	1	0	1	0	0	3	3	3	0	1	0	0	1.43	6.25
	Dărmănești	1	1	0	1	0	0	3	3	3	2	0	0	0	3.02	27.32
	Domnești	2	1	0	1	0	1	3	3	3	0	1	0	0	5.04	20.04
	Dragoslavele	1	0	1	1	0	0	0	-	-	1	0	0	0	0.84	-
	Lunca Corbului	1	1	0	1	0	0	3	3	3	1	1	1	1	0.97	9.49
	Mălureni	1	1	0	1	0	0	4	4	4	2	0	2	2	0.93	5.35
	Merișani	1	1	0	1	0	0	3	3	3	1	0	0	0	6.90	21.98
	Mihăești	2	2	0	2	0	0	8	4	4	2	0	0	0	5.88	-
	Miroși	1	0	1	1	0	0	0	-	-	2	0	0	0	2.08	16.61
	Negrași	4	3	1	4	0	0	7	1.75	2.33	1	0	0	0	7.95	58.82
	Oarja	1	1	0	1	0	0	2	2	2	1	0	0	0	2.59	19.12
	Pietroșani	2	2	0	2	0	0	3	1.5	1.5	6	0	0	0	4.08	106.95
	Popești	2	2	0	2	0	0	6	3	3	1	0	0	0	3.64	76.92
	Rătești	6	2	3	5	0	1	5	1	2.5	7	0	0	0	6.33	75.53
	Recea	1	1	0	1	0	0	4	4	4	1	0	0	0	1.58	-
	Rociu	3	2	1	3	0	0	7	2.33	3.5	3	2	0	0	3.77	34.68
	Schitu Golești	2	2	0	2	0	0	8	4	4	0	2	0	0	7.75	33.73
	Slobozia	1	1	0	1	0	0	5	5	5	2	0	0	0	1.61	8.64
	Stolnici	1	1	0	1	0	0	3	3	3	1	0	0	0	1.36	-
	Ștefan cel Mare	2	2	0	2	0	0	8	4	4	1	0	0	0	5.83	49.38
	Ștefănești	1	1	0	1	0	0	3	3	3	2	0	0	0	1.77	8.90
	Șuici	1	1	0	1	0	0	2	2	2	1	0	0	0	2.88	17.61
	Teiu	1	1	0	1	0	0	3	3	3	0	1	0	0	2.24	19.65
	Țițești	1	1	0	1	0	0	3	3	3	1	0	0	0	4.07	23.87
	Ungheni	1	1	0	1	0	0	2	2	2	1	0	0	0	1.33	16.67
	Vlădești	1	1	0	1	0	0	4	4	4	1	0	0	0	1.64	23.81
Total		74	55	11	66	0	8	172	2.60	3.12	55	13	1	5	2.71	21.95

Noticeable is the nest from Dragoslavele, locality situated in the mountain zone, between Iezer-Păpușa, Piatra Craiului and Leaota Mountains, in front of Rucăr-Bran Mountain Corridor, where the small depression with the same name is crossed by the Dâmbovița River (with a discharge over 4.4 m³/s/year measured upstream, at Podu Dâmboviței, cf. www.rowater.ro). Also, other nests are positioned in depressions: Corbeni (2 nests), Corbi (1 nest) and Câmpulung (1 nest) Submountain Depressions, and Curtea de Argeș (1 nest), Domnești-Pietroșani (4 nests), Aninoasa-Valea Siliștii-Berevoești (3 nests) and Schitu Golești (2 nests) Intra-hilly Depressions. So, the total number of the nests located in depressions is 15 (20.27% of all number of nests from Argeș County). The nest from Șuici (on the Topolog Valley) is placed in the submountain region, so that Getic Subcarpathians totalize 15 nests (20.27%). In Cotmeana Piedmont there are only 2 nests (2.70% of all, one at Ciofrângenii, on the Topolog Valley, in the northern extremity of the area, and one at Merișani, in the Argeș Valley, at the contact with Argeș Piedmont). In Căndești Piedmont, there is only a nest (1.35% of all, at Ștefănești, on the Argeș Valley, at the contact with the Romanian Plain). The majority of the nests from the piedmont region were registered in Argeș Piedmont (13, 17.56% of all). As a result, in the Getic Piedmont there are 16 nests (21.62% of all). The biggest group was recorded in the Romanian Plain (Table 2).

About the hydrographical basins, most of the nests (56, 75.67% of all) were identified in the Argeș basin, where the Râul Doamnei, its principal feeder from the mountain and hilly area, had 21 nests (28.37% of all), (Table 2). 1 nest (1.35% of all) was identified in the Dâmbovița basin.

The majority of the nests were situated between 200 and 299 m and the fewest were placed over 500 m altitude (Table 2). Function of relief, in other regions, the most numerous nests were found at 300 – 400 m altitude (Moldova, in 2007), the data from 2004, 2006 and 2007 showing an important distribution between 0 and 400 m altitude (BALTAG et al., 2009). In the middle and upper basin of the Olt River, 64% of the registered couples were found between 500 and 1000 m altitude (KÓSA et al., 2002a). In Cluj County (2014), the majority of the nests (55.28%) were found at altitudes between 300-500 m (KÓSA, 2015). Across the Romanian territory (2004), the majority of the couples (61.66%) brood below 200 m altitude and only 4.7% higher than 600 m (KÓSA, 2005, 2013).

The average altitude of the nests was 308.4 m (min. 131 m – Bârla, max. 664 m - Dragoslavele), (Table 3). It was used the GPS measurement, that differs by the Google Earth one (cf. Google Earth Database). On the unit of relief, it varied between 450 m (in the Topolog basin) and 184.93 m (in the Vedeia Basin), respectively between 209.11 m (in the plain area) and 664 m (in the mountain area). In Moldova (2007), the highest altitude above sea level was 947 m, while the lowest one was 8 m (BALTAG et al., 2009) and at the national level, in 2004, the highest one was over 900 m (KÓSA, 2005). In the Caucasus, the nests are met up to 3000 m (LOVÁSZI, 2012). The mean altitude of all localities with stork nests in Romania was 248.4 m (KÓSA, 2013). In Cluj County (2014), it was 409.6 m (KÓSA, 2015).

With reference to the sea level altitude of the first nests (from the upstream to the downstream of the rivers that spring from the mountains zone), the mean is 549.28 m (n=7 rivers: the Topolog, the Argeș, the Vâlsan, the Râul Doamnei, the Bratia, the Bughea and the Dâmbovița, the minimum = 372 m at Mălureni, on the Vâlsan River, the maximum = 664 m at Dragoslavele, on the Dâmbovița River).

The number of unoccupied nests (uH) represents 10.81% of all nests (H), the number of nests with couples (HPa) represents 89.18% of all nests, the number of pairs not bearing chicks (HPo) represents 16.66% of all pairs (above the value of the national level – 5.01%; KÓSA, 2013), the number of pairs bearing chicks (HPm) represents 83.33% of all pairs (HPa). In Moldova, uH represents 3.93% (BALTAG et al., 2009).

172 chicks were counted in total (Table 1). Among the localities with nests, 3 (Dragoslavele, Bradu and Miroși, 7.5%) did not have chicks, 36 (90.0%) had between 1 and 9 chicks and 1 (2.5%, Căteasca) had between 10 and 19 chicks (more exactly 17). Among the pairs with chicks (HPm), 4 (7.27%, at Mihăești – in Argeș Piedmont, and Bârla, Slobozia, and Ștefan cel Mare – in the Romanian Plain) had 5 chicks (Fig. 4).

In the middle and upper part of the Olt basin, the percentages were: 1.96% – 1 chick, 15.19% – 2 chicks, 37.25% – 3 chicks, 36.52% – 4 chicks, 8.57% – 5 chicks. 2 nests had each 6 fledglings (KÓSA et al., 2002a). In Cluj County, 2014, 4 young storks (38.37%) were the most common (KÓSA, 2015). In Romania: HPm1 – 3.52%, HPm2 – 28.57%, HPm3 – 37.31%, HPm4 – 26.59%, HPm5 – 3.88%; five nests had 6 young storks each. In Argeș, 19 nests (25.67%) did not host chicks, 13 nests (17.56%) hosted between 1 or 2 chicks, 38 nests (51.35%) hosted 3 or 4 chicks and 4 nests (5.40%) hosted 5 or 6 chicks.

We observe that JZa (the mean of chicks/pair), respectively JZm (the mean of chicks/pair with chicks), were the highest (5) in one locality – Slobozia (2.5% of all localities), where a couple with

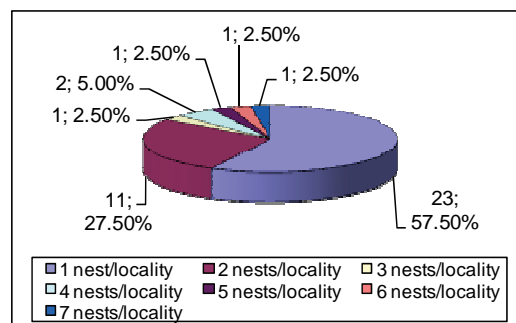


Figure 3. The distribution of the localities (%) by the number of nests (n=74).

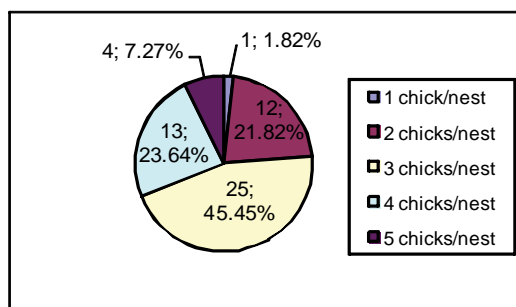


Figure 4. The nests distribution (%) by the number of chicks/nest (n=74).

5 chicks was observed. In 8 localities (20.00%, Corbi, Costești, Mălureni, Mihăești, Recea, Schitu Golești, Ștefan cel Mare and Vlădești), JZa, respectively JZm, were 4. At the other extreme, JZa was 1 in one locality (2.5%, Rătești, where at 5 pairs, among them 3 without chicks, only 5 young storks were recorded) and JZm was 1.5 (2.5%, Pietroșani, where 3 young storks were recorded at 2 pairs). These facts highlight that the white storks breed successfully anywhere they find sufficient resources of food and places of nests, from the depressions of the submountain regions to the plains. The situations from Rătești and Pietroșani could be determined by the unfavourable weather conditions or other unknown factors that intervened during the eggs incubation and upbringing of chicks. In the mountain region, a conclusion cannot be drawn. In the submountain region, JZa and JZm were equal (2.83), which suggests a good state of the population. In the Getic Piedmont, there were the biggest values (3.14, respectively 3.38), in other words the population of white storks increases here. They had the best conditions for growing chicks, where they nested. In the Romanian Plain, also there is a stable population (2.41, 3.13), but we observe an important number of pairs without chicks (23.07%). Regarding the hydrographical basins, the population is stable in each of them. The one from the Neajlov basin is at the inferior limit of JZa (2.15) and the one from the Topolog Basin at the inferior limit of JZm (2.5). The populations from the Vedea basin and from the Argeș basin (including tributaries) are well situated. The population from the Râul Doamnei basin (with tributaries) deserves a special attention, because it has the biggest values of all analysed basins (3.0, respectively 3.18). At the general level, JZa was 2.60 and JZm was 3.12, which means that the population is more than constant (minimal values considered to be necessary are 2, respectively 2.5). For the first nests from upstream to downstream of the rivers that spring from the mountain region we have JZa=2.5 and JZm=3 (Table 2). In Moldova, JZa was 2.25 and JZm, 2.73 (BALTAG et al., 2009), in the middle and upper part of the Olt basin, JZa and JZm were 2.88 and 3.33 (KÓSA et al., 2002a), in Cluj County, 2014, JZa was 3.12 and JZm was 3.38 (KÓSA, 2015), and at the national level, JZa was 2.72 and JZm was 2.99 (KÓSA, 2005).

StD is 0.96 HPa/100 km² for the entire territory of Argeș County (Table 1). It varies between 0.83 HPa/100 km² at Dragoslavele and 8.54 HPa/100 km² at Câmpulung (the areas of the localities, by <https://cjarges.ro> and <http://www.ghidulprimariilor.ro>). At Buzoești, the largest locality among the localities with nests, it was 2.49 HPa/100 km² and at Căteasca, the locality with the biggest number of nests and chicks, it was 7.36 HPa/100 km². Regarding the built-up area only (by <http://www.ghidulprimariilor.ro>), it fluctuated between 5.35 HPa/100 km² at Mălureni and 106.95 HPa/100 km² at Pietroșani. Per total localities with nests, StD is 2.72 HPa/100 km² and StD in the built-up area is 21.95 HPa/100 km². In the mountain area, StD is 0.06 HPa/100 km², in the hilly area (Submountain region and Getic Piedmont) StD is 0.69 HPa/100 km², and in the plain area StD is 2.85 HPa/100 km². Regarding the hydrographical basins, we have only the Râul Doamnei Basin where StD is 0.93 HPa/100 km² (that is comparable to the one of the county level), but, if the mountain area is not taken into consideration (nearly 30% of the drainage surface), StD is approximately 1.33 HPa/100 km². These indicate that the most advantageous area for breeding is the plain. Other densities obtained in our country: 0.89 HPa/100 km² in Moldova (maximum 4.36 HPa/100 km² in the Suceava River basin and minimum 0.72 HPa/100 km² in the Siret River basin), (BALTAG et al., 2009), 5.46 HPa/100 km² in the middle and upper basin of the Olt River (KÓSA et al., 2002a), 1.39 HPa/100 km² in Cluj County, in 2014 (KÓSA, 2015) and 4.17 HPa /100 km² at the national level (KÓSA, 2005). Generally, the densities we calculated were below the national level one, except those at small scale from some localities, where in the built-up area they exceeded 100 HPa/100 km². Densities that reach 50 HPa/100 km² were calculated locally in our country, too (KÓSA, 2013).

The nests were placed especially on the low voltage electric poles (Table 1, Fig. 5). In other areas: 92.92% – electric poles, 1.97% – trees and 1.97% – chimneys, in Moldova (2007), 89.10% – electric poles, 6.04% – trees and 1.75% – chimneys, in Moldova (2004, 2006 and 2007, BALTAG et al., 2009), 91.86% – electric poles, 1.62% – trees and 6.5% – buildings, in Cluj County, 2014 (KÓSA, 2015), 83.9% – electric poles, 3.49% – trees and 12.2% – buildings, in Romania, 2004 (KÓSA, 2013). In SE Europe, in 1994, 50-70% of the nests were built on electric pylons; locally, this rate reached 95-97% (LOVÁSZI, 2012). These show the adaptability of the birds to the new conditions of life. The situation is similar if we take in account the main relief units from the area, the hydrographical basins, the altitude above sea levels or the first nests (from upstream to downstream of the rivers that spring from the mountain zone). A mention has the Râul Doamnei (with tributaries) basin, where 61.90% of the nests were installed on simple electric poles, and 38.10% on electric poles with support; 8 nests were in this situation, here starting the process of supports montage (Table 2, Fig. 5).

All the nests installed on trees were built on ashes (*Fraxinus excelsior*) from the plain, even if there are many artificial adequate places in the area; so, there are just a few birds that prefer their breeding ancestral conditions. Though there is only a case of nesting on chimney, it represents the nest from the highest elevation (at nearly 15 m, on a building from Corbeni). The minimum height of the nest place (5 m) was recorded in a tree at Șerboeni. The mean of the heights for Argeș County where the nests were installed is 8.66 m (Table 4).

It is remarkable the inclination of the storks for the precompressed vibrated poles as regard the nests places (66 nests, 97.05% of all). Only 2 nests were installed on concrete round pole (1.48%) and these reflects the higher frequency of the precompressed vibrated poles (Fig. 6). Concerning the thickness, 59 nests (86.76%) were installed on thick poles and 9 nests (13.24%), on narrow poles, in relation with the better stability for the nests, which the thicker poles offer by comparison with the narrow ones.

Table 2. The white stork breeding parameters by areas and sea level altitudes and the nests placement (n=74).

Parameter		Number of nests (H)	Number of nests (H) (%)	Pairs with chicks (HPm)	Pairs without chicks (HPo)	Number of pairs (HPa)	Solitary stork	Unoccupied nests (uH)	JZG	JZa	JZm	Nests on simple electric poles	Nests on electric poles with support for nest	Nests on chimneys	Nests on trees
Forms of relief	Mountain region	1	1.35	0	1	1	0	0	0	-	-	1	0	0	0
	Submountain region	15	20.27	12	0	12	0	3	34	2.83	2.83	9	5	1	0
	Getic Piedmont	16	21.62	13	1	14	0	2	44	3.14	3.38	12	4	0	0
	Romanian Plain	42	56.75	30	9	39	0	3	94	2.41	3.13	33	4	0	5
Hydrographic basin	Topolog	2	2.70	2	0	2	0	0	5	2.5	2.5	2	0	0	0
	Vedea	16	22.97	13	2	15	0	1	40	2.66	3.07	11	3	0	2
	Argeş with tributaries	56	75.67	40	9	49	0	7	127	2.59	3.17	42	10	1	3
	Neajlov	19	25.67	13	6	19	0	0	41	2.15	3.15	15	1	0	3
	Râul Doamnei with confluents	21	28.37	16	1	17	0	4	51	3	3.18	13	8	0	0
Altitude above sea level	100-199 m	15	20.27	12	2	14	0	1	40	2.85	3.33	12	2	0	1
	200-299 m	27	36.49	19	6	25	0	2	57	2.28	3	21	2	0	4
	300-399 m	12	16.22	9	2	11	0	1	29	2.63	3.22	11	1	0	0
	400-499 m	13	17.57	10	0	10	0	3	31	3.1	3.1	6	7	0	0
	500-599 m	4	5.41	4	0	4	0	0	13	3.25	3.25	3	1	0	0
	600-699 m	3	4.05	1	1	2	0	1	2	1	2	2	0	1	0
The first nests from upstream to downstream		7	9.45	5	1	6	0	1	15	2.5	3	5	1	1	0

Table 3. The average sea level altitude (m) of the nests from Argeş County (n=74).

Parameter	General	Topolog Basin	Vedea Basin	Argeş Basin	Râul Doamnei Basin	Neajlov Basin	Submountain Area	Getic Area	Plain Area	100-199 m	200-299 m	300-399 m	400-499 m	500-599 m	600-699 m	First nests from upstream to downstream
Mean	308.4	450	184.9	338.6	444.4	218	502.9	364.3	209.1	164.2	232.0	349.4	451.6	527.7	639.3	549.2
Standard Error	15.61	69	8.88	17.59	16.39	9.34	15.83	12.32	6.37	4.36	4.40	8.72	7.89	7.90	18.55	38.61
Minimum	131	381	131	150	329	150	426	254	131	131	200	306	402	513	603	372
Maximum	664	519	263	664	651	309	651	443	309	189	274	383	495	549	664	664
Confidence Level (95.0%)	31.12	876.72	18.94	35.26	34.20	19.62	33.96	26.27	12.87	9.36	9.04	19.19	17.19	25.17	79.81	94.48

Table 4. The average of the height (m) of the nest places (n=74).

Parameter	General	Submountain area	Piedmont	Plain	Topolog Basin	Vedea Basin	Argeş Basin	Neajlov Basin	Râul Doamnei Basin	100-199 m	200-299 m	300-399 m	400-499 m	500-599 m	600-699 m	First nests from upstream to downstream
Mean	8.66	9.45	8.66	8.38	7.5	8.21	8.83	8.47	9.26	8.11	8.54	8.35	9.44	8.12	11.33	9.39
Standard Error	0.18	0.57	0.34	0.20	0	0.42	0.20	0.25	0.35	0.08	0.30	0.28	0.50	0.62	1.92	1.00
Minimum	5	7.5	7.5	5	7.5	5	7.5	7.5	7.5	7.5	5	7.5	7.5	7.5	8.5	7.5
Maximum	15	15	11.8	13.5	7.5	13.5	15	11.44	13.5	8.62	13.5	10.8	13.5	10	15	15
Confidence Level (95.0%)	0.36	1.23	0.74	0.41	0	0.90	0.41	0.53	0.74	0.18	0.63	0.63	1.09	1.98	8.270	2.46

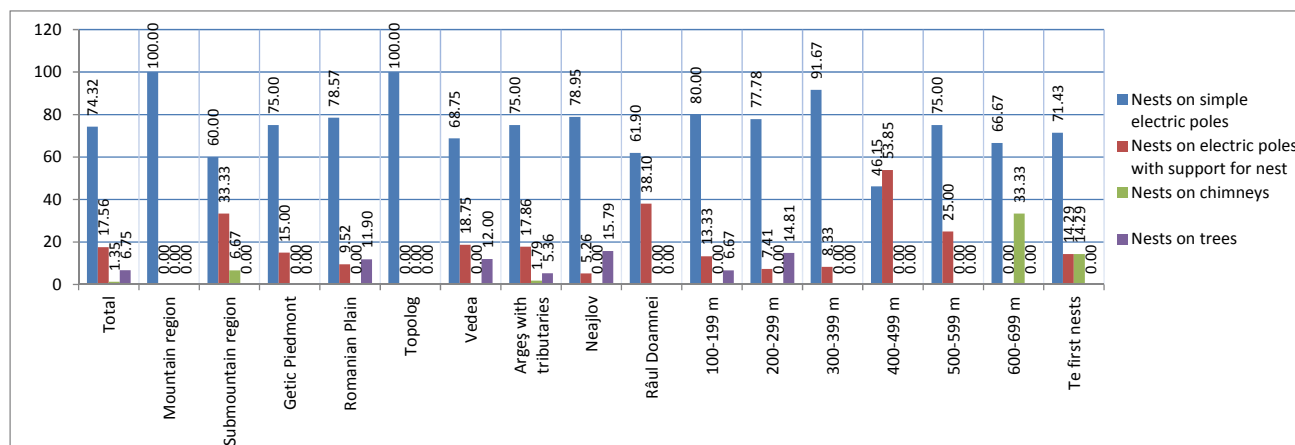


Figure 5. The placement of the nests (%) according to the units of relief (n=74).

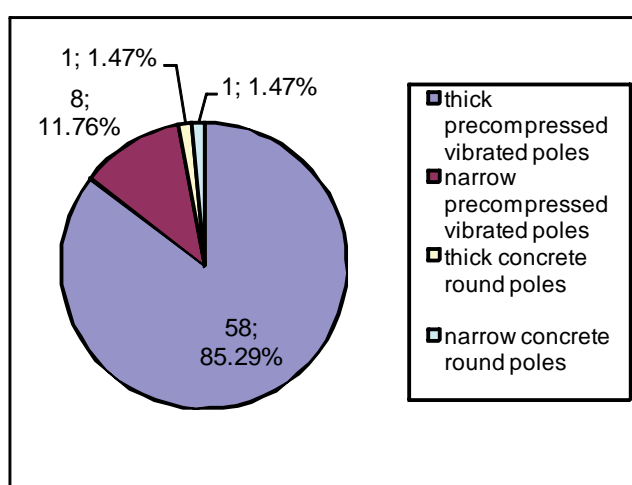


Figure 6. The distribution of the nests (%) by the type of electrical poles (n=74).

From the point of view of the position of the nests relative to human settlements, only 1 nest (1.35%, at Căldăraru, in the Romanian Plain) was built outside the localities (Fig. 7), whereas here there are sufficient favourable nest supports (electrical concrete poles along the roads or trees along the rivers). The better assurance against the predators in localities is the principal reason that explains this state of facts.

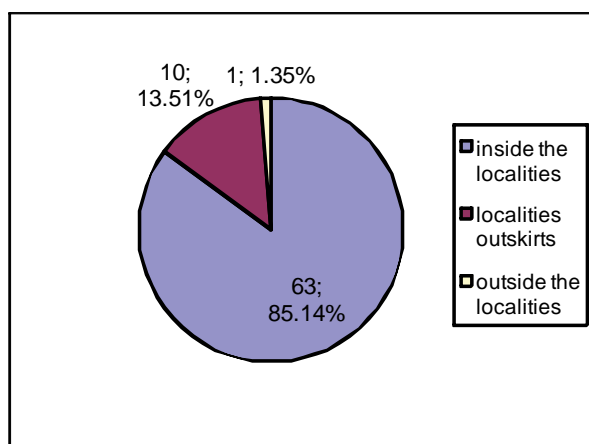


Figure 7. The distribution of the nests (%) by their location in rapport to the human settlements (n=74).

It is interesting that 68 nests (91.89%) were realised on supports located near the roads (mains or secondary roads), that because often the low voltage net marginalises these. Moreover it is outstanding that many nests were placed near the crossroads, good visual marks and generally large places, and the explanation that here there are thick poles is only partially valid, as they can also be found in other places (Fig. 8).

No locality can be considered colony (village with at least 5 breeding pairs no more than 1 km from their nearest neighbour, KÓSA, 2013). The distance between the nests varied between 461 m and 12,784 m, the mean being 3,458.91 m. The maximum was between the nest from Ciofrângenii and the one from Curtea de Argeş, but probably the nest from Ciofrângenii is closer to one from Vâlcea County. Thus, the biggest distance among the each nest and the nearest one seems to be between the nests from Dragoslavele and Câmpulung (11,780 m). In Cluj County, the average was bigger – 4,320.54 m, with maximum of 25,399 m (KÓSA, 2015).

Wetlands are not necessary, but the white storks are more aquatic in the nesting area than in the wintering sites (LOVÁSZI, 2012). Because a good part of the food consists of aquatic and amphibious items, the discharge and the length of the rivers and the distance between the nests and the wetland feeding places can be important.

From the point of view of the average multi-annual discharge of the rivers from the vicinity (cf. www.rowater.ro), the first nests from upstream to downstream were placed in mean somewhere between 1.89 m³/s (for the first 7 points of measurements from upstream) and 3.21 m³/s (for the first 10 points of measurements from downstream). An exact situation cannot be sketched because of the insufficient hydrometric posts. There are not assays at the corresponding place of these nests and, also, we do not have measurements of the discharge for the other nests from Argeş County.

Regarding the length of the rivers up to the nest sites, the one for the rivers that spring from the mountain area is more significant: this varied between 8 km (at Campulung, on the Bughea River) and 68.2 km (at Mălureni, on the Vâlsan River), the mean being 41.95 km (n=7 rivers: the Topolog, the Argeş, the Vâlsan, the Râul Doamnei, the Bratia, the Bughea and the Dâmboviţa).

In the same context, concerning the distance between the nests and the nearest wetland feeding place, the mean is 299.71 m (n=7 samples, the minimum = 372 m at Corbi, on the Râul Doamnei, the maximum = 664 m at Câmpulung – Grui District, on the Bughea, tributary to the Bratia River). On the general level, this mean was calculated at 393.01 m (Table 5), but it is known that the birds may hunt several km around their nests (LOVÁSI, 2012). The distances were measured in Google Earth and they are not very accurate.

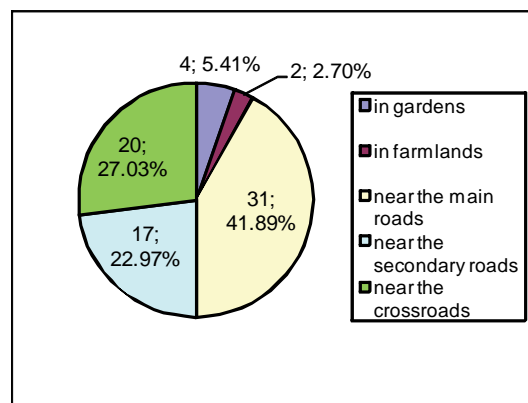


Figure 8. The distribution of the nests (%) by their location (n=74).

Table 5. Distance (m) between nest and the nearest feeding place.

Parameter	Value	Observations
Mean	393.01	
Standard Deviation	24.92	
Minimum	63	At Căldăraru
Maximum	1028	At Coşeşti
Confidence Level (95.0%)	49.67	

The dynamics of the breeding

By comparison with the situation from Argeş County at the precedent census (MESTECĂNEANU et al., 2012), that was performed in 2004 (a little warmer and rainier year than normal in Romania for 1961-1990: 9.4°C – the average air temperature, +0.6°C, and ca. 680 mm – the annual precipitation, +38 mm, cf. Sandu, 2005), we remark: 1) **an increase of 1.96% of the localities where there were identified the white stork nests**, where the number of cities increased from 1 to 4; 2) an increase of 7.5% of the localities with 1 nest, a decrease of 6.71% of the localities with 2 nests, a decrease of 8.02% of the localities with 3 nests, an increase of 5.00% of the localities with 4 nests, a decrease of 0.13% of the localities with 5 nests, an increase by 2.5% of the localities with 6 nests, an increase by 2.5% of the localities with 7 nests, and a decrease by 2.63% of the localities (Bârla) with 9 nests; 3) a decrease of 4.76% (from 21 to 20) of the localities with stork nests from the hilly area and an increase of 18.75% (from 16 to 19) of the localities with stork nests from the plain area; 4) **an increase of 4.05% of the total number of nests**; 5) a more accurate evaluation of the number of pairs (maximum 70-90, that mains 1.45% of the Romanian population); 6) a decrease by 1.52% of the nests from the Topolog basin, a decrease by 0.97% of the nests from the Vedea basin and an increase by 3.84% of the nests from the Argeş basin; 7) an increase by 2.36% of the number of unoccupied nests, a decrease by 2.36% of the number of nests with couple, an increase by 13.85% of the number of pairs not bearing chicks, and a decrease by 5.4% of the number of pairs bearing chicks; 8) **an increase by 19.18% of the total number of chicks**; 9) the highest JZa, respectively JZm, increased from 3 to 5; 10) the lowest values of JZa, respectively JZm, remained constant (1, respectively 1.5); 11) **an increase of JZa (from 2.13 to 2.60) and JZm (from 2.20 to 3.12%) at the general level**; 12) **a small increase of 0.01 HPa/100 km² for the entire territory of Argeş County**; 13) an increase by 1.34% of the pairs with 1 chick, a decrease by 51.19% of the pairs with 2 chicks, an increase by 21.65% of the pairs with 3 chicks, an increase by 23.64% of the pairs with 4 chicks, and an increase by 7.27% of the pairs with 5 chicks; 14) a decrease by

6.78 m of the average altitude of the nests, but this can be the effect of different types of measurements (GPS versus Google Earth); 15) a decrease by 2.26% of the number of nests located between 100 and 199 m, an increase of 11.14% of the number of nests located between 200 and 299 m, a decrease by 9.13% of the number of nests located between 300 and 399 m, a decrease by 3.55% of the number of nests located between 400 and 499 m, an increase of 4.01% of the number of nests located between 500 and 599 m, and a decrease by 0.17% of the number of nests located between 600 and 699 m; 16) **an increase of 21.47% of the nests placed on the low voltage electric poles, a decrease by 21.41% of the nests placed on the trees**, and a decrease by 0.05% of the nests placed on the chimneys, fact that shows the adaptability of the birds to the new breeding circumstances.

Though the number of chicks increased by comparison with 2004, despite the fact that 2014 was warmer (+1.4 °C, 15.90% – annual air temperature increase) and rainier (+165.8 mm, 26.63% – annual precipitation increase; 39.61% – precipitation increase in April-July) than usual (1961-1990), it does not indicate for sure good conditions for the storks, because even if these involve an increase of the food supply, also they can led to the egg chilling and to the increase of the chicks mortality, mainly in the first days after hatching.

CONCLUSIONS

Comparing the actual results to the ones from 2004 census, some conclusions can be done:

- The white storks avoided the breeding areas where there did not exist concomitantly some fundamental factors; among them, the human settlements, mainly the rural ones, and the food resources are the most important, because into the human settlements the birds have protection against predators and benefit from the friendly people attitude;
- The incorrect agricultural practices and the quality of the waters can limit the distribution in the breeding season; other factors like the collisions with the electrical wires/the wind turbines are minimal/inexistent;
- The plain and the hilly area, dominated by large valleys with villages and crops, are the most favourable for the birds breeding, fact that is obvious from the sea level altitude of the nests, the JZa, JZm, StD, etc., too;
- The storks adapted very well to live near the humans: the nests are placed chiefly on the non-natural supports and the disposition of the nests is predominantly into localities; this results, also, from the obvious increase in ten years of the nests installed on the low voltage electric poles that is almost equal to the decrease of the nests installed on the trees;
- The population of the white storks from Argeș County shows a slight increase, that is visible in the number of the localities occupied by them, in the whole number of nests, in the total number of chicks, in JZa, JZm, and StD at the county level; this reflects the positive trend of the species at national and European level but, also, can be the effect of the climate from the respective years;

We consider that the actions of protection of the species begin to demonstrate encouraging consequences. The insulating of the electrical installations against electric shock and the sustaining of the nests with artificial supports must continue, in tandem with the improving of the agricultural politics and the increasing of the water quality. Also, we think that, for the moment, the development of the colonies through the placement of artificial nesting supports on the electric poles is inopportune, if the birds did not have sufficient food resource, and, at this moment, the transferring of the old and any new nests on artificial supports is a better solution. Also, the educational measures have to be better taken into account. Despite of these, the protection in the breeding areas is without great successes for the storks if there is not protection in the passage and winter quarters.

The monitoring must continue to observe the adaptability of the birds to the future anthropogenic conditions and to adopt the necessary measures if the population decreases again.

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Received: March 23, 2017
Accepted: June 12, 2017

CLIMATIC VARIABILITY OF THE WINTER 2016-2017 IN SOUTH-WESTERN ROMANIA

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Abstract. Winter 2016-2017 was normal from the thermal viewpoint, with a general mean value of -1.4°C for the area with altitudes below 600 m, although December 2016 was thermally normal. The winter was marked by the months December, thermally normal but dry, and January, which was cold, displaying a mean value of -5.07°C for the entire region, value that made it the fifth coldest January month in the last 57 years. In December 2016, between the 6th and the 12th (7 days), it was registered the first heat wave of the winter. Two cold waves of 10 days each (January 7-16 and January 20-29) marked January and, in spite of the fact that there were not registered absolute thermal records, the frosty days and nights and the continuous cold produced casualties and triggered an energy crisis during this month. In February, the weather warmed continuously starting with the 2nd and, in the interval February 21-28, it was also registered a moderate heat wave. Climatic warming is well-emphasized even in January, although it was a cold month. The analysis of the temperature mean values calculated for the entire region highlight the decrease of the intensity of the cold waves registered during the winter peak month and a well-marked upward tendency of this parameter. All winter months were dry. The warming occurred in February had important effects on biotopes, crops and fruit trees determining an early spring arrival. The paper is part of a series of extensive studies on climate variability in south-western Romania and the effects of climate warming. The paper is useful for all those interested in the climate evolution in this part of Romania.

Keywords: mean monthly temperatures, Hellmann criterion, warm winter phenomena, cold waves, vegetative processes.

Rezumat. Variabilitatea climatică din iarna 2016-2017 în sud-vestul României. Iarna 2016-2017 a fost normală termic, cu media generală de -1.4°C pentru arealul cu altitudinea sub 600 m, cu toate că luna decembrie 2016 a fost termic normală. Iarna a fost marcată de lunile decembrie, normală termic și secetoasă, și ianuarie, lună rece cu media de pentru întreaga regiune de -5.07°C , fiind a cincea lună ianuarie rece din ultimii 57 de ani. În decembrie, în intervalul 6-12 decembrie 2016 (cu durata de 7 zile) s-a înregistrat primul val de căldură al iernii. Două valuri de frig cu durata de câte 10 zile fiecare (7-16 ianuarie și 20-29 ianuarie), au marcat luna ianuarie și cu toate că nu s-au înregistrat recorduri termice absolute, zilele și nopțile geroase și frigul continuu au produs victime umane și apariția crizei energetice din această lună. În luna februarie, vremea s-a încălzit continuu, începând cu data de 2 februarie, iar în intervalul 21-28 februarie s-a înregistrat un val moderat de căldură. Încălzirea climatică este bine pusă în evidență și pentru luna ianuarie, cu toate că a fost o lună rece. Analiza mediilor lunare de temperatură calculate pentru întreaga regiune arată scăderea intensității valurilor de frig din luna de vârf a iernii și o tendință crescătoare bine marcată a graficului acestui parametru. Toate lunile iernii au fost secetoase. Încălzirea vremii în luna februarie a avut efecte importante în cadrul biotopilor, culturilor agricole și pomilor fructiferi, determinând premisele înfrimăvării timpurii. Lucrarea face parte dintr-o serie de studii extinse privind variabilitatea climatului în sud-vestul României și efectele încălzirii climatice. Lucrarea este utilă tuturor celor interesați de evoluția climatului în această parte a României.

Cuvinte cheie: medii lunare de temperatură, criteriul Hellmann, fenomene de iarnă caldă, valuri de frig, procese vegetative.

INTRODUCTION

On the 15th of June 2016, it was appreciated that El Nino ended (<http://edition.cnn.com/2016/06/15/weather/weather-el-nio-dead-la-nia-coming/>) and that a La Nina episode would occur (75% probability) by the end of 2016 (<http://edition.cnn.com/2016/06/15/weather/weather-el-nio-dead-la-nia-coming/>). The observation was correct and, in January, a short La Nina episode occurred, which would explain, also taking into account the teleconnection with the North Atlantic Oscillation, the cold and extremely cold weather registered for long periods in January. By the end of January, there began a La Nada episode (namely a period characterized by normal water temperature in the Eastern Equatorial Pacific) and it was mentioned the possibility of a new El Nino episode during spring (<https://weather.com/news/climate/news/la-nina-noaa-update-november>, <https://www.yahoo.com/news/u-forecaster-says-la-ni-faded-sees-el-145420425.html>). In February, warming occurred on large surfaces in Europe. Thus, on the 12th of February, it was registered a maximum value of 19.1°C at Eyjabakkar, Iceland. Positive maximum temperatures, even $> 10.0^{\circ}\text{C}$, were registered on large surfaces within the Scandinavian Peninsula, which is the origin area of the cold air advection from January. 2015 registered the first climatic record of mean global temperature, namely $\geq 1.0^{\circ}\text{C}$ than the global mean of the last century and the entire observation period 1880-1899. By the end of 2015, it was considered that a mean 1.0°C above the mean global temperature would not be registered quite soon. The climatic evolution from 2016 infirmed this hope, as the global mean temperature in 2016 exceeded the mean value of the last century by 1.03°C (<http://www.ziaruldevrancea.ro/international/1588839218-temperaturile-globale-au-atins-un-nivel-record-in-2016.html>).

It is worth mentioning that this global thermal record was registered in the conditions of minimum solar activity. "Even if we do not take into account the warming induced by El Nino phenomenon, 2016 will remain the hottest year registered in modern history", affirmed professor Piers Forster, director of Priestley International Centre for Climate, affiliated to University of Leeds, UK. At global level, January 2017 was a very warm month. In the 137 years of modern recordkeeping, it was the third warmest January month (<http://www.click.ro/news/national/ianuarie-2017-fost-al-treilea-cel-mai-cald-ianuarie-din-istorie>). The temperature was 0.92°C higher than the mean temperature of January calculated for the

period 1951-1980 (NASA). The map rendering Loti index for January 2017 (land-ocean temperature index) emphasizes that the highest positive anomaly was registered in North America and Siberia, where it was much warmer than in the period 1951-1980. A large part of the rest of Asia was also relatively warm. Two of the three top positive anomalies for January were registered in the last years. 2016 registered the greatest anomaly, 1.12°C warmer than the mean temperature, followed by 2007, 0.96°C (NASA, Goddard Institute for Spatial Studies (GISS) from New York based on data from 6,300 meteorological stations located all over the globe. There have not been processed the data from Antarctica yet). Consequently, there is to be noticed a great variability of air temperature at global level. The present paper is part of a series of extended papers dedicated to climate variability in the south-west of the country and the effects of climate warming, being useful to all those interested in the evolution of the climate in this part of Romania (BOGDAN et al., 2008; MARINICĂ & CHIMIŞLIU 2008; BOGDAN & MARINICĂ, 2009; BOGDAN et al., 2010; MARINICĂ et al., 2010; MARINICĂ et al., 2011; MARINICĂ & MARINICĂ, 2012; MARINICĂ et al., 2012; MARINICĂ et al., 2013).

We will further analyse this exceptional climatic variability registered in the winter 2016-2017 within Oltenia region and its consequences upon crops, biotopes, economy, and environment in general.

MATERIAL AND METHODS

In order to achieve the paper there were used the results of daily data processing with forecast specialized softs, the data archives of NAM, the maps realized on current basis during the operative activity, the maps supplied by international centres of analysis and forecast and those supplied by NAM Bucharest (<http://www.meteoromania.ro/anm2/vremea/starea-vremii-romania/>). Tables and graphs were achieved based on Office Software.

The paper analyses the climatic variability of the winter 2016-2017 in the south-west of Romania based on the thermal and pluviometric regime of the months December 2016, January and February 2017 and the thermal and pluviometric regime of the entire winter 2016-2017. There are also analysed the effects upon environment and biotopes.

RESULTS

1a. The thermal regime of December 2016.

The monthly mean air temperatures oscillated between -3.5°C within Voineasa intra-Carpathian depression and 2.2°C in the extreme south-west of the Danube Alluvial Plain, at Calafat. Their deviations compared to the normal values were between -2.3°C within Apa Neagră Sub-Carpathian depression and 1.2°C at Calafat, thus determining the classification of the thermal types from cold (C) on a small area near Apa Neagră to warmish (Ws) on a small area near Calafat. Within most of Oltenia, there were normal values, while cool (Cl) weather was registered in the hilly area and certain areas from the Sub-Carpathian depressions (Table 1). *The monthly air temperature mean*, calculated for the entire Oltenia region (at altitudes below 600 m) was -0.4°C, while its deviation compared to the normal was -0.3°C, thus confirming that the monthly mean of December 2016 was normal (N).

The minimum monthly air temperatures were mostly registered on the 14th and the 31st of December and varied between -14.4°C (registered on the 14th of December) within Romanaţi Plain, at Caracal, and -8.1°C (registered on the 31st of December 2016) within Mehedinţi Hills, at Băcleş. The coldest morning was registered on the 14th of December 2016, when the mean minimum temperature for the entire region was -10.3°C; the thermal regime specific to December started with the 30th of November 2016. *Frost units*¹ in December 2016 oscillated between 15.4 at Calafat and 118.9 at Voineasa, while the mean value for the entire Oltenia region was 50.5. There was not registered *agrometeorological frost*. Weather cooling in December was normal and there was not registered any cold wave. *Heat units* varied between 9 at Voineasa and 83.9 at Calafat, and the mean value for the entire region was 38.3, thus marking a reduced difference between frost and heat units, which signifies a thermally normal month from the agrometeorological viewpoint. These values contributed to the development of vegetative processes at autumn crops and, generally, at vegetation, and biotic processes within biocoenoses². The adaptation of autumn cultivated plants to the slower vegetative processes and to the appearance of the vegetative rest (preparation for wintering) occurred slowly during the entire month.

¹ *The degree of winter bitterness* in agrometeorology (winter type) is classified according to the sum of frost units (Σ of differences between the daily minimum temperatures <-15°C and the agroclimatic critical threshold of -15.0°C, in the interval December – February). Therefore, a frost unit is the difference of 1°C between the critical threshold of -15.0°C and an air minimum thermal value \leq -15°C (for example, for T min = -16.0°C, then the difference -15.0°C - (-16.0°C) = 1, namely a frost unit (SANDU et al., 2010); *Frost units for the entire cold season* are calculated as Σ of daily mean temperatures \leq 0°C, in the period November-March; A day of frost is the day in which the mean temperature is \leq 0°C; *The active temperature are those \geq 0°C*, and the temperature of the biological minimum is 0°C. A winter day is a day in which air temperature is < 0°C. *Heat units* (Σ of daily mean temperatures \geq 0°C). From the point of view of weather forecast, for people, the notion 'frost' means temperature values of \leq -10°C. Therefore the term frost defined by weather forecast (which are adapted to living organisms) is different from *agrometeorological frost* (temperatures of \leq -15°C), plants being better adapted to climatic conditions (due to their cellular structure and specific biotic processes).

² The term of biocoenoses (Greek *koinosis* – to share) represents a supra individual level of organizing living matter and describes the totality of living, vegetal (*phytocoenosis*) and animal (*zoocoenosis*) organisms, which interact with each other and live together in a habitat or a sector of the biosphere (*biotope*), forming a whole and are in a dynamic balance dependent on that particular environment. It is characterized by a certain structure and functioning given by the model of matter, energy and information flow. The term of biocoenoses was proposed by Karl Möbius in 1877 (<http://ro.wikipedia.org/wiki/Biocenoza>).

Table 1. The regime of air temperature within Oltenia and the temperature minimum and maximum values on ground surface in December (N = normal values calculated for the interval 1901-1990, M = mean monthly values in December 2016, CH= Hellmann Criterion).

No.	Meteorological Station	Hm	N	M	$\Delta=M-N$	CH	minT air		maxT air		minT soil		maxT soil	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Drobeta Turnu Severin	77	1.4	1.6	0.2	N	-8.5	14	17.8	11	-11.0	14;15	21.0	11
2	Calafat	66	1.0	2.2	1.2	WS	-9.1	1	19.9	11	-12.0	1	24.9	11
3	Bechet	65	0.4	0.2	-0.2	N	-13.0	14	16.8	11	-6.0	14	11.8	11
4	Băilești	56	0.4	0.3	-0.1	N	-10.2	1	17.9	11	-11.0	1	19.3	11
5	Caracal	112	-0.1	-0.5	-0.4	N	-14.4	14	14.9	11	-14.0	14	20.1	11
6	Craiova	190	0.1	-0.4	-0.5	N	-12.3	14	15.5	11	-14.4	14	14.1	11
7	Slatina	165	0.3	-0.6	-0.9	N	-10.1	14	14.2	11	-12.8	14	10.4	11
8	Bacșeu	309	-0.4	-0.1	0.3	N	-8.1	31	16.2	11	-	-	-	-
9	Târgu Logrești	262	0.1	-1.3	-1.4	CO	-12.4	31	16.6	9	-12.6	30	19.0	11
10	Drăgășani	280	0.6	0.4	-0.2	N	-9.1	14	13.6	10	-8.0	5	18.6	2
11	Apa Neagră	250	0.1	-2.2	-2.3	CL	-12.7	31	15.9	11	-9.8	31	12.6	11
12	Târgu Jiu	210	0.1	-1.1	-1.2	CO	-10.4	31	16.1	11	-10.6	31	15.6	11
13	Polovragi	546	0.1	-0.9	-1.0	CO	-11.4	14	14.2	11	-12.8	31	15.8	11
14	Rm.Vâlcea	243	0.5	-0.1	-0.6	N	-9.2	30	14.8	11	-9.8	31	18.6	10
15	Voineasa	587	-1.9	-3.5	-1.6	CO	-12.4	31	6.6	12	-	-	-	-
16	Parâng	1585	-3.7	-	-	-	-14	30	8.6	11	-	-	-	-
	Mean Oltenia	-	-0.1 ³	-0.4	-0.3	N	-11.1	-	15.0	-	-5.3	-	17.1	-
17	Obârșia Lotrului	1404	-4.9	-7.2	-2.3	CL	-19.8	14	6.4	11	-	-	-	-

(Source: Data processed from NMA archive).

The maximum temperature values were registered in the interval December 9-12 (most of them on the 11th of December) and varied between 6.6°C at Voineasa and 19.9°C at Calafat; the mean value for the entire region was 15.0°C. In the interval December 6-12, there was registered a moderate heat wave. The daily maximum temperatures were positive in almost all the days, thus contributing to the maintenance of active biotopes and vegetative processes; moreover, there were also sunny days.

The graph rendering the variation of air temperature in December 2016 presents a reduced decrease tendency due to the slow cooling occurred mainly after the 13th of December.

The warmest day of December 2016, according to the mean of maximum temperatures for the entire region, was 14.7°C and it was registered on the 11th of December, while the coldest day, with a mean of -0.6°C, was registered on the 14th of December. There were registered only 2 winter days, on the 13th and 14th of December, while in the mountain area, there were 18 days at Parâng.

At the ground level, most of the minimum temperatures were registered on the 14th and 31st of December, as well as in case of air temperature, and varied between -14.4°C at Craiova and -6.0°C at Bechet, with a mean value for the entire region of -5.3°C. Processes of superficial freeze-thaw of the soil occurred daily. The maximum temperatures at the ground level were mostly registered on the 11th of December and varied between 10.4°C at Slatina and 24.9°C at Calafat, while the mean value for the entire region was 17.1°C. The thermal regime specific to December installed on the 30th of the month.

1b. The pluviometric regime of December 2016

In December 2016, the monthly precipitation amounts were between 0.0 l/m² at Drobeta Turnu Severin and 9.5 l/m² at Caracal, while in the mountain area, at Parâng, they reached 34.0 l/m² (Fig. 1).

The percentage deviation of the precipitation amounts compared to the normal were between -100% at Drobeta Turnu Severin and -75.9% at Caracal, which determined the classification of the month as exceptionally dry for the entire Oltenia Region, except the mountain area, where the percentage deviation was -37.7%, which means very dry (VD) (Table 2). The mean precipitation amount for the entire region was 4.2 l/m², and the percentage deviation compared to the normal -91.8%, which confirms its classification as an exceptionally dry month (ED) for the entire region. However, crops were not damaged as the autumn 2016 was a rainy one and the available soil water reserve in the ploughed layer with a thickness of 0-100 cm was optimum or close to the optimum and there was registered only atmospheric drought⁴.

³ The normal mean calculated for the area below 600 m, as the entire territory of Oltenia except the mountainous area displays such altitudes, is +0.2°C, which determines a deviation of the monthly mean of -0.5°C, but this does not change the classification of the month as thermally normal.

⁴ Hellmann criterion is very useful in the determination of the pluviometric types and it refers only to the registered precipitation amounts, thus becoming useful in determining atmospheric drought and precipitation excess. Pedological drought is determined based on criteria that take into account the soil water reserve.

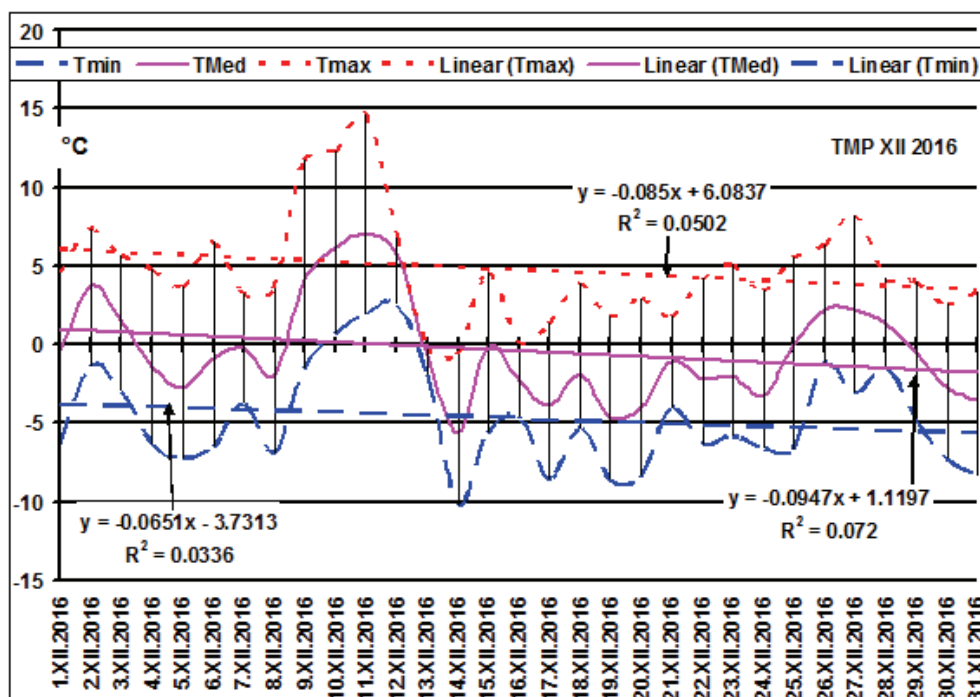


Figure 1. Air temperature variation (daily minimum, mean and maximum temperatures) in December 2016.
(Source: Data processed from NMA archive).

Table 2. Precipitation amounts registered in the winter 2016-2017 (Σ) compared to the normal values⁹ (N);
($\Delta\%$ =percentage deviation compared to the normal, CH=Hellmann criterion).

No.	Meteorological Station	Hm	December 2016				January 2017				February 2017			
			Σ XII	N	$\Delta\%$	CH	Σ I	N	$\Delta\%$	CH	Σ II	N	$\Delta\%$	CH
1	Drobeta Turnu Severin	77	0.0	61.2	-100	ED	17.0	51.4	-66.9	ED	39.8	47.9	-16.9	LD
2	Calafat	66	0.1	45.5	-99.8	ED	42.5	40.4	5.2	N	24.7	38.0	-35.0	VD
3	Bechet	65	3.8	36.3	-89.5	ED	43.4	33.5	29.6	R	14.5	34.8	-58.3	ED
4	Băilești	56	1.0	46.8	-97.9	ED	44.8	38.5	16.4	LR	19.6	36.1	-45.7	VD
5	Caracal	112	9.5	39.5	-75.9	ED	49.8	34.7	43.5	VR	12.5	34.5	-63.8	ED
6	Craiova	190	4.1	41.8	-90.2	ED	33.4	37.5	-10.9	LD	31.5	30.4	3.6	N
7	Slatina	165	4.4	42.8	-89.7	ED	39.0	36.0	8.3	N	15.6	38.4	-59.4	ED
8	Băcleș	309	0.0	54.7	-100	ED	50.5				11.5	44.1	-73.9	ED
9	Târgu Logrești	262	1.2	44.8	-97.3	ED	24.8	35.9	-30.9	VD	29.2	41.0	-28.8	D
10	Drăgășani	280	2.1	44.6	-95.3	ED	20.9	34.1	-38.7	VD	22.9	35.4	-35.3	VD
11	Apa Neagră	250	1.7	82.3	-97.9	ED	10.3	70.9	-85.5	ED	51.8	66.4	-22.0	D
12	Târgu Jiu	210	2.4	64	-96.3	ED	8.0	53.9	-85.2	ED	46.6	52.0	-10.4	LD
13	Polovragi	546	2.1	56.1	-96.3	ED	4.7	48.9	-90.4	ED	39.8	48.4	-17.8	LD
14	Râmnicu Vâlcea	243	0.5	46.2	-98.9	ED	6.7	35.5	-81.1	ED	33.0	38.4	-14.1	LD
15	Voineasa	587	0.2	55.1	-99.6	ED	42.7			ED	0.5	44.0	-98.9	ED
16	Parâng	1585	34.0	54.6	-37.7	VD	13.4	57.7	-76.8	ED	36.5	47.7	-23.5	D
	Media Oltenia		4.2	51.0	-91.8	ED	25.6	43.9	-41.1	VD	26.9	42.3	-36.5	VD
17	Obârșia Lotrului	1404	50.1	-	-	-	18.7	-	-	-	32.7	-	-	-

(Source: Data processed from NMA archive).

2a. The thermal regime of January 2017

The monthly mean air temperatures oscillated between -6.5°C at Voineasa and -3.3°C at Drobeta Turnu Severin, and their deviations compared to the normal values were between -4.0°C at Băilești within Oltenia Plain and -1.4°C at Polovragi and Râmnicu Vâlcea, thus determining the classification of the month as cold (C) within most of the region (Table 3). Lower deviations that determined the classification of the weather as cool (CI) were registered in the hilly area, the sub-Carpathian depressions and Voineasa intra-mountain depression. In the interval January 6-31, it was registered a thermal inversion, which explains the lower thermal deviations from the area characterized as cool. The monthly mean air temperature for the entire region was -5.06°C and the deviation compared to the normal -2.26°C , which determined the classification of the month as cold (C) within the entire region. This low general monthly mean value (-5.06°C) emphasizes that January was the fifth coldest month in the last 57 years in an upward hierarchy of the general temperature means (Table 4). The coldest January months in the last 57 years registered in: **1963** (VC, a mean temperature of -8.41°C), **1985** (C, a mean of -6.94°C), **1969** (C, a mean of -5.94°C), **1964** (C, a mean of -5.29°C), **2017** (C, a mean of -5.06°C). **January 1942 was the coldest winter month of the 20th century and the only one classified as exceptionally cold (EC), according to the values of the temperature field at the 850hPa level, (reanalysis maps) (BOGDAN et al., 2014).**

Table 3. The regime of air temperature within Oltenia and the temperature minimum and maximum values on ground surface in January 2017 (N = normal values calculated for the interval 1901-1990, M = mean monthly values in January 2017, CH= Hellmann Criterion).

No.	Meteorological Station	Hm	N	M	$\Delta=M-N$	CH	air Tmin		air Tmax		min Tsoil		maxT soil	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Drobeta Turnu Severin	77	-1.1	-3.3	-2.2	CL	-15.1	10,	10.9	2,	-18.0	10,	15.0	2,
2	Calafat	66	-1.8	-5.3	-3.5	CL	-19.9	27,	12.5	2,	-24.0	10,	18.6	2,
3	Bechet	65	-2.2	-5.9	-3.7	CL	-23.7	12,	11.1	2,	-25.0	12,	12.8	4,
4	Băilești	56	-2.3	-6.3	-4.0	CL	-18.3	22,	11.3	2,	-21.4	12,	16.1	2,
5	Caracal	112	-2.9	-5.5	-2.6	CL	-19.2	10,	7.6	2,	-23.5	10,	12.1	2,
6	Craiova	190	-2.6	-5.1	-2.5	CL	-17.7	10,	8.6	2,	-19.6	10,	5.6	2,
7	Slatina	165	-2.4	-5.3	-2.9	CL	-21.3	10,	7.6	2,	-25.4	10,	8.3	4,
8	Bacleş	309	-3.0	-5.2	-2.2	CL	-16.4	10,	9.0	2,				
9	Târgu Logrești	262	-2.7	-5.9	-3.2	CL	-25.4	10,	8.2	3,	-26.0	10,	10.8	3,
10	Drăgășani	280	-2.2	-4.1	-1.9	CO	-16.2	10,	6.9	2,	-21.2	10,	9.9	1,
11	Apa Neagră	250	-2.6	-5.1	-2.5	CL	-21.1	10,	7.7	3,	-19.2	10,	10.9	15,
12	Târgu Jiu	210	-2.6	-4.2	-1.6	CO	-18.5	10,	8.5	3,	-18.6	10,	13.2	3,
13	Polovragi	546	-3.2	-4.6	-1.4	CO	-20.0	10,	7.8	2,	-28.9	10,	10.3	2,
14	Râmnicu. Vâlcea	243	-2.2	-3.6	-1.4	CO	-19.4	10,	8.0	15,	-20.8	10,	11.5	2,
15	Voineasa	587	-4.7	-6.5	-1.8	CO	-18.7	10,	5.1	21,	-	-	-	-
16	Parâng	1585	-5.9	-	-	-	-22.6	8,	6.3	24,	-	-	-	-
	Mean Oltenia		-2.8	-5.06	-2.26	CL	-19.6		8.6		-22.4		11.9	
17	Obârșia Lotrului	1404	-6.2	-10.7	-4.5	CL	-28.8	10,	6.1	28,	-	-	-	-

(Source: Data processed from NMA archive).

Thus, *in the 20th century, it was registered only one exceptionally cold (1942) and only one very cold January (VC) (1963)*. In the last 57 years (1961-2017), *most of the January months were warm*, 27 cases (namely 47.4%); there were also normal months, 19 cases (33.3%), while cold months registered the lowest number, 11 (namely 19.3%). The increasing tendency of the mean monthly temperature for the entire region is obvious, the increase coefficient being significant (0.033) (Fig. 2). Due to this temperature increase, the frequency, duration and intensity of cold waves decreased in January. *Only two January months were very warm (VW): January 1983 with a mean value of 2.62°C and January 2007 with a general mean of 4.73°C* (at a difference of only 0.27°C compared to an excessively warm month) (Table 4). Consequently, climatic warming is clear also in January, which is the winter peak month.

Table 4. The thermal classification of January months in the last 57 years. (avgT = mean January temperature calculated for the entire Oltenia region with altitudes below the 600 isohypse, (°C), Type = thermal classification of the month according to Hellmann criterion, Cold = no. of cold winters and their percentage, Normal = no. of normal winters and their percentage, Warm = no. of warm winters and their percentage, EC= exceptionally cold, VC = very cold, C = cold, Cl = cool, N = normal, Ws = warmish, W = warm, VW = very warm, EW = exceptionally warm).

YEAR	avgT	TIP	YEAR	avgT	TIP	YEAR	avgT	TIP	YEAR	avgT	TIP
1961	-1.99	N	1976	0.34	C	1991	-0.41	C	2006	-4.23	RC
1962	-1.17	CL	1977	-2.11	N	1992	-0.65	CL	2007	4.73	FC
1963	-8.41	FR	1978	-1.83	N	1993	-0.79	CL	2008	-3.05	N
1964	-5.29	R	1979	-2.16	N	1994	2.14	C	2009	-0.49	C
1965	-0.41	C	1980	-4.79	R	1995	-2.7	N	2010	-4.81	R
1966	-2.88	N	1981	-2.22	N	1996	-2.69	N	2011	-1.14	CL
1967	-3.12	RC	1982	-2.46	N	1997	-2.28	N	2012	-1.23	CL
1968	-2.31	N	1983	2.62	FC	1998	0.17	C	2013	-0.24	C
1969	-5.94	R	1984	0.96	C	1999	-0.22	C	2014	0.47	C
1970	-1.86	N	1985	-6.94	R	2000	-4.07	RC	2015	0.83	C
1971	-0.25	C	1986	0.46	C	2001	0.69	C	2016	-2.58	N
1972	-2.46	N	1987	-3.75	RC	2002	-0.81	CL	2017	-5.06	R
1973	-2.82	N	1988	1.31	C	2003	-1.47	CL	Cold	11	19.3%
1974	-1.99	N	1989	0.03	C	2004	-3.21	N	Normal	19	33.3%
1975	0.71	C	1990	-2.71	N	2005	1.21	C	Warm	27	47.4%

(Source: Data processed from NMA archive).

In January 2017, *frost units* varied between 112.4 at Drobeta Turnu Severin and 199.6 at Băilești, while the general mean for the entire region was 160.3, which means a moderately cold winter month, from the agrometeorological point of view. *Heat units* were insignificant and varied between 0 at Voineasa and 12.0 at Calafat, with a mean for the entire region of 3.5°C.

The minimum values of air temperature were mostly registered on the 10th of January and oscillated between -15.1°C at Drobeta Turnu Severin, in the western extremity of the region, and -25.4°C at Târgu Logrești, in the hilly area of Oltenia. The mean value for the entire region was -19.6°C. There occurred *two cold waves*, in the intervals January 7-

16 and 20-29, the duration of which totaled 20 days. *The coldest morning* was also registered on the 10th of January when the mean value for the entire region was -18.9°C, the day when cold reached the winter peak. In 12 mornings, the mean temperatures for the entire region were $\leq -10.0^\circ\text{C}$. After this date, air temperature slowly increased and the last cold morning was registered on the 2nd of February 2017. The only winter month characterized by **agrometeorological frost** was January. *The units of agrometeorological frost* were between 0.1 at Dr. Tr. Severin and 30.6 at Târgu Logrești, and the classifications of the agrometeorological winter type at the meteorological stations (according to the criterion proposed by SANDU et al., 2010) varied between mild winter within most of the region to cold winter at Târgu Logrești in the hilly area. Within Băilești Plain, Apa Neagră Sub-Carpathian Depression and in the mountainous area, at Parâng, the winter was moderate. *The mean of agrometeorological frost units* for the entire region was 10.8, highlighting a moderate winter for the entire region of Oltenia. *Temperature mean range* in January was comprised between 23.1°C at Drăgășani and 34.8°C at Bechet, while *the maximum range for the entire region* was 37.9°C.

Most of the *maximum monthly temperatures* were registered on the 2nd of January, when the mean of the daily maximum values for the entire region was 7.7°C, the highest in January. The monthly maximum values oscillated between 5.1°C at Voineasa and 12.5°C at Calafat, and their average for the entire region was 8.6°C. *The graph of the variation of air temperature* in January 2017 presents slightly decreasing tendencies of all the analysed parameters (daily minimum, mean and maximum values) (Fig. 3).

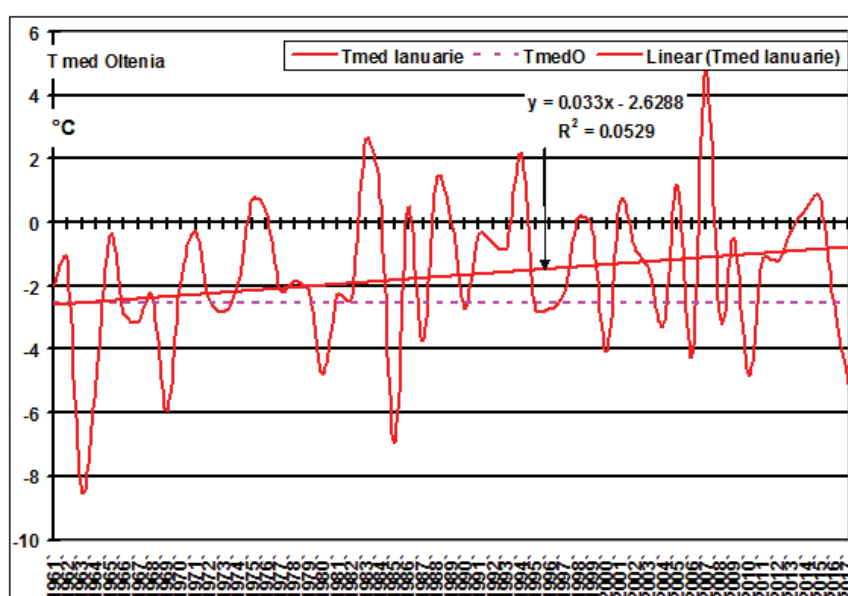


Figure 2. Variation of the monthly mean temperature calculated for the entire region (except the mountainous area) in the interval 1961-2017 (TmedO=mean temperature for Oltenia). (Source: Data processed from NMA archive).

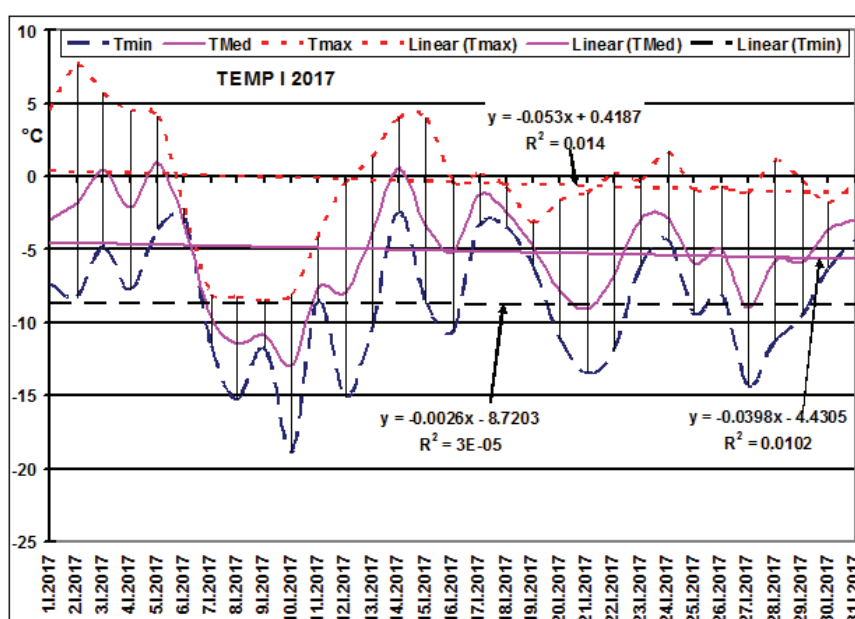


Figure 3. Variation of air temperature (daily minimum, mean and maximum values) in January 2017. (Source: Data processed from NMA archive).

There was also registered a *weak heat wave* of 5 days, in the interval January 1-5. *At the ground level, the monthly minimum temperatures* were mostly registered on the 10th of January and varied between -28.9°C at Polovragi and -18.0°C at Drobeta Turnu Severin, and their mean for the entire region was -22.4°C. Consequently, the soil was frozen in the interval January 6-31, and thaw started on the 1st of February. The value of **-28.9°C, registered at Polovragi, represents the minimum thermal value of the winter 2016-2017 at ground level**. Most of the maximum temperatures at ground level were registered in the interval January 1-4 and oscillated between 5.6°C at Craiova and 18.6°C at Calafat; their mean value for the entire region was 11.9°C.

2b. The pluviometric regime of January 2017

Precipitation amounts varied between 4.7 l/m² at Polovragi and 49.8 l/m² at Caracal, and their percentage deviations from the normal varied between -90.4% at Polovragi and 43.5% at Caracal, determining the classification of the months from exceptionally dry (ED) and very dry (VD) within most of the region to very rainy (VR) within a reduced area from Romanați Plain, at Caracal (Table 2). *The monthly mean amount of precipitations* calculated for the entire region was 25.6 l/m² and the deviation compared to the normal was -41.1%, thus determining the classification of the month as very dry (VD) as an average. In January, there occurred three intervals characterized by generally reduced precipitations: January 5-6, 8-11 and 16-18; in case of the first interval, precipitation amounts were significant for crops in the southern half of the region. In the beginning, precipitation were liquid and then, they transformed into snow; thus, starting with the 6th of January, there formed a snow cover, which reached the maximum thickness on the 7th of January and, isolatedly, on the 11th and the 12th of January, while in the mountainous area on the 13th and the 14th of January. *The maximum thickness of the snow cover* varied between 5 cm at Târgu Jiu and 38 cm within Romanați Plain, at Caracal; in the mountains, it reached 52 cm at Parâng and 75 cm la Obârșia Lotrului. Due to cold weather, the snow cover maintained during the entire month, although thickness gradually decreased as snow settled and thawed. It ensured a good protection for the crops in the southern part of the region; in the north, it was insignificant and, in certain areas, there was no snow cover during January (Fig. 4). *The length of the snow cover* varied between 9 days at Târgu Jiu and 26 days within most of the region. The thawing of the snow cover occurred in the interval February 1-6, persisting in the southeastern extremity until the 17th of February, even if it had an insignificant thickness, due to the thermal inversion phenomenon, and within the Sub-Carpathians, until the 23rd of February.

3a. The thermal regime of February 2017

The monthly mean temperatures gradually varied between 0.5°C at Voineasa and 2.7°C at Drobeta Turnu Severin, and their deviations compared to the normal were comprised between 0.9°C within Oltenia Plain, at Bechet and Băilești, and 3.0°C within Voineasa intra-mountainous depression, determining the classification of the month from normal (N) within Băilești Plain to warm (W) within the hilly area, in the Sub-Carpathians and the mountains (Table 5). *The monthly mean temperature calculated for the entire region* was 1.4°C and its deviation from the normal was 2.2°C, which means that this month was warm (W) for the entire region of Oltenia.

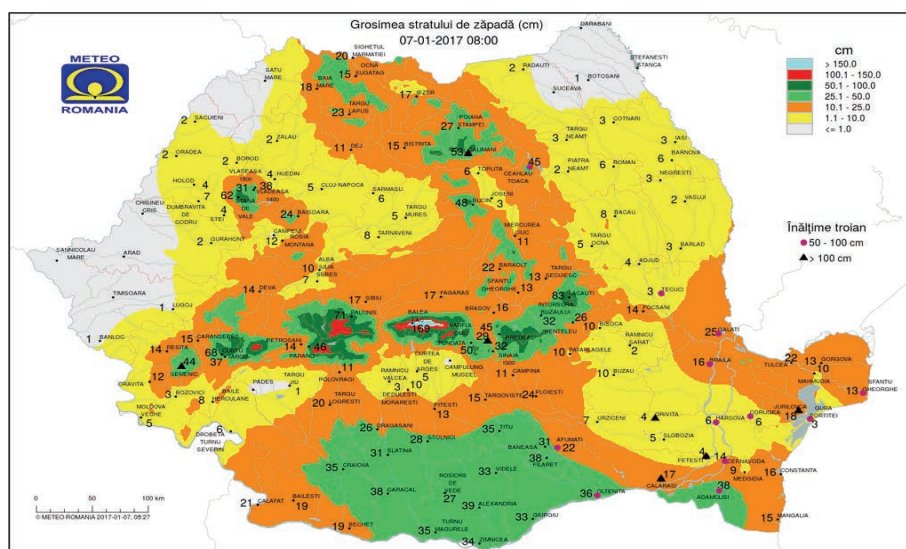


Figure 4. Spatial distribution of the snow cover with maximum thickness during the winter 2016-2017, on the 1st of January 2017, at 8 a.m. (according to NAM Bucharest).

The daily means calculated for the entire region varied between -5.9°C on the 12th of February and 9.4°C on the 28th of February. *The warmest interval of February* and of the entire winter 2016-2017 was February 21-28, when, isolatedly, the maximum values slightly exceeded 20.0°C and there were registered the maximum values of the winter 2016-2017. *The minimum monthly values of air temperature* were registered in the interval February 1-12 and varied

between -15.5°C within Romanați Plain, at Caracal, and -6.3°C at Drobeta Turnu Severin, while their average was -10.0°C, which is 9.6°C higher than that of January. *The coldest morning* was registered on the 12th of February, when the mean of the minimum values for the entire region was -8.0°C. *The frost units* were reduced and varied between 15.9 at Drobeta Turnu Severin and 51.8 at Caracal, while their mean for the entire region was 34.5. They were registered in the intervals February 1-2 and February 8-17, namely 11 days.

Table 5. The regime of air temperature within Oltenia and the temperature minimum and maximum values on ground surface in February 2017.

No.	Meteorological Station	Hm	N	M	$\Delta=M-N$	CH	minT air		maxT air		minT soil		maxT soil	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Drobeta Turnu Severin	77	0.9	2.7	1.8	W	-6.3	12,	19.7	23,	-9.4	1,	28.9	27,
2	Calafat	66	0.4	1.6	1.2	WS	-10.9	1,	20.8	23,	-13.2	1,	20.6	24,
3	Bechet	65	-0.1	0.8	0.9	N	-11.7	1,	20.9	24,	-11.8	1,	19.0	23,
4	Băilești	56	-0.1	0.8	0.9	N	-11.4	1,	19.1	24,	-13.0	1,	20.2	24,
5	Caracal	112	-0.7	0.7	1.4	WS	-15.5	1,	18.9	24,	-16.0	1,	23.3	27,
6	Craiova	190	-0.4	1.4	1.8	WS	-9.5	1,	18.4	24,	-13.0	1,	19.8	27,
7	Slatina	165	-0.2	1.3	1.5	WS	-9.9	2,	18.2	23,	-11.8	1,	19.5	23,
8	Băcleș	309	-0.9	1.5	2.4	W	-9.4	12,	18.8	28,				
9	Târgu Logrești	262	-0.7	1.1	1.8	WS	-9.3	11,	18.5	28,	-13.2	2,	23.0	23,
10	Drăgășani	280	-0.2	1.9	2.1	W	-9.5	12,	18.3	24,	-8.5	1,	22.4	27,
11	Apa Neagră	250	-0.6	1.4	2	W	-8.8	21,	17.2	23;27,	-8.8	21,	17.0	27,
12	Târgu Jiu	210	-0.4	2	2.4	W	-7.0	12,	18.7	28,	-8.2	11;12,	24.4	26,
13	Polovragi	546	-1.4	1	2.4	W	-10.5	11,	16.5	28,	-17.5	11,	20.7	27,
14	Râmnicu Vâlcea	243	0.0	2.2	2.2	W	-9.2	11,	19.6	23,	-14.8	11,	21.1	23,
15	Voineasa	587	-2.5	0.5	3	W	-10.9	1,	17	28,				
16	Parâng	1585	-5.6				-10.4	14,	17.8	28,				
	Mean Oltenia		-0.8	1.4	2.2	W	-10.0		18.7		-12.2		21.5	
17	Obârșia Lotrului	1404	-5.5	-2.6	2.9	W	-18.9	13,	10	28,				

(Source: Data processed from NMA archive).

Agrometeorological frost did not occur in February. *Heat units* were registered in the intervals February 3-7 and February 18-28, namely 14 days, and varied between 42.7 at Voineasa and 92.8 at Dr. Tr. Severin; the mean for the entire region was 73.4, much higher than in case of frost units, which confirms the characteristic of warm winter month and *the translation of the spring season towards winter*. *The hottest day* was registered on the 24th of February with a mean value for the entire region of 9.3°C. *The maximum monthly temperatures* were registered at different dates, namely the 23rd, the 24th and the 28th of February within most of the region, and on the 27th of February in the northern extremity of Apa Neagră Subcarpathian Depression. These oscillated between 16.5°C within Polovragi Subcarpathian Depression and 20.9°C at Bechet, while the mean value for the entire region was 18.7°C, exceeding the mean of maximum values registered in the other winter months. The highest daily mean of the mean maximum temperatures was 18.1°C, on the 28th of February. A moderate heat wave occurred during the interval February 21-28, which lasted until the 5th of March 2017, and triggered the start of the vegetation period at crops, the opening of the buds of weeping willows and the appearance of leaves, the blooming of the white magnolia (on the 5th of March) and the swelling of the buds of apricot, almond, cherry and cherry trees, etc. which means an early spring arrival.

The graph of the air temperature variation in February 2017 presents upward tendencies for all the analysed parameters (daily minimum, mean and maximum means) (Fig. 5); the most rapidly increasing was the maximum temperature. Due to the warm weather determined by air advection within most of the European continent starting with the end of January and occurring during most of February, it was registered an early spring arrival; migratory birds arrived and starlings arrived starting with the 30th of January 2017. Bees went for pollen and propolis in many days. Biotopes maintained their activity during February. At the ground level, *temperature minimum values* were mostly registered on the 1st of February and varied between -8.2°C at Târgu Jiu and -17.5°C at Polovragi, and their mean for the entire Oltenia region was -12.2°C. After the 30th of January, the soil superficial thaw occurred during days and freezing during nights (freeze-thaw cycle); starting with the 20th of February, the soil remained frozen. The freeze-thaw cycle may occur in certain areas cultivated with autumn crops, and there may occur 'bare-root of plants'⁵ and, if after that, there is registered an intense cooling or warming, crops might be damaged. *The monthly maximum temperatures at the ground level* were mostly registered on the 26th and the 27th of February and varied between 17.9°C at Apa Neagră and 28.9°C at Dr. Tr. Severin, while their mean value for the entire region was 21.5°C.

⁵ The term of *bare-root of plants* induced by the freeze-thaw cycle refers to the physical process of soil removal from the plant roots, thus the roots remaining exposed; consequently, there is an increased risk of frost bite in case of intense cold or dryness in case of warming, which makes it a dangerous process for autumn crops.

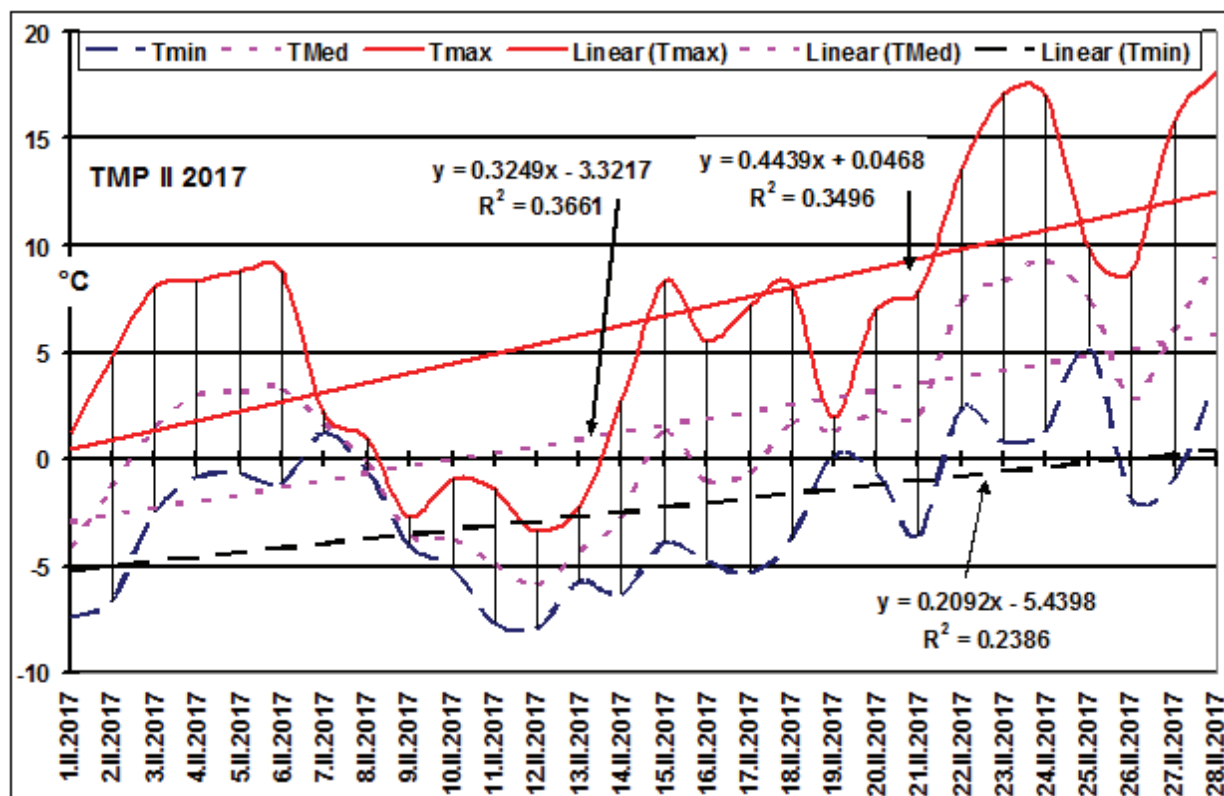


Figure 5. Variation of air temperature (daily minimum, mean and maximum values) in February 2017.

(Source: Data processed from NMA archive).

3b. The pluviometric regime of February 2017

The monthly precipitation amounts varied between 12.5 l/m² at Caracal and 51.8 l/m² at Apa Neagră, and their percentage deviations compared to the normal values were between -63.8% at Caracal and 3.6% at Craiova, determining the classification of the months from the pluviometric type viewpoint from exceptionally dry (ED) in the extreme south of Oltenia Plain, at Bechet, within Romanați Plain, at Caracal, and within the Getic Piedmont, at Slatina, to normal, on a reduced area in the central part, at Craiova. The mean amount for the entire Oltenia was 26.9 l/m², while the percentage deviation compared to the normal was of -36.5%, which classifies February as a very dry (VD) month. Precipitation amounts significant for crops were registered on the 7th, the 18th and the 19th of February. Except for the mountain area, precipitations were liquid.

4a. General thermal characteristics of winter

The mean seasonal temperatures oscillated between -3.2°C at Voineasa and 0.3°C at Drobeta Turnu Severin, and their deviations compared to the normal values were comprised between -1.0°C within Oltenia Plain, at Bechet, and Băilești, within the Sub-Carpathian Depressions, at Apa Neagră, and 0.1°C in the area of high hills, at Băcleș and on the Olt Valley, at Râmnicu Vâlcea; thus, the winter was thermally classified as cool (Cl) within Oltenia Plain and a small hilly area (Târgu Logrești), within the Subcarpathian Depression, at Apa Neagră, and normal (N), within most of Oltenia (Table 6).

The winter mean temperature for the entire region was -1.4°C and its deviation compared to the normal was of -0.2°C, thus confirming that the winter 2016-2017 was thermally normal (N) for the entire Oltenia.

4b. General pluviometric characteristics of winter

The seasonal precipitation amounts were comprised between 40.2 l/m² on the Olt Valley, at Râmnicu Vâlcea, and 71.8 l/m² within Romanați Plain, at Caracal; the percentage deviations compared to the normal were between -70.9% at Apa Neagră and -33.9% at Caracal, which determined the classification of the winter as excessively dry within most of the region (Table 6). The mean winter precipitation amount for the entire region was 60.3 l/m², and its percentage deviation was of -55.7%, thus, confirming that the winter 2016-2017 was excessively dry for the entire region.

Table 6. *Overall pluviometric and thermal regime of the winter 2016-2017* (Hm = altitude of the meteorological station, W 15-16=mean of the winter 2016-2017 temperature values (°C), NW = normal values of winter temperature (°C), $\Delta = W-N$ = deviations of the mean temperatures compared to normal values (°C) CrH = Hellmann criterion; SW = sum of precipitation amounts for the winter 2016-2017 (l/m²), NW = normal values of winter precipitation amounts (l/m²), $\Delta = S-N$ = deviations compared to the normal (l/m²), $\Delta\%$ = percentage deviations compared to the normal).

	Meteorological Station	Hm	Thermal Regime (°C)				Pluviometric regime (l/m ²)				
			W 16-17	NW	$\Delta=W-N$	CrH	SW	NW	$\Delta=S-N$	$\Delta\%$	CrH
1	Drobeta Turnu Severin	77	0.3	0.4	-0.1	N	56.8	160.5	-103.7	-64.6	ED
2	Calafat	66	-0.5	-0.1	-0.4	N	67.3	123.9	-56.6	-45.7	ED
3	Bechet	65	-1.6	-0.6	-1.0	CO	61.7	104.6	-42.9	-41.0	VD
4	Băilești	56	-1.7	-0.7	-1.0	CO	65.4	121.4	-56.0	-46.1	ED
5	Caracal	112	-1.8	-1.2	-0.6	CO	71.8	108.7	-36.9	-33.9	VD
6	Craiova	190	-1.4	-1.0	-0.4	N	69.0	109.7	-40.7	-37.1	VD
7	Slatina	165	-1.5	-0.8	-0.7	CO	59.0	117.2	-58.2	-49.7	ED
8	Băcleș	309	-1.3	-1.4	0.1	N	-	-	-	-	-
9	Târgu Logrești	262	-2	-1.1	-0.9	CO	55.2	121.7	-66.5	-54.6	ED
10	Drăgășani	280	-0.6	-0.6	0.0	N	45.9	114.1	-68.2	-59.8	ED
11	Apa Neagră	250	-2	-1.0	-1.0	CO	63.8	219.6	-155.8	-70.9	ED
12	Târgu Jiu	210	-1.1	-1.0	-0.1	N	57.0	169.9	-112.9	-66.5	ED
13	Polovragi	546	-1.5	-1.5	0.0	N	46.6	153.4	-106.8	-69.6	ED
14	Râmnicu Vâlcea	243	-0.5	-0.6	0.1	N	40.2	120.1	-79.9	-66.5	ED
15	Voineasa	573	-3.2	-3.0	-0.2	N	-	-	-	-	-
16	Parâng	1585		-5.1			83.9	160.0	-76.1	-47.6	ED
	Mean Oltenia		-1.4	-1.2	-0.2		60.3	136.1	-75.8	-55.7	ED
17	Obârșia Lotrului	1348	-6.8	-5.2	-1.6	CL	101.5	-	-	-	-

(Source: processed data from NMA archive).

DISCUSSIONS

In January, there were registered 25 cold, cool or frost days (80.6% of the month days) during the interval January 7-31; the significant cold waves of this winter were registered during the following intervals: January 7-16 and January 20-29, totaling 20 days (67.7% of the month days). ***The coldest interval of the month and, at the same time, of the winter 2016-2017 was between the 7th and the 10th of January***, when, in many settlements from Oltenia, frost was registered during the day, as well (maximum values did not exceed -10.0°C), and the mean of the daily maximum temperatures calculated for the entire Oltenia varied between -8.5°C (on the 9th of January) and -8.1°C (on the 7th and the 10th of January). The coldest morning was on the 10th of January, when there were also registered the lowest minimum temperatures of the winter and the thermal minimum value of the entire winter, namely -25.4°C at Tg. Logrești. This value is the third lowest temperature of January for this station since determinations have been made and ***it characterizes the intensity of the cold wave within Oltenia***. In the same morning, the lowest temperature in the country was -31.0°C, at Întorsura Buzăului, which ***characterizes the intensity of the cold wave in Romania***. There were registered casualties and damages as a consequence of frost and the price of fruit and vegetables increased. As the frost affected almost the entire Europe, most of the south-east of Europe was also affected by an energy crisis. We further render some press releases: 'On the 12th of January 2017, the Ministry of Energy, during a Government Meeting, made an analysis regarding the functioning of the National Energy System (NES), due to the six peak winter days, marked by historical consumption of natural gas and electric power. In the presented analysis, the minister referred to certain data regarding the state of the National Energy System, weather forecasts and evolution of fuel stocks. On the 11th of January 2017, Transelectrica, the transport and system operator, officially notified the Ministry of Energy, the Minister of Economy and ANRE with regard to the imminent crisis in the functioning of NES, motivated by:

- Weather forecasts, which indicate a new interval characterized by severe weather in the next period (January 17– 20, 2017)
- The electric power deficit induced by the Danube low flow, which decreased to a minimum unprecedented in recent years (about 1,800 m³/s).
- Reduction of the water reserves of the large reservoirs due to their use to balance the system;
- The significant deficit of electric power in the south-east of Europe due to the cold wave affecting the region starting with the 6th of January 2017.
- Large consumption of natural gas (on an average, more than 70 million m³/day) and electric power (more than 9,500 MW during the peak hours, starting with the 9th of January 2017, and a maximum of 9,730 MW on the 10th of January 2017, between 6 and 7 p.m.).
- Impairment of renewable sources of electric power, particularly wind farms.
- Difficulty of ensuring the coal supply due to transportation problems.
- Impact of malfunctions upon the production capacity of some energetic groups."

The decision to limit the consumption of electric power and gas, as well as energy exports, etc. was adopted by Law 123/2012, art. 24, which transposes the European Directive 2009/72/CE in the Romanian legislation. Article 42 of the Directive, crisis situations on the energy market in the next period (the 16th of January – the 15th of February 2017).

(http://www.economica.net/romania-se-pregatesste-pentru-limitarea-consumului-de-energie-electrica_131596.html#n).

The synoptic causes of the most extended and intense cold wave of the January 2017

The advection of cold air (arctic air mass (A)) above Europe started on the 5th of January 2017, 00 UTC, and was induced by a vast blocking circulation that persisted until the end of the month. Initially, the Carpathians played a blocking role for the cold air that stationed above Transylvania for two days, but then surpassed the mountains and reached Oltenia from the east and north-east, but also from the west, along the Danube Valley. Afterwards, on the 8th of January, at 6 p.m., a vast nucleus of extremely cold air, with temperatures of -20...-15°C at the 850 hPa level (about 1500 m) separated above South-Eastern Europe (including Romania), and, in spite of the fact it was not 'supplied' by cold arctic area from the polar zone, it continues to get colder. The cooling was favoured by the presence of a consistent snow cover, accumulated due to the heavy snowfall from the interval January 5-11, the thermal radiation registered during the long January nights, which, in the first part of the month, are of 15 hours (14 hours and 53 minutes on the 10th of January).

This nucleus of cold air slowly moved southwards above the Balkan Peninsula and, then, north-eastwards. The thermal inversion determined the positioning of this extremely cold air with temperatures of -31.0°C to -15.0°C at the ground level, at 0-2 m level.

In Fig. 6, it is rendered the vast atmospheric blockage positioned above Europe on the 9th of January 2017, 12 UTC. At the ground level, above the Balkan Peninsula, the east of the Black Sea and Asia Minor Peninsula, it can be noticed a weak cyclonic field, below 1015 mb, originating in the Mediterranean Cyclone, that generated the snowfalls from the interval January 6-9 and that, due to atmospheric circulation, naturally positioned here. The north of the continent was dominated by vast cyclonic field of Icelandic origin (delimited by the 1015 mb isobar). Between these, there was the western part of the anticyclone belt generated by the coupling of the Azores Anticyclone and the East European Anticyclone above Central and Western Europe (Voeikov ridge⁶). For Eastern Europe, this location of the baric centres represents a real mechanism of continuous transportation of the extremely cold air of arctic origin from Siberia above the Russian Plain in the lower troposphere. At altitude, at the 500 hPa level (the level of nondivergence of the atmosphere), where airflow is free (uninfluenced by the unevenness of the terrestrial surface), it can be noticed a vast blocking circulation (the 552 dampp isohypse had the shape of the letter 'Ω'). In these conditions, the extremely cold arctic air from northern latitudes is transported by the atmospheric circulation above the south and south-east of Europe.

The massive advection of arctic cold air above the East and South-East Europe is well emphasized by the synoptic situation at the 850 hPa level registered on the 8th of January 2017, 00 UTC (Fig. 7).

At this level, it can be observed the atmospheric blocking circulation, the advection of the extremely cold air with temperatures of -20.0°C, above South-East Europe, the blockage of the cold air firstly induced by the Carpathians, when Oltenia and Muntenia remained under the dominance of an air mass with higher temperatures (-10.0°C), and then the penetration of the extremely cold air above this territory from two directions, west and north-east. At the same time, above the Atlantic Ocean and Western Europe, it can be observed a massive advection of warm air, favoured by the Gulf Stream, which reached the south of the Scandinavian Peninsula. This type of atmospheric circulation is very stable as it is supported by the Earth rotation and Coriolis force that deviates the cold air on a north-eastern trajectory, bringing it from the polar region and Siberia above Europe.

Consequently, these dynamic and thermal causes contributed to the maintenance, with certain variations, of this type of atmospheric circulation during the interval January 8 – February 2, 2017, which determined this cold January episode.

The synoptic conditions for the most extended and intense warm air wave of the winter 2016-2017

Starting with the 2nd of February 2017, weather gradually got warmer, which led to the thaw of the snow cover, soil thaw, start of the vegetation period for autumn crops and initiated and sustained the process of spring arrival¹² (12: **Spring arrival** is the long-lasting climatic process that determines the gradual increase of air and soil temperature starting with February until the 10th of April (Fig. 8).

The process is complex and mainly generated by the variation in the geometry Earth-Sun that determines the increase of the day length, thus increasing the amount of heat received by the northern hemisphere from the Sun; consequently, there occur important modifications of the atmospheric circulation and increase of the frequency and intensity of warm air advections from the south and south-west. The process is evaluated by means of the **spring arrival index** = \sum of daily mean positive temperatures from the interval February 1 – April 10).

In the interval February 21 – March 9, 2017, there occurred a heat wave of 17 days, which reached the maximum intensity on the 28th of February (according to its extension and temperature values at the 850 hPa level). We will further briefly analyse the causes and dynamics of this heat wave that determined alternant climatic evolutions during the winter.

⁶ The Russian-Siberian Anticyclone is called in certain climatology books the Asiatic Anticyclone. The East-European Anticyclone was treated by the Romanian researcher Ecaterina Ioan Bordei. In climatological works (especially Russian ones) the belt of high pressure uniting the Azoric Anticyclone with the Siberian one is called the **Voeikov ridge**. Other notions bearing the name Voeikov: **Axis of Voeikov** – axis of the high pressure ridge on climatological maps joining in winter the Azoric Anticyclone to the Siberian one. It was discovered by the Russian climatologist A. I. Voeikov. **Variant: Axis of Voeikov** – line separating the E and NE winds from the W and SW winds. **Variant: Axis of Voeikov** – axis of the baric ridge formed by joining the W flank of the Siberian Anticyclone with the E flank of the Azoric Anticyclone, as a consequence the cold and dry air masses of Siberia (cPk+A) advance towards Western Europe, considerably lowering the ground temperatures.

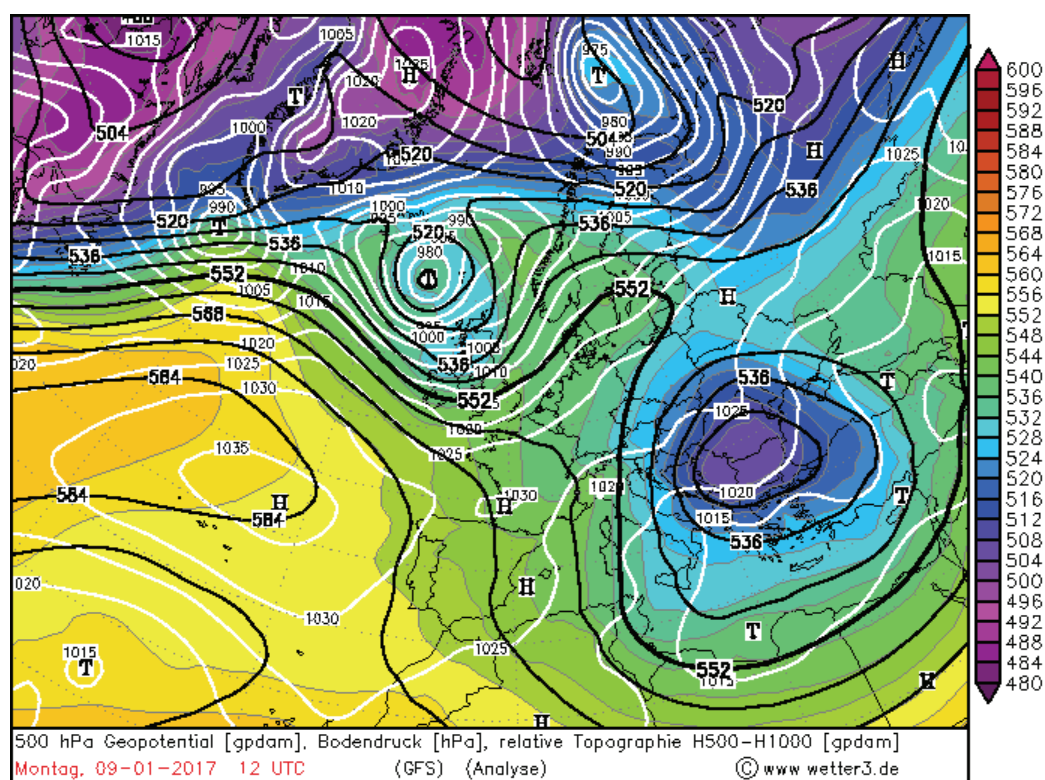


Figure 6. Synoptic situation at ground level (pressure field, white isohypses), superposed on altitude baric topography at the level of 500 hPa (about 5000 m altitude, geopotential field, black thick isohypses) and relative topography TR 500/1000, black thin isohypses (these are equivalent to the mean isotherms of the air comprised between 1000 hPa and 500 hPa), on the 9th of January 2017, 12 UTC.

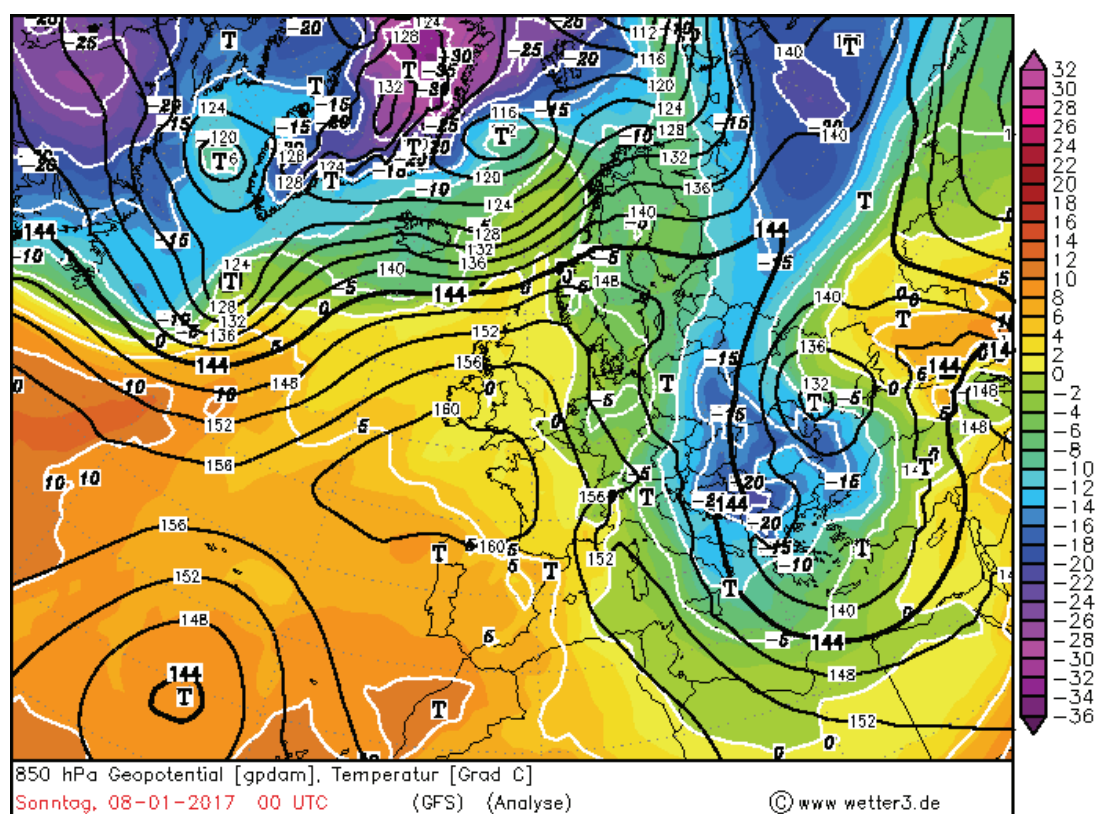


Figure 7. The geopotential field (black thick isohypses, the thermal field – white isohypses (°C)) and the thermal field at the 850 hPa level, on the 8th of January 2017, 00 UTC.

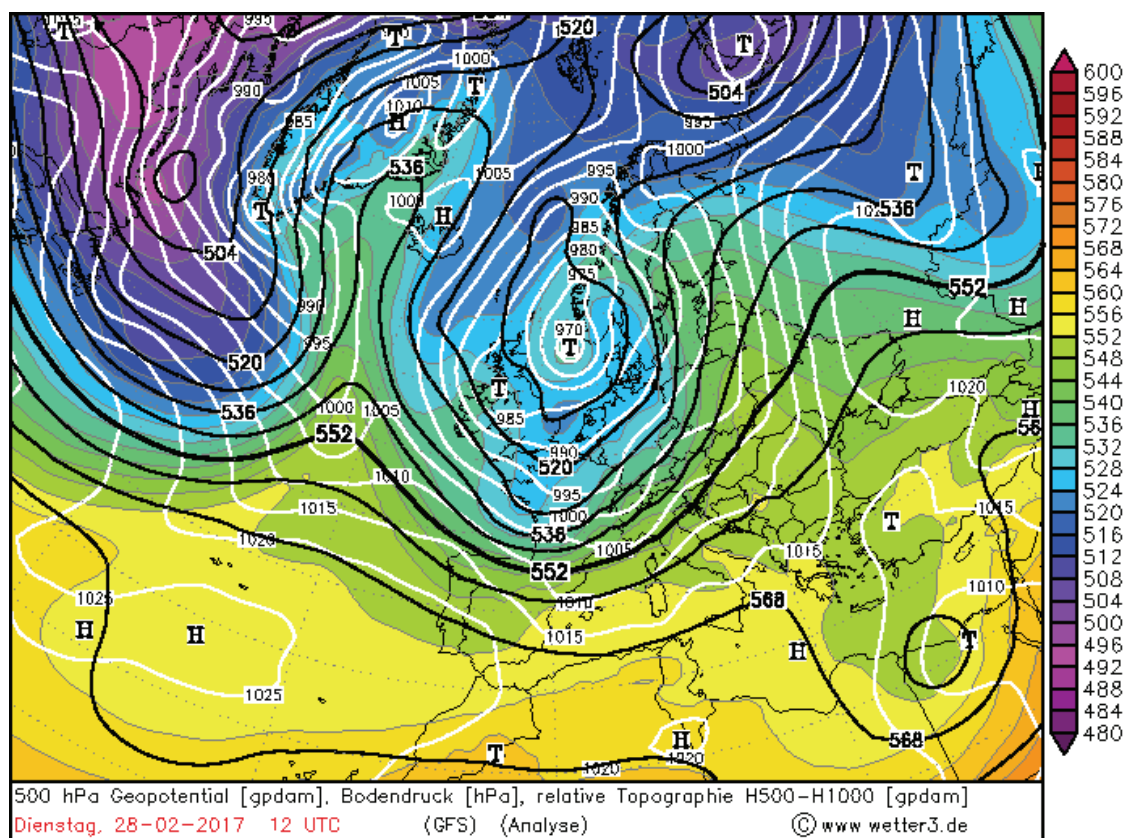


Figure 8. The synoptic situation at the ground level (pressure field, white isohypses), superposed on the synoptic situation at 500 hPa level (about 5000 m altitude, geopotential field, black thick isohypses) and relative topography TR 500/1000, black thin isohypses (these are equivalent to the mean isotherms from the air layer between the 1000 hPa and 500 hPa levels), on the 28th of February 2017, 12 UTC.

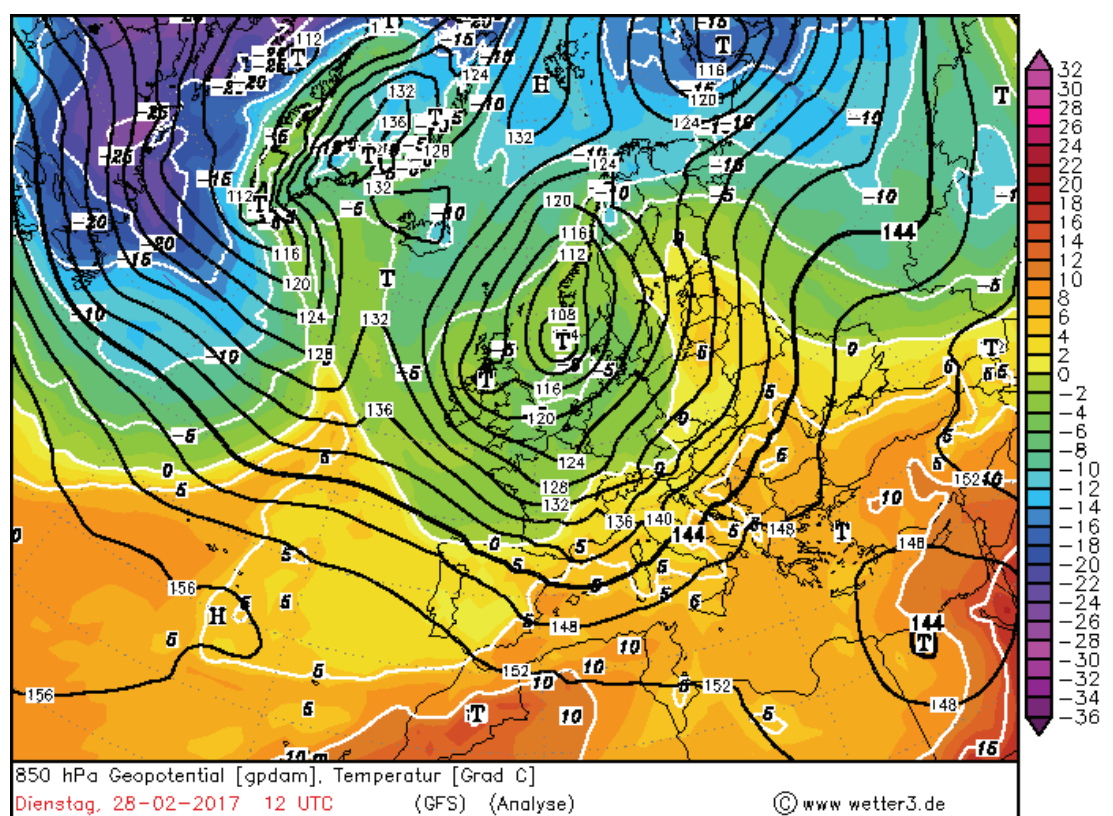


Figure 9. The geopotential field (black thick isohypses, thermal field white isohypses (°C)) and the thermal field at 850 hPa level, on the 28th of February 2017, 12 UTC.

The synoptic situation from the 28th of February 2017, 12 UTC, in the medium and upper troposphere (500 hPa level, about 5000 m), is dominated by a blocking circulation above the Atlantic Ocean (shape of 'Ω' letter of the 520 dampp isohypse), while in front of this blockage, above a vast surface of Europe, there developed and maintained a tropical south-western circulation (Fig. 9). At the ground level, above Eastern Europe, it can be noticed the East-European Anticyclone (that triggered the cold waves from January) that gradually withdrew eastwards during February leaving space for warm air advections. Northern Europe but also a large part of Central Europe was dominated by the vast Icelandic Low with values below 970 hPa at the centre, while the extreme west of Europe was dominated by the Azoric Anticyclone centred above the Atlantic Ocean. This situation of typical tropical circulation is quite stable in time and, in the last years, it also determined early and more intense heat waves. At the 850 hPa level, it can be noticed the massive advection of warm air that exceeded the Arctic Circle (60° N), reaching the north of the Gulf of Bothnia. Above Romania, the air mass at this altitude (about 1500 m) had temperatures between 5 and 8° C, while at the ground level, the maximum values registered in Oltenia on the 28th of February varied between 16.5°C within Polovragi and Apa Neagră Sub-Carpathian Depressions and 19.5°C at Bechet. In Oltenia, the maximum temperature of February 2017 was 20.9°C, registered at Bechet on the 24th, value determined not only by the warm air advection, but also by the cloud cover and wind values registered during that day. An even higher value was registered on the 1st of March at Bechet, namely 22.4°C.

CONCLUSIONS

The winter 2016-2017 was marked by a particular climatic variability induced by an even more obvious variability in the northern hemisphere, including Europe. However, in Oltenia, the winter was normal, a characteristic based on the mean of the temperatures of a normal (N) month (December 2016), a cold (C) month (January 2017) and a warm (W) month (February 2017). The soil maintained frozen between the 8th of January and the 3rd of February, and, in the northern part of the region, crop protection against frost was poor as the snow cover was thin or even not present in certain areas. The frost registered in January provoked casualties and damages and determined an energy crisis both in Romania and a large part of Eastern Europe. The short interval of only three days (January 17-19) between the cold waves made us consider that cold and frost occurred almost continuously for 20 days in January. All these emphasize that, in winter, there still *is a high risk of occurrence of cold waves* although global warming continued even if solar activity was at its minimum. Therefore, we conclude that the preparation at national level for passing over winter should be carefully and thoroughly made, taking into account all the possibilities for energy production and supply. Although there were two cold waves lasting for 20 days, spring arrival was early and the vegetation of crops and habitats reactivation occurred in the first days of February. Migratory birds arrived early, starting with the 30th of January, due to the appearance of the heat wave developed over Europe beginning with February. The winter of 2016-2017 was excessively droughty (ED), but due to the rainy autumn, as well as the winter season precipitation and the snow layer, the soil water reserve in the 0-100 cm layer was optimal. As the weather warming progressed in February and March, on the 8th of March 2017, the water reserve in the soil was low for the largest part of Oltenia and a moderately pedological drought ("edaphic drought") was registered (according to the NAM website). Increased climate variability is the direct consequence of global warming. Although some authors speak about 'climate patterns', in our view, there are only general patterns caused by the cyclicity of seasons, which will always keep, in particular because of the geometry Earth-Sun.

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Received: March 21, 2017
Accepted: June 5, 2017

ASSESSMENT OF HUMAN IMPACT ON ENVIRONMENTAL QUALITY OF METROPOLITAN AREAS. CASE STUDY – CRAIOVA METROPOLITAN AREA

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Abstract. The paper is concerned with the establishing a methodology for the analysis of landscape transformation in metropolitan areas due to human activities such as agriculture and industry (oil extraction industry) through the application of a set of indicators meant to assess the landscape transformations. Human pressure on the environment is evaluated through the use of agricultural land, the index of naturalness of modified landscape, index of naturalness and landscape transformation index. The results are calculated for the metropolitan area of Craiova in order to assess the environmental quality. This type of evaluation can be evaluated by local authorities for urban planning in the perspective of urban sprawl and development.

Keywords: Craiova metropolitan area, environment, landscape, indicators, human pressure.

Rezumat. Evaluarea impactului activităților umane asupra calității mediului din zonele metropolitane. Studiu de caz – Aria metropolitană Craiova. Lucrarea de față propune o metodologie de analiză a transformării peisajului în ariile metropolitane sub impactul activităților umane cum ar fi agricultura și industria (extracția petrolului), prin aplicarea unui set de indicatori mențiți să evalueze transformarea peisajului. Presiunea umană asupra mediului este evaluată prin utilizarea terenului agricol, indicele de naturalitate și indicele de transformare a peisajului. Rezultatele au fost calculate pentru aria metropolitană Craiova în scopul evaluării calității mediului. Acest tip de evaluare poate fi valorificat de către autoritățile locale pentru planificarea urbană în perspectiva dezvoltării zonei metropolitane.

Cuvinte cheie: arie metropolitană Craiova, mediu, peisaj, indicatori, presiune umană.

INTRODUCTION

The metropolitan area of a city represents a critical space where land-use conflicts can contribute to the degradation of environmental quality. There are to be mentioned studies of PĂTROESCU et al., 2009 regarding metropolitan area of Bucharest, PĂTRU-STUPARIU (2012) with the structural modeling and functional landscapes but also ANTROP (2004) with the urbanization process in Europe and Landscape changes, BOTEQUILHA LEITAO & AHERN (2002) with landscape ecological concepts and metrics in sustainable landscape planning. There must be mentioned that standardized indexes for the assessment of the environmental quality were mainly used for landscape changes analysis within non metropolitan areas, such as landscape transformation in managed forested areas (LÖFMAN & KOUKI, 2001).

STUDY AREA

The present paper is a case-study of Craiova metropolitan area, which is situated in the south-western part of Romania and which is one of the most important metropolitan areas in the South-Western Region of Oltenia. It has been settled by the association of Craiova municipality with 21 administrative units and two towns namely, Segarcea and Filași, since 2008 (MARINESCU, 2006). The metropolitan area of Craiova has a total area of 149,862 hectares, which represents almost 20% of the total area of the county (Fig. 1). The metropolitan area is constituted by the association of voluntarily partnership between the great urban areas and urban and rural settlements, which developed multiple purpose cooperation relationships (Fig. 2).

MATERIALS AND METHODS

Agriculture (cereals, crop plants for industrial end uses and vegetable crops) and industry represent the most important sources for land use conflicts and environmental pollution. They have a direct negative impact on landscapes quality through the degradation or even destruction of natural ecosystems (MUNTEAN, 2005). The scientific research is based on statistical data for Dolj County (INSSE. RO 2014).

It was calculated the **human pressure on environment (P)** by taking into account the type of use of agricultural land. The way lands are used can induce a specific environmental pressure. For its calculation there has been used the formulae used by FAO.

$$P = S/N [1]$$

where

P = human pressure (ha/ inh.);

S = analyzed surface (ha);

N = number of inhabitants within the analyzed perimeter (inh.);

There was also calculated the **index of naturalness of modified landscape (Nat)** by the use of the following formulae:

$$\text{Nat} = (F + M)/S \times 100 \text{ [2]}$$

where

Nat = index of naturalness

F = forested surface

M = surface of meadows

S = total surface

Environmental transformation index (Etr) was used for the first time by Maruszczak in 1988 in Poland and applied by Pietrzak in 1998 for the evaluation of the human impact on the pre-Carpathian landscape from Poland, as the ratio between forest, meadows and built surface.

$$\text{Etr} = F+M/B \text{ [3]}$$

Where:

Etr = environmental transformation index

F = forested surface

M = surface of meadows

B = built area

Absolute Naturalness Index (Nabs) was the last to be analyzed. It is the ratio between forested surface and total surface of the territorial unit of reference.

$$\text{N abs} = F/S \text{ [4]}$$

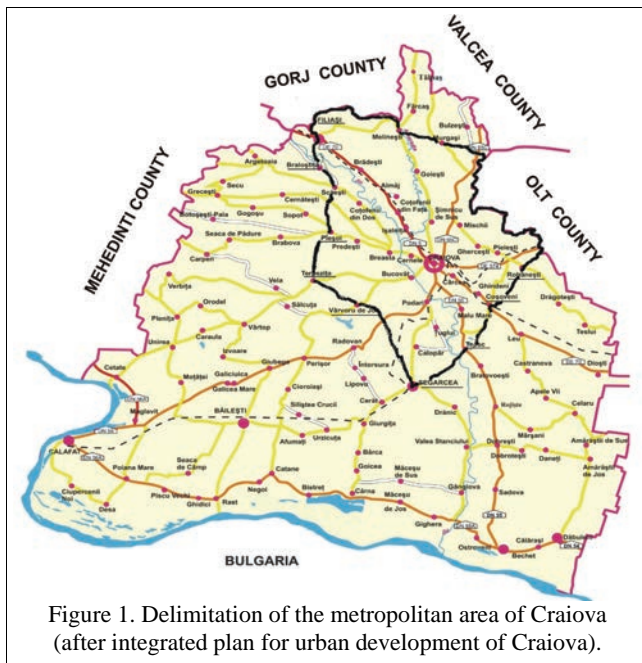


Figure 1. Delimitation of the metropolitan area of Craiova (after integrated plan for urban development of Craiova).

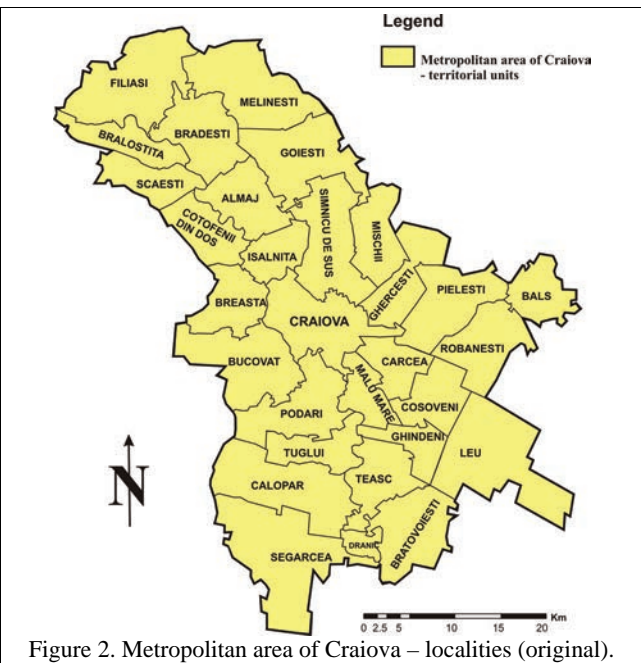


Figure 2. Metropolitan area of Craiova – localities (original).

RESULTS AND DISSCUSIONS

Adaptation of **human pressure on environment (P)** index to the metropolitan area of Craiova points out a significantly increase of human pressure on the environment through the agricultural use of lands. These types of changes are influenced by a range of factors such as:

- numerical growth of the population
- the increase of agricultural surface by including flooded areas from the alluvial plain of the Jiu or sandy lands in the agricultural circuit, through the plantation of adapted agricultural crops such as vineyards, tobacco, melons, etc.;

The calculated values reveal that the administrative units situated in the eastern part of the metropolitan area (Mischii, Ghercești) present values of the human pressure index over the average (1.7 ha/inh. – 2.1 ha/inh.) (Fig. 3). One main cause of these high values may be generated by the human pressure on agricultural surface, with a small percent of land per capita (PĂTROESCU, 2000). Another cause is food industry (mill-bakery), due to extended surfaces planted with wheat and rye (Ghercești) and maize (Mischii).

The maximum values are recorded for Ghercești commune (2.8 ha/inh.) and the minimal value for Ișalnița Commune (0.3 ha/inh.). In Romania, the average value of the index is 0.68 ha/inh., while the county average ranges between 0.5 and 1.4 ha/inh. (PĂTROESCU, 1983). The first category (0.5- 1.0 ha/inh.) indicates territories classified to the limit of environmental equilibrium of natural elements of landscape (Fig. 4).

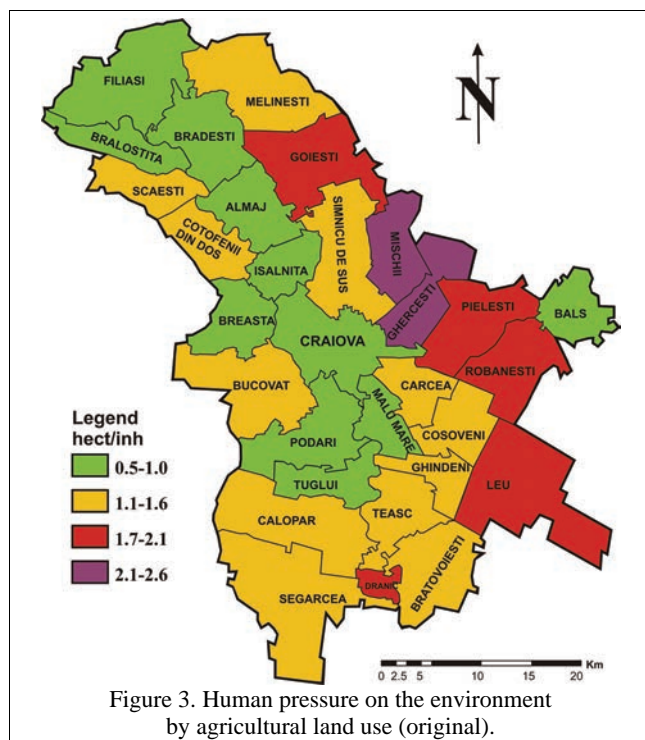


Figure 3. Human pressure on the environment by agricultural land use (original).

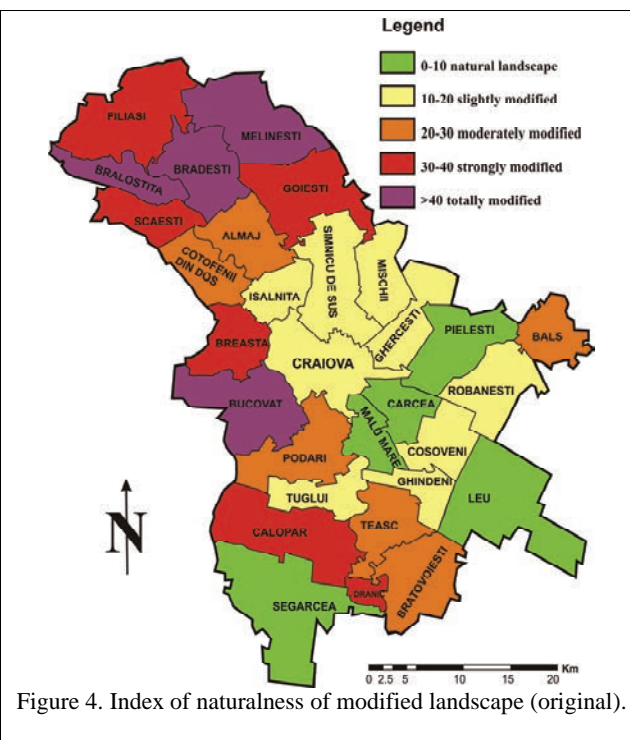


Figure 4. Index of naturalness of modified landscape (original).

The second category (1.1-1.6 ha/inh.) indicates rural moderate landscape modifications and feebly modified landscapes, which are characterized by an alternance of cultivated surfaces and different land use (built surface, forest patches). Values of 1.7-2.1 ha/inh. indicate strongly modified surfaces, which are exclusively used for agriculture with scarce forest patches. Last category (2.1-2.6 ha/inh) indicates most strongly modified landscapes with areas used exclusively for agricultural purpose.

The index of naturalness of the landscape indicates the extent of human intervention within a territorial unit. It has been applied to the study and indicated mixed areas of natural landscapes (Segarcea, Leu) but also completely modified landscapes (Melinești, Brădești) (Fig. 4).

The environmental transformation index reflects the environment transformation degree, in this case the metropolitan area of Craiova (Figs. 5; 6).

Totally affected landscape is recorded in the communes situated in the eastern and south-eastern parts. The maximum value is recorded at Cârcea, which confronts in the present with an increasing demand for plots of land for the development of residential buildings and economic purpose.

The main urban expansion is recorded eastward and south-eastward. Westward expansion is limited by the existence of the natural barrier of the Jiu River. Another cause of totally affected landscape is due to the reduced surface of forests (Segarcea, Leu), which records far below 100 hectares, as compared to the other communes such as Bucovăț, Melinești, which own large forested areas (over 2000 ha).

Values less than 1 indicate a strong anthropization, while values greater than 1 indicate the dominance of the natural elements (PĂTRU-STUPARIU, 2012). The last analyzed indicator is the index of naturalness, which represents the ratio between the forest area and total area; to be mentioned in this indicator, it is reported the presence of forest in the study area, and not the natural state of forest.

Adaptation of this to the analyzed space presents obvious failure on the proportion of forests; there are areas with a very strongly affected landscape: Craiova and the majority of communes situated in its proximity (Cârcea, Ișalnița, Podari). The main cause of this situation is the presence of anthropogenic elements (Fig. 6).

Another cause, designated as the main problem in the analyzed area, is from the perspective of natural area, the very small percentage of the forest area (11.5 % of total surface), well below the national (28.3%) and regional (29.5 %) average (SDES Dolj, 2014), which emphasizes the risk of climate change and desertification, especially in the south of the county, where there are very strongly affected landscape respectively at the limit of ecological equilibrium (Podari, Țui, Teasc communes with a predominant agricultural land use). Places with a deficit of forested areas (<10%) are: Segarcea, Leu, Ghercești (under 100 ha each one), which has a strong agricultural profile.

By contrast, large forested areas are found in the hilly area of the metropolitan area: Calopăr, Bucovăț, Melinești, with values recording slightly affected landscape, respectively landscape with relative established ecological equilibrium (here, forest area covers more than 2000 ha.).

The Forestry Department Craiova proceeds programs of afforestation yearly, on almost 400 hectares of full afforestation and 200 hectares by natural regeneration; also at the county level there are plans for arrangement of about 500 ha of forest plantations to protect forest land and settlements.

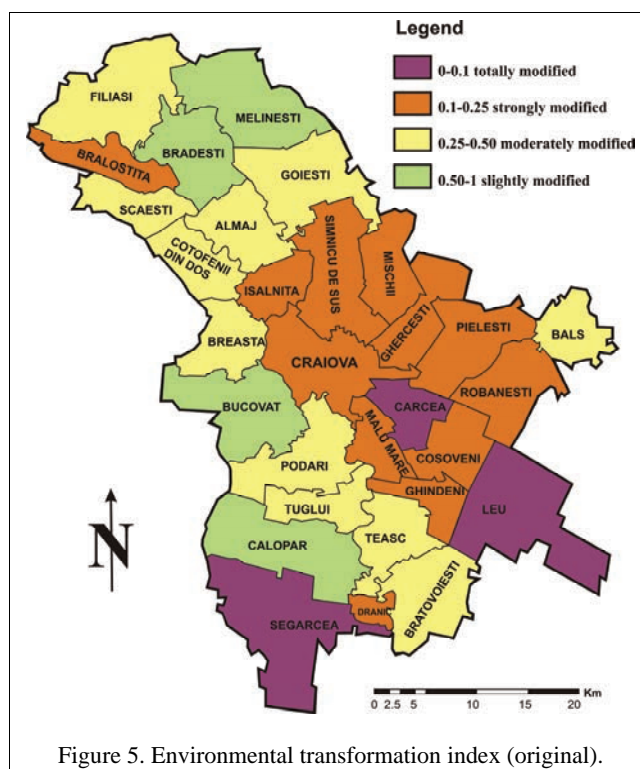


Figure 5. Environmental transformation index (original).

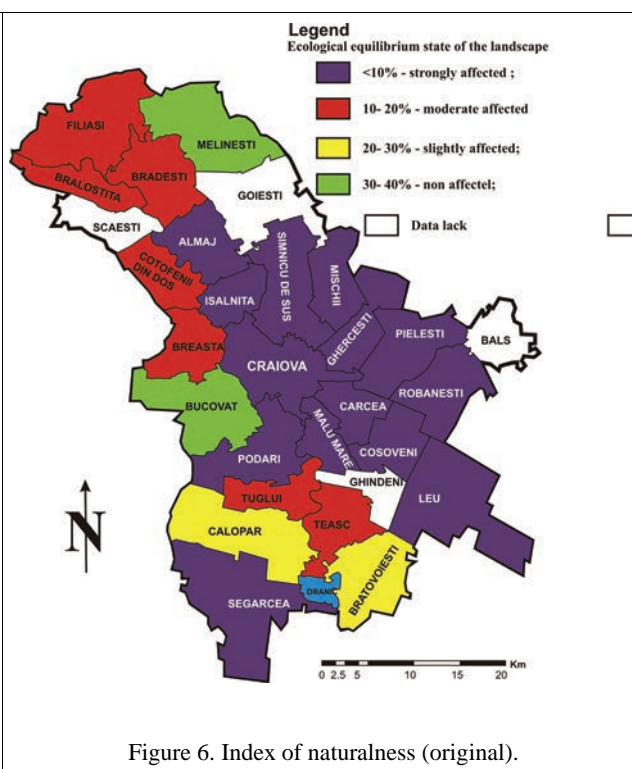


Figure 6. Index of naturalness (original).

CONCLUSIONS

Over time, the analyzed landscape confronted with a number of changes: economic, demographic, and especially ecological, imposed by the society development, changes which mostly had negative effects on the environment.

The landscapes analysis of the metropolitan area Craiova by the use of environmental assessment indices allowed us to identify strongly affected landscape and totally affected landscape largely present within the analyzed perimeter. Thus, there were indicated “hotspots” in this regard, such as: the northern zone of the metropolitan area characterized by strongly and totally modified landscapes. The main cause was industrial and industry, with direct effect on natural ecosystem.

Another strongly affected environment is in the eastern and south-eastern parts of the analysed area. In this area, urban expansion with its implications was the main unleash factor. By contrast, in the western and north-western part of the metropolitan area, the main cause is the natural barrier of urban spreading left to the Jiu River.

For a more detailed analysis of the projection of human activities in the quality of the environmental state of the metropolitan area of Craiova, we suggest additional indicators for assessing the natural landscape transformation: the general index capitalization of agricultural land, use intensity (CSI) and density of population.

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Received: March 31, 2017

Accepted: June 23, 2017

CHARACTERIZATION OF WATERS AND SEDIMENTS FROM LACUSTRINE COMPLEX ADUNAȚII OF GEORMANE

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Abstract. The purpose of this paper is to evaluate the quality of water and sediment in Lacustrine Complex Adunații of Geormane under the influence of anthropogenic factors in order to understand the complex processes taking place in these habitats, in order to develop strategies for rehabilitation and conservation of the affected aquatic ecosystems. Seasonal samples of water and sediment were taken from various points of the lacustrine complex represented by Victoria Lake and Marica Pond, respectively the shore areas (the head and tail of the lacustrine ecosystems) and the central ones. A number of physicochemical and enzymatic analyses were made. Thus, the pH of the water of Victoria Lake was 8.24 to 8.54 units, fixed residue 322.7 g/l and chloride 87.2 g/l. The hardness of Victoria and Marica lakes varies between 10.66 degrees Ge and 18.74 degrees Ge. The eutrophic Victoria Lake has a *chlorophyll* content 8 to 25 µg/l. These are intended to highlight the functional diversity of the microbiota involved in biogeochemical cycles in these media (water, sediment). Enzymatic activity records large variations, depending on the nature of the studied enzyme, sampling point, environment, season, main pollutants of the lake, and physico-chemical characteristics of the water. Dehydrogenase activity of sediments shows relatively low seasonal fluctuations; the minimum value was 0.23 µg formazan / 1 g sludge (dry matter) and phosphatase activity is moderate in Marica pond, the minimum phosphatase being 73.5 µg phenol / g sludge. Victoria Lake has an intense catalase activity of 2.30 mg H₂O₂ / g sludge. The knowledge of the intensity of the enzymatic activity represents a new method of research within the framework of water protection programs, which allows the characterization of the impurity degree of an aquatic ecosystem and offers the possibility to forecast the evolution in time, respectively quality maintaining.

Keywords: lacustrine ecosystems, sediments, physico-chemical analyses, enzymes.

Rezumat. Caracterizarea apelor și sedimentelor din Complexul Lacustru Adunații de Geormane. Scopul lucrării de față îl constituie evaluarea calității apei și sedimentului din Complexul Lacustru Adunații de Geormane sub influența factorilor antropici în vederea înțelegerii proceselor complexe care au loc în aceste habitate, în scopul elaborării unor strategii de reabilitare și conservare a ecosistemelor acvatice afectate. Au fost prelevate sezonier probele de apă și sediment din diferite puncte ale complexului lacustru reprezentat de lacul Victoria și balta Marica, respectiv zonele litorale (capul și coada ecosistemelor lacustre) și centrale. Au fost determinate o serie de analize fizico-chimice și enzimatice. Astfel, pH-ul în apa lacului Victoria a fost de 8,24 - 8,54 unități, reziduu fix 322,7 g/l și clorurile 87,2 g/l. Durețea în cazul lacurilor Victoria și Marica variază între 10,66 grade Ge și 18,74 grade Ge. Lacul eutrof Victoria are un conținut de *clorofilă a* cuprins între 8 - 25 µg/l. Acestea au rolul de a evidenția diversitatea funcțională a microbiotei implicate în ciclurile biogeochimice din aceste medii (apă, sediment). Activitatea enzimatică înregistrează variații mari, dependente de natura enzimelor studiate, de punctul de prelevare a probelor, de mediu, de anotimp, de principalii poluanți ai lacului, cât și de caracteristicile fizico-chimice ale apei. Activitatea dehidrogenazică a sedimentelor prezintă fluctuații sezoniere relativ scăzute, valoarea minimă înregistrată a fost de 0,23 µg formazan / 1 g nămol (substanță uscată), iar activitatea fosfatazică este moderată în balta Marica, valoarea minimă a fosfatazei fiind de 73,5 µg fenol / g nămol. Lacul Victoria prezintă o activitate catalazică intensă de 2,30 mg H₂O₂ / g nămol. Cunoașterea intensității activității enzimatice reprezintă o nouă metodă de cercetare în cadrul programelor de protecție a apelor, acestea permițând caracterizarea gradului de impuritate al unui ecosistem acvatic și posibilitatea de a prognoza evoluția în timp, respectiv menținerea calității.

Keywords: ecosisteme lacustre, sedimente, analize fizico-chimice, enzime.

INTRODUCTION

The protected area of national interest Lacustrine Complex Adunații of Geormane (code: 2393) is located in a plain area within the hydrographical basin of the Jiu River and it extends to the territory of Bratovoști and Teasc settlements, being part of the wetland category. This zone is characterized by the presence of lake ecosystems, such as Marica Pond and Victoria Lake, which have adjacent wetlands.

Victoria Lake is located on the upper left terrace of the Jiu, called Rojiștea terrace, at about 25 km south of Craiova, in Oltenia Plain. This lake forms an isolated biological unit linked to the Jiu through a canal for the surplus water discharge through Marica Pond (MARX, 1982) (Fig. 1).

The soils in this Protected Natural Area of National Interest are sandy, with a low humus content, which makes them vulnerable to erosion caused by surface water. In order to prevent or reduce erosion effect of the shores, it is recommended to plant native tree species to maintain their integrity.

The clogging of Marica Pond and Victoria Lake is closely related to erosion and natural eutrophication. Thus, by their combined actions, they can contribute to the increase of the sediment load of the lakes; they can favor the excessive development of the vegetation and can lead to the reduction of the surface of the water. Natural eutrophication occurs as a result of their organic load and is particularly evident during summer, when high nutrient concentrations in water also increase. The accumulation of organic mass, increased amounts of nutrients such as nitrogen and phosphorus, lead to the abundant development of various microorganisms, which consume large amounts of oxygen in the water.

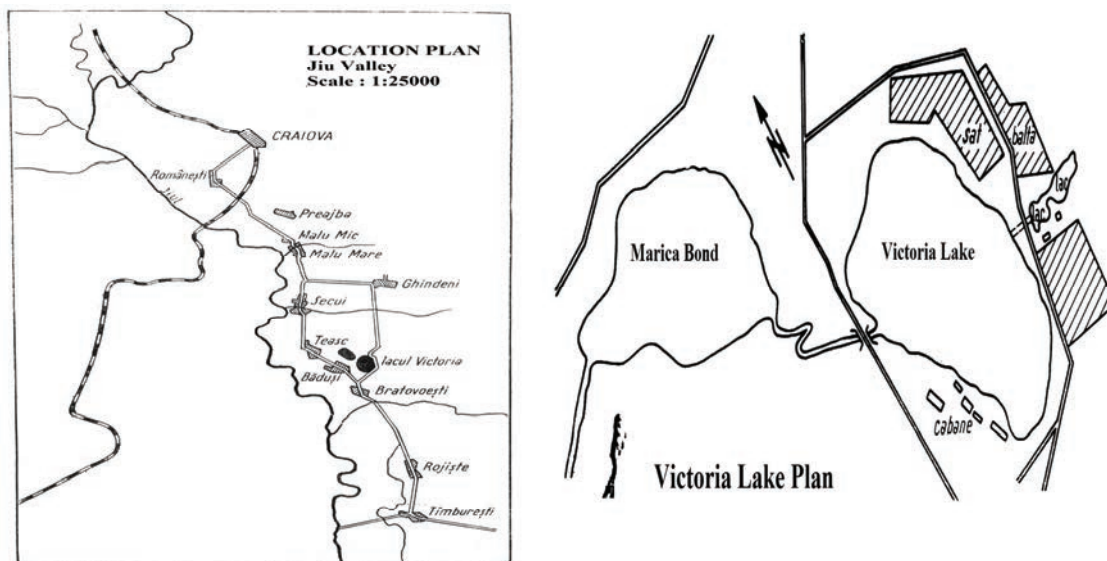


Figure 1. Victoria Lake and Marica Pond in the lacustrine complex (after MARX, 1982).

The human settlements in the vicinity of the protected natural area do not have a proper wastewater collection and treatment system; thus, wastewater can end up through the percolation process or surface drainage in Victoria Lake, contributing to the decrease of the water quality. In order to minimize the effects of this pressure, it is necessary to implement projects aimed at the provision of localities with a unitary collection system for household wastewaters, as well as adequate treatment. This form of the impact was considered as a pressure on the protected natural area as a result of the observations made on the site: the localities and the configuration of adjacent lands. The diffuse pollution is caused by agricultural and forestry activities.

This lacustrine complex is located in a region where the main activity of the locals is represented by agriculture. As a result of the use of fertilizers and pesticides in agriculture, through percolation or drainage, they can reach the water of Victoria Lake and Marica Pond, contributing to the decrease of water quality. The decrease of the water quality will impact on all fauna species, directly on fish, amphibians or turtles, as well as indirectly by reducing food resources or the degradation of feeding and resting habitats of mammalian species. These lakes are occupied with paludous macrophytes: *Phragmites communis*, *Typha angustifolia*, *Scirpus lacustris*, *Carex riparia* and aquatic: *Lemna minor*, *Polygonum amphibium*, *Salvinia natans*, *Ceratophyllum submersum*, *Myriophyllum spicatum*. Zoocenoses, both planktonic and benthic, are typically stagnant.

GIANFREDA & BOLLAGE (1996) considers that sediments contain three major components: detritus material derived as a result of erosion, biogenic material formed by biological productivity and autogenous material formed *in situ*. The final character of the sediment is given by the relative proportion of these components.

The sediments are extremely heterogeneous systems where the various phases (solid, liquid and gaseous), biotic components (many microorganisms), small organisms (enzymes) and abiotic components (minerals, humus, organo-mineral aggregates) are involved in physical, chemical and biological processes in these environments. All biochemical transformations at sediment level depend on the presence of enzymes.

The action of microorganisms on the substrate in the environment is done enzymatically and is accomplished by the processes of oxidation and hydrolysis, respectively, as a result of the action of some end products of microbial metabolism. In this sense, the determination of enzymatic activity yields suggestive results in much shorter time on processes occurring in sediment or other natural habitats than microbiological analyses. Sediments are environments where different factors participate in complex functions. These factors are considered to be the major mineral matrix, texture, amount of organic carbon, position and geographic conditions.

MATERIALS AND METHODS

The Lacustrine Complex Adunații of Geormane has a surface of 102 hectares (the considered surface was extended to 111.25 ha, considering important both Victoria and Marica lakes and the canal connecting the two lakes). The shape of the lakes is alluvial Plain of the almost oval, with low, sandy shores and very few trees. Thus, the protected natural area is located within the Jiu - Jieț (Fig. 2).

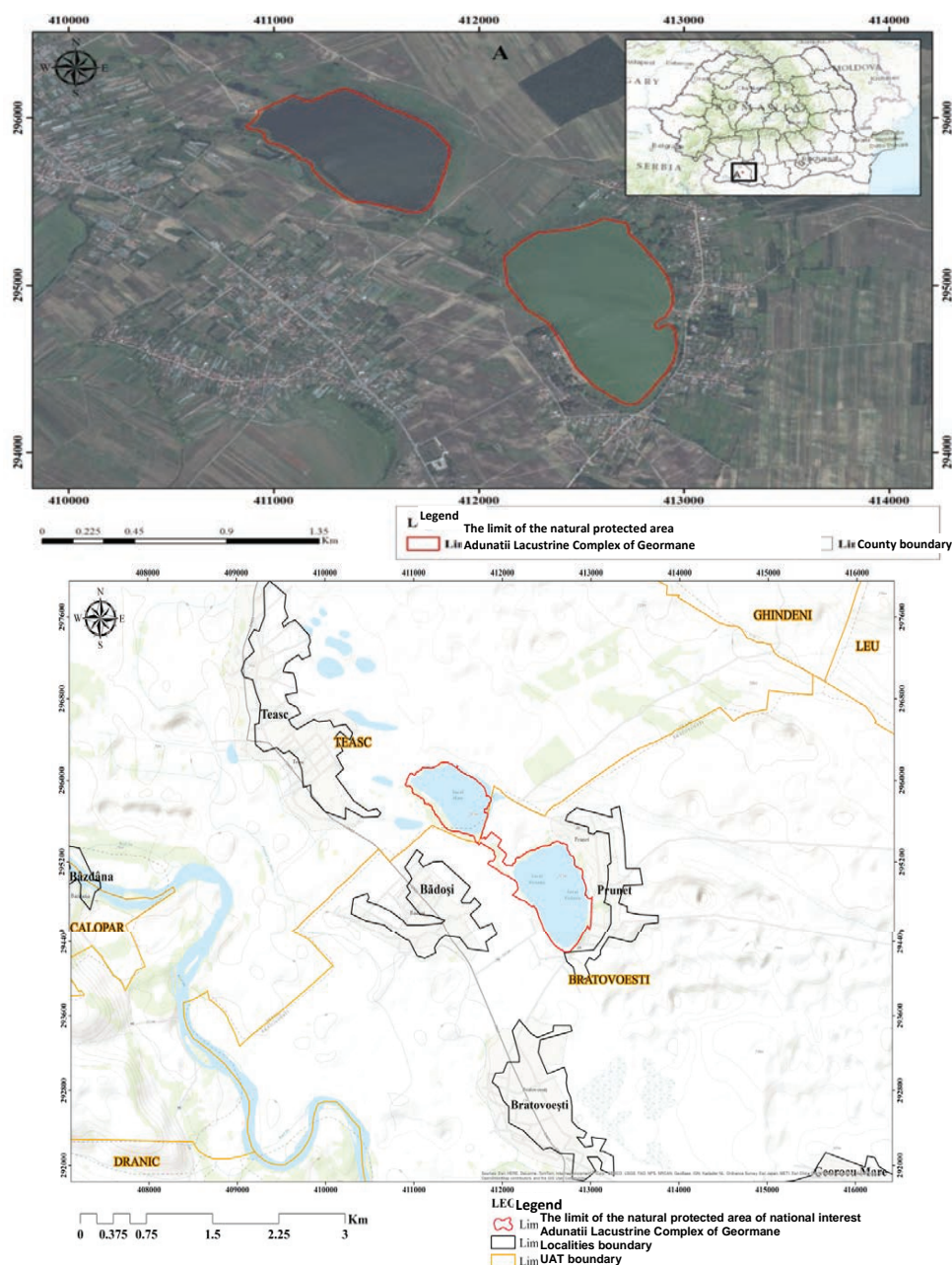


Figure 2. Sketch of Adunatii Lacustrine Complex of Geormane in the lower sector of the Jiu (Google Earth, accessed: February 18, 2017).

The physico-chemical and enzymological studies on water and sediments have been made over the years 2016, 2017. In order to establish the influence of abiotic environmental factors on the density and composition of the studied microbial communities, there were determined the following physico-chemical parameters: pH with Hanna pH meter, electrical conductivity with Hach conductivity meter, dry fixed residue 105°C, dissolved oxygen (O₂), organic matter quantity determined by CCO-Mn, nitrates, nitrites, ammonium, sulphates, total phosphorus (total P), sulphates with spectrophotometer DR2010 and chlorophyll.

Enzymatic studies consisted in determining quantitative enzymatic activity as follows: phosphatase activity (AF) - Kramer and Erdei method (PUKÁS et al., 2005), catalase (AC) - Kappen method based on H₂O₂ decomposition processes and current dehydrogenase activity (ADA) - Caside method by reducing 2.3.5-triphenyltetrazolium chloride - TTC in the absence of glucose, respectively, potential dehydrogenase activity (ADP) - in the presence of glucose. As different sediment categories may have a different content in water, the degree of moisture of each sample was determined, which may influence the expression of microbial load and the enzymatic activity relative to dry sediment grams (CUȘA, 1996).

RESULTS AND DISCUSSIONS

The climate is continental characteristic to plain areas. The area is exposed to very cold continental air invasions ($-10 \dots -20^{\circ}\text{C}$) and very hot summer invasions ($30 - 35^{\circ}\text{C}$), thus being characterized by an increased temperature amplitude during the year. The climate is continental temperate with Mediterranean influence, with hot and dry summers, relatively cold winters, short springs and long autumns. The multiannual average temperature is 10.8°C . Precipitation has a multi-annual average of 509 mm, with a maximum of rainfall in the warm (June) period. The winds with the highest intensity and frequency are those from the eastern sector (24.6% with 4.3m/s).

Hydrological characteristics. The hydrographic network is influenced by the lithological structure of the soil and by the climate, being represented by two valleys: Prunet and Giorocul Mare. The surface waters are represented by a series of lakes, the largest one being Victoria Lake, which has about 70-80 ha and is arranged for recreation, with a flow rate of 20-25 l/s; this area is also crossed by the Gioroc stream. The lake is fed by groundwater and three streams that do not dry out in summer and do not freeze in winter (BREZEANU et al., 2011).

Water chemistry. The analysis of the main physico-chemical indicators reveals the formation conditions of the chemical composition of the water and the mineralization stage of these lacustrine ecosystems. The chemical composition of the water is characteristic to eutrophic ecosystems. According to the ionic balance and the anion and cation content, the water of the lakes belongs to the bicarbonate-sulphato-calcic-magnesium category, characteristic to the mixed mineralization stage. From the point of view of quality conditions for surface waters, the lakes fall into category II and can be used for fish farming (Tables 1; 2).

Table 1. Physical and chemical composition of the water in Victoria Lake.

Indicators analyzed	Victoria Lake	Method of analysis
Conc. Hydrogen ions, unit. pH	7.5	STAS 6325-75 Hanna pH-meter
Electrical conductivity max.	390	STAS 7722-84 Hach conductivity meter
Dissolved Oxygen, mg / dm^3 , min.	8.6	STAS 6536-87
Subst.org. Oxidab. CCO_2 mg O_2 / dm^3 , max	11.7	STAS 3002-85
Total hardness, German grades, max	12.7	STAS 3026-76
Fixed residue, mg / dm^3 , min. / max	195	STAS 3638-76
Ammonia, mg / dm^3 , max	0.270	STAS 6328-85 Spectrophotometer DR2010
Calcium, mg / dm^3 , max	59	STAS 3662-62
Magnesium, mg / dm^3 , max	19	STAS 6674-77
Nitrites, mg / dm^3 , max	0.058	STAS 3048-90 Spectrophotometer DR2010
Nitrates, mg / dm^3 , max	9.7	STAS 3048- 77 Spectrophotometer DR2010
Chlorides , mg / dm^3 , max	21	STAS 3049- 86
Phosphates, mg / dm^3 , max	0.05	STAS 3265-66 Spectrophotometer DR2010
Sulfates, mg / dm^3 , max	13	STAS 3002-87 Spectrophotometer DR2010
A chlorophyll μg / l-16 μg	11.8	Spectrophotometer DR2010

The pH values are between 7.5 and 8.4 (slightly alkaline) in accordance with the content of bicarbonate elements. The content of biogenic elements is a particular feature of the lakes. The amount of nitrates and nitrates 0.058 and 9.7 mg/dm^3 is due to the supply of nutrients as a result of the administration of mineral and organic fertilizers on the neighbouring agricultural lands.

The presence of nitrates (NO_3^-), which represents the most advanced oxidation degree in the natural nitrogen cycle, is also the result of a bacterial oxidation activity of abundant organic matter in the water and the substrate. The same explanation can be given to the presence of phosphate ions (PO_4^{3-}) the concentration of which reaches 0.05 mg/dm^3 . Among the cations, we firstly mention calcium (Ca^{2+}), his origin of which is considered to be the sedimentary rocks of the lakes, but also the amendments applied to agricultural land.

The ions of calcium and magnesium (Ca^{2+} and Mg^{2+}) together with carbonates, bicarbonates and sulphates present in the water of the lakes, are the cause of relatively high values of temporary and total water hardness. What needs to be emphasized is that, as a whole, water chemistry is more or less similar to that characteristic to all lakes. There are also some differences between the concentrations of the various components related to the peculiarities of the station the samples were taken from. It is the case of sulphate (SO_4^{2-}), which has a concentration of 13 mg/dm^3 (POSTOLACHE, 2006; BUCUREȘTEANU et al., 2007; CIOBOIU, 2011; CIOBOIU & CISMAȘIU, 2016).

Table 2. Physico-chemical composition of the water of Marica pond.

Indicators analyzed	Marica Pond	Method of analysis
Conc. Hydrogen ions, unit. pH	8,4	STAS 6325-75 Hanna pH-meter
Ammonia, mg / dm ³ , max	SLD	STAS 6328-85 Spectrophotometer DR2010
Nitrites, mg / dm ³ , max	0,01	STAS 3048-90 Spectrophotometer DR2010
Nitrates, mg / dm, max	3,61	STAS 3048- 77 Spectrophotometer DR2010
Chlorides, mg / dm ³ , max	14,18	STAS 3049- 86
Phosphates, mg / dm ³ , max	0,033	STAS 3265-66 Spectrophotometer DR2010
A chlorophyll μg / l-16 μg	15,8	Spectrophotometer DR2010

A *chlorophyll* represents alongside phosphorus and nitrogen in all its forms, an important quality indicator used to assess the degree of eutrophication of lakes. Using the chlorophyll concentration values as a quality indicator, the eutrophication level of water according to Order 161/2006 was estimated, the lakes being eutrophic - with a chlorophyll content ranging from 8 to 25 $\mu\text{g/l}$ – Victoria lake and 10 $\mu\text{g/l}$ -16 $\mu\text{g/l}$ – Marica pond (SANDU et al., 2004; FAUR & GEORGESCU, 2009; OBASOCHAN et al., 2010; CISMAȘIU, 2012a, b; PĂCEȘILĂ, 2012).

Enzyme monitoring in sediments. The activity of phosphatase was detected in all analyzed samples, with a rather high numerical fluctuation. The highest values were observed during the warm season, indicating that sediments are the main phosphorus reservoir (COJOCARU, 2005; GAVRILESCU, 2011). Phosphatase, being an accumulated enzyme, better keeps its activity for a long time. This is less influenced by external factors (temperature and pollution), which are immediately visible on the activity of microorganisms.

Victoria Lake has an intense phosphatase activity; the mean value is 229.1 mg of phenol / g dry substances in the middle of the lake, while the minimum amount is 14 mg of phenol phosphatase / g dry substance, in February. The highest values are in September, 199 mg of phenol / g wet substance, in sediments, also in the middle of the lake. The annual mean phosphatase activity of the sediment for this lake is around 100 μg phenol / g s.u. (COJOCARU et al., 2007; GAVRILESCU & POPESCU, 2012).

The sediments of Marica Pond have an annual average of the phosphatase of 178.9 μg phenol / g s.u. Sediment in the middle area and the seasonal fluctuations ranged between 28.5 and 196.7 μg phenol / g s.u. Sediment, with an average value of 131.2 μg phenol / g s.u. (Fig. 3).

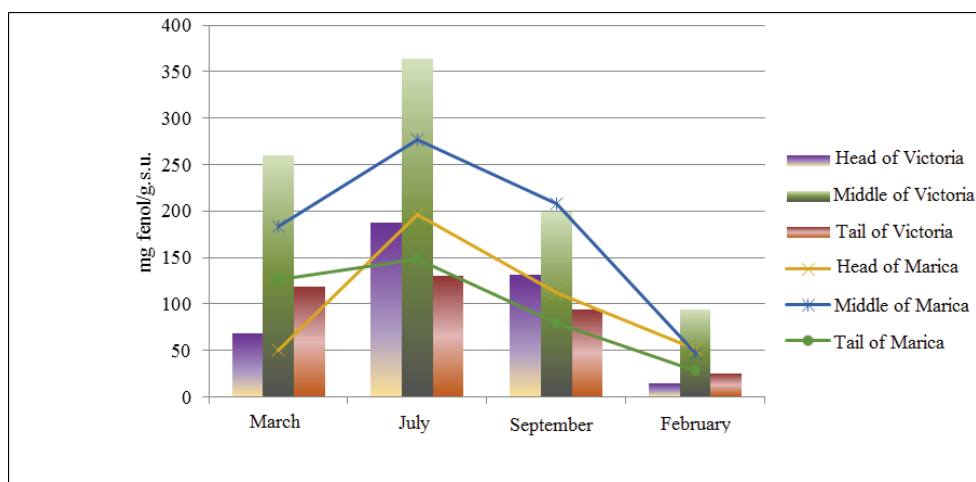


Figure 3. The activity of phosphatase in the sediments of the studied lakes.

The catalases are found in almost all animal cells and in smaller quantities in higher plants. In the case of microorganisms, the catalases are found only in aerobic ones (cyanobacteria). The catalase has long been attributed to the decomposition of hydrogen peroxide in order to keep the living cell from its damaging action. Lately, it has been demonstrated that they participate in xenobiotic degradation in the organic matter of the soil and sediment (GIANFREDA & BOLLAG, 1996).

Victoria Lake has a catalase activity comprised between 20.1 mg H_2O_2 / g s.u. at the head of the lake and 22.6 mg H_2O_2 / g s.u. in the middle of the lake. The most intense activity is in March and July, respectively 29.7 mg and 21.5 mg H_2O_2 / g s.u., the mean value being 19 mg H_2O_2 / g s.u.

Marica Pond had a catalase activity of 16.8 mg H_2O_2 / g s.u. in March; the maximum value of 25.90 mg H_2O_2 / g s.u. was determined for the sediment in July, with an annual average of 18 mg H_2O_2 / g s.u. (Fig. 4).

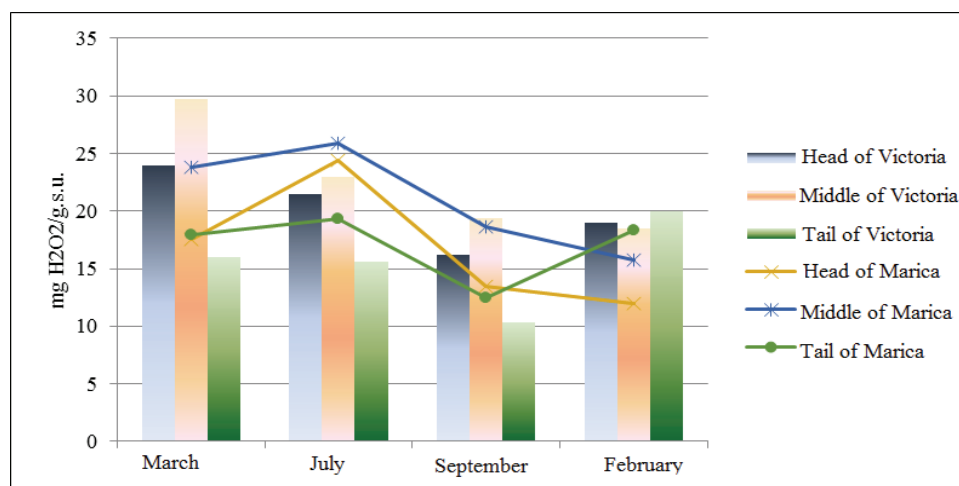


Figure 4. The catalase activity in the sediment of studied lakes.

The dehydrogenase activity can be considered as an important biological indicator of sediment microorganisms but has also been used as an ecotoxicological test to evaluate the effect of pollutants on soil microbes or sediments. The current dehydrogenase and potential dehydrogenase activity were found in all analyzed samples (Figs. 5; 6).

The current dehydrogenase activity is much more intense than the potential dehydrogenase activity, which may be due to the stimulating action of carbon assimilation by microorganisms in the enzymatic synthesis process. The highest values for the dehydrogenase activity were observed in autumn, when plant material of organic nature favours the development of microorganisms and enhances their enzymatic activity. The activity of current dehydrogenases is intensified especially in summer, when the microbial activity in the sediment level increases as a result of the accumulation of organic substances deposited at the end of the vegetation period.

Victoria Lake, depending on the current sediment of the dehydrogenase activity, shows significant seasonal fluctuations; the minimum value was 0.09 μg formazan / 1 g s.u. in September, the maximum was 19.9 μg formazan / 1 g s.u., with intense activity in June and September. Marica Pond shows high seasonal fluctuations in the current dehydrogenase activity, this being between 0.8 μg formazan / 1 g s.u. and 14.9 μg formazan / 1 g s.u. The mean value recorded during the monitored period was approximately 8.15 μg formazan / 1 g s.u. (Fig. 5).

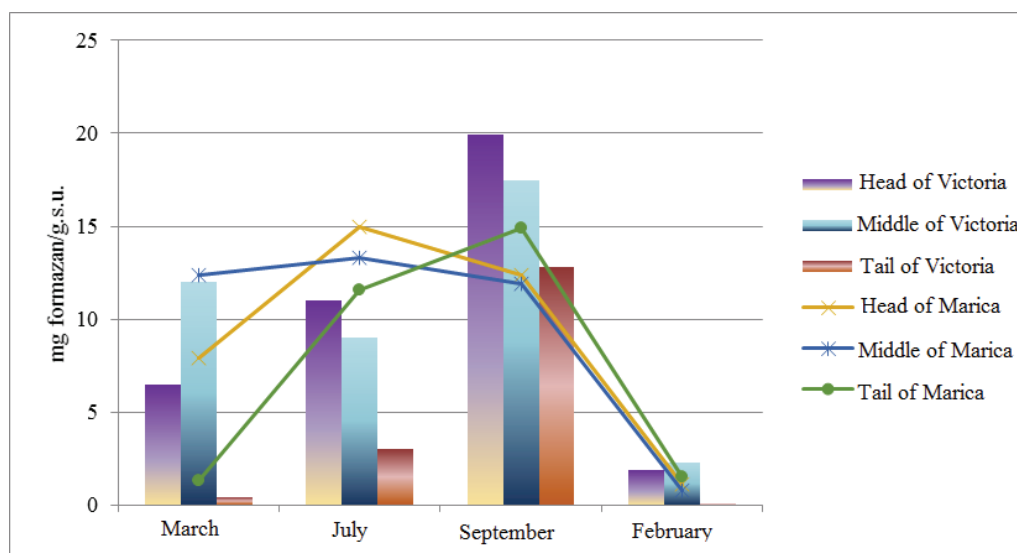


Figure 5. Activity of dehydrogenase in the sediments of studied lakes.

The potential dehydrogenase activity is maximum in both lakes in July and September (7.1 - 8.1 μg formazan / 1 g s.u.), with significant values in the middle sections of the lake. In March and February, potential dehydrogenase values are lower (Fig. 6).

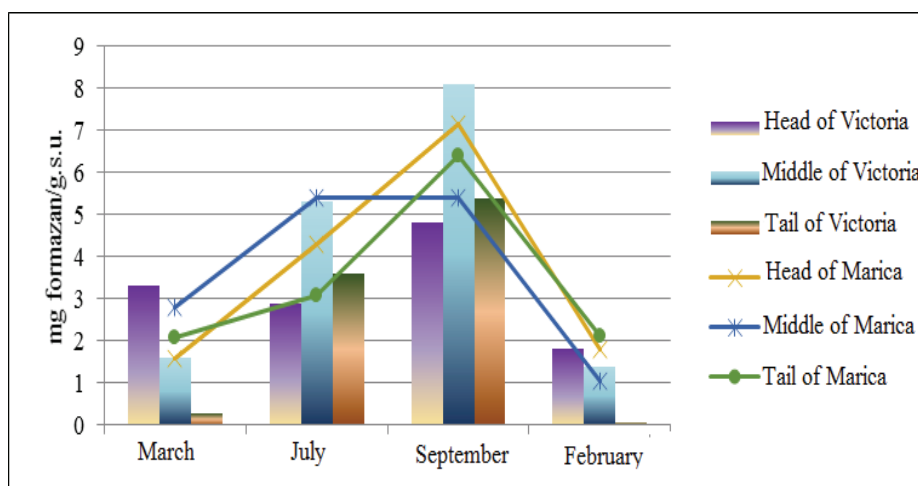


Figure 6. The activity of potential dehydrogenase in the sediment of the studied lakes.

CONCLUSIONS

The present study was carried out within Adunatii Lacustrine Complex of Geormane between 2016 and 2017. According to the physico-chemical and enzymatic analyses performed on water and sediment samples, it was found that the pH is between 7.5-8.4 units, fixed residue 195 mg/dm³, chlorides 21 g/l, and hardness ranges between 10.66 and 12.7 degrees Ge. The eutrophic Victoria Lake has a chlorophyll content of 8 - 25 µg/l and Marica Pond has a chlorophyll content > 25 µg/l being a hypertrophic lake. Victoria Lake, with an intense phosphatase activity, has an annual average of the phosphatase value of 299.1 µg phenol / g s.u., and seasonally, the highest values are recorded in September. Marica Pond shows an average catalase activity of 18 mg H₂O₂ / g s.u. and Victoria Lake has an intense catalase activity of 29.7 mg H₂O₂ / g s.u. in March. Also, depending on the dehydrogenase activity of sediments, the lacustrine ecosystems show relatively low seasonal fluctuations; the minimal value was 0.09 µg formazan / g s.u. in February and the maximum 19.9 µg formazan / g s.u. in September.

The potential of the dehydrogenase activity is maximal in both lakes in July and September (7.1 - 8.1 µg formazan / 1 g s.u.), with significant values in the middle sections of the lake. In March and February, potential dehydrogenase levels are lower. The determination of the enzyme activity produces suggestive and more rapid results on the processes occurring in sediments or other natural habitats compared to microbiological analyses. The clogging of the lakes can contribute to increase of the sediment load of lakes, favours the excessive growth of the vegetation (algae blossoming) and reduces the water surface. The obtained results highlight the current state of the water of the two lakes under the influence of the anthropogenic factors, which act cumulatively by modifying the water quality.

ACKNOWLEDGEMENTS

The presented paper is the result of the collaboration between Institute of Biology Bucharest, the Department of Microbiology and the Museum of Oltenia Craiova, Natural Science Section represented by the collaboration convention numbers 1797 / 20.05.2015, respectively 1402 / 21.05.2015 on the topic: *Biodiversity of microbiota in Oltenia industrial contamination areas and potential biotechnological applications in order to reduce it*. Also, some of the presented data are results of project no. RO1567-IBB05 / 2017 developed at the Institute of Biology of the Romanian Academy.

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Received: March 31, 2017

Accepted: June 9, 2017

MICROBIAL DIVERSITY IN RIVER WATER AND SEDIMENT FROM SULINA AREA

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Abstract. Research on the bacterial diversity of the Danube waters from the flowing or stagnant area, somewhat adjacent to Sulina branch and port, is a study case integrated with traditional ecological research, contributing to a more complex characterization of the permanent or accidental populations from these areas. The differences or similarities with respect to the benthic microbiota and the one present in the water mass, as well as the abiotic and biotic characteristics of the delta channels and lakes, correlated with the seasonal climatic variations or generated by the extreme or deficient pluviometric regime, constitute extremely complex and interesting study material that will be able to supplement the results of the research undertaken so far.

Keywords: bacterial diversity, benthic microbiota, sediments samples.

Abstract. Diversitatea microbiană a apei și a sedimentelor din zona Sulina. Cercetările privind diversitatea bacteriană a apelor Dunării, din zona curgătoare sau stagnantă, limitrofă într-o oarecare măsură brațului și portului Sulina, constituie un caz de studiu, integrat cercetărilor ecologice deja cu tradiție, contribuind la o mai complexă caracterizare a populațiilor de organisme, permanente sau accidentale din aceste areale. Diferențele sau similitudinile în ceea ce privește microbiota bentonică și cea prezentă în masa apei, cât și caracteristicile abiotice și biotice ale apelor lacurilor de deltă și ale canalelor, corelate cu variațiile climatic sezoniere sau generate de regimul pluvial extrem sau deficitar, constituie un material de studiu extrem de complex și de interesant care va putea să completeze rezultatele cercetărilor întreprinse până în prezent.

Cuvinte cheie: diversitate bacteriană, microbiotă bentonică, probe de sediment.

INTRODUCTION

The studies undertaken to fully characterize the biodiversity of the Danube River, supplement the projects of mapping and distribution of rare and protected species of plants and animals, in the enhanced interest of protecting the environment, not only in the Danube Delta Biosphere Reserve, but anywhere where accurate knowledge of fish, ornithological, botanical and microbial groups is required (KIRSCHNER et al., 2009). In this respect, we are working on the application of the most appropriate measures required by specialists from very diverse but related fields, thus justifying the interest of carrying out studies on the microbiota in the delta area, adjacent to Sulina Ecological Station, a research point belonging to the Institute of Biology Bucharest, under the aegis of the Romanian Academy.

The present paper is part of a series of three studies, based on the analysis of the samples taken in September 2016 from the Delta lakes Puiu, Rosu and Rosulet, as well as from the related linking channels. The papers are subject to presentations at international scientific events organized by the University of Pitești and by the County Museum of Oltenia during 2017. Thus, at the Scientific Symposium Current Trends in Natural Sciences organized in Pitești in April 2017, the paper "Highlighting of some physiological bacterial groups isolated from the Danube Delta Biosphere Reserve, Rosu, Roșuț and Puiu lakes" was presented, which signals of the main physiological groups of microorganisms present in the water and benthos samples taken from several delta points where previous environmental analyses were performed.

In the other two papers brought to the attention of specialists and of those interested in the microbial diversity of the Danube Delta, we present a physico-chemical characterization of both water and benthic soil samples on the one hand, and an interpretation of the presence of certain bacterial physiological groups (PĂCEȘILĂ et al., 2008), thus making a comparison between the microbiota present in the water mass and the one identified in the sediment layer.

At the same time, by isolating and testing bacterial populations from the same analyzed samples, selections of bacterial strains with biotechnological potential were made. These researches on the bacterial cell metabolism and the possible uses of the obtained bioproducts are the subject of the third scientific communication that will be presented this autumn at the international scientific manifestation organized by the Oltenia Museum, Craiova.

MATERIAL AND METHODS

Field sampling. Water samples were collected in September 2016. The analyzed Danube water sampling points were located on Busurca Channel (M3), Împuțita Channel, at the confluence with Rosuleț Lake (M4), in Roșu Lake (M6), at the mouth of Roșu Lake (M8), and in Mândra backwater (M9).

For the sediment samples, the chosen sampling sites were Împuțita Channel at the confluence with Roșuleț Lake (M4), Roșu Lake (M6), Musura Gulf (3) and Sulina harbor area.

The samples consisted of 500 mL of column water from each selected station point; some water was filtered through GF / F filters (65 μm) for dissolved forms of nutrients and preserved for further analyses.

Sediment samples: surface sediments samples were also sampled and transported in plastic bags to the lab and preserved at -20 °C until extraction and analysis.

Measurement of physical parameters. Depth and transparency were determined using Secchi disc, the redox potential, pH, temperature, conductivity and salinity were measured in the field with a multiparameter WTW 340i, Germany.

Water chemistry. Nutrients were determined spectrophotometrically following a modified Berthelot method for N-NH₄ (KROM, 1980), Griess-Ilosvay modified method for N-NO₂ (KEENEY & NELSON, 1982; TARTARI & MOSELLO, 1997) for N-NO₃, P-PO₄ and TP.

Selective growing media. In order to highlight the main physiological groups of bacteria present in the analyzed water and sediment samples, the following selective cultivation media were used: VL medium (BEERENS, 1954), for anaerobic heterotrophic bacteria, Postgate for reducing sulphate bacteria, Nutrient Broth for aerobic heterotrophic facultative anaerobic bacteria, medium with starch for amylolytic bacteria, Vinogradsky for ferrobacteria, medium for nitrite bacteria, Giltay medium for denitrifying bacteria and 9K medium for iron oxidizing chemolithotrophic bacteria. Serial dilutions were grown on the selective media in triplicates (three repetitions) and incubated at 28 °C for varying lengths of time. The bacterial growth was assessed according to the McReady comparative method.

RESULTS AND DISCUSSIONS

A first step was to establish the physico-chemical parameters of both the water in the sampling points and the collected sediment.

As it can be seen in Tables 1 and 2, parameters such as temperature, conductivity, transparency, pH, NO₂, NO₃, etc. have been measured.

In the case of water set parameters, it can be observed that there are no major fluctuations between the five sampling points. The measured parameters fall within the set limits for river water. Table 1 presents the physico-chemical analysis of the collected Danube water samples.

Table 1. Physico-chemical analysis of water.

Parameter/ station	M3 (Busurca Channel)	M4 (Împuțita Channel in Roșuleț Lake)	M6 (Roșu Lake)	M8 (channel entrance in Roșu Lake)	M9 (Mândra backwater)
Depth (m)	2	1.1	2.7	1.6	1.7
Transparency (m)	0.4	1.1	0.4	0.4	0.4
T/A	0.2	1.0	0.15	0.25	0.24
Temperature (°C)	17.5	16.2	16.9	17.1	16.9
pH	7.91	8.114	8.96	8.491	8.602
Conductivity (ms/cm)	421	545	385	386	441
Salinity	0.1	0.2	0.1	0.1	0.1
Redox	-56.9	-56.6	-110.5	-90.5	-92.6
NH ₄ (mgN/L)	0.007	0	0.024	0.088	0.054
NO ₂ (mg/L)	0.003	0.001	0.001	0.009	0.001
NO ₃ (mg/L)	0.33	0.25	0.30	0.15	0.53
DIN (mgN/L)	0.336	0.252	0.326	0.247	0.583
PO ₄ (μg/L)	21.25	10	26.25	32.5	32.5
Whole P (μg/L)	30	56.25	68.75	82.5	70

The physico-chemical parameters of the sediment were assessed using the same method used to establish the physico-chemical parameters of the water. As it can be seen in Table 2, the sediment samples originated from Împuțita Channel and Roșu Lake. Water samples were also collected from the same points. Thus, the temperature, redox and pH parameters were similar for water and sediment samples, while parameters such as salinity, conductivity, increased, showing a double value in the sediment samples as compared to those of the water at the same sampling point. This is due to a higher degree of mineralization in the sediment, which led to increased concentrations of ammonium, nitrite, nitrate, orthophosphate ions.

Table 2. Physico-chemical analysis of the sediment.

Parameter/station	M4 (Împuțita Channel in Roșuleț Lake)	M6 (Roșu Lake)	Musura Channel	Sulina Harbour
Depth (m)	1.1	2.7	1.6	1.0
pH	8.149	8.639		
Redox	-64.5	-94.5		
Temperature (°C)	19.3	19		
Salinity	0.4	0.4		
Conductivity (ms/cm)	940	855		
NH ₄ mg/g s.u	17.76	22.48	11.17	33.96
NO ₂ mg/g s.u	0.623	0.516	0.073	0.065
NO ₃ mg/g s.u	8.38	7.28	1.45	1.72
PO ₄ μg/g s.u	3488.25	5892.57	1642.47	1411.17

In the case of sediment samples taken from Musura Channel and Sulina Harbor, the ammonium, nitrite, nitrate, orthophosphate ions quantities were found to be lower in comparison to the sediment samples M4, M6, due to the presence of denitrifying bacteria present in large number in the sediment, depleting the nitrogen compounds from the soil by reducing the nitrates and nitrites. Both sediment and water samples were analyzed from the microbiological point of view, by seeding on specific media of different physiological groups. In this study, we focused on signaling the presence of the dominant physiological groups of microorganisms in both the analyzed water and sediment samples (Tables 3; 4).

Table 3. Limit value number of bacteria/ml water sample.

	M3 (Busurca Channel)	M4 (Împușita Channel in Roșuleț Lake)	M6 (Roșu Lake)	M8 (channel entrance in Roșu Lake)	M9 (Mândra backwater)
No. of cell/ml	11 x 10⁵ sulphate reducing bacteria – 15 x 10⁸ iron bacteria	3 x 10³ heterotrophic anaerobic bacteria – 11 x 10⁶ iron bacteria	9.5 x 10³ sulphate reducing bacteria; heterotrophic aerobic and facultative anaerobe bacteria; amylolytic bacteria – 11 x 10⁴ heterotrophic anaerobic bacteria	0.4 x 10³ heterotrophic anaerobic bacteria – 11 x 10⁷ nitrite bacteria	0.4 x 10² iron bacteria – 11 x 10⁷ nitrite bacteria

Table 4. Limit value bacterial count/ml sediment sample.

	M4 (Împușita Channel in Roșuleț Lake)	M6 (Roșu Lake)	Musura Channel	Sulina Harbour
No. of cell/ml	1.5 x 10 Iron-oxidizing chemolithotrophic bacteria – 4.5 x 10⁷ Heterotrophic anaerobic bacteria	4.5 x 10 Iron-oxidizing chemolithotrophic bacteria – 11 x 10⁹ heterotrophic anaerobic and facultative anaerobic bacteria	9.5 x 10 Iron-oxidizing chemolithotrophic bacteria – 11 x 10⁹ Denitrifying bacteria	2.5 x 10 Iron-oxidizing chemolithotrophic bacteria – 14 x 10⁸ Heterotrophic anaerobic bacteria

It should be noted that in the water samples from the Busurca and Împușita Channels ferrobacteria are predominant, while in Roșu Lake and in Mândra backwater the nitrite bacteria are preponderant. In the analyzed sediment samples, the bacteria belonging to the anaerobic heterotrophic group predominate, and in Musura Bay the denitrifying bacteria were present.

The comparison between the two sets of samples, water and sediment, reveals that in all four sediment samples there are minimal and relatively constant concentrations of iron-oxidizing chemolithotrophic bacteria. It can be concluded that the sedimentary benthic layer, due to the presence of aerobic facultative anaerobic bacteria, is microbial-active.

The circulating water mass, with a depth of 1.0 to 2.7 meters, varies depending on the Danube water shares at different time intervals, as well as the degree of transparency. It is necessary to periodically analyze the same sampling points in order to observe any variations of the microbiota.

CONCLUSIONS

The analyzed samples presented a wide variety of physiological groups of the microorganisms.

Ferrobacteria were predominantly present in the mass of water coming from channels with a relative circulating flow, while in the lakes with stagnant water volume there are increased amounts of nitrite bacteria.

Sediment samples taken from depths of 1 down to 2.7 meters show normal benthic microbial activity.

ACKNOWLEDGEMENTS

The study was funded by the project no. RO1567-IBB05/2016 of the Institute of Biology Bucharest of the Romanian Academy.

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Received: March 30, 2017

Accepted: July 7, 2017

THE EVALUATION OF PLUVIOMETRIC RISK IN PĂLTINIȘ TOURISTIC AREA

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Abstract. In terms of climate change, the adaptation to weather conditions in vulnerable areas is of great importance, as it is the case of mountainous areas. Among the geographical factors, the relief has a determinant role in the rainfall regime, establishing itself by altitude, slope orientation, and configuration of its forms. Altitude causes vertical change of all climatic elements. Rainfall increases as altitude increases, up to a certain height called pluviometric optimum beyond which it begins to decrease. For specific winter sports in the highlands and agritourism in the lowlands, a persistent and consistent snow cover generated by solid precipitation is almost mandatory. The snow and the snow cover ensure good conditions for skiing at altitudes > 1600 m, due to its natural potential and the superior capitalization of modern equipments ski tracks have. Considering the specific agro-pastoral and tourist activity in the area of Păltiniș, environmental quality improvement depends on encouraging environmentally friendly practices.

Keywords: risk, pluviometry, snow cover, natural potential, environmental quality.

Rezumat. Evaluarea riscului pluviometric în arealul turistic Păltiniș. În condițiile schimbărilor climatice, adaptarea la condițiile meteorologice în zonele vulnerabile este de mare importanță, cum este cazul zonelor montane. Printre factorii geografici, relieful are un rol determinant în regimul precipitațiilor, fiind direct dependent de altitudine, orientarea versanților și configurație. Altitudinea cauzează modificări pe verticală ale tuturor elementelor climatice. Precipitațiile cresc pe măsură ce crește altitudinea până la o anumită înălțime, numită optim pluviometric, dincolo de care începe să scadă. Pentru practicarea sporturilor specifice sezonului rece în regiunile înalte și a agroturismului în regiunile joase existența unui strat de zăpadă persistent și consistent, generat de precipitațiile sub formă de ninsoare sunt condiții aproape obligatorii. Ninsorea și stratul de zăpadă asigură condiții bune pentru practicarea schiului la altitudini > 1600 m, prin potențialul natural bogat și printr-o valorificare a mijloacelor moderne de dotare a pârtiilor la valențe superioare. Având în vedere activitatea specific agro-pastorală și turistică a arealului stațiunii Păltiniș, componenta de îmbunătățire a calității mediului depinde de încurajarea practicilor ecologice.

Cuvinte cheie: risc, pluviometrie, strat de zăpadă, potențial natural, calitatea mediului înconjurător.

INTRODUCTION

The Climate Resort Păltiniș was founded in 1894 by SKV (Transylvanian Carpathian Society - Siebenbürgischer Karpathen-Verein) and it is the oldest resort in the country, located at the highest altitude of 1442 m. Păltiniș resort is among the oldest and most representative tourist regions of Romania (Fig. 1).



Figure 1. Old postal card representing Păltiniș Resort (Dragoteanu M., personal archive).

For tourism activities, solid precipitation has favourable effect. For practicing specific winter sports in the highlands and agritourism in the lowlands, a persistent and consistent snow, generated by precipitation in the form of snow, is very important. Snow accumulates and forms the snow cover, important for its thickness and persistence in terms of socio-economic activities in the area of study.

MATERIAL AND METHODS

This paper is based on climate data analysis, more specific on average, maximum and minimum precipitation quantities, including solid precipitation, and depth of the snow cover. The data were taken from the meteorological station Păltiniș and analyzed compared to the elevation, since the relief influences by the height and slope exposure the presence of snow on the ground (CROITORU, 2003).

The range of climatic parameter analysis is 1986-2015, given that an emphasis on the variability of the precipitation should be on a longer period of time and using homogeneous data.

From the climatic perspective, an area is considered to be optimal for winter sports if there are not registered extremely low negative temperatures or blizzards; there are also added the average lifetime of the snow cover at least 120 days / year and the average thickness of the snow cover at least 15-20 cm per ten-day intervals (***. National Institute for Research - Development in Tourism, 2003).

The average annual number of days with snow cover is 208 days at Păltiniș and more than 280 days on the highest peaks. At Păltiniș, where the risk of melting in winter is lower, the average thickness of snow increases gradually, from early autumn to late spring, due to the accumulation of fresh snow fallen over the existing layer (Table 1).

Table 1. Climatic suitability for practicing winter sports at Păltiniș between November and March.

Favorable climate indicators for winter sports	Păltiniș (1450 m)
Average of minimum air temperatures	2,7°C annual or -4,9°C (November-March)
Average of maximum air temperatures	9,5°C annual or 2,5°C (November-March)
The duration of time interval with snow cover	208 days
The number of days with snow cover with thickness greater than 20 cm	100 days
The average date of the first snow	18 October
The average date of the last snow	10 May
The number of days with frost (minimum temperature below 0°C)	142 days

With regard to the spatial distribution of rainfall, there is an increasing amount in parallel with the increase in height until reaching the optimum precipitation (as the amount of precipitation decreases slowly), the situation demonstrated in the case of Păltiniș, where the annual average quantity is 915.4 mm, although the cloudiness is not so high.

Inverse correlation between cloudiness and rainfall occurs only at the annual analysis and is due to the persistence of stratiform clouds developed during the cold semester above the depression, which generate reduced precipitation quantities. On the contrary, in the warm semester, the thermal and frontal convection increases and the cumuliform clouds, which give heavy rain showers, and cloudiness is bigger at Păltiniș.

Regarding the seasonal distribution, from the total annual rainfall 12.9% (118.2 mm) fall in winter, 27.9% (255.3 mm) fall in spring, 39.4% (360.6mm) fall in summer and 19.8% (181.3) fall in autumn. The annual regime is characterized by the increase of the rainfall quantities from February to June and their decrease from July to February, with one exception (in December 42.7 mm). The minimal precipitation amount registered in January (34.2 mm) is due to the very low cloud systems related to the fronts coming from the Mediterranean cyclones; the southern and western slopes of the Carpathians receive most of the precipitation amount. The maximum in June (135.3 mm) is due to the increased Atlantic cyclone activity, when moist ocean air enters the northern part of the ridge and to the eastern Azores High; at the same time, thermal convection becomes more intense, increasing precipitation amount by 17 mm.

The greatest amount of precipitation occurred in years of intense cyclonic activity and low amounts of rainfall occurred in years when continental anticyclone regime and penetration of air from North Africa predominated. The precipitation amounts on short intervals do not always have a torrential nature, but in some cases, in favorable synoptic situations (the consequence of strong convective processes) they totalize in 24 hours a higher amount than the average of the respective month (April 1933, 110.4 mm compared to the average of the month from the period 1986-2015 of 81.1 mm). The maximum amount of rainfall in 24 hours in the period 1986-2015 was 76.8 mm and it was recorded on May 8, 1987, and the absolute maximum amount of rainfall in 24 hours was recorded in April 1933, 110.4 mm (Table 2).

Table 2. The monthly average and maximum amount of rainfall (mm) in the interval 1986 to 2015 at Păltiniș.

Rainfall	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Average of rainfall quantity	34.2	41.3	56.4	81.1	117.8	135.3	118.8	106.5	85.4	57.1	38.8	42.7	915.4
Monthly maximum in 24 h	30.1	36.7	39.1	59.5	76.8	68.6	67.4	57.4	62.4	56.0	37.8	26.6	76.8
Absolute maximum in 24 h	33.8	36.7	40.1	110.4	76.8	88.3	68.1	78.4	62.4	56.0	37.38	32.2	110.4

Source: processed data from Păltiniș weather station

Given the configuration of the relief - slight slopes (under 6° inclination), moderate slopes (6° to 15°) and few areas with very steep slopes (15° to 30°), respectively the high density of the coniferous forests, in the area Păltiniș, there is no strong phenomenon of soil erosion even if rainfall reaches great amounts, such as 76.8 mm in 24 hours, produced on April 8.

The snow and the snow cover ensure good conditions for skiing at altitudes > 1600 m, due to its natural potential and the superior capitalization of modern equipments ski tracks have. In the Carpathians, the ski area has just a small share of the total area of about 70,000 km² (ERDELI & GHEORGHIȚAȘ, 2006).

Snow represents one of the characteristics of the high mountain regions, which is characterized by the amount, intensity, frequency and duration, contributing effectively to the formation of the snow cover. Calendar data which delimits the possible duration of snow fit, as a rule, between the average data of the first and last days of snow. The average data of the appearance and disappearance of the snowfall are dependent on the thermal values recorded at the end of the autumn, early winter and early spring when, in general, minimum average daily temperatures are 2-3 °C, but they are directly dependent on elevation. Thus, the first snowfalls are early in the highlands, > 2000 m (Cindrel Peak on September 8) and increasingly delayed as the altitude decreases (Păltiniș, October 8) as a result of the cooling processes produced from the lowest to the highest altitude. Also, the last snow disappears early at lower altitudes, due to the fact that heating processes occur from the lowest to the highest altitude. At Păltiniș, the last snow occurs, on average, on the May 10.

The extreme dates of the first snowfall, compared to the average dates of autumn, are possible almost one month and a few days earlier, at 1453 m altitude (Păltiniș, September 14) and almost two months earlier at > 2000 m altitude (Cindrel Peak 2224 m). Also, compared to the average dates of the last snow of the spring, the latter snow are possible about a half month later, at about 1453 m (Păltiniș, May 25) and approximately one month later, at more than 2000 m (2224 m Cindrel Peak).

Due to the wide variability of climate, snow is possible in any month of the year to over 2000 m altitude and range from September to May at Păltiniș, contributing, to the possibility of practicing winter sports (skiing, snowboarding and snowmobile). An average interval between possible snow data is within the average snowfall production and it shows a proportional increase with altitude, according to a vertical gradient of 7-8 days / 100 m.

An average duration of this interval varies from about 208 days at altitudes of 1453 m (208 days at Păltiniș) and 240 days on the highest ridges. The maximum possible range with snow between the earliest and the latest dates of the occurrence of the first snow of autumn and the late snow of spring is 300 days at over 2000 m altitude, and increasingly lower as the altitude decreases (253 days Păltiniș). The smallest duration possible, ranges from 145 days to 225 days at Păltiniș and Cindrel Peak.

The minimum, average and maximum monthly number of days with snow, unlike the possible duration interval with snow, includes exclusively the number of days with solid precipitation that generate snow cover. Being conditioned by the lower temperatures of the air, but also by the atmospheric circulation, the distribution across Massif Cindrel is largely determined also by altitude and slope orientation (BLANCHET, 2009).

On average, snowfalls occur between 68-69 days/year at Păltiniș and 87 days/year on Peak Cindrel. Within these limits, it is placed the Meteorological Station Păltiniș, where the multiannual averages have values of about 69 days/year. The maximum number of days with snow from a year varies between 97 and 99 days at Păltiniș and 137 days on Cindrel Peak (Table 3).

Table 3. Average, minimum and maximum number of days with snow at Păltiniș between 1986 and 2015.

Dates Păltiniș/ month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Average	10.9	10.8	11.1	7.2	1.3				0.3	3.2	6.9	10.4	68.5
Minimum (2008)	6	7	5	3						1	3	11	36
Maximum (1987-1988 and 2004-2005)	23; 26	9; 18	18; 15	15; 6	4					3	12	18; 10	99; 90

Source: processed data from Păltiniș weather station

During the year, the distribution of the values shows a gradual increase of the monthly average number of days with snow, from August (Cindrel Peak) and September at Paltinis, reaching a maximum in winter and spring months (December, January, February and March (10.4; 10.9; 10.8; 11.1 days at Păltiniș), values that diminishes with increasing proportion of days with positive temperatures.

RESULTS AND DISCUSSIONS

The non-periodic variability of the number of days with snow in the Carpathian sector of Cindrel, during the period 1986-2015 highlights several aspects:

- at the meteorological station Păltiniș, positive deviations from the annual average have a higher share at the expense of negative in the first interval, and negative in the second;
- the higher deviations (positive) from the multiannual average in the analyzed which were recorded at Păltiniș were +30.5 and +29.5 days in 1987-1988 and 2013 and the lowest deviation (negative) from the annual average which was also recorded at Paltinis were -45.5 and -48.5 days in the winters 2009 and 2012;
- in the Carpathian sector of Massive Cindrel, the number of days with snow is in decline, registering a higher concentration of negative deviations from the annual average in the last part of the analyzed period (after 2005);

- in the last decade in particular, there is a sustained trend of reducing the number of days with snow on the background of global climate warming compared with the first period analyzed (1986-2005), when there is an alternation of positive and negative deviations.

The snow is a meteorological element particularly vulnerable to the effects of global warming, through the dependence on temperature, precipitation and wind (HAIDU, 2002). It is an important resource for tourism, water supply and energy production, but can cause some major natural hazards (avalanches, blizzards). Regarding the winter sports practice, snow is a source of economic development for the people around the mountain resorts and tourism resorts depending on the existence and persistence of snow thickness, optimal for sports specific to the cold season (ski, snowboard).

It was found that investments in the development of mountain tourism resorts where winter sports are profitable are made only if the number of days with snow per year is more than 100. Changes arising from global warming in the existence and persistence of snow may have direct implications on natural mountain habitat (rivers and ecosystems) and indirect in terms of economic activities.

The average data of the occurrence and persistence of snow are dependent on the average data for the first and last snowfall, which depends on the thermal regime, air circulation and wind regime.

The first snow, as average date, is in autumn, about four days later than the first snow at an altitude of 1453 m (Păltiniș), being increasingly closer to the date when the first snow falls as the altitude increases. The last snow disappears in spring, six days later than the last snow at about 1453 m altitude (at Păltiniș on the May 16) or 10-15 days later, as the altitude increases.

The extreme dates of the appearance and disappearance of snow are important both in terms of range of risk for snow, but also in terms of economic activities, by the damage it can make to society and above all to the tourism operators in the resort area. In the autumn, the emergence of snow associated with severe frost or snow storms can adversely affect transport in the region, given the transit taking place on DN 7 (it should be noted here the hearty snow from the autumn of 1995 between October 31 and November 5, when the access to the resort was blocked on DJ 106A for six days). In spring, sudden melting of snow may cause flooding (as the flooding in 1977) and reduce favorable period for practicing specific winter sports. Instead, the presence of the snow cover during late spring (as was the case in 1997), on the one hand, can promote tourism activities specific to the cold season, and on the other hand can increase the contingency of avalanches.

The earliest snowfall is possible at altitudes >2000 m, from the second decade of August (August 15 on Cindrel Peak), with delays of about a month at smaller altitudes (September 15 at Păltiniș). The latest snow (autumn) is possible about two months later than the average date. It produced at Păltiniș station during the second decade of November (November 17, 2000). The earliest snow (spring) first melts at altitudes of about 1453 m in the first decade of April (April 5 at Păltiniș) and gradually later as the altitude increases. The latest snow (spring) may resist even in summer, until the first decade of June (June 1, 1991 and June 5, 1997 at Păltiniș).

An average of the period with snow cover (between the average date of the first and the last day with snow) varies between 210 days at altitudes of 1453 m (Păltiniș) and 300 days at altitudes > 2000 m (Cindrel Peak). The maximum possible duration of this period (from extreme data, the earliest and that the latest snow) ranges from 259 days at Păltiniș to 300 days on Cindrel Peak. Minimum possible interval with snow is of 154 days at Păltiniș, but the value increases up to 228 days, at Cindrel Peak.

The minimum, average and maximum monthly days with snow is lower than the likely duration of snow cover, because hot air invasions occur in winter, when fallen snow melts. The average annual number of days with snow cover is about 222 days at high altitude and about 140 days at the resort. The maximum number of days per year with snow on the Cindrel Peak exceeds 262 days, and at Păltiniș, it oscillates around 188 days (year 1988). During the year, most days with ground covered with snow are in January (30 to 31 days / month), provided that at altitudes > 2000 m, the same maximum values (31 days / month) persists into early spring, in March. The number of days with snow cover reduces with the increasing proportion of days with positive temperatures. At more than 2000 m, the snow remains even during the warm season, when recording the smallest number of days with snow-covered ground (between 0.3 and 0.8 days / month of August and July). At Păltiniș, they occur in September (0.1-0.2 days / month).

Non-periodic variability of the number of days with snow cover determines the Massif Cindrel tourist vocation for practicing winter sports. If at altitudes >1500 m (Păltiniș weather station), positive deviations of the number of days with snow from the annual average have a lower frequency at the expense of negative deviations, at altitudes <1000 m, the prevailing negative deviations at the expense of positive throughout the period analyzed (1986-2015), indicate greater frequency of winters with less snow due to global warming (NICULESCU, 1996).

The greatest deviation (positive) of the number of days with snow-covered ground during the period 1986 to 2015 was recorded at Păltiniș Resort in 1988 (of + 48zile) and the smallest deviations (negative) from the multiannual average at Păltiniș Station, in winters 2010 and 2014 (to -61 or -58 days). In terms of number of days with snow cover, there was a sustained reduction at Păltiniș after 2005. This shows that, with global warming, the duration of possible time with snow drops and thickness decreases (Fig. 2).

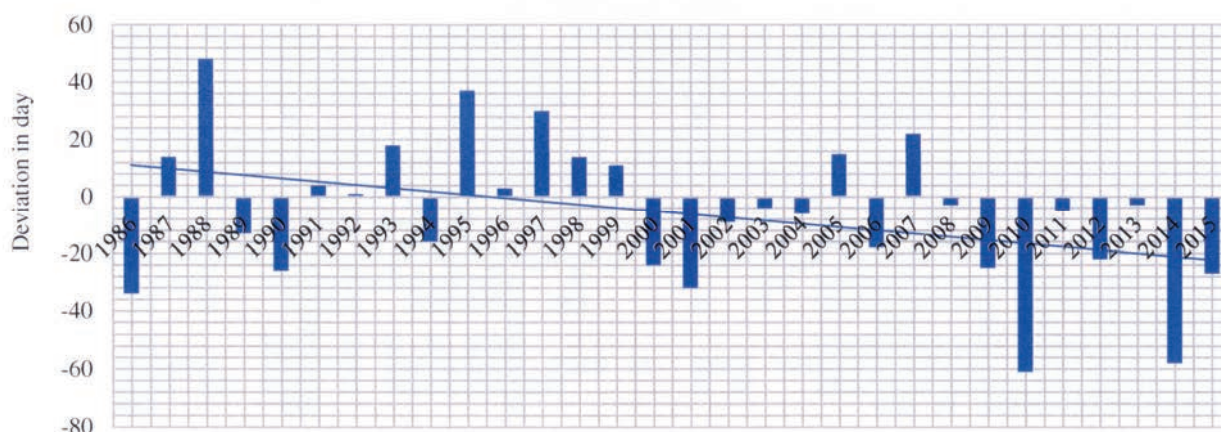


Figure 2. Variability of the number of days with snow cover at Păltiniș, between 1986 and 2015.

Average thickness and maximum decadal and monthly snow cover is an important source for tourism activity undertaken by people around mountain resorts where winter sports are practiced. Economic profitability of the tourism resorts is consistent with the presence of snow that has the appropriate thickness (at least 15-20 cm thick) for skiing. Eckel (1938, cited by LATERNER & SCHNEEBELI, 2003) highlighted the thresholds of the thickness of the snow layer as a prerequisite for the skiing resorts in Switzerland, showing the thickness of 30 cm is considered sufficient, 50 cm is the optimum thickness and the 70 cm is great for skiing (Table 4).

Table 4. Average, minimum and maximum thickness of the decadal and monthly snow cover at the meteorological station Păltiniș (1986-2015).

Păltiniș/month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
Average decade I	27	37	39	21	1					1	4	12	17,8
Average decade II	28	45	44	16	1					1	5	19	20
Average decade III	32	42	35	5	1				1	1	10	21	18,4
Monthly average	27	38	35	12	1					1	6	17	17,3
Maximum 1997 II	7	21	9	102							10	26	21,9
2006 II	49	68	107	6							6	2	29,8
Minimum 1986 I	4	5	8								2	0	2,4
II	10	9	2								1	5	3,4
Monthly maximum 2005	31	79	81	4						2	14	29	30
Monthly minimum 1986	5	8	4							3	1	8	3,6

Source: Processed data after National Meteorological Administration archive

The variation in time of the thickness of the snow cover is determined both by the values of solar radiation, which becomes minimum on the winter solstice and the geographical position of the massif Cindrel (exposure to sunlight or exposure to north), determined by the characteristics of the general circulation of the atmosphere.

At about 1453 m altitude (Păltiniș), the monthly average thickness of the snow cover gradually increases from early autumn (September or October) until second part of spring (April-May). At more than 2000 m (Peak Cindrel), the range for the production of snow is from September to May, but it may also range from August to May. The highest decadal average thickness of snow is reported in the second decade of February and March (45-44 cm). In terms of winter sports (skiing, snowboarding), monthly average thickness of the snow cover is considered sufficient at Păltiniș Resort between January and March.

The maximum thickness of the snow cover, in contrast to average values, is generated by exceptional circumstances, in the first place determined by the characteristics of the general circulation of the atmosphere. Heavy snowfalls may fall in certain winters as it was the case in 2004, 2005 and 2006, and previously analyzed period in the winter 1953-1954, when in the valleys, the snow reached 18 m thickness (TOPOR, 1957; BOGDAN & DRAGOTĂ, 2000).

In general, the highest decadal maximum thickness of the Carpathian Massive Cindrel ranged between 102 and 107 cm at Păltiniș (in the second decade of April 1997 and March 2006) and over 2,000 cm on the highest mountain peaks.

Due to the fact that the measurements were made in sheltered places, the maximum thicknesses are somehow not influenced by blizzards (SOROCOVSCHI, 2003).

Compared to other ski resorts (the Alps, the Caucasus and the Balkans), the Massif Cindrel and Păltiniș cannot be considered very favorable for practicing winter sports (except Oncești located at 1600-1700m). In relation to the climatic conditions of the area Cindrel Massif, there are good conditions for winter sports in the period from December to March, mainly on slopes located at 1500 m (slope Oncești) from Păltiniș resort (SURDEANU, 2002).

CONCLUSIONS

As a result of global warming and hence mountainous climate, important changes occurred in the thermal regime and the rainfall with significant economic implications for skiing in the winter season in most of the mountain resorts. The most important changes occurred between 1986 and 2015, when it was registered a downward trend in the number of days with snow cover (especially after 2005), both in the period from November to April and in full ski season (December - March). For this reason, local authorities should make substantial investments to help the owners in equipping ski slopes of artificial snow and with government projects, dedicated to the development of tourism infrastructure.

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Received: March 31, 2017
Accepted: July 7, 2017

RESEARCH APPROACHES REGARDING BIOLOGICAL CONTROL OF *Fusarium* sp. STEM ROT OF SWEET POTATO PRODUCED ON SANDY SOILS

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Abstract. The sweet potato *Ipomoea batatas* (L.) Lam. is a world wide appreciated vegetable due to its nutritional value. It is a member of the Convolvulaceae family, originated from the tropical areas of America. In Romania, the sweet potato is less known for both growers and consumers. However, at the Research-Development Centre for Field Crops on Sandy Soils (RDCFCSS) – Dăbuleni, this vegetable has been successfully introduced in the crop rotation for almost five years; the crop technology was adapted and improved for the sandy soils conditions from the southern Oltenia. For this crop, the spectrum of plant diseases is, however, reduced in our country, with no management problems or economic important losses before harvest. However, in 2016, one case of *Fusarium* stem rot was noticed for the first time in the field. The infected plant was visibly affected and its production potential was reduced to half. Although the infection was limited to a single plant and did not spread during the whole vegetation season, the severity of the attack triggered our concern. The aims of this study was the identification of the pathogenic infection as there are similarities between the symptoms of disease and detect some biological means to suppress the evolution of such an infection. Thirty bacterial strains were isolated for this purpose, from the rhizosphere of sweet potato grown in the same field, and two *Bacillus* sp. strains expressed high antagonistic activity, in vitro, against *Fusarium* stem rot of sweet potato.

Keywords: *Ipomoea batatas*, *Fusarium* stem rot, biocontrol bacteria.

Rezumat. Studiu privind combaterea biologică a putregaiului tulpinilor cauzat de *Fusarium* sp. la cartoful dulce cultivat pe soluri nisipoase. Cartoful dulce *Ipomoea batatas* (L.) Lam. este o legumă apreciată în întreaga lume datorită proprietăților nutritive. Specia face parte din familia Convolvulaceae, originară din zonele tropicale ale Americii. În România, cartoful dulce este mai puțin cunoscut atât pentru cultivatori, cât și pentru consumatori. Cu toate acestea, la Centrul de Cercetare-Dezvoltare pentru Cultura Plantelor pe Nisipuri - Dăbuleni această plantă este cultivată cu succes de aproximativ cinci ani, tehnologia de cultură fiind adaptată și îmbunătățită pentru condițiile solurilor nisipoase din sudul Olteniei. În prezent, spectrul de boli la această cultură este redus în țara noastră, iar menținerea sub control a bolilor nu creează dificultăți sau pierderi economice înainte de recoltare. Cu toate acestea, în 2016, a fost detectată o plantă cu putregai la nivelul tulpinii. Planta infectată era vizibil afectată, iar potențialul de producție i-a fost redus la jumătate. Chiar dacă infecția era izolată, și nu s-a extins la plantele adiacente pe tot parcursul sezonului de vegetație, severitatea atacului este îngrijorătoare. Scopul acestui studiu este acela de a identifica patogenul care a cauzat simptomele de boală și de a găsi o soluție pentru combaterea biologică a eventualelor infecții. Pentru aceasta au fost izolate treizeci de rizobacterii din aceeași cultură obținută pe terenuri nisipoase. Dintre acestea, două tulpini de *Bacillus* sp. au prezentat activitate antagonică, in vitro, față de specia de *Fusarium* care a cauzat putrezirea tulpinilor de cartof dulce.

Cuvinte cheie: *Ipomoea batatas*, fuzarioza tulpinilor de cartof dulce, bacterii de biocontrol.

INTRODUCTION

The sweet potato (*Ipomoea batatas*) is a world wide appreciated vegetable due to its nutritional value. It is rich in complex carbohydrates, minerals (P, K, Ca and Na), vitamins (mostly vitamin C, B5 and B6) and carotenoids, especially in orange and purple fleshed varieties (PARLE, 2015). It is also considered a medicinal plant with anti-cancer and anti-inflammatory activity (SANDHYA et al., 2011). Due to its lower glycaemic index sweet potatoes are also suitable in diabetes diet, as it slowly releases glucose into the bloodstream and raise the blood levels of adiponectin, which helps the body to metabolize insulin (DUTTA, 2015).

This plant is mainly grown for tubers production, although in some Asian counties, in the human diet, there are used both tubers and sprouts from the sweet potato plants. However, it can be also found as ornamental plant, improving the landscape architecture of outdoors public areas, where it is associated with other ornamentals, in big pots or containers.

In our country, the sweet potato was experimentally introduced by Maier I. in 1954, and formally studied by CIOFU et al. (2004) and MUȘAT (2013) at the Faculty of Horticulture, University of Agronomic Sciences and Veterinary Medicine Bucharest. Two Romanian varieties have been obtained through conservative selection process, Victoria IANB and Crux (CIOFU et al., 2004). These two varieties were available on the market until 2008 and 2009, respectively (Official Monitor of Romania – Part I, 2007). From 2015, the Korean company Love of Soil Machinery Co. LTD managed to register other two varieties in Romania, KSC1 (South Korean Chestnut) and KSP1 (South Korean Pumpkin), which are now listed in the Official Catalogues of ISTIS (State Institute for Variety Testing and Registration). The registration of these varieties was sustained by the “Romanian-Korean Collaborative partnership for the sweet potato”, established between Kyungpook National University (KNU) in South Korea and the Academy of Agricultural and Forestry Sciences “Gheorghe Ionescu Șişești” Bucharest (DIACONU et al., 2016). Based on this collaboration protocol, since 2012, research on sweet potato culture has been carried out in southern Oltenia, at Research-Development Centre for Field Crops on Sandy Soils (RDCFCSS) Dăbuleni. Currently, the sweet potato is considered a valuable crop for the pedoclimatic conditions of that area. To our knowledge, the sweet potato is now

cultivated on small areas in counties like Argeş, Brăila, Caraş-Severin, Cluj, Dolj, Gorj, Hunedoara, Ilfov, Olt, Prahova, Satu Mare and Vaslui (DIACONU et al., 2016).

Ipomoea batatas is a thermophilic plant, drought tolerant, which grows well on medium fertile soils, well drained with loose structure. In our country, the sandy soils of southern Oltenia region offer favourable pedoclimatic conditions for sweet potato crop. Therefore, during the last five years, the RDCFCSS Dăbuleni managed to acclimatize some Korean varieties of sweet potato, and also implemented and improved the culture technology of this crop in our country. During this time the phytosanitary aspects in the field did not raise crop management problems or economic losses before harvest, although large quantitative losses occurs during storage. However, in 2016, one case of *Fusarium* stem rot was noticed for the first time in the field. Although the infection was limited to a single plant, and did not spread during the whole vegetation season, the severity of the attack triggered our concern. Therefore, one of the aims of this study was to identify the pathogen inducing the stem rot as there are similar symptoms produced by different plant pathogens. Another goal was to suppress the evolution of such an infection using some native biological means.

In our study we isolated thirty bacterial strains from the sweet potato rhizosphere of the plants grown in the same field, with sandy soil conditions. Two *Bacillus* sp. strains were selected based on their high antagonistic activity, *in vitro*, against *Fusarium* stem rot of sweet potato.

MATERIAL AND METHODS

Phytopathogenic fungi. Several Korean varieties of *Ipomoea batatas* were experimentally grown in 2016, at the RDCFCSS Dăbuleni, Dolj County, Romania (Fig. 1). These five varieties, KSC1, KSP1, Hayanmi, Juhwangmi and Yulmi, were each grown on 10 square meters, using 30 plants/ variety.



Figure 1. Korean varieties of *Ipomoea batatas* experimentally grown in 2016, at RDCFCSS Dăbuleni (original).

In Hayanmi variety, one plant with symptoms of wilts and stem rot was detected (Fig. 2a, b). The leaves colour modified from green to reddish-purple and yellow (Fig. 2a). The main vein was dry starting from the base of the plants, the stem progressively turned black and it was easily broken by hand. Necroses of the vascular bundle were seen (Fig. 2b) and therefore, the plant material was taken in the laboratory for further analysis and pathogen identification.

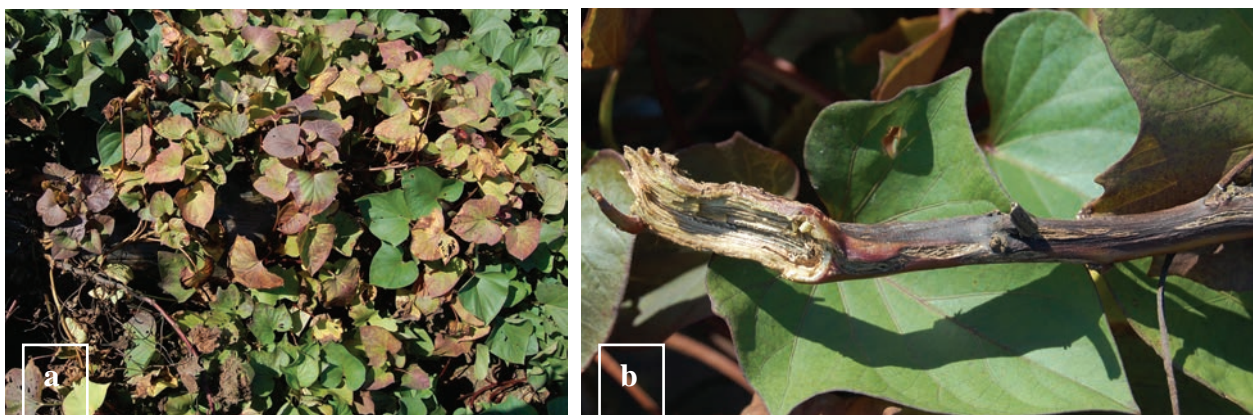


Figure 2. Wilting and dry stem rot of sweet potato plant from Hayanmi variety grown on the sandy soil of southern Oltenia (2016):
a. abnormal leaves colour, and b. dry stem rot of sweet potato (originals).

Beneficial bacteria. Soil samples from the sweet potato culture grown in the sandy soils of RDCFCSS Dăbuleni were analyzed in order to isolate indigenous bacterial strains with antagonistic activity against *Fusarium* stem rot of *Ipomoea batatas*. The performed isolation protocol was according to BOIU-SICUIA et al. (2016).

Purification and characterization of the isolates was carried out by growing the bacteria on different culture media. For colony morphology description, each strain was grown on LB agar using the streak plate method to obtain isolated colonies. To evaluate the oxygen requirement each strain was grown on nutrient broth in static incubation. Gram reaction was carried out using the 3% KOH test.

Antagonism evaluation. The antagonistic activity of the isolated bacteria was evaluated *in vitro* using the dual-culture assay. The test was performed on PDA media against *Fusarium* stem rot of *Ipomoea batatas*. The antifungal activity was calculated according to ISLAM et al. (2009).

Plant beneficial bacterial tests. The isolated bacterial strains were analyzed for their plant beneficial traits and biocontrol mechanisms. The phytohormone production was quantified on Luria Bertani (LB) medium and LB supplemented with 5mM tryptofan, as precursor of auxin (PATTEN & GLICK, 1996). Several enzymes production, like amylase, phosphatase, cellulase, chitinase, and proteases were analyzed (SICUIA et al., 2015), as they are correlated with plant growth promotion or plant protection. Bacterial swimming and swarming motility was also evaluated as it correlates with plant root colonization and pathogen competition for the niche (CONSTANTINESCU et al., 2010).

Microbial identification. The infected plant material was maintained in humid chamber for almost one month. The fungal growth developed on the sweet potato stem was analyzed under the binocular magnifier and then was purified on Potato–Dextrose–Agar (PDA) medium. The identification was made using two laboratory procedures. At first, there were used classical methods based on colony morphology and microscopic characteristics, and then the Biolog identification system for filamentous fungi was used according to the standard protocol. The antagonistic bacterial strains were identified based on their phenotypic and biochemical characteristics using the Biolog GEN III identification system.

RESULTS AND DISCUSSION

During the vegetation season of 2016, five Korean varieties of *Ipomoea batatas* were experimentally grown at RDCFCSS Dăbuleni. One case of *Fusarium* stem rot was noticed during the whole season of 2016, at a single plant, in Hayanmi variety. The incidence of disease in this variety was 3.33%, and 0.66% in the experimental plot. Although the infection was limited to a single plant and did not spread during the whole vegetation season, the severity of the attack triggered our concern. Therefore, the pathogen identification was carried out in laboratory conditions.

After one month of incubation at room temperature in the humid chamber, the pathogen developed white cottony mycelia on the sweet potato stem (Fig. 3a). The microscopic analysis showed a septate filamentous fungus (Fig. 3b) with typical *Fusarium* like macroconidia (Fig. 3c).

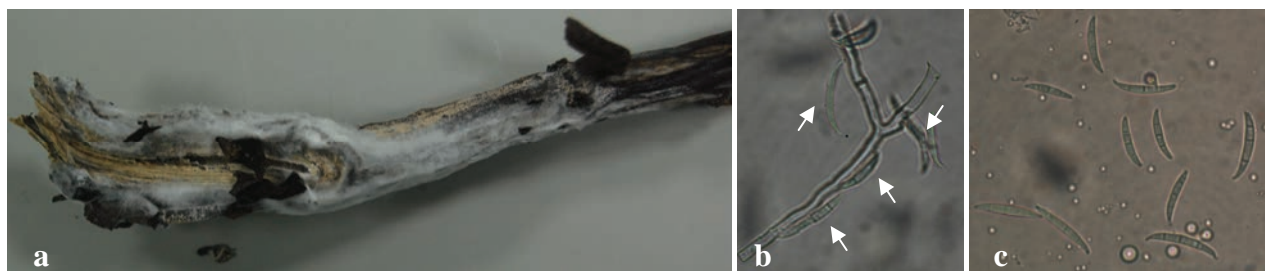


Figure 3. *Fusarium* stem rot of sweet potato: **a.** infected stem, **b.** septate mycelium with conidia (arrows), and **c.** *Fusarium* macroconidia with three-septa, and slight dorsi-ventral curvature (originals).

Pure cultures were obtained on PDA (Potato Dextrose Agar), MA (Malt extract Agar) and CYA (Czapek Yeast extract Agar) culture media. On PDA, the fungal colony was flat, cottony with purple pigmentation (Fig. 4a), and on MA the pigmentation was reddish (Fig. 4b) and the growth rate was much slower. Unlike these, on CYA medium, the pathogen grew abundantly and much faster, and developed woolly and buttery coloured colonies (Fig. 4c). On PDA medium, the pathogen produced both micro- and macroconidia, and also chlamydospores. However, on MA the sporulation was poor, but on CYA growth medium conidia production was highly stimulated, but only micro- and mesoconidia were produced.

Analyzed with the Biolog system for filamentous fungi, the pathogen was identified as belonging to *Fusarium* genus, the most similar species being *F. subglutinans*, *F. verticillioides* and *F. oxysporum* (Fig. 5, Table 1).

Both microbiologic and biochemical analysis revealed that the pathogen is affiliated to *Fusarium* genus. The Biolog FF identification is influenced by the metabolic reaction of the fungi grown in 95 carbon source kit, where substrate oxidation and cell growth are measured spectrophotometrically and compared with the database collection. Therefore, due to strain characteristics there can be found some differences in the time consumption of the culture substrate that can confuse the

identification or fungi similarity from one day to another (Table 1). However, the fungal species revealed as similar with our *Fusarium* sp. strain are basically the same: *F. subglutinans*, *F. verticillioides* and *F. oxysporum*. The macro and microscopic analysis leads to *F. subglutinans* but atypical to the characters of this species, the studied strain of *Fusarium* sp. can form chlamydospores, a character that does not exclude membership in *F. oxysporum* species. Despite uncertainty at species level, *Fusarium* spp. pathogens can cause particular problems in agricultural crops. Although in our country the sweet potato culture is not economically affected by fusariosis, the presence of *Fusarium* sp. pathogens suggests the importance of finding a cure for this disease before it becomes devastating.

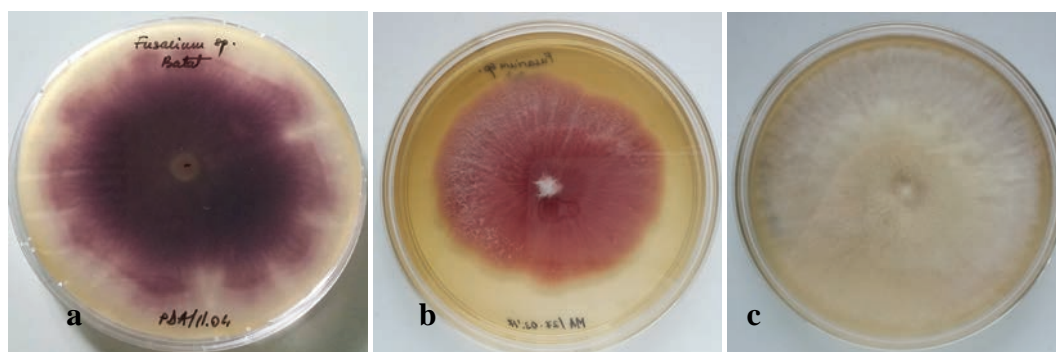


Figure 4. *Fusarium* colony morphology on: a. PDA, b. MA, and c. CYA growth media (originals).

Table 1. *Fusarium* biochemical similarities revealed by the Biolog identification system for filamentous fungi.

<i>Fusarium</i> species matches	SIM values at specific incubation times required for filamentous fungi identification			
	24h	48h	72h	168h
<i>F. subglutinans</i> (Wollenweber & Reinking) P.E.Nelson BGB	-	-	0.066	0.491
<i>F. verticillioides</i> (Saccardo) Nirenberg BGE	-	0.104	0.428	0.288
<i>F. oxysporum</i> Schlechtendahl: Fries BGB	-	0.372	-	0.007
<i>F. sacchari</i> (Butler) W.Gams BGA, current name and common synonym <i>F. subglutinans</i> (Wollenw. & Reink) Nelson	0.346	0.097	0.038	-
<i>F. pseudoanthophilum</i> Nirenberg & O'Donnell	-	0.153	-	-
<i>F. subglutinans</i> (Wollenweber & Reinking) P.E.Nelson BGA	0.026	-	0.021	-
<i>F. verticillioides</i> (Saccardo) Nirenberg BGA	-	-	-	0.010
<i>F. sambucinum</i> var. <i>sambucinum</i> Fuckel	0.005	-	-	-
<i>F. udum</i> E.Butler	0.002	-	-	-
Sum of the SIM	0.379	0.726	0.553	0.796

Note: For species identification the similarity index value (SIM) must be ≥ 0.9 at 24h of incubation, ≥ 0.7 at 48h of incubation, and ≥ 0.65 at 72h of incubation. If SIMs are under the values required, but all species listed belong to the same genus and their combined SIMs gives a value above the one recommended then the MicroLog identification system will give the confirmation that the analyzed microbe is in the listed genus.

View Details

Project: ML5
Plate Number: 1
Plate Type: FF
Strain Type: Fusarium
Incubation Hours: 168

Sample ID: Fusarium Batat
Isolated from: Ipomoea batatas cv. Hayanmi (crown & stem rot)
Strain designation:
Operator's name: Siciua Oana

Pos/Neg Graphic | Pos/Neg Numerical | ODs

Color Data

	1	2	3	4	5	6	7	8	9	10	11	12
A	+	+	+	+	+	+	+	+	+	+	+	+
B	+	+	+	+	+	+	+	+	+	+	+	+
C	+	+	+	+	+	+	+	+	+	+	+	+
D	+	+	+	+	+	+	+	+	+	+	+	+
E	+	+	+	+	+	+	+	+	+	+	+	+
F	+	+	+	+	+	+	+	+	+	+	+	+
G	+	+	+	+	+	+	+	+	+	+	+	+
H	+	+	+	+	+	+	+	+	+	+	+	+

Genus ID : Fusarium

	PROB	SIM	DIST	Organism Type	Species
=>1	---	0.491	2.746	Fusarium	<i>Fusarium subglutinans</i> (Wollenweber & Reinking) P.E.Nelson BGB
2	---	0.288	2.923	Fusarium	<i>Fusarium verticillioides</i> (Saccardo) Nirenberg BGE
3	---	0.010	4.039	Fusarium	<i>Fusarium verticillioides</i> (Saccardo) Nirenberg BGA
4	---	0.007	4.133	Fusarium	<i>Fusarium oxysporum</i> Schlechtendahl:Fries BGB

View Selected Species
Compare To Other Species
Clear Other Species
Close

Figure 5. *Fusarium* phenotypic identification with the Biolog system for filamentous fungi.

Comparing the symptoms of disease, the macroscopic and microscopic characteristic of the pathogen pure cultures and the nutritional preferences revealed by the Biolog system, the pathogen was identified as *Fusarium* sp. Taking into account that sweet potato is susceptible to *Fusarium* stem rot (OKADA et al., 2017), the management of this disease should be taken into consideration. In our study, the infected plant expressed an index disease of 3, according to OGAWA et al. (1979) disease scale. Therefore, preventing the sweet potato plants from this pathogen is an important issue that must be solved. In our study, we searched for biological control agents. In this regard, we isolated several bacteria from the rhizosphere of healthy plans. Thirty bacterial strains were purified, 17 of them being Gram positive (Table 2).

When analyzed for their plant growth promoting ability, 15 strains revealed phosphatase activity on Pikovskaya agar medium, after 7 days of incubation at 27°C. Amylase activity, correlated with gibberellins production, was revealed by 13 strains, when bacteria were grown for three days on nutrient agar medium supplemented with 4% soluble starch (Table 2).

Table 2. Characteristics of the rhizobacteria isolated from sweet potato.

Bacterial strain	Gram reaction (with 3%KOH)	Phosphatase* (on PKV) - 7 days -	Amylase* - 3 days -	Bacterial strain	Gram reaction (with 3%KOH)	Phosphatase* (on PKV) - 7 days -	Amylase* - 3 days -
Dj1	G +	–	–	Dj16	G +	–	+ 2mm
Dj2	G +	–	–	Dj17	G –	+ 4mm	–
Dj3	G +	+ 1mm	+ 15mm	Dj18	G +	–	–
Dj4	G +	–	–	Dj19	G –	+ 2mm	–
Dj5	G +	–	–	Dj20	G +	+ 2mm	–
Dj6	G +	+ 1mm	+ 5mm	Dj21	G –	+ 2mm	–
Dj7	G +	–	–	Dj22	G –	+ 2mm	–
Dj8	G +	–	–	Dj23	G +	–	–
Dj9	G –	+ 2mm	+ 2mm	Dj24	G –	–	+ 5mm
Dj10	G –	–	–	Dj25	G +	+ 1mm	+ 12mm
Dj11	G –	+ 2mm	+ 1mm	Dj26	G –	+ 1mm	–
Dj12	G –	–	–	Dj27	G +	+ 1mm	+ 3mm
Dj13	G +	–	+ 1mm	Dj28	G –	+ 1mm	+ 1mm
Dj14	G –	–	+ 19mm	Dj29	G +	+ 3mm	+ 1mm
Dj15	G –	–	–	Dj30	G +	+ 1mm	+ 1mm

Legend: "G" gram reaction, "–" negative reaction, "+" positive reaction, * clear zone width induced by the enzyme.

Twenty-two of the isolated bacterial strains were also examined for their ability to produce auxin phytohormone. Indole 3-acetic acid (IAA) was quantified in cultures obtained in LB broth and LB supplemented with tryptophan, as precursor of IAA phytohormone. Among the tested bacterial isolates, four of them, designated as Dj 17, Dj 19, Dj 21 and Dj 30 produced high amounts of IAA (Table 3), therefore suggesting their potential in plant growth stimulation. These strains were able to synthesize 42.76 to 57.6 μg IAA/ml in LB broth and 90.14 to 98.08 μg IAA/ml in LB with tryptophan. According to these results, our strains were superior to the plant growth promotion strains isolated by ISLAM et al. (2016) where the maximum concentration of IAA was 51.28 μg IAA/ml in the culture medium supplemented with 2 mg/ml L-tryptophan. These results suggest that some of these isolates possess a number of traits associated with plant growth promotion.

To evaluate the biocontrol potential of the isolated strains, we analyzed *in vitro* some of the mechanism involved in direct competition against plant pathogens. Thus, we identified sixteen bacterial isolates with both swimming and swarming motility, which can easily colonize the rhizosphere and compete the pathogens of this niche. Enzymes involved in fungal cell wall degradation were also screened, but only nine strains (Dj3, Dj6, Dj9, Dj11, Dj14, Dj18, Dj22, Dj24, and Dj29) revealed cellulase activity and three strains (Dj3, Dj6 and Dj24) revealed chitinase production (Table 3).

Table 3. Production of IAA phytohormone by the rhizobacterial strains isolated from sweet potato.

Bacterial strain	IAA ($\mu\text{g}/\text{ml}$)		Bacterial strain	IAA ($\mu\text{g}/\text{ml}$)	
	LB	LB with 5mM tryptophan		LB	LB with 5mM tryptophan
Dj1	1.7	3.79	Dj18	19.82	27.4
Dj3	8.37	14.05	Dj19	57.24	90.14
Dj6	9.61	15.42	Dj20	17.55	34.62
Dj7	0.72	8.24	Dj21	57.6	92.91
Dj8	8.24	24.63	Dj22	16.8	54.66
Dj9	1.44	3.4	Dj24	10.05	25.1
Dj10	9.8	16.73	Dj25	1.76	7.19
Dj11	1.5	4.05	Dj27	2.61	37.65
Dj14	2.22	5.42	Dj28	6.01	36.5
Dj16	5.1	6.99	Dj29	17.98	58.86
Dj17	49.62	97.34	Dj30	42.76	98.08

The rhizobacterial strains were also tested for acetoin production, using Voges-Proskauer test (Table 3). Six of the analyzed strains (Dj3, Dj17, Dj19, Dj21, Dj23, Dj25) revealed clear acetoin production, however for other four strains (Dj6, Dj18, Dj20 and Dj24) this volatile compound was not always detected (in one of the three replicates). Acetoin (also known as 3-hydroxy-2-butanone), along with other microbial volatile compounds, such as 2,3-butanediol, produced by plant beneficial rhizobacteria, were shown to activate induced systemic resistance in the model plant *Arabidopsis thaliana* (RYU et al., 2003; RUDRAPPA et al., 2010).

Table 4. Biochemical analysis of the rhizobacteria isolated from sweet potato.

Bacterial strain	Motility		Protease activity* (after 3 days)			Cellulase* (5 days)	Chitinase (5 days)	Acetoin (3 days)
	Swimming	Swarming	Milk casein	Pure casein	Gelatine			
Dj1	+	+	–	–	+ 0.5cm	–	–	–
Dj2	+	–	+ 0.5cm	–	+ 1cm	–	N.A.	–
Dj3	+	+	+ 2cm	+ 1.2cm	+ 2.4cm	+ 0.6cm	+	+
Dj4	–	–	+ 0.4mm	–	+ 1.9 cm	–	N.A.	–
Dj5	–	+	+ 0.1cm	–	+ 0.6cm	–	N.A.	N.A.
Dj6	+	+	+ 2.2cm	+ 1.9cm	+ 2.4cm	+ 1cm	+	±
Dj7	–	+	+ 0.1cm	–	+ 0.9cm	–	–	–
Dj8	+	–	+ 0.1cm	–	–	–	–	–
Dj9	+	–	+ 0.7cm	–	+ 1.3cm	+ 1.2cm	–	–
Dj10	–	+	+ 1.4cm	+ 1.4cm	+ 1.4cm	–	–	–
Dj11	–	–	+ 0.1cm	–	–	+ 0.4cm	–	N.A.
Dj12	+	–	N.A.	–	–	–	N.A.	N.A.
Dj13	–	–	+ 0.5cm	–	+ 1.6cm	–	N.A.	–
Dj14	+	+	–	–	+ 1.7cm	+ 1.7cm	–	–
Dj15	–	–	–	–	+ 0.4cm	–	N.A.	–
Dj16	+	–	+ 0.2cm	+ 0.8cm	+ 1cm	–	–	–
Dj17	+	+	+ 0.5cm	–	+ 0.5cm	–	–	+
Dj18	+	+	+ 0.9cm	+ 1.4cm	+ 2.7cm	+ 1.9cm	–	±
Dj19	+	+	–	–	+ 0.7cm	–	–	+
Dj20	+	+	+ 0.6cm	+ 1.4cm	+ 2.2cm	–	–	±
Dj21	+	+	+ 0.2cm	–	+ 1cm	–	–	+
Dj22	+	+	+ 1.5cm	+ 1.5cm	+ 3cm	+ 0.9cm	–	–
Dj23	+	+	–	–	+ 0.5cm	–	N.A.	+
Dj24	+	+	+ 2.1cm	+ 1.8cm	+ 3.1cm	+ 1cm	+	±
Dj25	+	+	N.A.	+ 1.5cm	+ 2cm	–	–	+
Dj26	+	+	N.A.	–	–	–	N.A.	–
Dj27	+	+	N.A.	+ 0.6cm	+ 1.5cm	–	–	–
Dj28	+	+	N.A.	+ 0.9cm	+ 0.6cm	–	–	N.A.
Dj29	–	–	N.A.	+ 1.5cm	+ 1.8cm	+ 0.8cm	–	–
Dj30	–	–	N.A.	–	+ 0.3cm	–	–	–

Legend: "–" negative reaction, "+" positive reaction, "N.A." not available, * clear zone width induced by the enzyme.

Although most of the isolated strains (~80%) revealed biocontrol and plant growth promoting traits, only five strains revealed *in vitro* antifungal activity against *Fusarium* stem rot of sweet potato (Dj3, Dj6, Dj17, Dj19, and Dj24). The strains Dj17 and Dj19 delayed the fungal growth in the first 5 days of co-cultivation, and Dj24 strain limited de fungal development at the vicinity of the bacterial colony. The best antifungal activity was revealed by the strains Dj 3 and Dj6, which expressed 62.35% and 61.18% inhibitory efficacy against the pathogen. Moreover, Dj 3 imposed a clear inhibitory zone of 4mm, where the pathogen was not able to colonize the growth substrate (Fig. 6b). At contrary, Dj6 strain inhibited the spread of the pathogen on the nutrient medium by colonizing the substrate with the bacterial colony (Fig. 6). The microscopic analysis of the interaction zones, between the rhizobacteria and the fungal pathogen, revealed that bacterial motility and competition for nutrients and niche are the basic mechanisms involved in the antifungal activity of Dj6 strain (Fig. 6c). Although Dj3 strain expressed similar antifungal potential *in vitro*, compared to Dj6 strain, the mechanisms of interaction were quite different. The bacterial growth did not migrate near the fungal mycelia, however some extra cellular compounds were released from the microorganism and visibly affected the terminal endings of the hyphae. Several swelling of the *Fusarium* hyphae and cell membranes destruction were seen under the microscope, probable due to osmotic stress caused by bacterial antifungal metabolites excreted by the bacterial strain Dj3 (Fig. 6a).

Among the isolated rhizobacteria only 4 of them were selected for Biolog GEN III identification, Dj3 due to its antifungal metabolites production, Dj6 for its inhibitory action against *Fusarium* sp., Dj17 and Dj19 especially for their ability to produce phytohormones and solubilize phosphates.

The biochemical identification revealed that Dj3 and Dj6 are both *Bacillus* sp. strains, Dj3 strain being identified as *B. subtilis* ssp. *subtilis*, and Dj6 as *B. subtilis*/ *mojavensis*. These two species are omnipresent bacteria in the environment, commonly found in soil and rhizosphere, many strains being reported as biocontrol agents and formulated as plant protection products. The other two strains, detected as Gram negative bacteria, were identified as *Enterobacter* sp. (Dj17) and *Pantoea agglomerans* (Dj19). Although *Enterobacter* sp. are included on the list of opportunistic human pathogens, some studies showed that it could be used as plant growth regulator (GEORGIEVA, 2003).

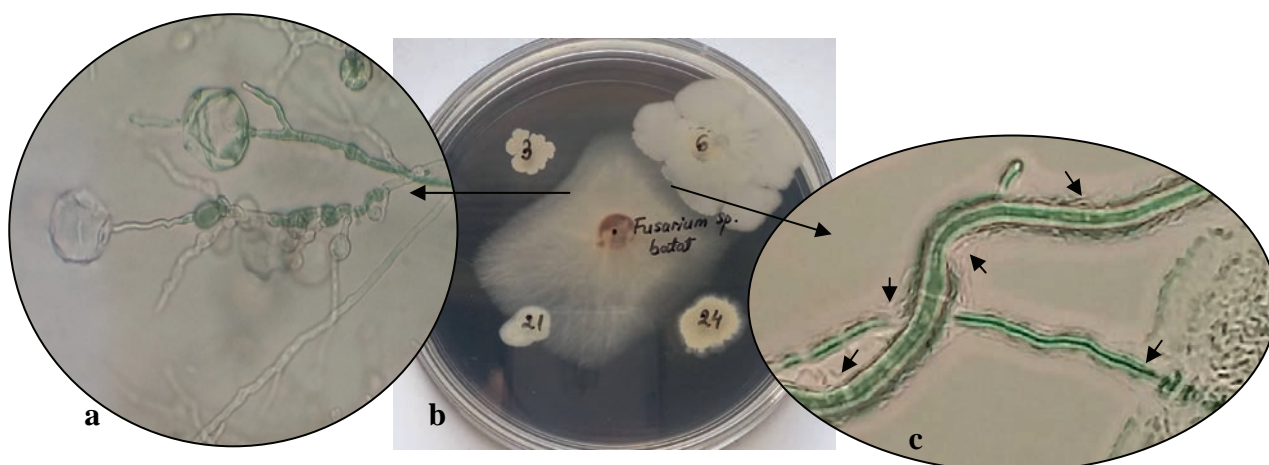


Figure 6. Bacterial inhibitory activities against *Fusarium* stem rot of sweet potato. **a.** swelling of the fungal cell walls caused by Dj3 bacterial metabolites, **b.** *in vitro* antagonistic activity of some beneficial rhizobacteria against *Fusarium* sp., and **c.** *Fusarium* hyphae colonized by Dj6 bacterial cells (originals).

Pantoea agglomerans however, was formerly known as *Enterobacter agglomerans* or *Erwinia herbicola*. This species is commonly associated with plant tissues, but it can also be found in animal and human faeces. Although, certain *P. agglomerans* strains were previously used as biocontrol agents, for the suppression of plant diseases, due to the biosafety concerns this microorganism could not be commercially registered for plant protection purposes (BONATERRA et. al, 2014). As *Bacillus subtilis* is worldwide accepted as a plant beneficial bacterium with various biocontrol mechanisms, Dj3 and Dj6 strains could be further used as potential biocontrol agents (SICUIA et al., 2015).

CONCLUSIONS

One case of *Fusarium* stem rot was detected in 2016, infecting the Korean variety Hayanmi growth in the sandy soils of southern Oltenia (Romania). The pathogen was identified based on its henotypic and biochemical characteristics with the Biolog system for filamentous fungi, but also based on the microscopic aspect and colony morphology.

For the biological control of this pathogen, thirty bacterial strains were isolated from the rhizosphere of healthy sweet potato, grown in the sandy soils of CCDCPN Dăbuleni. But only two of these isolates showed significant antagonistic activity against *Fusarium* stem rot. These strains were identified as *Bacillus subtilis* ssp. *subtilis* Dj3 and *Bacillus subtilis/mojavensis* Dj6. They expressed 61% to 62% *in vitro* inhibitory activity against *Fusarium* sp., and showed several lytic enzymes production, high motility and plant growth promoting activity, as mechanisms involved in plant protection against the fungal pathogenic attack.

ACKNOWLEDGEMENTS

This study was published under the frame of the sectorial project ADER 2.2.2./2015 "Developing sweet potato cultivation technology in the context of climate change and promoting measures for this vegetable in Romania" financed by the Ministry of Agriculture and Rural Development.

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Received: March 30, 2017

Accepted: June 9, 2017

AGROTOURISM AND RURAL TOURISM THE WAY OF SUSTAINABLE DEVELOPMENT IN RURAL AREAS OF SIBIU COUNTY – ROMANIA

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Abstract. This paper presents the actual stage of development in the fields of agrotourism and rural tourism in Sibiu County. Using data provided by the Tourism Ministry of Romania and Sibiu Association of Tourism enabled us to analyze the number of units specific to rural tourism. It was conducted a sociological survey in 70 rural pensions from 15 localities situated in Sibiu County, between 2015 and 2016. The work instrument was a questionnaire with 24 items. Sustainable development is harmoniously combined with tourism development, especially the rural one.

Keywords: agrotourism, gastronomy, rural tourism, sustainable development, trends.

Rezumat. Agroturismul și turismul rural, calea dezvoltării durabile a zonelor rurale din județul Sibiu – România.

Lucrarea prezintă stadiul actual de dezvoltare în domeniul agroturismului și turismului rural în județul Sibiu. Utilizarea datelor oferite de către Ministerul Turismului din România și Asociația Județeană de Turism Sibiu a făcut posibilă analiza numărului de unități specifice de turism rural. S-a desfășurat o anchetă sociologică în 70 de pensiuni din 15 localități situate în zona rurală a județului Sibiu, între 2015-2016. Metoda de lucru a fost chestionarul cu 24 de itemi. Dezvoltarea susținută este armonios legată de dezvoltarea turistică, mai ales în zona rurală.

Cuvinte cheie: agroturism, gastronomie, turism rural, dezvoltare sustenabilă, direcții.

INTRODUCTION

In Romania, at the end of 2014, there were 6,089 tourist units, and at the end of 2015, there were 6,821 tourist units, compared to 3,121 in 2000, the increase being of 195.1% in 2014, and of 215.5% in 2015, with an annual average increase of 434 tourist accommodation units until in 2014. The number of agrotourism pensions was at national level 1,918 units in 2015. In the same year, the number of the touristic pensions at national level was 1,527 units (IOVA et al., 2016; POPESCU, 2016).

As a general definition, agrotourism represents a concept that includes tourism activity organized and led by rural population and it is based on a close connection with the natural and human environment. Agrotourism is directly related to agricultural activities, supported by small farmers, their own household activity remaining the main source of income (CONDEI et al., 2016). Rural tourism is a general term, which can be defined as all forms of tourism practiced in the rural area. Agrotourism occurs on a working farm and not just in a rural area. Agrotourism is a more limited concept, making reference to several forms of tourism concerning agricultural activities and/or agricultural facilities. This particular form of rural tourism is organized by farmers, usually as a secondary activity, while agriculture remains their main occupation and source of income (TALESKA, 2015).

Rural areas are specific in many ways different from other tourist destinations, particularly in urban areas (BURGHELEA et al., 2016). Rural tourism and agrotourism developed significantly in Romania. Agrotourism should be regarded as an economic activity, generating additional income for rural households, meaning the capitalization of their economic potential by hosting activities and exploitation of local products (CHIRAN et al., 2016). Authors like CIOBAN (2016) found that Sibiu County together with other five counties, Brașov, Harghita, Argeș, Maramureș and Suceava, is one of the most representative regions for rural tourism in Romania.

Sibiu is one of the counties with an intense activity in the area of the Romanian rural tourism. The analysis of existing data on the website of the National Tourism Authority shows that, in 2016, in the county of Sibiu there were licensed to operate 493 tourist structures with accommodation function. In order to see how many of them operate in rural areas, from the total tourist structures with accommodation function classified and existing at county level, there were excluded those which operate in urban areas, in the mountain resort Păltiniș, the SPA resort from Ocna Sibiului, and all the hotels, hostels or motels. Data processing from the Tourism National Authority website allow us to say, that in rural areas of Sibiu county there are 250 tourist units classified by type: apartments for rent (4), bungalows (1), chalets (21), houses for rent (13), camping (2), agrotouristic pensions (19), touristic pensions boarding (167), rural guesthouses (5), cottages (18) (<http://turism.gov.ro/autorizare-turism>).

These rural touristic structures from the rural area have a total number of 2,063 rooms and an accommodation capacity of 4,518 seats. The localities with the highest number of touristic structures with accommodation function in the rural area of Sibiu County are Sibiul (28), Gura Râului (28), Rășinari (27), Cârțișoara (25), Poplaca (19), Avrig with the touristic zone of Valea Avrigului (14), Șelimbăr (14), Cristian (11).

In Sibiu County there are still very well kept local traditions, especially those related to the shepherds in many of the 18 localities that make up the famous area "Mărginimea Sibiului" (STANCIU et al., 2012, 2014; BLAJ, 2014).

The tourism resources of Sibiu County, such as environmental and human resources, represent the basis for the development of tourism domain. This kind of resources generates specific forms of tourism that complete each other in different types of destinations (SIMTION & LUCA, 2013).

At the county level, various associations have contributed to the implementation and development of rural tourism and agrotourism, such as Sibiu County Tourism Association, which proposes five trails of discovery of Sibiu County: (Făgăraș trail - Olt Country; Nature trail – Hârtibaci Valey; Cheese trail – Mărginimea Sibiului; Fortifications trail – Târnave Valey; Salt trail – Secașe Valey); Transylvanian Rural Tourism Association; National Association for Rural, Ecological and Cultural Tourism in Romania – Sibiu branch; "My Transylvania" Association, etc. (CĂRĂTUȘ STANCIU, 2016a, b, c).

MATERIALS AND METHOD

In order to know the reality on the ground there was conducted a sociological survey in 70 agrotouristic pensions and rural pensions in Sibiu County in the following localities: Arpașu de Sus, Cârțișoara, Porumbacu de Sus, Valea Avrigului, Bradu-Avrig, Gura Râului, Sadu-Tocile, Rășinari, Sibiul, Săliște, Biertan, Bazna, Blăjel, Buzd.

The study objective was to know the situation of the rural pensions and rural guesthouses form the rural area of Sibiu County. The hypothesis from which it started was that most of the rural tourism structures from rural area are agrotouristic guesthouses and are managed by the owners. The main work instrument was a questionnaire with 24 items, administered to the pension owners or their managers, applied by six interviewers during July - August 2015 and July - September 2016.

The chosen items targeted to know the motivation for such activities, accommodation capacity and comfort level, average length of stay, origin of tourists, their average age, identification of other activities in the touristic structure, ways of spending free time in touristic pensions, local events and in the surroundings, workshops and other activities organized, identification by the managers /owners of touristic pensions the types of tourism resources existing in the area, the agricultural activities of the pension and production of traditional foods.

We also wanted to know what kind of traditional food is served in the rural pensions, the perception of the owners and the motivation of tourists in choosing traditional products and traditional culinary preparations. We also were interested in aspects related to the workforce form the rural pension and its qualification. We wanted also to know the future intentions of the owners of rural pensions, job satisfaction in relation to the effort and difficulties encountered.

RESULTS

Following the sociological survey conducted in 70 rural pensions form Sibiu County in 2015 and 2016, and the processing of data obtained from questionnaires, there were obtained more results. Over 90% of the rural pensions in which the study was conducted, have more than 10 years of experience in rural tourism.

The rural tourism and agrotourism have a motivational base, represented by: return to nature; knowledge of tradition and culture, creation of various rural communities; health care; playing some sports - hunting, fishing, climbing, etc.; consumption of natural food and fresh fruit (IOVA et al., 2016).

Among the motivations that have led the owners to start such activities as: hospitality, the desire to obtain additional income, attractiveness and reputation of the area, entrepreneurship, the existence of accommodation surplus capacity, the desire for personal development and the desire to promote the village and traditions.

The average size of rural pensions form Sibiu County is between 6 and 10 rooms in 43% of cases, while approx. 30% of pensions, usually those which are family pensions, were under 5 rooms.

DISCUSSIONS

At national level, regarding quality standards, the trend of the agrotourism pensions comfort level, in the interval 2007-2014 shows us that the share of agrotourism pensions with one and two flowers decreased from 78% in 2007 to 38% in 2014. The difference up to 100% is represented by agrotourism pensions with 3 stars/flowers (50%) and pensions with 4 stars/flowers representing 11% of this study (CONDEI et al., 2016). In the analyzed rural pensions from Sibiu County, comfort level falls at a rate of approx. 83% on 2 and 3 stars/flowers, the 4 and 5 stars/flowers pensions representing the difference.

The average length of stay of tourists in these rural pensions is approximately 2-3 days in 61% of the cases. There is a positive correlation between length of stay and level of comfort. The average age of tourists is between 20 and 50 years old in approximate 67% of the cases. All owners of rural guesthouses have identified the existence of natural, cultural and historical touristic resources in the area where it is located the guesthouse. These are major attractions for tourists.

The origin of tourists from rural guesthouses show that approximately 68% of those are Romanian tourists in 75 % of cases, and foreigners, in 25 % of cases. The owners of rural guesthouses related that the local authorities organizes events to attract visitors and tourists, but the level of involvement is different in the rural area of Sibiu County.

Local authorities from localities like Gura Râului, Rășinari and Tilișca organize numerous events that have reached a lot of editions. They highlight the traditions, customs, folklore and local gastronomy.

Among the most important events taking place in the rural areas of Sibiu County, we mention "Folkloric Festival of Peony", held on the first weekend of July, "Meeting of shepherds from Tilișca", held on August 15, Folkloric Festival "Up on Jina Mountain", held on the last Sunday of July and "Cheese and Plum Festival", which takes place in the last weekend of August. Craft workshops are not well represented at local level and old crafts tend to disappear.

In the future, the craft workshops must enter into rural tourism circuits. For leisure, there are proposed various activities: hiking, cycling, horse-drawn carriage or sleigh, sightseeing tours in the area, engaging in games or team sports, horseback riding, renting ATVs, folklore evenings, evenings dedicated to traditional cuisine, visit sheepfolds, wine tastings, etc. Only about 23% of the investigated pensions have farm animals. Generally, the owners have orchards. Over 80% of those who are food producers share their products exclusively through pensions. Those who do not produce food, generally purchase it from other authorized agricultural producers in the area. The main local and traditional products for tourists are dairy products (73%), sausages (61%), vegetables and fruits (59%), and other traditional products (25%).

Gastronomy is one of the elements incorporated in a new concept of cultural heritage and cultural tourism, driven by growing trends of a wellbeing lifestyle, authenticity, environmental protection and the need to have a high-quality experience. Tourists increasingly want foods, which emphasize the heritage and culture of a place, which assist the preservation of traditional forms of agriculture and cultural heritage (CĂRĂTUȘ STANCIU, 2016b)

The traditional culinary products offered to the tourists are cold cuts of pork and beef, polenta with cheese, cabbage rolls, Transylvanian soups, mutton stew, dishes based on trout, fish soup, traditional pies, homemade cakes, jams and fruit syrups, homemade bread, cheese and cow, sheep or goat curd, yoghurts, homemade wine and brandy. Owners say that tourists prefer traditional culinary products because they consider that they are tasty, fresh and healthy.

The work force from rural pensions was represented in 49% of cases only by the family members. More than 90% of pension owners have the qualification of pension administrator. The workforce have the following qualifications: cook, waiter, bartender, maid, receptionist.

If in year 2015, approximate 73% of owners said that they have no intention of further development of the pension, in year 2016, only 30% of owners said they want to maintain activity at current levels. The others owners want further development. Over 80% of owners are satisfied with the results obtained in relation to the effort.

The difficulties encountered are poor legislation, too high taxes, the overall infrastructure of poor quality, poor promotion of the area, too often controls, tourists behavior, lack of support from the local authority, the need for permanent investments, competition.

CONCLUSIONS

The rural tourism represents an important opportunity to promote Romania at international level like it happens in other countries. Touristic and agrotouristic pensions play an increasingly important role in Romanian tourism.

Sustainable development is harmoniously combined with tourism development, especially the rural one. In rural tourism, the offered food and environmental specificity represent an advantage for attracting potential tourists, the changing quality of life, economic growth, as much as sustainable development (ANDREI et al., 2012).

Gastronomy is one of the elements incorporated in a new concept of cultural heritage and cultural tourism, driven by growing trends of a well-being lifestyle, authenticity, environmental protection and the need to have a high-quality experience.

Gastronomy, as a tourist resource, is appreciated not only for its own sake, but also for its ability to generate rural development. Gastronomic tourism helps to increase rural revenue sources and improve income levels and employment of local labor (especially women).

Tourism development will involve the development of other domains in economic and social areas (transport infrastructure, cottage industries, Agrofood industry, various services) generating a multiplier effect in the local economy.

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Received: March 30, 2017
Accepted: June 12, 2017

PROTECTED AREAS NEEDS REGARDING THE DEVELOPMENT OF MANAGEMENT MEASURES FOR CONTROLLING CLASSICAL SWINE FEVER (CSF)

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Abstract. Romania is one of the European countries which have the richest mainland biodiversity. Biodiversity conservation is a challenge for the 21st century especially when it is necessary to ensure the health of species and habitats with a positive impact on the economy of countries. The biggest challenges are given by veterinary and phytosanitary measures that are to be implemented due to the outbreak of quarantine diseases and pests. This paper addresses the problem of classical swine fever (CSF) that appeared during 2005 and all national territory was under sanitary-veterinary quarantine. Recently, Romania has been under alert of infestation for African swine fever. The implementation of the current sanitary-veterinary action plan for monitoring and surveillance already has 10 years and associated costs are high. In our country conditions, the main vector of this disease of viral origin is wild boar (*Sus scrofa*). Being a country with a rich biodiversity, for the year 2016, it was approved the collection from the wild of 37,725 boar individuals throughout Romania. It is recorded a territorial overlap between the distribution of wild boar and outbreaks of classical swine fever. A major gap is recorded in protected areas in the implementation of phytosanitary quarantine measures having Sibiu County as a case study. Management plans adopted so far do not contain preventive measures to support the national plan for CSF quarantine. Thus, it should be adopted synergetic measures in the management plans of protected areas with those of the national plan for CSF controlling and eradication.

Keywords: classic swine fever, boars *Sus scrofa*, sanitary-veterinary quarantine, protected areas.

Rezumat. Necesitățile ariilor protejate de a dezvolta măsuri de management pentru controlul pestei porcine clasice (CSF). România este una dintre țările Europene care prezintă cea mai bogată diversitate biologică pentru partea continentală. Conservarea biodiversității constituie o reală provocare pentru secolul XXI mai ales când este necesară asigurarea stării de sănătate a speciilor și habitatelor cu impact pozitiv asupra economiei țărilor. Cele mai mari provocări sunt date de măsurile fitosanitare și sanitar-veterinare ce se impun a fi implementate datorită apariției unor boli și dăunători de carantină. Această lucrare abordează problema pestei porcine clasice care a infestat România în 2005 provocând instalarea carantinei sanitar-veterinare pentru pesta porcină clasică (CSF). Recent România este în alertă pentru infestarea cu pestă porcină africană. Implementarea actualului plan sanitar-veterinar de monitorizare și supraveghere are deja 10 ani, iar costurile asociate sunt mari. Principalul vector al acestei boli virale este porcul mistreț (*Sus scrofa*) pentru condițiile țării noastre. Fiind o țară cu o bogată biodiversitate, doar pentru anul 2016 s-a aprobat colectarea din sălbăcie a 37725 de porci mistreți de pe întreg teritoriul României. Este înregistrată o suprapunere teritorială între distribuția porcului mistreț și focarele de pestă porcină clasică. O deficiență majoră este înregistrată în implementarea în ariile protejate a măsurilor de carantină fitosanitară având ca studiu de caz județul Sibiu. Nici un plan de management adoptat până în prezent nu conține măsuri de prevenție în susținerea planului național de carantină CSF. Astfel, se impune adoptarea în planurile de management ale ariilor protejate a măsurilor sinergice de susținere a planului național de carantină sanitar-veterinară pentru controlul și eradicarea CSF.

Cuvinte cheie: pestă porcină clasică, mistreț *Sus scrofa*, carantină sanitar-veterinară, arii protejate.

INTRODUCTION

Biodiversity (i.e. genetic resources, species and habitats) is an asset that needs to be conserved and sustainably used based on the scope of the Convention on biological diversity (SMITH & MALTBY, 2003). Starting with 1932 Romania has continuously declared natural protected areas, a total surface that covers today 24.84% of its territory of which only the European ecological network Natura 2000 represents 17.84% (ANTONESCU et al., 2015). 302 management plans have been officially recognized at the government level up to March 2017, covering one third of the total of management plans that need to be published in the Official Gazette (***, 2017a). The major challenge in case of protected areas is to develop and implement management plans that effectively work for nature conservation and equally develop innovative economic chains in supporting nature by defining product stewardships that lead to sustainable development from local communities up to the national level (MIEMCZYK et al., 2016). Therefore, when management plans are to be developed local communities' knowledge, needs and traditions must be addressed, accessed and understood to make effective their implementation (HERNES & METZGER, 2017). In case of Romania, the process for developing management plans included relevant stakeholders but still, some major stakeholders are silent and already some gaps in the management process of coherently addressing risks can be addressed. Among these stakeholders, relevant from economic point of view are those related to phytosanitary and sanitary-veterinary authorities in direct connection with species that may act as vectors or reservoirs for pests and/or diseases. One of the first official record on classical swine fever (CSF) or hog cholera, based on historical records, happened in the beginning of the XIX century in the United States of America and Europe (HANSON, 1957; COLE et al., 1962; EDWARDS et al., 2000). Based on recent studies, oral vaccination on both domestic pigs and boars must be introduced considering that this disease of viral origin is highly contagious (i.e. a *Pestivirus* virus of the Flaviviridae family). Based on these authors, it is already known the composition of the virus (i.e. proteins and nucleic acid). Among these molecular components, E2 glycoprotein is considered as being the most immunogenic CSFV protein (RENSON et al., 2013). Also, these authors stated that this virus can periodically be reintroduced or activated by wild boar population living in close neighbouring

with livestock or due to movement of pigs. On the other hand, the global market demands on swine meat continues to remain in a steady position since 2005 up today pointing its market demand and economic importance against all issues related to quarantine diseases (WTO, 2016). One proposed measure, in countries where a large effective of wild boars exists, is to start their vaccination and to develop measures protecting householders where domestic pigs exist (ROSSI et al., 2010). This proposal is accepted by the today scientific community that established the importance of understanding the transmitting pathways of this zoonosis, from the livestock to wild animals and inversely, as well as the importance of applying measures in the border of target populations (MARTIN et al., 2011). Based on Rossi and collaborators' study, there is a net connectivity between the abundance of wild boar population and the infectious emerging and intensity of disease, and consequently they highly recommend oral vaccination based on bites for wild boars based on previous studies (ROSSI et al., 2005; 2010). The described project was implemented with the support of major stakeholders and proved in the end the efficiency of oral baits vaccines. The scope of this article is to discuss the current regulatory framework regarding the sanitary-veterinary action plan on monitoring and surveillance on CSF in Romania and to evaluate the connections between measures adopted for the national plan for controlling CSF and measures adopted in the current management plans for protected areas.

MATERIAL AND METHODS

This paper is developed based on an integrative approach regarding the SWOT analysis (strengths, weaknesses, opportunities, and threats) of the national sanitary-veterinary action plan on monitoring and surveillance on classical swine fever (CSF) and the current situation of management plans for protected areas with a specific focus on Sibiu for evaluating the existence of synergies between environmental protection measures and the national plan for controlling CSF.

RESULTS AND DISCUSSIONS

Romania established the first protected area in 1932 and recorded the incidence of CSF before the Second World War proved by a long series of regulatory acts such as The Law for Veterinary Health no. 840/1942, the Decree no. 167/1956 and another subsequent Low for Veterinary Health no. 60/1974 (INDRIE & MĂNZAT, 2009). However, the largest outbreaks related to CSF were recorded between 1993 and 1994, when it was officially recognized the infestation of boar meat exported by Romania. On the occasion, the world trade market policies imposed sanitary-veterinary measures at national level that close the export of pork meat (RIBBENS et al., 2004). Starting with this period, drastic measures were imposed for controlling CSF that went up to full vaccination of all domestic feral pigs and wild boars, ceasing the export of pork meat under the supervision of national sanitary-veterinary authority. This situation is positively correlated to the low economy of the country at the time, as well as to traditional way of breeding pigs such as demi-feral in certain region of the country (e.g. South, and South-East Romania), the movement and trade of domestic pigs on local markets and the abundance of boars. The entire regulatory framework for sanitary-veterinary control developed more after 2001 based on harmonizing policy of the country with that of the European Community and future European Union (INDRIE & MĂNZAT, 2009).

Control and eradication plan for CSF. The national competent authority responsible for implementing the control and eradication plan for CSF is the National Sanitary Veterinary and Food Safety Authority (NSVFSa) under the direct subordination of the Government that is working through county inspectorates and perform laboratory investigations in line with the provisions of the Order 67/2005 for sanitary-veterinary norms regarding the control of CSF transposing the provisions of Directive 2001/89/EC. The current European Union regulatory framework still refers to the Council Directive 82/894/EEC on the notification system and the Diagnostic Manual as it was adopted by the Commission Decision 2002/106/EC with further amendments (FRENTZEL et al., 2013). Before the accession to the European Union, in Romania, it was implemented starting with 2004, a nine months emergency plan, for controlling the eradication of CSF both for domestic pigs and boars (i.e. the 1st of January 2007). It was a hard decision considering restrictions imposed for forbidding the export of pork meat and full vaccination into all territories where this pest was recorded based on Commission Decision 2006/802 (***, 2006; LEIFER et al., 2009). The plan was approved later and prolonged up to the 31st of December 2007 based on Commission Decisions 2007/625/EC and 2007/870/EC (***, 2007). After one year, the quarantine was prolonged again up to June 2008 and followed by the Commission Decision 2008/855/EC repealing the Commission Decision 2006/805/EC and Commission Decision 2006/802/EC (***, 2008a; ***, 2008b). The latest decision was strict and expensive for Romania only mentioning the compulsory examination of thousands of biological samples by polymerase chain reaction diagnostic (Art. 3 c). The decision applied to all national territory and it is associated with the prohibition of pork meat export over the borders or movement of live animals. In 2013, another decision will be addressed based on Commission Decision 2013/764/EU (***, 2013a) to reinforce the control and eradication of CSF up to the 31st of January 2017. In the last report of self-evaluation to OIE (World Animal Health Information System), it is underlined that the last outbreak of CSF was recorded on the 9th of October 2007 and due to constant vaccination on pigs (stopped on the 30th of November 2009) and boars (stopped on the 31st of December 2011) supported by negative results obtained in certified laboratories proves the absence of CSF free circulation inside the country (***, 2013b).

Swine breeding for trade has a negative evolution that is highly dependent on issues related to sanitary veterinary monitoring and surveillance for CSF. Based on the last USDA reports, since 2010 it has been recorded a continuous falling by 7% of the swine in numbers (USDA, 2015: USDA, 2016) (Fig. 1).

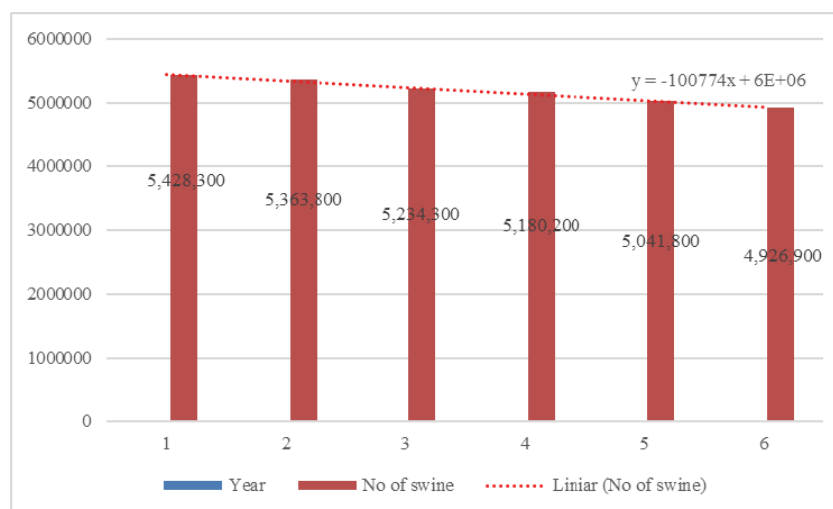


Figure 1. The negative trend of swine trade on the world market in the last 6 years starting with 2010 (1) to 2015 (6) based on USDA data published in 2015 and 2016 for Romania.

Romania also encounters losses in piglet reproduction system that lately proved not to reach market demands. The USDA considers this sector as undeveloped both for 2015 and 2016 (USDA, 2015: USDA, 2016). Due to these negative issues Romania imports on piglets increased during the last years originating from countries such as, Denmark, Germany, Hungary, Netherlands and Slovakia with a correlated positive trend. The pig export is insignificant and only for Eastern countries such as Republic of Moldova, Georgia and Albania. These figures are relevant when it is taken into considerations the actual agriculture contribution to the GDP of the country (Gross Domestic Product). Based on the last report of World Trade Organization, Romania is losing the export market in favour of importing (WTO, 2016). However, the trend in pigs breeding is negative also based on FAOSTAT data (***, 2017b) (Fig. 2). Based on Romania's authorities, at least 75% of the current swine population is held in individual households and under 25% are bred in large farms that may supply the export. The costs are high and as a comparison only Spain lost between 1997 and 2001 more than 108 million Euros in implementing a similar control plan (FERNÁNDEZ-CARRIÓN et al., 2016).

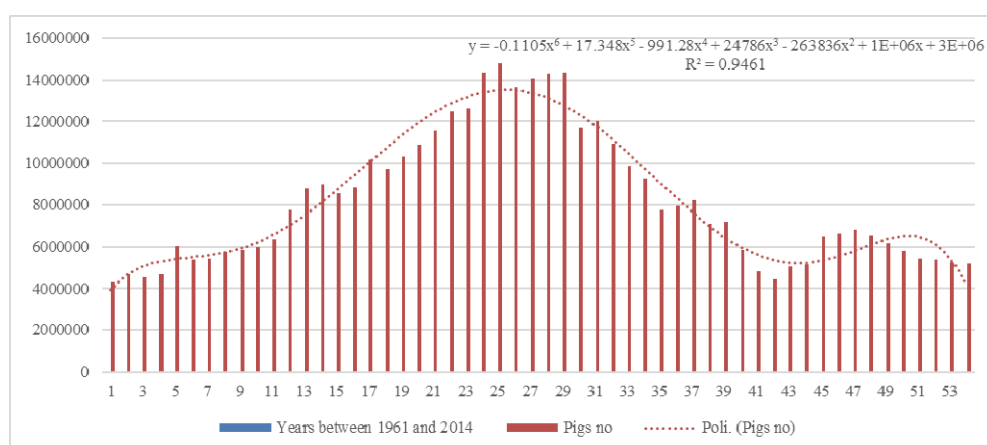


Figure 2. The evolution of pig breeding in the country based on FAO statistics data. The today figures for pig no are half compared to 30 years ago, 1997 (position 25) and like 1966 (position 5).

Protected areas wild boars and domestic pigs. Romania entered the European Union with one of the biggest biodiversity in terms of genetic resources, species and habitats and it was underlined by different scientists that conflictual situations will occur between domestic situation and the EU regulatory framework (YOUNG et al., 2007). This was not the case only for Romania, but for all countries with low economic growth entering the EU. In such conditions, Romania considered as a European treasure for large carnivores (DORRESTEJIN et al., 2016), with huge implication in socio-economic issues was not properly prepared to face phytosanitary and sanitary-veterinary challenges that increase with biodiversity. As it is already known, all large carnivores rely for their life on herbivores and wild boars are among the favourite species for native large carnivores. On the other hand, rural population use to breed swine

in their households all over the Carpathians for centuries. At the same time, wild boars use to damage crops fields and to enter in contact with pigs (directly or indirectly) spread all over the country (Fig. 3). Based on the current plan for wild boar collecting from the wild only in Sibiu County were proposed 930 individuals to be collected from a surface of 5432 km² or 2.46% from the total of 37,725 specimens to be collected from the wild for all the country (2016). Maintaining a huge biological diversity is counterproductive for the trading products of animal or vegetal origin especially due to pests and diseases of quarantine interest. A constant connection between wild boars and pigs is established with a very long history with a negative impact on national economy.

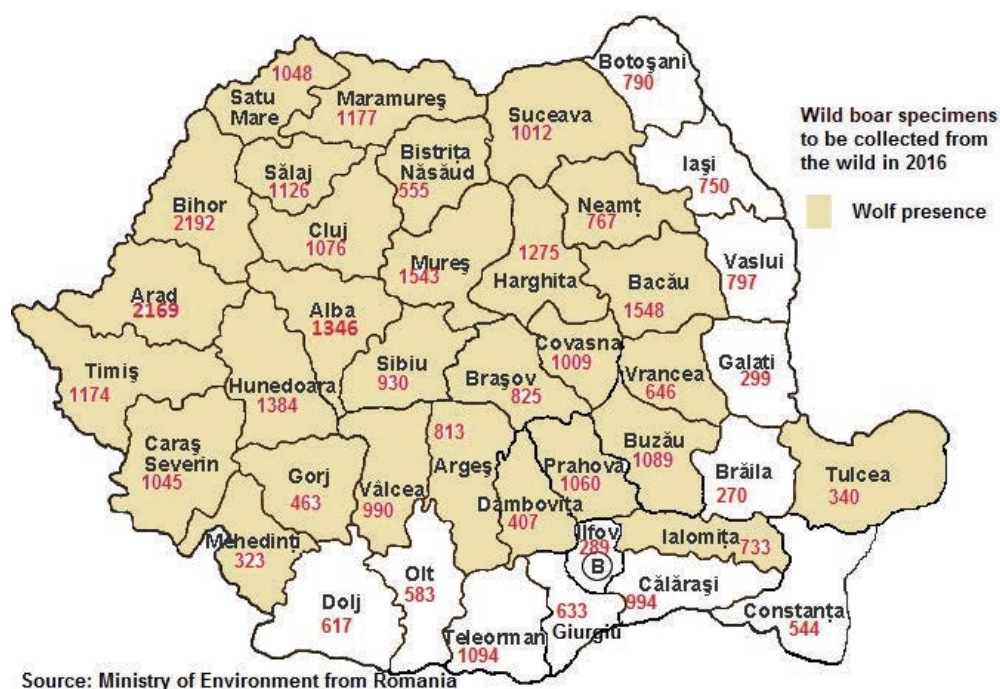


Figure 3. The map of wild boar specimens to be collected from the wild for 2016 based on the Ministry of Environment public data (original).

In Sibiu County, protected areas cover more than 50% of the total territory and include in more than half small rural communities. Only into this territory 9 Sites of Community Importance and 4 Sites of Avifauna Importance are officially recognized. Of these 9 SCIs, wolves and bears live in three of them, such as: ROSCI0085 Frumoasa, ROSCI0122 Munții Făgăraș and ROSCI0227 Sighișoara - Târnava Mare. For all these protected areas, there have been officially adopted management plans in 2016. In case of the management plan of ROSCI0122 Munții Făgăraș wild boars are a constant presence in the site (***, 2016a; b). In Sibiu County are couples of administrative units that covers the management of the site such as: Arpașu de Jos 36%, Avrig 25%, Boița <1%, Cârțișoara 64%, Porumbacu de Jos 42%, Racovița 24%, Turnu Roșu 51% but no synergic measures are in place for the management of sanitary-veterinary plan controlling the spread of CSF. Based on the management plan of ROSCI0227 Sighișoara - Târnava Mare, the impact of wild boars on rural communities is high and still no measure is in place for reducing the impact of spreading of any pests from the wild population in the domestic pigs and inversely (***, 2016c). It is the only management plan rising attention on the importance of connecting the sanitary-veterinary offices on issues related to diseases and pest control and eradication of national importance. In this area, it is well known the case of CSF infestation for more than 400 domestic pigs that have been slaughtered by the sanitary-veterinary inspectorates associated with losses of more than 4500 Euros for rural communities in 2014. In the management plan of ROSCI0085 Frumoasa, it is recognized the abundance of wild boars and other ungulates in the site, but no synergic management measures of sanitary-veterinary interest are in place (***, 2016d).

Based on the sanitary-veterinary authority from Sibiu County report, in 2014, there were taken 445 samples of wild boar meat for sanitary-veterinary analysis in official laboratories that were tested based on the Decision 2007/870/EC (***, 2014). Officials recognize the movement of boars down to the villages it is emphasized the hunting management importance and proved the constant contact between wild boars and the habitat of pigs in rural communities. On one hand, in 2014, in Sibiu County, there were slaughtered for self-consuming during the winter season over 11,000 pigs of a total of almost 28,000. A third part of these pigs are breed by householders (i.e. around 10,000 pigs). On the other hand, only in 2014, there were collected 229 samples from pigs bred in householders and 26,378 samples from large farms. This proves the large market demands for swine meat as well as the negative economic impact of veterinary quarantine imposed from national to local level.

Currently, it is implemented all over the country, including inside protected areas, the Operational Guidelines regarding the CSF control in case of sanitary-veterinary quarantine and published in 2014 based on the Directive 80/217/EC. New cases arose at the border with neighbouring countries such as those related to the African CSF that may enter through Ukraine or Bulgaria (COSTARD et al., 2013) and will emphasize again the weaknesses of the management plans inside protected areas. However, starting with 2015, it was published a guideline for CSF in case of boar hunting (***, 2015) and it is the first time when it is stated that infested boar bodies should not be released in protected areas.

Developing new management measures inside protected areas that need to be synergic with that imposed by the national plan for controlling CSF will further support facing these challenges for the future. Among these measures, it is relevant to be declared “free zones” of this disease inside protected areas (PLUIMERS et al., 1999), to be coupled with the boars collecting from the wild in case it is needed such as: the proved occurrence of the short migration of boars into domestic pigs’ habitats, in case of new outbreaks in the borders of protected areas that need to be associated on a case by case basis on the vaccination of wild boar population. Such measures are in line with the recommendations regarding the need to maintain the healthy status of species and habitats (HERMAN et al., 2005; DUDLEY, 2008). Installing prophylaxis measures is relevant in all protected areas and related to this, it is relevant to closely communicate to local communities about the incidence of quarantine measures on their own economy, change attitude and develop guidelines for breeding pigs in households and finding financial solutions in preventing rather than in controlling and eradicating.

CONCLUSIONS

Implementing at the national level a quarantine action plan followed by a monitoring and surveillance action plan in case of CSF has dramatic costs reflected on the domestic pig breeding and meat trade as a commodity. Applying vaccination is only related with the effect of outbreak based on the diagnostic of the disease and may be implemented only based on a national plan run by the veterinary authorities. Currently, the management plans for protected areas do not include prediction studies regarding the trend of wild boars, conflictual situation and synergetic measures to support sanitary-veterinary authorities in case of quarantine diseases. Such a gap reveals the major stakeholders’ lack of knowledge related to these issues of major economic importance. Developing and declaring free zones of CSF must be a future step in applying prophylaxis measures against CSF and not only, inside and in the borders of protected areas as well as for pig farms. Householders breeding pigs and relevant stakeholders closely working with need to be informed and aware of the safety measures imposed for breeding, trading and movement of pigs and piglets in order to avoid contamination.

ACKNOWLEDGMENTS

This study was supported by the Research Center for Agricultural Sciences and Environmental Protection of the University Lucian Blaga from Sibiu for 2014-2020.

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Received: March 30, 2017
Accepted: June 12, 2017

PROF. ION POPESCU-VOITEȘTI
AS THESIS COORDINATOR AT 'KING FERDINAND I' CLUJ UNIVERSITY

CODREA Vlad, POPESCU Aurelian

Abstract. A rare document – probably the single copy still preserved – is presented herein: Augustin Vancea's bachelor's thesis corrected by his coordinator, Prof. Ion Popescu-Voitești. It is a thesis defended in 20th inter-wars time, the coordinator and the student being both nowadays outstanding personalities, sharing merits in the Romanian petroleum geology. The handwritten marginal notes are valuable, showing the professor's various viewpoints related to petroleum geology, more exactly to the natural gas pools in Romania or worldwide. His exigency is obvious, as well as his will to share his geological knowledge with younger disciples. The thesis is rather an account than an original contribution, but we know that it was in fact an exercise for Vancea's next professional step - his Ph. D. thesis, coordinated by the same professor.

Key words: petroleum geology, Romania, I. P.-Voitești, A. Vancea.

Rezumat. Prof. Ion Popescu-Voitești - coordonator de teză la Universitatea „Regele Ferdinand I” din Cluj. Un document rar – probabil unicul exemplar păstrat – este prezentat în continuare: teza de licență a lui Augustin Vancea, corectată de către îndrumătorul său, Prof. Ion Popescu-Voitești. Teza a fost susținută în perioada interbelică a secolului trecut, îndrumătorul și studentul de atunci fiind astăzi personalități recunoscute, ambii cu merite în geologia petrolului din România. Notele marginale manuscrite sunt valoroase, arătând punctele de vedere diferite ale profesorului privitoare la geologia petrolului, mai exact a zăcămintelor de gaz metan din România sau de pe plan global. Sunt evidente atât exigența, cât și dorința de a-și împărtăși cunoștințele geologice mai tinerilor discipoli. Teza este mai degrabă un referat decât o contribuție originală, însă știm că, de fapt, reprezenta un exercițiu al lui Vancea spre pasul profesional următor - teza sa de doctorat, coordonată de același profesor.

Cuvinte cheie: geologia petrolului, România, I. P.-Voitești, A. Vancea.

INTRODUCTION

At the end of the World War I, when Transylvania became part of the Romanian Kingdom, the academic studies taught in Romanian in Cluj University (the former Hungarian Royal University) were in sooth a main challenge for the Romanian authorities. Until 1919, all disciplines at this level were taught exclusively in Hungarian. Therefore, the former 'Hungarian Royal University' turned into the new 'King Ferdinand I' by the Decree 4090/September 12, 1919 and Romanian professors were called to positions in Cluj according the Decree 241/January 27, 1920 issued in the Official Gazette 222/January, 29, 1920 (MOCIOI & HUICĂ, 2002). In this new-born university, the geological studies were a main priority, because after war the economy was on a rising trend mainly based on geological resources. As a matter of fact, two geological chairs started to function.



Figure 1. Prof. Ion Popescu-Voitești (1876-1944).



Figure 2. I.P.-Voitești - bas-relief made by Mircea Ilie (curate at Babeș-Bolyai University, Department of Geology, Cluj-Napoca).

The first one was on petrology-mineralogy, where Gheorghe Munteanu-Murgoci (Vădeni, Braila County, July 20, 1872 - Bucharest, March 5, 1925) (ILIE, 1957) was the first holder. Geologist with rich contributions on tectonics, mineralogy, petrology, soil science and even geography, he gave the first course on petrology-mineralogy in Romanian

until a definitive occupant came in this position, as Ludovic Mrazec specified in his declamation at Murgoci's funerals (whole text in PAUCĂ, 1998; pp. 63-64). Therefore, Murgoci's stay in Cluj was almost ephemeral (only on the academic year 1919/1920; however, time enough to give a professional trend to his follower, Victor Stanciu).

The second chair was on palaeontology-stratigraphy, led by Ion Popescu-Voitești (Voitești, Gorj County, November 18, 1876 - Voitești, October 4, 1944) (Figs. 1, 2). Unlike Murgoci, he spent seventeen years of his life (October 1, 1919- November 20, 1936) and built most part of his academic career (with essential contributions on tectonics, palaeontology, stratigraphy, field geology, teaching etc.) in Cluj (STANCIU, 1936; ILIE, 1957; MAXIM, 1945, 1948; HUICĂ & TEOTOI, 1976; CORVIN-PAPIU, 1980; PAUCĂ, 1998; MOCIOI & HUICĂ, 2002).

In the personal collection of documents of one of us (VAC), there is a copy of the graduation thesis that the student Augustin Vancea (1925) defended at Cluj University. It is extremely valuable because it keeps handwritten side notes belonging to his coordinator: the geologist Prof. I.P.-Voitești.

THE MENTOR: I.P.-VOITEȘTI

It's really hard to add new, original, data to Voitești's contributions after the afore-mentioned biographers, almost all of them contemporaneous with this one. Just for reminding, it is amazing how genial was his teacher on Latin – prof. Faur, from 'Carol I' Gymnasium in Craiova -, when he had the intuition to turn the 'too common' name Ion Popescu into Ion Popescu-Voitești, by adding the name of his schoolboy's native locality. Probably Faur never believed that later, his young scholar will give fame to this additional name, making famous the village he originated from worldwide. In fact, this addition was done just for very practical reasons, for perceiving him from another colleague also named Ion Popescu (HUICĂ & TEOTOI, 1976). At that time, it happened often in schools: it was the same situation in the case of Murgoci, the name Munteanu being added in same manner, for same reasons. But unlike Voitești, this one disliked the additional name and asked all his close friends to use after graduation, simply Murgoci.

Among his main contributions to the Romanian geology, we can list: his conception about the thrust nappes in the Carpathians and his tentative to correlate these nappes with the Alpine ones (VOITEȘTI, 1929; BLEAHU, 1980) (it is worth to point out that at the beginning of the 20th, this theory was not agreed by a lot of geologists; but, as he was a former disciple of the Austrian geologist Viktor Uhlig [see 1907] or the French Émile Haug, his opening for such ideas is easy to be understood and explained); the contributions about the relationships between the salt geology and the presence and distribution of petroleum reservoirs; the various data on the Cenozoic invertebrate and vertebrate faunas (he was interested mainly in the large Paleogene foraminifers, the nummulites; BOMBIȚĂ, 1980); the rich data on the Romanian stratigraphy (BOMBIȚĂ, 1980) and last, but not least his synthesis on the Romanian geology (he coined the discipline Geology of Romania, now taught in all the Romanian geological departments of universities; but as seemingly stars were against, just in Cluj-Napoca University where this course was introduced by Voitești, it has now the briefest extension...). Every once in a while, he reviewed his overview on the Romanian geological structure, since 1921 (BLEAHU, 1980). Unfortunately, the last one (1944) remained in manuscript.

Perhaps, the best reference list where all these topics are not simply mentioned but in some cases also briefly described, can be find in HUICĂ & TEOTOI (1976) and also in HUICĂ (1980), although a fair list including the contributions until 1928 belongs to VOITEȘTI (1928) himself. It is also important to underline that he was among the first defenders of Alfred Wegener's theories (MAXIM, 1945) in a time when the continental drift was strongly called in question by a lot of geologists. As stratigrapher he outlined and defined some new 'horizons' (i.e. the Brezoi Conglomerates, the Lucăcești Sandstone), as well as specific facies (Fusaru Sandstone, Siriu Sandstone, the 'Senonian red marls', the Eocene 'marginal facies', the Eocene Șotriș facies; MAXIM, 1945, 1948; BOMBIȚĂ, 1980).

But above all things, in Cluj University, Voitești was a teacher. When he won his position as professor in Cluj University, he already had twenty years of experience as lyceum teacher, teaching natural sciences, geography, physics and chemistry (HUICĂ, 1980). He taught in various towns of Oltenia and Muntenia, such as Tg. Jiu or Bucharest. As in those times the manuals about geology were extremely few, he published the first treatise on palaeontology (1928; unfortunately, he achieved only the first volume on invertebrates, while the second one, on vertebrates, never issued), as well as courses on geology either for schoolboys (e.g. Elements of Geology - first edition in 1921, followed by other two on 1924 and 1927; or, Concepts of Geology, in 1943) or students (e.g. 1924 a, b; 1925, 1930 a, b).

Himself, he was a brilliant student: when he applied as Ph.D. candidate in Paris in Sorbonne at Émile Haug, his studies and graduation diploma obtained in Bucharest was equated, the first such case (HUICĂ, 1980). In Vienna, in 1907, he was elected president of a student society named 'Junimea', giving the most conferences on various scientific topics (HUICĂ, 1980).

As a professor, he was a demon for work: his courses were of exemplary brightness and clarity, each one trying to expose in detail the progress of a geological phenomenon. He was exigent with his pupils and students, but never unfair. A true friend, he was forgiving always even his hostile colleagues. He tried always to help the weak and worried people. Undoubtedly, his talents helped a lot in the didactic work, being an instinctual, skilful sketcher. It was very important for exposing clearly the geological sections or logs. The students were also fascinated by his field trips, where he presented in a very clear manner the geological structure of each visited region (MAXIM, 1948). But he never resumed to geology: visits to historical monuments or folkloric events were added. He was crazy aware about field

work, which he considered essential (Fig. 3), using to say: '*Nature represents the great laboratory of a geologist*' (PAPIU, 1980). He was also a patriot, trying to plant this feeling in the soul of each of his students.



Figure 3. I. P. Voitești in a field mission.



Figure 4. Augustin Vancea (1892-1973).

THE DISCIPLE: AUGUSTIN VANCEA

Undoubtedly, among the petroleum geologists of Romania, Augustin Vancea (Parhida, Bihor County, December 19, 1892 - Cluj, August 3, 1973) (Fig. 4) was a personality (PANAITESCU et al., 2014). His first studies were at Beiuș (Bihor County, 1903-1907), than at Năsăud (Bistrița-Năsăud County, 1908-1912; PLEȘ, 2011, 2013; SENI, 2016). In his youth, immediately after the end of the First War, he was secretary of the Mine Direction (1919-1920) of the Industry Resort (SENI, 2016).

He followed academic studies in geology in inter-war times at the University of Cluj, where he followed Voitești's courses. The professor was Vancea's teacher but moreover, he was also supervisor of his graduation dissertation.

THE THESIS

Popescu-Voitești received the copy in 1925, as he handwritten on the front page: 'Received with the Dean's Office' address no. 506/7.03.925' (Fig. 5). It means that several months passed between the moment when the thesis was achieved by VANCEA on 1924 (as it appears on page 92) and this official receipt.

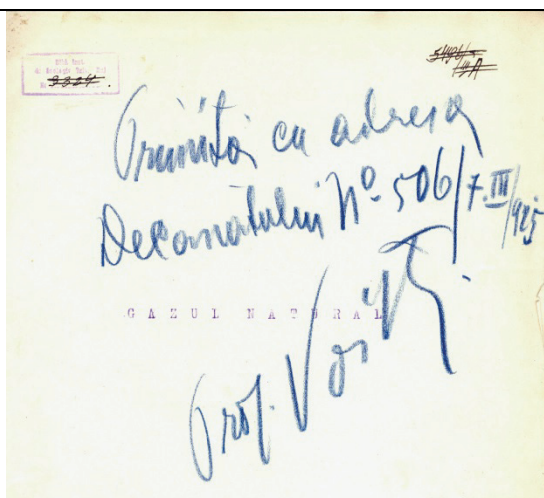


Figure 5. Front page of Vancea's graduation thesis

The thesis, the title of which is 'The Natural Gas' is typewritten on 92 pages + 2 pages of references, unnumbered. It has eight chapters, each one with various numbers of sub-chapters. A map showing the areal distribution of the anticlines and domes bearing methane pools in the Basin of Transylvania (drawn after Hugo Böckh) and 12 figures (various drawings exposing mainly theoretical cases related to different methane fields, labelled from 6 to 17; the first five figures, i.e. 1-4 related to mud 'volcanoes' and the 5th probably dealing with some boreholes from Transylvania, are lost) complete the text.

A short introduction – not included among chapters – opens the lecture, underlining the importance of geology for the theoretical progress, but mainly for its applied targets like raw materials and combustibles as oil and coal: '[...] without coal and oil, the nowadays economic conditions couldn't be imagined' (page 1).

He points out the richness of oil and gas pools in our country and defines the targets of his thesis: i. to show the geographical distribution –worldwide and national - of the gas fields, ii. the geological genesis of gas and iii. the gas chemical structure, the extraction and use, as well as its economic value for Romania. It is interesting to point out that he mentioned about gas: '[...] *usually it bode the oil and by its emissions to surface, gives us clues about the deep existence of an oilfield.*' (page 2). A marginal Voitești's pencil blue mark probably express the teacher's agreement.

Firstly, he dealt with the geographical distribution of the gas fields. Voitești's notes refer to: '*Are they missing in South Africa?*' or '*In Central and Southern France there are nice oil seepages*'. Rightfully, the professor did not agree at all with the location of Țețcani (Neamț County) and Pârjol-Câmpeni (Bacău County) localities in Muntenia, mentioning correctly that both are in Moldova. He is intrigued by the idea that the Caucasus oilfields are '*crossing beneath the Black Sea*' extending to Crimea. Visibly, he was not pleased either by pleonasm or strange enunciations as '*monstrous gas field*' or '*In North America the fields do not show any regularity*' (page 4).

In the second chapter - mentioning a reference - Vancea points out the ancient wasted values of the gas seepages in our country: '*Until then, gas of enormous value was let to spread into the atmosphere, therefore billions of lei* (note: the Romanian currency) *were lost for the national economy (...)*' (page 8). Voitești added that this situation continued until those days...

The gas genesis was a challenge because there were various theories in that time. Again, the professor disliked some allegations as: '*The opinions of scientists were very variable and led to different theories, the old being reversed by the new ones, than the forgotten ones being recovered, put into competition with the new ones*' (page 15), or '[...] *the hypothesis expressed by a series of researchers, who, with a rich fantasy, tried to invent various modalities for explaining the origin of bituminous rocks*' (page 15; underlined by Voitești). As it is well known, there were two basic explanations for the origin of the oil and gas: the inorganic theory and the organic one. Nowadays, the first one is obsolete if we try to explain the big reserves of some oilfields and gas pools, the organic theory being largely accepted by scientists. The inorganic theory could eventually explain only small hydrocarbon accumulations. But, it was not the same either at the end of the 19th, or at the beginning of the 20th, when sustainers of the inorganic origin were still vocals. In this context, Vancea mentioned for Romania, Murgoci's opinions. It is true, Murgoci was an outstanding defender of this theory but earlier, the geologist who introduced and defended this kind of origin was Cobălcescu. The author of the first geological paper written in Romanian (1862) was also at least for a part of his career the convinced advocate of the inorganic genesis for oil and gas. His reception address at the Romanian Academy (1887) was dealing with this topic. Vancea did not mention anything about it.

About the organic theory, Voitești did not have objections or corrections to note, but he did not agree that Ludovic Mrazec is '*the true sustainer of the organic origin hypothesis of the bitumen (...)*' (page 21). Would it be a sign about some disagreements with Mrazec? It is hard to know, but we remind that after their common paper on the nappe structure of the East Carpathians (1913), they had not another common work. Moreover, when Voitești went to Cluj, he did not remain geologist-collaborator of the Geological Institute where Mrazec was a director. In 1930, when Mrazec retired rather against his will, Voitești became director in his place. Anyway, after this note, the professor did not have any intervention in the text where Vancea exposed Mrazec's ideas in a detailed manner.

In the four chapter, it is important to note that Vancea defined the '*gas horizon*' and '*geological horizon*'. The definition of the gas horizon concerns: '*Strata that contain gas and share same structure, their gas content and their pressure*'. Further, '*The complex of strata of the same field, which belong to the same geological formation, we name it formation or geological horizon*' (page 25). Concerning the classification into primary and secondary accumulations of oil and gas that Vancea assigned the paternity to Mrazec, Voitești noted: '*According to all petroleum geologists, not only to Mrazec*' (page 26). The primary status of the gas accumulations in Oswege (USA) intrigued Voitești, who briefly noted: '*Based on what?*'. An even more laconic message is related to the idea that '*The migration can be done also directly through the mass of marl clay rocks, by capillarity and diffusion*' (page 33) - '*!? Hard*'.

A valuable note can be found on page 45, where Vancea gave some data about the gas pools from Transylvania. He wrote about the Basin of Transylvania: '*Interiorly it has a typical plain (Câmpie, in Romanian) character*'. In fact, the name Câmpie is usual in Transylvania, mainly for the inner depression areas, bounded by the Mureș-Arieș rivers to South and the Someș rivers to North (VANCEA, 1929). In the actual stratigraphy, the bulk of the Badenian (Middle Miocene) formations from the Basin of Transylvania are included in the Câmpie Group (FILIPESCU, 2001; i.e., the 'Câmpie Strata' *sensu* KOCH, 1900). For the huge majority of readers, but also for Vancea at that time, 'plain' had a strictly geographic, geomorphological connotation, meaning a flat relief at low altitude. There, Voitești mentioned: '*The sense of Plain gave by the Transylvanian people is not equal with the one understood by these geographers = a flat area, devoid of folds, but a Deforested one. The Transylvanian Plain = the deforested portion in Transylvania, surrounded by mountains*' (Fig. 6). In this manner Voitești clarified the genuine regional sense of this name, even nowadays misunderstood by a lot of people.

Related to the basin sole, the professor wrote: '*certainly in sole there are also: the Cretaceous, Eocene and Oligocene*', because he considered that this sedimentary basin started to function in the Cretaceous. In a table where Vancea wrote that the Oligocene is unknown in this basin (page 48), Voitești retorted: '*not even on its margins? On North and NE (...)* *there is also Eocene*'. Nowadays, the complex structure of the basin sole was in a large part solved by several borehole data, part of them already reported in Vancea's monograph (VANCEA, 1960). Obviously, this sole concerns in its deeper portions parts of the nappe structures from the neighbouring Carpathian Alpine orogene CIUPAGEA et al., 1970;

BALINTONI et al., 1998; CIULAVU et al., 2000; SĂNDULESCU & DIMITRESCU, 2004; IONESCU & HOECK, 2004; IONESCU et al., 2009).

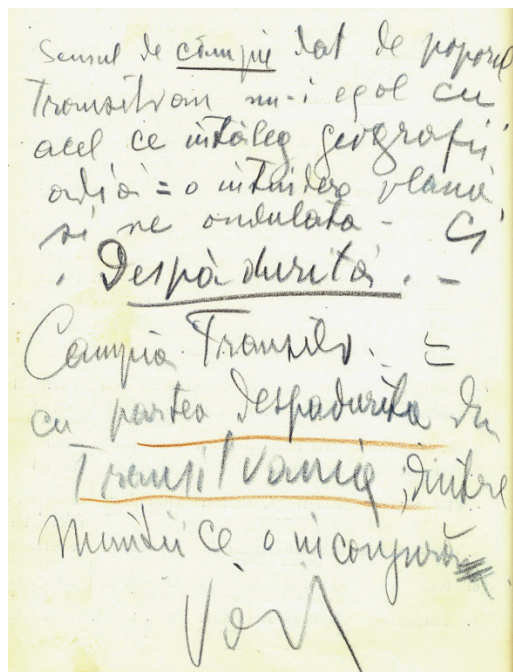


Figure 6. Facsimile of Voitești's marginal note.

Vancea's Miocene environmental reconstructions obviously intrigued Voitești: '(...) the sea is restricted in narrower boundaries, and the warm and dry climate, through an intense evaporation, concentrated so much the waters (salinity), that the salted clay and salt laid. /This idea finds support in the fact that the gas pools have a strong tectonic relationship with the salted waters./ After this a change follows, the sea is transgressing, volcanic eruptions take place, which related tuffs reach considerable thicknesses mainly on the northwestern areas of the basin, and in other places form thinner strata. The basin was covered by some water, here and there forming expanded swamps, until the end of Pontian' (page 47). Such a palaeogeographical evolution pattern explains why Voitești was cautious. The recent advances in the geology of the Basin of Transylvania (e.g. GIVULESCU, 1997; CHIRA et al., 2000; PETRESCU, 2003) pointed out that the Middle and Upper Badenian climate was not so warm and dry as presumed before, and the post-Badenian geological history was different compared to Vancea's reconstructions.

It would be difficult even to presume that the professor did not have any comment about the tectonics of the Basin of Transylvania! He mentioned about the folds, which Vancea considered Lower Miocene: '*The folds in their actual shape are post-Pliocene*'. About the ages of some sedimentary deposits from the dome cores, presumed to be Sarmatian, he wrote that one should interpret them with precaution: '*one presumed, because there is no paleontological evidence*' (p. 51).

If considering strictly the natural gas, Voitești was right to disagree its accumulation into clay (page 57). Vancea also wrote that '*the natural gas has a peculiar oil odour*' (page 51), but Voitești supervised: '*In general, the odour is given by the salted waters where the hydrocarbons are dissolved in some strata*' and '*Just in Transylvania it has this odour, which presume the presence of oil hydrocarbons*'. This phrase reflects the professor's supposition about the presence of the oil somewhere in the older sediments of the Basin of Transylvania, a theory which underlay some further investigations in this basin. Vancea himself mentioned some paragraphs above this idea, but in his mind the oil could be under the Burdigalian rocks, underlying that the gas origin was an unsolved challenge. In fact, the oil presence was proved since long time ago into the rocks of the basin margins, near Someș-Odorhei, in the granular reservoirs of the Jibou Formation (Maastrichtian-Lutetian), where the oil was even extracted in small amounts since the end of 19th century (KOCH, 1894). But the origin of this oil remains even nowadays, unknown: it is unclear if it has an origin related to the rocks belonging to the Transylvanian Basin as the geologist Ion Athanasie presumed (BULIGA et al., 2014) or, in our mind, it could migrate from the Șimleu Basin, where deep sediments and sole are very poorly known, due to the too few deep boreholes. At Bârsa, where the oil was once extracted, there is exactly the limit between the Șimleu and Transylvanian sedimentary basins, the Miocene deposits of the first, transgressing the Jibou Formation, which on its turn, is draping the metamorphic rocks of the Meseș uplift (CODREA & GODEFROIT, 2008).

It is relevant to say that Voitești made an exigent lecture of this text. He corrected some grammar mistakes and he asked about the authors of some data included in tables. But in the last chapters, his interventions are fewer: perhaps, he was not interested too deep on the gas extraction and transport, or on its consumption and economic targets.

Vancea ended his thesis as a motherland lover: '*...the methane gas locked in the deep Earth will not savagely erupt without any benefit, but it will be calmed down by our own creativity. Only in this way we'll make Romania a wealthy and respected country.*' (page 92). The further history showed how this direction became reality, or not...

CONCLUSIONS

Herein analysed, Vancea's thesis shows the work of a laborious student eager to learn a lot about the natural gas, a field where he later became a top geologist. Obviously, he was an implicate student in the local scientific life, being among the founders of the Society of Sciences of Cluj and the Naturalists Student Chapter, whose first session

was presided by MURGOCI (1921). However, at first sight, this thesis could seem rather an account, than an original contribution. But for any biographer interested by Vancea, it is very clear that it reflects nothing else but plain and simple an exercise for his Ph.D. thesis (Diploma from August 8, 1929, Magna cum laude; Fig. 7), Voitești being both coordinator and commission president. According to the rules of that time, Vancea defended in fact two theses. The first was entitled ‘Geological observations in the South-West area of the Transylvanian Plain – with a general view on the geology of the Basin of Transylvania and special description of the natural gas dome from Zau de Câmpie’, while the second one was on ‘Positions proposed by faculty’, including ‘Natural Hydrocarbon pools. Geographical distribution and their pool environment’ and ‘Fossil waters. The importance of their chemical composition for the study of the hydrocarbon pools’. The title of the first chapter of the second thesis (unfortunately, unprinted at Cluj University) is extremely close to the topic of the graduation thesis.

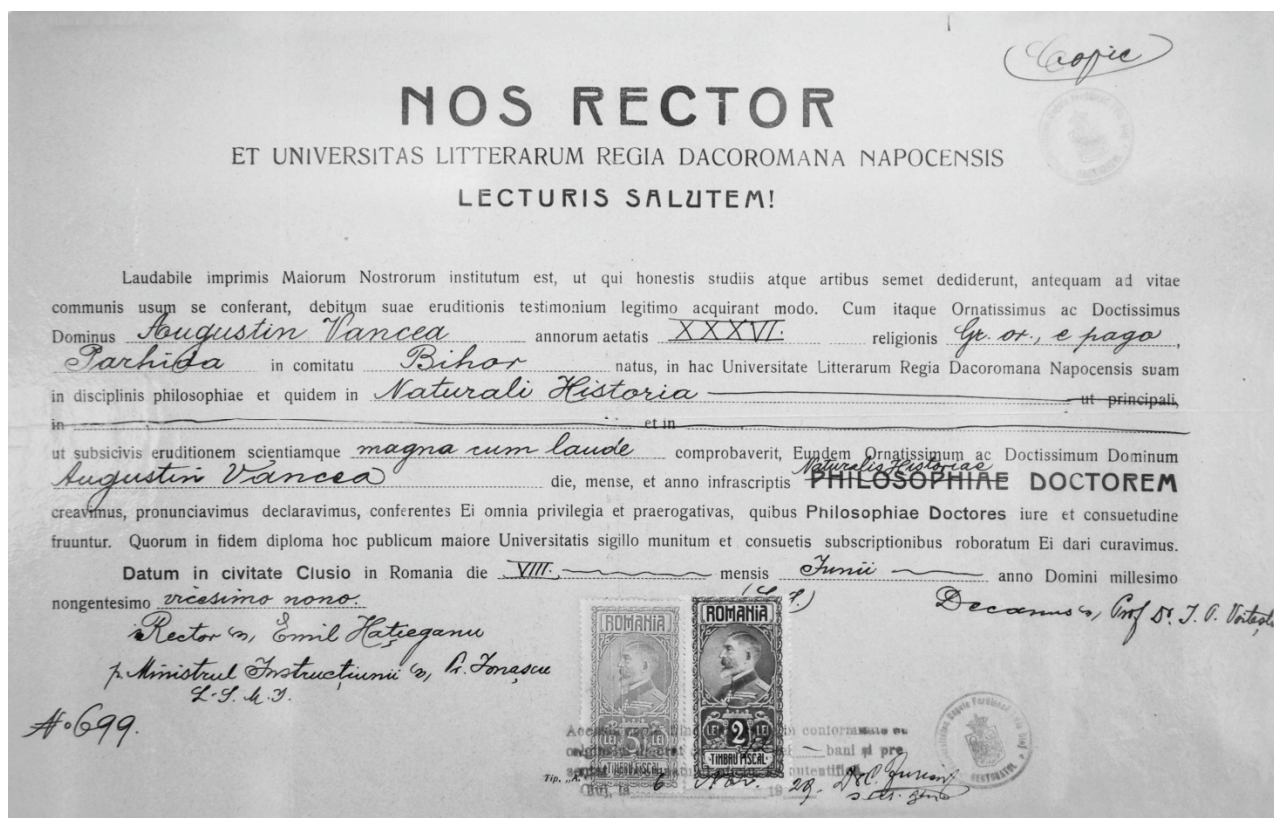


Figure 7. Vancea's Ph.D. diploma (photo of a document copy curate at Natural Gas Museum Mediaș).

The fate of these two petroleum geologists were very different. Voitești left Cluj University in 1936 and gave courses as professor at the University of Bucharest, continuing his research on the petroleum and gas bearing formations of Romania and the Carpathians tectonics, until his retirement. In spite of his great and original contributions, he was never elected member of the Romanian Academy, but was among the founders of the Academy of Sciences (PETRESCU & FABIAN, 2008), whose member he remained until his sudden death in his own native village, when he retired from hunting. It is worth to be mentioned that his former colleague in Paris, George Macovei, in spite of lesser brilliant scientific contributions, became member of the Romanian Academy, probably as PAUCĂ (1998) presumed rather due to his Free Masson status, which Voitești never had. In 1930, he was named director of the Geological Institute of Romania – position extremely ephemeral –, based on his close relationship with the leaders of the National-Peasant Party (mainly with the ones of the former Romanian National Party, from Cluj; PAUCĂ, 1998). With such background, it would be interesting to imagine which would have been his fate after 1945, if he had had a longer life. Probably a sad one, because the Communist regime could not easily forget his political sympathies... On the other hand, his generous and truthful character, with frank attitude (STANCIU, 1936; MAXIM, 1945; ILIE, 1957; PAUCĂ, 2008) probably would have led him towards aversions and enemies. Or in that troubled epoch, all these could bring him to a tragic end as a lot of other Romanian intellectuals shared, all victims of the Stalinian system.

Even nowadays, our tribute to his personality could be stronger as it is: his native house from Voitești is now a museum, a street in Cluj-Napoca downtown bears his name (due to the late Prof. N. Mészáros' endeavour), the yearly symposium of the Department of Geology of Babeș-Bolyai University of Cluj-Napoca bears the name of this famous forerunner too, like a classroom in the central building of same university. In Gorj County, in the last years, few scientific meetings also pointed out his basic contribution to the Romanian geology.

Vancea browsed a different way. He was firstly, geologist at the Natural Gas Direction in Cluj, then one of the leaders of the National Society of Methane Gas in Mediaș (SENI, 2016) in high ranked positions. He worked a lot in the field geology, on several areas of interest for methane gas as Zau de Câmpie, Sărmășel, Cetatea de Baltă, Șaroș, Șamșudul de Câmpie etc. (SENI, 2016). Deeply engaged in such professional tasks, his time for the scientific research was surely not too generous. Therefore, he never reached the scientific level of his mentor, but his contributions for the regional geology and related gas pools from Transylvania remains important, although not excessively numerous. His scientific work includes few papers related to geology, gas reservoirs and stratigraphy (PANAITESCU et al., 2014; SENI, 2016) and a single book, but this one is the first monograph wrote in Romanian of the Basin of Transylvania (1960). He was elected president of the Society of Geological Sciences, Mediaș branch and he also won the State Prize on 1963 (SENI, 2016). It became corresponding member of the Romanian Academy, unusual election for a geologist working far from the capital Bucharest or the main universities from Cluj and Iași. Strangely, PAUCĂ (1998), one of the authors of the subsequent monograph on the Basin of Transylvania (1970), does not mention Vancea at all in his memories.

ACKNOWLEDGEMENTS

This work is a tribute dedicated to the 140th commemoration of Voitești's birth, on November 18, 2016. Authors thank a lot to Mrs. Angela Păucean, curator at the Natural Gas Museum Mediaș, for the photocopy of Vancea's Ph.D. thesis. Dr. George Pleș, kindly offered to one of us (VAC) valuable references about Vancea's studies in Năsăud. We also wish to express our gratitude to Silviu Rus, who provided us with a drawing portrait of A. Vancea, found in the Năsăud House of Culture, whose director he is. Last but not least, Marian Bordeianu gave us fair collegial help in processing on computer some of figures.

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Received: February 10, 2017

Accepted: June 26, 2017

FRAGMENTS FROM THE LIFE OF A GREAT ROMANIAN BIOLOGIST - UNIVERSITY PROFESSOR PHD, EMERITUS, CONSTANTIN CRĂCIUN - A LIFE DEDICATED TO THE STUDY OF THE CELL ULTRASTRUCTURE (1937-2016)

CORNEANU C. Gabriel, CORNEANU Mihaela



University Emeritus Professor
Constantin Crăciun, PhD (1937-2016).

Abstract. Biological sciences in general and cellular biology in particular have recently undergone an irrecoverable loss, the passing away of the renowned specialist, Professor Emeritus dr. hc. Constantin Crăciun, PhD (Babes-Bolyai University, Cluj-Napoca). Born in Pîrșcoveni settlement, former Romanati County (1937), he graduated Corabia Theoretical High School. Based on his further education, he is the product of the reputable scientific school of Transylvania, Babes-Bolyai University of Cluj-Napoca, Faculty of Natural Sciences (1961-1966). He had the chance to participate and be educated in the laboratories of some personalities of the Romanian science that were active at that time in Cluj-Napoca (Acad. Eugen A. Pora, animal physiology; Acad. Oreste Marcu (entomology); Acad. Vasile G. Radu (invertebrate zoology), Professor Victor Pop, PhD (vertebrate zoology), Professor Dumitru Rosca, PhD (cyto-histo-physiology), Prof. Ghișă Eugen, Prof. PhD Csuros Ștefan, PhD (Botany), Prof. Kiss Ștefan, PhD (microbiology) etc. After graduation, he worked as a researcher at the Centre of Biological Research in Cluj-Napoca (1966-1970) and was admitted to the PhD studies by Prof. Vasile Gh. Radu, C.M. of the Romanian Academy, with a subject the finalization of which required extensive investigations and a solid experience in the field of electron microscopy. During this period, Professor Vasile Gh. Radu, founded and organized the Laboratory of Electron Microscopy of the Faculty of Biology, Babes-Bolyai University of Cluj-Napoca. In these conditions, the future Prof. Constantin Crăciun, PhD, was transferred from the CBR-Cluj-Napoca to the Faculty of Biology, Babes-Bolyai University, as a scientific researcher. He was appointed Director of the newly created Centre of Electron Microscopy.

His main task was the organization and coordination of its activities (1971-2000). One of the co-authors of this material (currently Prof. Gabriel C. Corneanu, PhD, at that time a teaching assistant PhD at the University of Craiova) had the chance to do a specialization internship in the field of electron microscopy in the laboratory from Cluj-Napoca. This was the beginning of our friendship and collaboration that lasted 40 years. Afterwards, the other co-author (Prof. Mihaela Corneanu, PhD, currently at UASVMB Timișoara) benefitted from the same warm and honest friendship, as well as from the access to the investigation equipment, specialized literature and specialists' experience. Within the framework of interdisciplinary, inter-university research, there were also associated other specialists from other national and international education and research institutions and there were achieved research activities within the framework of numerous contracts and research grants. Professor Constantin Crăciun (figure 1) conducted experiments in 17 research grants financed by CNCIS, BCUM or CNMP. This resulted in hundreds of scientific papers published in reputable publications, scientific monographs, etc. The research conducted by Prof. Constantin Crăciun is huge and is represented by more than 531 scientific papers (106 in ISI publications), 25 books and monographs, patents, etc. A representative study is the monograph elaborated in collaboration with Prof. Dorina Cachita-Cosma, PhD (University of Oradea) and printed in the Handbook of Plant Cell Culture (vol. V, DA Evans ed., McGraw-Hill Publishing Publ. Co. New York, 1990). Prof. Constantin Crăciun was a member of numerous international scientific societies (ECBO, EMS, IAPTC, JSPP, Malpighi Academy, etc.) or Romanian scientific societies (SRME, SNBC, AOS, ARCTV, SOR, FORS, etc.), his activity being highly appreciated by great contemporary experts. The meeting in 1971 with the reputed specialist of Romanian origin, Prof. George Emil Palade, PhD (Nobel Prize in Medicine and Physiology, 1974) was beneficial for his activity assessment. As a result of positive appreciation, Professor Constantin Crăciun was invited to attend the ceremony held at Wayne State University, Detroit, USA at his 90 years celebration. We mention that there were invited only seven officials and only two were Eastern Europeans (Professors Gheorghe Benga and Constantin Crăciun, both born in Oltenia and working in Cluj-Napoca). On this occasion, it was held the manifestation "George Emil Palade Lecture" and the award International Prize and Gold Medal "George Emil Palade" and Wayne State University, Detroit was named "George Emil Palade" University. He was a PhD supervisor (Biology) and taught courses at the Master programme and the Doctoral School in Cluj-Napoca. As he was a good organizer, he organized and founded the Laboratory of Electron Microscopy at the University of Oradea, Vasile Goldis Western University of Arad and MFU Timișoara. He also established SNBC branches in the main cultural centres in western Romania (Oradea, Arad, Baia Mare, Satu Mare, Brașov, Sibiu, Zalău, etc.). He was involved in the editorial process of specialized publications (SRBC Annals; Oltenia. Studies and Research. Natural science, the Oltenia Museum Craiova, etc.). In this continuous activity that marked his whole life, the only moments of relaxation were when he was together with his family or when practicing his two hobbies: hunting and gardening. Along with his scientific and professional activity, they brought and were sources of great satisfaction. His wife, Veronica Crăciun, worked with him in all the activities of cell biology, being practically inseparable, at home and at work. Their two children are professionally accomplished. The daughter, Adina Crăciun, an appreciated dentist, has a dental clinic in Timișoara. The boy, Radu Crăciun, established in Belgium, has a PhD in cell biology at the Free University of Brussels, and is highly appreciated by others (actor Jean-Claude Van Damme, for example).

Keywords: scientific activity, professional activity (didactic and research), main results.

Rezumat. Fragmente din viața unui mare biolog român - profesor universitar doctor emerit Constantin Crăciun - o viață închinată studiului ultrastructurii celulei (1937-2016). Științele biologice în general și biologia celulară în special au suferit recent o pierdere irecuperabilă, prin trecerea în neființă a recunoscutului specialist Profesor Emerit Dr. Constantin Crăciun (Universitatea Babes-Bolyai, Cluj-Napoca). Născut în satul Pîrșcoveni, fostul județ Romanati (1937) a absolvit studiile liceale la Liceul

Teoretic Corabia. El a fost un produs al reputei școli științifice transilvane, Universitatea Babeș-Bolyai, Cluj-Napoca, Facultatea de Științele Naturii (1961-1966). A avut șansa de a fi educat în laboratoarele unor personalități a științei românești, care la vremea respectivă erau în activitate la Cluj-Napoca (Acad. Eugen A. Pora, fiziologie animală; Acad. Oreste Marcu (entomologie); Acad. Vasile G. Radu (zoologia nevertebratelor), Profesor dr. Victor Pop (zoologia vertebratelor), Profesor dr. Dumitru Rosca (cito-histo fiziologie), Prof. dr. Ghișa Eugen, Prof. dr. Csuros Ștefan (Botanică), Prof.dr. Kiss Ștefan (microbiologie), etc. După terminarea facultății a lucrat ca cercetător la Centrul de Cercetări Biologice Cluj -Napoca și a fost admis la doctorat de Prof. Vasile Gh. Radu, membru corespondent al Academiei Române, cu un subiect a cărui finalizare necesita investigații și experiență solidă în microscopie electronică. În timpul acestei perioade Prof. Vasile Gh. Radu a fondat și organizat Laboratorul de Microscopie Electronică a Facultății de Biologie a Universității Babeș-Bolyai, Cluj-Napoca. În aceste condiții tânărul doctorand Constantin Crăciun a fost transferat la noul laborator tot pe post de cercetător științific. În 1971 a fost numit Director al Centrului de Microscopie Electronica, poziție pe care a ocupat-o până în anul 2000, ocupându-se de organizarea și coordonarea activităților desfășurate aici. Unul dintre co-autorii acestui material (Prof.dr. Gabriel C. Corneanu, doctorand la vremea respectivă și asistent universitar la Universitatea din Craiova) a avut șansa unei specializări în domeniul Microscopiei Electronice în laboratorul din Cluj-Napoca. Acesta a fost începutul unei prietenii, care a durat 40 de ani. În cadrul unei rețele de cercetare inter-disciplinară și inter-universitară s-au realizat numeroase contracte și granturi de cercetare. Profesorul Constantin Crăciun a coordonat experimente în 17 granturi finanțate de CNCIS sau CNMP București. Din aceste granturi au rezultat sute de lucrări științifice publicate în reviste științifice de prestigiu, monografii, etc. Munca de cercetare coordonată de profesorul Constantin Crăciun a fost uriașă și s-a concretizat în 531 lucrări științifice (106 publicații ISI), 25 de cărți și monografii, brevete, etc. O publicație reprezentativă este monografia realizată în colaborare cu Prof. dr. Dorina Cachiță-Cosma (Universitatea din Oradea) tipărită în Handbook of Plant Cell Culture (vol. V, DA Evans ed., McGraw-Hill Publishing Publ. Co. New York, 1990). Prof. Constantin Crăciun a fost membru în numeroase societăți științifice internaționale (ECBO, EMS, IAPTC, JSPP, Malpighi Academy, etc.) sau din România (SRME, SNBC, AOS, ARCTV, SOR, FORS, etc.), activitatea lui fiind apreciată de comunitatea științifică. Întâlnirea cu Prof.dr. George Emil Palade (Premiul Nobel pentru Medicină și Fiziologie, 1974) din anul 1971 a fost benefică pentru dezvoltarea carierei sale. În semn de apreciere Prof.dr. Constantin Crăciun a fost invitat să participe la ceremonia de celebrare a 90 de ani a Prof. George Emil Palade, la Wayne State University, Detroit, USA. La această ceremonie au fost doar șapte invitați din Europa, doar doi din Europa de Est (Profesorii Gheorghe Benga și Constantin Crăciun, ambii născuți în Oltenia și profesând la Cluj-Napoca). Cu această ocazie a avut loc manifestarea științifică "George Emil Palade Lecture", s-a fondat Premiul Internațional și Medalia de Aur "George Emil Palade", iar Wayne State University, Detroit a fost redenumită "George Emil Palade" University. Profesorul Constantin Crăciun a fost conducător de doctorat (Biologie) și a predat cursuri la programul master și școala doctorală din Cluj-Napoca. Fiind un bun organizator a fondat și coordonat Laboratoare de Microscopie Electronica la Universitatea din Oradea, Universitatea de Vest Vasile Goldiș, Arad. De asemenea el a înființat filiale ale Societății Române de Biologie Celulară în principalele centre culturale din vestul țării (Oradea, Arad, Baia Mare, Satu Mare, Brașov, Sibiu, Zalău, etc.). A fost implicat în procesul editorial al mai multor publicații de specialitate (Analele SRBC, Oltenia. Studii și cercetări Științele Naturii, etc.). Cu o activitatea de cercetare continuă, care i-a marcat existența, momentele de relaxare le petrecea împreună cu familia sau dedicându-se celor două pasiuni: vânătoarea și grădinăritul. Soția lui Veronica Crăciun a lucrat împreună cu el în laborator, fiind practic inseparabili, la serviciu și acasă. Cei doi copii s-au realizat profesional. Fiica lui Alina Crăciun este un apreciat medic stomatolog în Timișoara, iar fiul Radu Crăciun a obținut titlul de doctor în biologie celulară la Free University of Brussels și este stabilit în Belgia.

Cuvinte cheie: activitate științifică, activitate profesională (didactică și cercetare), rezultate principale.

General data, pre-university studies.

Professor Emeritus dr. hc. Constantin Crăciun, PhD (Babeș-Bolyai University, Cluj-Napoca) (Fig.1) was born on the 14th of March, 1937, in Pîrșcoveni commune, the former Romanati County. He studied at Corabia Theoretical High School. Due to the conceptions of that time related to the so-called 'unhealthy origin', he could not continue his university studies immediately after high school. He graduated the Technical School of Topography in Bucharest (1957), after which he was appointed as topographer at the Cadastre Office of Crișana Region. Due to the same label ('unhealthy origin'), he performed his military service within the **Work Battalion (DGSM)**, with the **rank of 'uninstructed soldier'**. As the Romanian society slightly 'changed' in the 7th decade of the last century, he was allowed to attend university courses at the Faculty of Natural Sciences (Biology), 'Babeș-Bolyai' University of Cluj (1961-1966).

Research and university activity.

After graduating the university, he was appointed as a scientific researcher at the Center for Biological Research in Cluj-Napoca (1966-1978). Passionate about scientific research and studies of new information, he enrolled in the PhD studies at Prof. Vasile Gh. Radu PhD, who founded the **Electron Microscopy Laboratory** at the Faculty of Biology in Cluj-Napoca. Being a PhD student on the subject of optical and electron microscopy, he organized and led the **Electron Microscopy Center** (1971-2000), being the director of this modern research base. There were achieved many scientific research papers, research contracts and specialists from both Romania and abroad were trained in this field. Among those who were trained and approached research on cell ultrastructure in this fascinating field of cell biology were also the authors of this commemorative text (Corneanu Gabriel, starting with 1976 and Corneanu Mihaela, starting with 1986); the research studies were carried out within MURF (Multiple Users Research Foundation), founded in 2000 at the Faculty of Biology, Babeș-Bolyai University of Cluj-Napoca.

As a result of his activity, he became a consultant professor at the Faculty of Biology and Geology, having the responsibility of coordinating and teaching two courses at the master and doctoral programmes on two subjects: **Advanced Aspects of Cell Structure and Ultrastructure** and **Electron Microscopy**. His exceptional scientific knowledge and organizational qualities made him be designated to teach of new subjects at newly established faculties in Romania. In this way, he became associate professor at the University of Oradea, the faculties of Medicine and Biology and at "Vasile Goldiș" Western University of Arad. Here, he set up, organized and led the following subjects:

Histology, Cell Biology, Cellular Cytology and Electron Microscopy. Supported by the Romanian authorities in the field, Professor Constantin Crăciun became PhD supervisor in Biology, Specialization Cell Biology at Babeș-Bolyai University of Cluj-Napoca; 17 PhD students supervised by him graduated (a doctoral student from abroad).

A positive event in his life and professional activity was the meeting with the eminent Romanian scientist, the winner of the Nobel Prize in Medicine and Physiology (1974), Professor George Emil Palade, in 1971, when visiting Romania. Professor George Emil Palade positively appreciated Professor Constantin Crăciun's professional activity at UBB Cluj-Napoca. The confirmation of this appreciation was the invitation and the participation of Professor Constantin Crăciun in 2003, together with seven scientific personalities (only two personalities from the countries of Eastern Europe, namely Prof. Gheorghe Benga, **Iuliu Hațieganu UMF Cluj-Napoca** and Prof. Constantin Crăciun, **BBU Cluj-Napoca**) at the festivity organized by Wayne State University, Detroit, USA, on his 90 years celebration. On this occasion, there took place the event '**George Emil Palade Lecture**' and the awarding of "**George Emil Palade**" **International Award** and **Gold Medal**. The first winner was Gunther Blobel, a disciple of Professor G.E. Palade and winner of the Nobel Prize in Medicine and Physiology in 1999. On this occasion, Wayne State University, Detroit received the name "George Emil Palade" University (Cristian Colceriu, Cluj University Elites, 2004).

Scientific and publishing activity.

Professor Constantin Crăciun achieved a fruitful scientific activity, highlighted by the number and quality of the elaborated scientific works and the number of scientific manifestations he participated in, the number of books and monographs written or co-authored, the number of scientific grants obtained through competition, the number of patents, and so on. Thus, Professor Constantin Crăciun elaborated over 531 scientific papers published in extenso (out of which 106 in ISI publications), 25 books and edited scientific monographs (4 abroad and 2 ISI), 9 patents (4 ISI), 22 collective volumes, 17 CNCIS and CNMP grants as a Director and 13 as a partner, 140 research contracts to which he was Director or Main Partner, etc.

At a SNBC session held in Craiova, we invited 12 friends to a party organized at home. The piece of resistance was a large goose, besides classical appetizers (cheese, sausage, etc.) and sweets from local confectioneries or prepared by our colleagues from SNBC Craiova. The table being too loaded and to be a surprise, after sorting the goose, I asked a colleague to offer my colleague, Prof. Constantin Crăciun PhD, one of the 'cotoaie' of the goose. Being Transylvanian and not knowing the meaning of the term 'cotoi', she asked her husband, original from Bihor, to tell her the meaning of this term. But neither colleague Bită knew it. He asked Costică (his brother-in-law) for clarifications. Costică asked immediately from which bird the 'cotoi' came. When hearing of the word goose, he answered: 'Sir, it is one of the legs of the bird, taken entirely from the spinal cord. At this symposium, we also established together with the illustrious leaders of SNBC (the spouses Nicolae and Maya Simionescu) that the third day would be dedicated to cultural activities specific to the region where the Symposium was taking place, in this case, the Art Museum of Craiova.

The place and theme of the meeting being previously established, in the third day of the Symposium, on a heavy rain, 'armed' with two umbrellas under which I protected the cakes made by my colleagues, Dr. Irina Păunescu and Dr. Marcela Popilian, we went to the Art Museum. Fortunately, I lived in the central area of the city, because there were not available taxi drivers. The presentation in the halls of the Art Museum of Craiova was made by the colleague Prof. Paul Rezeanu PhD, the director of the museum, for several hours, with significant details, in the smell of coffee and cakes. The action was a success, being 'tasted' by SNBC leadership (Acad. Prof. Nicolae Simionescu PhD, President of SNBC, Acad. Prof. Maya Simionescu PhD, Vice-president, etc.).

It seems that SNBC sessions were the most attractive also due to the scientific programs, which made us glad. Thus, at another session of SNBC that also took place in Craiova, the opening of the annual SNBC session coincided with the inaugural phase of the World Football Championship. My friend Crăciun arrived by car on the route Cluj - Slatina, together with our colleague Prof. Octavian Popescu PhD, and from here, each of them travelled to Craiova with their own relatives. We decided to watch the first football match of the W.C. at my place. One of my neighbours suggested watching the match at his apartment as he had a better TV set sent by his son settled in the USA. The two apartments were in two neighbouring blocks: I was living on the ground floor and my neighbour at the mezzanine in the adjacent block. We parked the car in front of the block, got the luggage, entered the elevator, pressed the button for the 2nd floor (the block had a mezzanine, information not marked on the elevator) and we went directly to my colleague's residence.

We were in a little delay, so we agreed that the polite words to be addressed during the first pause. We were greeted by an unknown person. I ask him directly: Are you here for the match, isn't it? He answered affirmatively. A little while later, when tasting the wine offered by the hosts, I asked him: but Mr. Nicu and Mrs. Nelica, where are they? He answered that the Constantin family lives under them, at the mezzanine! After the confusion passed (due to the fact that we went one floor up), I realized that, at the back of the block, there was no sign of a mezzanine, but of one more floor. The behaviour of the two spouses was slightly bizarre because they were in divorce and each of them thought that we had been invited by the other partner to watch the match. However, the follow-up was positive because the two spouses reconciled. At the SNBC symposiums there were numerous funny situations, as there were numerous other participants besides us who were the heroes of numerous scenes, including the county party secretary, from Mureș County, and, of course, Professor Constantin Crăciun and the undersigned!

The scientific and publishing activity is accomplished through the activities carried out within numerous Romanian or international scientific societies where he was a member and which awarded him prizes and scientific titles.

Scientific societies to which he was affiliated.

He was affiliated to 13 scientific societies, namely: **International societies:** ECBO (European Cell Biology Organization since 1995), EMS (European Microscopy Society since 1998), IAPTC (International Association for Plant Tissue Culture since 1997), INTECOL (International Association for Ecology, 1998), JSPP (Japanese Society of Plant Pathology, 1998), **Malpighi Academy** for the Study of Microscopic Anatomy (Rome, 1999), etc. **Romanian Scientific Societies:** **Romanian Electron Microscopy Society** (since 1972), **Romanian Society for Cell Biology** (1982), AOS Romania (Association of Romanian Scientists, 1986), **RACCPT** (Romanian Association of Cell Culture and Plant Tissue, 1994), **ROS** (Romanian Ornithological Society, 1997), **FORS** (Governmental Science Foundation, 1999), etc.

Awarded scientific prizes and titles: **Traian Savulescu Prize** of the Romanian Academy (2001), **Maya and Nicolae Simionescu Prize** of SNBC (2003), **Doctor Honoris Causa** of Vasile Goldiș Western University of Arad (2003); **Doctor Honoris Causa** of Iuliu Hațieganu UMF of Cluj-Napoca (2008) (Fig. 2), **Professor Emeritus** at Babeș-Bolyai University of Cluj-Napoca (2012) (Fig. 3). Since 2007, he has been president of Cluj-Napoca branch of RSCB (Romanian Society for Cell Biology, as it is recently named) (Fig. 4).



Figure 2. The ceremony **Doctor Honoris Causa** of Iuliu Hațieganu UMF of Cluj-Napoca (2008).



Figure 3. At his desk in the laboratory of Electron Microscopy (2006).



Figure 4. In the Organizing Committee of the 28th Annual Session RSCB (Constanța, 2010).

In the last two decades, due to his organizational qualities, he organized and set up branches of RSCB in the western part of Romania, where annual scientific sessions of RSCB took place: Oradea (1996), Arad (1997), Baia Mare (2001), Satu Mare (2002), Zalău (2003), Brașov (2004), Sibiu (2005). He was also editor of prestigious scientific

publications: Bulletin of SNBC, Annals of SNBC, presently called *Annals of the Romanian Society for Cell Biology* (Associate Editor), *Oltenia Museum Craiova, Oltenia Journal for Studies in Natural Sciences* (Craiova, member of the Editorial Board). In the last two decades, he has set up Electron Microscopy Laboratories at higher education institutions in Oradea, Arad and Timișoara.

Science news introduced in the specialized literature. As a result of laborious scientific investigations, Professor Constantin Crăciun, alone or within different research collectives, introduced a series of science news in the specialized literature. Among these, there can be mentioned.

(a) *Eracosome* - a super complex of mucoprotein synthesis in the glandular cell of a terrestrial crustacean (*Porcellio scaber*). It is involved in the synthesis and preservation of reserve substances for sperm nutrition during hibernation.

(b) He highlighted the existence of **insulin-producing cells** in the hepatopancreas of some Black Sea molluscs and fish.

(c) Studies on **vacuolar compartmentalization** that elucidated the development of various metabolic processes (the involvement of vacuolar subdivision in the clearing of cellular debris, etc.).

Scientific mentors involved in his training.

Professor Constantin Crăciun benefited from the guidance of some of the greatest specialists in Biology field. Besides scientific knowledge and practical skills, they also represented wonderful models of life: Acad. Eugen A. Pora (Animal Physiology); Acad. Oreste Marcu (Entomology); Acad. Vasile G. Radu (Invertebrate Zoology), Victor Pop (Vertebrate Zoology), Dumitru Rosca (Animal Physiology), Eugen Ghișa, Ștefan Csűrös (Botany), Prof. Ștefan Kiss (Microbiology).

His faculty colleagues, in the scientific climate of Cluj-Napoca, maintain their ascendancy in the scientific world and represent current scientific personalities of Romania in Biology field.

In the last 40 years, I have worked together with Professor Constantin Crăciun, along with other colleagues, in inter-disciplinary, inter-university collectives that have brought real contributions to scientific knowledge. Among these, we can mention:

- the study of some metabolic structures of the nucleus and their role in the cell (*bodyguard* and *NAB's*), aspect remarked by great specialists (James D. Watson, winner of the Nobel Prize);

- the reaction of eukaryotic and prokaryotic cell, when maintaining the body in conditions similar to the extra-terrestrial environment (the value of the geomagnetic and geoelectric field; the acceleration force, etc., research grant with the Romanian Space Agency);

- analysis of various factors that can modify the cell response under different experimental conditions, and so on.

A few days before the Final, before the presentation of a paper on the ultrastructural changes at the spleen level under various environmental factors at an International Conference, we talked on the phone about the implication of different experimental parameters. Professor Constantin Crăciun, attentive as he always was, insisted on some involved structural aspects. I remark that, during our collaboration of over five decades, between the two mentioned works that marked the beginning and still not the final point of our collaboration (the first paper described the ultrastructural modifications of the genetic material in mitosis, and the last paper, sent for publication, the ultrasound modifications induced in the spleen), several hundred works rendering different ultrastructural aspects were published. Moreover, there is a rich analysed material based on experimental data, which has not been published yet, waiting to be written and disseminated.

He had a family life as we all want, but few enjoy it. After an intense day of work at the electron microscope, we went together in 'Zorilor 42', where Mrs. Veronica, his wife, was waiting for us, as usually, with game delicacies. On his way home, he used to remove the snow from the branches of coniferous trees as they were bent under its weight, thus protecting nature.

The scientific and research activity was interwoven with two hobbies, which relaxed him: hunting and gardening. These are two practical aspects of biology, respectively two characteristics that played an important role in the evolution of human populations. Other recreational activities were those carried out in the family (together with his wife and two children, professionally accomplished), as well as the participation in scientific events in different countries and continents. This activity (writing and presenting the results of scientific research) was supposed to be the specific activity of the third age. Unfortunately, we only succeeded to do it together just partially. However, we are pleased with what we have achieved so far. We believe our friend COSTICĂ is of the same opinion.

Good bye, DEAR FRIEND!

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Received: March 18, 2017

Accepted: July 12, 2017

**PROFESSOR GHEORGHE G. POPESCU, PhD.
– COMMUNION IN BOTANY (1939-2017)**

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Professor Gheorghe G. Popescu, PhD. (1939-2017)

Abstract. In the research activity in the botanical field, we have the chance to be friends and to collaborate with Professor Gheorghe G. Popescu PhD. Born on the 28th of November 1939, he attended the university studies at the Faculty of Biology, University of Bucharest (graduated in 1962). He is native from a wonderful region, from Păușești-Oțasau site, located on the Oțăsău river, tributary of the Bistrița river (Vâlcea county), from an area rich in flora and fauna, with numerous historical monuments and significant culture. The PhD thesis was inspired by his native sites: *The floristic and geobotanical studies in the hydrographic basin of the Vâlcea Bistrița River (Vâlcea, 1974)*. Since the graduation of the university studies until his retirement, Professor Gheorghe G. Popescu PhD performed his professional and scientific activity, at the same subject, at the same University (Biology, Botany, University of Craiova, achieving all the didactic positions, from teaching assistant to full professor). He greatly contributed to the improvement of the Botany matter base from the University of Craiova, with herbarium collections and microscopic preparations, with plants collected by himself. Altruist and full of initiative, he also contributed to the development of Botany at Craiova and of the research in this field.

The didactic and research activity was highly appreciated by the management staff of the University of Craiova; thus, he was coordinator and Director of Professor Dr. Doc. Alexandru Buia Botanical Garden from Craiova and decisively contributed to the establishment of the other unit, namely the Prof. Dr. Doc. Marin Păun Alpine Botanical Garden from Râncă (Gorj County). He edited many monographic studies in the botanical field, organized scientific international symposia, published numerous papers and formed valuable scientific staff. He was a member in many scientific societies, such as Biological Science Society, Vice-President, Romanian Phytocoenological Society, International Federation of Phytocoenology (Bailleu, France). He conducted research studies in different botanical fields, such as: systematic botany, morphology and plant anatomy, phytocoenology, phytosociology, etc. He decisively contributed to the achievement of many theses of pre-university professors for obtaining the first didactic degree. He also monitored the research and didactic activity in the field of Botany at the University of Craiova. Thus, the colleagues formed under the guidance of Professor Gheorghe G. Popescu, from teaching assistant to associate professors, must continue and develop the didactic and research activity in Botany Field, at the University of Craiova.

Keywords: professional development, didactic and scientific activity, commemoration.

Rezumat. Profesor dr. Gheorghe G. Popescu – comuniune în botanică (1939-2017). Am avut șansa să fim prieteni și colaboratori ai Profesorului dr. Gheorghe G. Popescu în activitatea de cercetare. Născut la 28 Noiembrie 1939, el a urmat studiile Universității București, Facultatea de Biologie (licențiat în 1962). A fost originar dintr-o regiune frumoasă, bogată în floră și faună, cu numeroase monumente istorice și culturale, satul Păușești-Oțăsău (județul Vâlcea), așezat pe râul Oțăsău, afluent al râului Bistrița. Teza sa de doctorat a fost inspirată de locurile natale: *Studii floristice și geobotanice în bazinul hidrografic al râului Bistrița (Vâlcea, 1974)*. De la absolvirea facultății și până la pensionare Prof. dr. Gheorghe G. Popescu și-a desfășurat activitatea didactică și de cercetare la aceeași universitate (Universitatea din Craiova, Disciplina Botanică, parcurgând toate gradele didactice de la asistent la profesor universitar). El a contribuit la dezvoltarea bazei materiale a Disciplinei de Botanică, a colecției de herbar și preparate microscopice, cu material colectat de el. Altruist și plin de inițiativă a deschis direcții de cercetare noi în botanică, contribuind astfel la dezvoltarea disciplinei. Activitatea sa didactică și de cercetare a fost apreciată de conducerea universității, fiind numit Director al Grădinii Botanice Profesor Dr. Doc. Alexandru Buia din Craiova și contribuind decisiv la înființarea Grădinii Botanice Alpine Prof. Dr. Doc. Marin Păun, Râncă (județul Gorj). A editat numeroase studii monografice în domeniul botanicii, a organizat simpozioane științifice internaționale, a publicat numeroase lucrări științifice și a format tinere cadre didactice. A fost membru în societăți științifice: Societatea de Științe Biologice (vicepreședinte), Societatea Română de Fitocenologie, Societatea Internațională de Fitocenologie (Bailleu, Franța). A coordonat activitatea de cercetare în diferite ramuri ale botanicii: botanica sistematică, morfologia și anatomia plantelor, fitocenologie, fitosociologie, ș.a. A coordonat numeroase lucrări de grad ale profesorilor din învățământul preuniversitar. Cadrele didactice formate sub coordonarea prof. dr. Gheorghe G. Popescu au datoria să continue și să dezvolte activitatea didactică și de cercetare începută de acesta la Universitatea din Craiova.

Cuvinte cheie: dezvoltare profesională, activitate didactică și științifică, comemorare.

Professional development.

I had the chance to be friend and collaborate with Professor Gheorghe G. Popescu, PhD, from the University of Craiova. He was born on the 28th of November 1939, in the commune Păușești-Oțăsău, Vâlcea, a settlement located on both banks of the Oțasau River, rich in history and traditions, flora and fauna. He graduated the Faculty of Biology of the University of Bucharest (1962), in a promotion marked by graduates who honoured the education and research in

Romania: Prof. Andrei Marin PhD, Prof. Anghel Ion PhD, S.R. I. Brezeanu Aurelia PhD, S. R. I. Săvulescu Anastasia PhD, Prof. Toma Nicolae PhD, Prof. Popescu G. Gheorghe PhD, Prof. Simeanu Vasile PhD, Prof. Olimid Virgil PhD (the last three professors at the University of Craiova), etc.

After graduation, he worked as a biology professor at Olănești-Bai High School (Vâlcea County), being, at the same time, head of laboratory and teaching assistant at the Agronomic Institute from Craiova, Botany Department. The university career was carried out in a single university center (1964-2009, Craiova), achieving successively all the positions in higher education, at the same subject (Botany) and department (Biology-Botany). His organizational talent and work capacity, his altruistic character, dedication and very good cooperation with the people whose activity he guided and coordinated, resulted from the activities he carried out and his achievements.

The Botanical Garden from Craiova and the Alpine Botanical Garden from Râncea, Gorj.

Besides the activity in his field (Botany) and at the department, he was also coordinator of the Botanical Garden from Craiova (1992-1996) and Director of this prestigious scientific unit (from 1996 until his retirement). Involved in this activity, he brought plants from his field trips in the backpack, thus enriching the vegetation fund from the Botanical Garden of the University of Craiova, which is currently named after the illustrious botanist who founded it, **Professor Dr. Doc. Alexandru Buia Botanical Garden**.

Along with Prof. Docent Marin Păun PhD, he founded **Prof. Dr. Doc. Marin Păun Alpine Botanical Garden** from Râncea (Parâng Mountains). It should be mentioned that the University of Craiova is the only University in Romania and one of the few Universities in Europe, which has two Botanical Gardens, with distinct themes. Both Botanical Gardens represent a solid educational base that contributes to the formation of competent specialists in this field. Professor Gheorghe G. Popescu was highly appreciated by the colleagues from other Biology and Botany departments and coordinators of other Botanical Gardens in Romania and abroad, for his organizational talent, dedication, work and accomplishments. Thanks to his activity and results, in the period 1992-1996, he was the scientific secretary of the Horticulture Faculty from the University of Craiova (faculty with three departments: Horticulture, Biology and Technology of Agricultural Products Processing). The 50th anniversary of the establishment of the Botanical Garden of the University of Craiova was marked by the organization of a special scientific session, publication of reference volumes with papers of numerous specialists from Romania and other countries. The exchange of opinions, presentations of scientific papers and research projects were of great importance to all participants.

Affiliation to Professional and Scientific Societies.

Professionally, Professor Gheorghe G. Popescu was **Vice-president** of the **Romanian Society of Biological Sciences (B.S.S.)** and **President of Craiova Branch of S.S.B.** – an organization for higher education teachers and researchers from the University of Craiova, pre-university teachers from the five counties of Oltenia (Dolj, Gorj, Mehedinți, Olt and Vâlcea), Biology-Botany researchers from Oltenia Research Units (curators from the Oltenia Museum in Craiova, ROMSILVA research staff), and all those interested in the field. Research of general or systematic botany was used in phytocoenological and phytosociological studies. Thanks to these studies, Professor Gheorghe G. Popescu was a member of the **Romanian Society of Phytosociology** (Headquarter at the Botanical Garden in Cluj-Napoca) and a member of the **International Federation of Phytosociology**, Bailleud (France), since 1972.

Elaborated and published monographs and treatises. Scientific papers. To disseminate the results of the carried out scientific research, Professor Gheorghe G. Popescu PhD published volumes that enriched the Romanian literature in the field. Among them we mention: *The meadows in the sub-Carpathian area of Oltenia*. University of Craiova, 1973; *Botany*, University of Craiova, 1980; *Plant Morphology and Anatomy*. University of Craiova, 1980; *Systematic Botany*. Vol. II Cormobionta, University of Craiova, 1995; *Practical Guide, Part I: Plant Morphology and Anatomy*, University of Craiova, 1998; *Botany*, University of Craiova, 2000; *Introduction to Botany, Phylogenetics*. Sitech Publishing House, Craiova, 2009, etc. This last volume, written and published by our colleague, Prof. Gheorghe G. Popescu, is a reference volume for the Romanian literature in the field, which honours it. He also edited monographic volumes dedicated to the two Botanical Gardens (from Craiova and Râncea, etc.).

Participation in scientific manifestations and publication of research papers abroad. Prof. Gheorghe G. Popescu PhD participated in numerous scientific events with papers that were published in the volumes of the respective events or with papers involving the use of new criteria for the assessment of scientific research. Among the studies approached and achieved through our collaboration, there can be mentioned.

A. Papers presented at scientific events organized abroad.

A.1. Tercentenary of Berlin-Dahlem Botanical Garden, September 9-13, 1979. There were presented two scientific papers. One of the papers, presented as a poster, was distributed to the participants in the Congress (Corneanu G.G. & Popescu G. G. 1979 - *Chorologic and taxonomic studies on Fritillaria L. in Romania*). The second paper (Corneanu G. C. & Popescu G.G. 1982 – *Distributional and anatomical studies on Fritillaria L. in Romania*) was published in the volume with the support of **OPTIMA Scientific Society (Wildenowia Berlin-West, 11 (2): 307-315)**. We have to mention that the presence of the genus *Fritillaria* in Romania was presented in the paper ‘Botanical Research in Stan Forest (Farcas commune, Dolj Couty) / Cercetări botanice în pădurea Stanului (comuna Farcas, județul Dolj)’, Ziridawa, 1987, **17**: 79-81 (authors G.G. Popescu, G.C. Corneanu, C. Tomoiu), its presence being discovered by Constantin Tomoiu, a promotion colleague and teacher in his native village, Melinesti. The discovery in the field of the two species of *Fritillaria* took place in the first week after Easter in 1987 and it was accompanied by red egg knocking

and sacrifice of a presentable capon. The colleague Gh. G. Popescu analyzed and presented the floral composition in Stan forest, Farcas commune.

A.2. Biotechnology Congress 'Processing Plant Biotechnology as a Tool for the Exploitation of Mountain Lands', organized by Università degli Studi di Torino, Torino, Italy, 1997. It was presented and published the paper: Corneanu G. C., Popescu G. G., Mihaela Corneanu, Elena Glodeanu, Hanesu V., Ileana Popescu. 1998 – Biology and enzymatic activity in *Lycopodium* species from Parâng Massif (Romania), published in the volume: Processing Plant Biotechnology as a Tool for the Exploitation of Mountain Lands, Eds. Silvano Scannerini et al., Acta Horticulturae, **457**: 105-108.

B. Achieved and published papers with novelties in different fields of scientific literature:

B.1. Re-vegetation on a 'terrenum nudum'. Popescu G. G., Corneanu G. G., Costache I., Corneanu Mihaela et al., 1998 – The renovation of a terrestrial plant affected by derrick mud from Almaj-Mosneni (Dolj County). Acta Horti Botanici Bucurestiensis. Edit. Alo, Bucuresti **26**: 155-168.

B.2. Species of carnivorous plants cultivated in laboratory: Popescu G., Corneanu G. C., Popescu Ileana, Corneanu Mihaela. 1997 - *Pinguicula vulgaris* L., A carnivorous plant in Parâng Mountains. The systematics, biological, chorological, and ecological data; attempts of a laboratory culture. Acta Botanica Horti Bucurestiensis, Edit. Universitatii Bucuresti, **25**: 79-83.

C. Species of plants with bioactive substances. The species in which valuable bioactive substances are synthesized form an important group, which has been the subject of multiple investigations in the framework of different research projects won by competition. Among these, we mention the investigations carried out in the genus *Achillea* and the species *Nigella sativa*.

C.1. Corneanu G. C., Elena Glodeanu, Hanesu V., Popescu G. G., Mihaela Corneanu. 1997 – Enzymatic variability of some *Achillea* genotypes with different polyploidy level and from different geographical regions. Bul. Grădinii Botanice Iași, **6**: 499-504.

C.2. Corneanu G. C., Simeanu V. D., Popescu G. G., Micle F. 1985 – Chorologic, anatomical studies on *Nigella* L. genus (Fam. *Ranunculaceae*) in Romania. Rev. Roum. Biol., Biol. Veget., Bucharest. **30**(2): 89-99.

C.3. Corneanu G. C., Popescu M., Aurelia Sitoris, Popescu G. G. 1986 – Researches concerning the biology of the *Nigella* L. species (Fam. *Ranunculaceae*) from Romania. Notule Botanicae Horti Agro Botanici, Cluj-Napoca, **16**: 151-163.

D. Species of pioneer plants cultivated on ash disposal sites and waste dumps, on land degraded by oil spills (Moreni Oil Extraction Site, Almaj Oil Exploitation, Dolj, etc.).

D.1. Reclamation of lands disturbed by oil pollution: Popescu G. G., Corneanu G. C., Costache I., Babeanu C., Corneanu M. 1998. The renovation of a terrestrial plant communities affected by derrick mud from Almaj-Mosneni (Dolj County). Acta Horti Bot. Buc. **26**: 155-168.

D.2. Restoration of the vegetal communities affected by different stress factors. Corneanu G. C., Popescu G. G., Mihaela Corneanu. 1993 – Renovation for terrestrial vegetal communities degraded by different stress factors. In: Agric. and Environmental Biotechnology: Biodiagnosis Biocell. Bioprocesses. Eds. P. M. Galletti, C. Rosso, S. Scannerini, A. Ugatni, E. Spoldi, G. Buffo. M. A. F. Servizi Torino. 183 pp.

D.3. Pioneer species installed on degraded lands, due to different pollutants generated by mining and electric power industries, etc.

E. Participation in COST research programmes. Corneanu M., Corneanu G. C., Răduțiu D., Popescu G. G., 2010 – The landscape natural and artificial rehabilitation of the degraded areas. First Meeting COST Action FAO901 'Putting Halophytes to Work - From Genes to Ecosystems'. Dept. Agricultural Engineering and Agronomy (DIAAT), University of Naples Federico II, Italy and Dept. of Agriculture and Forest Systems Management "Mediterranean" Univ. of Reggio Calabria, Italy.

Field trips, especially in industrial areas or on water-borne terrain, were marked, besides pleasant events (reunion with colleagues, nature studies, etc.), also by some suspense events. Thus, one spring, we went to Botorogi, Gorj, to harvest plants in the field. At Ticleni, a truck came in front of us on the right. I saw my colleagues sitting on the front seats getting small and sliding beneath the dashboard to avoid a frontal contact with the road intruder. I shouted 'aim the wheel' and felt the impact with the wheels of the car in front of us. I know I ran to this, I opened the truck door and grabbed the driver by the throat. After some telephones, we went to a car service. At Botorogi, I went again a few years later, but also on a 'delicate' trip. Another spring, on the way to Targu Jiu, after a few days of rains, coming from Craiova, in a car from ICAS. Our driving colleague warned us that we were passing by Botorogi. He knew where the plants were located, so we headed for them. We harvested the plants, but we went too far into the water-drenched field and could not get out. I asked a tractor driver to get us out of there, but the tractor started to skid. Being near a car workshop, about 7-8 young people pushed the tractor and the car and we finally got out. We were invited to the nearby Forestry District to mark the event of the two cars recovery and the collecting of some specimens of the genus *Fritillaria* sp.

Improving the teaching activity of Biology teachers.

Professor Gheorghe G. Popescu was actively involved in improving the didactic training of Biology teachers by participating in the manner this process was achieved. Thus, he proposed the elaboration of Degree I theses on the topics with real practical application possibilities. The theses were achieved by Biology teachers from pre-university education system from southern counties (mainly from Oltenia and West Muntenia schools).

Another activity meant to improve the activity of Biology teachers was his participation in the competitions for occupying the positions of teacher in the school network. He made himself remarked by his academic attitude, balance in the analysis of different aspects that occurred during the evaluation activity of the capacity of the teachers involved in the competitions.

At one of the latest research projects, namely POLMEDJIU, we talked with Professor Gheorghe G. Popescu about the team that he recommends for us to do the botanical part. The area was known to us because we went together along the middle valley of the Jiu many times. He said he accepted to scientifically supervise the botanical research, but he recommended the team (Botany) and Mrs. Researcher Ioana Ciortan, Dr., for mushrooms. He specified that he personally selected those who were still in activity (didactic and scientific). We all knew it was his choice. He reminded us that we promised to visit him at Păusești-Otașău. He told us he wanted to come back home because he had a lot of work to do. Last autumn, we talked on the phone for the last time. He told us he had already moved in the country and started working. We were going to see each other in the near future.

Regretfully, I went on other occasions through Păusești-Otașău, but not specifically to meet the Professor. Our meetings were always agreeable, the professor having a little ironic and acidic voice. We shall meet you in another world, dear Georgică, perhaps less agitated and more alert to its members. You offered them everything you had and you could do, compared to what you received.

God rest you in peace!

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Received: March 21, 2017

Accepted: July 12, 2017

DAN MUNTEANU, PHD. CORRESPONDENT MEMBER OF THE ROMANIAN ACADEMY – A LIFE DEDICATED TO ORNITHOLOGY

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Abstract. The authors of this material had the chance to be colleagues with one of the prestigious Romanian scholars, Dan Munteanu PhD. – C. M. of the Romanian Academy. The period of time we have been friends covers over half a century (1965-2017), the co-author being a little younger (1987-2017). It is the period that coincided with our professional development. We personally believe that the environment in which we formed professionally, as well as the entourage, had a great importance. In addition to this, we may add keeping in touch during time because, although we had the same formation (biologists), we have followed different paths, namely the field of Ornithology (Dan Munteanu) and Genetics (Mihaela and Gabriel Corneanu). The young Dan had been fond of birds since childhood and he studied them in captivity. He studied their song and the influence of diet on the tone of their trills. This early passion marked his entire life, being also experienced by both his children, Claudia and Victor Munteanu. He attended the Faculty of Natural Sciences (currently the Faculty of Biology) of "*Babeș-Bolyai*" University in Cluj-Napoca (we present the current nomenclature of various academic institutions). He worked as a Scientific Researcher at "*Stejarul*" Biological, Geological and Geographical Research Station from Pângărați (Neamț County) of A. I. Cuza University of Iași (where he was also a Director). Being a rich and varied floral and faunistic region, the theme of his doctoral thesis reflected the choice of the theme of the study: "*The Avifauna of the Mountainous Basin of the Moldavian Bistrița*", his PhD thesis being defended in Bucharest in 1969. In 1973, he returned to Cluj, occupying the position of Senior Scientific Researcher at the *Biological Research Center in Cluj-Napoca*. He was *President-Founder* of the *Romanian Ornithological Society (R. O. S)*, a scientific organization with multiple achievements at national and international level. He was elected as a *correspondent member of the Romanian Academy (in 1999)* and was awarded the *Order of Academic Merit* in 2003. Since 2000, he has been *Chairman* of the *Committee for Protection of Natural Monuments (C. P. M. N.)* of the Romanian Academy. In this capacity, he has outstanding achievements in the direction of nature protection in Romania. The activity and paths opened by the scientist Dan Munteanu must be preserved and consolidated, this being the only way to honour his memory.

Keywords: stages of the professional development (biologist and ornithologist): Pângărați, Cluj-Napoca, the Romanian Academy; professional and scientific activity; president of R. O. S; president of C. P. M. N.

Rezumat. Dr. Dan Munteanu, membru corespondent al Academiei Române – o viață dedicată ornitologiei. Autorii acestui material, au avut șansa de a fi colegi de generație cu unul din savanții români de prestigiu, domnul Dr. Dan Munteanu – M. C. al Academiei Române. Analizând perioada de timp în care am fost prieteni, aceasta acoperă peste o jumătate de secol (1965-2017), celălalt co-autor fiind ceva mai tânăr (1987-2017). Este perioada care a coincis cu formarea noastră profesională. Personal considerăm că ambianța în care ne-am format profesional precum și mediul și anturajul, au contat foarte mult. La aceasta se adaugă păstrarea legăturilor în timp, deoarece deși suntem de aceeași formație (biologi), am parcurs drumuri diferite în specializare: ornitologie (Dan Munteanu), respectiv Genetică (soții Mihaela și Gabriel Corneanu). Tânărul Dan, încă din copilărie era pasionat de păsări, pe care le studia în captivitate. Studia cântecul lor și influența alimentației asupra tonalității trîlurilor. Aceasta pasiune precocă i-a marcat întreaga viață, fiind prezentă și la cei doi copii, Claudia și Victor Munteanu. A urmat cursurile Facultății de Științe ale Naturii (în prezent Facultatea de Biologie) de la *Universitatea „Babeș-Bolyai” din Cluj-Napoca* (prezentăm nomenclatura actuală a diferitelor instituții academice). A funcționat pe post de Cercetător Științific la *Stațiunea de Cercetări Biologice, Geologice și Geografice „Stejarul”* din Pângărați (județul Neamț), unitate patronată de Universitatea „A. I. Cuza” din Iași (îndeplinind și funcția de Director). Fiind o regiune bogată și variată din punct de vedere floristic și faunistic, tema tezei de doctorat a reflectat alegerea tematicii studiului: „*Avifauna bazinului montan al Bistriței moldovenești*”, teză susținută la București în anul 1969. Din anul 1973, a revenit la Cluj, ocupând postul de Cercetător științific principal la *Centrul de Cercetări Biologice din Cluj-Napoca*. A fost *Președinte-fondator al Societății Ornitologice Române (S. O. R)*, organizație științifică cu realizări multiple pe plan național și internațional. A fost ales *membru corespondent al Academiei Române (în anul 1999)*, primind și distincția *Ordinul Meritul Academic*, în anul 2003. Din anul 2000, a fost *Președinte al Comisiei de Ocrotire a Monumentelor Naturii (C. O. M. N.)* din Academia Române. În această calitate a obținut realizări deosebite pe direcția ocrotirii naturii în România. Activitatea și drumurile deschise de omul de știință Dan Munteanu, trebuie să păstrate și consolidate, singura modalitate pentru a îi cinste memoria.

Cuvinte cheie: etape în formarea profesională (biolog și ornitolog), Pângărați, Cluj-Napoca, Academia Română; activitatea profesională și științifică; președinte S. O. R; președinte C. O. M. N.

Family, family atmosphere and intellectual development

The eminent scientist Dan Munteanu is a sacred name in Ornithology. His passion and formation as an ornithologist dates back to his childhood, having a genetic determinism conferred by the heredity inherited from parents, personalities with deep Transylvanian roots, characterized by an avid desire to know the surrounding world. Both his parents were descendants of families of intellectuals with old roots in Transylvania. His father, Dr. Didi Munteanu, a paediatrician, was an associate professor at the University of Medicine in Cluj and director at the institution Child's Home in Cluj.



Photo. Dan Munteanu - PhD. C. M. of the Romanian Academy.

On the paternal line, he was the nephew of the martyr orthodox archpriest from Huedin, Aurel Muntean. His mother, Maria Cupcea, a reputed intellectual, composer, theatre and film artist, played in movies and onto stage of the National Theatre in Cluj, between 1949 and 1955, being also the director of the aforementioned institution. His mother was the descendant of an ancient family of Greek-Catholic priests and teachers from Maramures. On the maternal line, the young Dan was the nephew of the Greek-Catholic vicar Petru Cupcea, from Șimleul Silvaniei. As in his family there were different religious confessions, the environment in which his first perceptions and moral and psychological principles of life formed were characterized by tolerance and respect for others, humans or animals. The passion for ornithology of young Dan Munteanu developed in his childhood, when he studied the birds raised in captivity. He studied bird song and the influence of diet on it. Moreover, his first ornithological work is from this period, about the **southern woodpecker**, a new variety in Romania. The familiar environment allowed him to address these intellectual, but relatively eccentric preoccupations for the age and time of his childhood (the end of the Second World War). His mother, **Maria Munteanu, born Cupce**, was the daughter of a renowned teacher from Carei, George Pteancu. Thus, the attendance of the Faculty of Natural Sciences (later referred to as the Faculty of Biology) was inherent. Graduate of the **Faculty of Natural Sciences, "Babeș-Bolyai" University, Cluj**, he became a scientific researcher in the field of Biology and Zoology at **"Stejarul" Biological, Geological and Geographical Research Station from Pângărați of "A.I. Cuza" University of Iași**. In just two years, as a graduate of the Faculty of Biology of the University of Bucharest, one of the two authors of the present commemorative material (Corneanu C. Gabriel) was assigned in the same wonderful collective. I use to say that the most beautiful period in my life is represented by the two years spent at **"Stejarul" Station** from Pângărați (October 1965 - April 1967). As in the presentations available on line, there are no mentions about the period spent at **"Stejarul" Station**, where we both worked as scientific researchers for almost two years (October 1965 - April 1967 in my case), I consider it is necessary to present some events from this period.

The period "Stejarul" Pângărați. About the existence of **"Stejarul" Station** from Pângărați, located at the same distance from Piatra-Neamț Municipality and the town of Bicaz, situated at the end of the Lake Izvorul Muntelui near Bicaz (13 km), I found out on the day of my arrival at "A. I. Cuza" University of Iași, when the graduates of the 1965 promotion of the Biology faculties in the country (Bucharest, Iași and Cluj-Napoca) came for distribution. In the absence of a more tempting position in research or education, at the suggestion of Dr. Filimon Cardai, professor of Zoology at A. I. C. U. - Iași, I applied for the position of researcher at "A. I. Cuza" University, Iași. I started from the premise that I liked the city of Iași (seen during the morning of that day), about the culture of which I knew many beautiful things, even though I had never been there and I did not know if I had relatives or not in Iași or Moldova (in fact, I later found out that I had!) and I wanted to know people, history, nature and art monuments (a hobby of mine); thus, the position of scientific researcher in the field of hydrobiology was kind of attractive to me, involving permanent news. In addition, unlike my future friend, Dan Munteanu, who knew the field in which he would work (Ornithology), in my case (except for the general presentation "genetics, the science of heredity"), apart from the theoretical information approached in the bachelor graduation paper ("Nucleic Acids and Their Role in Heredity", elaborated and presented in 1965), I did not have a clear vision of the field in which I would have to work. Prof. Filimon Cârdei told me that in the Genetics field at A. I. C. U., there worked specialists trained abroad (Dr. Corneliu C. Zolyneak, trained in Germany, a radiobiologist, about whom I found out only after his premature death, that we were relatives), Dr. Iordachi I. Tudose (a cytogenetics expert with the Ph.D. obtained in Leningrad under the coordination of the famous Prof. Lobașev) or Prof. Ioan Cărăușu (trained in the country), etc.

On a beautiful October day, in the autumn of 1965 (when I arrived for a few weeks at my first job), I was with Dr. Ionescu Vasile, in the shadow of some towering coniferous trees in the courtyard of the ancient monastery of Pângărați (founded by Prince Alexandru Lăpușneanu in 1560). Being new in the team, my colleague Vasile Ionescu (former professor at the Pedagogical Institute of Bacău) offered me different information about our colleagues. He affirmed that the colleague Dan Munteanu impressed him most because, although he was at the beginning of his scientific activity, he knew what he wanted to study. He specified that he was struck by the fact that he arrived from Cluj with two boxes full of scientific works and ornithological scientific material. It must be mentioned that Dr. Vasile Ionescu, who had just retired from the Faculty of

Natural Sciences of the University of Bacău, had been teaching Zoology, being the author of the only vertebrate identification guide in the Romanian specialized literature. One month after I had started working, I knew both my colleagues (researchers, technical and administrative staff, the animals from the station), as well as aspects about the history of those places. In this way, at the meeting for choosing the leadership of the trade union, I actively participated in the nomination and election of my colleague Dan Munteanu as chairman of the union organization at "Stejarul" Station.

The organization of free time, after the departure of the colleagues who lived in other localities (mainly in Piatra Neamț, Bacău, etc.), was made by mutual agreement. Thus, out of the seven afternoons of the week, five were spent together at the house of a colleague who was the organizer of the action. At first, there was presented scientific information from different areas of Biology, including aspects of individual research, followed by discussions about various aspects of our life and work. There followed: watching TV, funny games, information and cultural debates (mainly supported by the Ionescu family), proposals for activities in the coming days, etc.

During the hunting season, Sunday was reserved for this sport activity, coordinated by our colleague and friend, Dan Munteanu. I was part of the team after I had been properly trained during the lessons I received, being both hunter and beater. My first hunt was a bird, its hunting being done thanks to Dan, who showed me its position on the tree (at the bifurcation of some branches at the base of the crown). There are many jokes about hunt and hunters. However, I have to mention that many of these stories are real. So, on a snowy and sunny Sunday, with pleasant atmosphere, dressed properly, we returned home (to "Castel") with empty bags, after lunch. Arriving on the territory of the station, Dan warned us that "there is something"; there were three foxes in a lair. Their capture created an atmosphere of great joy (it was the case to find something after a few hours of searching!). One of the picturesque and unusual actions was the reception and escort of the "Emil Racoviță" ship, transferred from the Marine Station **Prof. Ioan Borcea** from Agigea to "Stejarul" Station (both belonging to "A. I. Cuza" University of Iași). Entering the territory of Neamț County, we were given the privilege of accompanying the ship, on the road, to the Lake Izvorul Muntelui from Bicaz. Having an enviable "sound", the group of researchers from "Stejarul" Station, due to the hullabaloo they made, represented a redoubtable group. After 2-3 days, the "sound" of my voice succumbed. Gathered in the house of the Munteanu family, in the evening, there came out a real quarrel between me and Mrs. Monica Munteanu, I do not remember why (probably due to the jokes about the people from Oltenia and Transylvania that abounded during that period). Both of us were standing and talking to one another (Monica had a voice while mine was 'out') and our colleagues were taking photos of us. Dan was sitting on a chair between us, with the hand propping up the chin, waiting for us to finish, so that he could have dinner ... The photos are still in everyone's "golden photo collection". There were many group trips: around the Lake Izvorul Muntelui-Bicaz, along the Bistrița Moldovenească valley, at the Bicaz Gorges, Ceahlău Mountains, together with the colleagues from Agigea retracing the route of Ștefan a Petrei's Nica, visiting the painted monasteries of Northern Moldavia, the city of Neamț, the memorial houses in the area, etc.

The qualities of good manager and organizer determined the team of "Stejarul" Station and the leadership of the Faculty of Biology and Geography of "A. I. Cuza" University of Iași to entrust to Dan Munteanu the position of scientific director of "Stejarul" Station.

As in any human community, there were sometimes insignificant disputes, but the human criterion of mutual respect and friendship always prevailed. I left "Stejarul" Station in May 1967, but Dan remained there in order to finish and defend his PhD thesis, finalized in 1969 (defended in Bucharest).

PhD thesis and BRC Cluj-Napoca period. The doctoral thesis elaborated by our colleague, Dan Munteanu, was in the field of Ornithology (Zoology), having as topic *The Avifauna of the Mountainous Basin of the Moldavian Bistrița*. It is a dense material that includes studies on avifauna, ornithological geography, systematics, ecology, migration and bird biology in Romania. In 1973, he transferred to the Biological Research Institute in Cluj-Napoca, where he held the position of senior scientific researcher. Here, we met more frequently, as I went from Craiova to Cluj about 6 times per year and each trip lasted about 7 days.

Our friendship succeeded to overcome time and, then, the physical distance imposed by our jobs. After each separation of only 2-3 months, we naturally returned to Iași, Agigea, Pângărați, Cluj, Bucharest, Craiova and other places in the country, where we attended biology symposiums or conferences held at scientific sessions. As a representative of different human communities (collectives of researchers, groups of hunters, etc.) engaged in various social activities, research themes, works presented at scientific sessions, our colleague Dan Munteanu proved to be an excellent binder of interhuman relations, having outstanding achievements in this sense.

The Romanian Academy, President of R. O. S. and President C. P. N. M. He was elected a correspondent member of the Romanian Academy (January 29, 1999), being rewarded with the Order of Academic Merit for the activities carried out (2013). He was part of the Academic Staff of "Babeș-Bolyai" University of Cluj-Napoca. In this capacity, he was invited to various university centers to talk to the students and to organize field trips. Such a trip took place in Craiova, when courses and information presented to students and researchers (about 15-20 persons) were followed by field trips (the Jiu alluvial plain, Bucovăț Hill, Bibescu-Romanescu Park, etc.). He was an editor at various specialized journals, member of the editorial boards of certain periodicals published by the Romanian Academy, organizer of Scientific Symposia, coordinator of international contracts, rapporteur for Romania in two international reports on the state of the environment, etc. He was also part of the Editorial Board of various publications, including the journal published by the Oltenia Museum. Studies and Research, Natural Sciences, participating in the scientific sessions and field trips in all areas of Oltenia.

He was the **founder president of the Romanian Ornithological Society**, being a member of the Executive Board of the International Waterfowl and Wetlands Research Bureau (headquartered at Slimbridge, United Kingdom) and representative of the International Council for Bird Preservation (headquartered at Cambridge, United Kingdom). In these circumstances, he participated in the implementation of certain European programs. The solid knowledge of General Biology and the experience gained in ornithological research facilitated the realization of valuable studies, among which there can be mentioned: (a) *The provisional atlas of the brooding birds of Romania* (a work that will be included in the European Atlas); (b) Chapter *Birds*, in the Red Book of Vertebrates of Romania, Romanian Academy Publishing House, 2005; (c) *Important bird areas of Romania - Documentation*, ALMA MATER Publishing House, Cluj-Napoca, 2004; (d) *Rare, vulnerable and endangered birds in Romania*, Alma Mater Publishing House, Cluj-Napoca, 2009; (e) *Fauna of Romania. Aves*, Vol. XV, Fasc. 2. The Romanian Academy Publishing House, 2015.

The **Romanian Ornithological Society** (R. O. S.) is the first non-profit organization in Romania and the longest-lasting one, with regional offices in Bucharest, Cluj-Napoca and Tulcea, and branches where groups of people are involved in various aspects of bird life, biology and protection. By going through the materials we have at our disposal, we can trace Dan Munteanu's trips within the entire country. I came over friends and nature protectors' names (biologists, forest engineers or simply bird friends) that I had known for decades. If there is a passion for action, it is not necessary to be a large city with academic or economic potential. I remember that, in a locality from the Romanian Plain, a teacher passionate about Ornithology and Pestalozzi's pedagogical studies, made a study on the brooding of the black stork, study presented at a communication session SOMN-Oltina, held at the *Oltina* Museum in Craiova. He was helped by the family, as well. For several weeks he lived in a shelter on a tree, his boy bringing him the necessary food. The family of this passionate teacher acted according to the principle "*Where there's a will there's a way*". For this reason, ROS branches develop where there are people who are passionate about knowledge. They are located in Anieș, Caracal, Țândăreni, Vălenii de Munte, Ozun, Covasna County, etc. On the other hand, it is regrettable to notice the absence of branches in prestigious university and cultural centers, although there are specialists in some of them, but, for various reasons, they did not organize branches, which have both obligations and opportunities to make their presence felt actively. The main localities without branches, although having a rich history in avifauna study, different economic and social importance, museums and researchers, etc., can be considered: Craiova, Timișoara, Sibiu, Oradea, etc.

Committee for Protection of Natural Monuments. According to the documents displayed by the Romanian Academy, the activity carried out within the CPNM consisted in: elaboration of some regulations and legislative acts; the setting up of *Natura 2000* ecological network in the member states of the European Union; approval of the documentation regarding special avifaunistic protection areas, sites of community importance, elaboration of the documentation regarding the setting up of new protected areas (national parks, natural parks, nature reserves, capitalization of natural resources, ecological restoration works and reforestation, the types of works that can be carried out within protected areas, etc.). C. P. N. M. worked in collaboration with the Ministry of Environment and ROMSILVA (National Forestry Administration).

When I arrived in Cluj, we gathered around the dining table, usually at the Munteanu family, in Jiu Street in Cluj. It was a similar situation to the one at Pângărați, when, as I was not married, dinner preparation (when it was my turn) was usually done by my friends' wives, Mrs. Monica Munteanu or Mrs. Sabina Ciaglic. It was the time of stories, memories of the shared background of living realities. We did not think that, over time, everyday happenings would become memories and we ourselves would also become memories.

Synthesis of the carried out activities. I together with his family grouped the numerous activities my colleague Dan Munteanu, PhD, C. M. of the Romanian Academy was involved in as it follows:

Positions: **Junior scientific researcher** at "Stejarul" Station from Pângărați of the "A. I. Cuza" University of Iași; ***Scientific Director** at "Stejarul" Station from Pângărați; ***Senior scientific researcher I** at the Institute of Biological Research Cluj-Napoca; ***Senior scientific researcher** at the **Romanian Academy**, Bucharest (2004-2017).

Prizes, scientific recognition: *"Emil Racoviță"* Prize of the Romanian Academy, collectively awarded; *20 diplomas and medals; *"The title 'Senior of the Citadel'"* awarded by Cluj-Napoca City Hall (August 2009); * Member of two International Scientific Societies (Oradea and USA); **Coordinator of PhD theses, Biology, at "Babeș-Bolyai" University of Cluj-Napoca.*

Published scientific papers: *Participations in national and international scientific events; *Over 100 scientific papers published in the country and abroad; chapters published in 13 books (8 printed abroad); main author of 10 books; 140 papers of scientific information and popularization;

Administrative jobs: *Scientific Director of "Stejarul" Biological, Geological and Geographical Research Station, Pângărați (Piatra-Neamt); * Founder President and Executive Director of R. O. S.; * President of C. P. N. M., the Romanian Academy since 2000.

Other activities: *Editor of specialized journals; *Member of the editorial boards of some periodicals of the Romanian Academy (Revue Roumaine, Biologie, etc.); Member of the Editorial Board of scientific publications (The Oltina Museum, Studies and Research; *Organizer of Scientific Symposia, Coordinator of national and natural parks and biosphere reserves in Romania; *Coordinator of international projects; *Rapporteur for Romania in two international reports on the state of the environment, etc.

Pedagogical and spiritual activities: ***Didactic:** Students training during summer field trips; Didactic: Training of young specialists in ornithology; ***Didactic:** guidance of biology PhD students; ***Spiritual:** After 1990, he supported the rights

and recognition of the Roman Catholic Church; he actively participated in the activities of religious confessions, being physically exposed in certain cases. Thus, after 1990, when the weather was nice, we met at the service held at the Roman-Catholic church, which was under construction in the area of the Romanian National Theatre in Cluj.

Family life: He was a devoted father and husband, who, together with his wife (Monica Munteanu), was involved in raising and educating his children (Claudia and Victor) and grandchildren (Paul-Cristian and Mihai).

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Received: March 31, 2017

Accepted: July 18, 2017

RECOMMENDATIONS
regarding the elaboration of the papers for the scientific journal
“Oltenia. Studii și comunicări. Științele 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 CNCIS 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	
<i>two spare rows (12 pt.) between the title and the name of the author/s</i>		
Author/Authors	name, capital letters, first name, noncapital, 11 pt., bold, normal, aligned right	between two or many authors, use comma
<i>One spare row, 10 pt.</i>		
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
<i>One spare row, 9 pt.</i>		
Keywords (English)	from the beginning of the line, without tab, maximum 5 words, 9 pt., normal	
<i>One spare row, 9 pt.</i>		
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
<i>One spare row, 9 pt.</i>		
Cuvinte cheie (Romanian)	from the beginning of the line, without tab, maximum 5 words, 9 pt., normal	
<i>One spare row, 14 pt.</i>		
INTRODUCTION	10 pt. (capital letters, bold)	content – 10 pt., normal
<i>One spare row, 10 pt.</i>		
MATERIAL AND METHODS	10 pt. (capital letters, bold)	content – 10 pt., normal
<i>One spare row, 10 pt.</i>		
RESULTS	10 pt. (capital letters, bold)	content – 10 pt., normal
<i>One spare row, 10 pt.</i>		
DISCUSSIONS	10 pt. (capital letters, bold)	content – 10 pt., normal
<i>One spare row, 10 pt.</i>		
CONCLUSIONS	10 pt. (capital letters, bold)	content – 10 pt., normal
<i>One spare row, 10 pt.</i>		
ACKNOWLEDGEMENTS	10 pt. (capital letters, bold)	content – 10 pt., normal
<i>One spare row, 10 pt.</i>		
REFERENCES	10 pt. (capital letters, bold)	content – see bibliographical references
<i>One spare row, 10 pt.</i>		
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.: <i>Cossus cossus</i> (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:

EXAMPLE
Book reference: BOȘCAIU N. 1971. <i>Flora și vegetația Munților Țarcu, Godeanu și Cernei</i> . Edit. Academiei R. S. R. București. 300 pp.
Paper published in a journal: GULII V. & PAMUJAC M. 1994. Elemente ale protecției integrate a culturilor agricole de dăunători și boli. <i>Protecția integrată a plantelor</i> . Edit. „Știința”. Chișinău: 112-118. STAN MELANIA & BACAL SVETLANA 2006. New contributions to knowledge stafilinidelor (Coleoptera: Staphylinidae) of the landscape reserve "Codrii Tigheci" (Moldova). <i>Oltenia. Studii și comunicări. Științele Naturii</i> . Muzeul Olteniei Craiova. 22 : 155-159.
Reference to a part of a collective paper; volume (with editors): IFTIME Al. 2005. Amfibieni și Reptile. In: Botnariuc & Tatole (Eds.) <i>Cartea Roșie a Vertebratelor din România</i> . Edit. Academiei Române. București: 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". <i>Sesiunea Științifică dedicată împlinirii a 75 de ani de la înființarea Stațiunii Biologice Marine „Prof. Dr. I. Borcea”</i> . Agigea-Constanța. 19-20 octombrie 2001: 125-131.
Official publications (laws, decrees, official reports): ***, România. Legea nr. 13 / 1993 pentru aderarea României la Convenția privind conservarea vieții sălbatice și a habitatelor naturale din Europa, adoptată la Berna la 19 septembrie 1979. <i>Monitorul Oficial al României</i> . An V, nr. 62/25 martie 1993. București: 1-20.
PhD thesis: COSTACHE I. 2005. <i>Flora and vegetation Motru River Lower Basin</i> . Ph. D. Thesis, University of Bucharest. Romania. 290 pp., 8 Pl.
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Entire electronic document or service (data base):
***. Fauna Europaea: Chironomidae. In: <i>Fauna Europaea: Chironomidae, Diptera, Nemathocera</i> . (Ed. H. de Jong) Fauna Europaea version 1.5, http://www.faunaeur.org . (accessed: June 23, 2012).
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AHMADJIAN V. 1967. <i>The Lichen Symbiosis</i> . Blaisdell Publishing Company. Massachusetts. Available from: http://books.google.ro/books?id=at7uXMn8iMC&printsec=frontcover&hl=ro&source=gbg_summary_r&cad=0#v=onepage&q&f=false . 152 pp. (accessed: January 15, 2013).
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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.). <i>Fauna and taxonomy: Proceedings of Zoological Museum of the Byelorussian University</i> , Minsk: Nauka Tekhnika. 1: 52-68. [In Russian].

III. Illustration

<ul style="list-style-type: none"> 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.
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Legend is placed below a table, graph, etc., 8 pt., normal (English)	
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- it is sustained within the framework of the International Conference "Museum and scientific research";
- the publication fee is paid;
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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, 2018**.

With all the respect for the authors, papers that do not correspond to the recommendations will be sent back.

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