FIRST NOTE ON THE EDAPHIC AND SUBTERRANEAN FAUNA FROM THE EVAPORITIC KARSTIC REGIONS OF ROMANIA

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Jusqu'à présent, la faune édaphique et souterraine des zones karstiques développées sur des evaporites (gypse et sel) n'a pas été encore recherché en Roumanie. Notre travail est la première contribution faunistique à la connaissance des deux des plus intéressants biotopes de Roumanie.

1. INTRODUCTION

The karst developed on limestone has been intensely studied in the last century (and the studies continue in the present) from a faunistical point of view. Until now there is a void of data concerning the edaphic and subterranean fauna from the Romanian karstic regions developed on gypsum and salt.

This note dealing with the fauna from the karst on evaporites (the karst on gypsum from Bertea – Prahova and the karst on salt from Meledic – Buzău) represents the first contribution to the knowledge of the edaphic and subterranean fauna from two of the most interesting biotopes of Romania.

2. MATERIAL AND METHODS

The species presented in table 2 were collected between the 11th and the 21st of June 2001 using purely qualitative methods (the direct method with the tweezers and the exhaustor, Barber traps, Winkler and Tulgren methods). The values of temperature and relative humidity have been recorded for the principal types of habitats investigated. To establish the chorotypes we have taken into consideration the terms proposed by V. Taglianti *et al.* [16].

3. DISCUSSIONS

The karst on gypsum from Bertea is located in the Subcarpathian hills region, in the Aluniş Depression carved in helvetian deposits, near the confluence of the rivers Bertea and Vărbilău (Fig. 1A).

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Fig.1. - The U.T.M. coordinates of the investigated sites: A- the karst on gypsum from Bertea; B- the karst on salt from Meledic.

Three caves prospected prior to our expedition were known to have modest development (between 4 and 10 m). In the present they are completely or almost completely filled up with soil and dead leaves, as a result of the erosion of the banks by the rain dripping water carrying detritus into the cave (Fig. 2). The flooding of the caves during the seasons rich in rainfall is proved by the presence of some edaphic, hygrophilous (*Hyloniscus siculus*, *Cercyon granarius*) or even hydrophilous species (*Helophorus nubilus*) in the moist detritus within the cave.

Fig. 2 – The entrance of a cave in gypsum filled up with detritus. The habitat of the troglophilic species *Trachysphaera costata, Trechus cardioderus, Neohylara subterranea.*

The temperature and relative humidity values of the detritus from the caves, compared with the same parameters of the edaphon and the exterior environment, are presented in Table 1.

Table 1

The values of temperature and relative humidity for the investigated sites

SITE	**Relative humidity (%)**	**Temperature (t°C)**
Bertea /Cave 1 in gypsum (~ 1 m inside)	78.3	10
Bertea / Cave 2 in gypsum (~ 1 m inside)	80.6	12.5
Bertea/ Cave 3 in gypsum (~ 1 m inside)	76.5	15
Bertea/ Tensional fractures in gypsum (4.5 m inside)	72.6	12.5
Edaphon / exterior (air)	62.4 / 50.8	18.4 / 22
Meledic / Cave on salt + gypsum(17 m inside)	79	15

The characteristic species of the clogged caves are: *Ligidium hypnorum* and *Hyloniscus riparius* (troglophilic species); *Trachysphaera costata* (troglophilic), *Lithobius parietum* (troglophilic species) – [11]; *Trechus cardioderus cardioderus*, nominotypical form (troglophilic), endemically for the Carpathians and *Neohilara subterranea*, (troglophilic species known in Romania from the mountainous regions).

Dominant species: *Hyloniscus siculus*, an edaphobiont species endemical for the Romanian Carpathians [13], *Abax carinatus*. Codominant species: *Calathus fuscipes*, *Polydesmus montanus montanus* and *Cylindroiulus boleti*.

Beside these caves, we have investigated three tensional fractures in gypsum about 0.5 m width and 3 to 5 meters in length (Fig. 3). In comparison with the caves, the tensional fractures, opened almost on the hill ridge, have a lower relative humidity (Table 1). Their ceilings are penetrated by the roots of the shrubs of *Rosa canina* and *Crategus monogyna* (Fig. 4).

Fig. 3 – Bertea – opening of a tensional fracture in gypsum.

Fig. 4 – Bertea. Aspect from the interior of a tensional fracture in gypsum (at 4.5 from the entrance. On ceilings-roots of shrubs). Habitat of Lithobius punctulatus moldavicus.

Among the species captured at 4.5 m depth, with Barber traps (without specifying the characteristic species) we mention *Lithobius punctulatus moldavicus*, a subspecies known so far only from Moldova and Banat – a single record from Băile Herculane, leg. Matic [12]. The identification of this subspecies was done on the only one male specimen. According to the Eason's revisons [3,4], *L. punctulatus* C. L. Koch should be rejected as a *nomen dubium*. Only a revision

of the *validus* Meinert group based on female and male specimens will be able to make clear the systematic status of *Lithobius punctulatus moldavicus* Prunescu (verbal note St. Negrea).

Cryptophagus deubeli a trogloxenic species, endemically for the Carpathians has been captured also from the caves.

The karst on salt from Meledic is situated in the north-east of the Ivăneţu Massif (the meridional area of the Buzău Mountains) (Fig. 1B).

The Meledic Plateau (600 m altitude) occupies an area of about 1.7 km^2, with no major positive variations in level and with small sinkholes of 25 m maximum depth and a maximum diameter of 40 meters. Some of them have at the bottom freshwater pluvio-nival lakes, meanwhile others harbour the entrances of the salt caves (Figs. 5–6) with lengths from a few meters to 1257 m (6S Mânzăleşti Cave) [8]. The plateau has steep slopes, here and there with overhangs. In their upper part there is a layer of clay and marls of 10 – 30 m thick, covering the salt massif (Fig. 7). Following L. Drăgănescu [2], the Meledic – Mânzăleşti salt deposits are of Badenian (Langhian) age (approx.15 million years) but they have emerged quite recently in the Pliocene – the Attic period (approx. 5 million years). These depressions alternate with deep valleys – sometimes dried up, sometimes with hypersaline springs – dug into consolidated gravel (Fig. 8). According to H. Grumăzescu [9], the process of gravel consolidation started during the Pleistocene, when the climate suffered three relevant changes in the Middle Pleistocene and two in the Superior Pleistocene and Holocene, with consequences on the landscape and the development of the edaphic and hypogaeic fauna. The last change (important for the structure of the present day edaphic fauna), at the Pleistocene – Holocene boundary, is characterized by a cooler and more humid climate than the previous period, reflected in the pollinic deposits from the Pleistocenic clay. These deposits consist in coniferous associations (*Pinus* and *Picea*) with *Alnus* and *Betula* [10].

The caves investigated by us (P7S, P6S) have been largely flooded and covered with a thick, hypersaline layer of silt on the first 15 m from their entrance. In this situation, only in the Cave 7S (at the entrance, in the photic area) we could capture some specimens of *Bembidion atlanticum megaspilum*, a halophilic, hygrophilous species. A cave in gypsum and salt, with a development of about 17 m and a floor sloping downward, covered by a thick layer of leaves, let us capture a trogloxenic species (*Bembidion dalmatinum*). The temperature and relative humidity values (recorded at 17 m from the entrance) are presented in table 1. It is worth mentioning the presence of *Disdera crocata* (Araneae), frequently found under the stones from the salt crust of the Salty Spring. Only a few species of Oniscidea (*Armadillidium vulgare, Trachelipus nodulosus* and *Porcellio laevis*) were found under stones deeply sunk in the hypersaline soil in the "Marele Canion" and under the salt crust covering the stones from a steep gully near the Cave 7S.

Hyloniscus riparius was captured under the roots of the few plants growing on patches of soil. As for the Diplopoda, we have found only *Meagraphyllum bosniensis*, in the "Marele Canion", at the same location as *Hyloniscus riparius*. All species belonging to the class Chilopoda, were captured under roots, logs and stones from the salt crust in the "Marele Canion", while *Pachymerium antipai* was also captured under the stones from a steep gully near the Cave 7S.

Compared with the limestone karst (4602 km^2, meaning 9.29% of the karstifiable rocks of Romania), evaporitic karst has a smaller development: only 150 km^2 of karst on salt (0.30% of the karstifiable rocks of Romania) [15] and even a smaller proportion of karst on gypsum. Nevertheless, there are some reasons to study the edaphic and subterranean fauna of the evaporitic karstic regions, although there are fewer chances to find true troglobiontic species. The geographical location and the topoclimate of the presently investigated areas are different from all the limestone karstic regions. So far we know many edaphic and subterranean species, defined in the literature as calciphilous or troglophilic, but their spreading in the gypsum karst is not known yet. As it could be expected, a series of species known from the literature as calciphilous and troglophilic or trogloxenic in the limestone karstic areas, were found by us in the gypsum karst (*Trechus cardioderus, Platyola fusicornis, Neohylara subterranea*). The particular combination of abiotic factors represented by the net of fissures in gypsum and the local climate offers the survival conditions for some species which are known to be endemic in small Carpathic areas; the study on the evaporite karstic areas will provide brand new data concerning their repartition. For example, *Pachymerium antipai* has been recorded only once [1] from Ciucea (Transylvania), so its existence on the salt karst area of Meledic brings new ecological and biogeographical data. Other interesting case is that of *Lathrobium dilutum* (Fam. Staphylinidae), which is spread all over Europe and considered very rare even from the past century [7, 14, 5]. The information concerning the abiotic preferences of *L. dilutum* is very vague (an edaphic species collected from humid environments and under stones). This species was captured by us under the salt crust covering the steep slopes from the entrance of the Cave 7S (Fig. 6), but also under the stones deeply sunk in the hypersaline soil (covered by a layer of crystallized salt) from the region of the "Marele Canion" – Meledic (Fig. 9). Finally, another reason to continue these faunistic studies on the salt karstic areas is represented by the fact that information regarding the distribution and ecology of the halophylous and halobitic species, particular for these biotopes, are only sparse and, sometimes, inexact. It is the case of the euedaphic, halobitic species *Brachygluta retowskii* (Coleoptera, Pselaphidae) mentioned in the literature from Romania but without any further specifications [6] and recorded by us as a dominant species in the karstic Meledic Plateau. All the edaphic and hypogeous collected species are presented in table 2.

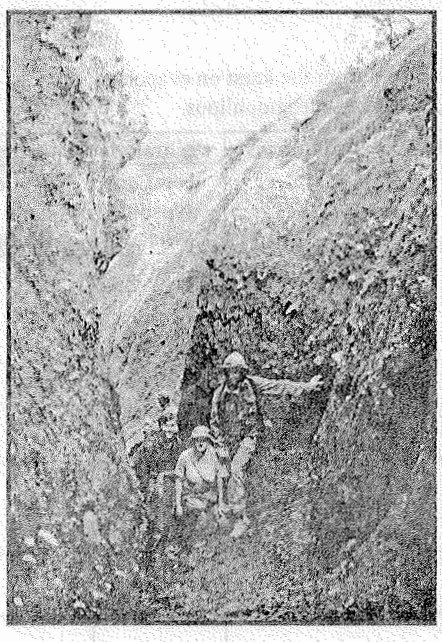

Fig. 8 – Consolidated gravel in Meledic Plateau.

Fig.7 – Deep lopes on salt from Meledic.

Fig. 9 – Crystallised salt on the banks of a hypersaline spring in Meledic.

Fig. 5 – Partially collapsed cave in salt (Meledic).

Fig. 6 – Meledic Plateau. The entrance of the Cave 7S – the habitat of *Lathrobium dilutum* and *Anthicus humilis.*

Table 2

The edaphic and subterranean species collected from the karst on evaporites.
TX-trogloxene; TF-troglophilous; STF-subtroglophilous.

Taxa	Chorology	Abiotic preferences of species	Karst on evaporites	
			Karst on gypsum Bertea	Karst on salt Meledic
Cls. Malacostraca, Ord Isopoda (det. A. Giurginca) **Fam. Ligidiidae** *Ligidium hypnorum* Cuvier, 1792	European	Edaphic, hygrophilous-umbraticolous, TF	+	
Fam. Trichoniscidae *Hyloniscus siculus* Mehely, 1929	Endemic for the Romanian Carpathians	Edaphic, hygrophilous-umbraticolous	+	
Hyloniscus riparius C. L. Koch, 1838	European	Hygrophilous, TF, expansive	+	+
Fam. Porcellionidae *Trachelipus arcuatus* Budde-Lund, 1885	Balcano-Central European	Edaphic, hygrophilous	+	
Trachelipus nodulosus C. L. Koch, 1938	Balcano-Central European	Edaphic, thermophilous		+
Porcellio laevis Latreille, 1804	Cosmopolitan	Edaphic, thermophilous		+
Fam. Armadillidiidae *Armadillidium vulgare* Latreille, 1804	Cosmopolitan	Euryoecious	+	+
Cls. Diplopoda (det. L. Vanoaica) **Ord. Glomerida** **Fam. Trachysphaeridae** *Trachysphaera costata* Waga, 1857	Balcano-European	Edaphic, detriticolous, TF	+	
Trachysphaera acutula Laetzel, 1884	Endemic for the Carpathians	Edaphic, detriticolous	+	
Ord. Julida **Fam. Iulidae** *Cylindroiulus boleti* C. L. Koch, 1847	Central European	Edaphic, detriticolous	+	

Taxa	Chorology	Abiotic preferences of species	Karst on evaporites	
			Karst on gypsum Bertea	Karst on salt Meledic
Megaphylum bosniensis Verhoeff, 1897	Balcano – Central European	Edaphic, detriticolous		+
Ord. Chordeumatida Fam. Chordeumatidae			+	
Melogona transsylvanicum Verhoeff, 1897	Central European	Edaphic, detriticolous, TF		
Ord. Polidesmida Fam. Polydesmidae				
Polydesmus montanus Daday, 1907	Central european	Edaphic, detriticolous, TF	+	
Cls. Chilopoda (det. V. Ilie)				
Ord. Lithobiomorpha Fam. Lithobiidae	Central European	Edaphic	+	
Lithobius punctulatus moldavicus Prunescu, 1966 (?)				
Lithobius forficatus (Linnaeus, 1758)	Holarctic	Edaphic, TF	+	+
Lithobius parietum Verhoeff, 1899	Central European	Edaphic, hygrophilous, STF		+
Ord. Geophilomorpha Fam. Geophilidae				+
Pachymerium antipai Căpuşe, 1968	Endemic for Romania	Edaphic		

Taxa	Chorology	Abiotic preferences of species	Karst on evaporites	
			Karst on gypsum Bertea	Karst on salt Meledic
Ord. Scolopendromorpha Fam. Cryptopidae *Cryptops anomalans* Newport, 1844	Europeo-Mediterranean	Lapidicolous, TX		+
Cls. Insecta Ord. Collembola (Det. M. Gruia) **Fam. Hypogastruridae** *Ceratophyrella silvatica* Rusech, 1964	Endemic for the Carpathians	Edaphic	+	
Fam. Onychiuridae *Heterophroura carpatica* Stach, 1954	S-E. European	Endogeous, TF	+	
Fam. Tullbergiidae *Mesaphoura kransbaueri* (Börner, 1901)	Europeo – N. American	Endogeous, TX	+	
Fam. Isotomidae *Flosonia alpina* Ksenem, 1936	Alpino-Carpathic	Edaphic	+	
Isotoma notabilis Schäffer, 1896	Cosmopolitan	Endogeous, detriticolous	+	
Isotoma violacea Tullb., 1876	Cosmopolitan	Endogeous, TX	+	
Fam. Entomobryidae *Orchesella maculosa* Ionesco, 1915	Endemic for the Oriental Carpathians	Lapidicolous (tensional fractures), TX	+	
Lepidocyrtus lignorum Fabricius, 1781	European	Edaphic, TX	+	
Lepidocyrtus paradoxus Uzel, 1890	European	Endogeous, lapidicolous	+	
Seirra saxatilis Gisin et Gama, 1962	European	Endogeous, calciphilous, thermophilous	+	

Taxa	Chorology	Abiotic preferences of species	Karst on evaporites	
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Fam. Tomoceridae *Pogonognathelus flavescens* (Tullb., 1871)	European	Detriticolous, hygrophilous, lapidicolous, TF	+	
Tomocerus minor (Lubbock, 1876)	Cosmopolitan	Detriticolous, hygrophilous, lapidicolous, TF	+	
Fam. Sminthuridae *Heterosminthurus novemlineatus* (Tullb., 1871)	European	Endogeous	+	
Ord. Coleoptera (det. E. Nitzu)				
Fam. Carabidae *Carabus coriaceus rugifer* Kraatz, 1877	Endemic subspecies (the Romanian Carpathians)	Edaphic, TX	+	
Carabus violaceus wolffi Dejean, 1826	Endemic subspecies (Romania)	Edaphic	+	
Leistus ferrugineus (Linnaeus, 1758)	Sibirico-European	Edaphic	+	
Trechus cardioderus cardioderus Putzeys, 1870	Endemic for the Carpathians	Edaphic, TF	+	
Tachys inaequalis Kolenati, 1845	Europeo-Mediterranean	Edaphic, euryhaline		+
Tachys scutellaris Stephens 1829	Turanico-European	Edaphic, halophilous		+
Bembidion (Metallina) properans Stephens, 1829	Holarctic	Edaphic, euryoecious, TX	+	+
Bembidion (Ocydromus) atlanticum megaspilum Walker, 1871	S-Euro-Mediterranean	Edaphic, halophilous		+
Bembidion (Peryphus) dalmatinum Dejean, 1831	Mediterraneo-caucasian	Edaphic, TX	+	+

Taxa	Chorology	Abiotic preferences of species	Karst on evaporites	
			Karst on gypsum Bertea	Karst on salt Meledic
Harpalus (Pseudophonus) rufipes (De Geer, 1774)	Palearctic	Edaphic, euryoecious	+	
Harpalus (s.str.) roubali Schauberger, 1928	S-E European	Edaphic	+	
Pterostichus (Platysma) niger (Schaller, 1783)	W-Paleaerctic	Edaphic	+	
Pterostichus (Phonias) ovoideus (Sturm, 1824)	Europeo-Caucasian	Edaphic	+	
Abax carinatus (Duftschmid, 1812)	Euro-Balcano-Pontic	Edaphic, TX	+	
Abax parallelus (Duftschmid, 1812)	European	Edaphic	+	
Calathus fuscipes (Goeze, 1777)	W-Palearctic	Euedaphic	+	
Calathus melanocephalus melanocephalus (Linnaeus, 1758)	Palearctic	Edaphic	+	
Platynus (Limodromus) assimilis (Paykull, 1790)	Europeo-Caucasian	Edaphic, hygrophilous	+	
Badister meridionalis Puel, 1925	Holarctic	Edaphic	+	
Cymindis humeralis (Fourcroy, 1785)	Europeo-Mediterranean	Edaphic, detriticolous	+	
Fam. Staphylinidae *Stenus (Nestus) humilis* Erichson	Palearctic	Edaphic, myrmecophilous	+	
Lathrobium dilutum Erichson, 1839	European	Lapidicolous, euryhaline		+
Stilicus rufipes (Germar, 1836)	Europeo-Caucasian	Edaphic, detriticolous, hygrophilous	+	
Trogophloeus (Myopinus) elongatulus Erichson, 1939	European	Endogeous, TX	+	

Taxa	Chorology	Abiotic preferences of species	Karst on evaporites	
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Philonthus concinnus (Gravenhorst, 1802)	Palearctic	Edaphic, euryhaline		+
Quedius (Raphirus) nigriceps Kraatz, 1857	European	Edaphic, xero-thermophilous	+	
Quedius (Raphirus) humeralis Stephens, 1832	European	Edaphic, umbraticolous, montane	+	
Tachyporus hipnorum (Fabricius, 1775)	Palearctic	Edaphic, detriticolous	+	
Sepedophilus (=Conosoma) testaceus (Fabricius, 1792)	Palearctic	Edaphic, detriticolous	+	
Liogluta oblongiuscula Scharp, 1869	European	Edaphic	+	
Platyola fusicornis Mulsant et Rey, 1874	S-European	Endogeous, TF	+	
Neohilara subterranea (Mulsant et Rey, 1853)	European	Subterranean, TF	+	
Atheta (s.str.) ermischi Benik	European	Edaphic, umbraticolous	+	
Fam. Catopidae *Sciodrepoides watsoni* (Spence, 1815)	Europeo-Sibirico-Caucasian	Edaphic TX	+	
Fam. Pselaphidae *Brachygluta retovskii* Simon, 1883	S-E. European	Edaphic, hygrophilous, halobiont		+
Bryaxis simplex (Baudi, 1869) =Bryaxis glabricollis auct. [nec. *Pselaphus glabricollis* Reichenbach, 1816]	European	Euedaphic	+	
Bryaxis carpathicus (Saulcy, 1875)	Endemic (The Carpathians)	Euedaphic	+	
Fam. Hydraenidae *Ochthebius nanus* Stephens, 1829	European	Hydrophilous, euryhaline		+
Helophorus nubilus Fabricius, 1776	Holarctic	Hygrophilous	+	

Taxa	Chorology	Abiotic preferences of species	Karst on evaporites	
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Fam. Hydrophilidae *Cercyon granarius* Erichson, 1837	Euro-Caucasian	Hygrophilous	+	
Fam. Anthicidae *Anthicus humilis* Germar, 1824	Ponto-European	Edaphic, halophilous		+
Anthicus schmidtii Rosenhauer, 1847	European	Edaphic, euryhaline		+
Notoxus trifasciatus Rossi, 1792	Europeo-Mediterranean	Edaphic	+	
Fam. Elateridae *Zorochrus meridionalis* (Cast, 1840)	Europeo-Pontic	Ripicolous-psammophilous		+
Fam. Liodidae *Amphicyllis globus* Fabricius, 1792 (f. ferruginea Strm.)	European	Detriticolous	+	
Fam.Cryptophagidae *Cryptophagus deubeli* Ganglbauer, 1897	Endemic (the Carpathians)	Detriticolous TX	+	
Fam. Lathridiidae *Aridius nodifer* (Westwood, 1839)	Cosmopolitan	Detriticolous	+	
Enicmus minutus (Linnaeus, 1767)	Palaearctic	Edaphic-detriticolous	+	

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