BRVKENTHAL
ACTA MVSEI
XV. 3

PUBLICAȚIILE MUZEULUI NAȚIONAL BRUKENTHAL

2020

BRVKENTHAL. ACTA MVSEI

XV. 3

MINISTERUL CULTURII

MUZEUL NAŢIONAL BRUKENTHAL

BRVKENTHAL.

ACTA MVSEI

XV. 3

Sibiu / Hermannstadt, 2020

ISSN: 1842-2691

MUZEUL NAȚIONAL BRUKENTHAL

Editura Muzeului Naţional Brukenthal

Începând cu anul 2009, revista a fost indexată în baze de date internaţionale astfel:
2009 − INDEX COPERNICUS http://www.journals.indexcopernicus.com/karta.php?action=masterlist&id=4759
2010 − EBSCOHOST http://www.ebscohost.com/titleLists/tnh-coverage.htm
2012 – SCOPUS http://www.elsevier.com/online-tools/scopus/content-overview
2015 − ERIH PLUS https://dbh.nsd.uib.no/publiseringskanaler/erihplus/periodical/info?id=484924
Începând din anul 2011, publicaţia este vizibilă şi pe platforma editorială **SCIPIO** (http://www.scipio.ro/web/brukenthal.acta-musei).

Starting with 2009, the publication is indexed in the following international date-bases:
2009 − INDEX COPERNICUS:http://www.journals.indexcopernicus.com/karta.php?action=masterlist&id=4759
2010 – EBSCOHOST http://www.ebscohost.com/titleLists/tnh-coverage.htm
2012 – SCOPUS http://www.elsevier.com/online-tools/scopus/content-overview
2015 − ERIH PLUS https://dbh.nsd.uib.no/publiseringskanaler/erihplus/periodical/info?id=484924
Starting with 2011, the publication is to be found on **SCIPIO** editorial platform (http://www.scipio.ro/web/brukenthal.acta-musei).

Orice corespondenţă referitoare la această publicaţie rugăm a se adresa la:
Muzeul Naţional Brukenthal, Piaţa Mare 4-5, 550163, Sibiu. **Tel:** +40/269/217691, **Fax:** +40/269/ 211545;
E-mail: ioan.tausan@ulbsibiu.ro; **Website**: www.brukenthalmuseum.ro
Autorii îşi vor asuma întreaga responsabilitate pentru informaţia de specialitate din materialele trimise, care vor fi supuse procesului de peer review, ale cărui detalii pot fi consultate la http://www.brukenthalmuseum.ro/publicatii/01.htm.
Ghidul pentru autori se regăseşte pe website: http://www.brukenthalmuseum.ro/publicatii/01.htm

Please send any mail or messages regarding this publication at:
Brukenthal National Museum, Piaţa Mare 4-5, 550163, Sibiu. **Phone number**: +40/269/217691; **Fax** +40/269/211545;
E-mail: ioan.tausan@ulbsibiu.ro**; Website**: www.brukenthalmuseum.ro
The entire responsibility for the specialized information of the article's content is to be assumed by the author; all materials will be submitted to a peer review process. The details can be found at http://www.brukenthalmuseum.ro/publicatii_en/01.htm.
The guide for the authors can be found at: http://www.brukenthalmuseum.ro/publicatii_en/01.htm.

TABLE OF CONTENTS

ZOOLOGY

SYMPOSIUM ON *AGRICULTURE AND ITS IMPLICATIONS IN NUTRITION AND HUMAN HEALTH*

MUSEOLOGY

REVIEWERS FOR *BRUKENTHAL ACTA MUSEI XV.3*

The Natural History Museum of Sibiu staff is deeply grateful to the following specialists who gave of their time to review manuscripts submitted in 2020 for publication in ***Brukenthal Acta Musei* XV.3**:

ANLAR Hatice Gul, Zonguldak Bulent Ecevit University, Faculty of Pharmacy, Turkey
BUCUR Mirel Vasile, "Lucian Blaga" University of Sibiu, Romania
CHIȘAMERA Bogdan Gabriel, "Grigore Antipa" Natural History Museum, Bucharest, Romania
DEHELEAN Bogdan, Eurofins-Mitox, Netherlands
DRĂGULESCU Constantin, "Lucian Blaga" University of Sibiu, Romania
GAVRIL Viorel, Romanian Academy Institute of Biology – Bucharest, Romania
GĂLĂBUȚ Alexandra Maria, Brukenthal National Museum, Sibiu, Romania
GLIGOR Felicia Gabriela, "Lucian Blaga" University of Sibiu, Romania
GRĂDIANU Ionuț, Piatra Neamț Natural History Museum, Piatra Neamț, Romania
GHEORGHE Laurian, "Lucian Blaga" University of Sibiu, Romania
IONESCU Silvia, Romanian Society of Pharmacy History, Sibiu, Romania
MARTON Venczel, Țara Crișurilor Museum, Oradea, Romania
PRUNAR Florin, Banat's University of Agricultural Sciences and Veterinary Medicine, Timișoara, Romania
SCHNEIDER Erika, Universität Karlsruhe, Bereich WWF Auen Institut, Germany
STĂNESCU Mihai, "Grigore Antipa" Natural History Museum, Bucharest, Romania
TÖRÖK Sergiu-Cornel, Mediaș Municipal Museum, Natural Science Department, Romania

THE BUTTERFLY FAUNA (LEPIDOPTERA, PAPILIONOIDEA) OF GHEORGHENI AREA (HARGHITA COUNTY, ROMANIA)

Lehel Csaba SÁNDOR*,
Levente SZÉKELY**

Abstract*. This work is a synthesis of the results of field researchof Sándor Lehel Csaba made in this region of Romania, between 1998-2018. 117 species of butterflies are listed here, which is more than half of the known butterflies in Romania. The relative richness and diversity of species has several explanations. First of all, the region has a distinct climate compared to the rest of Romania, a cold mountain continental climate, being called also the cold pole in Romania. Apparently that most of the cold-adapted species, which have disappeared from many regions of the country, still have stable and viable populations in this area. Due to the special climate conditions, there are still many important species, several protected at European level, such as: Colias myrmidone (Esper, 1780) (the largest population in Europe, discovered by the first author), Maculinea teleius (Bergstrasser, 1779), Lopinga achine (Scopoli, 1763), Euphydryas aurinia (Rottemburg, 1775) etc. Just as many species of butterflies protected at national level have most important populations here: Lycaena hippothoe (Linnaeus, 1761), Boloria titania transsylvanica Tiltscher, 1913, Polyommatus dorylas magna Czekelius, 1917, Coenonympha tullia (Müller, 1764) etc. Only the species Parnassius apollo (Linnaeus, 1758) is likely extinct from the region (the same throughout Romania!). We consider that the Gheorgheni Basin (as well as other intramontane basins in the Eastern Carpathians), still offers survival conditions for the cold-adapted species in Romania, which disappear in the last years from most areas of the country due to climate changes.*
Keywords*: Lepidoptera, Romania, Gheorgheni, faunistics, conservation.*

Rezumat. *Lucrarea este o sinteză a rezultatelor colectărilor lui Sándor Lehel Csaba efectuate în această regiune din România, între 1998-2018. 117 specii de fluturi de zi sunt listate de aici, ceea ce reprezintă mai mult decât jumătatea fluturilor diurni cunoscuți din România. Relativa bogăție și diversitate de specii are mai multe cauze. În primul rând regiunea are un climat deosebit față de restul României, un climat continental montan rece, fiind numit și polul frigului în România. Se evidențiază că majoritatea speciilor de climat mai rece, care au dispărut din multe regiuni ale țării, au încă populații stabile și viabile în acest areal. Datorită condițiilor de climă deosebite, aici există încă numeroase specii importante, multe protejate la nivel European, precum: Colias myrmidone (Esper, 1780) (cea mai mare populație din Europa, descoperită de primul autor), Maculinea teleius (Bergstrasser, 1779), Lopinga achine (Scopoli, 1763), Euphydryas aurinia (Rottemburg, 1775) etc. La fel multe specii de fluturi de zi protejați la nivel național au cele mai stabile populații din țară aici, precum: Lycaena hippothoe (Linnaeus, 1761), Boloria titania transsylvanica Tiltscher, 1913, Polyommatus dorylas magna Czekelius, 1917, Coenonympha tullía (Müller, 1764), etc. Numai Parnassius apollo (Linnaeus, 1758) este cel mai probabil o specie extinctă din regiune (la fel în toată România!). Considerăm că Bazinul Gheorgheni (la fel și alte bazine intramontane din Carpații Orientali), oferă încă condițiile de supraviețuire pentru speciile de climat rece din România, care dispar în ultimii ani din majoritatea zonelor țării datorită schimbărilor climatice.*
Cuvinte cheie: *Lepidoptera, România, Gheorgheni, faunistică, conservare.*

Introduction

The investigated area largely comprises the eastern part of the Gheorgheni Depression, located in the northeastern part of the Szekler Land.)

The main area of research is the city of Gheorgheni located at an altitude of 818 m (geographical coordinates: 46°44′ north latitude and 25°37′ east longitude) and the surrounding areas (Fig. 1).

Gheorgheni has become a tourist city, gaining profit of from its geographical position, near the tourist resort Lacu Roșu / Cheile Bicazului (25 km), and Praid resort (60 km). The population of the area is made up predominantly of Hungarians, which is why this work also provides the names of

*Independent researcher, Gheorgheni, Romania, sandorlcs@freemail.hu
** Independent researcher, Braşov, Romania. levi.szekely@gmail.com

the localities in Hungarian. The climatic conditions are quite particular the Gheorgheni Basin being characterized by a particular mountain variation of the temperate continental climate. The annual averagetemperature is only 5,2°C. It is considered the coldest region in Romania. The minimum annual temperature can reach up to -30°C, while the maximum annual temperature is around + 28-30°C. Forests cover 55% of the area. Forests are dominated by spruce (*Picea abies*), but in many areas there is also *Abies alba*, *Fagus sylvatica*, *Acer pseudoplatanus*, *Populus tremula*, *Tilia cordata*, *Salix caprea*, *Corylus avellana*, *Betula pendula*, etc. The Gheorgheni Basin was once characterized by extensive marshes that were largely drained. The largest marshy areas are between Joseni and Remetea, where live many rare species of flora and fauna of the region, including lepidopterans (butterflies and moths) (Markó & Sárkány-Kiss, 2011).

Material and methods

The data from the paper comes mainly from the collecting and observations from 1998-2018. In addition, we have also included numerous data from literature. The research of the fauna of lepidopterans from this areastarted over a century ago. The first lepidopterist active in the area was Pál Tiltscher (1891-1917) (Fig. 2), born in Gheorgheni, who died very young in the First World War. In 1913 he described *Boloria titania transsylvanica*, a characteristic subspecies for this region (Tiltscher, 1913). He was followed by Gyula Lengyel (1891-1968), born in Odorheiul Secuiesc, and by János József (1901-1984), born in Firtușu (Firtosváralja), Harghita County. Although after 1950-1960 numerous lepidopterists from Romania and Hungary passed through Gheorgheni area, the published data so far were few. This is mainly because all went to the area of Lacu Roșu / Cheile Bicazului (25 km from Gheorgheni), where the last population of *Parnassius apollo transsylvanicus* Schweitzer, 1912, survived in Romania (extinct since the period 1990-1997). Most data regarding the lepidopterans of the Gheorgheni Basin are from Lacu Roșu / Cheile Bicazului (Popescu-Gorj, 1970; Bálint, 1980-1983; Izsák, 1980; Simonyi & Szécsényi, 1992; Peregovits, 1995; Vizauer, 2006). The Lepidoptera fauna from the Lacu Roșu / Cheile Bicazului areais well known today, especially due to research by Sándor and Zoltán Kovács. The only paper regarding Gheorgheni and strictly neighboring areas was published by Cuvelier and Dincă (Cuvelier & Dincă, 2007). The data presented in this paper come mainly from Lehel Csaba Sándor, preserved in the personal collection and at the "Tarisznyás Márton" Museum in Gheorgheni. Material determination was done according to Tolman & Lewington (1997), Bálint (1996), Székely (2008), Gyulai & al. (2010) and Rákosy (2014). Systematic order by Wiemers & al. (2018).

Results and discussions

Climate change has become much more evident nowadays. According to our observations in the Gheorgheni Basin, many cold-adapted species find suitable conditions here. Species widely widespread in Romania 30 - 40 years ago, which have disappeared from large areas, still have stable and important populations here. The forest roads are still well populated by *Apatura iris* (Linnaeus, 1758) (Fig.17), *Apatura ilia* ([Den. & Schiff.], 1775), *Limenitis populi* (Linnaeus, 1758) and other spectacular species. We believe that the relative richness and diversity of butterflies, is determined by the specific climate conditions and the traditional agriculture, which is still practiced here.

Below we present the taxa considered to be of particular significance (rare or localized) for the Romanian fauna:

Suprafam. PAPILIONOIDEA Latreille, [1802**]**

Fam. PAPILIONIDAE Latreille, [1802**]**

Subfam. Parnassinae Duponchel, [1835]

Parnassius apollo transsylvanicus Schweitzer, 1912

(Figs. 3, 4, 5, 6) It was the largest and arguably most beautiful subspecies of *P. apollo* in the Carpathian chain (Popescu-Gorj, 1970). We do not know the exact location (from a century ago) of the population from Gheorgheni, but some specimens still exist in the Museum of the Entomological Institute from Berlin (Niculescu, 1960) (Fig.3). Six specimens of *P. apollo* labeled "Gyergyószentmiklós" (24.VII.1909 and

28.VII.1910) can be found in the "Daniel Czekelius" collection at the Brukental Museum in Sibiu, Romania (Török & Cuzepan, 2012). Another 17 specimens are preserved in the Hungarian Natural History Museum in Budapest (Bálint, Takáts & Katona, 2016). It is possible that these specimens labeled "Gyergyószentmiklós" come from Medgyeshavas (altitude of 1200 m located quite close to Gheorgheni). The last population survived at Lacu Roșu / Cheile Bicazului, 25 km from Gheorgheni (Figs. 4, 5, 6) (extinct before 2000). Possible causes of the disappearance are reduced fertility, genetic impoverishment (inbreeding), interspecific relationships (competition, predators, parasites), habitat change (natural afforestation due to the protection of the area), and climate change (lack of snow cover over the last 20 years). For example, the classical place of *Parnassius apollo* from Cupaș Valley (Bicazului Gorges) does not look like it has 30-40 years ago, being completely forested today. All *P. apollo* populations in the Romanian Carpathians were small and very isolated. Today *P. apollo* is considered an extinct species in Romania!

Fam. PIERIDAE Duponchel, [1835]

Subfam. Coliadinae Swainson, 1837
Colias myrmidone (Esper, 1780)
(Figs. 13, 14).
The most important populations of this species throughout Europe are found in this area. The largest is from Chiuruț (Kürüc), near Gheorgheni. It was discovered by the first author in 1999 with the help of colleagues from Hungary, Tamás Hácz and István Juhász. At that time the species had already been extinct in most regions of Romania, for example from southern Transylvania (Covasna, Brașov, Sibiu, Alba, Mureș, Hunedoara counties) and from Satu Mare. After 2000 the species disappeared from most countries in Europe, today there are only several populations in Romania, Slovakia, Poland and Ukraine. The population of Chiuruț is probably the largest and most viable in Europe (in years when the species has gradations, isolated specimens also appear within the city of Gheorgheni) (Szentirmai & al. 2014). Protected species at European and national level.

Fam. LYCAENIDAE [Leach], [1815]

Subfam. Lycaeninae [Leach], [1815]
Lycaena hippothoe (Linnaeus, 1761)
(Fig. 8)
It is known in Romania only from the Eastern Carpathians (eastern Transylvania, western Moldova and Bucovina). Species in regress due to climate change. It disappeared from vast territories in the country (for example from the Vrancei Mountains). It is protected in Romania. Near Gheorgheni we have stable populations of this species.
Subfam. Theclinae Swainson, 1831
Thecla betulae (Linnaeus, 1758)
(Fig. 7). This species is also declining in many regions of the country. After 2000 it disappeared from the plains (for example from Dobrogea). It has been scarce in most regions of Romania, for example in Brașov (it has not been observed in the last 20 years). Around Gheorgheni there are important populations, even within the town.
Subfam. Polyommatinae Swainson, 1827
Phengaris teleius (Bergstrasser, 1779)
This species, characteristic of wetlands, is still quite widespread in the Gheorgheni Basin (found near Gheorgheni, along the Belchia valley, Joseni and Izvorul Mureșului). Protected species at European and national level.
Eumedonia eumedon (Esper, 1780)
Relict species, with isolated populations. In Romania it is known from all over the Carpathian chain, but it is quite local. Around Gheorgheni it is known only from Sâncrăieni-Ciuc, where there is an important population.
Polyommatus dorylas magna Czekelius, 1917
(Figs. 9, 10)
Considered as a distinct subspecies by some authors, it is quite widespread in the area. It differs in size from *P. dorylas dorylas* ([Den. & Schiff.], 1775) (larger by 6-8 mm), and has only one annual generation (*P. dorylas dorylas* has two).

Fam. NYMPHALIDAE Swainson, 1827

Subfam. Heliconiinae
Boloria titania transsylvanica Tiltscher, 1913
(Figs. 12, 15)
Extremely local, it is known only from the Eastern Carpathians, from the Ciuc and Gheorgheni

Basins (ssp. *transsylvanica*). Near Gheorgheni there are numerous stable populations, the most important being near Voșlobeni (Heveder) (Fig. 19), where the species is quite common. It is protected in Romania.

Subfam. Nymphalinae Swainson, 1827

Euphydryas aurinia (Rottemburg, 1775) (Fig. 16).

Species known in Romania from Transylvania, Banat and Crișana. The Gheorgeni Basin has many important populations; according to our observations, it is extending. Protected species at European and national level.

Nymphalis xanthomelas (Esper, 1781) Widespread species in Romania in hilly and mountainous areas, except for Dobrogea. According to some authors it is in regression in Romania. There are important populations here and sometimes we observed numerous specimens in the city of Gheorgheni. It is protected in Romania.

Subfam. Satyrinae Boisduval, [1833]

Lopinga achine (Scopoli, 1763)

(Fig. 11)

Local species in Romania, but in certain localities itcan be quite common. In the area wediscovered quite recently, the only population is found in Izvor Cerbul (Szarvasforrás) (Fig.18), where it is quite common. Protected species at European and national level.

Coenonympha tullia (Müller, 1764) Very local species in Romania, known only from marshy areas of the Eastern Carpathians. It is in regress in Romania. In the last years the regression was evident here in the Gheorgheni Basin. 10-20 years ago it was a common species here. It is protected in Romania.

Conclusions

The 117 species of butterflies published here characterize a region with a great biodiversity. More than half of the species known in Romania are present. We believe that the Gheorgheni Basin (as well as other intramontane basins in the Eastern Carpathians), still offers survival conditions for the cold-adaptedspecies in Romania, which disappear in the last years from most areas of the country due to climate change.A similar situation occurs for certain day active moths that maintained strong populations here, such as *Hemaris tityus* (Linnaeus, 1758), *Parasemia plantaginis,* (Linnaeus, 1758), *Callimorpha dominula,* (Linnaeus, 1758) etc. These species are in decline in many provinces of the country.

It is also worth noting that, in recent years, several species have appeared here, that were not present 20-30 years ago, such as *Iphiclides podalirius* (Linnaeus, 1758). We hope that due to the traditional agriculture most of the species will be maintained here in the future!

Acknowledgements

Thanks to all colleagues who participated to the collecting actions: Tamás Hácz, István Juhász, Gergely Petrányi, Zsolt Bálint, Szabolcs Sáfian (Hungary), Tom Brereton (England), Gheorghe Ardeleanu and Nora Anghelescu (Romania).

The list of species in systematic order:

Abbreviations:

BE / Pârâul Belchia (Békénypatak) (46°43′55″N, 25°41′16″E)
CI / Ciumani (Gyergyócsomafalva) (46°38′20″N, 25°27′34″E)
CH/ Chiuruț (Kürüc) (46°44′45″N, 25°34′79″E)
GH/ Gheorgheni (Gyergyószentmiklós) (46°44′70″N, 25°36′33″E)
HE/ Heveder, Voșlobeni (Hevederpatak, Vasláb) (46°40′30″N, 25°20′39″E)
IC/ Izvor Cerbul (Szarvasforrás) (46°44′40″N, 25°39′25″E)
IM/ Izvorul Mureșului (Marosfő) (46°37′57″N, 25°43′16″E)
JO/ Joseni (Gyergyóalfalu) (46°42′24″N, 25°28′00″E)

LA/ Lăzarea (Gyergyószárhegy) (46°43′12″N, 25°31′56″E)
PA/ Păuleni (Székelypálfalva) (46°25′21″N, 25°11′36″E)
SC/ Sîncrăieni Ciuc (Csikszentkirály) (46°18′46″N, 25°48′40″E)
SU / Suseni (Gyergyóújfalu) (46°40′12″N, 25°32′40″E)
VL/ Vlăhița (Szentegyháza) (46°22′53″N, 25°31′44″E)

R. = rare (3-5 specimens collected or observed/ day)
C = common (6-30 specimens collected or observed/ day)
RC = relatively common (sometimes common, sometimes rare / or in one year is common, in another year is rare)
EX = extinct
.

Taxon	BE	CI	CH	GH	HE	IC	IM	JO	LA	PA	SC	SU	VL
Suprafam. **PAPILIONOIDEA** Latreille, [1802]													
Fam. **PAPILIONIDAE** Latreille, [1802]													
Subfam. **Papilioninae** Latreille, [1802]													
Iphiclides podalirius (Linnaeus, 1758)	**BE** R			**GH** RC	**HE** R					**PA** C	**SC** RC		
Papilio machaon (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Subfam. **Parnassinae** Duponchel, [1835]													
Parnassius mnemosyne transsylvanica Schmidt, 1930	**BE** RC		**CH** RC	**GH** RC			**IM** C	**JO** C	**LA** R	**PA** RC		**SU** R	**VL** RC
*Parnassius apollo transsylvanicus** Schweitzer, 1912				**GH** EX									
Fam. **HESPERIIDAE** Latreille, 1809													
Subfam. **Heteropterinae** Aurivillius, 1925													
Carterocephalus palaemon (Pallas, 1771)	**BE** R			**GH** R		**IC** RC	**IM** R	**JO** RC					**VL** R
Subfam. **Hesperiinae** Latreille, 1809													
Thymelicus sylvestris (Poda, 1761) Other remarks: Cuvelier & Dincă,2007	**BE** RC	**CI** RC	**CH** RC	**GH** R	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** R	**SC** R	**SU** R	**VL** R
Thymelicus lineolus (Ochsenheimer, 1808)	**BE** RC	**CI** R	**CH** RC	**GH** R		**IC** RC		**JO** RC	**LA** RC			**SU** R	
Hesperia comma (Linnaeus, 1758)	**BE** RC		**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC		**LA** RC	**PA** RC			
Ochlodes sylvanus (Esper, 1793) Other remarks: Cuvelier & Dincă, 2007	**BE** RC		**CH** RC	**GH** RC		**IC** RC	**IM** RC		**LA** RC	**PA** RC		**SU** RC	
Subfam. **Pyrginae** Burmeister, 1878													
Erynnis tages	**BE**	**CI**	**CH**	**GH**						**PA**			**VL**

(Linnaeus, 1758)	RC	RC	RC	R						C			C
Carcharodus alceae (Esper, 1793)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC		**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	
Carcharodus flocciferus Zeller, 1847	**BE** R		**CH** RC	**GH** RC	**HE** R	**IC** RC	**IM** RC		**LA** RC	**PA** RC		**SU** RC	**VL** RC
Pyrgus carthami (Hübner, 1813)	**BE** R			**GH** R									
Pyrgus malvae (Linnaeus,1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Pyrgus armoricanus Oberthur,1910	**BE** RC			**GH** RC		**IC** RC	**IM** RC		**LA** R	**PA** C		**SU** RC	
Pyrgus alveus (Hübner, 1803)		**CI** R	**CH** R			**IC** R	**IM** R	**JO** R	**LA** R				
Fam. **PIERIDAE** Duponchel, [1835]													
Subfam. **Dismorphiinae** Schatz, [1886]													
Leptidea sinapis (Linnaeus, 1758)	**BE** VC	**CI** VC	**CH** VC	**GH** C	**HE** VC	**IC** VC	**IM** VC	**JO** VC	**LA** VC	**PA** VC	**SC** VC	**SU** VC	**VL** VC
Leptidea morsei major Grund, 1907	**BE** R			**GH** R			**IM** R						
Leptidea juvernica Williams, 1846 (Dincă & al. 2011)	**BE** ?			**GH** ?									
Subfam. **Coliadinae** Swainson, 1827													
Colias myrmidone (Esper, 1780)	**BE** R		**CH** RC	**GH** R					**LA** R				
Colias croceus (Fourcroy, 1785)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Colias hyale (Linnaeus, 1758)	**BE** C	**CI** C	**CH** C	**GH** C	**HE** C	**IC** C	**IM** C	**JO** C	**LA** C	**PA** C	**SC** C	**SU** C	**VL** C
Colias alfacariensis Ribbe, 1905 Other remarks: Cuvelier & Dincă, 2007	**BE** RC		**CH** RC	**GH** R	**HE** R		**IM** RC	**JO** RC	**LA** RC	**PA** RC			**VL** R
Gonepteryx rhamni (Linnaeus, 1758)	**BE** C	**CI** RC	**CH** C	**GH** C	**HE** C	**IC** C	**IM** RC	**JO** C	**LA** C	**PA** C	**SC** RC	**SU** RC	**VL** C
Subfam. **Pierinae** Duponchel, [1835]													
Aporia crataegi (Linnaeus, 1758)	**BE** R		**CH** R	**GH** RC			**IM** R	**JO** R	**LA** R			**SU** R	
Anthocharis cardamines (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** C	**CI** RC	**CH** RC	**GH** C	**HE** C	**IC** C	**IM** RC	**JO** RC	**LA** C	**PA** C	**SC** RC	**SU** RC	**VL** RC
Pieris brassicae (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Pieris rapae (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Pieris napi (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Pieris bryoniae carpathensis Moucha, 1956 Other remarks: Cuvelier & Dincă, 2007	**BE** R			**GH** R									
Pontia edusa (Fabricius, 1777)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC

Fam. **RIODINIDAE** Grote, 1895													
Hamearis lucina (Linnaeus, 1758)	**BE** RC		**CH** RC	**GH** RC		**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	
Fam. **LYCAENIDAE** [Leach] [1815]													
Subfam. **Lycaeninae** [Leach] [1815]													
Lycaena phlaeas (Linnaeus, 1761) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Lycaena hippothoe (Linnaeus, 1761) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** R	**CH** R	**GH** R	**HE** RC	**IC** R	**IM** RC	**JO** R	**LA** R			**SU** R	
Lycaena dispar rutila (Werneburg, 1864) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Lycaena tityrus (Poda, 1761) Other remarks: Cuvelier & Dincă,2007	**BE** RC			**GH** RC			**IM** RC			**PA** RC			
Lycaena virgaureae (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Lycaena alciphron (Rottemburg, 1775) Other remarks: Cuvelier & Dinca, 2007	**BE** RC		**CH** RC	**GH** RC		**IC** RC	**IM** RC					**SU** RC	
Subfam. **Theclinae** Swainson, 1831													
Thecla betulae (Linnaeus, 1758)				**GH** C			**IM** RC			**PA** RC			
Callophrys rubi (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Satyrium ilicis (Esper, 1779)										**PA** R			
Satyrium pruni (Linnaeus, 1758)				**GH** R					**LA** R	**PA** R			
Subfam.**Polyommatinae** Swainson, 1827													
Celastrina argiolus (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Phengaris arion (Linnaeus, 1758)			**CH** RC	**GH** R									
Phengaris alcon ([Den.& Schiff.], 1775)	**BE** RC		**CH** RC	**GH** R		**IC** C	**IM** RC	**JO** C	**LA** C			**SU** RC	
Phengaris teleius (Bergstrasser, 1779)	**BE** RC			**GH** R			**IM** RC	**JO** RC					
Pseudophilotes vicrama Hemming,1792										**PA** R			
Scolitantides orion lariana Fruhstorfer, 1910			**CH** R	**GH** R	**HE** R		**IM** R					**SU** R	
Glaucopsyche alexis (Poda, 1761)		**CI** RC	**CH** RC	**GH** RC		**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	
Cupido minimus (Fuessly, 1775) Other remarks: Cuvelier & Dincă, 2007			**CH** RC	**GH** R		**IC** RC	**IM** R		**LA** RC	**PA** RC		**SU** R	
Cupido argiades	**BE**			**GH**		**IC**			**LA**	**PA**	**SC**	**SU**	

(Pallas, 1771) Other remarks: Peregovits, 1995	RC			RC		RC			R	RC	R	R	
Eumedonia eumedon (Esper, 1780)											**SC** RC		
Cyaniris semiargus (Rottemburg, 1775) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Plebejus argus (Linnaeus, 1761) Other remarks: Cuvelier & Dincă, 2007	**BE** C	**CI** C	**CH** C	**GH** C	**HE** C	**IC** C	**IM** C	**JO** C	**LA** C	**PA** C	**SC** C	**SU** C	**VL** C
Plebejus idas (Linnaeus, 1758)	**BE** R		**CH** R	**GH** R									
Plebejus argyrognomon (Bergstrasser, 1779)			**CH** R	**GH** R						**PA** R			
Aricia agestis ([Den. & Schiff.], 1775)	**BE** C	**CI** C	**CH** C	**GH** C	**HE** C	**IC** C	**IM** C	**JO** C	**LA** C	**PA** C	**SC** C	**SU** C	**VL** C
Lysandra bellargus (Rottemburg, 1775)	**BE** R	**CI** RC	**CH** R	**GH** R	**HE** RC	**IC** R	**IM** RC	**JO** R	**LA** RC	**PA** RC	**SC** R	**SU** R	**VL** R
Lysandra coridon (Poda, 1761)	**BE** RC		**CH** R	**GH** R		**IC** R	**IM** RC			**PA** C			
Polyommatus icarus (Rottemburg, 1775) Other remarks: Cuvelier & Dincă,2007	**BE** VC	**CI** VC	**CH** VC	**GH** C	**HE** VC	**IC** VC	**IM** VC	**JO** VC	**LA** VC	**PA** VC	**SC** VC	**SU** VC	**VL** VC
Polyommatus thersites (Cantener, 1834)				**GH** R		**IC** R	**IM** R			**PA** R			
Polyommatus dorylas magna Czekelius, 1917 Other remarks: Cuvelier & Dincă, 2007	**BE** RC		**CH** R	**GH** R		**IC** RC	**IM** C		**LA** RC				
Polyommatus daphnis ([Den. & Schiff.], 1775)	**BE** RC						**IM** RC			**PA** VC			
Fam. **NYMPHALIDAE** Swainson, 1827													
Subfam. **Limenitidinae** Behr, 1864													
Neptis rivularis (Scopoli, 1763) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Neptis sappho (Linnaeus, 1758)										**PA**			
Limenitis populi (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC			**GH** R	**HE** RC		**I** R	**JO** R	**LA** RC	**PA** R	**SC** R	**SU** R	**VL** R
Limenitis camilla ([Den. & Schiff.], 1775)	**BE** RC	**CI** RC	**CH** RC	**GH** R	**HE** C	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** C	**SC** RC	**SU** C	**VL** RC
Subfam. **Heliconiinae** Swainson, 1827													
Issoria lathonia (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Brenthis hecate ([Den. & Schiff.], 1775)			**CH** R	**GH** R			**IM** R						
Brenthis ino (Rottemburg, 1775) Other remarks: Cuvelier & Dincă, 2007	**BE** RC		**CH** RC	**GH** R	**HE** RC		**IM** R	**JO** R	**LA** R		**SC** RC	**SU** RC	
Brenthis daphne ([Den. & Schiff.], 1775)										**PA** R			
Argynnis paphia	**BE**	**CI** R	**CH**	**GH**	**HE**	**IC**	**IM**	**JO**	**LA**	**PA**	**SC**	**SU**	**VL**

(Linnaeus, 1758)	RC		RC	R	C	RC	C	C	C	C	RC	RC	RC
Argynnis laodice (Pallas, 1771)			**CH** R							**PA** RC			
Speyeria aglaja (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Fabriciana niobe (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** R	**HE** RC	**IC** RC	**IM** C	**JO** RC	**LA** RC	**PA** C	**SC** RC	**SU** RC	**VL** RC
Fabriciana adippe (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IM** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Boloria selene ([Den. & Schiff.], 1775) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Boloria euphrosyne (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Boloria dia (Linnaeus, 1767) Other remarks: Cuvelier & Dincă, 2007	**BE** C	**CI** C	**CH** RC	**GH** RC	**HE** C	**IC** C	**IR** C	**JO** RC	**LA** RC	**PA** RC	**SC** C	**SU** RC	**VL** RC
Boloria titania transsylvanica Tiltscher, 1913 Other remarks: Peregovits, 1995; Cuvelier & Dincă, 2007	**BE** RC			**GH** R	**HE** C		**IM** RC		**LA** R				
Subfam. **Apaturinae** Boisduval, 1840													
Apatura iris (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Apatura ilia ([Den. & Schiff.],1775)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Subfam. **Nymphalinae** Swainson, 1827													
Araschnia levana (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Vanessa cardui (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Vanessa atalanta (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Aglais io (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Aglais urticae (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Polygonia c-album (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Nymphalis polychloros (Linnaeus, 1758)				**GH** RC						**PA** R			
Nymphalis xanthomelas (Esper, 1781)	**BE** R			**GH** RC			**IM** R						
Nymphalis antiopa (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Euphydryas aurinia (Rottemburg, 1775)	**BE** C			**GH** RC		**IC** C	**IM** C		**LA** RC				**VL** C
Melitaea didyma (Esper, 1779) Other remarks: Cuvelier & Dincă, 2007	**BE** RC		**CH** R	**GH** R					**LA** RC	**PA** C			
Melitaea phoebe	**BE**		**CH**	**GH**			**IM**			**PA**			**VL**

([Den. & Schiff.], 1775)	RC		RC	R			C			C			RC
Melitaea cinxia (Linnaeus, 1758)	**BE** RC			**GH** RC	**HE** C		**IM** RC		**LA** C				
Melitaea diamina (Lang, 1789)			**CH** R										
Melitaea britomartis Assmann, 1847	**BE** R		**CH** R										**VL** R
Melitaea athalia (Rottemburg, 1775) Other remarks: Cuvelier & Dincă,2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Melitaea aurelia Nickerl, 1850 Other remarks: Cuvelier & Dincă, 2007	**BE** R		**CH** R			**IC** R	**IM** R						
Subfam. **Satyrinae** Boisduval, [1833]													
Coenonympha pamphilus (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** C	**CI** C	**CH** C	**GH** C	**HE** C	**IC** C	**IR** C	**JO** C	**LA** C	**PA** C	**SC** C	**SU** C	**VL** C
Coenonympha tullia (Müller, 1764) Other remarks: Cuvelier & Dincă, 2007				**GH** RC		**IC** RC							
Coenonympha glycerion (Borkhausen, 1788) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Coenonympha arcania (Linnaeus, 1761) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Lopinga achine (Scopoli, 1763)						**IC** C							
Pararge aegeria tircis (Butler, 1867) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Lasiommata maera (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** C	**CH** C	**GH** C	**HE** C	**IC** C	**IR** C	**JO** C	**LA** C	**PA** C	**SC** C	**SU** C	**VL** C
Lasiommata megera (Linnaeus, 1758)	**BE** C	**CI** C	**CH** C	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** C	**LA** C	**PA** C	**SC** C	**SU** C	**VL** C
Melanargia galathea (Linnaeus, 1758)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Hipparchia fagi (Scopoli, 1763)										**PA** RC			
Hipparchia semele (Linnaeus, 1758)										**PA** R			
Minois dryas (Scopoli, 1763)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Hyponephele lycaon (Kühn, 1774)				**GH** R			**IM** R						
Aphanthopus hyperanthus (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** C	**CI** C	**CH** C	**GH** C	**HE** C	**IC** C	**IR** C	**JO** C	**LA** C	**PA** C	**SC** C	**SU** C	**VL** C
Maniola jurtina (Linnaeus, 1758) Other remarks: Cuvelier & Dincă, 2007	**BE** C	**CI** C	**CH** C	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Erebia ligea nikostrate Fruhstorfer, 1909	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC		**SC** RC	**SU** RC	

Other remarks: Cuvelier & Dincă, 2007													
Erebia euryale syrmia Fruhstorfer, 1919 Other remarks: Cuvelier & Dincă, 2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** C	**IR** RC	**JO** RC	**LA** RC		**SC** RC	**SU** RC	**VL** RC
Erebia medusa ([Den. & Schiff.], 1775)	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC	**PA** RC	**SC** RC	**SU** RC	**VL** RC
Erebia aethiops (Esper, 1777) Other remarks: Cuvelier & Dincă,2007	**BE** RC	**CI** RC	**CH** RC	**GH** RC	**HE** RC	**IC** RC	**IR** RC	**JO** RC	**LA** RC		**SC** RC	**SU** RC	

REFERENCES

Bálint 1980 — Bálint Zsolt, *Adatok a nagylepkék elterjedéséhez Erdélyben (Lepidoptera).* In: *Folia entomologica hungarica*, 41(2) (1980), p. 363-366.

Bálint 1981 — Bálint Zsolt, *Adatok a nagylepkék elterjedéséhez Erdélyben II. (Lepidoptera). In: Folia entomologica hungarica*, 42(1) (1981), p. 227-235.

Bálint 1983 — Bálint Zsolt, *Újabb adatok a Keleti-Kárpátok nagylepke faunájának ismeretéhez (Lepidoptera).* In: *Folia entomologica hungarica*, 44(2) (1983), p. 324-326.

Bálint 1996 — Bálint Zsolt, *A Kárpát medence nappali lepkéi.* In: *Ed. MME Budapest*, (1996), 183 pp, 12 pls.

Bálint *et al.* 2016 — Bálint Zsolt, Takáts Kornél, Katona Gergely, *A nagy apolló (Parnassius apollo L., 1758; Lepidoptera: Papilionidae) kutatástörténete a Kárpát-medencében.* In: *Annales Musei historico-naturalis hungarici,* 108 (2016), p. 251–282.

Csiki1917 — Csiki Ernő, *Dr. Tiltscher Pál*, In: *Rovartani Lapok,* 24(9-12) (1917), p. 179-180.

Cuvelier, Dincă 2007 — Cuvelier Sylvain, Dincă Vlad Eugen, *New data regarding the butterflies (Lepidoptera, Rhopalocera) of Romania, with additional comments (general distribution in Romania, habitat preferences, threats and protection) for ten localized Romanian species.* In: *Phegea* 35(3) (2007), p. 93-116.

Dincă *et al.* 2011 — Dincă Vlad Eugen, Zakharov Evgeny, Hebert D. N. Paul, Vila Roger, *Complete DNA barcode reference library for a country's butterfly fauna reveals high performance for temperate Europe.* In: *Proceedings of the Royal Society B,* 278 (2011), p. 347-355.

Gyulai *et al.* 2010 — Gyulai Péter, László Manfréd Gyula, Pekarsky Oleg, Peregovits László, Ronkay Gábor, Ronkay László, Szabóky Csaba, Varga Zoltán, Witt J. Thomas, *Magyarország nagylepkéi – Macrolepidoptera of Hungary.* In: *Heterocera Press, Budapest* (2011), 253 pp.

Izsák 1980 — Izsák Zoltán, *Date asupra unor lepidoptere rare din zona Gheorgheni-Lacu Roşu.* In: *Acta Harghitensia, Miercurea-Ciuc* (1980), p. 452-462.

Markó, Sárkány-Kiss 2011 — Markó Bálint, Sárkány-Kiss Endre, *A Gyergyói-medence: egy mozaikos táj természeti értékei / Valorile naturale ale Depresiunii Giurgeului,* In: *Apáthy Könyvek, Kolozsvári Egyetemi Kiadó* (2011), 243 pp.

Niculescu 1960 — Niculescu V. Eugen, *Fauna Republicii Populare Române, Fam. Papilionidae,*In: *Ed. Acad. R.P.R., Bucureşti* (1960),103 pp, 9 pls.

Peregovits — Peregovits László, *Data to Macrolepidoptera fauna of Transylvania (Romania). I.*

1995 — *Faunistical data.* In: *Folia entomologica hungarica,* 56 (1995), p. 163-178

Popescu-Gorj 1970 — Popescu-Gorj Aurelian, *Date privind lepidopterele de la Lacul Roşu şi Cheile Bicazului.* In: *Studii şi Cercetări de Geologie, Geografie, Biologie şi Muzeologie. Muzeul de Ştiinţele Naturii Piatra Neamţ, 1* (1970), p. 331-355.

Rákosy 2013 — Rákosy, László, *Fluturii diurni din România. Cunoaştere, protecţie, conservare.* In: *Ed. Mega, Cluj-Napoca,* (2013), 352 pp.

Simonyi, Szécsényi 1992 — Simonyi Sándor, Szécsényi Lajos, *Adatok Erdély magashegységi nagylepkefaunájának Ismeretéhez (Erdélyi gyűjtőutak nagylepke anyagának feldolgozása) (Lepidoptera).* In: *Folia entomologica hungarica,* 53 (1992), p. 225-230.

Szentirmai *et al.* 2014 — Szentirmai István, Mesterházy Attila, Varga Ildikó, Schubert Zoltán, Sándor Lehel Csaba, Ábrahám Levente, Kőrösi Ádám, *Habitat use and population biology of the Danube Clouded Yellow butterfly Colias myrmidone (Lepidoptera: Pieridae) in Romania.* In: *Journal of insect conservation,* (2014), 18. pp. 417-425. ISSN 1366-638X

Székely 2008 — Székely Levente, *The Butterflies of Romania – Fluturii de zi din România.* In: *Brastar Print-Braşov,* (2009), 305 pp.

Tiltscher 1913 — Tiltscher Pál, *Argynnis amathusia var. transsylvanica.* In: *Entomologische Zeitschrift, Frankfurt am Main,* 26 (1913), p. 210-211

Tolman, Levington 1997 — Tolman Tom, Lewington Richard, *Butterflies of Europe*, In: *Princeton University Press, Oxford,* 320 pp.

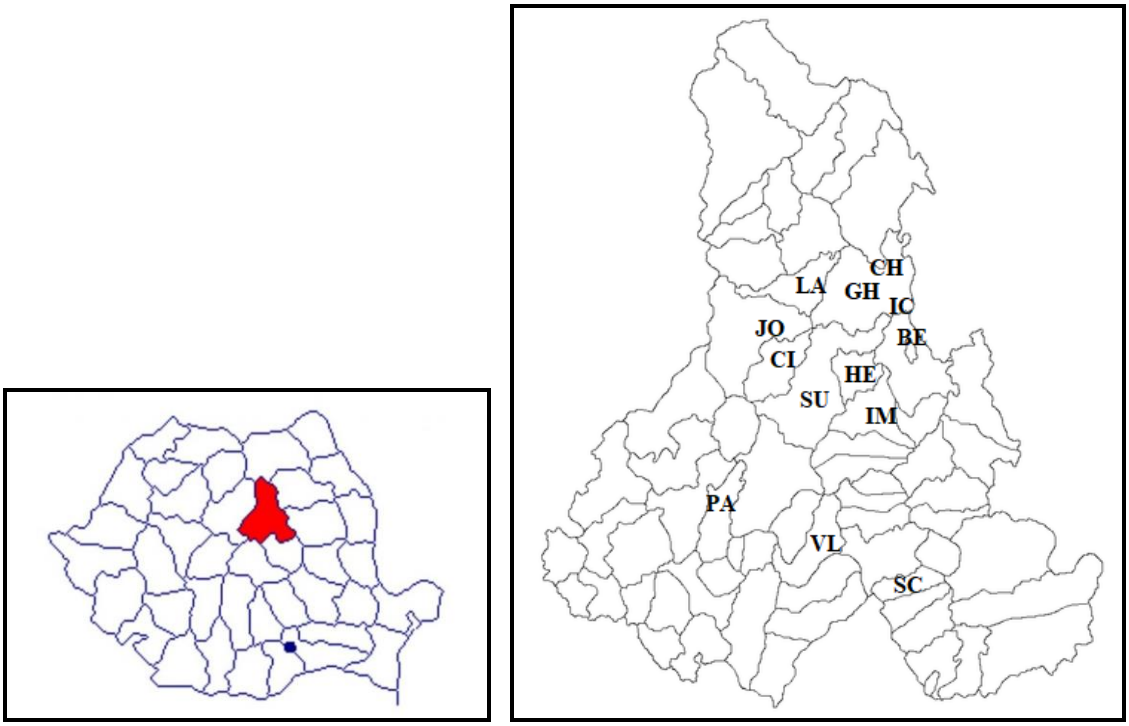
Török, Cuzepan 2012 — Török Sergiu Cornel, Cuzepan Gabriela, *Data regarding genus Parnassius Latreille, 1804 (Lepidoptera: Papilionidae) preserved in Natural History Museum collections from Sibiu* .In: *Brukenthal Acta Musei*, VII.3 (2012), p. 459-473.

Vizauer 2006 — Vizauer Tibor Csaba, *Adatok a Székelyföld nappalilepke faunájának ismeretéhez,*In:*Acta Siculica,* 1 (2006), p.109-116.

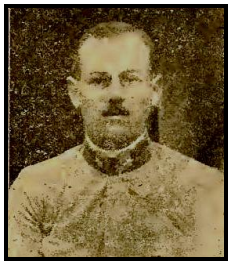
Wiemers *et al.* 2018 — Wiemers Martin, Balletto Emilio, Dincă Vlad Eugen, Faltynek Fric Zdenek, Lamas Gerardo, Lukhtanov Vladimir, Munguira Miguel, van Swaay Chris, Vila Roger, Vliegenthart Albert, Wahlberg Niklas, Verovnik Rudi, *An updated checklist of the European Butterflies (Lepidoptera, Papilionoidea)* In: *ZooKeys* 811(2018), p. 9–45.

LIST OF ILLUSTRATIONS

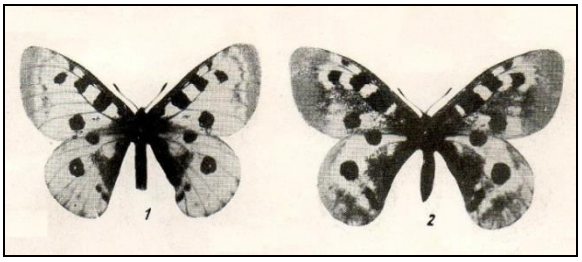
LISTA ILUSTRAȚIILOR



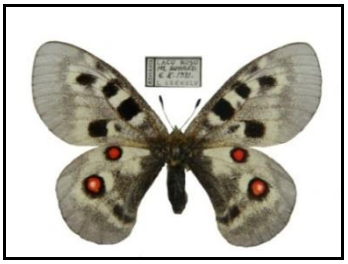
1



2



3



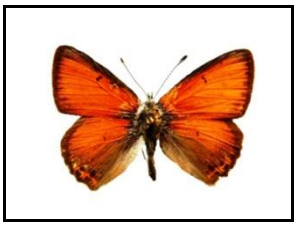
4

5

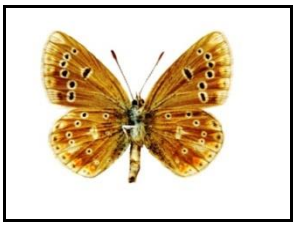
6

Fig. 1 Map of Harghita county; **Fig. 2** Dr. Tiltscher Pál; **Figs. 3-6** Different Lepidoptera species


7


8


9


10


11


12


13


14


15


16


17


18


19

Figs. 7-17 Different Lepidoptera species **Fig. 18** Izvor Cerbul; **Fig.19** - Heveder, Voșlobeni

NEW DATA ABOUT LEPIDOPTERA (INSECTA) IN ROMANIA, ESPECIALLY FROM DOBROGEA (SOUTH-EASTERN ROMANIA)

Levente SZÉKELY*
Roberth GÖRBE**
István JUHÁSZ***

Abstract*. This work is a new contribution to the knowledge of the Romanian Lepidoptera fauna, and it includes data on very rare and localized species, little known in the fauna of the country. Some of the presented species have not been observed in Romania for several decades, such as Fabula (Luperina) zollikoferi (Freyer, 1836) (last reported in Romania in 1977), Polymixis trisignata (Ménetries, 1847) (last reported in Romania in 1965, as Mniotype leuconota (Herrich-Schäffer, [1850])), and Furcula bicuspis (Borkhausen, 1790). Other species are reported for the first time in several regions of the country, such as: Polymixis rufocincta (Geyer, [1827 –1828]) – first record for Moldova. The study also includes many rare species in Romania, known in the past based on very few specimens, such as: Idaea sericeata (Hübner, 1813) – the third population discovered on the territory of Romania, Rhodometra sacraria (Linnaeus, 1767), Aspitates mundataria (Stoll, 1782), Arctia festiva (Hufnagel, 1766), Rhyparioides metelkana (Lederer, 1861), Ocnogyna parasita (Hübner, 1790), Calocucullia celsiae (Herrich-Schäffer, 1850), – the fifth population discovered on the territory of Romania, Cervina (Gortyna) cervago Eversmann, 1844, Saragossa siccanorum (Staudinger, 1870), Saragossa porosa (Eversmann, 1854), Dichagyris melanura (Kollar, 1846) etc. The work also includes a list of species collected from different locations in Dobrogea (south-east of Romania) in recent years: Izvoarele, Sulina, Sarinasuf - Plopul, Jurilovca - Cape Doloșman, Corbu Beach, and Histria - areas hitherto little known from a lepidopterological point of view. A total of 505 species of Lepidoptera are listed in the table provided.*
Keywords*: Insecta, Lepidoptera, faunistics, Romania.*

Rezumat. *Lucrarea este o contribuție nouă la cunoașterea faunei lepidopterelor României, și include date despre specii foarte rare și localizate, puțin cunoscute în fauna țării. Unele specii prezentate nu au fost observate în România de mai multe decenii, precum Fabula (Luperina) zollikoferi (Freyer, 1836) (semnalat ultima dată în România în 1977), Polymixis trisignata (Ménetries, 1847) (semnalat ultima dată în România în 1965, ca Mniotype leuconota (Herrich-Schäffer), [1850])), și Furcula bicuspis (Borkhausen, 1790). Alte specii sunt raportate pentru prima dată în diferite regiuni ale țării, precum: Polymixis rufocincta (Geyer, [1827-1828]) - prima semnalare din Moldova. Studiul include de asemenea multe specii rare, cunoscute în trecut pe baza a foarte puține exemplare, de exemplu: Idaea sericeata (Hübner, 1813) - a treia populație descoperită pe teritoriul României, Rhodometra sacraria (Linnaeus, 1767), Aspitates mundataria (Stoll, 1782), Arctia festiva (Hufnagel, 1766), Rhyparioides metelkana (Lederer, 1861), Ocnogyna parasita (Hübner, 1790), Calocucullia celsiae (Herrich-Schäffer, 1850) - a cincea populație descoperită pe teritoriul României, Cervina (Gortyna) cervago Eversmann, 1844, Saragossa siccanorum (Staudinger, 1870), Saragosa porosa (Eversmann, 1854), Dichagyris melanura (Kollar, 1846) etc. Lucrarea include și o listă de specii colectate din diferite locații din Dobrogea (sud-estul României) în ultimii ani (Izvoarele, Sulina, Sarinasuf - Plopul, Jurilovca - Capul Doloșman, Plaja Corbu și Histria - zone până în prezentputin cunoscute din punct de vedere lepidopterologic). În total 505 specii de lepidoptere sunt lístate în tabel.*
Cuvinte cheie: *Insecte, lepidoptere, faunistică. România.*

Introduction

In this paper we intend to emphasize that, in the Romanian lepidopterofauna, Dobrogea is the territory that offers new and new discoveries. However, new findings are also possible in other provinces, for example in Moldova. Due to the westward penetration of many steppe elements from southern Russia and Ukraine, and the southern ones from the Balkans, the Lepidoptera fauna of Dobrogea is the most diverse and richest in Romania, with approximately 1000 reported macrolepidoptera species. This work also includes

*Independent researcher, Romania, levi.szekely@gmail.com;
** Independent researcher, Romania, robi_gorbe@ yahoo.com;
** *Independent researcher, Hungary, lepkesz@gmail.com / Istvan.Juhasz@vizmuvek.hu.

a list of species collected from different locations in Dobrogea in recent years (Izvoarele, Sulina, Sarinasuf-Plopul, Jurilovca-Cape Doloșman, Corbu Beach and Histria - areas hitherto little known from a lepidopterological point of view). The number of reported species is slightly lower compared to other areas in Dobrogea. These investigated areas do not include forests, they are primarily open areas (salty steppes, marshes, wetlands, with very little forest vegetation and bushes). A total of 505 species of Lepidoptera are listed in the table provided.

Material and methods

The material was collected using 80 W or 125 W mercury vapor lamp placed in front of a white sheet, powered by a portable gasoline generator. In parallel, 5-8 light traps with 8W black and white UV tubes were used every night. An entomological net was used for butterflies.

Discussion

Below we present the taxa considered to be of particular significance (rare or very localized) for the Romanian fauna:

Suprafam. BOMBYCOIDEA Latreille, [1803]

Fam. LASIOCAMPIDAE Harris, 1841

Trichiura crataegi (Linnaeus, 1758)

Material: Esechioi Forest (44°24′54″N, 27°24′36″E), SW Dobrogea, 25.IX.2019 (1♂) (Fig. 7) Relatively common species in Romania in the hilly and submontane regions. Little known in the plains. In Dobrogea, there is only an old record from the Danube Delta (Popescu Gorj, Olaru & Drâghia, 1972).

Suprafam. GEOMETROIDEA Leach, [1815]

Fam. GEOMETRIDAE Leach, [1815]

Subfam. Sterrhinae Meyrick, 1892

Idaea sericeata (Hübner, 1813)
Material: Jurilovca, Razelm Lake, Cape Doloșman (44°45′25″N, 28°56′24″E), 19 – 20.V.2018 (12 sp.) (Fig. 12). The third population discovered on the territory of Romania. Very localized species, distributedfrom Central and Southern Europe, to Crimea, Caucasus, Transcaucasia and Central Asia. Extremely local in Romania, found in Transylvania a century ago (Săcârâmb and Harghita Mountains) (Kovács & Kovács, 1998). Currently it is known only in Dobrogea, Măcin Mountains (Kovács & Kovács, 1998, Rákosy & Wieser, 2000), and near the Enisala Fortress. Possibly more widespread in dry and chalk areas in Dobrogea.
Rhodometra sacraria (Linnaeus, 1767)
Material: Esechioi Forest (44°24′54″N, 27°24′36″E), SW Dobrogea, 25.IX.2019 (6 sp.), Jurilovca, Razelm Lake, Cape Doloșman, (44°45′25″N, 28°56′24″E), 25.X.2019 (2sp.) (Fig. 13). Subtropical, migratory species. Common in southern Europe, in Romania quite rare. Found in Romania in all the provinces of the country, with most records from Dobrogea.

Subfam. Ennominae Duponchel, 1845

Aspitates mundataria (Stoll, 1782)
Material: Histria (44°32’10”N, 28°46’12”E), 22.VI.2009 (4♂), 20.VII.2009 (2♂, 1♀), 19.VI.2015 (1♂), (Figs. 14, 17)
Euarsiatic. Distributed from Eastern Europe across large parts of the Palaearctic and reaching the Russian Far East, Korea and Japan. Dobrogea currently represents the western limit of distribution of this species. Larvae have been found on *Artemisia*.

Suprafam. NOCTUOIDEA Latreille, 1809

Fam. NOTODONTIDAE Stephens, 1829

Subfam. Dicranurinae Duponchel, [1845]

Furcula bicuspis (Borkhausen, 1790)

Material: Vrancei Mountains, Tişiţei Gorges, (45°54′45″N, 26°32′30″E), 16. VIII.2019 (1♂) (leg. & coll. R. Görbe) (Fig. 4). Spread throughout Europe (except for Spain), to Siberia, the Far East and Japan. An extremely rare species in Romania, it has not been reported in the country for several decades. It was found in Romania at Tecuci, Târgu Mureș, Sadu, Codlea, Meseș Mountains (Ciucea), Harghita Mountains and Vrancei Mountains (Székely, 2010). For Tișiței Gorges it is practically a confirmation as the species was found here 40 years ago (Popescu Gorj & König, 1976).

Fam. NOCTUIDAE Latreille, 1809

Subfam. Arctiinae Leach, 1815

Arctia festiva (Hufnagel, 1766)
Material: N. Dobrogea, Horia, (45°1′10″N, 28°24′19″E), 8.X.2016 (1♂) (leg. P. Haneschlager).Very likely a partial second generation.
Rhyparioides metelkana (Lederer, 1861)
Material: Sulina, (45°9′03″N, 29°41′28″E), 24.VIII.2019 (1♂). Small size fresh specimen,

most likely belonging to a partial second generation.

Ocnogyna parasita (Hübner, 1790)
Material: Enisala Fortress, (44°53′55″N, 28°49′7″E), 25-31.III.2016-2019. Probably a much more widespread species in Dobrogea!

Subfam. Cucullinae Herrich-Schäffer, 1850

Calocucullia celsiae (Herrich-Schäffer, 1850)
Material: Vrancei Mountains, Tişiţei Gorges (45°54′45″N, 26°32′30″E), 25.IV.2019 (2♂) (Fig.5).The first record in southern Moldova, and the fifth population found in Romania. Ponto-Mediterranean species, distributed from the Balkans to Turkey, Armenia N-Iran, N-Iraq and the Middle East. The most northern populations in Europe are in Central Transylvania (Rimetea), and Northern Moldova (Botoșani). It is also known in Romania from the south of Banat, and from the south of Dobrogea.

Subfam. Xyleninae Guenée, 1837

Fabula (Luperina) zollikoferi (Freyer, 1836)
Material: Jurilovca, Razelm Lake, Cape Doloșman, (44°45′25″N, 28°56′24″E), 28.IX.2018 (1♀), (Fig. 3) (leg. & coll. R. Görbe). Characteristic of the steppes of southern Siberia and western Asia (pontocaspic-turkestanian element), having stable populations only in those geographical areas. Large moth (52-60 mm), with the flight period in September-October (in Romania). Larvae develop on species of *Thalictrum, Phragmites* and on *Cladium mariscum* (Rákosy, 1996). In Europe it appears only as an exceptional migrant, when the populations of Central Asia, (in Kazakhstan, Mongolia) have pronounced outbursts. Sporadic reports are known almost all over Europe (England, Switzerland, Germany, Austria, Hungary, Finland and Poland). Closer to Romania, it was found in Hungary, many years ago, at Inota (1970), and Jászberény (1982) (Gyulai & al. 2010). Several reports originate from Ukraine, while in Crimea it appears that the species has native populations. All previous reports from Romania are from the south of Moldova and Dobrogea, from the period 1938-1977: Tecuci, 2.X.1938 (leg. Leibovici) (Nemeș & Voicu, 1973), Hagieni, 14.IX.1974 (Popescu-Gorj & Brătășeanu, 1979), Hagieni 14.IX.1974, Olimp-litoral, 6.IX.1977 (Székely & Cernea, 2007), as *Luperina zollikoferi*. Following the most recent reviews, the species was included in the monotypic genus *Fabula* (Zilli et al., 2005).

Cervina (Gortyna) cervago Eversmann, 1844
Material: Enisala, Izvoarele, Histria, Sarinasuf-Popul, Cape Doloșman, generally common from mid-August to mid-October (Fig. 9). Very common at Enisala. Recently it was reported also from Bucharest (after a photo, not yet published). The species appears to be in expansion. Mediterranean - Turanian element, present in Asia Minor, the eastern part of the Balkan Peninsula, Ukraine, Armenia, Turkmenistan and Southern Russia.

Polymixis rufocincta (Geyer, [1827–1828])
Material: Vrancei Mountains, Tişiţei Gorges, Ciuta, (45°56′34″N, 26°35′16″E), 23.X.2017, (2♂) (Fig. 6). First report of this species from Moldova. Material: Jurilovca, Razelm Lake, Cape (Capul) Doloșman, (44°45′25″N, 28°56′24″E), 25.X.2019 (52 sp.) (Fig. 16). Ponto-Mediterranean species, distributed in Southern Europe, Balkan Peninsula, Near and Middle East. The moths fly in late autumn, in Romania in October-November. Characteristic of dry rocky habitats. Locally it can be common. A very good example is the Cape Doloșman, with over 50 specimens per night.

Polymixis trisignata (Ménetries, 1847)
Material: Jurilovca, Razelm Lake, Cape Doloșman, (44°45′25″N, 28°56′24″E), 25.X.2019 (2♂, 1♀) (Figs. 1, 2). Published in Romania over 50 years ago as *Mniotype leuconota* (Herrich-Schaffer, 1850). In 2003 it was first mentioned that *P. trisignata* replaces *M. leuconota* in Romania (Rákosy, Goia & Kovács, 2003). Reported from Bucharest (as *M. leuconota*), data from J. de Joannis before 1910 (Salay, 1910), later from Tecuci, 20.IX.1938, leg. A. Alexinschi (Nemeș & Voicu, 1973), and from Comarova and Hagieni, 25-30.X.1965 (Popescu-Gorj & Drâghia, 1967). Ponto-Mediterranean species, distributed in the Balkan Peninsula and the Near and Middle East (Bulgaria, N.-Macedonia, Greece, S.-Romania, Ukraine, Southern Russia, Turkmenistan, Afghanistan). The moths fly in late autumn, in Romania in October-November. The larvae develop on Poaceae. *Polymixis leuconota* is currently considered asendemic to Crete (lepiforum.de).

Subfam. Hadeninae Guenée, 1837

Saragossa siccanorum (Staudinger, 1870)
Material: Sarinasuf–Plopul (45°1′19″N, 29°7′45″E), 16–17. VIII. 2018 (24 sp.), 9.VIII.2019 (3 sp.) (Fig.10).
Turano-Eremic species that reaches in Dobrogea its western distribution limit in Europe.Widespread from Dobrogea (SE.-Romania), throughout Ukraine, Azerbaijan, Southern Russia, Iraq, Afghanistan, Turkestan, Mongolia and Western China. Characteristic of halophile steppes. The host plant is still unknown.

It seems that in the steppes with *Artemisia* from Dobrogea, it is not as rare as previously believed.

Saragossa porosa (Eversmann, 1854)

Material: Sarinasuf–Plopul (45°1′19″N, 29°7′45″E), 9.VIII.2019 (3 sp.) (Fig. 11).

Xerothermophilous species characteristic of steppe areas with *Artemisia*. It is very local in Romania where it has populations in the west and south-east of the country. The larvae develop on *Artemisia maritima*.

Ulochlaena hirta (Hübner, [1813])

Material: Extremely common species almost throughout Dobrogea, with hundreds of specimens attracted by artificial light, from mid-October to early winter (Fig. 15). Despite the abundance of this species, until now we have not been able to collect any female specimens. Ponto-Mediterranean species, distributed in south-eastern Europe, as well as the Near and Middle East. The larvae feed on Poaceae.

Subfam. Noctuinae Latreille, 1809

Dichagyris melanura (Kollar, 1846)

Material: Jurilovca, Razelm Lake, Cape Doloșman, (44°45′25″N, 28°56′24″E), 15.VI.2019 (45 sp.) (Fig. 8). Turano-Eremic species distributed in the Balkan Peninsula (Greece, Albania, Dalmatia, Bulgaria, SE-Romania), through Turkey, Transcaucasia and Northern Iran. The habitats of this species in Dobrogea are the salty areas, cliffs, and dry and warm steppes. It seems that it is not as rare as previously believed.

Acknowledgements

Thanks to Péter Gyulai (Hungary) for confirming the determinations of difficult species. Also thanks to all the colleagues who participated in the collectings actions in Dobrogea in recent years: Peter Haneschlager, Helmut Forster (Austria), György Makranczy, András Orosz, Tamás Hácz, Attila Podlussányi, István Rozner, Kálmán Székely, Pál Marosi (Hungary), László Rákosy, Vlad Eugen Dincă, Irén Kocs, Sorin Marius Stanciu, Dragoș Firța, Ionuț Ștefan Iorgu (Romania).

The list of species in systematic order:

Abbreviations:

♂ = male; ♀ = female; sp. = specimen; **R** = rare (3-5 specimens per collecting day or night); **C** = common (6-29 specimens per collecting day or night); **V.C.** = very common (30-100 specimens per collecting day or night); **R.C.** = relatively common (sometimes common, sometimes rare / or in one year is common, in another year is rare);
leg. = legit (collected by).

IZV – **Izvoarele** (45°3′56″N, 28°31′28″E) (Fig.18) - It is a commune in Tulcea County, comprising the villages Alba, Iulia and Izvoarele (residence). The area consists of hills, mostly with steppe vegetation, shrubs and rocks. In the area there is the most important population of *Catopta thrips* (Hübner, 1818) in Dobrogea.

SUL – Sulina (45°9′03″N, 29°41′28″E) (Fig.22).The only town in the Danube Delta, it is the easternmost locality of Romania. The landscape consists of coastal sands, swampy areas and few forests (especially plantations).It is part of the Danube Delta Biosphere Reserve.

SAR -Sarinasuf – Plopul (45°1′19″N, 29°7′45″E) (Fig.23) - Sarinasuf and Plopul (Beibugeac) are two villages of the Murighiol commune in Tulcea County, north of Razelm Lake. The land around the lake is dominated by extensive meadows with *Artemisia*. It is part of the Danube Delta Biosphere Reserve.In the immediate vicinity there are also wetlands, lakes, remnants of meadow forests and agricultural lands.

JUR - Jurilovca / Cape Doloșman, (44°45′25″N, 28°56′24″E) (Fig.19) The landscape is particularly picturesque here, and includes rocky cliffs, steppe meadows with halophilic vegetation, swampy areas and a few bushy areas. It resembles Cape Kaliakra, in north-eastern Bulgaria, but is smaller in size. It is also an archaeological site, comprising the ancient Greek fortress Argamum.The whole area is protected, it is part of the Danube Delta Biosphere Reserve.

COR - Corbu Beach (44°24’32”N - 28°39’30”E) (Fig.20) - It is one of the most important wild beaches that have remained on the Romanian Black Sea coast. It is characterized by psammophile and halophile vegetation, with few species strictly adapted to the ecological conditions, such as *Ephedra distachya, Crambe maritima, Elymus arenarius, Medicago marina, Silene pontica, Eryngium maritimum*etc.It is part of the Danube Delta Biosphere Reserve.

HIS – Histria (44°32’10”N - 28°46’12”E) (Fig.21) - The former Greek fortress (Histria) is the oldest certified city on the present territory of Romania. Currently, its ruins are on the administrative territory of Istria commune, Constanța County.The landscape consists of salt vegetation, swampy areas and sands.The whole area is protected, it is part of the Danube Delta Biosphere Reserve.

Taxon:	IZV	SUL	SAR	JUR	COR	HIS
Suprafam. ZYGAENOIDEA Latreille, 1809						
Fam. LIMACODIDAE Stephens, 1850						
Apoda limacodes (Hufnagel, 1766)	IZV/ RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Suprafam. COSSOIDEA, Mosher, 1916						
Fam. COSSIDAE Leach,[1815]						
Cossus cossus (Linnaeus, 1758)	IZV/R	SUL/R	SAR/R		COR/R	HIS/R
Parahypopta caestrum (Hübner, 1808)	IZV/RC	SUL/R	SAR/C	JUR/C	COR/RC	HIS/RC
Catopta (Paracossulus) thrips (Hübner, 1818)	IZV/RC					
Dyspessa ululа (Borkhausen, 1790)	IZV/RC	SUL/R		JUR/C		
Dyspessa salicicola (Eversmann, 1848)						HIS
Zeuzera pyrina (Linnaeus, 1761)	IZV/R	SUL/R		JUR/R	COR/R	
Phragmatecia castaneae (Hübner, 1790)	IZV/RC	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Suprafam. BOMBYCOIDEA Latreille, [1803]						
Fam. LASIOCAMPIDAE Harris, 1841						
Malacosoma castrensis (Linnaeus, 1758)	IZV/R		SAR/C	JUR/RC		HIS/RC
Malacosoma neustria (Linnaeus, 1758)		SUL/R				HIS/R
Odonestis pruni (Linnaeus, 1758)	IZV/RC		SAR/R			
Macrothylacia rubi (Linnaeus, 1758)				JUR/R		
Lasiocampa trifolii ([Denis & Schiffermüller], 1775)						HIS/C
Lasiocampa eversmanni (Eversmann, 1843)					COR/3sp.	HIS/C
Gastropacha quercifolia ([Denis & Schiffermüller], 1775)	IZV/R	SUL/RC	SAR/R	JUR/RC		
Gastropacha populifolia ([Denis & Schiffermüller], 1775)		SUL/R	SAR/R			
Phyllodesma tremulifolia(Hübner, 1790)	IZV/RC					
Fam. LEMONIIDAE Hampson, 1918						
Lemonia balcanica (Herrich-Schaffer, 1847)	IZV/RC			JUR/RC		HIS/R
Fam. SPHINGIDAE Latreille, [1802]						
Subfam. Sphinginae Latreille, [1802]						
Acherontia atropos (Linnaeus, 1758)		SUL/1sp.	SAR/1sp.			HIS/3sp.
Agrius convolvuli (Linnaeus, 1758)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Sphinx ligustri (Linnaeus, 1758)	IZV/R	SUL/R				
Subfam. Smerinthinae Grote & Robinson, 1865						
Laothoe populi (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/R	HIS/R

Marumba quercus ([Denis Schiffermüller], 1775)	IZV/R					
Mimas tiliae (Linnaeus, 1758)	IZV/RC	SUL/RC				
Smerinthus ocellata (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC		
Subfam. Macroglosiinae Harris, 1839						
Macroglossum stellatarum (Linnaeus, 1758)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS//RC
Proserpinus proserpina (Pallas, 1777)						HIS/1sp.
Deilephila elpenor (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Deilephila porcellus (Linnaeus, 1758)	IZV/VC	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Hyles euphorbiae (Linnaeus, 1758)	IZV/RC	SUL/C	SAR/RC	JUR/C	COR/C	HIS/RC
Hyles galii (Rottemburg, 1775)		SUL/R	SAR/RC			
Hyles hippophaes (Esper, 1793)	IZV/RC	SUL/VC	SAR/RC	JUR/RC	COR/C	HIS/RC
Hyles livornica (Esper, 1780)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Fam. SATURNIIDAE Boisduval, [1837] 1834						
Saturnia pyri ([Denis & Schiffermüller], 1775)			SAR/R	JUR/R		HIS/R
Fam. DREPANIDAE Meyrick, 1895						
Cilix asiatica Bang-Haas, 1908	IZV/R			JUR/R		
Cilix glaucata (Scopoli, 1763)	IZV/R					
Watsonalla binaria (Hufnagel, 1766)	IZV/RC					
Fam. THYATIRIDAE Smith, 1893						
Subfam. Thyatirinae Smith, 1893						
Thyatira batis (Linnaeus, 1758)	IZV/RC					
Tethea or ([Denis & Schiffermüller], 1775)	IZV/R	SUL/RC				
Suprafam. GEOMETROIDEA Leach, [1815]						
Fam. GEOMETRIDAE Leach, [1815]						
Subfam. Orthostixinae Meyrick, 1892						
Orthostixis cribraria (Hübner, 1799)	IZV/R			JUR/R		
Subfam. Geometrinae Stephens, 1829						
Thetidia smaragdaria (Fabricius, 1787)	IZV/C		SAR/C	JUR/C	COR/RC	HIS/RC
Microloxia herbaria (Hübner, [1813])		SUL/RC	SAR/C	JUR/RC	COR/RC	HIS/C
Chlorissa viridata (Linnaeus, 1758)		SUL/RC	SAR/R			HIS/RC
Chlorissa cloraria(Hübner, [1813])		SUL/RC				
Phaiogramma etruscaria (Zeller, 1849)	IZV/C			JUR/RC		HIS/RC
Subfam. Sterrhinae Meyrick, 1892						
Idaea muricata (Hufnagel, 1767)		SUL/R	SAR/RC		COR/RC	HIS/R
Idaea sericeata (Hübner, 1813)				JUR/RC		

Idaea seriata (Schrank, 1802)			SAR/RC			HIS
Idaea ochrata (Scopoli, 1763)	IZV/RC					
Idaea dimidiata (Huhnagel, 1767)		SUL/R				
Idaea emarginata (Linnaeus, 1758)						HIS/RC
Idaea rusticata ([Denis & Schiffermüller], 1775)	IZV/C	SUL/C	SAR/C		COR/C	HIS/C
Idaea filicata (Hübner, 1799)	IZV/C	SUL/C		JUR/C		
Idaea silvestraria (Hübner, 1799)		SUL/R				
Idaea subsericeata (Haworth, 1809)					COR/RC	
Idaea elongaria (Rambur, 1833)					COR/R	
Idaea laevigata (Scopoli, 1763)	IZV/R	SUL/RC				
Idaea seriata (Schrank, 1802)		SUL/R				
Idaea aversata (Linnaeus, 1758)	IZV/C	SUL/C		JUR/C		
Idaea deversaria (Herrich-Schäffer, 1848)				JUR/RC		
Scopula immorata (Linnaeus, 1758)				JUR/RC	COR/RC	HIS/RC
Scopula tessellaria (Boisduval, 1840)	IZV/R			JUR/R		
Scopula ornata (Scopoli, 1763)	IZV/RC		SAR/R	JUR/R		HIS/R
Scopula decorata ([Denis & Schiffermüller], 1775) / *Scopula orientalis* (Alphéraky, 1876) - ?	IZV/RC			JUR/RC		
Scopula rubiginata (Hufnagel, 1767) Other remarks / Bobîrnac & Stânoiu, 1975		SUL/C	SAR/C	JUR/C		HIS/RC
Scopula immutata (Linnaeus, 1758)				JUR/R		
Scopula flaccidaria (Zeller, 1852)		SUL/RC	SAR/RC			HIS/RC
Rhodostrophia vibicaria (Clerck, 1759)	IZV/C	SUL/C	SAR/C	JUR/C		HIS/RC
Rhodotrophia calabra (Petagna, 1787)	IZV/R			JUR/R		HIS/R
Rhodostrophia discopunctata Amsel, 1935						HIS/R
Rhodometra sacraria (Linnaeus, 1767)				JUR/R		
Timandra comae A. Schmidt, 1931	IZV/RC			JUR/RC		
Subfam. Larentiinae Duponchel, 1845						
Lythria purpuraria (Linnaeus, 1758)	IZV/C	SUL/C	SAR/C	JUR/C		HIS/C
Cataclysme riguata (Hübner,1813)	IZV/RC			JUR/RC		
Xanthorhoe fluctuata (Linnaeus, 1758)	IZV/R	SUL/R				
Orthonama obstipata (Fabricius, 1794)		SUL/R		JUR/R		
Camptogramma bilineata (Linnaeus, 1758)	IZV/C			JUR/RC		HIS/RC
Costaconvexa polygrammata (Borkhausen, 1794)	IZV/C	SUL/C	SAR/C	JUR/C		HIS/C
Pelurga comitata (Linnaeus, 1758)				JUR/RC		HIS/RC
Nebula salicata (Hübner,1799)				JUR/RC		
Horisme tersata ([Denis & Schiffermüller], 1775)	IZV/R					

Eupithecia biornata Christoph, 1867			SAR/RC			HIS/RC
Eupithecia innotata (Hufnagel, 1767)		SUL/RC				
Eupithecia variostrigata Alphéraky, 1878			SAR/RC			HIS/RC
Eupithecia centaureata ([Denis & Schiffermüller], 1775)		SUL/RC	SAR/RC		COR/RC	
Eupithecia graphata (Treitschke, 1825)				JUR/3sp		
Eupithecia simpliciata (Haworth, 1809)					COR/R	
Eupithecia tenuiata (Hübner,1813)						HIS/R
Eupithecia extensaria (Freyer, 1844)			SAR/RC	JUR/RC		HIS/RC
Lithostege griseata ([Denis & Schiffermüller], 1775)			SAR/RC	JUR/C		HIS/RC
Lithostege farinata (Hufnagel, 1767)			SAR/R	JUR/RC		HIS/R
Subfam. Ennominae Duponchel, 1845						
Lamaspilis marginata (Linnaeus, 1758)	IZV/RC			JUR/RC		
Ligdia adustata ([Denis & Schiffermüller], 1775)	IZV/RC					
Chiasmia clathrata (Linnaeus, 1758)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Heliommata glarearia ([Denis & Schiffermüller], 1775)	IZV/C			JUR/C	COR/C	
Godonella aestimaria sareptanaria (Staudinger, 1891)	IZV/C		SAR/C	JUR/C	COR/C	HIS/C
Narraga tessularia kasyi Moucha & Povolny, 1957		SUL/RC	SAR/C			HIS/C
Tephrina arenacearia ([Denis & Schiffermüller], 1775)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Tephrina murinaria ([Denis & Schiffermüller], 1775)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Epione repandaria (Linnaeus, 1758)		SUL/R				
Neognpharmia stevenaria (Boisduval, 1840)	IZV/RC			JUR/RC		HIS/RC
Therapis flavicaria ([Denis & Schiffermüller], 1775)				JUR/RC	COR/RC	
Pseudopanthera macularia (Linnaeus, 1758)				JUR/RC		
Eilicrinia cordiaria (Hübner, 1790)	IZV/RC	SUL/RC		JUR/RC		
Eilicrinia trinotata (Metzner, 1845)				JUR/RC		
Ennomos autumnaria (Werneburg, 1859)	IZV/RC					
Ennomos fuscantaria (Haworth, 1809)		SUL/RC	SAR/RC			
Ennomos erosaria ([Denis & Schiffermüller], 1775)	IZV/RC					
Selenia dentaria (Fabricius, 1775)	IZV/C			JUR/RC		
Selenia lunularia (Hübner, 1788)	IZV/RC			JUR/RC		

Crocallis tusciaria ([Denis & Schiffermüller], 1775)	IZV/RC					
*Crocallis elinguaria (*Linnaeus, 1758)	IZV/RC			JUR/RC		
Colotois pennaria (Linnaeus, 1758)	IZV/C			JUR/RC		HIS/R
Biston betularia (Linnaeus, 1758)	IZV/R			JUR/R		
Synopsia sociaria (Hübner, 1799)					COR/RC	
Cleora cinctaria ([Denis & Schiffermüller], 1775)	IZV/RC					
Peribatodes rhomboidaria ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC				
Hypomecis punctinalis (Scopoli, 1763)		SUL/R				
Ascotis selenaria ([Denis & Schiffermüller], 1775)	IZV/C	SUL/C	SAR/C	JUR/C	COR/RC	HIS/RC
Tephronia sepiaria (Hufnagel, 1767)	IZV/R					
Ematurga atomaria (Linnaeus, 1758)	IZV/RC			JUR/RC		
Lomographa bimaculata (Fabricius, 1775)				JUR/R		
Campaea margaritata (Linnaeus, 1761)	IZV/RC			JUR/RC		
Charissa variegata (Duponchel, 1830)	IZV/R			JUR/R		
Charissa onustria (Hübner, 1809)	IZV/RC		SAR/RC	JUR/RC		HIS/R
Chariaspilates formosaria (Eversmann, 1837)	IZV/R	SUL/R	SAR/R	JUR/R		
Aspitates mundataria (Stoll, 1782)						HIS/R
Semiaspilates ochrearia (Rossi, 1794)	IZV/C	SUL/C		JUR/C	COR/C	HIS/C
Dyscia innocentaria (Christoph, 1885)	IZV/RC	SUL/R		JUR/RC		HIS/RC
Suprafam. NOCTUOIDEA Latreille, 1809						
Fam. NOTODONTIDAE Stephens, 1829						
Subfam. Dicranurinae Duponchel, [1845]						
Furcula furcula forficula Fischer von Waldheim, 1820		SUL/R	SAR/R			
Furcula bifida (Brahm, 1787)		SUL/R				
Harpyia milhauseri (Fabricius, 1775)	IZV/R					
Stauropus fagi (Linnaeus, 1758)	IZV/RC		SAR/R			
Pheosia tremula (Clerck, 1759)			SAR/RC			
Subfam. Notodontinae Stephens, 1829						
Notodonta dromedarius (Linnaeus, 1758)				JUR/R		
Notodonta ziczac (Linnaeus, 1758)		SUL/R	SAR/R	JUR/R		
Pterostoma palpina (Clerck, 1759)		SUL/RC	SAR/RC	JUR/RC		
Peridea anceps (Goeze, 1781)			SAR/R			
Spatalia argentina (	IZV/RC	SUL/RC		JUR/R		

[Denis & Schiffermüller], 1775)						
Subfam. Pygaerinae Duponchel, [1845]						
Clostera curtula (Linnaeus, 1758)	IZV/R			JUR/RC		
Clostera pigra (Hufnagel, 1766)		SUL/R	SAR/R			
Clostera anastomosis (Linnaeus, 1758)		SUL/R				
Clostera anachoreta ([Denis & Schiffermüller], 1775)		SUL (Popescu-Gorj & Draghia, 1972)				
Fam. NOCTUIDAE Latreille, 1809						
Subfam. Rivulinae Grote, 1895						
Rivula sericealis (Scopoli, 1763)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Subfam. Boletobiinae Grote, 1895						
Parascotia fuliginaria (Linnaeus, 1761)	IZV/R		SAR/R			HIS/R
Subfam. Aventiinae Tutt, 1896						
Laspeyria flexula ([Denis & Schiffermüller], 1775)	IZV/RC					
Subfam. Herminiinae Leach, 1815						
Paracolax tristalis (Fabricius, 1794)	IZV/RC					
Macrochilo cribrumalis (Hübner, 1793)						HIS/R
Subfam. Hypeninae Herrich-Schaffer, 1851						
Hypena rostralis (Linnaeus, 1758)	IZV/R					
Hypena proboscidalis (Linnaeus, 1758)		SUL/RC				
Schrankia taenialis (Hübner, [1809])		SUL/R				
Subfam. Eublemminae Forbes, 1954						
Calymma communimacula ([Denis & Schiffermüller], 1775)	IZV/R					
Odice suava (Hübner, 1793)	IZV/RC			JUR/RC		
Eublemma porphyrina (Freyer, 1845)			SAR/R			
Eublemma amoena (Hübner, [1803])	IZV/RC			JUR/RC	COR/RC	
Eublemma purpurina ([Denis & Schiffermüller], 1775)	IZV/RC		SAR/RC	JUR/RC	COR/RC	HIS/RC
Eublemma polygramma (Duponchel, [1842])	IZV/R			JUR/R	COR/RC	
Eublemma ostrina (Hübner, [1808])		SUL/R		JUR/RC	COR/R	HIS/R
Subfam. Phytometrinae Hampson, 1913						
Colobochyla salicalis ([Denis & Schiffermüller], 1775)		SUL/R		JUR/R		
Subfam. Calpinae Boisduval, 1840						
Calyptra thalictri (Borkhausen, 1790)	IZV/R		SAR/R			
Scoliopteryx libatrix (Linnaeus, 1758)	IZV/R		SAR/R		COR/R	HIS/R

Subfam. Lymantriinae Hampson, 1893						
Lymantria dispar Linnaeus, 1758	IZV/C	SUL/C	SAR/C	JUR/C	COR/RC	HIS/C
Callitaera pudibunda (Linnaeus, 1758)	IZV/R			JUR/R		
Orgyia antiqua (Linnaeus, 1758)		SAR/R	SAR/R			
Euproctis chrysorrhoea (Linnaeus, 1758)		SUL/RC	SAR/R			HIS/R
Euproctis similis (Fuessly, 1767)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Laelia coenosa (Hübner, 1808)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Leucoma salicis (Linnaeus, 1758)	IZV/R	SUL/RC	SAR/R	JUR/R		HIS/R
Arctornis l-nigrum (Müller, 1764)	IZV/R			JUR/R		
Subfam. Arctiinae Leach, 1815						
Spilosoma lubricipeda (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC		HIS/RC
Spilosoma urticae (Esper, 1789)			SAR/R	JUR/R	COR/R	HIS/R
Phragmatobia fuliginosa (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Hyphantria cunea (Drury, 1773)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Diaphora mendica (Clerck, 1759)			SAR	JUR		
Chelis maculosa mannerheimii (Duponchel, 1936)	IZV/C		SAR/RC	JUR/C	COR/RC	HIS/RC
Rhyparioides metelkana (Lederer, 1861)		SUL/RC				
Arctia villica (Linnaeus, 1758)	IZV/R		SAR/RC	JUR/C		
Euplagia quadripunctaria (Poda, 1761)	IZV/R		SAR/R	JUR/R		
Subfam. Lithosiinae Billberg, 1820						
Thumata senex (Hübner,[1808])			SAR/RC			HIS/C
Pelosia muscerda (Hufnagel, 1766)		SUL/RC	SAR/RC			HIS/C
Pelosia obtusa (Herrich-Schäffer, [1847])			SAR/C		COR/RC	HIS/RC
Lithosia quadra (Linnaeus, 1758)	IZV/RC		SAR/RC	JUR/RC		HIS/R
Eilema caniola (Hübner, 1808)			SAR/C		COR/C	HIS/C
Eilema complana balcanica (Daniel, 1939)			SAR/C		COR/RC	HIS/RC
Eilema palliatella (Scopoli, 1763)					COR/RC	HIS/RC
Eilema pygmaeola pallifrons (Zeller, 1847)			SAR/RC			HIS/RC
Wittia sororcula (Hufnagel, 1766)	IZV/C					
Subfam. Ctenuchinae Kirby, 1837						
Amata phegea (Linnaeus, 1758)	IZV/RC			JUR/RC		
Dysauxes ancilla (Linnaeus, 1767)			SAR/R			HIS/R
Dysauxes punctata (Fabricius, 1781)			SAR/R			HIS/R
Dysauxes famula (Freyer, 1836)	IZV/C		SAR/RC	JUR/RC	COR/RC	HIS/RC
Subfam. Catocalinae Boisduval, 1828						
Lygephila craccae ([Denis & Schiffermüller], 1775)	IZV/VC			JUR/RC	COR/RC	
Euclidia glyphica (Linnaeus, 1758)	IZV/RC					
Euclidia mi (Clerck, 1759)	IZV/RC			JUR/R		

Catephia alchymista ([Denis & Schiffermüller], 1775)	IZV/1sp.					
Dysgonia algira (Linnaeus, 1767)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Grammodes stolida (Fabricius, 1775)	IZV/VC	SUL/C	SAR/VC	JUR/VC	COR/C	HIS/C
Grammodes bifasciata (Petagna, 1787)			SAR/R	JUR/R	COR/R	HIS/R
Drasteria caucasica (Kolenati, 1846)	IZV/RC	SUL/C	SAR/R	JUR/R	COR/RC	HIS/C
Clytie syriaca (Bugnion, 1837)	IZV/R	SUL/C			COR/RC	HIS/R
Catocala hymenaea ([Denis & Schiffermüller], 1775)	IZV/RC			JUR/R		
Catocala nupta (Linnaeus, 1758)	IZV/R	SUL/RC	SAR/R	JUR/R		
Catocala elocata (Esper, 1787)	IZV/R	SUL/R	SAR/R	JUR/R		
Catocala puerpera (Giorna, 1791)		SUL/RC	SAR/R			
Subfam. Nolinae Bruand, 1846						
Nola chlamitulalis (Hübner, 1813)		SUL/R			COR/R	
Nola cristatula (Hübner, 1793)					COR/RC	
Bena bicolorana (Fuessly, 1775)	IZV/RC					
Pseudoips prasinana (Linnaeus, 1758)	IZV/R					
Earias clorana (Linnaeus, 1758)	IZV/RC	SUL/RC		JUR/RC	COR/RC	
Earias vernana (Fabricius, 1787)				JUR/RC		
Nycteola asiatica (Krulikovsky, 1904)	IZV/R		SAR/R	JUR/R		HIS/R
Subfam. Plusiinae Boisduval, 1828						
Abrostola asclepiadis ([Denis & Schiffermüller], 1775)	IZV/RC					
Abrostola triplasia (Linnaeus, 1758)			SAR/RC			HIS/R
Trichoplusia ni (Hübner, 1803)	IZV/R	SUL/RC	SAR/R	JUR/R	COR/RC	HIS/RC
Macdunnoughia confusa (Stephens, 1850)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Diachrysia chryson deltaica Rákosy, 1996			SAR/R			
Diachrysia chrysitis (Linnaeus, 1758)	IZV/RC		SAR/RC	JUR/RC	COR/RC	HIS/RC
Diachrysia stenochrysis (Warren, 1913)	IZV/R		SAR/R			HIS/R
Diachrysia nadeja (Oberthür, 1880)	IZV/R					HIS/R
Euchalcia consona (Fabricius, 1787)	IZV/R					
Chrysodeixis chalcites (Esper, 1789)			SAR/R		COR/R	HIS/R
Autographa gamma (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Cornutiplusia circumflexa (Linnaeus, 1767)						HIS/1sp.
Plusia festucae (Linnaeus, 1758)	IZV/RC	SUL/RC		JUR/RC		HIS/RC
Subfam. Eustrotiinae Grote, 1882						
Phyllophila obliterata (Rambur, 1833)	IZV/RC	SUL/RC	SAR/R			HIS/R
Pseudeustrotia candidula ([Denis & Schiffermüller], 1775)	IZV/R					

Deltote uncula (Clerck, 1759)	IZV/R	SUL/RC		JUR/R		
Deltote bankiana (Fabricius, 1775)	IZV/RC		SAR/RC			HIS/R
Subfam. Acontiinae Guenée, 1841						
Acontia lucida (Hufnagel, 1766)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Acontia (Emmelia) trabealis (Scopoli, 1763)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Acontia (Tarachidia) candefacta (Hübner, [1831])	IZV/R	SUL/R	SAR/R	JUR/R	COR/R	HIS/RC
Aedia funesta (Esper, [1766])	IZV/RC					
Aedia leucomelas (Linnaeus, 1758)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Subfam. Pantheinae Smith, 1898						
Colocasia coryli (Linnaeus, 1758)	IZV/RC			JUR/R		
Subfam. Acronictinae Heinemann, 1959						
Craniophora ligustri ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC		JUR/RC		
Craniophora pontica ([Denis & Schiffermüller], 1775)		SUL/R				
Oxicesta geographica (Fabricius, 1787)	IZV/R	SUL/R	SAR/R		COR/R	HIS/R
Moma alpium (Osbeck, 1778)	IZV/RC					
Symira nervosa ([Denis & Schiffermüller], 1775)	IZV/R	SUL/R	SAR/R	JUR/R	COR/R	
Symira albovenosa (Goeze, 1781)	IZV/R		SAR/R			HIS/R
Acronicta tridens ([Denis & Schiffermüller], 1775)		SUL/RC				
Acronicta psi (Linnaeus, 1758)		SUL/RC	SAR/R	JUR/RC		
Acronicta megacephala ([Denis & Schiffermüller], 1775)		SUL/RC	SAR/RC			
Acronicta rumicis (Linnaeus, 1758)		SUL/RC	SAR/RC		COR/R	
Acronicta aceris (Linnaeus, 1758)				JUR/R		
Subfam. Metaponinae Herrich-Schäffer, 1851						
Aegle koekeritziana (Hübner, [1799])	IZV/R		SAR/R	JUR/R		
Mycteroplus puniceago (Boisduval, 1840)		SUL/R	SAR/RC	JUR/R		HIS/RC
Tyta luctuosa ([Denis & Schiffermüller], 1775)	IZV/VC	SUL/VC	SAR/C	JUR/VC	COR/C	HIS/C
Subfam. Cucullinae Herrich-Schäffer, 1850						
Shargacucullia lychnitis (Rambur, 1833)			SAR 1sp, 13.VI.2012			
Cucullia argentina (Fabricius, 1787)			SAR/R			
Cucullia scopariae Dorfmeister, 1854			SAR/R			
Cucullia umbratica (Linnaeus, 1758)				JUR/R		

Cucullia biornata Fischer von Waldheim, 1840			SAR/R			HIS/R
Cucullia tanaceti ([Denis & Schiffermüller], 1775)	IZV/RC			JUR/C		
Cucullia santonici (Hübner, [1813])	IZV/RC			JUR/RC		
Cucullia chamomillae ([Denis & Schiffermüller], 1775)				JUR/R		
Cucullia asteris ([Denis & Schiffermüller], 1775)			SAR/R			HIS/R
Subfam. Oncocnemidinae Forbes & Franclemont, 1954						
Calophasia lunula (Hufnagel, 1766)	IZV/R			JUR/R		
Calophasia opalina (Esper, [1794])	IZV/R	SUL/R	SAR/R	JUR/RC	COR/RC	HIS/R
Omphalophana antirrhini (Hübner, [1803])	IZV/R					
Subfam. Amphipyrinae Guenée, 1837						
Amphipyra pyramidea (Linnaeus, 1758)	IZV/RC			JUR/RC		
Amphipyra livida ([Denis & Schiffermüller], 1775)	IZV/RC			JUR/RC		
Amphipyra tragopoginis (Clerck, 1759)	IZV/R		SAR/RC			HIS/RC
Subfam. Psaphidinae Grote, 1896						
Lamprosticta culta ([Denis & Schiffermüller], 1775)	IZV/RC			JUR/RC		
Allophyes oxyacanthae (Linnaeus, 1758)	IZV/C			JUR/R		
Subfam. Condicinae Poole, 1995						
Eucarta virgo (Treitschke, 1835)	IZV/RC	SUL/R	SAR/RC			
Subfam. Heliothinae Boisduval, 1828						
Periphanes delphinii (Linnaeus, 1758):	IZV/RC		SAR/RC	JUR/C	COR/RC	HIS/RC
Chazaria incarnata (Freyer, 1838)	IZV/R					
Pyrrhia umbra (Hufnagel, 1766)				JUR/R		HIS/R
Pyrrhia purpurina (Esper, [1804])	IZV/R					
Protoschinia scutosa ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Heliothis peltigera ([Denis & Schiffermüller], 1775)	IZV/RC		SAR/RC	JUR/R	COR/RC	HIS/RC
Heliothis viriplaca (Hufnagel, 1766)		SUL/RC	SAR/RC	JUR/RC		HIS/RC
Heliothis adaucta Butler, 1878		SUL/RC				HIS
Helicoverpa armigera (Hübner, 1808)	IZV/VC	SUL/VC	SAR/VC	JUR/VC	COR/VC	HIS/VC
Subfam. Bryophilinae Guenée, 1852						
Cryphia algae (Fabricius, 1775)		SUL/RC		JUR/RC	COR/RC	
Cryphia receptricula (Hübner, 1803)		SUL/R				

Cryphia raptricula ([Denis & Schiffermüller], 1775)		SUL/R				
Bryophila tephrocharis Boursin, 1953	IZV/C			JUR/C		
Nyctobria amasina (Draudt, 1931)	IZV/C			JUR/C		
Nyctobria muralis (Forster, 1771)				JUR/R		
Subfam. Xyleninae Guenée, 1837						
Spodoptera exigua (Hübner, [1808])	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Elaphria venustula (Hübner, 1790)			SAR/R	JUR/R		HIS/R
Caradrina morpheus (Hufnagel, 1766)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Caradrina kadenii Freyer, 1836	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Caradrina aspersa (Rambur, 1834)		SUL/R		JUR/R		
Caradrina clavipalpis (Scopoli, 1763)			SAR/C		COR/RC	HIS/C
Hoplodrina octogenaria (Goeze, 1781)	IZV/C		SAR/C		COR/C	HIS/C
Hoplodrina blanda ([Denis & Schiffermüller], 1775)		SUL/RC		JUR/RC	COR/RC	
Hoplodrina respersa ([Denis & Schiffermüller], 1775)		SUL/RC		JUR/RC		
Hoplodrina ambigua ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC	SAR/RC		COR/RC	
Chilodes maritima (Tauscher, 1806)		SUL/RC	SAR/RC			HIS/RC
Charanyca trigrammica (Hufnagel, 1766)	IZV/C		SAR/RC	JUR/RC	COR	HIS
Enargia abluta (Hubner,[1808])			SAR 1sp./15.VIII.2010			
Rusina ferruginea (Esper, [1785])	IZV/R		SAR/R			
Athetis gluteosa (Treitsche, 1835)	IZV/RC		SAR/RC			HIS/RC
Athetis furvula (Hubner,[1808])					COR/R	
Proxenus lepigone (Moschler, 1860)		SUL/R				HIS/R
Trachea atriplicis (Linnaeus, 1758)	IZV/R		SAR/R	JUR/RC		
Dypterygia scabriuscula (Linnaeus, 1758)	IZV/RC		SAR/RC	JUR/RC		
Polyphaenis sericata Esper, 1787	IZV/RC					
Thalpophila matura (Hufnagel, 1766)	IZV/RC	SUL/RC		JUR/RC		
Actinotia polyodon (Clerck, 1759)				JUR/R		
Phlogophora meticulosa (Linnaeus, 1758)	IZV/RC		SAR/RC	JUR/RC		HIS/RC
Euplexia lucipara (Linnaeus, 1758)	IZV/RC	SUL/R	SAR/R	JUR/R		
Calamia tridens (Hufnagel, 1766)	IZV/C			JUR/C		
Eremobia ochroleuca ([Denis & Schiffermüller], 1775)		SUL/R				
Gortyna flavago ([Denis & Schiffermüller], 1775)	IZV/R					
Gortyna cervago Eversmann, 1844	IZV/R		SAR/R	JUR/RC		HIS/R

Hydraecia micacea (Esper, [1789])						HIS/R
Luperina testacea ([Denis & Schiffermüller], 1775)	IZV/C		SAR/C	JUR/RC		HIS/C
Luperina rubella (Duponchel, 1826)				JUR/R		HIS/R
Luperina dumerilli (Duponchel, 1826)				JUR/R		HIS/R
Fabula zolikofferi (Freyer, 1836)				JUR 1sp./28.IX.2018		
Rhizedra lutosa (Hübner, [1803])	IZV/C	SUL/C	SAR/C	JUR/C		HIS/C
Nonagria typhae (Thunberg, 1784)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Lenisa geminipuncta (Haworth, 1809)			SAR/RC			HIS/RC
Archanara dissoluta (Treitschke, 1825)	IZV/RC	SUL/RC	SAR/RC			HIS/RC
Archanara sparganii (Esper, 1790)		SUL/R				
Archanara algae (Esper, 1789)						HIS/RC
Oria musculosa (Hübner, [1808])			SAR/R	JUR/R		HIS/R
Chortodes fluxa (Hübner, [1809])				JUR/RC		HIS/RC
Chortodes pygmina (Haworth, 1809)						HIS/R
Globia sparganii (Esper, 1790)	IZV/RC		SAR/RC			HIS/RC
Globia algae (Esper, 1789)	IZV/RC	SUL/RC				
Sedina buttneri (E. Hering, 1858)		SUL/RC	SAR/R			HIS/RC
Apamea monoglypha (Hufnagel, 1766)	IZV/RC			JUR/R		
Apamea anceps ([Denis & Schiffermüller], 1775)	IZV/RC		SAR/R	JUR/RC		
Apamea sordens (Hufnagel, 1766)			SAR/R			
Mesapamea secalis (Linnaeus, 1758)			SAR/RC		COR/RC	
Oligia strigilis (Linnaeus, 1758)	IZV/RC			JUR/RC		HIS/RC
Episema glaucina (Esper, [1789])	IZV/R					HIS/R
Episema lederi Christoph, 1885						HIS/R
Episema tersa ([Denis & Schiffermüller], 1775)	IZV/C		SAR/RC	JUR/C	COR/C	HIS/C
Cleoceris scoriacea (Esper, [1789])						HIS/C
Cosmia trapezina (Linnaeus, 1758)	IZV/VC			JUR/C		
Atethmia centrago (Haworth, 1809)	IZV/C					
Tiliacea sulphurago ([Denis & Schiffermüller], 1775)	IZV/C					
Lithophane ornitopus (Hufnagel, 1766)	IZV/C					
Eupsilia transversa (Hufnagel, 1766)	IZV/C			JUR/C		
Ammoconia caecimacula ([Denis & Schiffermüller], 1775)	IZV/C			JUR/C		
Conistra vaccinii (Linnaeus, 1761)	IZV/C					HIS/C

Conistra ligula (Esper, [791])	IZV/C			JUR/C		HIS/C
Conistra erythrocephala ([Denis & Schiffermüller], 1775)	IZV/R			JUR/R		HIS/R
Sunira circellaris (Hufnagel, 1766)	IZV/C					HIS/RC
Anchoscelis humilis ([Denis & Schiffermüller], 1775)				JUR/C		HIS/C
Agrocola lychnidis ([Denis & Schiffermüller], 1775)				JUR/C		
Leptologia lota (Clerck, 1759)				JUR/C		
Aporophyla lutulenta ([Denis & Schiffermüller], 1775)	IZV/C		SAR/C			
Polymixis rufocincta (Geyer, [1827 –1828])				JUR/C		
Polymixis trisignata (Ménetries, 1847)				JUR/R		
Subfam. Hadeninae Guenée, 1837						
Mythimna turca (Linnaeus, 1761)	IZV/C	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Mythimna pudorina ([Denis & Schiffermüller], 1775)			SAR/RC		COR/RC	HIS/RC
Mythimna pallens (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Mythimna straminea (Treitschke, 1825)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Mythimna vitellina (Hübner, [1808])	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Mythimna albipuncta ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Mythimna ferrago (Fabricius, 1787)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Mythimna l-album (Linnaeus, 1767)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Mythimna impura (Hübner, [1808])					COR/RC	
Leucania comma (Linnaeus, 1761)			SAR/RC		COR/RC	HIS/RC
Leucania obsoleta (Hübner, [1803])		SUL/RC	SAR/RC		COR/RC	HIS/RC
Leucania zeae (Duponchel, 1827)						HIS/ 3sp. 26-30.VIII.2009 (det.L.Ronkay)
Leucania punctosa (Treitschke, 1825)			SAR/C			
Pseudaletia unipuncta (Haworth, 1809)			SAR/RC		COR/RC	HIS/RC
Senta flammea (Curtis, 1828)		SUL/R	SAR/R			HIS/R
Hadula trifolii (Hufnagel, 1766)	IZV/VC	SUL/C	SAR/VC	JUR/VC	COR/C	HIS/C
Hadula stigmosa (Christoph, 1887)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Sideridis lampra (Schawerda, 1913)	IZV/R			JUR/R		
Sideridis turbida (Esper, 1790)	IZV/R					
Heliophobus reticulata (Goeze, 1781)	IZV/R			JUR/R		
Conisania luteago ([Denis & Schiffermüller], 1775)	IZV/RC		SAR/RC	JUR/RC		HIS/RC

Saragossa implexa (Hübner, [1809])				JUR/R		
Saragossa porosa (Eversmann, 1854)			SAR/RC			
Saragossa siccanorum (Staudinger, 1870)			SAR/RC			
Ulochlaena hirta (Hübner, [1813])	IZV/C		SAR/RC	JUR/VC		HIS/RC
Mamestra brassicae (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Melanchra persicariae (Linnaeus, 1761)	IZV/RC			JUR/RC		
Ceramica pisi (Linnaeus, 1758)						
Lacanobia w-latinum (Hufnagel, 1766)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Lacanobia thalassina (Hufnagel, 1766)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Lacanobia suasa ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC		JUR/RC		
Lacanobia oleracea (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Lacanobia splendens(Hübner, [1808])	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Lacanobia praedita (Hübner, [1813])			SAR/R	JUR/R		HIS/R
Lacanobia blenna (Hübner, [1824])	IZV/RC	SUL/RC	SAR/RC	JUR/RC		HIS/RC
Hecatera bicolorata (Hufnagel, 1766)	IZV/RC			JUR/RC		
Hecatera dysodea ([Denis & Schiffermüller], 1775)	IZV/RC			JUR/RC		
Hecatera cappa (Hübner, 1809)	IZV/RC		SAR/RC	JUR/RC		HIS/RC
Tholera decimalis (Poda, 1761)	IZV/C			JUR/C	COR/C	HIS/C
Cardepia hartigi (Parenzan, 1981)			SAR/RC			HIS/RC
Subfam. Noctuinae Latreille, 1809						
Peridroma saucia (Hübner, 1808)						HIS/R
Dichagyris flammatra ([Denis & Schiffermüller], 1775)			SAR/R			HIS/R
Dichagyris nigrescens (Höfner, 1887)			SAR/R			HIS/R
Dichagyris melanura (Kollar, 1846)				JUR/45.sp 15.VI.2019		
Euxoa obelisca ([Denis & Schiffermüller], 1775)			SAR/R			HIS/R
Euxoa aquilina ([Denis & Schiffermüller], 1775			SAR/R			HIS/R
Euxoa temera (Hübner, [1808])	IZV/RC		SAR/RC		COR/RC	HIS/RC
Euxoa nigricans (Linnaeus, 1758)						HIS/R
Euxoa segnilis (Duponchel, 1836)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Euxoa tritici (Linnaeus, 1761)						HIS
Agrotis bigramma (Esper, 1790)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Agrotis clavis (Hufnagel, 1766)						HIS
Agrotis exclamationis (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC

Agotis desertorum (Boisduval, 1840)					COR	
Agrotis segetum ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Agrotis ipsilon (Hufnagel, 1766)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Agrotis puta (Hübner, [1803])	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Agrotis vestigialis (Hufnagel, 1766)		SUL/C			COR/C	HIS/C
Axylia putris (Linnaeus, 1761)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Ochropleura plecta (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Chersotis fimbriola niculescui Rákosy, 1997				JUR		
Noctua pronuba (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Noctua fimbriata (Schreber, 1759)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Noctua orbona (Hufnagel, 1766)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Noctua interposita (Hübner, 1790)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Noctua comes (Hübner, 1813)	IZV/C		SAR/RC	JUR/RC		HIS/RC
Noctua interjecta (Hübner, 1803)	IZV/RC			JUR/R		
Noctua janthina ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC		JUR/RC		HIS/RC
Epilecta linogrisea ([Denis & Schiffermüller], 1775)	IZV/RC			JUR/RC		
Opigena polygona ([Denis & Schiffermüller], 1775)	IZV/RC			JUR/RC		
Xestia xanthographa ([Denis & Schiffermüller], 1775)	IZV/RC			JUR/RC		HIS/RC
Xestia cohaesa (Herrich-Schaffer, [1849])						HIS/RC
Xestia c-nigrum (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Metagnorisma depuncta (Linnaeus, 1761)	IZV/RC					
Suprafam. HESPERIOIDEA Latreille, 1809						
Fam. HESPERIIDAE Latreille, 1809						
Subfam. Pyrginae Burmeister, 1878						
Erynnis tages (Linnaeus, 1758)	IZV/R					HIS
Carcharodus alceae (Esper,[1780])	IZV/R					HIS/R
Carcharodus floccifera (Zeller, 1847)						HIS/R
Carcharodus orientalis Reverdin, 1913						HIS/R
Pyrgus armoricanus (Oberthür, 1910)	IZV/RC					
Pyrgus sidae (Esper,[1784])				JUR/C		
Subfam. Hesperiinae Latreille, 1809						
Suprafam. PAPILIONOIDEA Latreille, [1802]						
Fam. PAPILIONIDAE Latreille, [1802]						

Subfam. Parnassinae Duponchel, [1835]						
Parnassius mnemosyne wagneri Bryk, 1925	IZV/R					
Subfam. Papilioninae Latreille, [1802]						
Iphiclides podalirius (Linnaeus, 1758)	IZV/RC	SUL/C		JUR/RC		
Papilio machaon (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Fam. PIERIDAE Duponchel, [1835]						
Subfam. Coliadinae Swainson, 1827						
Colias erate (Esper, 1805)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Colias croceus (Fourcroy, 1785)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Colias hyale (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Colias alfacariensis Ribbe, 1905	IZV/RC			JUR/RC	COR/RC	
Subfam. Dismorphiinae Schatz, [1886]						
Leptidea sinapis (Linnaeus, 1758)	IZV/R					
Subfam. Pierinae Duponchel, [1835]						
Pieris brassicae (Linnaeus, 1758)	IZV/RC	SUL/RC		JUR/RC		HIS/RC
Pieris napi (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Pieris rapae (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Pontia daplidiceedusa (Fabricius, 1777)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Euchloe ausonia (Hübner, [1804])				JUR/RC		
Fam. LYCAENIDAE [Leach] [1815]						
Subfam. Lycaeninae [Leach] [1815]						
Lycaena phlaeas (Linnaeus, 1761)	IZV/RC					
Lycaena dispar rutila (Werneburg, 1864)	IZV/RC	SUL/C	SAR/RC	JUR/C	COR/R	
Lycaena thersamon (Esper, 1784)			SAR/C			
Subfam. Theclinae Swainson, 1831						
Satyrium w-album (Knoch, 1782)	IZV/R					
Subfam. Polyommatinae Swainson, 1827						
Lampides boeticus (Linnaeus, 1758):				JUR/R		
Leptotes pirithous (Linnaeus, 1758)	IZV/R	SUL/RC		JUR/R	COR/RC	HIS/RC
Celastrina argiolus (Linnaeus, 1758)	IZV/RC					
Cupido (Everes) argiades (Pallas, 1771)	IZV/RC			JUR/RC		
Cupido (Everes) alcetas (Hofmannsegg, 1804)			SAR/R			
Pseudophilotes schiffermülleri Hemming, 1792	IZV/R					
Plebejus argus (Linnaeus, 1761)	IZV/RC		SAR/R	JUR/R		HIS/R
Aricia agestis ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Polyommatus icarus (Rottemburg, 1775)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC

Polyommatus (Lysandra) bellargus (Rottemburg, 1775)	IZV/RC			JUR/RC		
Lysandra coridon (Poda, 1761)		SUL/RC				
Fam. NYMPHALIDAE Swainson, 1827						
Subfam. Heliconiinae Swainson, 1827						
Argynnis pandora ([Denis & Schiffermüller], 1775)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Issoria lathonia (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Subfam. Apaturinae Boisduval, 1840						
Apatura metis Freyer, 1829		SUL/RC				
Subfam. Nymphalinae Swainson, 1827						
Melitaea phoebe ([Denis & Schiffermüller], 1775)	IZV/R			JUR/R		
Melitaea trivia ([Denis & Schiffermüller], 1775)	IZV/RC					
Nymphalis (Inachis) io (Linnaeus, 1758)	IZV/RC	SUL/RC				HIS/RC
Nymphalis (Polygonia) c-album (Linnaeus, 1758)	IZV/RC					
Vanessa atalanta atalanta (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Vanessa cardui cardui (Linnaeus, 1758)	IZV/C	SUL/C	SAR/C	JUR/C	COR/C	HIS/C
Subfam. Satyrinae Boisduval, [1833]						
Lasiommata megera (Linnaeus, 1758)	IZV/R			JUR.R		
Lasiommata maera (Linnaeus, 1758)	IZV/R			JUR/R		
Coenonympha pamphilus (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC		HIS/RC
Maniola jurtina (Linnaeus, 1758)	IZV/RC	SUL/RC	SAR/RC	JUR/RC	COR/RC	HIS/RC
Hipparchia syriaca (Staudinger, 1871)				JUR/R		

REFFERENCES

Bobârnac, Stănoiu `975 — Bobârnac Bogdan, Stânoiu Ioan, *Contribuţii la studiul lepidopterelor din zona litoralului Românesc şi DeltaDunării,* In: *Studii şi Comunicări, Muzeul de Ştiinţele Naturii Bacău* (1975) 1, p. 147-152.

Gyulai *et al*. 2010 — Gyulai Péter, László Manfréd Gyula, Pekarsky Oleg, Peregovits László, Ronkay Gábor, Ronkay László, Szabóky Csaba, Varga Zoltán, Witt J. Thomas, *Magyarország nagylepkéi – Macrolepidoptera of Hungary*. In: *Heterocera Press, Budapest* (2011), 253 pp.

Kovács, Kovács 1998 — Kovács Sándor, Kovács Zoltán, *Idaea sericeata (Hübner, [1813]) (Lepidoptera, Geometridae) în fauna României.* In: *Studii şi cercetări (Ştiinţele naturii). Muzeul Bistriţa-Năsăud* (1998) 4, p.269-271.

Nemeș, Voicu — Nemeș Ioan, Voicu C. Marin, *Catalogul colecţiei de lepidoptere"Alexei Alexinschi"de la Muzeul Judeţean Suceava, Partea a 3-a, Superfam: Noctuoidea, Bombycoidea și*

1973 *Sphingoidea*. In: *Studii și Comunicări, Muzeul Județean Suceava* (1973) 4, p.1-102.

Popescu-Gorj, Drâghia 1967 Popescu-Gorj Aurelian, Drâghia Ion, *Ord. Lepidoptera. In: L'Entomofaune des forêts du sud Dobroudja.*In: *Travaux du Museum d'Histoire naturelle„Grigore Antipa" Bucarest* (1967) 7, p. 181-212

Popescu-Gorj, Brâtășeanu 1979 Popescu-Gorj Aurelian, Brătășeanu Mircea, *Données sur la presence en Roumanie de quelques espéces rares de Lépidoptéres.* In: *Travaux du Museum d'Histoire naturelle „Grigore Antipa" Bucarest* (1979) 20, p. 265-279.

Popescu-Gorj, König 1976 Popescu-Gorj Aurelian, König Frederic, *Ord. Lepidoptera. In: Contributions la connaissance de la faune du departement Vrancea.*In: *Travaux du Museum d'Histoire naturelle „Grigore Antipa" Bucarest* (1976) 17, p. 303-330.

Popescu-Gorj *et al*. 1972 Popescu-Gorj Aurelian, Olaru Vladimir, Drâghia Ion, *Ord. Lepidoptera. In: L'Entomofaune du "grind de Caraorman (Delta du Danube).*In: *Travaux du Museum d'Histoire naturelle „Grigore Antipa" Bucarest*(1976)12, p. 181-206.

Rákosy 1996 Rákosy László, *Die Noctuiden Rumäniens*. In: *Stapfhia, Linz.* 648 pp.

Rákosy, Wieser 2000 RákosyLászló, Wieser Christain, *Das Măcin Gebirge (Rumänien, Nord-Dobrudscha). Ein durch hohe Biodiversität gekennzeichnetes Refugium reliktärer Arten. Fauna und Flora, unter besonderer Berücksichtigung der Schmetterlinge und der Vegetationsverhältnisse.* In: *Carinthia II, Jahrgang, 190/110, Klagenfurt* (2000), p.1-115.

Rákosy 2003 Rákosy László, Goia Marin, Kovács Zoltán, *Catalogul Lepidopterelor României - Verzeichnis der Schmetterlinge Rumäniens.*In: *Societatea Lepidopterologică Română, Cluj-Napoca*(2003), 446 pp

Salay 1910 Salay Franz, *Katalog der Makrolepidopteren Rumäniens.*In: *Bulletin Societes des Sciences, Bucarest,* (1910) 19, p.76-206, 453-516

Székely, Cernea 2007 Székely Levente, Cernea Elena, *Catalogul colecţiei de lepidoptere „Mircea Brătăşeanu" – The Catalogue of „Mircea Brătăşeanu" Lepidoptera collection*, In: Ed. C2 Design Braşov (2007), 208 pp.

Zilli *et al.* 2005 Zilli Alberto, Ronkay László, Fibiger Michael, *Apameini, Noctuidae Europaea, Vol.8.* In: *Entomological Press Soro* (2005), 321 pp.

LIST OF ILLUSTRATIONS

Fig. 1 *Polymixis trisignata,* Tulcea, Jurilovca, Cape Doloșman, 25.X.2019 (Photo: P. Gyulai)

Fig. 2. *Polymixis trisignata,*Tulcea, Jurilovca, Cape Doloșman, 25.X.2019, slide GYP 5123 (Photo: P. Gyulai)

Fig. 3 *Fabula zollikoferi,* Tulcea, Jurilovca, Cape Doloșman, 28.IX.2018 (Photo: R. Görbe)

Fig. 4 *Furcula bicuspis,*Vrancei Mountains, Tişiţei Gorges, 16.VIII.2019 (Photo: L. Székely)

Fig. 5 *Calocucullia celsiae,*Vrancei Mountains, Tişiţei Gorges, Ciuta, 25.IV.2019 (Photo: L. Székely)

Fig. 6 *Polymixis rufocincta,*Vrancei Mountains, Tişiţei Gorges, Ciuta, 23.X.2017 (Photo: L. Székely)

Fig. 7 *Trichiura crataegi,* Constanța, Ostrov, Esechioi Forest, 25.IX.2019 (Photo: L. Székely)

Fig. 8 *Dichagyris melanura,* Tulcea, Jurilovca, Cape Doloșman, 15.VI.2019 (Photo: L. Székely)

Fig. 9 *Cervina cervago,* Tulcea, Enisala, 27.IX.2019 (Photo: L. Székely)

Fig. 10 *Saragossa siccanorum,* Tulcea, Sarinasuf, 8.VIII.2019 (Photo: L. Székely)

Fig. 11 *Saragossa porosa,* Tulcea, Sarinasuf, 8.VIII.2019 (Photo: L. Székely)

Fig. 12 *Idaea sericeata,* Tulcea, Jurilovca, Cape Doloșman, 20.V.2018 (Photo: L. Székely)

Fig. 13 *Rhodometra sacraria,* Constanța, Ostrov, Esechioi Forest, 25.IX.2019 (Photo: L. Székely)

Fig. 14 *Aspitates mundataria,* Constanța, Histria, 22.VI.2009 (Photo: L. Székely)

Fig. 15 *Ulochlaena hirta,* Tulcea, Jurilovca, Cape Doloșman, 25.X.2019 (Photo: L. Székely)

Fig. 16 *Polymixis rufocincta,* Tulcea, Jurilovca, Cape Doloșman, 25.X.2019 (Photo: L. Székely)

Fig. 17 *Aspitates mundataria,* Constanța, Histria, 22.VI.2009 (Photo: L. Székely)

Fig. 18 Tulcea, Izvoarele, 29.IX.2017 (Photo: L. Székely)

Fig. 19 Tulcea, Jurilovca, Cape Doloșman, 15.VI.2019 (Photo: L. Székely)

Fig. 20 Constanța, Corbu Beach, 18.VIII.2017 (Photo: L. Székely)

Fig. 21 Constanța, Histria, 25.X.2009 (Photo: L. Székely)

Fig. 22 Tulcea, Danube Delta, Sulina, 23.VIII.2019 (Photo: L. Székely)

Fig. 23 Tulcea, Sarinasuf, 8.VIII.2019 (Photo: L. Székely)

LISTA ILUSTRAȚIILOR

Fig. 1 *Polymixis trisignata,* Tulcea, Jurilovca, Capul Doloșman, 25.X.2019 (Foto: P. Gyulai)

Fig. 2 *Polymixis trisignata,*Tulcea, Jurilovca, Capul Doloșman, 25.X.2019, slide GYP 5123 (Foto: P. Gyulai)

Fig. 3 *Fabula zollikoferi,* Tulcea, Jurilovca, Capul Doloșman, 28.IX.2018 (Foto: R. Görbe)

Fig. 4 *Furcula bicuspis,*Munții Vrancei, Cheile Tişiţei, 16.VIII.2019 (Foto: L. Székely)

Fig. 5 *Calocucullia celsiae,* Munții Vrancei, Cheile Tişiţei, Ciuta, 25.IV.2019 (Foto: L. Székely)

Fig. 6 *Polymixis rufocincta,* Munții Vrancei, Cheile Tişiţei, Ciuta, 23.X.2017 (Foto: L. Székely)

Fig. 7 *Trichiura crataegi,* Constanța, Ostrov, Pădurea Esechioi, 25.IX.2019 (Foto: L. Székely)

Fig. 8 *Dichagyris melanura,* Tulcea, Jurilovca, Capul Doloșman, 15.VI.2019 (Foto: L. Székely)

Fig. 9 *Cervina cervago,* Tulcea, Enisala, 27.IX.2019 (Foto: L. Székely)

Fig. 10 *Saragossa siccanorum,* Tulcea, Sarinasuf, 8.VIII.2019 (Foto: L. Székely)

Fig. 11 *Saragossa porosa,* Tulcea, Sarinasuf, 8.VIII.2019 (Foto: L. Székely)

Fig. 12 *Idaea sericeata,* Tulcea, Jurilovca, Capul Doloșman, 20.V.2018 (Foto: L. Székely)

Fig. 13 *Rhodometra sacraria,* Constanța, Ostrov, Pădurea Esechioi, 25.IX.2019 (Foto: L. Székely)

Fig. 14 *Aspitates mundataria,* Constanța, Histria, 22.VI.2009 (Foto: L. Székely)

Fig. 15 *Ulochlaena hirta,* Tulcea, Jurilovca, Capul Doloșman, 25.X.2019 (Foto: L. Székely)

Fig. 16 *Polymixis rufocincta,* Tulcea, Jurilovca, Capul Doloșman, 25.X.2019 (Foto: L. Székely)

Fig. 17 *Aspitates mundataria,* Constanța, Histria, 22.VI.2009 (Foto: L. Székely)

Fig. 18 Tulcea, Izvoarele, 29.IX.2017 (Foto: L. Székely)

Fig. 19 Tulcea, Jurilovca, Capul Doloșman, 15.VI.2019 (Foto: L. Székely)

Fig. 20 Constanța, Plaja Corbu, 18.VIII.2017 (Foto: L. Székely)

Fig. 21 Constanța, Histria, 25.X.2009 (Foto: L. Székely)

Fig. 22 Tulcea, Delta Dunării, Sulina, 23.VIII.2019 (Foto: L. Székely)

Fig. 23 Tulcea, Sarinasuf, 8.VIII.2019 (Foto: L. Székely)

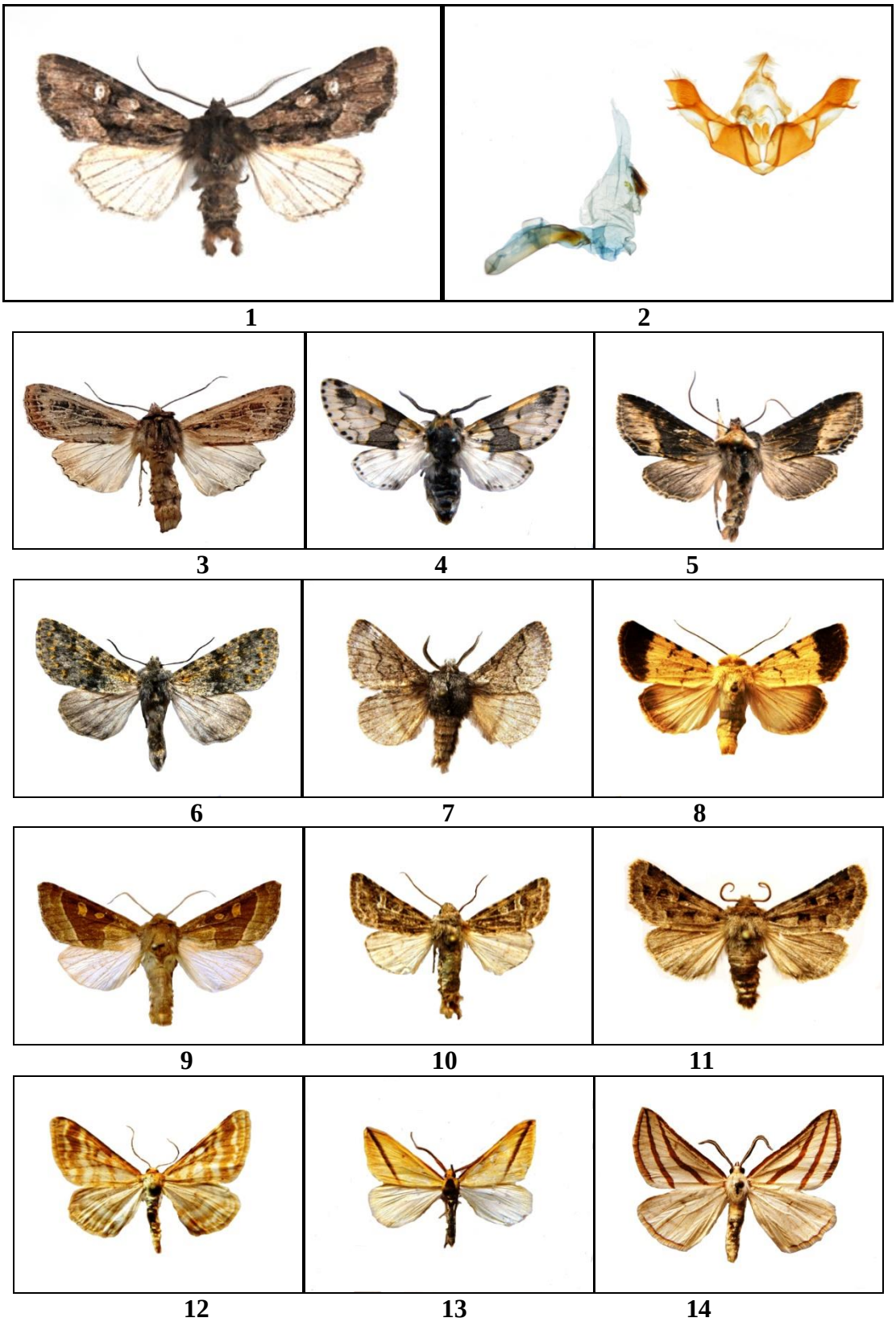


Fig. 1 – 14 Different Lepidoptera species


15


16


17


18


19


20


21


22


23

Fig. 15 – 17 Different Lepidoptera species; **Fig. 18 – 23** Different habitats

THE GENUS *Carabus* LINNAEUS, 1758 NATURA 2000 (COLEOPTERA: CARABIDAE) FROM THE NATURAL HISTORY MUSEUM OF SIBIU ENTOMOLOGICAL COLLECTIONS)

Iulia MUNTEAN*
Florin PRUNAR**
Ioan TĂUȘAN***

Abstract. *The familiy Carabidae Latreille, 1802 includes more than 40.000 species in the world and 2.700 species in Europe. The genus Carabus Linnaeus, 1758 (Carabidae: Carabinae) is represented in the Holarctic by about 800 species, in Europe by about 132 species, in Romania by about 32 species. Only four species benefit from the protection status within the Natura 2000 network, however, the protection of the species of community importance Carabus hampei Kuster 1846 is unclear, given the differences in systematic classification and sometimes the difficulties of differentiating from taxa: comptus Dejean 1831, incompsus Kraatz 1880 or rothi Dejean 1829. The genus Carabus has important role in agricultural ecosystems, it feeds on harmful insects. In Romania, 32 species of this genus are reported, including 4 species from Natura 2000 Network. The present paper contains the list of species Natura 2000 of genus Carabus from the Entomological Collections from the Natural History Museum of Sibiu: Transylvanian Society for Natural Sciences collection, Dr. Eugen Worell Entomological collection, Prof. Rolf Weyrauch Entomological collection, Dr. Karl Petri collection of Palaearctic and exotic beetles, Dr. Eckbert Schneider Entomological collection and Heinrich Hann v. Hannenheim Entomological collection. The data from the museum's collections are particularly valuable through the indications regarding the stations of origin, the data from the calendar collection, but also through the systematic framing in the case of systematically debatable taxa.*
Keywords*: Carabus, list, Natura 2000 species, Entomological Collections, Natural History Museum of Sibiu.*

Rezumat. *Familia Carabidae Latreille, 1802 cuprinde peste 40.000 specii în lume și 2.700 specii în Europa. Genul Carabus Linnaeus, 1758 (Carabidae: Carabinae) este reprezentat în Holarctic prin aproximativ 800 specii, 132 dintre ele fiind prezente în Europa respectiv 32 în România. De statut protector în cadrul rețelei Natura 2000 beneficiază doar patru specii, însă protecția speciei de importanță comunitară C. hampei Kuster 1846 nu este clară, date fiind divergențele de încadrare sistematică și uneori a dificultăților de diferențiere în raport cu taxonii: comptus Dejean 1831, incompsus Kraatz 1880 sau rothi Dejean 1829. Genul Carabus are un rol important în ecosistemele agricole, consumă insecte dăunătoare. În România, 32 de specii ale acestui gen sunt semnalate, 4 dintre aceste specii sunt incluse în Rețeaua Natura 2000. Lucrarea prezentă conține lista cu specii Natura 2000 ale genului Carabus existente în Colecțiile Entomologice ale Muzeului de Istorie Naturală din Sibiu: Colecția Societății de Științe Naturale, Colecția Entomologică Dr. Eugen Worell, Colecția Prof. Rolf Weyrauch, Colecția de Coleoptere palearctice și exotice Dr. Karl Petri, Colecția Dr. Eckbert Schneider, Colecția Heinrich Hann v. Hannenheim. Datele din colecțiile muzeale sunt deosebit de valoroase prin indicațiile referitoare la stațiunile de proveniență, datele calendaristice de colectare, dar și prin încadrările sistematice în cazul taxonilor discutabili din punct de vedere sistematic.*
Cuvinte cheie: *Carabus, listă, specii Natura 2000, Colecții Entomologice, Muzeul de Istorie Naturală din Sibiu*

Introduction

The family of Ground Beetles (Coleoptera: Carabidae) contains more than 40.000 species (Erwin 1985). It is one of the most common groups of arthropods found in and on the soil. Ground Beetles are important for agriculture as they can feed on harmful species (Thiele 1977) and are frequently used in biodiversity studies as indicators for environmental changes (Thiele 1977).

*Brukenthal National Museum, Natural History Museum, Sibiu, Romania, iuliamaria.muntean@yahoo.com;
** Banat's University of Agricultural Sciences and Veterinary Medicine, Timișoara, Romania, fprunar@yahoo.com;
*** Lucian Blaga University of Sibiu, Faculty of Sciences, Applied Ecology Research Center, Sibiu, Romania, ioan.tausan@ulbsibiu.ro.

Council Directive 92/43/EEC for wildlife protection in the European Union was legitimated in 1972 (Brînzan 2013). For this reason, was established the Natura 2000 Network for promoting conservation of habitats, wild fauna and flora species. Its main purposes are: protecting biodiversity and preservation of wild life. This initiative is based on the Birds Directive of 1979 and the Habitats Directive of 1992. In Romania, 4 species of the genus Carabus are mentioned in Annex II of the Habitats Directive from OUG 57/2007.

Same species of ground beetles are endemic, rare or endangered, requiring special attention or appropriate conservation measures. In Romania, species of the genus *Carabus* Linnaeus, 1758 included in Natura 2000 Network are *Carabus hampei* Küster, 1846 (code 4012), *Carabus hungaricus* Fabricius, 1792 (code 4013), *Carabus variolosus* Fabricius, 1787 (code 4014) and *Carabus zawadzkii* Kraatz, 1854 (code 4015) (Ghid sintetic pentru monitorizarea speciilor de nevertebrate de interes comunitar din România).

Ecology

Carabus hampei Küster, 1846 is widespread in the west of the Carpathic arc (Barloy, Prunar 2012). Showing genetic variability and hight morphological diversity in size, color and elitral sculpture, the species is divided into numerous subspecies. Preferred habitats of this species are deciduous forests, forest edge, next to the meadows (Gîdei, Popescu 2012).

Carabus hungaricus Fabricius, 1792 completely black with an oval, wide and stocky body shape. In Romania, the species is widespread in Banat and Oltenia, being an extremely located species (Prunar et al. 2006, Barloy, Prunar 2012). The species was recently reported in northwestern Romania (Ciocort-Lucaciu 2020, Prunar 2020 communication on facebook) in ROSCI2020 Câmpia Careiului. This beetle prefers sandy areas, xerophilous vegetation, underwood with *Prunus spinosa* L. and *Crataegus monogyna* Jacq. (Iorgu et al. 2015).

Carabus variolosus Fabricius, 1787 is frequent, especially in mountainous and hilly zones (Barloy, Prunar 2012). *C. variolosus* has black body, with deep foveae on elytra (Trautner, Geigenmüller 1987). This species inhabits in wet areas, on the banks of streams, in forest up to 1300 m (Barloy, Prunar 2012).

Carabus zawadzkii Kraatz, 1854 is encountered in Romania, in Maramureș and Bistrița-Năsăud county. The species color is totaly black, the elytra having sometimes bright greenish blue reflection. The edges of the elytra and pronotum are blue or a blackish blue (Barloy, Prunar 2011; Barloy *et al.* 2004). *C. zawadzkii* inhabits in forest, forest edge, areas with permanent streams (Iorgu et al. 2015).

Material

The list of the verified material from the Entomological Collections is given bellow.

Familiy Carabidae Latreille, 1802

Subfamily Carabinae Latreille, 1802

Tribe Carabini Latreille, 1802

Subtribe Carabina Latreille, 1802

Genus *Carabus* Linnaeus, 1758

Transylvanian Society for Natural Sciences collection

Subgenus *Morphocarabus* Géhin, 1885

***Carabus (Morphocarabus) hampei hampei* Küster, 1846**: 2 specs as *Morphocarabus hampei* (Inventory no 1481 – 1206, 1482 – 1207), Transilvania, 02.08.1889, leg. Kimakowicz 1895; 3 specs as *Morphocarabus hampei* (Inventory no 1483 -1208, 1484 – 1209, 1487 – 1210), P. Almas (village in Arad County), 1886, leg. Birthler 1895; 1 spec as *Morphocarabus hampei* (Inventory no 1485 – 1211), S. Regen 1883 (the old German name of Reghin, city in Mureș County also named Szászrégen in Hungarian), leg. Birthler 1895; 1 spec as *Morphocarabus hampei* (Inventory no 1486 – 1212), Kentelky 1886.

***Carabus (Morphocarabus) hampei hampei* Küster, 1846 *v. aurosericeus* Kraatz, 1880**: 7 specs as *Morphocarabus hampei* v. *aurosericeus* (Inventory no 1489 – 1213, 1490 – 1214, 1491 – 1215, 1492 – 1216, 1493 – 1217, 1494 – 1218, 1495 – 1219), Sz. Regen, 1886, leg. Birthler 1895; 2 specs as *Morphocarabus hampei* v. *aurosericeus* (Inventory no 1496 – 1220, 1497 – 1221), Nyarad szereda (hungarian name of Miercurea Nirajului, town in Mureș County), 1884, leg. Birthler 1895; 1 spec as *Morphocarabus hampei* v. *aurosericeus* (Inventory no 1498 – 1222), Târgu Mureș, leg. Birthler 1895.

***Carabus (Morphocarabus) hampei hampei* Küster, 1846 *v. hunyadensis* Csiki, 1926** (sin.

validus Csiki, 1906, nec. Kraatz, 1884): 1 spec as *Morphocarabus hampei* v. *validus* (Inventory no 1502 – 1224), Nagyag (Săcărâmb), Mallasz.

***Carabus (Morphocarabus) hampei hampei* Küster, 1846 *v. dacicus* Csiki, 1906**: 1 spec as *Morphocarabus hampei* v. *dacicus* (Inventory no 1503 – 1225), Ds, 1883, leg. Kimakowicz; 1 spec as *Morphocarabus hampei* v. *dacicus* (Inventory no 1504 – 1226), s. v. f. n. Dees (the locality Dej named in hungarian Dés, Deés).

***Carabus (Morphocarabus) hampei hampei* Küster, 1846 *v. diffinis* Csiki 1905**: 1 spec as *Morphocarabus hampei* v. *diffinis* (Inventory no 1505 – 1227), Hideg Szamos, leg. Kimakowicz (Someșul Rece is named in hungarian Hideg-Szamos)

***Carabus (Morphocarabus) hampei incompsus* Kraatz, 1880** *v. **spectabilis* Csiki 1906**: 2 specs as *Morphocarabus hampei* v. *spectabilis* (Inventory no 1506 – 1228, 1507 – 1229), Rodnaer – Gb., alpin, leg. Deubel; 1 spec as *Morphocarabus hampei* v. *spectabilis* (Inventory no 1508 – 1230), Kovonjis, Rodnaer G., 1900, leg. Petri (Corongis peak in Rodna Mt.); 2 specs as *Morphocarabus hampei* v. *spectabilis* (Inventory no 1509 – 1231, 1511 – 1232), Rodnaer Geb, Kuhhorn Kovonjis, 17-18.07.1980, leg. A. Muller.

***Carabus (Morphocarabus) hampei incompsus Kraatz, 1880* v. *mehelyanus* Csiki, 1906:** 2 specs as *Morphocarabus hampei* v. *mehelyanus* (Inventory no 1513 – 1233, 1514 – 1234), Nagy–Hagymas–Gbg., leg. Deubel (Nagy-Hagymas is Hășmașu Mare peak in Hășmaș Mountains); 1 spec as *Morphocarabus hampei* v. *mehelyanus* (Inventory no 1515 – 1235), 1894, leg. Deubel.

***Carabus (Morphocarabus) hampei incompsus* Kraatz, 1880:** 3 specs as *Morphocarabus hampei incompsus* (Inventory no 1517 – 1236, 1518 – 1237, 1519 – 1238), Kronstadter Gbg., leg. Deubel (Brașov in german is named Kronstadt); 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1520 – 1239), Kronst., 1885, Deubel, leg. Birthler 1895; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1521 – 1240), Kronst., 1886, Deubel, leg. Birthler 1895; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1522 – 1241), Kronst., leg. Birthler 1895; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1523 – 1242), leg. Birthler 1895; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1524 – 1243), Kronstr., leg. Birthler 1895; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1525 – 1244), Kronstr., leg. Birthler 1895; 2 specs as *Morphocarabus hampei* v. *incompsus* (Inventory no 1526 – 1245, 1527 – 1246), Kronstadter Gbg., leg. Deubel; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1528 – 1247), Schuler Geb., leg. Kimakowicz, Wfs.; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1529 – 1248), Rosenauer Gbg., leg. Deubel; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1530 – 1249), Bnsero, leg. R. Albrecht; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1531 – 1250), Bodzaer Geb. (Buzăului Mountains), leg. Deubel; 1 spec as *Morphocarabus hampei* v. *incompsus* (Inventory no 1510 – 1251), Rodnaer Ofb, Kuhhorn, Coronjis (Corongis peak in Rodna Mountains), 17 – 18.07.1930, leg. A. Muller.

***Carabus (Morphocarabus) zawadzkii zawadzkii* Kraatz, 1854:** 1 spec as *Morphocarabus zawadzkii* (Inventory no 1533 – 1252), Galizien, leg. Bielz 1858 (Galicia, historical and geographic region between Central and Eastern Europe); 2 specs as *Morphocarabus zawadzkii* (Inventory no 1534 – 1253, 1535 – 1254), Galicia, Dr. Kraatz, leg. Birthler 1895.

Subgenus *Pachystus* Motschulsky, 1865

***Carabus (Pachystus) hungaricus hungaricus* Fabricius, 1792**: 1 spec as *Pachystus hungaricus* (Inventory no 538 – 439), Banat, leg. Bielz 1858; 1 spec as *Pachystus hungaricus* (Inventory no 539 – 440), Vaterland folsch, Dalmatia, leg. Bielz 1858 (Dalmatia is one of the four historical regions of Croatia); 1 spec as *Pachystus hungaricus* (Inventory no 540 – 441), Dalmatia, leg. Bielz 1858; 1 spec as *Pachystus hungaricus* (Inventory no 541 – 442), Hung., leg. Bielz 1858 (Hung being Hungary); 1 spec as *Pachystus hungaricus* (Inventory no 542 – 443), Hung., Merkl, leg. Birthler 1895; 1 spec as *Pachystus hungaricus* (Inventory no 543 – 444), Hung., Merkl, leg. Birthler 1895; 1 spec as *Pachystus hungaricus* (Inventory no 544 – 445); 1 spec as *Pachystus hungaricus* (Inventory no 545 – 446), Buda (Hungary).

***Carabus (Pachystus) hungaricus cribellatus*, M.F. Adams 1812 v. *perforatus* Fischer von Waldheim, 1820**: 1 spec as *Pachystus hungaricus perforatus* (Inventory no 547 – 447), Sibirien, leg. Bielz 1858 (Siberia in german language is Sibirien).

Subgenus *Hygrocarabus* C.G. Thomson, 1875

***Carabus (Hygrocarabus) variolosus variolosus* Fabricius, 1787**: 1 spec as *Hygrocarabus*

variolosus (Inventory no 844 – 689), Kr. 20, Helden-graben (Brașov, Heldengraben means Heroes Valley), leg. Deubel; 1 spec as *Hygrocarabus variolosus* (Inventory no 845 – 690), Odweg (Râșnov), leg. Kr. A. Deubel; 1 spec as *Hygrocarabus variolosus* (Inventory no 846 – 691), Rosenauer – Gbg, leg. Deubel (Râșnov); 1 spec as *Hygrocarabus variolosus* (Inventory no 847 – 692), Siebenburgen, Fogarascher Geb, leg. R. Albrecht (the northern part of Fagaras Mountains, from Transylvania); 2 specs as *Hygrocarabus variolosus* (Inventory no 848 – 693, 849 – 694), 03.03.1882, Kzg, Hopffg, Transilvania, 1889; 1 spec as *Hygrocarabus variolosus* (Inventory no 850 – 695), Transilvania, 14.05.1887, leg. Kimakowicz 1895; 1 spec as *Hygrocarabus variolosus* (Inventory no 851 – 696), Transilvania, 07.1890, leg. Kimakowicz 1895; 1 spec as *Hygrocarabus variolosus* (Inventory no 852 – 697), Siebenburgen, Hermannstadt, leg. R. Albrecht (Sibiu in german is Hermannstadt); 1 spec as *Hygrocarabus variolosus* (Inventory no 853 – 698), Șanta, 24.6.88, leg. Kimakowicz (probably Șanta river in Sibiu County); 1 spec as *Hygrocarabus variolosus* (Inventory no 854 – 699), Sb., 1887, leg. Petri; 1 spec as *Hygrocarabus variolosus* (Inventory no 855 – 700), Karoly, Trans, 1886, leg. Birthler 1895 (Băile Chirui in Harghita County).

Dr. Eugen Worell Entomological collection

Subgenus *Morphocarabus* Géhin, 1885

***Carabus (Morphocarabus) hampei hampei* Küster, 1846:** 1 spec, Transilvania, Karlsburg; 1 spec, 07.1923, leg. Schuller 96 (Alba Iulia in german Karlsburg); 1 spec, Sărmaș Băi, 05.1930; 2 specs, RosenauerBurg, 4.V.1943 (Râșnov Fortress named in german Rosenauer Burg); 2 specs as *Carabus hampei* v. *mendax* Csiki, 1906 being *hampei* from Maramureș.

***Carabus (Morphocarabus) hampei hampei* Küster, 1846 *v. aurosericeus* Kraatz, 1880:** 1 spec, leg. Birthler 1895; 1 spec, ZeidnerBerg, 07.1923 (ZeidnerBerg german name of Măgura Codlei Mountains); 1 spec, Lino. Ibr.,07.1922.

***Carabus (Morphocarabus) hampei incompsus* Kraatz, 1880:** 3 specs, Schuller Sb., VII.1923.

Subgenus *Pachystus* Motschulsky, 1865

***Carabus (Pachystus) hungaricus* Fabricius, 1792**: 1 spec, FE; 1 spec, Pest. Hungaria.

Subgenus *Hygrocarabus* C.G. Thomson, 1875

***Carabus (Hygrocarabus) variolosus variolosus* Fabricius, 1787**: 1 spec, Carpathen, leg. Reitter; 1 spec, Kronstadter Gbg., leg. Deubel (Kronstadt german name of Brașov); 2 specs, HerkulesBad, 07.1927 (HerkulesBad german name of Herculane); 1 spec, Stezi – Tal, Bei Hermanstadt (Știi Valey in Sibiu County), 10.08.1939, leg. Dr. Worell; 1 spec, Kanabe Deszo.

Prof. Rolf Weyrauch Entomological collection

Subgenus *Morphocarabus* Géhin, 1885

***Carabus (Morphocarabus) hampei hampei* Küster, 1846 *v. aurosericeus* Kraatz, 1880:** 1 spec, Kerzi, 17.63, R. N.

Dr. Karl Petri collection of Palaearctic and exotic beetles

Subgenus *Hygrocarabus* C.G. Thomson, 1875

***Carabus (Hygrocarabus) variolosus variolosus* Fabricius, 1787**: 1 spec, Rodnaer Gb. (Rodna Mountains); 1 spec, Klauseburg. (Cluj Napoca), 1891; 1 spec, Rot. Turm (Turnu Roșu); 1 spec, Sohassbg.; 1 spec, Sohassburg (probably Sighișoara), 30.04; 1 spec, Parâng, 1898; 1 spec, Klauseburg (Cluj Napoca), 1891; 1 spec, Schassburg (Sighișoara), 1894; 3 specs, Kanabe Dezso, Per. falva.

Dr. Eckbert Schneider Entomological collection

Subgenus *Hygrocarabus* C.G. Thomson, 1875

***Carabus (Hygrocarabus) variolosus variolosus* Fabricius, 1787**: 2 specs, Munții Maramureșului, Valea Bistra, 900 m, 10.06.1974, leg. S. Sârbu; 2 specs, Cisnădie, V. Ursului, 650 m, 12.5.1974.

Heinrich Hann v. Hannenheim Entomological collection

Subgenus *Hygrocarabus* C.G. Thomson, 1875

***Carabus (Hygrocarabus) variolosus variolosus* Fabricius, 1787**: 1 spec, 10.05.55.

Discussions

In Romania, 4 species of genus *Carabus* Linnaeus, 1758 are part of Natura 2000 Network. These 4 species (*Carabus hampei*, *Carabus hungaricus*, *Carabus variolosus*, *Carabus zawadzkii*) are included in 6 of the Sibiu museum's entomological collections. The material investigated comprises 109 specimens.

The Transylvanian Society for Natural Sciences collection contains all 4 species: *Carabus hampei* – 42 specimens, *Carabus hungaricus* – 9 specimens, *Carabus variolosus* - 12 specimens, *Carabus zawadzkii* – 3 specimens. Dr. Eugen

Worell Entomological collection includes: *Carabus hampei – 15* specimens, *Carabus hungaricus* – 2 specimens, *Carabus variolosus* - 6 specimens. Prof. Rolf Weyrauch Entomological collection contains 4 specimens of *Carabus hampei*. 11 specimens of *Carabus variolosus* belong to Dr. Karl Petri collection of Palaearctic and exotic beetles, 4 specimens to Dr. Eckbert Schneider Entomological collection and 1 specimen to Heinrich Hann v. Hannenheim Entomological collection.

The Transylvanian Society for Natural Sciences collection contains the largest number of Natura 2000 specimens (66 of 109). The largest number of specimens belongs to the species *Carabus hampei* (61 of 109), which is the best represented species in Romania.

The oldest specimens were donated in 1858 by Eduard Albert Bieltz to the Transylvanian Society for Natural Sciences collection. The most recently-collected belongs the Schneider collection (1978).

Carabus hampei was collected mostly from the mountainous area of Transylvania. Specimens of *Carabus zawadzkii* come from Galicia, currently the border between Poland and Ukraine. *Carabus hungaricus* material cames from Hungary and Croatia, but also from western Romania. *Carabus variolosus* was collected especially from southern Transylvania, in wetland habitats.

Most of the material was collected from Romania (especially from Transylvania), Hungary and Croatia. The 4 Natura 2000 species have been classified in the IUCN Red List of Threatened Species, in the category Not Evaluated.

The Entomological collection from the Natural History Museum of Sibiu has historically and scientifically-documentary value through Natura 2000 species, protected by the Council Directive 92/43/EEC.

Acknowledgments

We would like to thank Bogdan Dehelean (Eurofins-Mitox, Netherlands) for his useful comments which improved the manuscript.

REFFERENCES

Arndt *et al.* 2005 — Arndt, E., Beutel RG,Will K., *Carabidae Latreille, 1802*. In: *Handbook of zoology* 4 (2005).

Barloy *et al.* 2004 — Barloy, Jean, Lie, Pompiliu, Prunar, Florin, *Inventaire et répartition géographique des espèces du genre Carabus (Coleoptera, Carabidae) au Banat roumain*. In: *L'Entomologiste* 60.2 (2004), p. 63-89.

Barloy *et al.* 2008 — Barloy, Jean, Lie, Pompiliu, Prunar, Florin, *Faune des espèces des genres Carabus et Cychrus du Banat roumain*. In: *Artpress* (2008).

Barloy, Prunar 2011 — Barloy, Jean, Prunar, Florin, *Studies on the populations of Carabus (Morphocarabus) scheidleri seriatissimus Reitter, 1896 (Insecta: Coleoptera) in Maramureş (North Romania).* In: *Travaux du Muséum National d'Histoire Naturelle «Grigore Antipa* 54.1 (2011), p. 95-103.

Barloy, Prunar 2012 — Barloy, Jean, Prunar, Florin, *Considerations on the genus Carabus species protected in Romania by the Natura 2000 network*. In: *Research Journal of Agricultural Science* 44.2 (2012).

Brînzan 2013 — Brînzan Tudor, *Catalogul habitatelor, speciilor şi siturilor Natura 2000 în România*. In: *Bucureşti: Exclus Prod* (2013).

Cicort-Lucaciu 2020 — Cicort-Lucaciu, Alfred, *Road-Killed Ground Beetles Prove the Presence of Carabus hungaricus (Coleoptera: Carabidae) In North-Western ROMANIA.* In: *Nature Conservation Research. Заповедная наука*, 5(3), (2020), p. 134-138.

Erwin 1985 — Erwin, Terry, *The taxon pulse: a general pattern of lineage radiation and extinction among carabid beetles. Taxonomy, Phylogeny and Zoogeography of Beetles and Ants. A volume dedicated to the Memory of Philip Jackson Darlingon, Jr.(1904-1983). Dordrecht, Dr W. Junk* (1985), p. 437-472.

Gîdei, Popescu 2012 — Gîdei, Paul, Popescu, Irinel, *Ghidul coleopterelor din România I*, Ed. *PIM*, (2012) Iaşi.

Lindroth 1985 — Lindroth, Carl Hildebrandt, Bangsholt, Frits, *The Carabidae-Coleoptera-Of Fennoscandia and Denmark*. In: *No. 1. Brill Archive* (1985).

Lorenz 2005 — Lorenz, W., *Systematic list of extant beetles of the world: Insecta Coleoptera "Geadephaga": Trachypachidae and Carabidae inc. Paussina, Cicindelinea, Rhysodinae*. Lorenz, Tutzing, (2005), 530 pp.

Luff 2007 — Luff, Martin, *The Carabidae (ground beetles) of Britain and Ireland*. In: *Royal Entomological Society* (2007).

Prunar *et al.* 2006 — Prunar, Florin, Barloy, Jean, Lie, Pompiliu, *C. (Morphocarabus) kollari, espèce endémique et C. (Pachystus) hungaricus, espèce rare du Banat roumain*. In: *Lucrările simpozionului internaţional comemorativ „Profesorul Ioan Coste (1942-2006)" Timisoara, Vasile Goldiş University Press Arad.* (2006), pp 121-141.

Prunar *et al.* 2017 — Prunar, Florin, et al., *The belonging of C.(Morphocarabus) rothi hampei telekii Csiki, 1937 to C.(Morphocarabus) rothi rothi Dejean, 1829, confirmed in molecular biology*. In: *Research Journal of Agricultural Science* 49.1 (2017), p. 119-126.

Riddick 2008 — Riddick, E., Capinera, J., Hangay, G., *Ground Beetle (Coleoptera: Carabidae) Feeding Ecology*. In: *Encyclopedia of Entomology* (2008).

Thiele 1977 — Thiele, Hans-Ulrich, *Carabid beetles in their environments: a study on habitat selection by adaptations in physiology and behaviour*. Vol. 10. In: *Springer Science & Business Media* (2012).

Thomas 2000 — Thomas, Michael C, ed. *American Beetles, Volume I: Archostemata, Myxophaga, Adephaga, Polyphaga: Staphyliniformia*. In: *CRC Press* (2000).

Trautner *et al.* 2014 — Trautner, J., Fritze, M. A., Hannig, K., & Kaiser, M., *Distribution Atlas of Ground Beetles in Germany*. In: *Books on Demand, Norderstedt* (2014).

*** — Uniuniea Europeană, Guvernul României, Instrumente structurale: Ghid sintetic pentru monitorizarea speciilor de nevertebrate de interes comunitar din România.

THE GENUS *Ponera* LATREILLE, 1804 IN ROMANIA AND THE FIRST RECORD OF *Ponera coarctata* (LATREILLE, 1802) (HYMENOPTERA: FORMICIDAE) FROM MOLDOVA (EASTERN ROMANIA)

Ioan TĂUȘAN*
Mădălina Ștefania BIBICU **
Alexandru-Mihai PINTILIOAIE ***

Abstract. *The Ponera genus includes hypogaeic species that usually forage cryptically in leaf litter on the ground. In Romania, the genus is represented by at least two species: P. testacea and P. coarctata. Scarce data is available on the distribution and biology of both species. However, P. coarctata is well known from Transylvania, lacking from other regions of the country. Herein, we report the first record from Moldova, togheter with other records of the species.*
Keywords*: new records, hypogaeic species, faunistics, insects.*

Rezumat. *Genul Ponera include specii hipogee care au un stil de viață criptic căutând hrana în litieră. În România, genul este reprezentat de cel puțin două specii: P. testacea și P. coarctata. Există puține date disponibile privind distribuția și biologia celor două specii. Totuși, în cazul speciei P. coarctata, se știe că este prezentă în Transilvania, cu puține alte semnalări în afara acestei regiuni. În prezenta lucrare semnalăm această specie din Moldova, alături de alte locații în România.*
Cuvinte cheie: *semnalări noi, specii hipogee, faunistică, insecte.*

The genus *Ponera* belongs to the Ponerinae subfamily alongside different and interesting genera that includes *Cryptopone*, *Hypoponera* and *Pachycondyla*. Because these genera have the same overall body shape they are often confused. However, *Ponera* is unique in having the lower surface of the petiole elaborate, with a thin, circular spot near the front and a sharp angle or small pair of spines towards the rear and also having an anterior fenestra in the subpetiolar process (Schmidt, Shattuck 2014).

However, a few species of *Hypoponera* appear to also have a fenestra, but they lack the paired posterior teeth on the subpetiolar process that are typical of *Ponera*, and *Hypoponera* has only a single maxillary palp segment while *Ponera* has two. Some *Belonopelta* and *Emeryopone* also have an anterior fenestra in the subpetiolar process, but these genera have narrow mandibles with long attenuated teeth, while *Ponera* has typical triangular mandibles with only short teeth (Schmidt, Shattuck 2014).

* Lucian Blaga University of Sibiu, Faculty of Sciences, Sibiu, Romania
** Lucian Blaga University of Sibiu, Faculty of Sciences, Applied Ecology Research Center, Sibiu, Romania, ioan.tausan@ulbsibiu.ro
*** Research Group in Invertebrate Diversity and Phylogenetics, Faculty of Biology, "Alexandru Ioan Cuza" University of Iași, Romania

Species of *Ponera* form small nests with less than 100 workers in protected places on the ground. They forage cryptically in leaf litter on the ground and are often collected using Berlese funnels.

In Europe, *Ponera* is represented by at least three species: *P. coarctata* (Latreille, 1802), *P. testacea* Emery, 1895 and *P. sysphinctoides* Bernard, 1950. The most common of these three species is *P. coarctata*. This species appears to have its center of distribution in the northern Mediterranean part of Europe. The records from North Africa and the Middle East are too sparse to allow a conclusion to the abundance of the species there, or to whether it is distributed also across North Africa. The records from Britain, Germany, and the former U.S.S.R. indicate a probable distributional limit at a latitude of about 52°N (note that the northern English records are questionable). *P. coarctata* has not been recorded from Scandinavia, although several active myrmecologists have resided there. The lack of records from some other areas (e. g., Turkey) is no doubt due to deficient collections (Taylor 1967).

Seifert (2018) stated his concern regarding the species distribution based on the taxonomic issues regarding the separation from *P. testacea*. Bearing this in mind, the range of *P. coarctata* extends from Iberia to the northern part of Africa and all the way to the Caucasus and Kopet Dagh.

In Romania, two *Ponera* species occur, namely *P. coarctata* and *P. testacea* (Markó *et al.* 2006). For both species, few records are available (Csősz 2003, Markó *et al.* 2006). However, *P. testacea* seems even more rare, being recorded only from five localities up to now: Bucharest (Montandon & Santschi 1910), Deva, Sibiu, Cluj-Napoca (Csosz, Seifert 2003) and Arad (Markó 2008). In the case of *P. coarctata*, it seems that the species is widely distributed in Transylvania, including the Carpathian basin (Csősz 2003).

The new myrmecological material of *Ponera coarctata* was collected from several location from Romania, as follows: 2 workers, 07.2015, from Cheile Sohodolului (Gorj county), leg. V. Gheoca; 2 workers, 09.2016, from Comănești (Bacău county), leg. A. Pintilioaie; 10 workers, 04.2020, from Băbeni (Sălaj county), leg. D. Scoarță and 1 queen 09.2020 leg. I. Tăușan from Sibiu (Sibiu County).

Based on our findings, the known distribution of the species includes the first record of *Ponera coarctata* for the Moldova region and suggests that the species could occur more frequently than thought before.

Concerning the species requirements, it prefers eurythermic, moist to dry, open or woodland habitats on mineral soil. It may occur even in urban areas in quite disturbed places such as the ballast bed of railway lines, soil disc of street trees, etc. Still, there is a clear preference for moist soil spots with mull or raw humus (Seifert, 2018).

Ponera coarctata is distributed in Transylvania, including the rest of the Carpathian basin, yet our new records suggest that this species may be more frequent in Romania. More specific trapping techniques should be undertaken to have a better understanding of the *Ponera* genus distribution in Romania.

Acknowledgments

We are in debt to Dr. Voichița Gheoca and David Scoarță for their data on the distribution of the species. The authors are grateful for the useful comments of Sergiu Torok, which improved the manuscript. We owe special thanks to Dr. Laurian Gheorghe for his help with the distribution map of the species, and to Maximilian Teodorescu for the photo of *Ponera coarctata*.

REFFERENCES

Csősz 2003 — Csősz Sándor, *A key to the Ponerinae species of the Carpathian Basin (Hymenoptera: Formicidae)*. In: *Annales Historico Naturales Musei Nationalis Hungarici* 95 (2003), p. 147-160.

Csősz, Seifert 2003 — Csősz Sándor, Seifert Bernhard, *Ponera testacea Emery, 1895 stat n. – a sister species of P. coarctata (Latreille, 1802) (Hymenoptera, Formicidae*). In: *Acta Zoologica Academiae Scientiarum Hungaricae* 49 (2003), p. 201-214.

Markó 2008 — Markó Balint, *Pyramica baudueri (Emery, 1875) – a new ant species (Hymenoptera: Formicidae) for the Romanian fauna*. In: *Fragmenta Faunistica* 51(2), (2008), p. 101-106

Markó *et al.* 2006 — Markó Balint, Sipos Botond, Csősz Sándor, Kiss Klara, Boros Istvan, Gallé Laszlo, *A comprehensive list of the ants of Romania (Hymenoptera: Formicidae)*. In: *Myrmecological News* 9, (2006), p. 65-76.

Montandon, Santschi 1910 — Montandon Arnold-Lucien, Santschi Felix, *Contributions á la faune entomologique de la Roumanie. Formicides.* In: *Bulletin de la Société Roumaine des Sciences* 19, (1910), p. 648-654

Seifert 2018 — Seifert Bernhard, *The Ants of Central and North Europe.* In: *Lutra Verlags- und Vertriebsgesellschaft* (2018), Tauer, Germany

Schmidt, Shattuck 2014 — Schmidt Chris, Shattuck Steven, *The higher classification of the ant subfamily Ponerinae (Hymenoptera: Formicidae), with a review of ponerine ecology and behavior.* In: *Zootaxa,* 3817(1), (2014), p. 1–242. https://doi.org/10.11646/zootaxa.3817.1.1

Taylor 1967 Taylor Robert, *A monographic revision of the ant genus Ponera Latreille (Hymenoptera: Formicidae)*. In: *Pac. Insects Monogr.* 13 (1967), p. 1-112

LIST OF ILLUSTRATIONS

Fig. 1. *Ponera coarctata* – worker (photo: Maximilian Teodorescu)

Fig. 2. Known distribution of the genus *Ponera* in Romania (codes: white circles – *Ponera testacea* – published data; white diamonds – *Ponera coarctata* – published data; red circles – *Ponera coractata* - new records)

LISTA ILUSTRAȚIILOR

Fig. 1. *Ponera coarctata* – lucrătoare (foto: Maximilian Teodorescu)

Fig. 2. Distribuția cunoscută a genului *Ponera* în România (coduri: cercuri albe *Ponera testacea* – data publicate; romburi albe – *Ponera coarctata* – published data; cercuri roșii – *Ponera coractata* – date noi)

Fig. 1. *Ponera coarctata* – worker (photo: Maximilian Teodorescu)

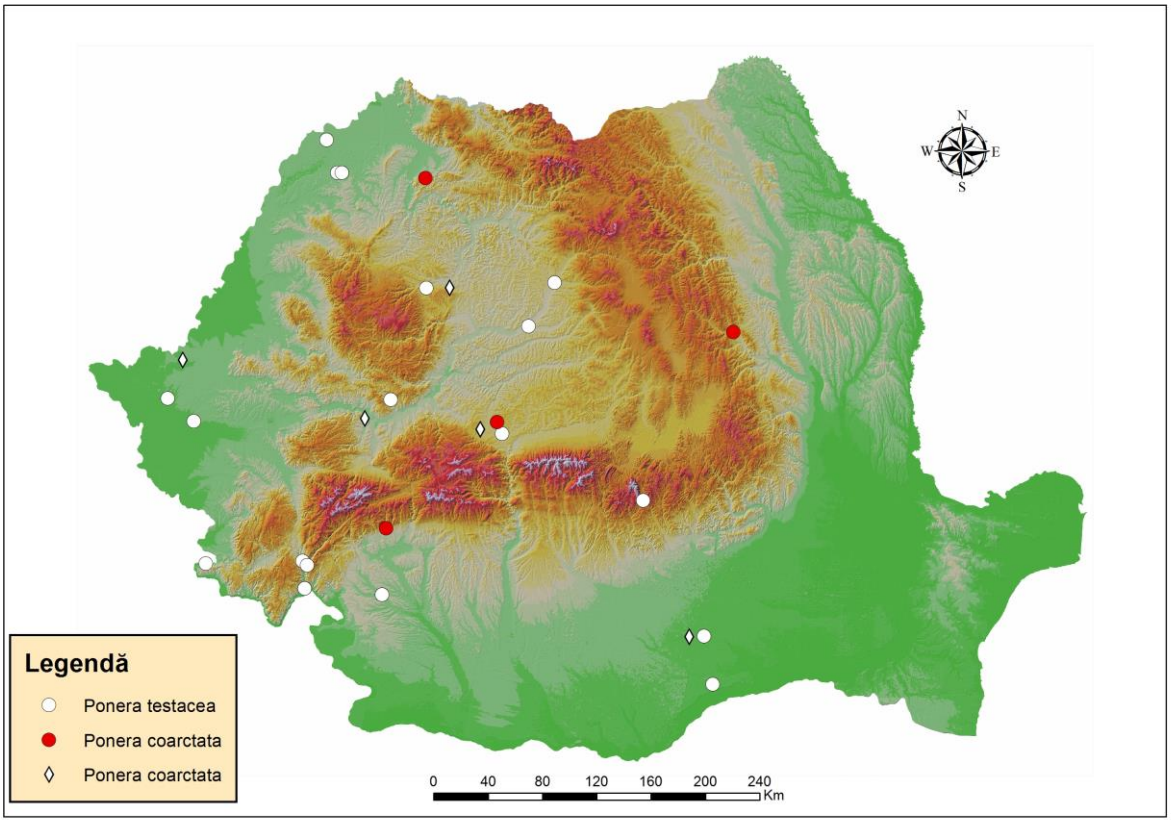


Fig. 2 Known distribution of the genus *Ponera* in Romania (codes: white circles – *Ponera testacea* – published data; white diamonds – *Ponera coarctata* – published data; red circles – *Ponera coractata* - new records)

STRUCTURE AND DYNAMICS OF SMALL MAMMAL COMMUNITIES (MAMMALIA, ORDERS SORICOMORPHA AND RODENTIA) IN THE DANUBE DELTA BIOSPHERE RESERVE

Anamaria LAZĂR*

Abstract. *The study was conducted between 2007 and 2018, based on a series of investigations in four stations and several habitats within the Danube Delta Biosphere Reserve using different types of traps to capture live mammals. During the study period, a number of 107 individuals belonging to 9 species, two soricomorphs and seven rodents were captured and information was collected regarding six other species observed or identified based on local testimonies.*
Keywords*: rodents, shrews, community structure and dynamics, live trapping, Danube Delta Biosphere Reserve.*

Rezumat. *Studiul a fost realizat în perioada 2007 - 2018 și se bazează pe o serie de investigații în patru stații și mai multe habitate de pe teritoriul Rezervației Biosferei Delta Dunării. Utilizându-se mai multe tipuri de capcane pentru capturarea mamiferelor vii. Pe perioada studiului, a fost capturat un număr de 107 indivizi aparţinând la 9 specii, două soricomorfe şi şapte rozătoare și redate informații cu privire la alte șase specii observate sau identificate pe baza mărturiilor localnicilor.*
Cuvinte cheie: *rozătoare, chițcani, structura și dinamica comunităților, capturi vii, Rezervația Biosferei Delta Dunării.*

Introduction

The Danube Delta, due to its characteristics, the periodic discharge of a large amount of water and the periodic deposit of alluviums, participates in the creation of habitats with special living conditions, directly influencing the structure and dynamics of small mammal communities. The present study aims to synthesize and complete data on the presence and distribution of species in the Danube Delta Biosphere Reserve (DDRB) area, elucidate problems such as the dynamics of the structure of small mammal communities affected by floods.

In the Danube Delta, studies on small mammals are few and mainly refer to species of economic value such as the muskrat, the otter and the European mink. Previous studies were conducted by Volosciuc (1959), who published some observations on the muskrat. Călinescu (1931) also referred to mammals from the Danube Delta, and Murariu (1984) mentioned *Microtus epiroticus* (syn. *M. rosiaemeridionalis*, presently recognized as *M. levis*) as new to Romania's fauna. Murariu also published in 1981 the results of researches carried out in several locations in the Danube Delta and the area of Lake Razelm, and in 1996 he published the work entitled *Mammals of the Danube Delta*.

More recent studies on small mammals were carried out by Cuzic and Cuzic who provide a series of faunal data from the Furtuna Lake area (2008) and from Vadu area (2010 and 2018). Pocora and collaborators (2012) also published faunal data based on the little owl (*Athene noctua*) pellets from Letea forest, Kiss and collaborators (2012) published a study on the status of the beaver in the Danube Delta, Miu and collaborators (2018) established conservation priorities for terrestrial mammals in Dobrogea Region, which includes the Danube Delta.

Study area and methods

Most of the Danube Delta is made up of water-covered surfaces. These range from 60-65% during low water to over 90% during high floods (Gâştescu 1971). The overall slope of the Danube Delta is very low 0.006 ‰, resulting in a low water flow rate. The most characteristic hydrological phenomenon in the delta is flooding, which transforms the delta into a huge lake from

* "Transilvania" University of Braşov, Faculty of Food and Tourism, Department for Engineering and Management in Food and Tourism, Braşov, Romania anagurzau@yahoo.co.uk

which rise the highest ridges of the Stipoc, Letea and Caraorman sand banks.

The variation of the water level is determined by the phases of the hydrological regime of the Danube and accidentally by the influence of the north winds that push the sea waters towards the mouths of the river, creating an oar that is felt especially during the period of the low waters on the Danube (Gâştescu 1971).

From 2007 to 2018 we carried out a series of investigations in several areas of the DDBR territory. The first investigated station was Sfântu Gheorghe. Here, in July 2007, we installed traps in a reed bed on the bank of a canal and in a pasture near the settlement, but no mammal was captured. In the months of August, between 2007 and 2018, we carried out a series of investigations in the riverside willow forests on the banks of the Crânjala canal near Maliuc locality (Fig. 1) and near Vadu locality (Constanța county), in a mixed deciduous forest, dominated by oak (*Quercus spp*.) and honey locust (*Gleditsia triacanthos*) (where no catches were recorded), reed bed and sand dunes (Fig. 2). Observations on the presence of *Spermophilus citellus* were made near southern end of Lake Sinoe.

The investigated station in Maliuc was located at 4 m altitude and 45°12'06"N latitude and 29°06'51"E longitude, in Sfîntu Gheorghe at -1 m altitude, 44°53'34"N latitude and 29°26'44" E longitude and the station near Vadu was located at 0 m altitude and at 44°27'07"N latitude and 28°44'37"E longitude. In Maliuc the investigations were repeated in September 2009 and 2012. Observations on mammals were also made in September 2008 in Letea Forest.

Animals were captured using different types of box-traps. We installed the traps in line or randomly, the distance between them being on average 10 m. For the positioning of the traps in the field we took into account the habitat configuration; they were hidden as far as possible at the base of the trees or in bushes. The traps were provided with different types of food, to attract the animals and to provide them with sufficient energy until their release, to prevent death through hypothermia. We checked the traps once (at dawn) or twice (at dusk and dawn) a day.

The individuals captured were determined, weighed, measured, marked, sex, age category (juvenile, subadult or adult) and reproductive status was assessed, and then all animals were released in the place where they were captured.

The species determination was made based on morphological characters, according to Puceck 1981), Murariu (2000), Popescu and Murariu (2001), Aulagnier and collaborators (2009). We marked the animals individually by trimming the fur on their back in different models. The marked individuals were released without being handled again.

We used between 10 and 30 traps per habitat, but most of the time some of the traps were non-functional for different reasons (being disturbed by animals, closed by rain or wind, etc.), so for the calculation of the capture index (Ci) we took into consideration only those traps that were functional, noted with SFT (sum of functional traps) (Sîrbu, Benedek 2012).

Relative abundance was expressed as the ratio of the species (in percentages) within a sample. Abundance, as a measure of population density, was expressed as capture index, meaning the number of captured individuals per 100 active trap-nights (SFT).

Results and discussion

During the study period, 107 individuals belonging to 9 species, two soricomorphs and seven rodents were captured and information was collected regarding six other species observed or identified by other methods, which are mentioned for each species under discussion. The systematic list of the species known from DDBR, was drawn up in accordance with Wilson and Reeder (2005), based on our data and on the literature.

Order Soricomorpha Gregory, 1910

Family Soricidae Fischer, 1814

1. *Sorex araneus* Linnaeus, 1758 (Common Shrew) - six specimens (two males and four females) were collected from the Caraorman forest and the Împuțita Hill (Murariu 1981 a), the species was captured in Cormorova and Sfântu Gheorghe forest (Murariu 2000 a), it was identified in the pellets of the little owl (*Athene noctua*) in the Letea Forest (Pocora *et al*. 2012), a specimen was found dead in the September 2008 campaign on the bank of a canal in the Letea locality, and another specimen was captured in the 2018 campaign on a canal near Maliuc. In Dobrogea, the region which includes DDRB the species is in drastic decline (Murariu *et al*. 2009).

2. *Sorex minutus* Linnaeus, 1766 (Eurasian Pygmy Shrew) - mentioned in the Danube Delta by Barbu

(1971) and Randik and colaborators (1980) (ap. Murariu 2000 a).

3. *Neomys fodiens* (Pennant, 1771) (Eurasian Water Shrew) - present only in areas with high humidity, a specimen was captured in the campaign of 2010 on the bank of the canal Crânjala near Maliuc. In Dobrogea, including DDRB, it is in sharp decline (Murariu *et al.* 2009).

4. *Neomys anomalus* Cabrera, 1907 (Mediterranean Water Shrew) - quoted from Sfântu Gheorghe (Barbu 1978, ap. Murariu 2000 a), collected from Crișan, Red Lake and Mila 23 (Randik *et al*., 1980, ap. Murariu 2000 a), collected from Letea and Sfântu Gheorghe forest (Murariu 1981 a). It was also identified in the pellets of the little owl in the Letea Forest (Pocora *et al.* 2012).

5. *Crocidura leucodon* (Hermann, 1780) (Bicolored Shrew) - captured in various habitats from Jurilovca – forest steppe and steppe (Suciu, 1971).

6. *Crocidura suaveolens* (Pallas, 181) (Lesser White-toothed Shrew) - was collected from pastures with *Hippophae rhamnoides*, from Jurilovca (Murariu 1996) and it was observed at Vadu (Cuzic, Cuzic 2010, 2018). In Dobrogea it is in sharp decline (Murariu *et al*. 2009).

Family Talpidae Fischer, 1814

7. *Talpa europaea* Linnaeus, 1758 (European Mole) - observed at Murighiol, and Jurilovca, on the margins of the marshes (Murariu 1996).

Order Rodentia Bowdich, 1821

Family Sciuridae Fischer of Waldheim, 1817

8. *Spermophilus citellus* (Linnaeus, 1766) (European Ground Squirrel) – observed at Vadu (Cuzic, Cuzic 2010, 2018), it was observed throughout the study period on the grasslands of Lake Sinoe. In Dobrogea it is in sharp decline (Murariu *et al.* 2009), decimated mainly due to the intensification of road traffic (Murariu 2006).

Family Castoridae Hemprich, 1820

9. *Castor fiber* Linnaeus, 1758 (Eurasian Beaver) - disappeared from Romania almost two centuries ago, but it has been reintroduced in several areas of the country, the closest to the Danube Delta being the lower part of the Ialomița river. It has long been thought that the Danube Delta does not provide a suitable habitat for the beaver due to the large fluctuations in water level (Kiss *et al*. 2012). It was observed in Maliuc in April 2011 (Petrescu E. in verbis), and one specimen was found dead following a boat collision on the Draghilea canal in July 2011 (Kiss *et al*. 2012).

Family Cricetidae Fischer, 1817

10. *Mesocricetus newtoni* (Nehring, 1898) (Romanian Hamster) - was captured at Jurilovca (Suciu 1971; Solomon 1968).

11. *Ondatra zibethicus* (Linnaeus, 1766) (Common Muskrat) - has been reported in the Danube Delta since 1951 (Popescu, Murariu 2001). It was observed south of Sulina on a grind with sedge and sea buckthorn (Murariu 1996), observed near Maliuc (Cuzic, Cuzic 2008). In the 1970s, although an intensive hunting of the muskrat was practiced, it had much larger populations. Today (although it is no longer hunted) it is a constant presence on the delta's canals, but the population sizes are much smaller (Eugen Petrescu in. verbis). Several individuals were observed during the study period on the adjacent canals to Furtuna Lake and on the Ciobănița Lake.

12. *Arvicola amphibius* (Blasius, 1858) (Eurasian Water Vole) - observed at Mila 23 on a sandbar (Murariu 1996), identified in little owl pellets collected from the Letea forest in April and June 2009 (Pocora *et al.* 2012). The species is declining (Murariu 2009). It was captured in Maliuc station in the campaign of 2012.

13. *Microtus arvalis* (Pallas, 1778) (Common Vole) - captured at Jurilovca and in the Danube Delta (Wegner 1970), captured at Calica, Jurilovca, Letea, Maliuc (Suciu 1971), Calica (Solomon 1968). *M. arvalis* prefers to feed on clover and alfalfa but it can be found in any plant culture (Popescu, Murariu 2001). It was collected from the Danube Delta (Murariu 1981a), from the sand banks near the Impuțita canal and from the Sulina city cemetery (Murariu 1996). It was identified in the little owl pellets collected near the Letea forest, representing 26% of the food of this species (Pocora *et al.* 2012). *M. arvalis* was observed at Vadu (Cuzic, Cuzic 2010, 2018). It was captured in Vadu station in the campaigns of 2007 and 2009. In Dobrogea *M. arvalis* populations are stable (Murariu *et al*. 2009).

14. *Microtus levis* Miller, 1908 (East European Vole) - has been mentioned in Romania's fauna since 1980 (Randik *et al*. 1980); mentioned by (Murariu 1984; Gavrilă *et al*. 1984, 1986; Murariu 2006), being known so far only from the Danube Delta and western Dobrogea (Popescu, Murariu 2001). It was collected from the Roşuleţ sand bank (Murariu 1996). During the present study *M.*

levis was captured in Maliuc station in August 2011, 2012, 2018 and in September 2012.

15. *Microtus subterraneus* (de Selys-Longchamps, 1836) (Common Pine Vole) - on the territory of the Danube Delta it was mentioned before 1970, subsequently not collected or observed (Murariu 1996). The species is considered to be declining in Dobrogea (Murariu *et al*. 2009).

Family Muridae Illiger, 1811

16. *Micromys minutus* (Pallas, 1771) (Harvest Mouse) - prefers areas with high humidity, shrubs, forest clearings and cereal crops (Răduleț 2005). A specimen was collected from the Danube Delta (Murariu 1981a), it was also found in reed beds on sand banks (*Phragmites australis*) at Împuțita (Murariu 1996). Identified in little owl pellets collected near the Letea forest, representing 42% of the identified prey (Pocora *et al*. 2012). Three juvenile specimens were captured by hand in a reed area on the bank of the Crânjala canal near Maliuc in 2013.

17. *Apodemus agrarius* (Pallas, 1771) (Striped Field Mouse) - prefers areas with high humidity (Popescu, Murariu 2001), was captured at Maliuc (Cuzic, Cuzic 2008), Vadu (Cuzic, Cuzic, 2010, 2018), collected from the Danube Delta, at Caraorman, Sulina, Sfântu Gheorghe, (Murariu 1996). At Sfântu Gheorghe it was observed the cache theft, food reserves of *Mus spicilegus* being pilfered by *A. agrarius* (Murariu 1981 b). It was probably identified in the little owl pellets collected near the Letea forest, and quoted wrongly as *Apodemus agrestis* (Pocora *et al.* 2012). *A. agrarius* was collected from the Danube Delta (Wegner 1970), Letea (Suciu 1971), Maliuc (Solomon 1968; Suciu 1971). It is considered that in Dobrogea it is in decline (Murariu *et al*. 2009). Throughout the present study, it was the dominant species in the Danube Delta, being captured in each campaign carried out in Maliuc station, with one exception, namely in August 2011.

18. *Apodemus flavicollis* (Melchior, 1834) (Yellow-necked Field Mouse) - prefers compact forests (Popescu, Murariu 2001), being collected Jurilovca (Wegner 1970; Suciu 1971). It is considered to be in decline in Dobrogea (Murariu *et al.* 2009).

19. *Apodemus sylvaticus* (Linnaeus, 1758) (Long-tailed Field Mouse) - is much more widespread than the previous species, occupying both forests and pastures, even agricultural lands (Murariu 2006, 2008). *A. sylvaticus* was captured at Maliuc (Cuzic, Cuzic, 2008), Vadu (Cuzic, Cuzic 2010, 2018) Murighiol, Sfântu Gheorghe (Murariu 1996), Jurilovca, Babadag and the Danube Delta (Wegner 1970), Calica, Jurilovca, Letea (Suciu 1971), Jurilovca, Calica, (Solomon 1968). During the study it was captured in Vadu and Maliuc stations.

20. *Apodemus uralensis* (Pallas, 1811) (Herb Field Mouse) - was collected from Jurilovca, from a thicket formed between grasslands and alfalfa crops (Murariu, 1996). It has been identified in little owl pellets from the Letea forest (Pocora *et al.* 2012). We captured a specimen in 2018 on a canal near the town of Maliuc and another specimen was captured on the dunes of Vadu in August 2012.

21. *Mus musculus* Linnaeus, 1758 (House Mouse) - is widely spread, preferring human settlements. It was captured at Maliuc (Cuzic, Cuzic 2008), Vadu (Cuzic, Cuzic 2010, 2018), collected from Gura Portiței, Jurilovca, Sulina, from dunes, pastures and maize crops (Murariu 1996). It was identified in little owl pellets from Letea (Pocora *et al.* 2012). We captured a specimen at Vadu in the bushes near the village's garbage dumps.

22. *Mus spicilegus* Petényi, 1882 (Mound - building Mouse) – is present in the agricultural areas of Dobrogea, being collected from Jurilovca (Wegner 1970; Murariu 1996), the Danube Delta (Wegner 1970), Jurilovca, Maliuc (Suciu 1971), Jurilovca (Solomon 1968). It was found in little owl pellets from Letea (Pocora *et al.* 2012) and observed at Maliuc (Cuzic, Cuzic 2008).

23. *Rattus norvegicus* (Berkenhout, 1769) (Brown Rat) - is a cosmopolitan species, adapted to different natural or anthropic habitats. It was captured from the Danube Delta (Wegner 1970), Maliuc (Solomon 1968), Gura Portiței, Caraorman, Împuțita, Sulina and Crișan (Murariu 1996), and observed at Maliuc (Cuzic, Cuzic 2008). We captured by hand a juvenile in the tourist area of Vadu beach in 2013.

24. *Rattus rattus* (Linnaeus, 1758) (Roof rat) - was observed in Caraorman (Murariu 1996).

Family Spalacidae Gray, 1821

25. *Spalax leucodon* (Nordmann, 1840) (Lesser Blind Mole Rat) - is present throughout Dobrogea, with no altitude limit, being easily recognizable by the specific shape of the mounds and the diameter of the galleries. *S. leucodon* was collected from Maliuc (Suciu 1971). It is a species in decline (Murariu 2009).

Family Myocastoridae Ameghino, 1904

26. *Myocastor coypus* (Molina, 1782) (Coypu) - in Romania, the first mention of a free living coypu was from Ilgani and it was mentioned as escaped from the breeding farms (Almășan *et al.* 1959). It was observed in Grindu, and Isaccea, probably escaped from the nearby stockfarms (Murariu 2006). A few specimens escaped from the stockfarm were also observed in the Danube Delta a few years ago, but they failed to survive in the wild (E. Petrescu in. verbis).

A summary of the bibliographic and original data is presented in table 1.

The structure of small mammal communities from the DDBR in the study sites, for study period (Fig. 3.) is clearly dominated by the mammals captured in the Danube Delta, and of these, by the *Apodemus agrarius*, with more than three quarters of the captured individuals (78.5%). *A. agrarius* was captured in every campaign in the Danube Delta with the exception of 2011 when no individuals were encountered. The high relative abundance of this species in the Danube Delta is explained by the high humidity of its habitats, which *A. agrarius* prefers (Popescu, Murariu 2001). It is considered that in the Danube flood plain and delta, due to the excessive humidity, *A. sylvaticus* is less frequent, being replaced by *A. agrarius* (Popescu, Murariu 2001),

Microtus levis has a lower relative abundance value (9.7%), being caught only in the Danube Delta, in 2011 and 2012. *Arvicola amphibius* and *Apodemus sylvaticus* have similar ratios (2.8%), although *A. amphibius* was captured in only one campaign, in August 2012.

The other species have low values of the relative abundance, with only a captured specimen.

In the Danube Delta at Maliuc (Fig. 4.) the small mammal community was also dominated by *Apodemus agrarius*, representing 82.4% of the captured individuals. Since we investigated only flood zones, figure 4 could be illustrative for the structure of small terrestrial mammal communities in the Danube Delta flood zones.

We captured only one specimen of *Neomys fodiens*, *Apodemus uralensis* and *Sorex araneus*. *N. fodiens* was identified in August 2010, on a dam of the Crânjala canal, and the last two in August 2018 .

The Vadu station (Fig. 5) is characterized by an extremely low abundance but a high heterogeneity. We captured only five individuals belonging to four species (Table 2). The specific structure of the community is completely different from that in the Danube Delta. *Microtus arvalis* is the predominant species in this station, being specific to open habitats. *Mus musculus* was caught in a bush on the edge of Lake Sinoe, probably arriving here from the nearby garbage dump. *Apodemus uralensis* was caught on the sand dunes near Vadu Beach, and *Apodemus sylvaticus* near the Sinoe Lake reed beds, this species being the only one caught in both Vadu and Maliuc.

Annual dynamics of small mammal communities in the Danube Delta Biosphere Reserve

In the Danube Delta (Fig. 6) the small mammal community was dominated by *Apodemus agrarius*, which was continuously present in this area with a more or less constant density in some periods (between August 2007 and August 2018 the capture index recorded values between 3.15 and 9.83). But it also presented significant fluctuations in the population density from one year to another. The maximum value for this species was recorded in August 2012 (Ci = 30), followed by September of the same year (Ci = 19.5). In August 2012 we recorded high values of the capture index also for the other species.

Microtus levis was first captured in August 2011 (when it was the only species encountered) and remained a constant presence until the end of the study. The rest of the species registered small abundances and they were captured stochastically, highlighting their low density in this area.

The small mammal community in Vadu station (Fig. 7.) was much poorer in individuals and species, each species being represented by a single individual in the campaign in which it was captured. *M. arvalis* was the dominant species in this station, being captured in the 2007 and 2009 campaigns, the latter being the most diverse, with three of the four species captured during the entire study period. The low densities in this station are probably due on the one hand to the high temperatures recorded during the periods during which the investigations took place, and on the other hand to the unfavorable biotope conditions for rodent and insectivorous species, characterized by a reduced supply of both trophic resources, as well as shelter (such as sand dunes).

Considering both stations within the DDBR, the dynamics of the small mammal communities is imprinted by the community from Maliuc, and mainly by the density variations of *Apodemus agrarius*, which is clearly dominant, presenting significantly higher values of the capture index

than the other species. The maximum value of the total capture index was recorded in August 2012, followed by September 2012, coinciding with the maximums calculated for *A. agrarius* in Maliuc.

The minimum values of the capture index were recorded in the campaign of August 2018, when few mammals were captured using a relatively large number of traps (Table 2).

Conclusions

During the field investigations carried out between 2007 and 2018 in the four stations located in the Danube Delta Biosphere Reserve, nine small mammal species were captured, two shrews and seven rodents, and seven other species were reported by other methods.

In the Danube Delta the community of small mammals was dominated by *Apodemus agrarius*, which represented a constant presence in this area, presenting significant fluctuations in its population density from year to year, but was not captured at Vadu.

The small mammal community in Vadu station was much poorer in individuals and species, each species being represented by a single individual in the campaign in which it was captured. *M. arvalis* was the dominant species at Vadu, being captured in two of the five field campaigns.

Acknowledgements

This study was conducted within the National Camp of the Romanian Ornithological Society, which supported all the logistical expenses, except the land campaign from Sfântu Gheorghe. I express my gratitude to the members of the Romanian Ornithological Society, especially to Mr. Gheorghe Zaharia, who assisted the field campaign in 2018, and to all those who helped me set and handle the traps throughout the study period.

REFFERENCES

Almăşan *et al.* 1959 — Almăşan Horea, Andone G., Nesterov Vasile, *Nutria în Delta Dunării*. In: *Vânătorul şi Pescarul Sportiv*, (1959), Bucureşti, 5: 10.

Aulagnier *et al.* 2009 — Aulagnier Stéphane, Haffner Patrick, Tony Mitchell-Jones, Moutou François, Zima Jan, *Mammals of Europe, North Africa and the Middle East.* In: *A&C Black Publishers*, London (2009): 1-272.

Călinescu 1931 — Călinescu Raul, *Mamiferele României. Repartiţia şi problemele lor biogeografice-economice*. In: *Bul. Min. Agric. Domenii*, (1931) 251, *1*: 1-103.

Cuzic, Cuzic 2008 — Cuzic Mariana, Cuzic Viorel, *Date faunistice privind mamiferele din zona lacului Furtuna din Delta Dunării*. In: *Brukental Acta Musei*, III.3, (2008). p. 123-127;

Cuzic, Cuzic 2010 — Cuzic Mariana, Cuzic Viorel, *Date faunistice privind mamiferele din zona Vadu*. In: *Brukental Acta Musei*, V.3 (2010), p. 539-542.

Cuzic, Cuzic 2018 — Cuzic Viorel, Cuzic Mariana, *Date cu referire la păsările şi mamiferele din zona tampon şi cea de dezvoltare durabilă a zonei strict protejate Grindul Chituc din cadrul R.B.D.D.*". In: *Studii si Cercetari de ştiinţele naturii şi muzeologie, Delta Dunării VII. (*2018*)* Tulcea.

Gâştescu 1971 — Gâştescu Petre*, Lacurile din România: limnologie regională*, București, (1971)

Kiss *et al.* 2012 — Kiss J. Botond, Doroșencu Alexandru, Marinov Mihai, Alexe Vasile, Bozagievici Raluca, *Considerations Regarding the Occurrence of the Eurasian Beaver (Castor fiber Linnaeus)*, In: *Scientific Annals of the Danube Delta Institute*, Tulcea (2012), vol. 18, pp. 49 – 56

Miu *et al.* 2018 — Miu V. Iulia, Chisamera B. Gabriel, Popescu D. Viorel , Iosif Ruben, Nita Andreea, Manolache Steluța, Gavril D. Viorel, Cobzaru Ioana, Rozylowicz Laurențiu, *Conservation priorities for terrestrial mammals in Dobrogea Region, Romania.* In: *ZooKeys* 792: 133–158. https:// doi.org/10.3897/zookeys.792.25314

Murariu 1981 a — Murariu Dumitru, *Contribuţii la cunoaşterea răspândirii şi ecologiei mamiferelor din zona Deltei Dunării şi a lacului Razelm*.In: *Trav. Mus. Hist. Nat. "Gr. Antipa",* București (1981)

23: 283-296.

Murariu 1981 b — Murariu Dumitru, - *Prezența lui Mus musculus spicilegus Petenyi, 1882 în Delta Dunării şi "parazitarea" lui de către Apodemus agrarius (Pall, 1771).*In: *Trav. Mus. Hist. Nat. "Gr. Antipa"*, București (1981) 23: 297-304.

Murariu 1984 — Murariu Dumitru, *Microtus epiroticus (Ondrias, 1966), specie recent semnalată în fauna României.* In: *Trav. Mus. Hist. Nat. "Gr. Antipa",* București (1984) 25: 333-340.

Murariu 1996 — Murariu Dumitru, *Mamiferele din Delta Dunări*. In: *Trav. Mus. Hist. Nat. "Gr. Antipa*", București (1996) 36: 361-371.

Murariu 2000 — Murariu Dumitru, *Insectivora. Fauna României*, XVI (Mammalia), București (2000) : p 1-142

Murariu 2006 — Murariu Dumitru, *Mammal Ecology and Distribution From North Dobrogea (Romania)*. In: *Travaux du Muséum National d'Histoire Naturelle «Grigore Antipa»* București (2006), Vol. XLIX pp. 387–399

Murariu 2008 — Murariu Dumitru, *Faunology, Biology, Ecology and Protection Statutge of the Mammals (Mammalia) of the Mãcin Mountains National Park (Romania),*In: *Travaux du Muséum d'Histoire Naturelle „Grigore Antipa"*, Bucureşti, (2008), Vol: 51, pp. 273-301

Murariu, Stanciu 2009 — Murariu Dumitru, Stanciu Cătălin Răzvan, *Data on the Presence of the Species Mesocricetus newtoni (Nehring, 1898) (Mammalia: Muridae: Cricetinae) in Dobrogea (Romania),* In: *Travaux du Muséum d'Histoire Naturelle „Grigore Antipa"*, București (2009), Vol 52: 336-369

Pocora *et al*. 2012 — Pocora Viorel, Popovici Mariana, Manci Cosmin, Iorgu Ionut Stefan, *Feeding of the Little Owl During Nesting Season in the Danube Delta (Romania),* In: *Scientific Annals of „Alexandru Ioan Cuza" University from Iași, s. Biologie animală*, Iași (2012) Tom LVIII.

Popescu, Murariu 2001 — Popescu Alexandrina, Murariu Dumitru, *Rodentia. Fauna României, XVI (Mammalia),* Editura Academiei Române, București, (2001) *2*: 1-214.

Puceck 1981 — Puceck Zdzislaw (edit), - *Keys to Vertebrates of Poland - Mammals.* Polish Scientific Publishers, Warszawa (1981)

Răduleț 2005 — Răduleț Năstase, *Contributions to the Knowledge of the Mammal Fauna from Dobrogea (Romania),* In: *Travaux du Muséum d'Histoire Naturelle „Grigore Antipa",* Bucureşti,(2005) Vol: 47, pp. 417-425

Roşu 1973 — Roşu Alexandru, *Geografia fizică a Românie*i, Bucureşti (1973)

Sîrbu 2009 — Sîrbu Ioan, *Bazele modelării proceselor și sistemelor ecologice,* (2009): 1-174.

Sîrbu, Benedek 2012 — Sîrbu Ioan, Benedek Ana Maria, *Ecologie practică. Ediția a 3-a.* Sibiu, (2012): 1-292.

Solomon 1968 — Solomon Livia, *Contribution a la connaissance de l acaroparasitofaune des petits mamiferes de Dobroudja.* In: *Trav. Mus. Hist. Nat. "Gr. Antipa"*, București (1968) 8, 2: 671-692.

Suciu 1971 — Suciu Maria, *Date ecologice asupra sifonapterelor parazite pe mamifere mici (Insectivora, Rodentia) din Dobrogea de Nord şi Delta Dunării*, In: *Studii şi cercetări de biologie. Seria Zoologie,* (1971) 23, 2: 173-184.

Vasiliu, Şova, 1968 — Vasiliu George, Şova Constantin, *Fauna Vertebratica Romaniae (index).* In: *Stud. Com. Muz. Şt. Nat. Bacău, 1, partea II* (1968): 215-254.

Volosciuc 1959 — Volosciuc A., *Bizamul.*In: *Vânăt. Pesc. Sportiv,* (1959)12, *4*: 15.

Wegner 1970 — Wegner Zofia, *Lice (Anoplura) of small Mammals caught in Dobroudja (Romania)*. In: *Com. Zool., Soc. Ştiinţe Biologice din R.S.R.*, Bucureşti (1970): 305-314.

Wilson, Reeder 2005 — Wilson Don E., Reeder Dee Ann M. (editors), *Mammal Species of the World. A Taxonomic and Geographic Reference* (3rd ed)**,** Johns Hopkins University Press, (2005), 1-142.

LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Fig. 1. Riverside willow forest at Maliuc

Fig. 2. Sand dunes at Vadu

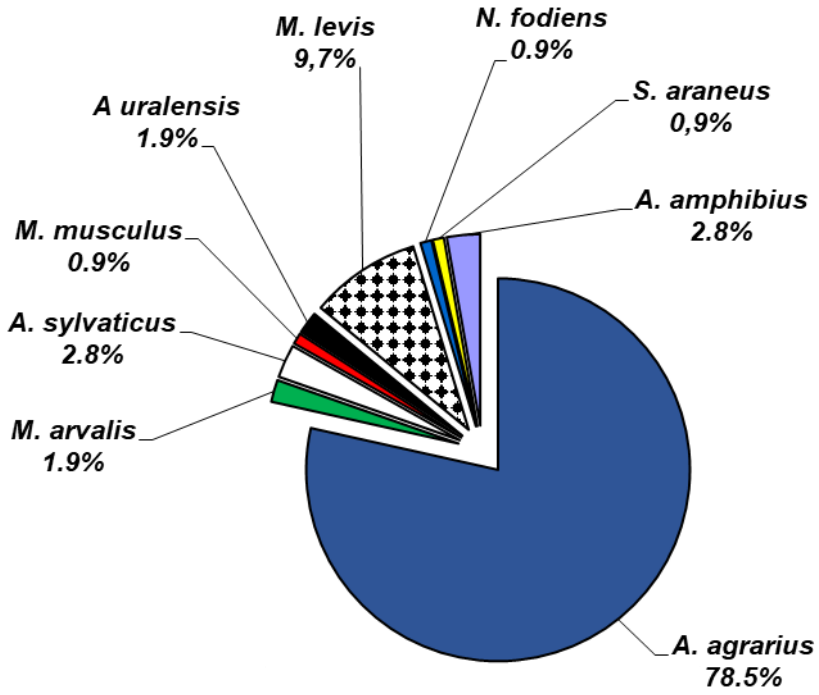


Fig. 3. Relative abundance of small mammal species captured between August 2007 - August 2018 in the Danube Delta Biosphere Reserve

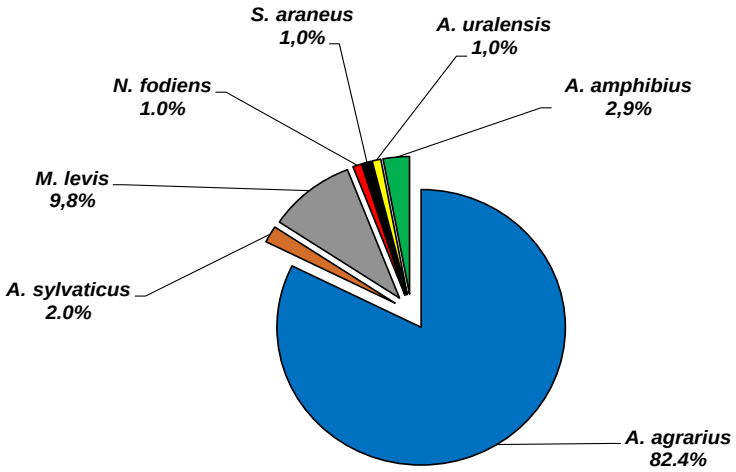


Fig. 4. Relative abundance of small mammal species captured between August 2007 and September 2012 in Maliuc station

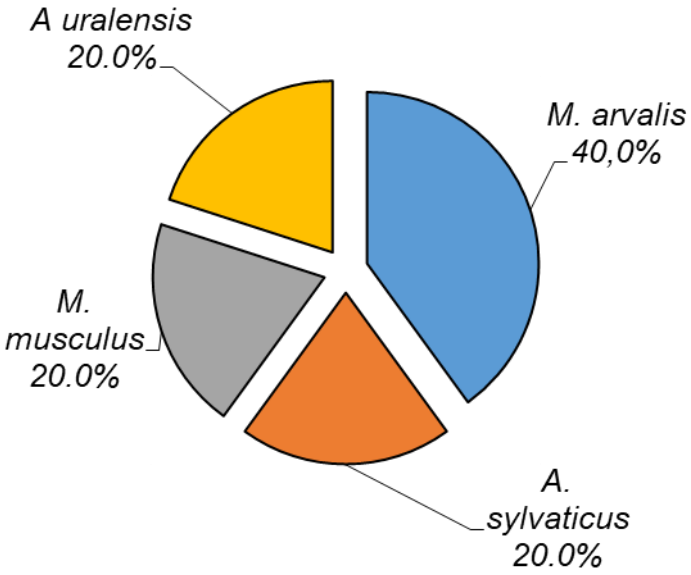


Fig. 5. Relative abundance of small mammal species captured during August 2007 - August 2012 at Vadu station

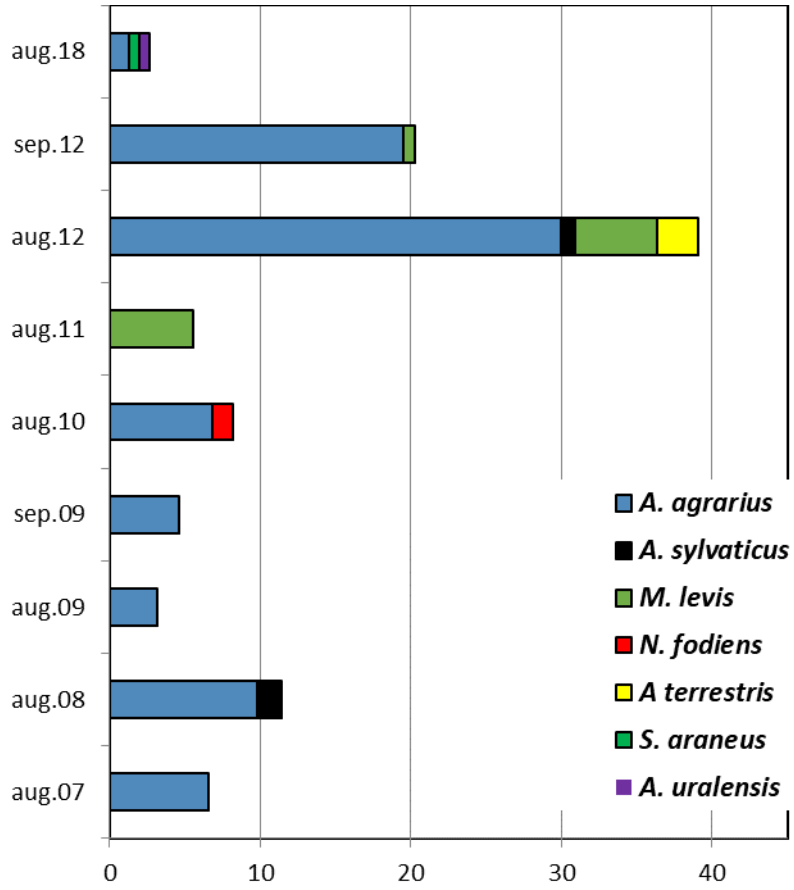


Fig. 6. Dynamics of capture index for small mammal species caught in Maliuc - Danube Delta station

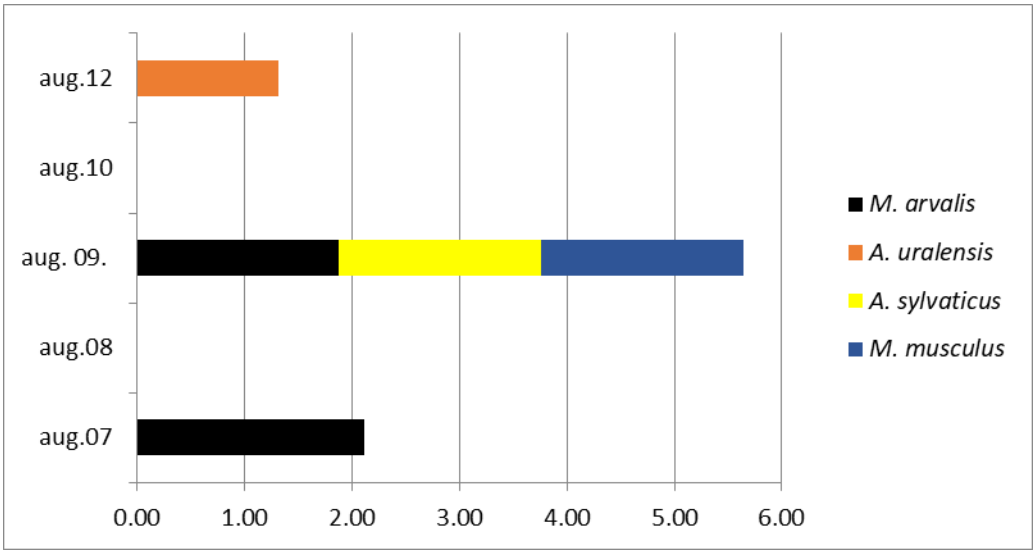


Fig. 7. Dynamics of capture index for small mammal species captured in Vadu station - Danube Delta Biosphere Reserve

Tab. 1. The species and place of capture in the bibliographic sources and in the present study

Species	References data	Captured in this study	Observed by other methods
Sorex araneus	Caraorman, Cormorova, Sf. Gheorghe, Letea	Maliuc 2018 N45°12'14.74" E29°06'50.19"	Found death in Letea 2008 45°19'07"N 29°26'44"E
Sorex minutus	Danube Delta		
Neomys fodiens		Maliuc 2010 N45°12'14.74" E29°06'50.19"	
Neomys anomalus	Sf. Gheorghe, Crișan, Red Lake, Mila 23, Letea		
Crocidura leucodon	Jurilovca		
Crocidura suaveolens	Jurilovca, Vadu		
Talpa europaea	Murighiol, Jurilovca		
Spermphilus citellus	Vadu		Observed at Sinoe Lake in 2007, 2008, 2009, 2010, 2012, 2013, 2014, 2016. N44°27'59.62" E28°45'06.68"
Castor fiber	Maliuc		Found death near Maliuc 2011 – Petrescu in verbis
Mesocricetus newtoni	Jurilovca		
Ondatra zibethicus	Danube Delta, Sulina, Maliuc		Observed on adjacent canals of Fourtuna Lake in 2008 45°11'42,67" E29°07'14,37", N45°11'53,53" E29°06'30,82" and on the Ciobănița Lake in 2018, N45°12'01,72" E29°05'45,35".
Arvicola amphibius	Mila 23, Letea	Maliuc 2012 N45°12'14.74" E29°06'50.19"	
Microtus arvalis	Jurilovca, Danube Delta, Sulina, Letea, Vadu	Vadu 2007, 2009	
Mirotus levis	Danube Delta, Roșuleț Lake	Maliuc 2011, 2012 N45°12'14.74" E29°06'50.19"	
Microtus suberraneus	Danube Delta		

Species	References data	Captured in this study	Observed by other methods
Micromys minutus	Danube Delta, Sulina, Letea		Captured by hand at Maliuc 2014 N45°12'14.74" E29°06'50.19"
Apodemus agrarius	Maliuc, Vadu, Caraorman, Sulina, Sf. Gheorghe, Letea,	Maliuc 207, 2008, 2009, 2010, 2012, 2018 N45°12'14.74" E29°06'50.19"	
Apodemus flavicollis	Jurilovca		
Apodemus sylvaticus	Maliuc, Vadu, Murighiol, Sf. Gheorghe, Jurilovca, Calica, Letea	Maliuc 2008, 2012 N45°12'14.74" E29°06'50.19"	
Apodemus uralensis	Jurilovca, Letea	Maliuc 2018, N45°12'14.74" E29°06'50.19" Vadu 2012, N44°26'07.77" E28°46'22.17"	
Mus musculus	Maliuc, Vadu, Gura Portiței, Jurilovca, Sulina, Letea	Vadu 2009 N44°27'34.55" E28°44'28.67"	
Mus spicilegus	Jurilovca, Danube Delta, Maliuc, Letea		
Rattus norvegicus	Danube Delta, Maliuc, Gura Portiței, Caraorman, Sulina, Crișan		Captured by hand at Vadu, 2013 N44°25'52.86" E28°45'59.87"
Rattus rattus	Caraorman		
Spalax leucodon	Maliuc		
Myocastor coypus	Ilgani, Grindu, Isaccea		

Tab. 2. The species and the number of individuals captured between July 2007 and August 2018 in the Danube Delta Biosphere Reserve (the recaptures from the same campaign are not considered)

Campaign			August2007	August 2008	august 2009	Sept. 2009	August 2010	August 2011	August 2012	Sept. 2012	August 2018	Total	AR%
Maliuc	Willows riverside forest	*Trapping effort* **SFT**	76	61	95	87	73	54	110	113	150	819	
		A agrarius	5	6	3	4	5	0	33	26	2	84	82.4
		A sylvaticus	0	1	0	0	0	0	1	0	0	2	2
		M. levis	0	0	0	0	0	3	6	1	0	10	9.8
		N. fodiens	0	0	0	0	1	0	0	0	0	1	1
		S.araneus	0	0	0	0	0	0	0	0	1	1	1
		A amphibius	0	0	0	0	0	0	3	0	0	3	2.9
		A uralensis	0	0	0	0	0	0	0	0	1	1	1
Vadu	Dunes	*Trapping effort* **SFT**	47	47	53	-	-	31	76	-	-	254	
		A uralensis	0	0	0	-	-	0	1	-	-	**1**	**20**
		M. arvalis	1	0	1	-	-	0	0	-	-	**2**	**40**
	thicket	*A sylvaticus*	0	0	1	-	-	0	0	-	-	**1**	**20**
		M. musculus	0	0	1	-	-	0	0	-	-	**1**	**20**
Total		***A agrarius***	**5**	**6**	**3**	**4**	**5**	**0**	**33**	**26**	**2**	**82**	**78.5**
		A sylvaticus	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**3**	**2.8**
		M. levis	**0**	**0**	**0**	**0**	**0**	**3**	**6**	**1**	**0**	**10**	**9.7**
		N. fodiens	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0.9**
		A amphibius	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**3**	**2.8**
		A uralensis	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1.9**
		M. arvalis	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1.9**
		M. musculus	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0.9**
		S. araneus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1.9**
Number of species			2	3	4	1	2	1	4	2	3	9	
Total number of specimens			**6**	**8**	**6**	**4**	**6**	**3**	**41**	**27**	**4**	**107**	**100 %**

A HISTORICAL PERSPECTIVE OF FOOD AND MEDICINAL USES OF ANTIOXIDANTS FROM NATURAL SOURCES

Andreea-Cristina TECUCIANU*
Simona OANCEA**

Abstract*. Natural antioxidants are compounds with a long history of medicinal and food uses. Initially, antioxidants were used to prevent lipid oxidation of several food products. Over time, the research have been enriched with new insights on health benefits of antioxidant compounds or extracts and the prevention of chronic diseases. The present paper aimed to describe the evolution of scientific publications on natural antioxidants, the analytical techniques involved over time to quantify them and determine the bioactivity, as well as application for food and medicinal purposes*
Keywords*: antioxidant activity, food antioxidant, food supplements, health.*

Rezumat. *Antioxidanții naturali reprezintă compuși chimici cu o istorie îndelungată privind utilizările lor în scopuri medicinale și alimentare. Inițial, antioxidanții au fost folosiți în scopul prevenirii oxidării lipidelor din alimente. De-a lungul timpului, cercetarea științifică a fost îmbogățită cu noi rezultate privind beneficiile compușilor antioxidanți sau extractelor asupra sănătății umane și prevenirea bolilor cronice. Lucrarea de față are drept scop descrierea evoluției cercetărilor asupra antioxidanților naturali, a tehnicilor analitice utilizate de-a lungul timpului și utilizările lor în scopuri alimentare și medicinale.*
Cuvinte cheie: *activitate antioxidantă, antioxidant alimentar, suplimente alimentare, sănătate*

Introduction

Antioxidant compounds can be defined in different ways, depending on the method used to determine their activity. The comparison of antioxidant activities of several substances or natural extracts is equivalent only if the same method is used to measure it. In a broad sense, the term antioxidant refers to "any substance that delays, prevents or removes oxidative damage to a target molecule" (Halliwell, Gutteridge 2007, 77). Antioxidants are either synthetic compounds (*tert*-butylhydroxyl-toluene, *tert*-butylhydroxyanisole, *tert*-butylhydroquinone, widely used in the oil industry) or natural molecules of great chemical variability (vitamins, polyphenols, carotenoids, steroids, thiol derivatives, enzymes) (Lü *et al.*, 2010).

There were several food uses of antioxidants over time, initially to prevent the rancidity of fat and oils as fundamental part of human diet, and to preserve their nutritional value (French *et al.*, 1935).

* Lucian Blaga University of Sibiu, Department of Agricultural Sciences and Food Engineering, Sibiu, Romania, andreea.stroe@ulbsibiu.ro
**Lucian Blaga University of Sibiu, Department of Agricultural Sciences and Food Engineering, Sibiu, Romania, simona.oancea@ulbsibiu.ro

Nowadays, the uses of natural antioxidants have been extended to the production of functional foods as items intended to prevent specific diseases, food supplements and cosmetics (Zehiroglu, Sarikaya 2019).

The antioxidants were originally used in food in order to prevent the oxidation of unsaturated fatty acids (Comert, Gokmen, 2018), molecules well-known for their bioactive properties. In the first half of the 19th century, most studies were carried out to isolate different types of antioxidants from raw materials, especially intended for use in the food industry, but not limited to it (Greenbank, Holm, 1934; Olcott, Mattill, 1935; Morawetz, 1949; Moore, Bickford, 1952). Since the end of the 19th century, the number of studies on antioxidants has steadily increased and significant discoveries have opened up new horizons of research.

Research over time has shown that antioxidants also exhibit their activity inside the body (Gyorgy, Rudolph, 1944). This new discovery has led to the expansion of the research area, studies beginning to focus on the action of antioxidants in organisms such as mice or poultry (Casselman, 1953; Machlin *et al.*, 1959).

Over the years, their health benefits and anti-aging effects have been discovered and research

continues in the direction of identification of new sources and application of various methods of administration in order to increase their *in vivo* efficiency (Lehman *et al*., 1957).

In the last decade of the 19th century, a great number of scientific publications related to the health effects of antioxidants has occurred (Niwa, Miyachi, 1986; Strakova *et al.*, 1988; Sinclair *et al*., 1990), while interest in topics on food antioxidant and antioxidant content in various sources began to grow (Beuchat, Jones, 1978; Pascal, 1979; Kabara, 1980).

By using the keywords "antioxidant" "antioxidant and health", "food antioxidants" and "antioxidant content" a great number of articles have been found in one of the most important international databases, Web of Science. So far, the number of researches on this topic has steadily increased, as presented in Fig. 1.

In the present paper, the topic of antioxidants is approached from a historical point of view and discussed in the following sections, in relation to their uses and health-promoting benefits.

A brief history of antioxidants

Generally, oxidation reactions of various substrates can generate chemical species (free radicals) that affect biomolecules, such as proteins, lipids, or nucleic acids. Such oxidative process may be delayed by the action of specific molecules, synthetic or natural antioxidants, through stabilization or elimination of free radicals by self-oxidation (Valentao *et al*., 2002).

Antioxidants were initially used in industrial processes to prevent corrosion of metals (Howard, Tong, 1980; Kovtun *et al*., 1980). Over time, antioxidants have been used to prevent fat rancidity (Bejambes, 1959; Olson, Stadelman, 1980; Jeremiah, 1985; Schaefer *et al.*, 1995) and to preserve the nutritional value of polyunsaturated fatty acids and oils by enrichment with fat-soluble vitamins (Vancaneghem *et al*., 1979), functioning as additives. At the same time, the *in vivo* antioxidant power has become a research topic of great interest, several techniques being performed to investigate the *in vitro* and *in vivo* mechanism of action (Jensen, Mcginnis, 1960; Zhigacheva, Kaplan, 1985; Salo *et al.* 1986).

The increased interest in finding valuable sources of natural antioxidants (Budincevic *et al*., 1995; Madsen, Bertelsen, 1995; Duh, Yen, 1997) developed since the end of the 19th century has led to the physical-chemical characterization of antioxidant compounds isolated from fruits, vegetables, herbs or spices (Kazimierz *et al*., 1997; Rao, Agarwal, 1999; Zhao *et al*., 2014). Until now, many natural antioxidants have been identified from a variety of sources such as tea leaves (Zandi, Gordon 1999), plant roots (Lin, Chang, 2013), plant seeds (Wettasinghe, Shahidi, 1999), mushrooms (Yen, Wu, 1999, Ribeiro *et al.*, 2015), spices (Menegali *et al*., 2020), wood extract (Cheng *et al*., 2015), plant shoots (Medini *et al*., 2014), seaweed (Vega *et al.*, 2020), fruit and vegetable peels (Sarabandi *et al.*, 2019), coconut water (Rodsamran, Sothornvit, 2018) or bee pollen (Jin *et al.*, 2018). Vegetable wastes, such as fruit peels, are sustainable sources to be valorized for the recovery of biological compounds of different chemical structures, exhibiting antioxidant properties. A published study reported that wastes obtained by squeezing citrus fruits to make fruit juice are rich in antioxidants, mainly phenolic acids, flavanones and polymethoxylated flavors that can be used in both medicine and cosmetics industry to obtain creams or masks with antioxidant effects (Singh *et al*., 2020). Another study indicated that large amounts of β-carotene can be recovered from the mold *Blakeslea trispora* able to grow on substrates containing fruit and vegetable wastes (cabbage, watermelon peel, peach peels), (Kaur *et al*., 2019). Red cabbage wastes have been also used for ultrasound-assisted extraction of compounds showing strong antioxidant properties (Oancea *et al.*, 2020).

Fig. 2 illustrates the major developments and milestones in the research regarding the *in vitro* and *in vivo* methods for analysis of antioxidants. A large number of analytical techniques has been developed to determine the *in vitro/ in vivo* antioxidant activity of molecules or natural extracts, such as α,α-diphenyl-β-picrylhydrazyl (DPPH), Total Reactive Antioxidant Potential (TRAP), Oxygen Radical Absorbing Capacity (ORAC), Trolox Equivalent Antioxidant Capacity (TEAC), 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid (ABTS), Ferric Reducing Antioxidant Power (FRAP), Copper Reducing Antioxidant Capacity (CUPRAC), N,N-dimethyl-*p*-phenylenediamine (DMPD) and Global Antioxidant Response (GAR).

Food antioxidants

Foods are the main source of natural antioxidants in the human body. In general, most fruits, vegetables, and spices are rich sources of compounds with antioxidant properties. In the last decade, a new concept has begun to develop, namely functional foods. Functional foods are

defined as traditional foods or food-derived products or ingredients improved in nutritional value by addition of bioactive products, which can positively influence human health (Santini *et al*., 2017). There is a large number of types of functional foods; it is worth to mention a product obtained by the incorporation of anthocyanin-rich rice into yogurts (Anuyahong *et al*., 2020). This combination enriches the nutritional value of yogurt by increasing the content of polyphenols, in particular anthocyanins, showing good antioxidant activity. Antioxidants of polyphenolic structure have been successfully used in edible oils rich in healthy polyunsaturated fatty acids in order to generate new products stable to oxidative degradation (Draghici *et al.*, 2018; Stoia, Oancea 2013).

Consumption of natural antioxidants generates many health benefits, generally associated with the prevention of diseases caused by harmful free radicals (reactive oxygen species). When diet does not provide the necessary antioxidants, there is a need for supplementation, usually with vitamins. Vitamins C and E are molecules known for their antioxidant properties (Ribiero *et al.*, 2010). The main sources of vitamins are vegetables and fruits, but currently a multitude of vitamin supplements are marketed, in order to balance a diet low in essential nutrients. A survey of female subjects showed that dietary supplements are used frequently. About 50% of participants reported taking a form of vitamin C supplements. Multivitamins are also good sources of antioxidants, being commonly consumed (Shikany *et al.*, 2003). There are many variations of vitamin C dietary supplements, both in their pure state or in combination with propolis, minerals such as zinc, and plant extracts such as roses or citrus. Vitamin E supplements generally contain only vitamin E or complex mixtures of tocopherols and minerals beneficial for stimulating the body immunity (Maggini *et al.*, 2007).

The investigation toward the methods involved for preservation and enrichment of nutritional value of food products by antioxidants is still a topic of interest. In terms of prepared foods, it has been shown that antioxidants isolated from spices, vegetables or fruits inhibit the formation of toxic compounds in cooked meat, which brings an extra benefit, in addition to the nutritional value and flavor they give (Jiang, Xiong, 2016). Pink pepper extract can be used as a natural antioxidant in a chicken burger, as it has been shown to increase the stability of the product over time and prevent the oxidation of lipids (Menegali *et al*., 2020).

In addition, there are studies that suggest a link between the antioxidant-rich feed and the quality of the food obtained from those animals. Supplementing the chicken diet with antioxidants led to an improved quality of their meat (Li *et al.*, 2020).

Antioxidants and health

Antioxidant compounds protect the body against oxidative stress, a process responsible for aging, heart disease, different forms of cancer, and hypertension. Aging is one of the factors that favor the onset of diseases such as cancer (Toren *et al*., 2007), neurodegenerative (Tony, 2016) or cardiovascular diseases (Nilesh, Van der Harst Pim, 2008).

The protective effect of antioxidants against heart diseases is associated with limiting the production of reactive oxygen species inside cells, which triggers the induction of the mitochondrial permeability transition. *In vitro* studies have shown that this process is involved in the apoptosis of myocardial cells that occur in ischemic heart disease (Zorov *et al*., 2000; Park *et al.*, 2009).

Studies over time have shown that antioxidant therapy can be effective in preventing several diseases. Tab. 1 presents a number of antioxidant compounds or extracts from natural sources (plants, mushrooms, algae), whose beneficial health effects have been confirmed by clinical trials. Most of investigated compounds belong to the class of polyphenols, in particular flavonoids. Such compounds are secondary plant metabolites with large applications in pharmacology, medicine, food and agriculture. In plants, polyphenols play a significant role as messengers, regulators of phytohormones, acting as biomarkers of abiotic stress (Boscaiu *et al.*, 2010).

Antioxidants are also known for their protective effect on immune cells. The inhibitory and stimulatory effects of several categories of natural compounds on various processes involved in immunity have been previously described (Stroe, Oancea, 2020).

The skin has an antioxidant defense system to combat the oxidative stress induced by UV radiation. However, excess UV radiation can overwhelm the skin's antioxidant capacity, which can lead to the development of diseases associated with oxidative stress (Steenvoorden, Beijersbengen van Henegouwen, 1997, 1). For

this reason, there is a need to supplement the amount of antioxidants both inside, through the diet, and outside through cosmetics intended for this purpose. The *Alkanna tinctoria* L. root bark extract has a high content of flavonoids and phenolics, which increase sun protection factor capacities of cosmetic creams (Jaradat *et al*., 2018, 93). Gels containing vitamin C have been shown to reduce redness and dehydration of the skin induced by UV radiation. An *in vivo* study in mice suggests that skin treatment with *Pinus halepensis* gels after irradiation helps heal damaged skin and prevents the spread of injury (Dimaki *et al*., 2019, 7).

Conclusions

Antioxidants are molecules of great chemical variety intensively studied over time, found abundantly in sources such as fruits, vegetables, spices, vegetable wastes, seeds, bark, petals. The end of the 19th century was the period in which antioxidants began to be used for medicinal purposes, to treat or prevent heart diseases, to increase immunity, or to protect cells against oxidative stress generated by free radicals. From then until now, the identification of new sustainable sources of antioxidants, as well as development of methods of investigation of their content and activity have remained topics for which interest is constantly growing.

REFFERENCES

Allahyari *et al.* 2014 — Allahyari Saeideh, Abbas Delazar, Moslem Najafi, *Evaluation of general toxicity, anti-oxidant activity and effects of Ficus carica leaves extract on ischemia/reperfusion injuries in isolated heart of rat*. In: *Advanced Pharmaceutical Bulletin* 4 Suppl 2, (2014), p. 577-582.

Anlar, Bacanli 2020 — Anlar Hatice Gul, Bacanli Merve, *Lycopene as an antioxidant in Human health.* In: *Pathology. Oxidative stress and dietary antioxidants* (2020), p. 247-254.

Anuyahong *et al.* 2020 — Anuyahong Tanisa, Chusak Charoonsri, Adisakwattana Sirichai, *Incorporation of anthocyanin-rich riceberry rice in yogurts: Effect on physicochemical properties, antioxidant activity and in vitro gastrointestinal digestion.* In: *LWT-Food Science and Technology* 129, (2020), p.109571.

Ashari *et al.* 2020 — Asgari-Kafrani, Fazilati Mohammad, Nazem Habib, *Hepatoprotective and antioxidant activity of aerial parts of Moringa oleifera in prevention of non-alcoholic fatty liver disease in Wistar rats*. In: *South African Journal of Botany, 129,* (2019), p. 82-90.

Bejambes 1959 — Bejambes M, *The preservation of butter: oxidation*. In: *Annales de la nutrition et de l'alimentation* 13, (1959), p. 281-297.

Beuchat, Jones 1978 — Beuchat Larry, Jones WK., *Effects of food preservatives and antioxidants on colony formation by by heated conidia of Aspergillus-Flavus*. In: *Acta alimentaria* 7.4, (1978), p. 373-384.

Boscaiu *et al.* 2010 — Boscaiu Monica, Sanchez Maria, Bautista Inmaculada, Donat Pilar, Lidon Antonio, Llinares Josep, Llul Cristina, Mayoral Olga, Vicente Oscar, *Phenolic compounds as stress markers in plants from Gypsum Habitats*. In: *Bulletin UASVM Horticulture*, 67.1, (2010), p. 44-49.

Budincevic *et al.* 1995 — Budincevic Mirko, Vrbasky Z, Turkulov J, Dimic Etelka, *Antioxidative activity of extracts of plants on feed fats.* In: *Fett wissenschaft technologie- fat science technology* 97.2, (1995), p. 461-466.

Casselman 1953 — Casselman Bruce, *Factors influencing the formation of ceroid in the livers of cholinedeficient rats. 2. Dietary antioxidants*. In: *Biochimica et Biophysica Acta* 11, (1953), p. 446-447.

Cheng *et al.* 2015 — Cheng Seng Sun, Yen Peiling, Chang Shangtzen, *Phytochemicals from wood extract of Cunninghamia konishii Hayata as antioxidant agents*. In: *Industrial Crops and Products* 64, (2015), p. 39-44.

Comert, Gokmen 2018 — Cömert Ezgi Doğan, Gökmen Vural, *Evolution of food antioxidants as a core topic of food science for a century*. In: *Food Research International* 105, (2018), p.76-93.

Deepa *et al.* 2018 — Deepa Ponnuvel, Sowndhararajan Kandhasamy, Kim Songmin, Park Se Jin. *A role of Ficus species in the management of diabetes mellitus: a review.* In: *Journal of*

Ethnopharmacology 215, (2018), p. 210-232.

Dimaki *et al.* 2019 — Dimakia Aggeliki, Maria Kyriazi, Georgios Leonis Ioannis Sfiniadakis, Georgios Theodoros Papaioannou, Efstathia Ioannou , Vassilios Roussisc, Michail Rallis. *Diabetic skin and UV light: Protection by antioxidants*. In: *European Journal of Pharmaceutical Sciences* 127, (2019), p. 1-8.

Draghici *et al.* 2018 — Drăghici Olga, Păcală Mariana-Liliana, Oancea Simona. *Kinetic studies on the oxidative stabilization effect of red onion skins anthocyanins extract on parsley (Petroselinum crispum) seed oil*. In: *Food Chemistry* 265, (2018), p. 337-343.

Du *et al.* 2012 — Du Guang-Jian, Zhang Zhiyu, Wen Xiao-Dong, Yu Chunhao, Calway Tyler, Yuan Chun-Su, Wang Chong-Zhi, *Epigallocatechin Gallate (EGCG) is the most effective cancer chemopreventive polyphenol in green tea*. In: *Nutrients* 4.11, (2012), p. 1679-1691.

Duh, Yen 1997 — Duh Pin-Der, Yen Gow-Chin. *Antioxidative activity of three herbal water extracts*. In: *Food Chemistry* 60.4, (1997), p. 639-645.

Ebrahim, Sakthisekaran 1997 — Ebrahim Abdul Shukkur, Sakthisekaran Dhanapal, *Effect of vitamin E and taurine treatment on lipid peroxidation and antioxidant defense in perchloroethylene-induced cytotoxicity in mice.* In: *The Journal of Nutritional Biochemistry* 8.5, (1997), p. 270-274.

Fito *et al.* 2005 — Fito Montsrrat, Cladellas Mercedes, De la Torre R., Marti Josep Maria, Alcantara Mrcedes, Pujadas-Bastardes Maria, Marrugat Jaume, Bruguera Jordi, Lopez - Sabater Maria Cameron, Vila Joan Salvador, Covas Maria Isabel, *Antioxidant effect of virgin olive oil in patients with stable coronary heart disease: a randomized, crossover, controlled, clinical trial.* In: *Atherosclerosis* 181.1, (2005), p. 149-158.

French *et al.* 1935 — French, Rowland Barnes, Olcott HS, Mattill HA, *Antioxidants and the autoxidation of fats. III.* In: *Industrial & Engineering Chemistry* 27.6, (1935), p. 724-728.

Gavahian *et al.* 2019 — Gavahian Mohsen, Khaneghah Amin Mousavi, Lorenzo Jose, Munekata Paulo, Garcia-Mantrana Izaskun, Collado Maria Carmen Melendez-Martines Antonio, Barba Francisco, *Health benefits of olive oil and its components: Impacts on gut microbiota antioxidant activities, and prevention of noncommunicable diseases*. In: *Trends in food science & technology* 88, (2019), p. 220-227.

Greenbank, Holm 1934 — Greenbank George, Holm George, *Antioxidants for fats and oils*. In: *Industrial & Engineering Chemistry* 26(3), (1934), p. 243-245.

Gyorgy, Rudolph 1944 — Gyorgy Paul, Rudolph Tomarelli, *Further observations on physiological antioxidants*. In: *Journal of Biological Chemistry* 154, (1944), p.317-324.

Halliwell, Gutteridge 2007 — Halliwell Barry, Gutteridge John, *Free Radicals in Biology and Medicine*, fourth ed., *Oxford University Press*, Oxford (2007).

Hashemi, Abediankenari, 2013 — Hashemi Seyyed Abbas, Saeid Abediankenari. *Suppressive effect of fig (Ficus carica) latex on esophageal cancer cell proliferation*. In: *Acta Facultatis Medicae Naissensis* 30.2, (2013), p. 93-96.

Hoseinifar *et al.* 2020 — Hoseinifar Hossein Seyed, Shakouri Meysam, Doan Hien Van, Shafiei Shafigh, Yousefi Morteza, Raeisi Mojtaba, Yousefi Samira, Harikrishnan Ramasamy, Reverter Miriam. *Dietary supplementation of lemon verbena (Aloysia citrodora) improved immunity, immune-related genes expression and antioxidant enzymes in rainbow trout (Oncorrhyncus mykiss)*. In: *Fish & Shellfish Immunology* 99, (2020), p. 379-385.

Howard, Tong 1980 — Howard Jessica, Tong SB. *Metal-complexes as antioxidants.7.Kinetics of inhibition of styrene autoxidation by zinc di-isopropyldithiophosphate.* In: *Canadian Journal of Chemistry - Revue canadienne de chimie* 58.1, (1980), p. 92-95.

Jaradat *et al.* 2018 — Jaradat Nidal Amin, Abdel Naser Zaid, Fatima Hussen, Linda Issa, Mohammad Altamimi, Basil Fuqaha, Ahmad Nawahda, Maha Assadia. *Phytoconstituents, antioxidant, sun protection and skin anti-wrinkle effects using four solvents fractions of the root bark of the traditional plant Alkanna tinctoria (L.).* In: *European Journal of Integrative Medicine* 21, (2018), p. 88-93.

Jensen, Mcginnis 1960 — Jensen Leo S, McGinnis James *Influence of selenium, antioxidants and type of yeast on vitamin E deficiency in the adult chicken*. In: *The Journal of Nutrition* 72.1, (1960), p. 23-28.

Jeremiah 1985 — Jeremiah LE. *Effects of antioxidants on rancidity development and palatability of frozen bacon.* In: *Journal of Food Protection* 48.8, (1985), p. 653-658.

Jiang *et al.* 2017 — Jiang Lai, Tang Chaoliang, Rao Jie, Xue Qing, Wu Hao, Wu Dabao, Zhang Aijun, Chen

Ling, Shen Zhen, Lei Lei. *Systematic identification of the druggable interactions between human protein kinases and naturally occurring compounds in endometriosis.* In: *Computational Biology and Chemistry* 71, (2017), p. 136-143.

Jiang, Xiong 2016 — Jiang Jiang, Xiong Youling, L. *Natural antioxidants as food and feed additives to promote health benefits and quality of meat products: A review.* In: *Meat Science* 120, (2016), p. 107-117.

Jin *et al*. 2018 — Jin Tie-Yan, Kandasamy Saravanakumar, Myeong-Hyeon Wang. *In vitro and in vivo antioxidant properties of water and methanol extracts of linden bee pollen*. In: *Biocatalysis and Agricultural Biotechnology* 13, (2018), p. 186-189.

Kabara 1980 — Kabara Jared. *Antioxidants as multi-functional preservatives in food and cosmetisc.* In: *Journal of the American Oil Chemists Society* 57.1, (1980), p. A158-A159.

Kalia *et al.* 2017 — Kalia Sahil, Bharti Vijay, Giri Arup, Kumar Bhuvnesh. *Effect of Prunus armeniaca seed extract on health, survivability, antioxidant, blood biochemical and immune status of broiler chickens at high altitude cold desert.* In: *Journal of Advanced Research* 8.6, (2017), p. 677-686.

Kaur *et al*. 2019 — Kaur Prabhjot, Ghoshal Gargi, Jain Ashay. *Bio-utilization of fruits and vegetables waste to produce β-carotene in solid-state fermentation: Characterization and antioxidant activity.* In: *Process Biochemistry* 76, (2019), p.155-164.

Kazimierz *et al*. 1997 — Kazimierz Gasiorowski, Katarzyna Szyba, Barbara Brokos, Beata Koztaczynska, Magda Jankowiak-Wtodarczk, Jan Oszmianski. *Antimutagenic activity of anthocyanins isolated from Aronia melanocarpa fruits.* In: *Cancer Letters* 119.1, (1997), p. 37-46.

Kovtun *et al*. 1980 — Kovtun GA, Lysenko DL, Berenblyum AS, Moisev Ilya. *Mechanism of the inhibition of oxidation reactions by metal-complexes.3. the effect of coordination on the antioxidant properties of n-phenylanthranilic acid*. In: *Bulletin of the Academy of Sciences of the USSR Division of Chemical Science* 29.4, (1980), p. 540-543.

Latief *et al*. 2018 — Latief Uzma, Husain Hadiya, Ahmad Riaz. *β-Carotene supplementation ameliorates experimental liver fibrogenesis via restoring antioxidant status and hepatic stellate cells activity.* In: *Journal of Functional Foods* 49, (2018), p. 168-180.

Lee *et al*. 2012 — Lee Bor-Jen, Huang Yi-Chia, Chen Shu-Ju, Lin Ping-Ting, *Coenzyme Q10 supplementation reduces oxidative stress and increases antioxidant enzyme activity in patients with coronary artery disease*. In: *Nutrition* 28.3, (2012), p. 250-255.

Lehman *et al*. 1957 — Lehman Arnold, Fitzhugh Garth O., Nelson Arthur A., Woodard Geoffrey, *The pharmacological evaluation of antioxidants*. In: *Advances in Food Research.* 3, (1951), p. 197-208.

Li *et al*. 2018 — Li Shangshang, Hui Liu, Wenshuai Wang, Xiuxiu Wang, Chen Zhang, Jianjun Zhang, Huijuan Jing, Zhenzhen Ren, Zheng Gao, Xinling Song, Le Jia. *Antioxidant and anti-aging effects of acidic-extractable polysaccharides by Agaricus bisporus.* In: *International Journal of Biological Macromolecules* 106, (2918), p. 1297-1306.

Li *et al*. 2020 — Li Wei, Zhang Xiaoying, He Zeqi, Chen Yunjiao, Meng Tianmeng, Li Yifeng, Cao Yong. *In vitro and in vivo antioxidant activity of eucalyptus leaf polyphenols extract and its effect on chicken meat quality and cecum microbiota.* In: *Food Research International* (2020), 109302.

Lin, Chang 2013 — Lin Huanyou, Chang Shangtzen. *Antioxidant potency of phenolic phytochemicals from the root extract of Acacia confusa*. In: *Industrial crops and products* 49, (2013) p. 871-878.

Lü *et al.* 2010 — Lü Jian-Ming, Lin Peter H, Yao Qizhi, Chen Changyi. *Chemical and molecular mechanisms of antioxidants: experimental approaches and model systems*. In: Journal of Cellular and Molecular Medicine 14, (2010) p. 840-860.

Machlin *et al*. 1959 — Machlin, Lawrence, Gordon Robert S, Meisky KH, *The effect of antioxidants on vitamin E-deficiency symptoms and production of liver peroxide in the chicken.* In: *Journal of Nutrition* 67, (1959), p 333-343.

Madsen, Bertelsen 1995 — Madsen Helle Lindberg, Bertelsen Grete. *Spices as antioxidants*. In: *Trends in Food Science and Technology*, 6.8, (1995), p. 271-277.

Maggini *et al*. 2007 — Maggini Silvia, Wintergerst Eva S, Beveridge Stephen, Hornig Dietrich. *Selected vitamins and trace elements support immune function by strengthening epithelial barriers and cellular and humoral immune responses*. In: *British Journal of Nutrition* 98.1, (2007), p. 29–35.

Matsuda *et al*. 2018 — Matsuda Yumi, Minagawa Takayoshi, Okui Takafumi, Yamazaki Kazuhisa. *Resveratrol suppresses the alveolar bone resorption induced by artificial trauma from occlusion in mice*. In: *Oral Diseases* 24.3, (2018), p. 412-421.

Medini *et al*. 2014 — Medini Faten, Fellah Hanen, Ksouri Riadh, Abdelly Chedly. *Total phenolic, flavonoid and tannin contents and antioxidant and antimicrobial activities of organic extracts of shoots of the plant Limonium delicatulum.* In: *Journal of Taibah University for Science* 8.3, (2014), p. 216-224.

Menegali *et al*. 2020 — Mengali Beatriz Schmidt, Selani Miriam Mabel, Saldana Erick, Patinho Iliani, Diniz Julia Pereria, Melo Priscilla Siquiera, Filfo Natan de Jesus Pimentel, Contreras-Castillo Carmen. *Pink pepper extract as a natural antioxidant in chicken burger: Effects on oxidative stability and dynamic sensory profile using Temporal Dominance of Sensations.* In: *LWT-Food Science and Technology* 121, (2020), p. 108986.

Moore, Bickford 1952 — Moore RN, Bickford WG., *A comparative evaluation of several antioxidants in edible fats*. In: *Journal of the American Oil Chemists' Society* 29(1), (1952), p.1-4.

Morawetz 1949 — Morawetz Herbert, *Phenolic Antioxidants for Paraffinic Materials*. In: *Industrial & Engineering Chemistry* 41(7), (1949), p. 1442-1447.

Negishi *et al*. 2004 — Negishi Hiroko, Xu Jin-Wen, Ikeda Katsumi, Njelekela Marina, Nara Yasuo, Yamori Yukio, *Black and green tea polyphenols attenuate blood pressure increases in stroke-prone spontaneously hypertensive rats*. In: *The Journal of Nutrition* 134.1, (2004), p. 38-42.

Nilesh, Pim 2008 — Nilesh Samani, Pim van der Harst. *Biological ageing and cardiovascular disease*. In: *Heart* 94.5, (2008), p. 537-539.

Niwa, Miyachi 1986 — Niwa Yukie, Yoshiki Miyachi. *Antioxidant action of natural health products and Chinese herbs*. In: *Inflammation* 10.1, (1986) p. 79-91.

Oancea *et al*. 2020 — Oancea Simona, Radu Maria, Olosutean Horea. *Development of ultrasonic extracts with strong antioxidant properties from red onion wastes*. In: *Rom. Biotech. Lett.* 25.2, (2020) p. 1320-1327.

Ojo *et al*. 2019 — Ojo Oluwafemi Adeleke, Ojo Adebola Busola, Ajiboye Basiru Olaitan, Olaiya Oluranti, Okesola Mary Okesola, Boligon Aline Augusti, Anraku de Campos Marli Matiko, Oyinloye Babatunji Emmanuel, Kappo Abidemi Paul. *HPLC-DAD fingerprinting analysis, antioxidant activities of Tithonia diversifolia (Hemsl.) A. Gray leaves and its inhibition of key enzymes linked to Alzheimer's disease.* In: *Toxicology Reports* 5, (2018), p. 585-592.

Olcott, Mattill 1935 — Olcott Henry Steel, Mattill HA, *Antioxidants and the Autoxidation of Fats. VI. Inhibitols1*. In: *Journal of the American Chemical Society* 58(9), (1936) p. 1627-1630.

Park *et al.* 2009 — Park S, Kim MY, Lee DH, Lee SH, Baik EJ, Moon CH., Park SW, Ko EY, OH SR, Jung YS. *Methanolic extract of onion (Allium cepa) attenuate ischemia/hyopaxia-induced apoptosis in cardiomyocytes via antioxidant effect.* In: *European journal of nutrition*, 48.4, (2009), p. 235-242.

Pascal 1979 — Pascal Gerard. *Foods antioxidants - tehnological, legislative, toxicological and nutritional aspects.* In: *Cahiers de nutrition et de dietetique* 14.4, (1979), p. 271-290

Rao, Agarwal 1999 — Rao Venketeshwer, Agarwal Sanjiv. *Role of lycopene as antioxidant carotenoid in the prevention of chronic disease: A review*. In: *Nutrition Research* 19.2, (1999), p. 305-323.

Reyes-Becerril *et al.* 2019 — Reyes-Becerril Martha, Angulo Carlos, Sanchez Veronica Vazquez-Martinez Juan, Lopez Mercedes. *Antioxidant, intestinal immune status and anti-inflammatory potential of Chenopodium ambrosioides L. in fish: In vitro and in vivo studies.* In: *Fish & shellfish immunology* 86 (2019), p. 420-428.

Ribeiro *et al*. 2010 — Ribeiro Carine Muniz, Budni Patricia, Pedrosa Roberto Coury, Farias Mirelle Sifroni, Parisotto Eduardo Benedetti, Dalmarco Eduardo Monguilhott, Frode Tania Silvia, Oliviera-Silva Diogo, Colepicolo Pio, Filho Danilo Wilhelm. *Antioxidant therapy attenuates oxidative insults caused by benzonidazole in chronic Chagas heart disease*. In: *International Journal of Cardiology* 145.1, (2010), p. 27-33.

Ribeiro *et al*. 2015 — Ribeiro Andreia, Ruphuy Gabriela, Lopes Jose Carlos, Dias Madalena Maria, Barros Lillian, Barreiro Filomena, Ferreira Isabel. *Spray-drying microencapsulation of synergistic antioxidant mushroom extracts and their use as functional food ingredients.* In: *Food chemistry* 188, (2015) p. 612-618.

Rodsamran, Sothornvit 2018 — Rodsamran Pattrathip Rungsinee Sothornvit. *Bioactive coconut protein concentrate films incorporated with antioxidant extract of mature coconut water*. In: *Food Hydrocolloids* 79,

(2018), p. 243-252.

Saboori *et al.* 2016 — Saboori Somayeh, Koohdani Fariba, Nematipour Ebrahim, Yousefi Rad Esmaeil, Saboor-Yaraghi Ali Akabar, Javanbakht Mohammad Hassan, Eshraghian Mohammad Reza, Ramezani Atena, Jalali Mahmoud. *Beneficial effects of omega-3 and vitamin E coadministration on gene expression of SIRT1 and PGC1α and serum antioxidant enzymes in patients with coronary artery disease.* In: *Nutrition, Metabolism and Cardiovascular Diseases* 26.6, (2016), p. 489-494.

Salo *et al.* 1986 — Salo Matti K, Gey Fred K, Nikkari T. *Stability of plasma fatty-acids at -20-degrees-C and its relationship to antioxidants.* In: *International Journal for Vitamin and Nutrition Research* 56.3, (1986), p. 231-239.

Santini *et al.* 2017 — Santini Antonello, Gian Carlo Tenore, Ettore Novellino. Nutraceuticals: A paradigm of proactive medicine. In: *European Journal of Pharmaceutical Sciences* 96, (2017), p. 53-61.

Sarabandi *et al.* 2019 — Sarabandi Khashayar, Jafari Seid Mahdi, Mahoonak Alireza Sadeghi, Mohammadi Adelh. *Application of gum Arabic and maltodextrin for encapsulation of eggplant peel extract as a natural antioxidant and color source.* In: *International Journal of Biological Macromolecules* 140, (2019) p. 59-68.

Schaefer *et al.* 1995 — Schaefer Douglas Michael, Liu QP, Faustman Cameron, Yin Mei-Chin. *Supranutritional administration of vitamin-E and vitamin-C improves oxidative stability of beef*. In: *Journal of Nutrition* 125.6, (1995), p. S1792-S1798.

Shang *et al.* 2020 — Shang Hongmei, Zhang Hexiang, Guo Yang, Wu Hongxin, Zhang Nanyi. *Effects of inulin supplementation in laying hens diet on the antioxidant capacity of refrigerated stored eggs.* In: *International Journal of Biological Macromolecules* 153, (2020), p. 1047-1057.

Shih *et al.* 2010 — Shih Ping-Hsiao, Chan Yin-Ching, Liao Jiunn-Wang, Wang Ming-Fu, Yen Gow-Chin. *Antioxidant and cognitive promotion effects of anthocyanin-rich mulberry (Morus atropurpurea L.) on senescence-accelerated mice and prevention of Alzheimer's disease.* In: *The Journal of Nutritional Biochemistry* 21.7, (2010), p. 598-605.

Shikany *et al.* 2003 — Shikany James, Patterson Ruth E., Agurs-Collins Tanya, Anderson Garnet. *Antioxidant supplement use in Women's Health Initiative participants.* In: *Preventive Medicine* 36.3, (2003), p. 379-387.

Sikiru *et al.* 2019 — Sikiru Akeem Babatunde, Arangasamy Arunachalam, Alemede IC, Guvvala Pushpa Rani, Egena Acheneje, Ippala Jr, Bhatta Raghavendra. *Chlorella vulgaris supplementation effects on performances, oxidative stress and antioxidant genes expression in liver and ovaries of New Zealand White rabbits.* In: *Heliyon* 5.9, (2019), e02470.

Sinclair *et al.* 1990 — Sinclair Alan, Barnett Anthony, Lunec Josep. *Free radicals and antioxidant systems in health and disease*. In: *British Journal of Hospital Medicine* 43.5, (1990) p. 334-344.

Singh *et al.* 2020 — Singh Balwinder, Singh Pal Jatinder, Kaur Amritpal, Singh Narpinder. *Phenolic composition, antioxidant potential and health benefits of citrus peel.* In: *Food Research International* (2020), p. 109114.

Song *et al.* 2018 — Song Xinling, Shen Qiang, Liu Min, Zhang Chen, Zhang Lan, Ren Zhenzhen, Wang Wenshuai, Dong Yuhan, Wang Xiuxiu, Zhang Jianjun, Jia Le. *Antioxidant and hepatoprotective effects of intracellular mycelium polysaccharides from Pleurotus geesteranus against alcoholic liver diseases.* In: *International Journal of Biological Macromolecules* 114, (2018), p. 979-988.

Srinivasan *et al.* 2019 — Srinivasan R, Aruna A, Manigandan K, Pugazhendi A, Kim Myunghee, Shivakumar MS, Natarajan D. *Phytochemical, antioxidant, antimicrobial and antiproliferative potential of Elaeagnus indica*. In: *Biocatalysis and Agricultural Biotechnology* 20, (2019), 101265.

Steenvoorden, Beijersbengen van Henegouwen 1997 — Steenvoorden David, Beijersbengen van Henegouwen Gerard. *The use of endogenous antioxidants to improve photoprotection.* In: *Journal of Photochemistry and Photobiology B: Biology* 41.1-2, (1997), p. 1-10.

Strakova *et al.* 1988 — Strakova J, Skarka P, Polasek L., Papesova L, Paulova J, Sestakova I, Nastuneak J, Kolouch F, Vanova L, Cechova I. *The Neox antioxidant, the health and hygiene aspects and effect on performance in chickens*. In: *Biologizace a Chemizace Zivocisne Vyroby-Veterinaria* 24.3, (1988), p. 261-273.

Stoia, Oancea — Stoia Mihaela, Oancea Simona. *Health reasons for improving the oxidative stability of*

2013 *sunflower oil – Review*. In: *Oxidation Communication* 36.3, (2013), p. 636-668.

Stroe, Oancea 2020 Stroe Andreea Cristina, Oancea Simona. *Immunostimulatory Potential of Natural Compounds and Extracts: A Review.* In*: Current Nutrition & Food Science* 14.4, (2020), p. 1-10.

Subash *et al*. 2014 Subash Selvaraju, Essa Mohamed Musthafa, Al-Asmi Abdullah, Al-Adawi Samir, Vaishnav Ragini. *Chronic dietary supplementation of 4% figs on the modification of oxidative stress in Alzheimer's disease transgenic mouse model*. In: *BioMed Research International* 2014, (2014), p. 1-8.

Taleb *et al*. 2018 Taleb Abdoh, Ahmad Khalil Ali, Ihsan Awais Ullah Qu Jia, Lin Na, Hazam Kamal, Koju Nirmala, Hei Lei, Qilong Diong. *Antioxidant effects and mechanism of silymarin in oxidative stress induced cardiovascular diseases*. In: *Biomedicine & Pharmacotherapy* 102, (2018), p. 689-698.

Tamaki *et al*. 2014 Tamaki Naofumi, Orihuela-Campos Cristina, Inagaki Y, Fukui M, Nagata T, Ito HO, *Resveratrol improves oxidative stress and prevents the progression of periodontitis via the activation of the Sirt1/AMPK and the Nrf2/antioxidant defense pathways in a rat periodontitis model*. In: *Free Radical Biology and Medicine* 75, (2014), p. 222-229.

Tony 2016 Tony Wyss-Coray. *Ageing, neurodegeneration and brain rejuvenation.* In: *Nature* 539.7628, (2016), p. 180-186.

Toren *et al*. 2007 Toren Finkel, Serrano Manuel, Blasco Maria A. *The common biology of cancer and ageing.* In: *Nature* 448.7155, (2007), p. 767-774.

Valentao *et al*. 2002 Valentao Patricia, Fernandes Eduarda, Carvalho Felix, Andrade Paula B., Seabra Rui Machado, Bastos Maria Lourdes. *Antioxidant activity of Hypericum androsaemum infusion :Scavenging activity against supeoxide radical, hydroxyl radical and hypochlorous acid*. In: *Biological and Pharmaceutical Bulletin* 25.10, (2002), p. 1320-1323.

Vancaneghem *et al*. 1979 Vancaneghem Patricia, Deby-Dupont Ginette, Goutier R, Deby C, Bacq ZM. *Relations between antioxidants and essential fatty-acids, in the rat.* In: *Archives internationales de physiologie de biochimie et biophysique* 87.1, (1979), p. 130-130.

Vazquez-Sanchez *et al*. 2018 Vazquez-Sanchez Kenia, Martinez-Saez Nuria, Rebollo-Henanz Miguel, Dolores del Castillo, Gaytan-Martinez Marcela, Campos-Vega Rocio, *In vitro health promoting properties of antioxidant dietary fiber extracted from spent coffee (Coffee arabica L.) grounds*. In: *Food Chemistry* 261, (2018), p. 253-259.

Vega *et al*. 2020 Vega Julia, Alvarez-Gomez Felix, Guenaga Leire, Fifueroa Felix L., Gomez-Pinchetti Juan Luis. *Antioxidant activity of extracts from marine macroalgae, wild-collected and cultivated, in an integrated multi-trophic aquaculture system.* In: *Aquaculture* 522, (2020), 735088.

Verma *et al*. 2012 Verma Surendra Kumar, Vartika Jain, Dharm Pal Singh. *Effect of greater cardamom (Amomum subulatum Roxb.) on blood lipids, fibrinolysis and total antioxidant status in patients with ischemic heart disease*. In: *Asian Pacific Journal of Tropical Disease* 2, (2012), p. S739-S743.

Wang *et al*. 2010 Wang Jun, Pfleger Cathie, Friedman Lauren, Vittorino Roselle, Zhao Wei, Qian Xianjuan, Conley Lindsay, Ho Lap, Pasinetti Giulio. *Potential application of grape derived polyphenols in Huntington's disease.* In: *Translational Neuroscience* 1.2, (2010), p. 95-100.

Wettasinghe, Shahidi 1999 Wettasinghe Mahinda, Shahidi Fereidoon. Antioxidant and free radical-scavenging properties of ethanolic extracts of defatted borage (Borago officinalis L.) seeds. In: Food chemistry, 67.4, (1999), p. 399-414.

Yen, Wu 1999 Yen Gow-Chin, Wu Jun-Yi. *Antioxidant and radical scavenging properties of extracts from Ganoderma tsugae*. In*: Food Chemistry* 65.3, (1999), p. 375-379.

Yoo *et al*. 2013 Yoo Donghyuck, Guk Kyeonghye, Kim Hyugmin, Khang Gilson, Wu Dongmei, Lee Dongwon. *Antioxidant polymeric nanoparticles as novel therapeutics for airway inflammatory diseases*. In: *International journal of pharmaceutics* 450.1-2, (2013), p. 87-94.

Zandi, Gordon 1999 Zandi Parvin, Gordon Michael. *Antioxidant activity of extracts from old tea leaves.* In: *Food chemistry*, 64.3, (1999), p. 285-288.

Zehiroglu, Sarikaya 2019 Zehiroglu Cuma, Sarikaya Sevim Beyza Ozturk. *The importance of antioxidants and place in today's scientific and technological studies*. In: *Journal of Food Science and Technology* 56, (2019), p. 4757–4774.

Zhang *et al*. 2014 — Zhang Chun-Nuan, Li Xiang-Fei, Jiang Guang-Zhen, Zhang Ding-Dong, Tian Hong-Yan, Li Jun-Yi, Liu Wen-Bin. *Effects of dietary fructooligosaccharide levels and feeding modes on growth, immune responses, antioxidant capability and disease resistance of blunt snout bream (Megalobrama amblycephala).* In: *Fish & Shellfish Immunology* 41.2, (2014), p. 560-569.

Zhang *et al*. 2020 — Zhang Lun, Gui Shuiqing, Wang Jian, Chen Qingru, Zeng Jiali, Liu Along, Chen Zhaoxia, Lu Xuemei. *Oral administration of green tea polyphenols (TP) improves ileal injury and intestinal flora disorder in mice with Salmonella typhimurium infection via resisting inflammation, enhancing antioxidant action and preserving tight junction.* In: *Journal of Functional Foods* 64, (2020), 103654.

Zhao *et al*. 2014 — Zhao Yan, Du Shuang-Kui, Wang Hanxin, Cai Meng. *In vitro antioxidant activity of extracts from common legumes.* In: *Food Chemistry* 152.1, (2014), p. 462-466.

Zhigacheva, Kaplan 1985 — Zhigacheva Irina V, Kaplan EY. *Fatty-acid composition and energetics of liver-mitochondria in albino-rats injected with antioxidants of the ionol series*. In: *Biochemistry-Moscow* 50.10, (1985), p. 1348-1352.

Zhong *et al*. 2013 — Zhong Zlatan, Xiao WJ, Zhou, DW, Tan CY, Tan ZL, Han XF, Zhou CS, Tang SX, *Effect of tea catechins on regulation of cell proliferation and antioxidant enzyme expression in H_2O_2-induced primary hepatocytes of goat in vitro.* In: *Journal of Animal Physiology and Animal Nutrition* 97.3, (2013), p. 475-484.

Zhou *et al*. 2020 — Zhou Li, Xie Minhao, Yang Fu, Liu Jikai. *Antioxidant activity of high purity blueberry anthocyanins and the effects on human intestinal microbiota.* In: *LWT Food Science and Technology* 117, (2020), 108621.

Zorov *et al*. 2000 — Zorov Dmitry, Filburn Charles, Klotz Lars-Oliver, Zweier Jay, Sollott Steven. *Reactive oxygen species (ROS)-induced ROS release: A new phenomenon accompanying induction of the mitocondrial permeability transition in cardiac myocytes.* In: *Journal of Experimental Medicine* 192.7, (2000), p. 1001-1014.

LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Tab. 1 The health benefits of antioxidant compounds and extracts as confirmed by clinical trials.

Type of antioxidant/ Source	Effects on health	Ref.
Anthocyanins/ blueberries	- positive effects on human intestinal microbiota by increasing the number of *bifidobacterium*	(Zhou *et al*., 2020)
Anthocyanins, phenolic compounds/mulberries	- improve learning and memory ability - increase antioxidant enzymes activity - decrease lipid oxidation in the brain and liver of mice	(Shih *et al*., 2010)
Antioxidant dietary fiber/ coffee grounds	- inhibits the alpha-glucosidase which becomes more bioaccessible	(Vazquez-Sanchez *et al*., 2018)
β-carotene	Supplementing the diet with 20 mg/kg b.wt of β-carotene for 14 days, 3 times a week, restores the liver function and increases the level of antioxidants in the liver of rats subjected to high oxidative stress	(Latiel *et al*., 1018)
β-carotene, α-tocopherol, caffeic acid/ virgin olive oil	Consumption of antioxidant-rich olive oil is associated with a low incidence of heart disease Administration of 50 ml of virgin olive oil for 3 weeks increased the activity of glutathione peroxidase and decreased the plasma level of peroxides	(Fito *et al*., 2005)
	- positive effects on the intestinal microbiota - could reduce the risk of cardiovascular disease, type 2 diabetes, high blood pressure, and cancer	(Gavahian *et al*., 2019)
Caffeic acid, catechins, neochlorogenic acid/ *Prunus armeniaca*	*In vitro* studies on peripheral chicken lymphocyte cultures indicated a protective effect of aqueous extract from *Prunus armeniaca* seeds. The results of *in vivo* studies in chickens indicated an increase in total antioxidant capacity and a decrease in interleukin-2 and 6 levels, globulin, and malondialdehyde levels. Regulation of blood glucose, cholesterol and triglycerides in chickens has been also observed.	(Kalia *et al*., 2017)
Chenopodium ambrosioides L. dried leaf extract	- the antioxidant effect in splenocytes - beneficial effects on the intestinal health of fish by stimulating the activity of antioxidant enzymes and by the anti-inflammatory effect on the intestine	(Reyes-Becerril *et al*., 2019)
Chlorella vulgaris	- food supplement for animals because it protects against oxidative stress, improves the reproductive process in rabbits but also in other food-producing mammal species	(Sikiru *et al*., 2019)
Curcumin	Supplementing the diet of laying hens with curcumin had a positive effect on the general health and on the production and quality of eggs. Moreover, an improvement in the health of chickens naturally infected with *Escherichia coli* has been observed.	(Da Rosa *et al*., 2020)
Coenzyme Q10	Supplementing the diet with 150 mg coenzyme Q10 may decrease oxidative stress and increase the activity of antioxidant enzymes in patients with coronary artery disease	(Lee *et al*., 2012)
Elaeagnus indica extract	*Elaeagnus indica* extract contains phytochemicals such as carbohydrates, ascorbic acid, proteins, flavonoids, phenols and tannins - the significant antibacterial, antioxidant and antiproliferative effect, being indicated in the prevention and treatment of microbial infections and diseases associated with oxidative stress	(Srinivasan *et al*., 2019)
Fid extracts	Administration of 70% methanolic extract of fig leaves showed protective effects against myocardial infarction in rat heart	(Allahyari *et al*., 2014)
	In vivo studies have shown that bioactive compounds in figs have a	(Deepa *et*

	hypoglycaemic effect manifested by increased insulin secretion	*al*., 2018)
	Figs could improve memory deficits by reducing oxidative damage and improving the antioxidant system in transgenic mice	(Subash *et al*., 2014)
Fig latex	- inhibitory effect *in vitro* on esophageal cancer cell lines at 10 mg/ ml	(Hashemi, Abedianke nari, 2013)
Fructooligosaccharid es	- improve the growth, immune response and antioxidant capacity of fish, increasing resistance to diseases	(Zhang *et al*., 2014)
Gallic acid, quercetin, caffeic acid/ *Moringa oleifera*	- hepatoprotective effect against non-alcoholic fatty liver disease in Wistar rats	(Asgari *et al*., 2020)
Grape seed phenolic extract	Grape seed extract contains large amounts of Vitamin E, flavonoids, linoleic acid, and resveratrol. - reduces inflammation - limits lipid peroxidation	(Wang *et al*., 2010)
Greater cardamom (*Amomum subulatum* Roxb.)	- improves fibrinolytic activity, antioxidant activity and lipid profile in patients with ischemic heart disease	(Verma *et al*., 2012)
Hydroybenzyl alcohol	The nanoparticles of hydroxybenzyl alcohol-incorporated polyoxalate (HPOX) reduced the generation of intracellular reactive oxygen species and pro-inflammatory cytokines in stimulated macrophages	(Yoo *et al*., 2013)
Inulin	The use of inulin in feeding laying hens increased the shelf life of eggs, stimulated the activity of antioxidant enzymes in egg yolks and decreased the lipid peroxidation in long-kept eggs	(Shang *et al*., 2020)
Lemon verbena leaves powder	- beneficial effect on growth, immune parameters and antioxidant enzyme activity of rainbow trout (*Oncorrhyncus myskiss*)	(Hoseinifar *et al*., 2020)
Lycopene	- increases the activity of antioxidant enzymes (catalase, glutathione peroxidase, superoxide dismutase)	(Anlar, Bacanli, 2020)
Omega-3 and vitamin E	- beneficial effects by increasing the expression of sirtuins (SIRT1) and peroxisome proliferator-activated receptor 1-alpha coactivator (PGC1α) and by improving the oxidative stress and the inflammatory process in patients with coronary artery disease	(Saboori *et al*., 2016)
Phenolic acids/ *Tithonia diversifolia*	The phenolic compounds in the leaf of *Tithonia diversifolia* have antioxidant and anti-cholinesterase activity, stronger than the prostigmine of the standard drug. They have the effect of inhibiting key enzymes linked to Alzheimer's disease.	(Ojo *et al*., 2018)
Polyphenols/ tea	- lowers blood pressure - increases catalase activity in hypertensive rats	(Negishi *et al*., 2004)
Polysaccharides/ *Pleurotus geesteranus* / *Agaricus bisporus*	*In vivo* studies performed in Kunming strain mice suggested that intracellular mycelium polysaccharides from *Pleurotus geesteranus* improve the hepatic parameters (myeloperoxidase, alanine aminotransferase, total cholesterol, aspartate aminotransferase, alkaline phosphatase, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol)	(Song *et al*., 2018, 997)
	Polysaccharides extracted from *Agaricus bisporus* can be used as functional foods in the prevention of liver and nephric damage in D-galactose induced aging mice	(Li *et al*., 2018)
Resveratrol	- prevents the progression of periodontitis in rats by activating the Sirt1 /	(Tamaki *et*

	AMPK and Nrf2 / antioxidant defense pathways.	*al*., 2014)
	- inhibits *in vivo* alveolar bone resorption induced in mice by artificial trauma from occlusion	(Matsuda et al., 2018)
Silymarin	- antioxidant effects against cardiovascular diseases - protection against oxidative stress-induced hypertension, atherosclerosis, and cardiac toxicity	(Taleb *et al*. 2018)
	Catechins from green tea decrease the oxidative stress and inhibit cell proliferation in human colon cancer cells HTC-116 and SW-480.	(Du *et al*., 2012)
	Regulates cell proliferation and the expression of antioxidant enzymes in goat hepatocytes subjected to the action of hydrogen peroxide.	(Zhong *et al*., 2013)
	Protects against lipid oxidation in the structure of the human colon cancer cell line (Colo-205).	(Jiang *et al*., 2017)
	Reduces the oxidative stress that occurs in the process of ileal lesion induced by *Salmonella typhimurium* in male mice.	(Zhang *et al*., 2019)
Vitamins E + C	Administration of 500 mg/ day of vitamin C and vitamin 400 IU/ day of vitamin E for 6 weeks improves endothelial function in young patients suffering from hyperlipidemia	(Engler *et al*., 2003)
	Administration of 500 mg/ day vitamin C and 800 mg/ day of vitamin E for 6 months inhibits oxidative stress caused by benznidazole administered in amounts of 5 mg/ kg/ day to healthy subjects	(Ribeiro *et al*., 2010)
Vitamin E + taurine	- improved metabolic changes related to cellular damage caused by perchloroethylene in mice	(Ebrahim, Sakthisekaran, 1997)

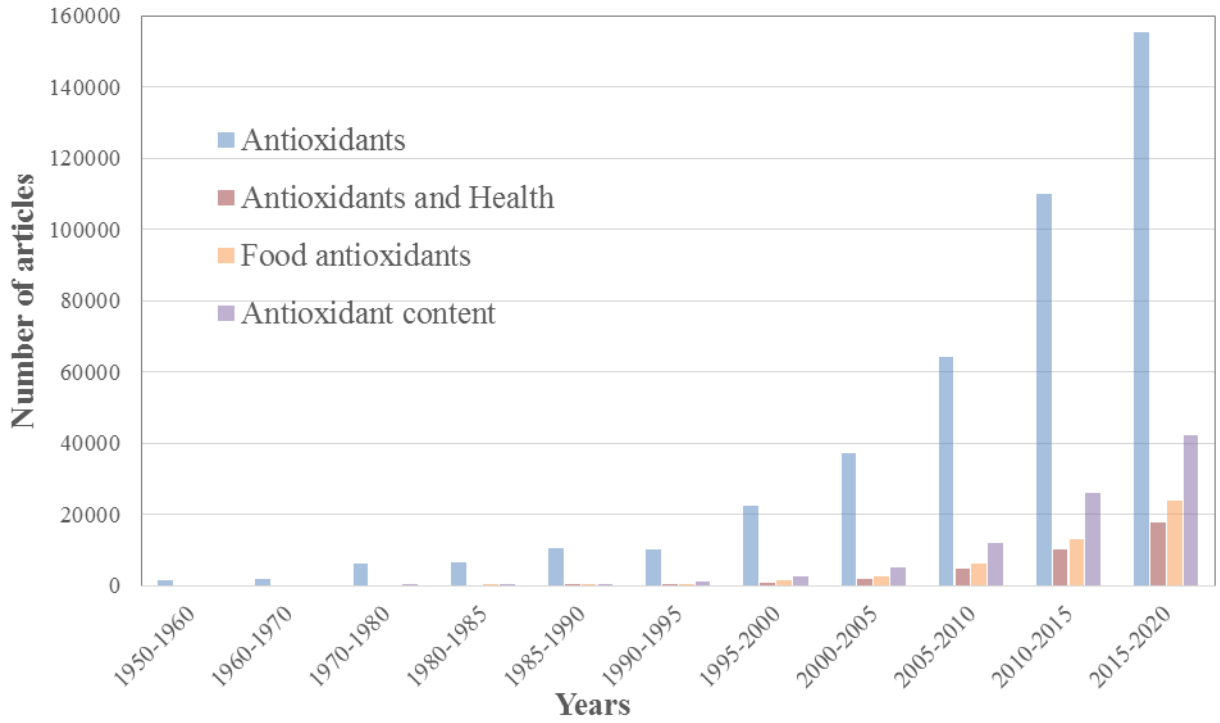


Fig. 1. The trend of published research articles by using the keywords "antioxidants", "antioxidants and health", "food antioxidants" and "antioxidant content" (data from Web of Science Thomson Reuters).

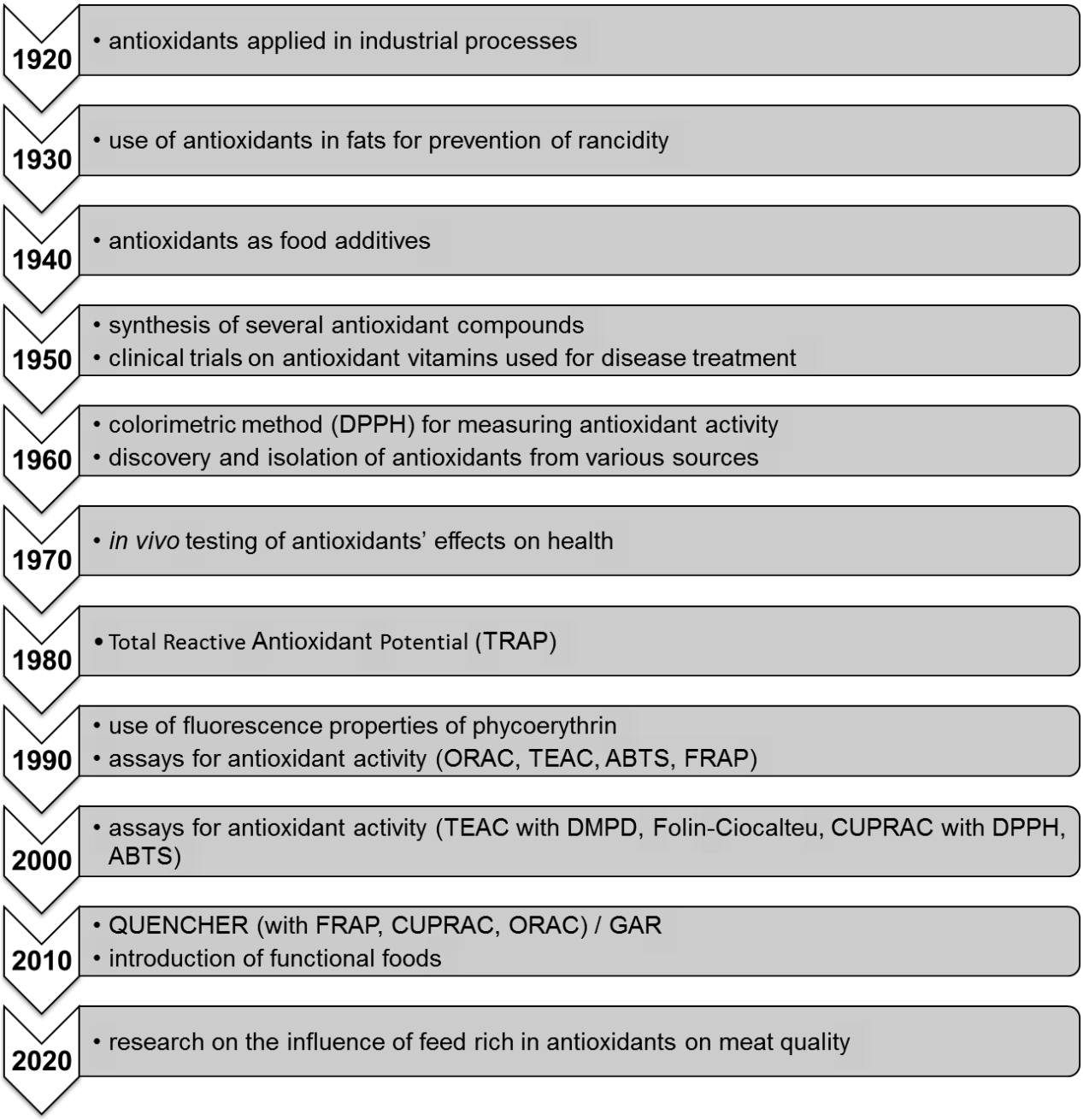


Fig. 2. Timeline on key discoveries related to the research on antioxidants and analytical techniques for the determination of their bioactivity (adapted from Comert and Gokmen, 2018).

AN OVERVIEW ON EDIBLE MUSHROOMS WITH HEALTH BENEFITS AND APPLICATIONS IN THE FOOD INDUSTRY

Florentina Miruna POPA-VECERDEA*
Simona OANCEA**

Abstract. *Edible mushrooms represent an important food source not only for their nutritional value but also for their high content in biologically active compounds, being valued as functional food. Mushrooms, medicinal and culinary, have positive effects on human health, such as immunomodulatory, antiinflammatory, anticancer, antioxidant and antimicrobial. This paper reviews general features, cultivation techniques, positive health effects and food and pharmaceutical application of three edible mushroom types, Lentinula edodes, Pleurotus eryngii and Ganoderma lucidum.*
Keywords*: Ganoderma lucidum, Pleurotus eryngii, Lentinula edodes, food, agriculture, health.*

Rezumat*. Ciupercile comestibile reprezintă o sursă alimentară importantă, atât din punct de vedere al valorii nutriționale, dar și datorită conținutului ridicat în compuși biologic activi, fiind evaluate ca alimente funcționale. Ciupercile, medicinale și cele utilizate în scop culinar, determină efecte pozitive asupra sănătății umane, având proprietăți imunomodulatoare, antiinflamatoare, anticancerigene, antioxidante și antimicrobiene. Lucrarea de față reprezintă un studiu asupra caracteristicilor generale, tehnicilor de cultivare, efectelor pozitive asupra sănătății umane și aplicațiilor în sectorul alimentar și farmaceutic a trei tipuri de ciuperci, Lentinula edodes, Pleurotus eryngii și Ganoderma lucidum.*
Cuvinte cheie*: Ganoderma lucidum, Pleurotus eryngii, Lentinula edodes, alimente, agricultură, sănătate*

Introduction

Wild edible mushrooms have been harvested and consumed by humans for thousands of years. According to Rojas and Mansur in 1995, archeologists discovered that edible species of mushrooms had been consumed by people in Chile even as far away in time as 13,000 years ago. In China, fossilized wood, estimated to be 3000 years old, had grown around wild mushrooms that seemed to have been part of primitive humans' diet in those times (Pegler 2002).

In the Greek and Roman antiquity, wild mushrooms were highly appreciated, being eaten by the rich rather than by peasants (Buller 1914).

Today, around 14,000 species of mushrooms are known. This number represents 10% of the total species spread all over the Earth. Not rarely, a dear price was paid in exchange for this knowledge, since many daring experiences led to people's death (Hawksworth 2001).

Thanks to the Chinese people's cult for mushrooms, 981 edible species were established out of a total of 1,500 – 2,000 types. According to Mau *et al.* 2004, until 2002, 92 species had been domesticated in order to be grown for commercial purposes.

Interest in cultivating mushrooms has increased lately, leading to a development of the business, not only with a purpose for producing food, but also as a resource with medicinal value, given their high content in biologically active compounds. The uses of mushrooms for medicinal purposes include supplements with anticancer, antiviral, liver protective, cholesterol lowering and immune-boosting properties. The nutritional components of mushrooms can be extracted from the mycelium or their fruiting body (Chang, Buswell 1996). This represents an important issue of development for biotechnological industries.

Along time, several studies were made, demonstrating that an intake of mushrooms or food supplements based on them improves human health. One other great advantage is that they help decompose agricultural and forestry wastes, turning them into useful substrates and at the same time reducing environment pollution. Therefore,

* Lucian Blaga University of Sibiu, florentina.popa@ulbsibiu.ro
** "Lucian Blaga" University of Sibiu, Department of Agricultural Sciences and Food Engineering, simona.oancea@ulbsibiu.ro

mushrooms are beneficial for the food and nutrition supplements industry, as well as for the environment protection.

Description of mushrooms

Mycology is the field that deals with the study of mushrooms, which is done by professionals called mycologists. Lately, the research methods have become quite diverse, hence the knowledge on the nature of mushrooms has increased. Many studies are being performed on fungi that cause damage to plant cultures or on edible mushrooms that can be hybridized, in order to be released for commercial use. Yet, few studies are dealing with wild edible mushrooms, and only a certain group of them, such as truffles and boletus, has stirred some higher interest. This neglection is explained by the fact that such wild species are still less known in developing countries (Boa 2004).

We know today that mushrooms are a distinct group of organisms that belong to a separate kingdom, being neither plants, nor animals. They are being classified in the kingdom of fungi (Miles, Chang 1997).

In the past, mushrooms were placed by Linnaeus in the category of inferior plants, Division Thallophytae. This occurred as a result of the observation of their cellular wall, although the visible anatomic features are quite evident, in terms of lack of leaves, flowers or roots. Newer studies placed macromycetes together with the other mushrooms into the kingdom of fungi. The difference between fungi and the vegetal and animal kingdoms lies in the presence of the cellular wall, which enables heterotrophic nutrition in plants, and in animals has an osmotic role (Chang, Quimio 1982).

Even if the differences between plants and mushrooms are clear, since the latter are lacking chlorophyll to perform the photosynthesis and to convert solar energy into nourishment, they are still often being classified as plants. It is important to know well the taxonomy of the mushroom species, not only by their popular names, particularly for those persons who are collecting and selling mushrooms, in order to ensure consumer safety. This knowledge can assure people, in their communication, that in using similar terms, they are meaning exactly the same species of edible mushrooms.

While in the study of plants we use the word flora, for mushrooms the similar term is micota. **(**Chang 2008).

At present, there is a clear definition of the term mushroom in a large sense: „mushrooms are macrofungi with a fruiting body, which can produce erosion, can develop subterranean and have dimensions that can be seen with the naked eye, and can be picked by hand" **(**Chang, Chiu 1992; Boa 2004). Therefore, these must not be classified only as Basydiomicetes, since they can also be Ascomicetes that live under the ground, such as the truffles.

Scientists like Aristotle, Theophrastus, Dioscorides mentioned edible mushrooms in many of their works, this standing proof for the fact that humans have been consuming them since ancient times. Although mushrooms are well visible, they are among the least understood of all living organisms (Manic 2018).

The life of mushrooms is short, they decompose only a few days after their reaching adult size, and what remains at the surface of the ground are their reproductive organs, the sporophytes that yield the spores. In the substratum, the sporophyte is linked to the hyphae, and these blend together to form the mycelium, which can survive for hundreds of years. Mushrooms can appear after a good rain, which made them appear suspicious to people in the past (Manic 2018).

Mushrooms are being classified in three categories: saprophytes, parasites and mycorrhizal. A great deal from among the most cultivated ones for gastronomy are saprophytes, but there are also mycorrhizal mushrooms, such as truffles. The saprophyte mushrooms take their nutritious substances from the dead tissue, the parasites are absorbing the nutritious substances of the plants they are inhabiting, causing damage to it, and the mycorrhizal ones have a strong biological bond with the surrounding plants, enjoying each other's benefits and forming a team (Chang 2008). Some mushrooms cannot be completely ranked in a certain category, for example *Ganoderma lucidum* is saprophyte, but it can also turn into a pathogen.

Among the most cultivated species are those in a shape of an umbrella with pileus (a cap) and stipe (the foot). One of these is *Lentinula edodes* or Shiitake. Other species also have an annelus (a ring) and a volva (a thick membrane that covers the cap and foot of young mushrooms). Other mushrooms come in shapes of corals, chalices, balls or ears (Chang, Qimio 1982).

Cultivation of mushrooms

The reasons why species *Ganoderma lucidum*, *Lentinula edodes* and *Pleurotus eryngii* have been

selected for this study fall into three main categories: benefits for health, consumption and agriculture.

A lot of studies have shown that extracts of *Ganoderma lucidum* determine medicinal and therapeutic effects on the human body (González *et al.* 2020; Jana, Acharya 2020); *Lentinula edodes* is highly used over the world as a natural type of nourishment, but also as food supplements for various diseases, particularly for its antiinflammatory effects (Muszyńska *et al.* 2020; Paul *et al.* 2020); *Pleurotus eryngii* showed powerful antimicrobial effects, its extracts being used against *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis* and *Candida albicans*, as confirmed by a 2020 study of Acay *et al.* 2020.

From an agriculture point of view, these three species can be easily grown, as we will point out below. *Ganoderma lucidum* and *Lentinula edodes* can be cultivated outdoors in many different geographical areas in the world, on wooden stomps or on branches, while *Pleurotus eryngii* is not very thermophilic species, which means it does not require much heat to develop. These mushrooms can be cultivated using plant wastes (post-harvest), the nature of these plants differing in accordance with the country or region where they are produced (Chang 2008).

Ganoderma lucidum has a very high commercial value, since it produces many bioactive compounds such as triterpenoids (ganoderic acids) (Liu *et. al.* 2018). *Lentinula edodes* is a valuable food resource and presents a viable alternative for farmers wealth (Campbell, Racjan 1999). Along with other mushrooms of the boletus species, *Pleurotus eryngii* is most often found in the Italian cuisine, which is an indicator of its nutritional content and commercial value (Manzi *et al.* 2004).

The science of mushroom cultivation is divided into three domains, all together forming the applied biology of mushrooms: mushroom sciences dealing with their production, mushroom biotechnology dealing with the industrial development of mushroom-based products and the bio-remediation of mushrooms, which evaluates the beneficial impact of mushrooms on the environment and the ecology. The aim of applied mushroom biology is to develop threefold solutions: for food, health and environment (Chang, Quimio 1982).

Just like the culture of plants, the development of mushroom cultivation involves scientific research and technological elements. In order for the mycelium to allow the mushroom's fruiting body to mature, certain environmental conditions are to be met, such as appropriate light, fresh air and the right temperature. The main stages of a mushroom's development are: selection of a good strain that presents good quality yield, development of the mycelium, preparation of substratum, nurturing the mycelium, managing the fructification and finally the careful harvesting (Chang, Chiu 1992; Chang 1998). Each step is important, any bypass can lead to problems and a decrease in the yield.

In a current overview from 2017, about mushroom production in the world, Royse *et al*. addresses the topic of edible, medicinal and wild mushrooms. In 2013 the mushroom industry earned $63 billion. The percentage for cultivated edible and medicinal mushroom was 92% accounting for approximately $58 billion and 8% is represented by wild mushroom provided from foraging. World production of cultivated mushroom has increased since 2009 to 2018, according to statistical data from Food and Agriculture Organization of the United Nations (FAO). Statistical data of last 10 years (Worldometer) showed that the world population has been increased by 1.05-1.24% per year, consequently the consumption of mushroom has increased in the same time with the world population. In 2012, the world production of mushrooms and truffles has been increased of 9.647.478 tonnes. After this year a slight decrease was registered, despite it remained at a certain volume of production. Production of mushroom and truffles for the period 2009-2018 is outperformed by Asia with a percentage of 75,40%. Europe is on second place with a 17.60%, while Oceania and Africa are situated on the last places with 0.60% and 0.30%, respectively.

The evolution of the mushroom production shown in **Fig. 1,** represents a statistical view for the world production, also related to the geographical area; America, a biggest area, has a production of 6,10% of the total quantities.

Cultivation of the species *Lentinula edodes*

Biological nature. Lentinula edodes or shiitake, is a ligninous mushroom, one of the most cultivated mushroom strains in the world. It can be grown on tree stomps or on a cellulose substrate, has a rapid growth, a good yield and can take temperatures above 24 ºC (Quimio *et al.* 1990; Stamets 2000; Chang, Miles 2004). It is a thermophilous species, with a midsized fruiting body of 7-9 cm diameter.

This mushroom is heterothallic, which means it needs two sexual factors for breeding (Chang, Miles 1984,). The life cycle begins with a

germination of basidiospores. After the mating of the two mycelia, the fructification culture is established. The mother spawn can be produced from this culture, which is then merchandised. The mushroom fruiting body begins to develop when the mycelium is placed on an adequate substratum and under appropriate climatic conditions. When the fruiting body reaches maturity, the spores are spread in the air, and the life cycle ends (Chang 2008).

In nature, this mushroom grows on rotting wood or stomps of cut trees, consisting of crude proteins 0,38%, fats 4,5%, soluble sugars 0,56%, total nitrogen 0,146%, cellulose 52,7%, lignin 18,09% and ash 0,56%. If the nitrogen source is too high during reproduction, the mushrooms will not develop normally. The optimal temperature for the spores' development is of 22-26 °C, and for the mycelium development, 23-25 °C. The ideal temperature for the development and formation of the fruiting body lies within the range 10-20 °C, while the optimal pH of the substrate should be 5.0-5.5 (Chang 2008).

The culture medium

The mushroom can grow on several types of culture media, according to the purpose of cultivation. The synthetic medium is costly and takes much time to prepare. The simplest and most popular medium for the cultivation of mushroom mycelium is agar potato dextrose (PDA).

Substratum for the mycelium

There are several substrate recipes, such as: a) chopped wheat or rye straws + 1.5% gypsum or slaked lime, b) ground cottonseeds 40%, sawdust 38%, wheat bran 20%, sugar 1% and lime 1% (Chang 2008).

Substrate for cultivation

For the cultivation substrate, the following composition is recommended: 80% hardwood, fine and coarse mix, 10% cereals and 10% bran, while the recommended humidity in this substrate is 62-63%. Together with this, additions can be used to help develop the fruiting body.

For the mycelium cultivation, a number of agricultural wastes can be used, such as: wood shavings 78%, rice or wheat bran 16%, sugar 1.5 %, cornmeal 1.7%, ammonium sulfate 0.3%, calcium superphosphate 0.5% and lime 2%; or: wood shavings 64%, wheat bran 15%, spent coffee grounds 20% and lime 1%; or: wood shavings 78%, sucrose 1%, wheat bran 20% and calcium carbonate 1%. These mushrooms can be grown in the household or intensively as a business (Chang 2008).

Cultivation in the household

There are several types of substrate composition. Ingredients can vary from one country to another, according to the available materials and the climate conditions (Chang 2008). After mixing the dry ingredients, water is added manually, so that the final content of substrate has the optimal recommended moisture. These substrate components are then filled in sacs that are specially designed for mushroom cultivation. Polyethylene bags are expensive, yet more popular, they can offer clear insight to the substrate in case of pests, and plastic is harder than other materials. The bags filled to 3-4 kg each are tied at the mouth with a string, and a cotton cap is inserted.

Cultivation for business

The most frequently used wood shavings are oak, which explains its Japanese name „Shiitake": „shii" is mushroom, and „take" is a species of hard essence oak. The stages of obtaining the substrate are the following: first, the wood shavings or sawdust is mixed with supplements and water, the mixture is then filled in spawn bags and sterilized in the autoclave, at 121 °C; it is then left to cool, after which the bags are inoculated with 1% mycelium and sealed. The spawning takes place within an incubation time of 90 days. In order to start its development, the mycelium requires a temperature of 23 °C in the room and 25 °C in the substrate. The maturation phase takes place at 20-22 °C and takes 90 days. The next phase is the induction of the budding, when the substrates are opened and placed in the fruiting room. Conditions for fructification are as follow: temperatures 16-20 °C, humidity 85%, CO_2 concentration 800-1200 ppm, and light 500-1000 lux. Before harvesting, the mushrooms must be sprinkled 3 to 5 times with water in an interval of about 9 days, and after each sprinkle, the temperature must be raised to 20-22 °C, the CO_2 to 1700-2500 ppm, and humidity to 85%. The average yield is of 200-300 g mushrooms per one kg of substrate. After harvesting, they must be stored in refrigerators for delivery, or they can be sold fresh.

The indispensable equipment pieces in a mushroom farm are mixer, autoclave, gas vat, cooling tunnel, laminar flow cabinet, sealer for bags, air compressor for humidification, and

incubation shelves. For incubation, two rooms with different temperatures are needed. On incubation, the temperature must be maintained to 18-25 °C, and for the fructification, a thermal shock is needed, to make them harvestable (Chang 2008).

Cultivation of the species *Pleurotus eryngii*

Pleurotus eryngii or the king oyster mushroom belongs to the parasite mushrooms species, quite rare in nature, but very much cultivated by farmers. The origin of its name „eryngii" is given by the *Eryngium* group plants under which they grow. Many species of the *Pleurotus* kind are ligneous, they grow naturally on tree trunks or rotting tree stomps. *Pleurotus eryngii* grows on decomposing remains of plants of the *Eryngium* kind.

Biological nature

It is a thermophilous species prefering warm climates and chalky soils. The optimal temperature for the mycelium growth is 12-28 °C.

Culture medium

The study of Moonmoon *et al.* in 2010, points out on the use of agar with malt extract (MEA) as culture medium used for the inoculation of mycelium. This was poured in Petri dishes and inoculated with the stems of the pure culture. Incubation was done in the dark, at 25 °C for 10 days, until the mycelium growth covered the entire surface of the dishes. This culture was used for the inoculation of the mother spawn.

The substrate for the mycelium

For the mycelium substrate, several recipes exist, based on mixing different ingredients: a) wheat bran 1.5% and lime; b) cottonseed bran 88%, wheat bran 10%, sugar 1% and lime 1%; c) sawdust 78%, wheat bran 20%, sugar 1% and lime 1% (Chang 2008).

In a 2007 study, Akyüz and Yldiz, reported the use of 1 kg of wheat grains cooked for 40 minutes and mixed with 2 g of lime and 8 g of gypsum, to obtain the mycelium. The mixture's moisture level must be maintained at 65%. It is poured in polyethylene bags of 250 g each, the mouth is filled with cotton and tied with rubber bands. The full bags are then sterilized in autoclave for 1 hour at 121 °C, left to cool and then inoculated with mycelium. For the incubation, the optimal temperature is of 25 °C for 15 to 20 days, until the mycelium growth covers the surface of the grains (Moonmoon *et al.* 2010).

Cultivation substrate

For the substrate composition, several recipes can be applied, according to the region or country of cultivation: a) ground cottonseeds 95%, gypsum 2%, lime 1% and calcium superphosphate 2%; b) rice straw 80%, cotton remains 18%, gypsum 1% and lime 1% **(**Chang 2008). Water is then added to regulate the moisture to 65-70%.

Method of cultivation

In order to obtain better development, the following substrate method was tested: 75% hardwood, hard and fine mixture, 10% cereals, 5% seed oil and 10% bran. Water and lime are added for moisture regulation, and the whole mass is mixed well together. The mixture is filled into polyethylene bags and sterilized in autoclave at 121 °C for 1 hour. After cooling, the substrate is inoculated with mycelium 1%. The bags are then put to spawn in a dark room at a temperature of 23-25 °C for the mycelium to develop. The substrate temperature must be 25-28 °C for 10-15 days. Initially, the CO_2 concentration can be between 5000-20000 ppm. The mycelium maturation phase takes 35 days at a temperature between 20-22 °C. In the next phase of fructification, the bags must be opened and the temperature lowered to 18 °C. This will create a thermal shock. They are put under light to boost an appropriate development. The fructification conditions are as follow: room temperature 15-21 °C, humidity 85-90%, CO_2 concentration up to 2000 ppm, lighting 500-1000 lux. The total production cycle takes about 2 months, with two harvests. Between harvests, the recommended relative air humidity is 90%. The average productivity is of 150-180 g mushrooms per kg substrate (Tudor 2018).

Cultivation of the species *Ganoderma lucidum*

The medicinal value of the *Ganoderma lucidum* mushroom has been appreciated in China for over 2000 years, this mushroom being rarely found in its natural habitat. Due to this scarcity, the mushroom has been extremely valued and cherished, being considered the mushroom of longevity and even immortality (Chang, Miles 2004).

Biological nature

This species grows on different tree essences, such as beech and oak, in elevated areas, from tropical to subtropical regions. Its cultivation began in the 70's in China, and the industry grew rapidly due to its desirability. The most frequently used methods of cultivation on a wide level for

intensive exploitation and merchandising are those on wood, wood stomps, sawdust bags or glass jars (Hsu 1994; Mizuno *et al.* 1996; Hung 1996; Mayzumi *et al.* 1997; Chang, Buswell 1999; Stamets 2000).

Medium of culture

Potato Dextrose Agar (PDA) is the simplest and most used medium to grow the mycelium of this mushroom.

The substrate for the mycelium

There are several varieties of substrate where the mother mycelium can be inoculated, such as wheat, cottonseed, chopped wheat straw or proso millet.

Cultivation substrate

The recommended substrate is composed of 80% hardwood, fine and coarse mixture, 10% cereals, 10% bran, with substrate humidity 62-63%.

Cultivation method on tree stomps

This type of cultivation takes place directly in nature; the prepared mycelium is inoculated directly onto the stomps. One other technique is the use of sterilized sawed stomps of 12-15 cm length, to ensure best development of the mycelium. This method ensures a shorter growth cycle, higher biological efficiency, a better quality fruiting body, which all bring higher economic benefits. Although the economic gain is superior, this procedure is more complex and the production costs are higher than those in natural environments, on tree stomps. For this procedure, the tree stomps must be of hard essences, preferably oak. The wood's humidity must be around 45-55%. The cultivation process consists of several stages: cutting the tree in short segments, putting the stomps into plastic bags, sterilization, inoculation, spawning of the mycelium, burying of the wood in the soil, development of fruiting body, harvesting, drying, packaging. While the tree stomps are being buried in the ground, certain aspects must be considered: the soil must have optimal water drainage, so as to avoid excess humidity (Chang 2008).

Cultivation method in bags or glass jars

The substrate consists of the following materials: a) wood shavings or sawdust 78%, wheat bran 20%, lime 1% and soy powder 1%; b) sawdust 75%, wheat bran 22%, sugar 1%, lime 1% and soy powder 1%; c) cottonseed bran 88%, wheat bran 10%, sugar 1% and lime 1%; d) wood shavings or sawdust 70%, cornmeal 14%, wheat bran 14%, lime 1% and ash from burning cereal straw 1%; e) cornmeal 78%, wheat / rice bran 20%, lime 1% ash from cereal straw 1%. After sterilization, the plastic bags are placed horizontally on shelves or on the ground, for fructification (Chang 2008).

Values and human health benefits of mushrooms

Several studies emphasized on the prophylactic properties of mushroom-based products, mainly antimicrobial and immunomodulatory effects (Chang 2008).

Nutritional and medicinal value of mushrooms

In a healthy diet, the most important issue is to give our body the required amounts of nutrients. Together with water, human body needs macronutrients such as proteins, saccharides and fats, and micronutrients such as vitamins (Chang 2008). Fresh mushrooms have 70-95% moisture, while dried ones contain about 10-13% water. The protein content for cultivated species varies between 3.5 and 4% of their fresh weight, while dehydrated mushrooms contain 19-35% of their dry weight (Chang 2008). Mushroom proteins contain all nine essential amino acids. A total fat content between 0.6 and 3.1% of the dry weight was reported for different types of cultivated mushrooms. At least 72% of the essential fatty acids were found in the tested mushrooms (Huang *et al.*, 1985). Generally, mushrooms are low in carbohydrates and calcium. Mushrooms are a good source of some biominerals (phosphorus, iron), vitamins (thiamine, riboflavin, ascorbic acid, vitamin B3) and pro-vitamins (ergosterol).

Great attention was given to mushrooms' selenium content obtained through the enrichment of the compost (Wermer, Beelman 2002). Selenium is an essential trace mineral with antioxidant activity, involved in metabolism and nutrition, being applied in food industry for the development of new products (Beelman, Royse 2006). Selenium has different physiological functions, *e.g.* concerning the enzyme glutathione-peroxidase responsible for removing free radicals from the human body.

Other attributes of mushrooms are their medicinal properties. They have attracted scientists' interest due to their blood pressure-lowering effects, benefits for kidneys (Yip *et al.* 1987), immunoemodulatory and antitumoral effects of the polysaccharide-protein complex of mycelia (Liu *et al.* 1995, 1996; Wang *et al.* 1995a, 1996b), or of lectins from edible mushrooms (Wang *et al.* 1995b, 1996a, 1997), with particular focus on the

medicinal effects of *Ganoderma lucidum* (Chang, Buswell 1999; Chang, Miles 2004).

Mushrooms are rich in health-promoting polysaccharides, β-glucans having different linkages and side chains compared to cereals- and yeast-derived β-glucans, as shown in **Tab. 1** for the three type of mushrooms described in the present paper. Published studies have confirmed their significant immunomodulatory and anticancer effects (Villares *et al.* 2012).

Mushrooms β-glucan polysaccharides have been used in tumoral therapies, particularly in combined treatment of gastric or colorectal cancer. In a clinical study, it was shown that lifespan of patients with stomach cancer increased by administration of 2 mg of intravenous lentinan per week (Chihara *et al.* 1987; Ochiai *et al.* 1992). Similar results were obtained in patients with breast cancer, whose lifespan increased after 106 days with similar doses of lentinan isolated from *Lentinula edodes* (Taguchi *et al.* 1982).

Mushroom–based nutritional supplements

In the last time, many studies have focused on investigation of the bioactive content of mushrooms, either from mycelium or the fruiting body. These bioactive compounds are of great medicinal values, in particular in form of supplements with anticancer, antiviral, immuno-protective, cholesterol-reducing and liver-protecting properties (Chang, Buswell 1996). There are abundant studies in Asia, particularly in China and Japan, which confirmed an increase in life expectancy in patients with cancer that are following a conventional cancer treatment plus administration of mushroom extracts (Mizuno *et al.* 1995; Liu 1999). Alongside these, mushrooms improve the immune system to help the human body fight infections. Most nutritional supplements come from the fruiting body of farmed mushrooms.

Lately, there has been a growing interest for the production of food supplements using different mushroom strains, as a source of bioactive compounds with medicinal values and health-promoting properties. A great deal of these substances were extracted directly from the mycelium (Chang, Buswell 1996). Although all mushrooms contain polysaccharides in their cell walls, only some proved efficiency in the treatment of certain types of cancer and other diseases. There are studies which showed that administration of standardized mushroom extracts can prolong life of cancer patients (Mizuno *et al.* 1995; Liu 1999). If consumed earlier than disease occurred, mushrooms help boost the immune system and prevent infections. Powder of *Ganoderma lucidum* is used in various supplements, the daily recommended dose being 150-900 mg, as a tablet or capsule, and 1.5 to 9 g of dry powder.

The biologically active chemical compounds are obtained from the fruiting body, *e.g.* lentinan produced by *Lentinula edodes*.

One recent study of Yang *et al.* 2020 has proved that the fermentation in solid state of *Ganoderma lucidum*, *Lentinula edodes* and Okara (fermented soybean) significantly improved the antioxidant activity and the level of bioactive compounds valuable for the treatment of post-menopausal osteoporosis in women.

In 1996, Chang stated that the market value of mushrooms had grown in the period 1991-1994, from approximately 1.2 billion to 3.6 billion, estimating a double growth from 1994 to 1999. In 1995, products from *Ganoderma lucidum* brought a profit of 1628.4 billion USD (Chang, Buswell 1999). In the last years, the demand on the USA market for mushroom-based products raised by 20-40% annually.

Conclusions

Due to population growth, the quantity of food might become a serious problem, especially in less developed countries. Among food sources, mushrooms gained special interest, because of simple cultivation conditions on available lignocellulosic biomass and solar energy, not affecting the environment. Wood and cellulose wastes, such as spent coffee grounds, cereal straw can be used as raw materials for their cultivation. After harvesting, the substrate can be used as fodder or as fertilizer for other cultures. This concept has zero emissions and total productivity. Given the large variety of edible mushrooms species, their cultivation will contribute to a great extent to the feeding of population.

Mushrooms, medicinal and culinary, have positive effects on human health based on their nutritional value and pharmacological properties.

The mushroom industry can have a long-term positive global impact in fields such as nutrition, health, biotechnology, conservation and regeneration of environment, thus acting indirectly towards positive developments in economy and society.

This study described the general features, the cultivation techniques and the health benefits of

Ganoderma lucidum, *Lentinula edodes* and *Pleurotus eryngii* species, encouraging further applied research, given the promising results on their antimicrobial, antiinflammatory and antioxidant properties. The exploration of cultivated or wild mushrooms and their bioactive ingredients with therapeutic value constitutes a challenge for researchers all over the world.

REFFERENCES

Acay *et al*. 2020 — Acay Hilal, Yildirim Ayfer, Erdem Güzel Elif, Kaya Nalan, Baran Mehmet Firat, *Evaluation and characterization of Pleurotus eryngii extract-loaded chitosan nanoparticles as antimicrobial agents against some human pathogens.* In: *Preparative Biochemistry & Biotechnology* (2020), 1-10.

Akyüz, Yildiz 2007 — Akyüz Mehmet, Yıldız Abdunnasir, *Cultivation of Pleurotus eryngii* (DC. ex Fr.) Quel. on agricultural wastes. In: *Philippine Agricultural Scientist* (2007), 90.4: 346-350.

Beelman, Royse 2006 — Beelman Robert Bertrum, Royse Daniel J., *Selenium enrichment of Pleurotus cornucopiae (Paulet) Rolland and Grifola frondosa (Dicks: Fr.) S. F. Gray mushrooms*. In: *International Journal of Medicinal Mushrooms* (2006), 8.1.

Boa 2004 — Boa Eric R., *Wild edible fungi: a global overview of their use and importance to people*. In: *Food & Agriculture Org.* (2004).

Buller 1914 — Buller Athur Henry Reginald, *The fungus lores of the Greeks and Romans*. In: *Transactions of the British Mycological Society* (1914), 5: 21-66.

Campbell, Racjan 1999 — Campbell Alastair C., Racjan M., *The commercial exploitation of the white rot fungus Lentinula edodes (shiitake*). In: *International biodeterioration & biodegradation* (1999), 43:3, 101-107.

Carbonero *et al*. 2008 — Carbonero Elaine R, Gracher Ana Helena Pereira, Komura Dirce Leimi, Marcon Rodrigo, Freitas Cristina Setim, Baggio Cristiane H., Adair R.S. Santos, Giangiacomo Torri, Philip Albert James Gorin, Iacomini Marcello, *Lentinus edodes heterogalactan: Antinociceptive and anti-inflammatory effects.* In: *Food Chemistry* (2008) 111.3: 531-537.

Chang 1996 — Chang Shu-Ting, *Mushroom research and development--equality and mutual benefit*. In: *Mushroom biology and mushroom products: proceedings of the 2nd International Conference, June 9-12*, 1996, University Park, Pennsylvania. University Park, PA: Pennsylvania State University; [Sl]: World Society for Mushroom Biology and Mushroom Products, c1996. (1996).

Chang 1998 — Chang Shu-Ting, *Development of novel agroscience industries based on bioconversion technology*. In: *Frontiers in Biology: The Challenges of Biodiversity* (1998), 217-222.

Chang 2008 — Chang Shu-Ting, *Overview of mushroom cultivation and utilization as functional foods*. Mushrooms as functional foods (2008), 260.

Chang, Buswell 1996 — Chang Shu-Ting., Buswell John A., *Mushroom nutriceuticals.* In: *World Journal of Microbiology and Biotechnology* (1996), 12.5: 473–476.

Chang, Buswell 1999 — Chan Shu-Ting, Buswell John A., *Ganoderma lucidum (Curt.: Fr.) P. Karst (Aphyllophoromycetideae)− a mushrooming medicinal mushroom.* In: *International Journal of Medicinal Mushrooms* (1999), 1.2.

Chang, Buswell 2003 — Chang Shu-Ting, Buswell John A., *Medicinal mushrooms—A prominent source of nutriceuticals for the 21st century.* In: *Current Topics in Nutraceutical Research* (2003), 1: 257–280.

Chang, Chiu 1992 — Chang Shu-Ting, Chiu Siu Wai, *Mushroom production–An economic measure in maintenance of food security.* In: *Microbial Technology: Economic and Social Aspects, Cambridge University Press*, Cambridge (1992).

Chang, Miles 1984 — Chang Shu-Ting, Miles Philip G., *A new look at cultivated mushrooms*. In: *BioScience* (1984), 34.6: 358–362.

Chang, Miles 2004 — Chang Shu-Ting, Miles Philip G., *Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact*. In: *CRC Press*, (2004), p. 451.

Chang, Mshiheni 2001 — Chang Shu-Ting., Mshigeni Keto E., *Mushrooms and Human Health: Their Growing Significance as Potent Dietery Supplements.* University of Namibia, (2001).

Chang, Quimio — Chang Shu-Ting, Quimio T. H. (Eds.), *Tropical mushrooms: biological nature and*

1982 *cultivation methods*. In: *Chinese University Press* (1982).

Chihara *et al.* 1987 Chihara G., Hamuro J., Maeda Y.Y., Shiio T., Suga T., Takasuka N., Sasaki T., *Antitumor and metastasis-inhibitory activities of lentinan as an immunomodulator: an overview. Cancer detection and prevention*. In: official publication of the *International Society for Preventive Oncology*, Inc (1987), 1: 423-443.

Dong *et al.* 2012 Dong Qun, Wang Ying, Shi Lei, Yao Jian, Li Jie, Ma Fangli, Ding Kan, *A novel water-soluble β-D-glucan isolated from the spores of Ganoderma lucidum.* In: *Carbohydrate Research* (2012) 353, 100-105.

González *et al.* 2020 González Aránzazu, Atienza Violeta, Montoro Alegria, Soriano Jose Miguel, *Use of Ganoderma lucidum (Ganodermataceae, Basidiomycota) as Radioprotector.* In: *Nutrients* (2020), 12.4: 1143.

Hawksworth 2001 Hawksworth David L., *The magnitude of fungal diversity: The 1.5 million species estimate revisited*. In: *Mycological Research* (2001), 105.12: 1422–1432.

Hsu 1994 Hsu Z. C., *New Technology for Cultivation of Ganoderm lucidum [in Chinese]*. In: *Chaoyang Edible Fungi Research Institute* (1994), p. 54.

Huang *et al.* 1985 Huang Bu-Han, Yung Kung-Hing, Chang Shu-Ting, *The sterol composition of Volvariella volvacea and other edible mushrooms.* In: *Mycologia* (1985), 77.6: 959–963.

Hung 1996 Hung Z., *Artificial cutivation of Ganoderma lucidum*. In: *Modern Research on Ganoderma lucidum*, (1996), 61-87.

Jana, Acharya 2020 Jana Pradipta, Acharya Krishnendu, *Mushroom: A new resource for anti-angiogenic therapeutics*. In: *Food Reviews International* (2020), 1-22.

Li *et al.* 2020 Li Jia, Gu Feifei, Cai Chao, Hu Minghua, Fan Luodi, Hao Jiejie, Yu Guangli, *Purification, structural characterization, and immunomodulatory activity of the polysaccharides from Ganoderma lucidum.* In: *International journal of biological macromolecules* (2020), 143: 806-813.

Liu 1999 Liu Geng Tao, *Recent advances in research of pharmacology and clinical applications of Ganoderma P. Karst. species (Aphyllophoromycetideae) in China*. In: *International Journal of Medicinal Mushrooms* (1999), 1.1.

Liu *et al.* 1995 Liu F., Ooi Vincent Eng Choon, Chang Shu-Ting, *Antitumour components of the culture filtrates from Tricholoma sp.* In: *World Journal of Microbiology and Biotechnology* (1995), 11.5: 486–490.

Liu *et al.* 1996 Liu F., Ooi Vincent Eng Choon, Liu W. K., Chang Shu-Ting., *Immunomodulation and antitumor activity of polysaccharide-protein complex from the culture filtrates of a local edible mushroom, Tricholoma lobayense.* In: *General Pharmacology: The Vascular System* (1996), 27.4: 621-624.

Liu *et al.* 2018 Liu Rui, Cao Pengfei, Ren Ang, Wang Shengli, Yang Tao, Zhu Ting, Shi Liang, Zhu Jing, Jiang Ai- Liang, Zhao Ming-Wen, *SA inhibits complex III activity to generate reactive oxygen species and thereby induces GA overproduction in Ganoderma lucidum.* In: *Redox biology* (2018), *16*: 388-400.

Manic 2018 Manic Ștefan, *Ghid de ciuperci din Republica Moldova*, 2018, p. 8.

Manzi *et al.* 2004 Manzi Pamela, Marconi Stefania, Aguzzi Altero, Pizzoferrato Laura, *Commercial mushrooms: nutritional quality and effect of cooking.* In: *Food chemistry* (2004), 84.2: 201-206.

Mau *et al.* 2004 Mau Jeng-Leun, Chang Chieh-No, Huang Shih-Jeng, Chen Chin-Chu, *Antioxidant properties of methanolic extracts from Grifola frondosa, Morchella esculenta and Termitomyces albuminosus mycelia.* In: *Food Chemistry* (2004), 87.1: 111–118.

Mayzumi *et al.* 1997 Mayzumi Fumimaru, Okamoto Hidehumi, Mizuno Takashi, *IV. Cultivation of reishi (Ganoderma lucidum) Cultivation of reddish reishi (Ganoderma lucidum, Red).* In: *Food Reviews International* (1997), 13(3), 365-370.

Miles, Chang 1997 Miles Philip G., Chang Shu-Ting, *Mushroom biology: concise basics and current developments*. In: World Scientific (1997).

Miles, Chang 2004 Miles Philip G., Chang Shu-Ting, *Mushrooms: cultivation, nutritional value, medicinal effect, and environmental impact*. In: *CRC press* (2004).

Mizuno *et al.* 1995 Mizuno T., Saito H., Nishitoba T., Kawagishi H., *Antitumor-active substances from mushrooms.* In: *Food Reviews International* (1995), 11, 23–61.

Mizuno *et al.* Mizuno T., Naoi Y., Mayuzumi F., Ogino M., Okamoto H. *Artificial cultivation of*

1996 *Ganoderma lucidum in Japan. In Ganoderma lucidum.* Mizuno, T., editor. In: *Seoul: IL-Yang Pharmaceutical* (1996), p. 298.

Moonmoon *et al*. 2010 Moonmoon Mahbuba, Uddin Md Nazim, Ahmed Saleh, Shelly Nasrat Jahan, Khan Md Asaduzzaman, *Cultivation of different strains of king oyster mushroom (Pleurotus eryngii) on saw dust and rice straw in Bangladesh.* In: *Saudi Journal of Biological Sciences* (2010), 17.4: 341-345.

Muszyńska *et al.* 2020 Muszyńska Bozena, Kała Katarzyna, Włodarczyk Anna, Krakowska Agata, Ostachowicz Beata, Gdula-Argasińska Joanna, Suchocki Piotr, *Lentinula edodes as a source of bioelements released into artificial digestive juices and potential anti-inflammatory material*. In: *Biological Trace Element Research*, (2020) 194.2: 603-613.

Ochiai *et al.* 1992 Ochiai T., Isono K., Suzuki T., Koide Y., Gunji Y., *Effect of immunotherapy with lentinan on patients' survival and immunological parameters in patients with advanced gastric cancer: results of a multi-centre randomized controlled study*. In: *International journal of immunotherapy* (1992), 8.3: 161-169.

Paul *et al*. 2020 Paul Tanushree, Pal Shreyoshi, Roy Dipanwita, Sikdar Samir Ranjan, Mallick Pijush, *Amplification and sequence analysis of 'nad1'gene from edible mushroom Lentinula edodes*. In: *International Journal of Advancement in Life Sciences Research*, India (2020), 3.1: 32-36.

Pegler 2002 Pegler D. N., *Useful fungi of the world: The "Poor man's truffles of Arabia" and "Manna of the Israelites".* In: *Myocologist* (2002), 16.1: 8–9.

Quimio *et al.* 1990 Quimio T. H., Chang Shu-Ting, Royse Daniel Joseph, *Technical guidelines for mushroom growing in the tropics*, Philipine (1990), 170.

Rojas, Mansur 1995 Rojas C., Mansur E., *Ecuador: informaciones generales sobre productos non madereros en Ecuador*. In: *Memoria, consulta de expertos sobre productos forestales no madereros para America Latina y el Caribe*, (1995), 208-223.

Royse *et al.* 2017 Royse Daniel Joseph, Baars Johan, Tan Qi, *Current overview of mushroom production in the world.* In: *Edible and medicinal mushrooms: technology and applications*, (2017), 5-13.

Stamets 2000 Stamets Paul, *Growing Gourmet and Medicinal Mushrooms.* In: CA: Ten Speed, Berkeley (2000), p. 339.

Stamets 2005 Stamets Paul, *Mycelium Running: How Mushroom Can Help Save the World.* In: Random House Digital, Inc., Berkeley (2005), p. 574.

Synytsya *et al.* 2009 Synytsya Andriy, Míčková Katerina Synytsya Alla, Jablonský Ivan, Spěváček Jiri, Erban Vladimir, Čopíková Jana, *Glucans from fruit bodies of cultivated mushrooms Pleurotus ostreatus and Pleurotus eryngii: Structure and potential prebiotic activity*. In: *Carbohydrate polymers* (2009), 76.4: 548-556.

Taguchi *et al.* 1982 Taguchi T., Abe O., Enomoto K., Kusama S., Tomiyama J., Tominaga K., & Ogawa N., *Life span prolongation effect of lentinan on patients with advanced or recurrent breast cancer*. In: *International Journal of Immunopharmacology* (1982), 4.4: 271.

Tudor 2018 Tudor Ioana, *Pleurotus spp. păstrăvul de fag, bureți, tehnologia de cultură în sistem clasic și intensiv*, In: *Editura FDLR* (2018), 7, 203–207.

Villares *et al.* 2012 Villares Ana, Mateo-Vivaracho Laura, Guillamón Eva, *Structural features and healthy properties of polysaccharides occurring in mushrooms.* In: *Agriculture* (2012), 2.4: 452-471.

Wang *et al.* 1995a Wang Hexiang X., Liu Wingkeung K., Ng Tzi Bun, Ooi Vincent Eng Choon, Chang Shu-Ting. *Immunomodulatory and antitumour activities of a polysaccharide-protein complex from a mycelial culture of Tricholoma sp. A local edible mushroom.* In: *Life Science* (1995a), 57.3: 269–281.

Wang *et al.* 1995b Wang Hexiang X., Ng T. B., Liu Wingkeung K., Ooi Vincent Eng Choon, Chang Shu-Ting *Isolation and characterization of two distinct lectins with anti-proliferative activity from the cultured mycelium of the edible mushroom Tricholoma mongolicum.* In: *International Journal of Peptide and Protein Research*, (1995b), 46.6: 508–513.

Wang *et al.* 1996a Wang Hexiang X., Liu Wingkeung K., Ng Tzi Bun, Ooi Vincent Eng Choon, Chang Shu-Ting *The immunomodulatory & antitumour activities of lectins from the mushroom Tricholoma mongolicum.* In: *Immunopharmacology* (1996a), 31.2-3: 205–211.

Wang *et al.* 1997 Wang Hexiang X., Ng T. B., Ooi Vincent Eng Choon, Liu Wingkeung K., Chang Shu-Ting, *Actions of lectins from the mushroom Tricholoma mongolicum on macrophages,*

splenocytes and life-span in sarcoma-bearing mice. In: *Anticancer Research* (1997), 17.1A: 416–420.

Wang, Zhang 2009 — Wang Jianguo, Zhang Lina *Structure and chain conformation of five water-soluble derivatives of a β-D-glucan isolated from Ganoderma lucidum*. In: *Carbohydrate Research* (2009), 344.1: 105-112.

Wermer, Beelman 2002 — Wermer Andrew R., Beelman Robert B. *Growing high-selenium edible and medicinal button mushrooms (Agaricus bisporus (J. Lge) Imbach) as ingredients for functional foods or dietary supplements.* In: *International Journal of Medicinal Mushrooms*, (2002) 4.2, 167–171.

Wong 2008 — Wong Ka-Hing, Cheung Peter CK. *Sclerotia: emerging functional food drived from mushroom.* In: *Mushrooms as functional foods* (2008), 111: 146.

Yang *et al.* 2020 — Yang Li-Chan, Fu Tzu-Jung, Yang Fan-Chiang, *Biovalorization of soybean residue (okara) via fermentation with Ganoderma lucidum and Lentinus edodes to attain products with high anti-osteoporotic effects.* In: *Journal of bioscience and bioengineering* (2020),129(4), 514-518.

Yip *et al.* 1987 — Yip K. P., Fung K. P., Chang Shu-Ting, Tam S. C., *Purification and mechanism of the hypotensive action of an extract from edible mushroom Pleurotus sajor-caju.* In: Neuroscience Letters Supplement (1987), 28: S59.

Yuen, Gohel 2005 — Yuen John WM, Gohel Mayur Danny I. *Anticancer effects of Ganoderma lucidum: a review of scientific evidence.* In: *Nutrition and cancer* (2005), 53.1: 11-17.

Zhang *et al.* 2011 — Zhang Yangyang, Li Sheng, Wang Xiaohua, Zhang Lina, Cheung Peter C.K., *Advances in lentinan: isolation, structure, chain conformation and bioactivities.* In: *Food hydrocolloids* (2011), 25.2: 196-206.

LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Tab. 1. Structural features of polysaccharides occurring in *Ganoderma lucidum, Lentinula edodes* and *Pleurotus eryngii*

Mushroom	Type of polysaccharide	Structural features	Ref.
Ganoderma lucidum	Homopolysaccharide	β-(1→3)-linked D-glucan	Wang, Zhang *et al.* 2009
	Homopolysaccharide	(1→6)-glucan with (1→4) branches at O-4	Dong *et al.* 2012
	Heteropolysaccharide	α-(1→4)-D-glucopyranosyl and β-(1→6)-D-galactopyranosyl with branches at O-6 of glucose and O-2 of galactose	Li *et al.* 2020
Lentinula edodes	Homopolysaccharide	(1→3),(1→6)-D-polysaccharide	Zhang *et al.* 2011
	Heteropolysaccharide	Fucomannogalactan of (1→6)-linked α-D-galactopyranoses branched at O-2	Carbonero *et al.* 2008
Pleurotus eryngii	Homopolysaccharide	α-(1→3)-linked D-glucan	Synytsya *et al.* 2009

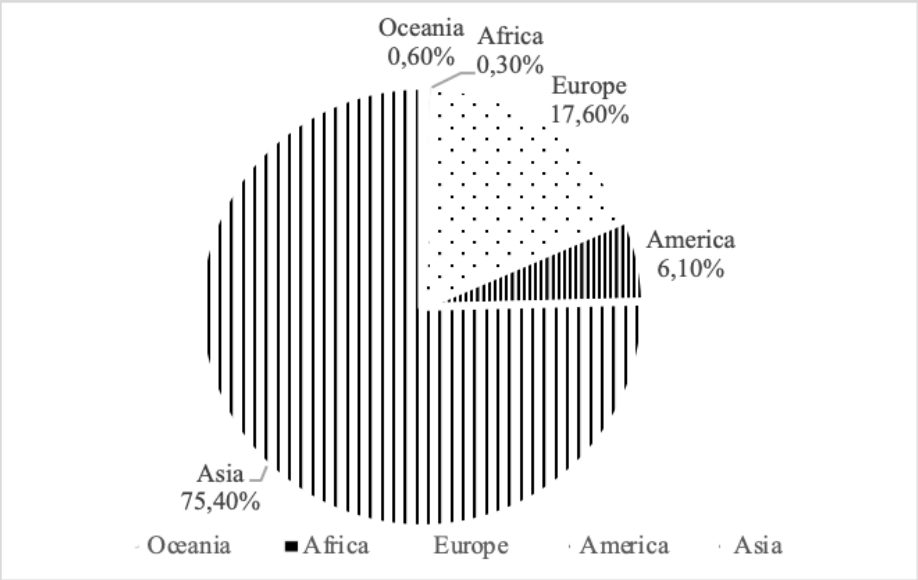


Fig. 1. Production of mushroom and truffles by region over 10 years (2009-2018) according to FAOSTAT published data (www.fao.org/faostat/en/#data/QC/visualize).

HOMEOPATHIC REMEDIES OF BOTANICAL ORIGINE FROM THE HISTORY OF PHARMACY MUSEUM COLLECTION, BRUKENTHAL NATIONAL MUSEUM FROM SIBIU

Daniela-Nicoleta DORDEA*
Elena-Nicoleta DEACONU**
Ana-Maria PĂPUREANU***
Ladislau ROSENBERG****

Abstract. *The Pharmacy History Museum in Sibiu, part of the Brukenthal National Museum, includes a unique collection of Homeopathic remedies. The aim of this study was to inventories the remedies of botanical origin from the total of 2910 vials. As a result 287 botanical sources were identified, from which more than half are of decimal homeopathic dilutions or potencies (D). The plants used to prepare the remedies were collected from Europe followed by North America and Asia. The paper analyses mainly the plants present also in the Romanian flora, considering the relationship between the uses of the plants in ethnopharmacology and homeopathy.*
Keywords*: Pharmacy History Museum, Homeopathy Collection, botanical sources.*

Rezumat. *Muzeul de Istoria Farmaciei din Sibiu, compartiment al Muzeului Național Brukenthal, deține o colecție unică la nivel național și anume colecția de 2910 remedii homeopatice. Scopul acestei lucrări a fost inventarierea și analiza remediilor de origine vegetală. În urma studiului au rezultat 287 plante, dintre care, mai mult de jumătate, au fost preparate sub forma de diluții decimale (D). Plantele utilizate au fost colectate în special din Europa, America de Nord și Asia. Lucrarea analizează în special plantele prezente și în flora României, având în vedere legătura dintre utilizarea remediile în homeopatie și etnoiatria românească.*
Cuvinte cheie: *Muzeul de Istoria Farmaciei, colecția de Homeopatie, surse botanice.*

Introduction

The Brukenthal National Museum in Sibiu is one of the most complex museums in Romania because of its sections and departments like the History of Pharmacy Museum. Opened to the public in 1972, it is a unique museum and the 2910 homeopathy objects contribute to this aspect. The homeopathic collection was donated to the museum on October 20th, 1950. At that time the vials and traveling kits were stored at the State Pharmacy number 4, in Sibiu, following the nationalization from 1949.

Doctor Julius Bielz (1884-1958) was designated from the Brukenthal Museum to take possession of the objects. J. Bielz was specialized in law, ethnography and art history, with studies in Berlin, Munich and Cluj-Napoca.

* "Lucian Blaga" University of Sibiu, Faculty of Medicine "Victor Papilian", dordea.daniela95@yahoo.com
** "Lucian Blaga" University of Sibiu, Faculty of Medicine "Victor Papilian", elena_winx06@yahoo.com
*** Brukenthal National Museum Sibiu, papureanu.ana@gmail.com
**** Romanian Society for the History of Pharmacy (SRIF) and "Lucian Blaga" University of Sibiu, Faculty of Medicine "Victor Papilian", rosenlaszlo@yahoo.com

He occupied many important positions during his life time: Adviser to the High Court of Auditors of Austria-Hungary, President of the *Cultural Council of the German Ethnic Group in Romania*, president of the *Association of Friends of the Brukenthal Museum*. He was appointed curator of the Brukenthal Museum in 1927. Here he will carry out all his scientific activity, becoming in 1955 deputy director. He was editor-in-chief of the *Mitteilungen aus dem Baron Brukenthalischen Museum* and a member of the editorial board of the *Verein fur Siebenburgische Landeskunde*. As an historian and ethnographer, J. Bielz accepted the task to gather all the objects with historical value from the soon to be nationalized pharmacies from Sibiu County and from other cities in Transylvania. Many, pharmacies in Sibiu had a homeopathy section in 1949, amid the nationalization of the private sector.

The tradition of homeopathy in Sibiu can trace back its rots to the year 1777 when Christian Friedrich Samuel Hahnemann (1755-1843), the father of Homeopathy, arrived in Sibiu, as *„medicine candidate and librarian of his excellency Baron Brukenthal"*. Păpureanu and Rosenberg (2017, 547-552) wrote inextenso about

the period that Hahnemann spent in Sibiu until the spring of 1779 when he registered at the Erlangen University as *promovendus* or *doctoral candidate*. Hahnemann spent most of his time in Sibiu fulfilling his assignment to catalog the Baron's book collection, task held together with Johann Michael Soterius senior (1742–1794). Deaconu (2019, bachelor's thesis) researched the catalogue from the Brukenthal Library containing the entries done by Soterius and Hahnemann, comprising around 5,000 book titles. The catalogue was finished in 1780, after Hahnemann left Sibiu. But the period spent in Sibiu is considered by many historians as one of the starting points in the development of Hahnemann's future medical career.

In Sibiu, one of the first pharmacies to open a homeopathic section was „*The Angel*" Pharmacy (*Zum Engel Apotheke*). The pharmacy was opened in 1905 by Ștefan Czipott (1872-1916). In 1919, „The Angel" Pharmacy was bought by two pharmacists Eugen Wittmeyer (1883-1958) and Johann Binder (1888-1963). The two pharmacists already practiced homeopathy at their old employment and so the new pharmacy was designed with a homeopathy laboratory as well (Maior 2015, 476-496). In the laboratory, were prepared, in general, successive dilutions that were bought from abroad (Ban 2003a, 271). The „Angel" Pharmacy also procured finished homeopathic remedies from renowned European laboratories like Schwabe and Madaus. Portable homeopathic kits were also found in the pharmacy inventory. With time the diversity of the homeopathy remedies sold at this pharmacy grew and so on April 2nd, 1949 when the pharmacy was nationalized becoming State Pharmacy number 4, in the homeopathy sector were counted 2910 homeopathic remedies. The vials and kits were catalogued as a collection and donated to the Brukenthal National Museum.

Considering the source of the remedies the museum homeopathy collection comprises: 1495 vials with remedies of botanical origin, 1188 of mineral origin and 227 of zoological and biotherapeutic origin (Fig. 1, Deaconu, 2019). The numbers have been updated following this paper because, in the past, the origin of the substances has been wrongly identified.

The collection has been researched from a historic and scientific point of view by pharmacist Maior O. (2014, 476-496) and, subsequently, by the curators of the museum especially pharmacist Ban M. (2001, 2003a, 2003b, 2007) who published various papers regarding this collection, mainly inventory lists.

Since 2016, the Romanian Society for the History of Pharmacy, Sibiu section, in collaboration with Brukenthal National Museum in Sibiu, has initiated the cultural-educational project „Pharmacy traditions in Sibiu", a project still continuing today. One of the objectives included in the project was to create a research group dedicated to the study of the History of Pharmacy Museum collection from Sibiu and from the country. As a result, such a group was formed with members of various backgrounds and areas of expertise. From this group, Pharmacy students were encouraged to research the homeopathy collection and in 2019, the results of their studies were presented as bachelor's theses (Deaconu E.N. 2019; Dordea D.E. 2019). This paper comprises the remedies of botanical origin included in the museum collection.

Material and results

In the museum homeopathic collection we encountered *unitary or single homeopathic remedies* (made from a single substance), *complex remedies* (combinations of several homeopathic medicines) and homeopathic *magistral* preparations (CH – hahnemannian dilutions). After the inventory, from the total of 1495 vials with remedies of botanical origin, resulted: 913 decimal homeopathic dilutions or potencies (D), 293 centesimal homeopathic dilutions or potencies (C), 241 mother tinctures (Ɵ), 14 homeopathic trituration (T or Tr.), 34 complex homeopathic remedies (Ex: Ɵ=1/3; FORTE, Rp.) (Fig. 2; Dordea 2019, 17).

After the inventory we identified 287 botanical sources, in alphabetical order, according to their inscriptions and inventory number (Fh):

1. ABIES NIGRA (Fh 1 to Fh 10), D2, D3, D4, D5, D11, D19, D19, D39, D49, D59.
2. ABROTANUM (Fh 11 to Fh 20), D1, D2, D3, D4, D5, D7, D9, D11, C28, C29.
3. ABSYNTHIUM (Fh 21 to Fh 25), D1, D2, D3, D4, D5.
4. ACALYPHA INDICA (Fh 26), Ɵ.
5. ACONIT/ ACONITIN/ ACONITUM/ ACONITUM FEROX (Fh 75 to Fh 100, Fh 2808), D1, D3, D4, D5, D6, D7, D8, D9, D10, D11, D14, D19, D24, D28, D29, D198, D199, Tr.2 and T4.
6. ACTEA/ ACTEA RACEMOSA/ ACTEA SPICATA (Fh 101 to Fh 112), D1, D2,

D3, D4, D7, C28, C29, C198, C199; Θ=1/3.

7. ADONIS VERNALIS (Fh 113 to Fh 115), D1, D2, Θ.
8. AESCULUS/ AESCULUS GLABRA/ AESCULUS HIPPOCAST (Fh 117 to Fh 125), D1, D2, D3, D4, D7, D11, D29, Θ.
9. AETHUS CYNAPIUM (Fh 128 to Fh 131), C6, C28, C29, Θ.
10. AGARICUS MUSCARIUS (Fh 132 to Fh 141), D1, D3, D4, D5, D6, D7, D11, C28, C29, Θ.
11. AGNUS CASTUS (Fh 142 to Fh 157), D2, D3, D4, D5, D10, D15, D20, D25, D30, D35, D40, D45, D50, D55, D58, D59.
12. AGRAPHIS NUTANS (Fh 158), Θ.
13. AILANTHUS GLAND (Fh 159), Θ.
14. ALETRIS FARINOSA (Fh 160 to Fh 167), D2, D3, D4, D5, D7, D9, D11; Θ.
15. ALFALFA (Fh 168), Θ.
16. ALIUM CEPA (Fh 169 and Fh 170), C4 Θ.
17. ALNUS RUBRA (Fh 171), Θ.
18. ALOES (inventory number Fh 172 to Fh 175), D2; C28, C 198 and C 199.
19. AMMONIUM VALERIANAE (Fh 204), D2.
20. ANACARDIUM (Fh 211 to Fh 221), D49, D58, D59; C6, C10, C24, C29, C30, C39, C198; Θ.
21. ANGINA COMPLEX DIFTERIQUE (Fh 222), D4.
22. ANGUST SPURIA (Fh 223 to Fh 225), D1 and D3.
23. APOCYNUM CANNABIS (Fh 276 and Fh 277), C28 and Θ.
24. AQUA AMYGD. AMAR./ AQUA AMYGD. PERSICA (Fh 280 and Fh 281), mother tinctures Θ.
25. AQUA NUX VOMICA (Fh 282), Θ.
26. ARALIA RACEMOSA (Fh 285), Θ.
27. ARISTOLOCHIA (Fh 315), D1.
28. ARNICA/ ARNICA COLOIDALE/ ARNICA MONTANA/ ARNICA TINCTUR (Fh 316 to Fh 340 and Fh 2811), D1, D2, D5, D8, D11, D13, D14, D29, D30, D 35, D40, D45, D50, D55, D58, D198, D199; Θ.
29. ARTEMISIA (Fh 363 to Fh 366), D1, D2 and D3; Θ.
30. ARUM TRIPHYLLUM (Fh 367 and Fh 368), D1; Θ.
31. ASA FOETIDA/ ASA OLIGOPLEX (Fh 369 to Fh 374), D1, D3; (Rp).
32. ASARUM EUROP. (Fh 375), Θ.
33. ASCLEPIA TUBEROSA (Fh 376 to Fh 379), C4, C5, C28, C29.
34. ATROPIN SULFURIC (Fh 392 to Fh 395, Fh 2846 and Fh 2847), D2, D3, D7, D10; T2 and T3.
35. AVENA SATIVA (Fh 419), Θ.
36. BALSAM PERUV. (Fh 425), D1.
37. BAPTISIA/ BAPTISIA TINCTOR (Fh 426 to Fh 433), D2, D3, D4, D5, D9; θ =1/3; Θ.
38. BELLADONNA (Fh 477 to Fh 491), D1, D2, D4, D5, D6, D29, D30, D49, D58, D59; Θ.
39. BELLIS PERENNIS/ BELLIS TINCTUR (Fh 492 to Fh 499, Fh 2814), D1, D2, D4, D5, D7, D9, D11.
40. BERBERIN/ BERBERIS/ BERBERIS VULGARIS (Fh 500 to Fh 510), D2, D3, D4, D6, D15, D20, D50, D58; Θ.
41. BOLDO (Fh 523), Θ.
42. BOVISTA (Fh 530 to Fh 532), D3; C28; Θ.
43. BRYONIA (Fh 536 to Fh 544, Fh 2815), D1, D2, D6, D8, D11; C28, C29; Θ.
44. CACTUS GRANDIFLOR (Fh 547 to Fh 558), D1, D2, D3, D4, D5, D9; C28, C29, C198, C199; Θ.
45. CAJEPUTUM (Fh 578), C4.
46. CALADIUM SEGUIN (Fh 561 to Fh 577), D1, D2, D3, D4, D5, D6, D7, D8, D9, D10; C25, C26, C27, C28, C29; Θ.
47. CALENDULA (Fh 667 to Fh 670, Fh 2821), C6, C26, C30; Θ.
48. CAMAEDRYS (Fh 819), Θ.
49. CANNABIS/ CANNABIS INDICA/ CANNABIS SATIVUS (Fh 683 to Fh 697), D1, D2, D3, D4, D5, D7, D9, D11; Θ.
50. CAPSICUM (Fh 718 to Fh 725), D4; C28, C29, C198, C199, C200; Θ.
51. CARBO VEGETALIS/ CARBO VEGETALIS COLLOID (Fh 735 to Fh 760), D2, D4, D5, D6, D7, D8, D9, D11, D12, D15, D20, D25, D28, D29, D30, D40, D50, D57; C198, C199; T1.
52. CARDAMINE PRAT. (Fh 763), Θ.
53. CARDUS MARIAN (Fh 764 to Fh 770), D4, D5, D7, D10; C2, C28; Θ.
54. CASCARA AMATGA (Fh 771), Θ.
55. CATECHU (Fh 772), Θ.
56. CAULOPHYLLUM/ CAULOPHYLLUM THAL. (Fh 773 to Fh 779), D2, D9, D13; Θ.
57. CEANATOS AMERIC. (Fh 814), Θ.

58. CEDRON (Fh 815 to Fh 817), C5, C28, C29.
59. CHAMOMILLA (Fh 820 to Fh 833), D3, D5, D7; C4, C5, C198, C199, C998, C999; Θ; Θ=1/2.
60. CHELIDONIUM (Fh 835), Θ.
61. CHENOPOD. ANTHEL. (Fh 835 to Fh 838), C28, C29; Θ.
62. CHIMOPHILA (Fh 839 to Fh844), D1, D3, D5, D7, D11; Θ.
63. CHIMAPHILA UMB. (Fh 845 and 846), C28 and C29.
64. CHINA (Fh 847 to Fh 857), D8, D19, D24, D29, D39, D49, D59; C6, C 198, C199; Θ.
65. CHIONANTH. VIRG. (Fh 873 to 880), D1, D2, D3, D4, D5, D7, D11; Θ.
66. CICUTA VIROSA (Fh 892 to Fh 896), C28, C29, C199; Θ.
67. CIMIFUGA (Fh 897 to Fh 890), D2, D3, D4; Θ.
68. CINA (Fh 908 to Fh 915), D2, D3, D4, D5, D7, D9, D11; Θ.
69. CLEMATIS RECTA/ CLEMATIS VITALBA (Fh 916 to Fh 924), D1, D3, D5, D7, D9, D11, D12; Θ.
70. COCULUS (Fh 926 to Fh 939), D1, D2, D3, D4, D6, D7, D8, D9, D10, D28, D29, D30; Θ.
71. COFFEA (Fh 947 to Fh 954), D3, D4, D5, D30; C198, C199; Θ.
72. COLCHICUM (Fh 955 to Fh 968), D1, D6, D7, D8, D9, D11, D14, D19, D29, D39, D49, D58, D59; Θ.
73. COLLINSONIA/ COLLINSONIA CAR. (Fh 971 to Fh 975), D1, D2; C28, C29; Θ.
74. COLOCYNTHYS (Fh 976 to Fh 980), D4, D6; C5, C28; Θ.
75. CONDURAGO (Fh 982 and Fh 983), C28, C29.
76. CONIUM/ CONIUM MACUL./ CONIUM OLIGOPLEX (Fh 984 to Fh 997), D2, D4, D5, D7, D9, D10; C28, C29, C30, C198; Θ.
77. CONVALLARIA MAJALIS (Fh 998 to Fh 1000), D1; Θ; Θ=1/2.
78. COPAIVA (Fh 1001), Θ.
79. CORNUS CRICIN (Fh 1003), D2.
80. CRATEGUS (Fh 1004), D2.
81. CROCUS (Fh 1005 to Fh 1012), D1, D2, D3, D4, D5, D7, D9, D11; Θ.
82. CROTON TIGL. (Fh 1021 to Fh 1024), C4, C5, C28, C29.
83. CURCUBITA PEPO. (Fh 1025), Θ.
84. CUPRESSUS SEPER. VIR. (Fh 1026), C2.
85. CURARE (Fh 1054, Fh 2880 and Fh 2881), D2, D4; C28.
86. CYCLAMEN (Fh 1055 to Fh 1070), D1, D, D3, D4, D6, D7, D11, D15, D18, D21, D25, D26, D28; Θ.
87. CYPRIPED PUB. (Fh 1073), Θ.
88. DAMIANA (Fh 1074), Θ.
89. DAPHNE MEZEREUM (Fh 1075 and Fh 1076), D3; Θ.
90. DAUCUS CAROTA (Fh 1077 to Fh 1081), D1, D2, D3, D4, D5.
91. DICTAMUS ALBUM (Fh 1082), D2.
92. DIGIPURAT/ DIGITALIN/ DIGITALIS (Fh 1083 to Fh 1099), D1, D2, D3, D4, D5, D6, D9, D14, D19, D28, D29, D39, D49, D59; T1, T3; Θ.
93. DIOSCORIN/ DIOSCOREA VILLOSA (Fh 1100 to Fh 1104), D2, D9; C28; Θ; Θ=1/3.
94. DOLICHOS PRURICUS (Fh 1106 to Fh 1113), D3, D4, D5, D7, D11; C28, C29; Θ.
95. DROSERA (Fh 1114 to Fh 1116), C28, C29; Θ.
96. DULCAMARA (Fh 1117 to Fh 1124), D1, D4, D5, D6, D7, D9, D11; Θ.
97. ECHINACEA (Fh 1125 and 1126), Θ.
98. EPIGEA REP. (Fh 1129), Θ.
99. EPIPHEGUS VIRGIN. (Fh 1130 and Fh 1131), C28 and C29.
100. EQUISETUM/ EQUISETUM ARV. (Fh 1132 and Fh 1133), Θ.
101. ERGOTIN (Fh 1134 and Fh 1135), D2; T4.
102. ERIGERON AERE (Fh 1136), Θ.
103. ERIODYCT. CAL. (Fh 1137), Θ.
104. ERYNGIUM (Fh 1138), Θ.
105. EUCALYPT GLOB. (Fh 1139 to Fh 1146), D2, D3, D4, D5, D7, D9, D11; Θ.
106. EUPATOR AROMAT/ EUPATORIUM PERF. (Fh 1147 to Fh 1152), C3, C4, C5, C28, C29; Θ.
107. EUPHORBIA CORALLAT/ EUPHORBIUM/ EUPHORBIUM VILLOS (Fh 1154 to Fh 1155), D3; Θ.

108. EUPHRASIA (Fh 1156 to Fh 1165 and Fh 2824), D2, D3, D4, D5, D6, D7; C3, C4, C5; Θ.
109. EVONYMIN/ EVONYMUS EUROP. (Fh 1166 and Fh 1167), D1 and D28.
110. EXTR. CRATEGUS. OXYACANTHA E BACUS FLUID (Fh 1168), Θ.
111. FAGOPYRUM (Fh 1169 and 1170), C4 and C5.
112. FRAGARIA VESCA (Fh 1217 to Fh 1222), D1, D2, D3, D4; Θ.
113. FRANGULA (Fh 1223), Θ.
114. FRAXINUS AMER. (Fh 1224 and Fh 1225), C29; Θ.
115. FUMARIA (Fh 1230 and Fh 1231), Θ.
116. FUSCUS/ FUSCUS VESICUL. (Fh 1226 to Fh 1229), Θ.
117. GELSENIUM (Fh 1232 to Fh 1242), D3, D4; C23, C29, C30, C98, C198, C199; Θ.
118. GERANIUM MACULAT. (Fh 1295), D1.
119. GNAPHALIUM/ GNAPHALIUM ARENARIUM/ GNAPHALIUM POLYCEPHAL. (Fh 1247 to Fh 1250), D1, D6; Θ.
120. GOSSYP. HERB. (Fh 1251), D2.
121. GRATIOLA/ GRATIOLA OFF. (Fh 1278 to Fh 1284), D1, D2, D3, D5, D7, D9; Θ.
122. GRINDELIA (Fh 1285 to Fh 1290), D1, D3, D5, D7, D8, D9.
123. GUAJACUM (Fh 1291 to Fh 1294), D2; Θ.
124. HAMAMELIS (Fh 1296 to Fh 1302), D1, D4, D5, D6, D8, D11; Θ.
125. HELIANTHUS ANNUUS (Fh 1308 to Fh 1312), D2, D3, D4, D5; Θ.
126. HELLEBORUS NIGER (Fh 1313 to Fh 1318), D1, D2, D4, D5, D6, D8; Θ.
127. HELOIN/ HELONIAS DIOICA (Fh 1319 to Fh 1328), D1, D2, D3, D4, D5, D7, D11; C29; mother tincture Θ.
128. HURA BRASILINSIS (Fh 1347 to Fh 1350), C5, C6, C28, C29.
129. HYDRAHGEA ARBOREA (Fh 1351 to Fh 1362), D1, D2, D3, D4, D5, D7, D9, D11; C28 and C29; Θ.
130. HYDRAGEA VIV. (Fh 1363), C199.
131. HYDRASTIS (Fh 1365 to Fh 1375), D1, D2, D3, D4, D5, D6, D7, D9, D11; C28, C29; Θ.
132. HYDROCOTYLE ASIOT. (Fh 1376 and Fh 1377), Θ.
133. HYOSCIAMUS (Fh 1378 to Fh 1390), D1, D2, D4, D5, D7, D9, D11, D14, D19, D24, D29; Θ.
134. HYPERICUM (Fh 1391 to Fh 1396), D2, D3, D4, D5; Θ.
135. IACEA (Fh 1397), Θ.
136. IGNATIA (Fh 1398 to Fh 1418, Fh 2826), D1, D3, D8, D14, D20, D29, D30, D40, D50, D57; C198, C 199, C 998, C999; Θ.
137. IPECACUANHA (Fh 1423 to Fh 1433, Fh 2827), D1, D2, D3, D4, D5; C5, C28, C29; Θ.
138. IRIS VERSICOLOR/ IRISINIUM (Fh 1434 to Fh 1446), D1, D2, D3, D7, D9, D11, D39, D49, D69; C198, C199.
139. JABORANDI (Fh 1447 to Fh 1450), D1, D2, D3; Θ.
140. JATROPH. CURE (Fh 1451), Θ.
141. JUGLANS REGIA (Fh 1460), Θ.
142. KALIMA LATIF. (Fh 1461 to Fh 1470), D1, D2, D3, D4, D5, D6; C28, C29; Θ.
143. LACHNANTH./ LACHNANTH. TINCT. (Fh 1592 to Fh 1602), D1, D2, D3, D4, D5, D7, D9, D11; C28, C29; Θ.
144. LAPPA MAJ. (Fh 1615), Θ.
145. LATHYRUM SATIVUS (Fh 1616), Θ.
146. LECITHIN (Fh 1621), D4.
147. LEDUM PALUSTRE (Fh 1622 to Fh 1628), D1; C5, C6, C10, C28, C29; Θ.
148. LEMNA MINOR (Fh 1638), Θ.
149. LEPTANDRA (Fh 1629 to Fh 1637), D1, D2, D3; C5, C6, C28, C29, C30; Θ.
150. LILIUM CANDIDUM (Fh 1639), D2.
151. LILIUM TIGRIN. (Fh 1640 to Fh 1648), D1, D2, D4, D6, D8, C11, C28, C29, Θ.
152. LOBELIA/ LOBELIA OLIGOPLEX (Fh 1654 to Fh 1657), D1, D2, D4, Θ.
153. LUETIN (Fh 1658), C199.

154. LUPULINUM (Fh 1659 and Fh 1660), Θ=D1, T1.
155. LYCOPODIUM (Fh 1661 to Fh 1680), D1, D2, D3, D6, D7, D11, D15, C25, C30, C198, Θ, T4, Tr.6, Tr.7, Tr.9, T10.
156. LYCOPUS VIRG. (Fh 1681 to Fh 1686), D1, D2,D3, C28, C29, Θ.
157. MACROTIN (Fh 1687), D3.
158. MALVA SYLV. (Fh 1705), Θ.
159. MAGNOL. GLAUC. (Fh 1715), D1.
160. MARUM. VER. (Fh 1722), Θ.
161. MELILOTUS (Fh 1735 to Fh 1745), D1, D2, D3, D4, D5, D7, D11, C28, C29, Θ.
162. MENISPERMUM CANAB. (Fh 1746), Θ.
163. MERYANTHES (Fh 1747 to Fh 1751) D1, D2, D3, Θ, Θ=1/2.
164. MEZEREUM (Fh 1806 to Fh 1824), D1, D2, D3, D4, D5, D7, D9, D11, D12, D19, D24, D29, D34, D39, D44, D49, D54, D60, Θ.
165. MILEFOLIUM (Fh 1826 to Fh 1831), D1, D2, D3, C3, C4, C5.
166. MOMORDICA OLIGOPLEX. (Fh 1832), Θ.
167. MYRICA CERIF. (Fh 1837 to Fh 1845), D7, D9, D11, C28, Θ.
168. MYRISTICA SEBIFER (Fh 1846 to Fh 1848), D1, D2, D6.
169. MYRTUS COMM. (Fh 1849), D2.
170. NUPHAR LUT. (Fh 1945 to Fh 1949), D2, C4, C5, C28, C29.
171. NUX MOSCATA (Fh 1950 to Fh 1954), D2, C3, C28, C29, Θ.
172. NUX VOMICA (Fh 1955 to Fh 1963), D3, D4, D14, D19, D28, D198, D202, C199, C998.
173. NYMPHAEA ODOR. (Fh 1964 to Fh 1965), C28, Θ.
174. OENANTHAE CROCATA/ OENANTHAE CROCATA OLIGOPLEX (Fh 1966 to Fh 1970), D3, C4, C5, C28, C29.
175. OENOTERA BIENNIS (Fh 1971), Θ.
176. OLEANDER (Fh 1972), Θ.
177. OLEUM TEREBINTH (Fh 1973), C29.
178. ONONIS SPIN. (Fh 1975 and Fh 1976), D2, Θ.
179. ONOSMODIUM/ ONOSMODIUM VIRGINIA (Fh 1977 to Fh 1983), C28, C29, Θ.
180. OPIU/ OPIUM (Fh 1984 to Fh 1999, Fh 2903, Fh 2904) D3, D5, D9, D11, D18, D20, D22, D24, D26, D28, D29, D39, D49, D59, C12, Θ.
181. ORIGANUM/ ORIGANUM VULG. (Fh 2000 to Fh 2004), D4, D5, D6, C29, Θ.
182. ORNITHOGALUM (Fh 2005), Θ.
183. OXALIS ACID (Fh 2006 and Fh 2007), D3, Θ.
184. PAEONIA (Fh 2008 to Fh 2012), C4, C5, C28, C29, Θ.
185. PAPAYOTIN (Fh 2016), D1.
186. PAREIRA BRAVA (Fh 2017 and Fh 2018), Θ.
187. PARIS QUANDRIF. (Fh 2019 and Fh 2020), D1, C28.
188. PASIFLORA (Fh 2021 and Fh 2022), D2, Θ.
189. PASTINA SATIVA (Fh 2023), Θ.
190. PENGHAW JAMBI (Fh 2024), Θ.
191. PETASITES (Fh 2026 and Fh 2027), D2.
192. PETROSELIN (Fh 2028), Θ.
193. PHELLANDRIUM/ PHELLANDRIUM AQUATIC. (Fh 2044 and Fh 2045), D2, Θ.
194. PHYSOSTIGMIN (Fh 2054 to Fh 2058), D2, D3, D4, D5, D7.
195. PHYTOLACCA (Fh 2059 to Fh 2063), D1, D2, D3, Θ.
196. PINUS TINCTUR (Fh 2065), Θ.
197. PIPER METH. (Fh 2066), Θ.
198. PIPER NIGRUM (Fh 2067), Θ.
199. PISCIDIA ERYTRINA (Fh 2069), C4.
200. PLANTAGO/ PLANTAGO MAJOR (Fh 2070 to Fh 2076), D2, D3, D4, D5, D7, D11, Θ.
201. PODOPHYLLUM (Fh 2100 to Fh 2109), D1, D2, D3, D4, D5, D7, D11, C28, C29, Θ.
202. POLYGON AVIC. (Fh 2110 and Fh 2111), Θ.
203. POPULUS TREM. (Fh 2112), Θ.
204. PATHOS FOETID. (Fh 2113), Θ.
205. PROSTADENUM (Fh 2114), D6.
206. PRUNUS PADUS (Fh 2115), Θ.
207. PRUNUS SPINOSA (Fh 2116 to Fh 2121), D1, D2, D3, D4, D5, Θ.

208. PTELEA TRIF. (Fh 2135 to Fh 2138), C4, C5, C28, C29.
209. PULSATILLA (Fh 2139 to Fh 2157), D1, D2, D3, D4, D5, D6, D10, D195, D197, D198, D199, C28, C29, C30, Θ.
210. PYRETRUM (Fh 2158), Θ.
211. QUASIA AMAR (Fh 2189), Θ.
212. QUERCUS CORTICIS/ QUERCUS GLANDIS SPIRIT (Fh 2190 and Fh 2191), Θ.
213. RANUNCULUS BULBUS/ RANUNCULUS SCELER (Fh 2194 to Fh 2204), D1, D2, D3, D4, D5, D7, D11, C28, C29, Θ.
214. RAPHAN SATIV (Fh 2205), D2.
215. RATANHIA (Fh 2206 to Fh 2211), D1, D2, D3, D5, D7, D11.
216. REUMADORON (Fh 2215 to Fh 2217), Θ.
217. RODODENDRON (Fh 2218 to Fh 2220), D5, D8, Θ.
218. RHUS GLABRA (Fh 2221), D6.
219. RHUS TOXIC (Fh 2222 to Fh 2227), D12, D18, D20, D39, C198, Θ.
220. RHUS VERNIX (Fh 2228 and Fh 2229), C4, C5.
221. RICINUS COMMUNIS (Fh 2230 to Fh 2234), D1, D2, D5, D9.
222. ROBIN PSEUD. (Fh 2235 to Fh 2243), D1, D2, D4, D6, D8, D10, D11, C29, Θ.
223. ROSENEISEN (Fh 2244 to Fh 2247), D2, D3, D4, D5.
224. ROSEMARINUS OLIGOPLEX (Fh 2248), Θ.
225. RUMEX (Fh 2249 and Fh 2250), D1, Θ.
226. RUTA/ RUTA GRAVEOLENS (Fh 2251 to Fh 2258), D1, D2, D3, D5, D6, D7, C28, C29, Θ.
227. SABADILLA (Fh 2267 to Fh 2277), D3, D4, D7, D9, D14, D19, D29, D39, D49, D58, D59.
228. SABAL SERULATA (Fh 2263 to Fh 2266), D1, D3, Θ.
229. SABINA (Fh 2278 to Fh 2285), D1, D2, D3, D5, D6, D7, Θ.
230. SALIX NIGRA (Fh 2286), Θ.
231. SAMBUCUS/ SAMBUCUS NIGRA (Fh 2258 to 2561, Fh 2287 to 2295), D2, D3, D4, C3, C4, C5, C28, C29, Θ.
232. SANGUINARIA (Fh 2296 to Fh 2315) D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D19, D24, D29,D39,D49,D58, D59,Θ.
233. SANGUISORBA OFF.(Fh 2316), Θ.
234. SARSAPARILLA (Fh 2317 to Fh 2321), D2, D11, C28, C29.
235. SCILLA (Fh 2322 to 2328),D1, D2, D3, D4, D5, C5, Θ.
236. SCROPHULARIA NOD. (Fh 2330 to Fh 2333), D=Θ, Θ.
237. SCUTTEL LAT. (Fh 2334), Θ.
238. SECALE CORNUT. (Fh 2335 to Fh 2347), D1, D4, D7, D11, C6, C8, C10, C15, C20, C28, C29, C30, Θ.
239. SEDUM ALPESTRE (Fh 2348 and Fh 2349), D2, D3.
240. SENECCIO AUR. (Fh 2360 to Fh 2369), D1, D2, D3, D4, D5, D7, D11, C28, C29, Θ.
241. SENEGA (Fh 2370 and Fh 2371), Θ=D1, Θ.
242. SENA (Fh 2372), Θ.
243. SOLANUM NIGR. (Fh 2414 and Fh 2415), C4, C5.
244. SOLIDAGO VIRGA AUR. (Fh 2416 to Fh 2424), D1, D2, D3, D4, D5, D6, D8, D10.
245. SPIGELIA (Fh 2428 to Fh 2432), Θ=D1, D2, C28, C29, C30.
246. SPIRAEA ULM. (Fh 2433 to Fh 2435), D1, D2, D3.
247. STAPHISAGRIA (Fh 2468 to Fh 2480), D3, D5, D6, D9, D14, D19, D29, D39, D49, D59, C5, Θ.
248. STELLARIA MEDIA (Fh 2481 to Fh 2482, Fh 2836), D1, D2, Θ.
249. STERCULLIA ACUMIN. (Fh 2483), Θ.
250. STICTA PULM. (Fh 2490 to Fh 2500), D1, D2, D3, D5, D7, D9, D11, C5, C28, C29, Θ.
251. STRAMONIUM (Fh 2501 to Fh 2509), D2, D3, D5, D7, D9, D19, C28, C29, Θ.
252. STROPHANTUS (Fh 2510 and Fh 2511), D2, D3.

253. SYCYGIUM JAMBOLANUM (Fh 2572), Θ.
254. SYMPHORICARPUS RACEM (Fh 2573), C4.
255. SYMPHYTUM (Fh 2574 to Fh 2584), D1, D2, D3, D4, D5, D7, D11, D198; C4, C5, Θ.
256. SYZYGIUM/ SYZYGIUM JAMBOLAN E CORT. (Fh 2562 to Fh 2571; Fh 2588 to Fh 2595), D2, D3, D4, D5, D6, D7, D8, D9, D11, D14, D19, D24, D29, D39, D49, D58, D59; C5.
257. TABACUM (Fh 2596 to Fh 2611), D2, D4, D5, D6, D8, D14, D19, D24, D39, D49, D58; C4, C28, C29, C198; Θ.
258. TANACETUM (Fh 2612), Θ.
259. TARAXACUM (Fh 2613 to Fh 2621), D1, D2, D4, D5, D7, D11; C28, C29; Θ.
260. TEREBINTHIN (Fh 2647 to Fh 2652), D2, D4, D5, D7, D9, D11.
261. TEUCRIUM MAR. VER./ TEUCRIUM SCORODON. (Fh 2653 to Fh 2659), D1, D3; C2, C29; Θ.
262. THLASPI. B. PASTORIS (Fh 2666 and Fh 2667), Θ.
263. THUJA (Fh 2668 to Fh 2697), D1, D2, D3, D4, D6, D7, D8, D9, D10, D11, D12, D20, D25, D27, D29, D30, D35, D40, D45, D50, D55, D57, D59; C196, C197, C198, C199, C200; Θ.
264. TINCT. COLLINSON (Fh 2703), Θ.
265. TINCT. EUPATOR PER. (Fh 2704), Θ.
266. TINCT. LEDUM (Fh 2705), Θ.
267. TINCT. RHEUM (Fh 2706), Θ.
268. TINCT. SOLIDAGO (Fh 2707), Θ.
269. TINCT. URTIC. UR. (Fh 2708), Θ.
270. TINCT. VERBASC (Fh 2709), Θ.
271. TRILLIUM PENDUL (Fh 2710 and Fh 2711), D10; Θ.
272. TRITIC REP. (Fh 2712), Θ.
273. TUSSILAGO FARFARA (Fh 2725), Θ.
274. URTICA DIOICA (Fh 2737 and Fh 2738), D1; C28.
275. URTICA URENS (Fh 2739 to Fh 2747), D1, D2, D3, D4, D5, D7, D11; C29, C199.
276. USTILAGO MAYDIS (Fh 2748 to Fh 2752), D1; C28, C29; Θ.
277. UVA URSI OLIGOPLEX (Fh 2753 and Fh 2754), FORTE.
278. UZARA (Fh 2755), D1.
279. VALERIANA (Fh 2756 and Fh 2757), Θ=D1, Θ.
280. VERATRUM VIRIDIS (Fh 2763 to Fh 2769), C198, C199, C200, C998, C999, C1000; Θ.
281. VERBASCUM/ VERBASCUM ALBUM (Fh 2758 to Fh 2762), D5, D7, D9; C5; Θ.
282. VIBURNUM/ VIBURNUM OPULUS/ VIBURNUM PRUNIF. (Fh 2770 to Fh 2781), D1, D2, D3, D4, D5, D7, D11; C28, C29; Θ=1/6; Θ.
283. VIOLA TRICOL. (Fh 2782 and Fh 2783), Θ=1/2; Θ.
284. VISCUM ALBUM/ VISCUM ALBUM OLIGOPLEX (Fh 2785 to Fh 2788), D1; Θ.
285. WYETHIA (Fh 2789), D2.
286. ZINGIBER (Fh 2800), D2.
287. ZIZIA AUREA (Fh 2801), Θ=2.

Discussions

The botanical sources of the remedies are multiple and the biogeographical origin of the plants is mainly from Europe followed by North America and Asia (Fig. 3; Dordea 2019, 32).

Neagu M. (1984, 1985) has researched for the first time in Romania the connection between homeopathy remedies of botanical origin and traditional Romanian phytotherapy and found over 200 wild and cultivated plants used in ethnoiatry and homeopathy for the same afflictions. These are some of the those plants: *Achillea millefolium L., Allium cepa L., Allium sativum L., Arnica montana L., Artemisia abrotanum L., Artemisia absinthium L., Arum maculatum L., Asarum europaeum, Atropa belladonna L., Berberis vulgaris L., Betula pendula Roth, Bryonia alba L., Calendula officinalis L., Cannabis sativa L., Capsicum*

annuum L., Cassia acutifolia Delile, Chelidonium majus L., Clematis recta L., Colchicum autumnale, Conium maculatum, Convallaria majalis, Crataegus monogyna, Daphne mezereum, Datura stramonium, Dianthus carthusianorum, Digitalis purpurea, Drosera rotundifolia L., Echinops spherocephalus, Equisetum arvense, Eryngium maritimum L., Eryngium planum, Euphorbia agraria, Euphorbia cyparisias, Euphrasia, Fagus sylvatica, Galium aparine, Galium verum L., Gentiana lutea, Geranium robertianum, Glecoma hederacea, Gratiola officinalis, Hedera helix, Helleborus purpurascens, Helianthus annuus, Hyosciamus niger, Hypericum perforatum, Juniperus sabina, Lanium album, Lappa major, Lolium perene L., Lycopodium clavatum, Matricharia chamomilla, Mellilotus albus, Mentha crispa, Mentha piperita, Menyantes trifoliate, Morus alba, Myrtus communis, Oenantha aquatica, Origanum vulgare, Oxalis acetosella, Papaver rhoeas, Papaver somniferum, Peucedanum areoselinum, Phyllitis scolopendrium, Pinus sylvestris, Plantago lanceolata, Plantago major, Polygonum aviculare, Polygonum bistorta, Polygonum mite, Prunus cerasifera, Prunus domestica, Prunus spinose, Pulsatilla vulgaris, Ribes nigrum, Rubia tinctorum, Rumex crispus, Rumex patientia L., Ruta graveolans, Sambucus nigra, Sanguisorba officinalis, Sanicula europaea, Schrophularia alata Gilib., Sedum faberia, Sedum maximum, Sempervivum tectorum, Senecio biebersteinii, Solanum dulcamara, Solidago virgaurea, Stellaria media, Taraxacum officinale, Thlaspi arvensis, Tilia tomentosa, Urtica dioica, Urtica urens, Valeriana officinalis, Verbena officinalis, Viola odorata L., Viola tricolor L., Viscum album L., Zea mays.

Here are some examples from the museum collection: CAPSICUM (Fh 718 to Fh 725), D4; C28, C29, C198, C199, C200; Θ. The remedy is used bought in homeopathic treatment and in Romanian ethnoiatry to prevent shivers and induce disgust for alcoholic beverages. Autumn corcus (*Colchicum autumnale* L.) found in the collection as COLCHICUM (Fh 955 to Fh 968), D1, D6, D7, D8, D9, D11, D14, D19, D29, D39, D49, D58, D59 and Θ, is used in homeopathy and Romanian ethnoiatry for rheumatism. The spurges (*Euphorbia sp.*) found in our collection as EUPHORBIA CORALLAT/ EUPHORBIUM/ EUPHORBIUM VILLOS (Fh 1154 to Fh 1155), D3 and Θ, are used in bought therapies for dermatological problems.

In general, we can assume that Romanian traditional medicine was a source of inspiration for Hahnemann in developing homeopathy. However, it seems that Romanian ethnoiatry used many medicinal plants, somewhat in the "homeopathic spirit", many centuries before Hahnemann. In this sense, Neagu M. (1984) claims that "in homeopathy there is an empirical tradition that is lost in the mists of time".

The Pharmacy History Museum in Sibiu Homeopathy Collection (Fig. 4) is an important cultural and scientifical asset in the research regarding the evolution of homeopathy as an alternative medical therapy.

REFFERENCES

Ban 1998 — Ban Minodora, *Colecția de istoria farmaciei*. In: *Studii și comunicări – Științele Naturii* 27, Sibiu (1998), pp. 247–251.

Ban 2001 — Ban Minodora, *Tradiții ale terapiei homeopate mineral545te prin colecția de istorie a farmaciei din Sibiu*. In: *Studii şi Cercetări. Complexul Muzeal Bistrița Năsăud, Geologie,* volumul 6 (2001), pp. 95–102.

Ban 2003a — Ban Minodora, *Repertoriul remediilor homeopate din colecția de istorie a farmaciei din Sibiu*. In*: Studii și Comunicări de Istorie Naturală Sibiu 28. Volum omagial 1849–1949 Societatea Ardeleană pentru Științele Naturii din Sibiu*, Sibiu: Hora Verlag Hermannstadt und Arbeitskreis für Siebenbürgische Landeskunde e. V. Heidelberg (2003), pp. 269–285.

Ban 2003b — Ban Minodora, *Remedii homeopate de origine mineral în colecția Muzeului de Istorie a Farmaciei din Sibiu*. In: *Argesis, Ştinţele Naturale. Muzeul Județean Argeş*, volumul 11 (2003), pp. 299 – 310.

Ban 2007 — Ban Minodora, *Remedii Homeopate de bază în Colecția Muzeului de Istoria*

Farmaciei din Sibiu. In: *Brukenthal Acta Musei*, II.3, Alba–Iulia: Editura Altip (2007), pp. 149 – 162.

Deaconu Elena-Nicoleta, 2019 — Deaconu Elena-Nicoleta, *Date despre activitatea doctorului Samuel Hahnemann* (2019), lucrare de licență (Universitatea ”Lucian Blaga” din Sibiu, Facultatea de Medicină ”Victor Papilian”, specializarea Farmacie), pp. 17-22.

Dordea Daniela-Elena 2019 — Dordea Daniela-Elena, *Remedii homeopatice de natură vegetală din colecția Muzeului de Istorie a Farmaciei din Sibiu* (2019), lucrare de licență (Universitatea ”Lucian Blaga” din Sibiu, Facultatea de Medicină ”Victor Papilian”, specializarea Farmacie), pp. 16-18,

Maior Ovidiu, 2014 — Maior Ovidiu, *Contribuții la farmaco-istoria Transilvaniei. Oficinele județului Sibiu*. Editura Echinox, Cluj-Napoca (2014), pp. 476-496.

Neagu Mihai, 1984 — Neagu Mihai, *Fitoterapia homeopatică în etnoiatria românească*. In: *Apărarea sănătății ieri și azi – Studii, note și documente*. Editura Medicală, București (1984), pp. 475-480.

Neagu Mihai, 1985 — Neagu Mihai, *Noi contribuții de etnofitoterapie homeopatică*. In: *Retrospective medicale – Studii, note și documente*. Editura Medicală, București (1985), pp. 79-88.

Păpureanu, Rosenberg — Păpureanu Ana-Maria, Rosenberg Ladislau, *From mineral to homeopatic remedy–celebrating 240 years since Samuel Hahnemann (1755 – 1843) came to Sibiu as ”medicine candidate and librarian of his excellency Baron Brukenthal” between 1777 and 1779*. In: *Brukenthal Acta Musei*, XII.3 (2017), pp. 547-552.

LIST OF ILUSTRATIONS

Fig. 1. The museum homeopathy collection according to the source of the remedies.

Fig. 2. Number of vials according to the type of homeopathic remedy (D-decimal homeopathic dilutions or potencies, C-centesimal homeopathic dilutions or potencies, Ɵ-mother tinctures, T/Tr,- homeopathic trituration, Complex-complex homeopathic remedies).

Fig. 3. Biogeographical distribution of the plants used for the remedies.

Fig. 4. Part of the museum Homeopathy Collection.

LISTA ILUSTRAȚIILOR

Fig. 1. Colecția muzeuală de homeopatie în funcție de sursa remediilor.

Fig. 2. Numărul flacoanelor în funcție de tipul de remediu homeopat (D-diluții decimale, C-diluții centezimale, Ɵ-tinctură „mamă”, T/Tr.-triturații homeopatice, Complex-remedii homeopatice complexe).

Fig. 3. Distribuția biogeografică a plantelor utilizate pentru remedii.

Fig. 4. O parte din colecția de homeopatie a muzeului.

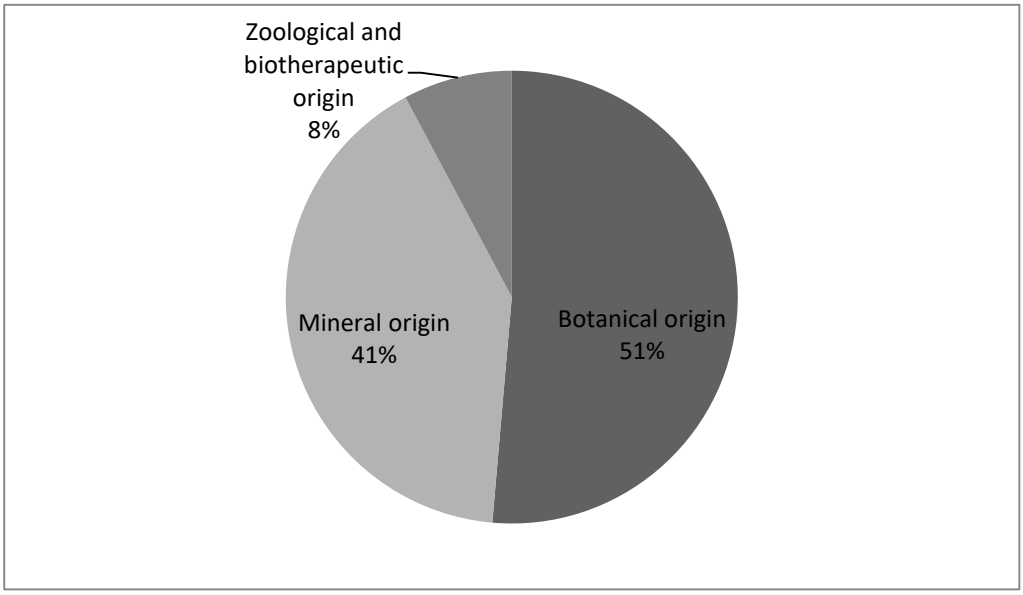


Fig. 1. The museum homeopathy collection according to the source of the remedies

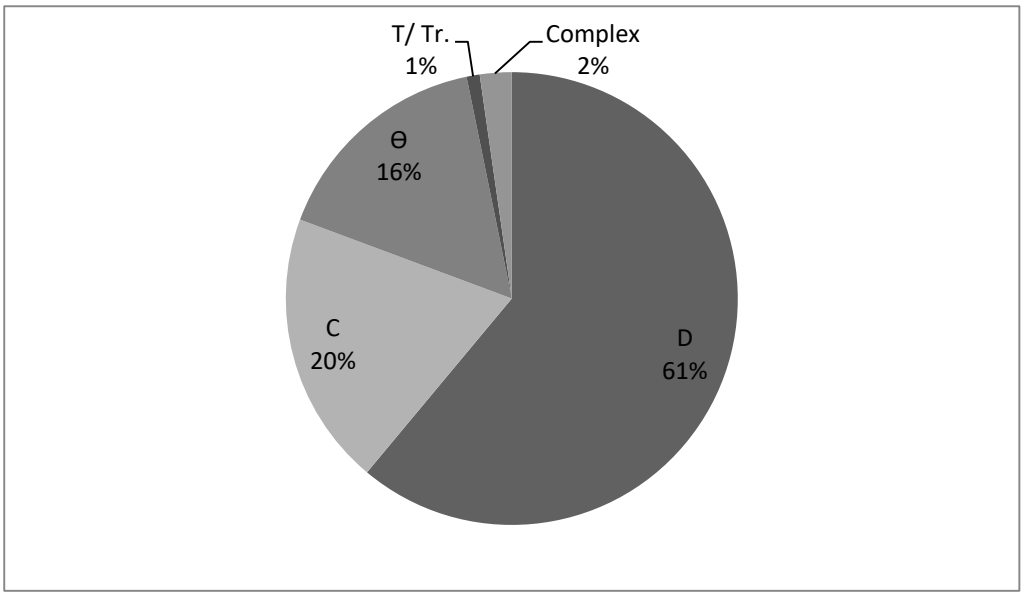


Fig. 2. Number of vials according to the type of homeopathic remedy (D-decimal homeopathic dilutions or potencies , C-centesimal homeopathic dilutions or potencies, Θ-mother tinctures, T/Tr,- homeopathic trituration, complex homeopathic remedies (Ex: Θ=1/3; FORTE, Rp.)

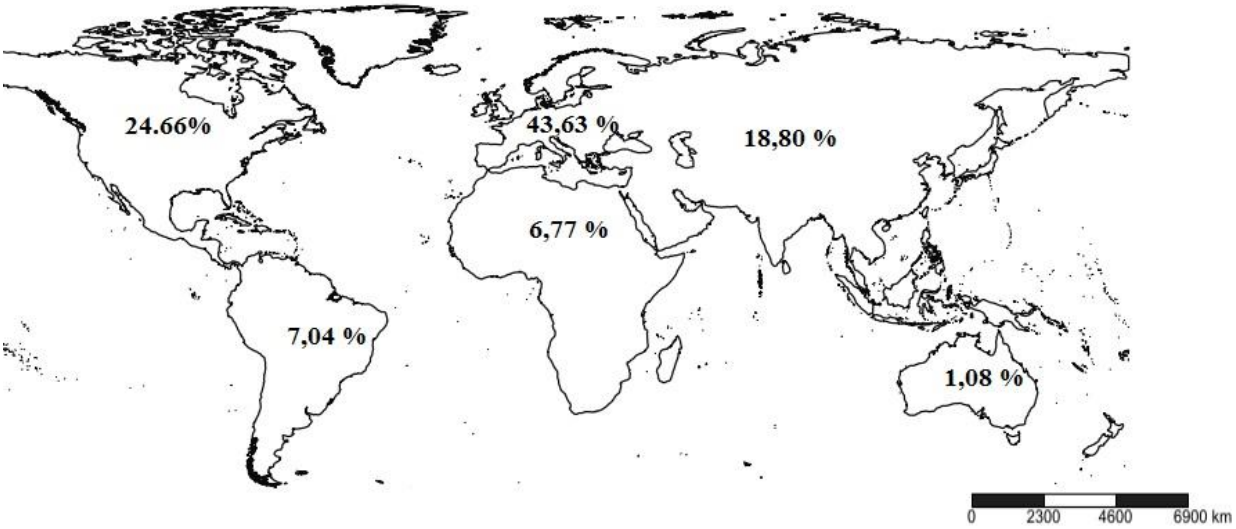


Fig. 3. Biogeographical distribution of the plants used for the remedies

Fig. 4. Part of the museum Homeopathy Collection

HOMEOPATHIC REMEDIES OF ANIMAL ORIGIN FROM THE HISTORY OF PHARMACY MUSEUM COLLECTION IN SIBIU (BRUKENTHAL NATIONAL MUSEUM)

Ioana IORDACHE*
Ana-Maria PĂPUREANU**
Ladislau ROSENBERG***

Abstract. *The Homeopathic collection included in the Pharmacy History Museum in Sibiu, part of the Brukenthal National Museum, counts 2910 vials. The homeopathic remedies were inventories and analyzed identifying 227 vials with 49 types of remedies of animal origin. From the total number 54 % have invertebrate origin, 23 % vertebrate sources and 23 % had biotherapeutic bases. The homeopathic remedies listed include decimal homeopathic dilutions or potencies (D), centesimal homeopathic dilutions or potencies (C), mother tinctures (Ø) and homeopathic triturations (T). Analyzing the use of these remedies we have discovered many resembles to old traditional medicine in Romania.*
Keywords*: Pharmacy History Museum Sibiu, Homeopathy Collection, animal resources.*

Rezumat. *Colecția de Homeopatie a Muzeului de Istoria Farmaciei din Sibiu, secție a Muzeului Național Brukenthal, numără 2910 flacoane. Acestea au fost inventariate și analizate identificând 227 inscripționate cu 49 de remedii de origine animală. Dintre acestea 54 % au ca sursă nevertebratele, 23 % vertebrate și 23 % bioterapicele. Remediile homeopate enumerate sunt de diferite diluții decimale (D), centezimale (C), tincturi mamă (Ø) și triturații (T). Analizând utilizarea acestor remedii homeopatice am constat similaritudini cu etnoiatria română.*
Cuvinte cheie: *Muzeul de Istoria Farmaciei din Sibiu, Colecția de homeopatie, surse animale.*

Introduction

The World Health Organization (WHO), International Union for Conservation of Nature (IUCN) and World Wide Fund for Nature (WWF) approximated that 80% of the world's population rely today primarily on animal and plant-based medicines.

Animals are a primary resource used by peoples since ancient times for food or for treating illnesses (O'Hara-May 1971, 61-97).

Empirical and traditional medicine has contributed to the use of these resources as pharmacologically active constituents. Society and cultural beliefs play an important part in the development of this type of medicine.

* Benu Apotheek Nijverdal Zuid, Netherlands, irina_iordache90@yahoo.com
** Brukenthal National Museum Sibiu, papureanu.ana@gmail.com
*** Romanian Society for the History of Pharmacy (SRIF) and "Lucian Blaga" University of Sibiu, Faculty of Medicine "Victor Papilian", rosenlaszlo@yahoo.com

Animal materials used in folk medicine is linked to superstitious beliefs, the animal was selected for a certain disease according to its physical and natural adaptations and properties.

Hoppál M. and Törö L. (1975, 91-95) considered that these magical-superstitious medical beliefs made use of animal materials on the same basis and analogical ideas as homeopathy *similia similibus curantur*. For example, in Hungarian ethnomedicine, snake bites were healed, in some areas, by bandaging the bitten area with crushed snakehead.

In Romanian traditional medicinal substances of animal origin were employed for a wide range of diseases. Bujoran G. (1936, 26-210) described that in some areas of the country to cure leucoma you had to pour in the eye fish oil especially from trout (*Salmo trutta* L.), in other areas an onion was mashed and the liquid with honey was the remedy, in other region for the same condition you had to use the fresh grinded eggshell from a stork and blow the powder in the eye using a straw from the reed grass. If all of these remedies did not work it was used snake lard, form viper (*Vipera sp.* Laurenti, 1768).

Burned skin was washed with elm peel decoction and then sprinkle charcoaled pork bone powder over the wound.

For blisters an ointment was made from fresh borscht mixt with flour and beetle powder (Fig. 1). Beetle burned powder mixt with fresh butter was used for mycosis. If the insects were found alive the best remedy for mycosis was to squeeze the animal directly on the affected area.

Deer or stag lard was meant for mycosis as well and after rubbing the area, on top it was spread the ashes from the burned deer or stag antlers (Fig. 2).

Butter or pig lard in which you boiled poplar buds with beef marrow was intended for growing hair.

During winter, frostbites were treated with pig bile and sour croute.

Insect bites required an ointment prepared from red coniferous sap and pig lard (Fig. 3).

Lumbago was treated with vine in which an European crayfish (*Astacus astacus* (Linnaeus, 1758)) was boiled. Also from crayfish were used the so called *Crab's eyes* or *Crab's stone*, the old medical term *Lapides cancrorum*, *Oculi cancrorum* or *Chelae cancrorum* (Fig. 4) was used also in Romanian traditional medicine for kidney stones. The powder was ingested with cold water. *Lapides cancrorum* are calcareous concretions which appear in the gastric region of the crayfish before it discards its old exoskeleton. The crayfish then dissolves these calculi again rapidly to mineralize its new exoskeleton (Bott 2013, 240).

For kidney stones, were sacrificed also snails (*Cernuella virgata* (Da Costa, 1778)). The vineyard snails were placed in a pot, which was sealed with bread dough and backed until the brad was done. The dried snails are grinded and three times a day one spoon of the powder is swallowed with cold water.

Rheumatism was treated using for four days badger (*Meles sp.* Brisson, 1762) lard.

In Romanian traditional medicine there was an affliction called ”guşter”, the Romanian name for the European green lizard (*Lacerta viridis* Laurenti, 1768). To cure ”guşter” were used bones and skin from the lizard. The head and skin of the lizard were kept for a period of time in water and that liquid was ingested as a remedy. Also, the head bones were powdered and used for the disease that manifested as acute hoarse and difficult swallowing.

There were also the extreme remedies for example is a person suffered a terminal heart disease the suffering would eat a raw still warm pigeon heart with sugar.

Many of the Romanian folk remedies of animal origin can be found in the *Pharmacopoea Austriaco-Provincialis* from 1774, published in Latin It was the first pharmacopoeia officially used in Transylvania and includes a special chapter dedicated to these substances of animal origin. The chapter is entitled *Animalia* and contains a list of animal substances used to prepare remedies, and next to each entry is indicated which part of the body should be used.

The remedies/substances included are (in the parenthesis is written the Latin name of the remedy as it appears in the pharmacopoeia): domestic duck fat; European eel (*Anguilla anguilla* (Linnaeus, 1758)) fat; domestic goose fat; grey heron (*Ardea cinerea* Linnaeus, 1758) skin and fat; grayling fish (*Thymallus thymallus* (Linnaeus, 1758)) fat; exoskeleton of Pagurus (*Pagurus* Fabricius, 1775); calcareous concretions from crayfish (*Astacus sp.*); common dog fat; the entire Spanish fly (*Lytta vesicatoria* (Linnaeus 1758)); Eurasian beaver (*Castor fiber* Linnaeus, 1758) secretions and fat;

Common domestic cat fat; bees wax of different colors; deer (*Cervus sp*. Linnaeus 1758) horns and secretions; sperm whale or cachalot (*Physeter macrocephalus Linnaeus, 1758* Linnaeus, 1758) spermaceti; the entire cochineal insect (*Dactylopius coccus* Costa, 1835); the entire Roman snail (*Helix pomatia* Linnaeus, 1758); common European viper (*Vipera berus* (Linnaeus, 1758)) fat; red coral (*Corallium rubrum* (Linnaeus, 1758)); ivory (*Loxodonta* Anonymous, 1827); entire red wood ant (*Formica rufa* Linnaeus, 1761); nutgalls made by the gall wasp (*Cynips quercusfolii* Linnaeus, 1758); domestic chicken fat and eggs; Asian common domestic goat (*Capra aegagrus hircus* (Linnaeus, 1758)) secretions; barn swallow (*Hirundo rustica* Linnaeus, 1758) nest; great sturgeon (*Huso huso* (Linnaeus, 1758)) collagen; isinglass obtained from the dried swim bladders of fish; skimmed milk and butter from various animals milk; mountain hare (*Lepus timidus* Linnaeus, 1758) fat; northern pike (*Esox lucius* Linnaeus, 1758) fat; earthworm (*Lumbricus terrestris* Linnaeus, 1758) entire animal dried; honey from the European honey bee (*Apis mellifera* Linnaeus, 1758); common woodlouse (*Oniscus asellus* Linnaeus, 1758) the entire crustacean; Siberian musk deer

(*Moschus moschiferus* Linnaeus, 1758) secretions; burbot (*Lota lota* (Linnaeus, 1758)) liver; European flat oyster (*Ostrea edulis* Linnaeus, 1758) body; common sheep (*Ovies aries* Linnaeus 1758) sebum; common pig and wild boar (*Sus scrofa* Linnaeus 1758) lard; European yellow-tailed scorpion (*Euscorpius flavicaudis* De Geer, 1778) entire scorpion and its venom; European common cuttlefish (*Sepia officinalis* Linnaeus, 1758) cuttlebone; sea sponge (*Spongia officinalis* Linnaeus, 1759) entire animal burned;

European badger (*Meles meles* Linnaeus 1758) fat; common cattle (*Bos bos taurus* Linnaeus, 1758) gall; *brown bear* (*Ursus arctos* Linnaeus, 1758) fat; common European viper (*Vipera berus* (Linnaeus, 1758)) fat; large Indian civet (*Viverra zibetha* Linnaeus, 1758) secretions.

The first Romanian Pharmacopoeia from 1862 (Brukenthal Library inventory B.M.B.S. II18169) included the following remedies of animal origin (Toma *et al.* 2012, 192-197): ambergris from cachalot (*Physeter microcephalus* Linnaeus, 1758); common pig lard; calcareous concretions from crayfish (*Astacus sp.*); animal charcoal; Eurasian beaver (*Castor fiber* Linnaeus, 1758) castoreum; bee wax; sperm whale or cachalot (*Physeter macrocephalus* Linnaeus, 1758 Linnaeus, 1758) spermaceti; the entire cochineal insect (*Dactylopius coccus* Costa, 1835); sea shells (it is not mentioned a certain species); deer (*Cervus sp.* Linnaeus 1758) horns; common cattle (Bos bos taurus Linnaeus, 1758) gall; isinglass obtained from the dried swim bladders of fish; Atlantic cod (*Gadus morhua* Linnaeus, 1758) fat; honey; Siberian musk deer (*Moschus moschiferus* Linnaeus, 1758) secretions; European common cuttlefish (*Sepia officinalis* Linnaeus, 1758) cuttlebone; burned bones; lactose; common sheep (*Ovies aries* Linnaeus 1758) sebum.

In the Library of the Brukenthal National Museum and the Pharmacy History Museum inventory, are various books that record the use of animal substances as remedies in the practice of traditional pharmacy (for example *Codex Medicamentarius Pharmacopée Française* from 1866; Hager 1833, 1884).

Ferrand E. (1891, 26-793) published a complete list of remedies from animal substances, with detailed descriptions.

Fischer. B. and Hartwich C. listed in 1900 and 1902: *Acidum formicicum, Acidum uricum, Adeps suillus, Albumen , Ambra grisea, Blatta orientalis, Cantharides, Carbo animalis, Caro, Castoreum, Cera, Cetaceum, Coccionella, Fel tauri, Formica, Gelatina animalis, Organo theraputica, Ovum, Pancreatinum, Sanguis, Sebum, Hirudo, Ichthyocolla, Keratinum, Lac., Mel, Moschus, Sepium.*

In Homeopathy, Schwabe W. (1934, 37-410) *Homöopathisches Arzneibuch* is a complete record of the homeopathic remedies used at that time, including those remedies obtained from animal substances: *Acidum formicum, Acidum lacticum, Ambra Aphis chenopodii glauci, Apis mellifica, Apisinium, Aranea avicularia, Aranea diadema, Asterias rubens, Aranea diadema, Badiaga, Blatta orientalis, Blatta Americana, Bombyx chrysorrhoea, Bombyx mori, Bufo, Cancer fluviatilis, Cantharis, Carbo animalis, Castor equi, Castor sibiricum, Ceratae, Cetonia aurata, Cimex lectularius, Coccinella septempunctata, Coccus cacti, Crotalus durissus, Crotalus cascavella, Cyprinus barbus, Doryphora decemlineata, Elaps corallinus, Fel Tauri, Formica rufa, Helix pomatia, Lac caninum, Lacerta agilis, Lachesis, Latrodectus mactans, Limax ater, Medusa, Meloë majalis, Melolontha vulgaris, Mephitis putoris, Millepedes, Moschus, Murex purpureus, Naja tripudians, Oleum animale aethereum (distilling animal cadavers), Oleum Jecoris Aselli (the liver of Gadus Morrhua L.), Pepsinum, Scorpio europaeus, Sepia, Spongia, Theridion curassavicum, Tarantula, Vipera berus, Vipera redii, Vespa crabro.*

Today, remedies of animal origin consist of the whole body or parts of the animal, its organs or secretions. Some remedies can consist of physiological or pathological secretions (Ceipidor B. and Gasparini L. 2007, 15-18, 67-68).

The medical subject of animal remedies also involves:

- the use of healthy animal organs and thus organ therapies are obtained;
-secretions from animal glands (example: snake venom, bee venom, skimmed cow's milk, fish oil)
- biotherapeutics (including nosodes and isopathics).

All sources of raw materials of human or animal origin must be qualitatively verified and must comply with the requirements of the European Pharmacopoeia, European Community legislation and/or the homeopathic pharmacopoeia after which they are processed (Eșianu and Laczkó-Zöld 2017, 1-79).

Material and results

The Homeopathic collection included in the Pharmacy History Museum in Sibiu, part of the Brukenthal National Museum, counts 2910 vials. The homeopathic remedies were inventories and analyzed by Iordache I. (2018), identifying 227 vials labeled with remedies of zoological and biotherapeutic origin used for various afflictions (Tab.1).

Analyzing all the remedies presented, it was highlighted that the most common diseases are angina, bronchitis, respiratory problems, varicose veins, urticaria, diseases of the CNS as well as the digestive tract, cancer, gout or cystitis, female genital or thyroid diseases. For the treatment of varicose veins there are preparations from the category of vertebrates, more precisely the class of vipers, for cancer also from the category of vertebrates, and for urticaria, female genital diseases, gout and cystitis, homeopathic remedies from the category of invertebrates are used.

Biotherapeutic preparations are found in the treatment of asthma, respiratory problems, CNS diseases, thyroid diseases.

According to the dilution types the list includes decimal homeopathic dilutions or potencies (D), centesimal homeopathic dilutions or potencies (C), mother tinctures (Ø) and homeopathic triturations (T), as follows:

1. ACID FORMICAR D1, D4, D9, D24 (Fh 37 to Fh 40);
2. ACID LACTIC D3 (Fh 41);
3. ADRENALIN D4 (Fh 116);
4. AMBRA GRISEA Ø= 1/100, D1, D2, D3, D5, D11, C28, C29 (Fh 182 to Fh 190);
5. APIS D1 Ø, D1, D3 (Fh 254 to Fh 259);
6. APISINUM D3, D4, D5, D6, D7, D8, D9, D10, D14, D19, D29, D39, D49, D59, C199 (Fh 260 to Fh 275);
7. ARANEA DIADEMA Ø, D3 (Fh 286 and Fh 287);
8. ASTACUS C28, C29 (Fh 380 and Fh 381);
9. ASTACUS FLUVIAT Ø=D1, D2, D3, D4, D5, D7, D9, D11 (Fh 382 to Fh 389);
10. ASTERIAS RUBENS Ø, D2 (Fh 390 and Fh 391);
11. BACCILIUM C28, C29 (Fh 420 and Fh 421);
12. BADIAGA Ø=D1, D1, D3 (Fh 422 to Fh 424);
13. BLATA ORIENTALIS Ø (Fh 522);
14. BUFO RANA C5, D8 (Fh 545 and Fh 546);
15. CALCULI BILIARI D4, C4, C28 (Fh 664 to Fh 666);
16. CANTHARIS Ø, D2, D3, D5, D6, D8, D9, D10, D14, D15, D19, D24, D29, D34, D39, D44, D49, D54, D58 (Fh 698 to Fh 717, Fh 2865 and Fh 2866);
17. CARBO ANIMAL T2, D3, D6, D30, C6, C29, C199 (Fh 726 to Fh 732);
18. CARCINOMIUM C5 (Fh 761 and Fh 761);
19. CHOLEASTERIN D3, T4, D4, D5, D11, D13, D14, C28, C29 (Fh 881 to Fh 890);
20. CHOLESTERIN OLIGOPLEX (Fh 891);
21. COCCUS CACTI (Fig. 8) Ø=1/10, Ø, D3, D9, D11, C28, C29 (Fh 940 to Fh 946);
22. CORALLIUM RUBRUM Rp. Orig. (Fh 1002 (Fig. 9).
23. CROTALUS C5, C6, D6 (Fh. 1013 to Fh 1014);
24. CROTALUS HORID D8, D9, D19, D29, D39 (Fh 1016 to Fh 1020);
25. ELAPS CORALL. D5, C29 (Fh 1127 and Fh 1128);
26. FEL TAURI D1, D2, T2 (Fh 1171 to Fh 1176);
27. FORMICA RUFA C4, C5, C28, C29 (Fh 1213 to Fh 1216);
28. LAC CANINUM C28, C29 (Fh 1575 and Fh 1576);
29. LACHESIS C4, D6, D7, D8, D9, D13, D20, D23, D29, D30, D35, D40, D198, D199 (Fh 1577 to Fh 1591);
30. LAPIDES CANCRORUM D1, D3, D5, D7, D9, D11, D13 (Fh 1608 to Fh 1614);
31. LATTRODECTUS MACTANS D12, D15, C28, C29 (Fh 1617 to Fh 1620);
32. MEDORRHINUM D10, D11, D12, D13, D14, D19, D39, D300, C198, C199, C298, C1000 (Fh 1723 to Fh 1734);
33. MENPHITIS PUTOR. D5 (Fh 1752);
34. MILKZUCKER D5 (Fh 1825);
35. MOSCUS D, C28, C29 (Fh 1833 to Fh 1835);
36. MUREX PURPUREA D6 (Fh 1836);
37. MATER PERLAR (Fh 1850);
38. NAJA TRIPUDIANS D6, D8, D11, C28, C29 (Fh 1853 to Fh 1857);

39. PSORINUM/ PSORINUM D12, C198, D14, D16, D18, D20, D29, D39, D49, D59, C198, C199 (Fh 2122 to Fh 2134);
40. SEPIA TINCTUR. Ɵ, Ɵ=D1, D3, D4, D8, D9, D11, C15, D20, C25, C28, D195, D196, D197, C198, D198, D199, C199 (Fh 2373 to Fh 2391);
41. SEPSINUM C30 (Fh 2392);
42. SPONGIA Ɵ=D1, D1, D2, D3, D4, D5, D7, D11, C28, C29 (Fh 2436 to Fh 2449);
43. SYPHILITIN C29, C30, C200 (Fh 2585 to Fh 2587);
44. TARANTULA C4, C5, D6, D19, D29, D39, D49, D59 (Fh 2622 to Fh 2630);
45. TARANTULA HISPANIC C998 (Fh 2631);
46. TUBERCULINUM C5, C7, C9, C11, C13, C15, C17, C23, C24, C27 (Fh 2713 Fh 2722);
47. TUBERCULINUM BURNETT. (Fh 2723);
48. TURBERCULIN HEATLS. C30 (Fh 2724);
49. VIPERA BERUS C5 (Fh 2784).

Discussions

Invertebrates with a percentage of 54% of the total homeopathic remedies are predominant, followed by biotherapies and vertebrates with the same percentage of 23%. (Fig. 5).

After analyzing all homeopathic remedies of animal nature, an analysis was performed according to the pharmaceutical form in which the homeopathic preparation was found and it was observed that most of the remedies are included as a pharmaceutical form in solutions with a percentage of 92.13 %, followed by powders with a percentage of 6.69%, tablets 0.79% and lastly globules with 0.39%.

Decimal homeopathic remedies take precedence over vertebrates with 68% of all remedies. Here you can also find preparations by crushing with a percentage of 6% (Fig. 6).

It can be said that out of the total homeopathic remedies of animal origin, the invertebrate category the largest share is represented by the combination of decimal-centesimal dilution (Fig. 7).

REFFERENCES

Biader Ceipidor and Gasparini, 2007 — Biader Ceipidor Carla and Gasparini Lucia, *Homeopatie pentru toți, Cum să ne îngrijim trupul, mintea și spiritual*, Editura Paralela 45 (2007), pp. 15-18,67-68.

Bott, 2014 — Bott Victor, *An Introduction to Anthroposophical Medicine: Extending the Art of Healing*. Rudolf Steiner Press (2014), p. 240.

Bujoran, 1936 — Bujoran George, *Boli, leacuri și plante de leac cunoscute de țărănimea română*. Biblioteca poporală a Ascoiațiunii ”Astra”, Editura Asociațiunii Astra, Sibiu (1936), pp. 26-210.

Eșianu and Laczkó-Zöld, 2017 — Eșianu Sigrid and Laczkó-Zöld Eszter, *Medicamente Homeopate*, Editura University Press, Tîrgu Mureș (2017), pp.1-79.

Ferrand, 1891 — Ferrand Eusèbe, *Aide-Mémoire de pharmacie, vade-mecum du pharmacien a l'officine et au laboratoire, Cinquième édition.* , Librarie J.-B. Boilliere et fils, Paris (1891), pp. 26-793 (Brukenthal National Museum Library, B.B.S. 620)

Fischer and Hertwich, 1900 — Fischer. B., Hartwich C., *Hagers Handbuch der Pharmaceutischen Praxis für Apotheker, Ärzte, Drogisten und Medicinalbeamte, Erster Band, A – G*, Verlag von Julius Springer, Berlin (1900). (Pharmacy History Museum in Sibiu, inventory number F 3831)

Fischer and — Fischer. B., Hartwich C., Hagers Handbuch der Pharmaceutischen Praxis für

Hertwich, 1902 Apotheker, Ärzte, Drogisten und Medicinalbeamte, Zwiter Band, H – Z, Verlag von Julius Springer, Berlin (1902) (Pharmacy History Museum in Sibiu, inventory number F 3832).

Hager, 1883 Hager Hermann, *Handbuch der Pharmaceutischen Praxis für Apotheker, Ärzte, Drogisten und Medicinalbeamte, Ergänzungsband*, Verlag von Julius Springer, Berlin, 1883 (Pharmacy History Museum in Sibiu, inventory number F 3830)

Hager, 1884 Hager Hermann, *Handbuch der Pharmaceutischen Praxis für Apotheker, Ärzte, Drogisten und Medicinalbeamte, Ergänzungsband*, Verlag von Julius Springer, Berlin,1884 (Brukenthal National Museum Library B.B.S. 222749)

Hoppál and Törö, 1975 Hoppál Mihály and Törö László, *Népi gyógyitás Magyarországon. Gyógyitás állati, emberi eredetű és ásványi anyagokkal.* In: *Népi gyógyitás Magyarországon. Orvostörténeti Közlemények - Communicationes de historia artis medicinale.* Supplementum 7-8, Budapest (1975), pp. 91-95.

Iordache, 2018 Iordache Irina, Remediile homeopatice de natură animală, din colecția Muzeului de Istorie a Farmaciei din Sibiu (2018), lucrare de licență (Universitatea ”Lucian Blaga” din Sibiu, Facultatea de Medicină ”Victor Papilian”, specializarea Farmacie), pp. 63.

O'Hara-May J., 1971 O'Hara-May J., *Foods or medicines? A study in the relationship between foodstuffs and materia medica from the sixteenth to the nineteenth century*. In: *Trans Br Soc Hist Pharm*. 1(2), (1071) pp.61-97.

Schwabe, 1934 Schwabe Willmar, *Homöopathisches Arzeibuch, 2 abgeänderte Auflage*. Verlag Dr. Willmar Schwabe (1934) (Pharmacy History Museum in Sibiu, inventory number F 3637), pp. 37-410.

Toma *et al*. 2012 Toma Elena-Cristina, Mesaroș Ana-Maria, Carata Ana, *Remedii farmaceutice de origine animală prezente în prima Farmacopee română de la 1862 si în colecția Muzeului de Istorie a Farmaciei din Sibiu*. In : *Lucrări in-extenso, cea de-a XXI-a Reuniune Națională de Istoria Farmaciei – 150 de ani de la prima Farmacopee română (1862-2012)*, Editura Sitech, Craiova (2012), pp. 192-197.

* Codex Medicamentarius Pharmacopée Française, Paris, 1866 (Pharmacy History Museum in Sibiu, inventory number II18480).

** Pharmacopoea Austriaco-Provincialis 1774 (Brukenthal National Museum Library BBS 963)

*** Pharmacopea Română 1862 (Brukenthal National Museum Library B.M.B.S. II18169)

**** WHO/IUCN/WWF: Guidelines on Conservation of Medicinal Plants. Switzerland 1993.

LIST OF ILLUSTRATIONS

Fig. 1 Beetle powder, pharmacy wood jar 18th century, Pharmacy History Museum Sibiu, inventory number F 760.

Fig. 2 Burned stag antlers, pharmacy glass jar 19th century, Pharmacy History Museum Sibiu, inventory number F 3585.

Fig. 3 Pig lard, ceramic pharmacy jar 19th century, Pharmacy History Museum Sibiu, inventory number F 2884.

Fig. 4 *Lapides Cancrorum*, pharmacy wood jar dated 18th century, Pharmacy History Museum Sibiu, F 1409.

Fig. 5 Category of animal resources.

Fig. 6 Homeopathic remedies of animal sources – vertebrates.

Fig. 7 Dilutions in remedies of invertebrates sources.

Fig. 8 Vials from the museum homeopathic collection *COCCUS CACTI, COCCULUS*.

Fig. 9 Homeopathic remedy *CORALLIUM RUBR. OPIX*.

Table 1 Homeopathic remedies of animal origin from the collection according to the disorder they are used for (Irodache 2018).

LISTA ILUSTRAȚIILOR

Fig. 1 Praf de gândaci, borcan farmaceutic din lemn datat secolul al XVIII-lea, patrimoniul Muzeului de Istoria Farmaciei din Sibiu, număr de inventar F 760.

Fig. 2 Coarne de cerb calcinate, borcan farmaceutic din lemn datat secolul al XIX-lea, patrimoniul Muzeului de Istoria Farmaciei din Sibiu, număr de inventar F 3585.

Fig. 3 Grăsime de proc, borcan farmaceutic din ceramică, Muzeul de Istoria Farmaciei din Sibiu, numărul de inventar F 2884.

Fig. 4 *Lapides Cancrorum*, borcan farmaceutic din lemn secolul al XVIII-lea, Muzeul de Istoria Farmaciei din Sibiu, F 1409.

Fig. 5 Categorii de surse animale.

Fig. 6 Remedii animale din surse zoologice – vertebrate.

Fig. 7 Ponderea diluțiilor la nevertebrate.

Fig. 8 Flacoane din colecția muzeului *COCCUS CACTI, COCCULUS*.

Fig. 9 Remediu homeopat *CORALLIUM RUBR. OPIX*.

Tabel 1 Remedii homeopate de origine animală din colecție grupate în funcție de afecțiuni (Iordache 2018).

1.

2.

3.

4.

Fig. 1-4: 1 -Beetle powder, pharmacy wood jar 18th century, Pharmacy History Museum Sibiu, inventory number F 760: **2 -** Burned stag antlers, pharmacy glass jar 19th century, Pharmacy History Museum Sibiu, inventory number F 3585; **3 -** Pig lard, ceramic pharmacy jar 19th century, Pharmacy History Museum Sibiu, inventory number F 2884; **4 -** *Lapides Cancrorum*, pharmacy wood jar dated 18th century, Pharmacy History Museum Sibiu, F 1409.

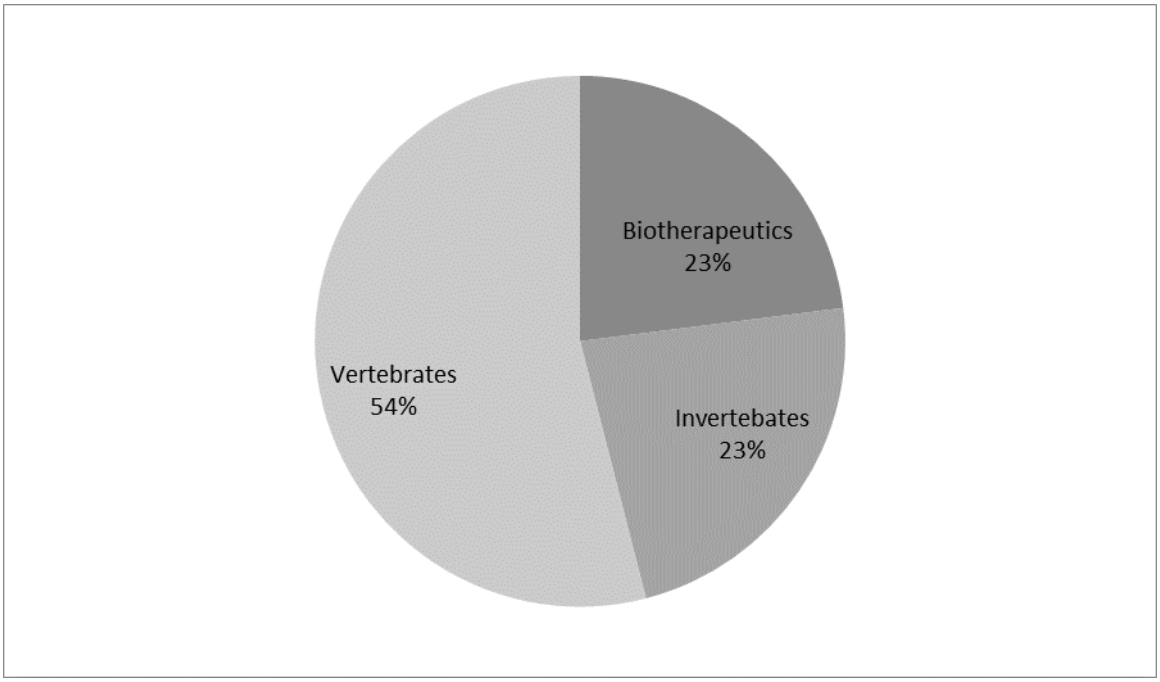


Fig. 5. Category of animal resources

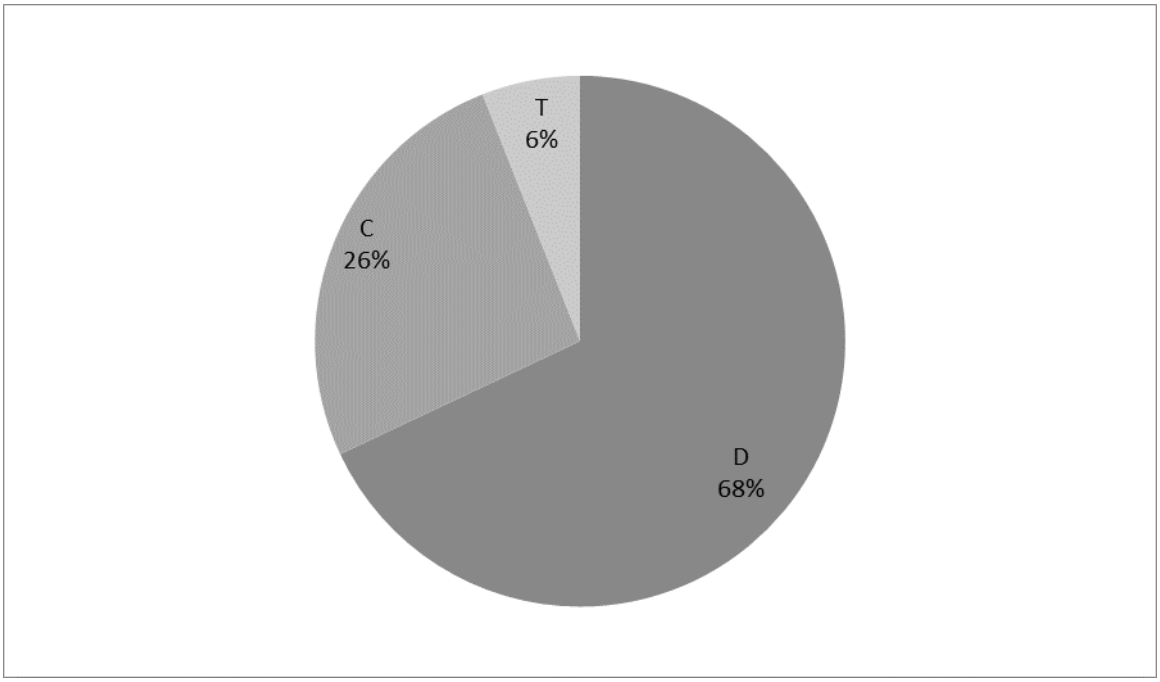


Fig. 6. Homeopathic remedies of animal sources – vertebrates

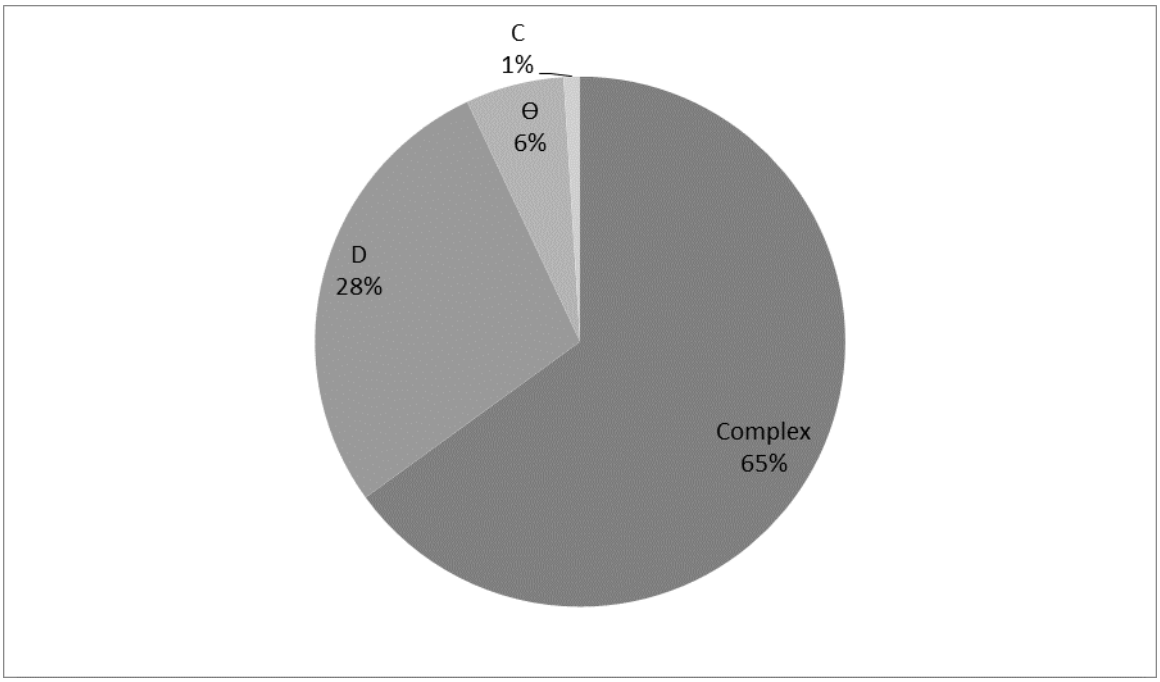


Fig. 7. Dilutions in remedies of invertebrates sources

Fig. 8. Vials from the museum homeopathic collection *COCCUS CACTI, COCCULUS*.

Fig. 9. Homeopathic remedy *CORALLIUM RUBR. OPIX*.

Tab. 1 Homeopathic remedies of animal origin from the collection according to the disorder they are used for (Iordache 2018).

Disorder	**Homeopathic remedies from the collection**
Angina	*Apis, Apisinum ,Grupa Arachnida, Naja tripud.*
Varicose veins	*Lachesis, Vipera*
Hives	*Apis, Apisinum, Bombyx Mori, Astacus fluviatilis*
Bronchitis	*Blatta orientalis, Tuberculinum*
Respiratory problems / asthma	*Blatta orientalis, Badiaga (Spongilla lacustris), Spongia (Euspongia off.), Carcinominum, Bacillinum, Medorrhinum, Syphilinum*
Mental disorders, CNS	*Tuberculinum, Syphilinum, Medorrhinum, Bacillinum, Ambra grisea, Crotalus, Elaps, Sepia tinctur., Arachnida group, Chantaris*
Digestive system	*Doryphora decemlineata, Sepia tinctur., Elaps coral., Fel Tauri*
Female genital system	*Vespa, Arachnida group, Asterias rubens*
Thyroid disorders	*Spongia (Euspongia off.), Thyreoidea*
Cystitis	*Apis, Apisinum, Arachnida group*

Gout	*Formica rufa*
Cancer	*Carbo animalis, Naja tripud.*

HOMEOPATHIC REMEDIES OF MINERAL NATURE FROM THE HISTORY OF PHARMACY MUSEUM COLLECTION IN SIBIU (BRUKENTHAL NATIONAL MUSEUM)

Carmen-Maria TUTELEA*
Ana-Maria PĂPUREANU**
Ladislau ROSENBERG***

Abstract. *The Pharmacy History Museum in Sibiu Homeopathy Collection counts 2910 vials from which 1188 held remedies of mineral origin. After analyzing the inscriptions from these vials were identified 214 major types of mineral remedies used in the past and today in homeopathy. The vials were donated to the museum by „The Angle Pharmacy" (Engel Apotheke) from Sibiu in 1950. The name of „The Angel Pharmacy" is marked on the majority of the labels, but there are many remedies acquired from renowned homeopathic laboratories in Leipzig, Stuttgart, Dresden, Budapest and London. This paper includes the complete list of the homeopathic remedies found in the museum collection.*
Keywords*: Pharmacy History Museum Sibiu, Homeopathy Collection, mineral sources.*

Rezumat. *Colecția de Homeopatie a Muzeului de Istoria Farmaciei din Sibiu numără 2910 flacoane dintre care 1188 cu remedii de origine minerală. După analiza inscripțiilor de pe flacoane au fost identificate 214 tipuri majore de remedii de origine minerală utilizate în homeopatie atât în trecut cât și în prezent. Flacoanele au fost donate de către Farmacia "La Înger" (Engel Apotheke) din Sibiu în 1950. Numele farmaciei donatoare este marcat pe majoritatea etichetelor, remediile au fost preparate în laboratorul de homeopatie al farmaciei, dar au fost achiziționate și din Leipzig, Stuttgart, Dresden, Budapesta și Londra. Lucrarea de față cuprinde lista completă a remediilor homeopate de origine minerală incluse în colecție.*
Cuvinte cheie: *Muzeul de Istoria Farmaciei din Sibiu, Colecția de homeopatie, sursă minerală*.

Introduction

The historical role of mineral materials or geopharmaceutical material in traditional medicine and the development of modern remedies has been largely studied by C. Duffin (2006, 2013, 2014, 2016, 2018, 2019, 2020).

According to Duffin (2013) *medical geology studies the influence of geological factors (such as the excess or deficiency of trace elements and minerals, radionuclides, mineral dusts and volcanic emissions, etc.) on the geographical distribution of health problems in both man and animals.*

For the first time in the history of pharmacy, Duffin (2014, 84-87) presented the uses of lapis lazuli in traditional medicine and pharmacy since Ancient Egypt until 1750.

* "Lucian Blaga" University of Sibiu, Faculty of Medicine "Victor Papilian" carmen.tutelea@yahoo.com,
** Brukenthal National Museum Sibiu, papureanu.ana@gmail.com
*** Romanian Society for the History of Pharmacy (SRIF) and "Lucian Blaga" University of Sibiu, Faculty of Medicine "Victor Papilian", rosenlaszlo@yahoo.com

In the Pharmacy History Museum from Sibiu collection there is a wood jar (Fig. 1, inventory number F 1494) from the"Crown" Pharmacy in Sibiu dated 18th century that still has inside powdered lapis lazuli.

Hendriksen (2018, 303-323) considers the use of mineral and fossil substances for the preparation of remedies in traditional pharmacies reached its peak in Europe during the 18th century. Pharmacists were well prepared in the nomenclature, curative properties, chemistry and transformations of minerals. In the Netherlands and England, Herman Boerhaave's (1668-1738) work on mineral medicine *Elementa Chemiae* reinterpreted traditional medicinal use of the minerals in to an "academic chemistry" for pharmacists.

The Pharmacy History Museum from Sibiu, comprises various wooden jars, dated 17th and 18th century, with remedies of mineral origin like *Terra Sigillata* (Fig. 2, inventory number F 886), *Terra Tripolit* (Fig. 3, inventory number F 832), *Terra Lemnia* (Fig. 4, inventory number F 805) researched extensively even today for their medical proprieties (Dannenfeldt 1984, 174-188;

Spałek and Spielvogel 2019; Venieri *et al*. 2020, 1-11).

Laudato *et al*. (2013, 419-423) consider that today's natural products of mineral origin used in pharmacies are alum, bismuth, calcium, magnesium, silicates and zinc compounds.

In homeopathy, minerals have been used since the beginning of this therapeutic doctrine especially Mercury and Sulphur. Hahnemann C. F., considered the father of homeopathy, included in his *The Chronic Diseases, their Peculiar Nature and their Homœopathic Cure* (1828-1830) the following substances of mineral origin: Alumina, Ammonium carbonicum, Ammonium muriaticum, Antimonium crudum, Arsenicum album, Aurum, Aurum muriaticum, Baryta carbonica, Borax venata, Calcarea carbonica, Causticum, Cuprum, Graphites, Hepar sulphuris calcareum, Iodium, Kali carbonicum, Magnesia carbonica, Magnesia muriatica, Manganum, Muriaticum acidum, Natrum carbonicum, Natrum muriaticum, Nitri acidum, Nitrum, Petroleum, Phosphorus, Phosphoricum acidum, Platina, Silicea terra, Stannum, Sulphur, Sulphuricum acidum and Zincum.

Homeopaths take into account that mineral remedies tend to act more deeply and possess a longer duration of activity. Minerals are inanimate substances, in comparison to animals and plants.

One of the homeopaths that contributed the most in the use of these elements in the preparation of the remedies was Jan Scholten, who developed in the nineties the concept of salts as the sum of their anions and cations components, the relationship between different groups of mineral remedies. Scholten also considers that there is a connection between certain phases in human development and the chemical order of the elements in the periodic table. In his work he includes the following group analysis: the cations (Calcarea, Magnesium, Kali, Natrium and single elements), the Carbonicum (Graphite, Calcarea Carbonica, Magnesium Carbonicum, Natrium Carbonicum), the Muriaticum (Chlorum, Calcarea Muriatica, Magnesium Muriaticum, Kali Muriaticum, Natrium Muriaticum), the Sulphuricum (Sulphur, Calcarea Sulphurica, Magnesium Sulphuricum, Kali Sulphuricum, Natrium Sulphuricum), the Phosphoricum (Phosphorus, Calcarea Phosphorica, Magnesium Phosphoricum, Kali Phosphoricum, Natrium Phosphoricum), the Baryta (Baryta Carbonica, Baryta Muriatica, Baryta Sulphurica, Baryta Phosphorica), the Acids (Sulphuric Acid, Phosphoric Acid), the Ammonium (Ammonium Carbonicum, Ammonium Muriaticum, Ammonium Sulphuricum, Ammonium Phosphoricum), the Nitricum (Nitric Acid, Calcarea Nitrica, Kali Nitricum, Natrium Nitricum, Baryta Nitrica), the Fluoratum (Calcarea Fluorata, Magnesium Fluoratum, Kali Fluoratum, Natrium Fluoratum, Baryta Fluoratum), the Bromatum (Bromium, Calcarea Bromata, Magnesium Bromatum, Kali Bromatum), Thelodatum (Magnesium Iodatum, Kali Iodatum, Natrium Iodatum) and the Ferrum group (Vanadium, Kali Bichromicum, Manganum, Ferrum Metallicum, Ferrum Muriaticum, Ferrum Sulphuricum, Ferrum Phosphoricum, Ferrum Iodatum, Niccolum, Cuprum, Zincum). Argentum Metallicum is included separately (Scholten 2013, 296). Scholten's theory is widely used today.

Another homeopath who dedicated his researche to homeopathic remedies of mineral origin is Rajan Sankaran, starting from Scholten theory he developed *the mineral sensation method* (Oliveira *et al*. 2015, 22-27).

Lockie (2006) describes in the *Encyclopedia of Homeopathy* 35 major mineral remedies.
This paper includes the homeopathic remedies of mineral origin held in the Pharmacy History Museum Collection in Sibiu with the aim of contributing to the research in the field of medical geology and history of homeopathy in Romania.

Material and results

The museum's homeopathy collection counts 2910 vials out of which 1188 held remedies of mineral origin. The vials are marked with the original labels marking the name of the remedy, its and the source laboratory from Sibiu ("The Angel" Pharmacy) or from abroad (Viena, Leipzig, Budapesta etc.) (Fig.5).

The substances are present in various homeopathic forms: "mother" tincture (Ɵ), homeopathic globules (gb), homeopathic granules (gn), homeopathic tablets (tb), homeopathic trituration (T/Tr.), decimal homeopathic dilutions (D) and centesimal homeopathic dilutions (C). There are unitary or single homeopathic remedies (made from a single substance), complex remedies (combinations of several homeopathic medicines) and homeopathic magistral preparations (CH/H – hanemannian dilutions).

The remedies of mineral origin included in the museum collection, in alphabetical order and ascending inventory number (Fh), are:

1. ACID ACETIC/ ACIDUM ACETIC (Fh 27 to Fh 31, Fh 2807) D3, D4, D5, D8, D11, C5;
2. ACID BENZOIC (Fh 32) D1;
3. ACIDUM CITRICUM (Fh 33) D2;
4. ACID. FLUOR. / ACID FLUORIC. (Fh 34 and Fh 35) D6, D7;
5. ACID HYDROFLUORIC (Fh 36) D3;
6. ACID LACTIC (Fh 41) D3;
7. ACIDUM MUR. (Fh 42 to Fh 47) D3, D4, D5, D7, D9, D11;
8. ACID NITRIC. (Fh 48 to Fh 52) D4, C28, C29, C198, C200;
9. ACID OXAL/ ACID OXALICUM (Fh 53 and Fh 54) C28 and C29;
10. ACID PHOSPHOR/ ACID PHOSPH./ ACID. PHOS./ ACIDUM PHOSPH. (Fh 55 to Fh 62, Fh 2837) D1, D2, D3, D5, D20, C29, C198, C199;
11. ACID PICRINICUM / ACID PICRINIC. (Fh 63 to Fh 70) D2, D3, D4, D8, D10, D11, D12;
12. ACID SULFURIC/ ACID SULFUR (Fh 71 to Fh 74) D2, D3, C28, C29;
13. ALUMINA (Fh 176 to Fh 181) T4, T6, D9, D11, C28, C29;
14. AMMONIUM BROMAT (Fh 191 to Fh 200) T1, D2, D3, D4, D5, D6;
15. AMMONIUM CARBONIC (Fh 201) D2;
16. AMMONIUM MURIATIC (Fh 202 and Fh 203) D2, D4;
17. AMMONIUM VALERIANAE (Fh 204) D2;
18. AMMONIUM VANADATUM (Fh 205) D4;
19. AMYLIUM NITROS (Fh 206 to Fh 210) D1, D4, D5, D7, D11;
20. ANTIMON (Fh 227) D3;
21. ANTIMON ARSENOCOS (Fh 228 and Fh 229) C4, C5;
22. ANTIMON CRUD (Fh 230 to Fh 243) D2, Tr. 3, D8, D9, D10, D14, D19, D24, D29, D39, D49, D58, D59, C198;
23. ANTIMON JODAT (Fh 244 and Fh 245) T3, D4;
24. ANTIMON SULF. AURANT (Fh 246 and Fh 247) T2, D4;
25. ANTIMON TARTAR (Fh 248 to Fh 251) C4, C5, C28, C29;
26. APATIT (Fh 252 and Fh 253) Tr. 4, Tr. 5;
27. AQUA SILICATA (Fh 2809);
28. ARGENTUM (Fh 288 and Fh 289) C28, C29;
29. ARGENTUM COLOIDAL (Fh 2810) D1;
30. ARGENTUM METALLIC (Fh 290 to Fh 294) Tr. 4, Tr. 5, Tr. 6, Tr. 8, Tr. 9;
31. ARGENTUM NITRIC (Fh 295 to Fh 314) D3, D4, D5, D6, D8, D9, D10, D12, D14, D19, D24, D28, D29, D34, C4;
32. ARSENICUM (Fh 2838 to Fh 2840) D6;
33. ARSENICUM ALBI. (Fh 2841 to Fh 2844) Tr. IV, D5, C30;
34. ARSENIC METALICUM (Fh 341 to Fh 355) D2, D5, D11, D13, D17, D21, D198, C4, C5, C28, C29, C198, C199, C999, C1000;
35. ARSENIC JODAT (Fh 356 to Fh 362, Fh 2848 to Fh 2856) D2, D3, D4, D5, D6, D7, D9, D10, D11, D28, C28;
36. ARSENICUM OLIG. (Fh 2857) D4;
37. ARSENICUM SULF. FLAV. (Fh 2845) T3;
38. ATROPIN SULFURIC (Fh 392 to Fh 395, Fh 2846 and Fh 2847) D2, D3, D7, D10, Tr.2, Tr. 3;
39. AURUM (Fh 396 and Fh 397, Fh Fh 2812) D4, D6, C29;
40. AURUM CLOR. NATR. (Fh 398 to Fh Fh 400) D4, Tr.;
41. AURUM METAL COLLOID (Fh 401 to Fh 409, Fh 2813) D4, D5, D6, D7, D8, D9, D10, D12;
42. AURUM MURIAT (Fh 410 to Fh 414) D2, D3, D4, C199;
43. AURUM MURIAT KALII (Fh 415) D2;
44. AURUM JODAT (Fh 416 to Fh 418) C2, D3, D4;
45. BARIUM ACETIC (Fh 434) C29;
46. BARIUM CARBONIC (Fh 435 to Fh 451) D4, D8, D9, D10, D12, D14, D19, D39, D49, D59, C28, C29, C198, C199;
47. BARIUM CITRIC (Fh 452 and Fh 453) D4, D5;
48. BARIUM JODAT (Fh 454 to Fh 457) D5, D6, C28, C29;
49. BARIUM MURIATIC (Fh 458 to Fh 463) D1, D2, D3, D4;
50. BARYT ACETIC (Fh 464) D5;
51. BARYT CARBONIC (Fh 465 to Fh 468) D2, D3, D4;
52. BARYT CITRIC (Fh 469) D2;
53. BARYT JODAT (Fh 470 to Fh 475) D1, D2, D4, C4, C5;

54. BARYT MUR. (Fh 476) D6;
55. BISMUTH METALIC (Fh 511 to Fh 515) D2, D3, D4, D7, D8;
56. BISMUTH SUBGALIC (Fh 516) D1;
57. BISMUTH SUBNITRIC (Fh 517 to Fh 521) D4, Tr. 5, Tr. 6, C28, C29;
58. BLEI (Fh 2802 to Fh 2804) D30;
59. BORAX (Fh 524 to Fh 529) D3, D6, C28, C198;
60. BROMUM (Fh 533 to Fh 535) Ø=D2, D5, C5;
61. CADMIUM (Fh 559) D3;
62. CADMIUM SULFURIC (Fh 560) D6;
63. CALCAR ACETIC (Fh 579 to Fh 581) Ø, D1;
64. CALCAR CARBONIC (Fh 582 to Fh 590) D2, D10, D14, D19, D24, D28, D29, C30, C200;
65. CALCAR FLORIC (Fh 591 and Fh 592) Ø, D10;
66. CALCAR IODAT (Fh 2816) D1;
67. CALCAR SULFURIC (Fh 2817) D3;
68. CALCIU ACETIC SOL. (Fh 593) H;
69. CALCIUM ARSENICOS (Fh 2858 to Fh 2861) D3, D4, T5;
70. CALCIUM CARB. HAH. (Fh 2818) D3;
71. CALCIU CARBONIC PUR. HAHN. (Fh 594 and Fh 595);
72. CALCIU CARBONIC H. (Fh 596 to Fh 610) D1, D2, D3, D7, D8, D9, D10, D12, C6, C28, C29, C198, C199, C1000;
73. CALCIU CHLORAT (Fh 611) D2;
74. CALCIUM FLUORATUM (Fh 612 to Fh 622) D1, D2, D3, D4, D6, D7, D8, D10, D12, C198;
75. CALCIUM HYPOPHOS. (Fh 623 to Fh 629) D2, D6, C28, C29, C198, C199;
76. CALCIU JODAT (Fh 630 to Fh 636) D2, D3, D4, D5, D6;
77. CALCIU MURIATIC PUR. (Fh 637);
78. CALCIU PHOSPHORIC ACID PUR (Fh 638 and Fh 639) D1;
79. CALCIUM PHOSPHORIC (Fh 640 to Fh 651) D5, D6, D7, D8, D9, D10, D13, C28, C30, C198, C199;
80. CALCIUM PHOSPH. COLL. (Fh 2819) D3;
81. CALCIUM SILICIC FLUORAT (Fh 652 and Fh 653, Fh 2820) D4, T2, T4;
82. CALCIUM SULFURIC (Fh 654 to Fh 662) D1, D2, D4, D6, D10, C4, C5;
83. CALCIUM SULFURIC STIBIAT (Fh 663) T2;
84. CALOMEL (MERCUR DULCIS) (Fh 2862 to Fh 2864) D2, D3, T3;
85. CARBON SULFURIC (Fh 733) D5;
86. CARBON SULF. JODAT (Fh 734) D3;
87. CAUSTICUM (Fh 780 to Fh 813) Ø, D1, D10, D11, D13, D15, D17, D19, D20, D21, D25, D30, D35, D40, D45, D50, D55, D60, D65, D70, D75, D80, D85, D90, D95, D100, D105, D110, D115, D120, D125, D130, D198;
88. CERIUM OXALIC (Fh 818) D3;
89. CHININ ARSENICOS (Fh 858 to Fh 860, Fh 2867 to Fh 2874) D3, D4, D5, D6, D8, D10, D12, C6, T3, T4;
90. CHININ FERO-CITRIC (Fh 861) D2;
91. CHININ MURIATIC (Fh 862) D1;
92. CHININ SULFURIC (Fh 863 to Fh 872) D1, T2, D3, D4, D5, D7, D11, C28, C29;
93. COBALT METALLIC (Fh 925) D3;
94. CUPRIT (Fh 1027 to Fh 1030) D2, D5, D6;
95. CUPRUM (Fh 1031 to Fh 1034) D10, C28, C29, C30;
96. CURPUM ACETIC (Fh 1035 to Fh 1042) D2, T3, T4, D4, D5, D6, D7;
97. CUPRUM ARSENICOS (Fh 2875 to Fh 2879) D3, D4, D6, T4;
98. CUPRUM BROMATUM (Fh 1043) D1;
99. CUPRUM METALL. (Fh 1044 to Fh 1046) T2, D3, D9;
100. CUPRUM METALL. COLLOID. (Fh 1047 to Fh 1051) D3, D4, D5;
101. CUPRUM OXIDAT (Fh 1052) D2;
102. CUPRUM SULFURAT (Fh 1053) Ø;
103. FERRUM (Fh 1178 to Fh 1183, Fh 1201 to Fh 1207) D1, D2, D3, D5, D6, D7, D12, C4, C5, C28, C29;
104. FERRUM ACET. (Fh 1184) D5;
105. FERRUM ALBUM. CUM. NATRII. CITRIS. IN LAMELIS (Fh 1185);
106. FERRUM CITRI (Fh 1186) D3;
107. FERRUM CYANATI (Fh 2882) D5;
108. FERRUM FLORAT (Fh 1187) D3;
109. FERRUM IODATUM (Fh 1188 to Fh 1193) D2, D3, D5, T3, T4;

110. FERRUM METALLIC (Fh 1194 to Fh 1197) D4, C28, C29, C30;
111. FERRUM METALIC COLLOID. (Fh 1198) Ɵ;
112. FERRUM PHOSPHORICUM (Fh 1199 and Fh 1200) D1, D4;
113. FERRUM PICRIC (Fh 1208) D4;
114. FERRUM SESQUICHLOR (Fh 1209 to Fh 1211) D1, D2, D3;
115. GLONOINUM (Fh 1243 to Fh 1246) Ɵ=D2, D4, D5, C29;
116. GRAPHITES (Fh 1252 to Fh 1256, Fh 1258, Fh 1260, Fh 1261, Fh 1264 to Fh 1277) D2, D4, D5, D10, D11, D12, D25, D29, C25, C26, C27, C28, C29, C30, C198, C199, C998, C999, C1000, T3;
117. GRAPHITES COLL. (Fh 1257, Fh 1259, Fh 1262, Fh 1263) D7, D10, D15, D20;
118. HEKLA LAVA (Fh 1303 to Fh 1307) D3, C4, C5, C28, C29;
119. HEPR SULFURIS (Fh 1329 to Fh 1343, Fh 2825) D1, D2, D3, D4, D6, D8, D198, D199, C4, C5, C6, C29, C198, T2;
120. HEPAR SULFURIS CALCII (Fh 1344 and Fh 1345) D7, D28;
121. HEPAR SULFURIS KALII (Fh 1346) D3;
122. HYDRARGYRUM BIJODATUM (Fh 1364) C29;
123. IODUM (Fh 1452 to Fh 1459) D7, D9, D11, D24, D29, D39, D49, C198;
124. KALIUM (Fh 1522 to Fh 1531) D2, D3, D4, D5, D6, C5, C10, C15, C20;
125. KALIUM ARSENICOS (Fh 1472 and Fh 1473, Fh 2883) D2, D3;
126. KALIUM BICROMIC (Fh 1474 to Fh 1491, Fh 2828) D1, D2, D3, D5, D6, D7, D15, D19, D23, D25, D27, C28, C29, C199;
127. KALIUM BIJODAT (Fh 1492);
128. KALIUM BROMAT (Fh 1493 to Fh 1501) D2, D3, D4, D6, D8, D10, C28, C29;
129. KALIUM CARBONICUM (Fh 1502 to Fh 1509) D3, D11, D20, D28, D35, D40, D50, D57;
130. KALIUM CHLORAT (Fh 1510) D6;
131. KALIUM CYANAT (Fh 1511 to Fh 1513) D2, D3, D4;
132. KALIUM FERR. CYANATI (Fh 2884) D5;
133. KALIUM HYDROJOD (Fh 1514) D1;
134. KALIUM JODAT (Fh 1515 to Fh 1520) D6, D8, D16, C28, C29;
135. KALIUM MURIATIC (Fh 1521 and Fh 1532) D2, C30;
136. KALIUM PHOSPHORIC (Fh 1533 to Fh 1558) Ɵ, D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D15, D19, D29, D39, D49, D59, D60, C198, C199;
137. KALIUM SILICIC (Fh 1559) D2;
138. KALIUM SULFURIC (Fh 1560 to Fh 1569) D3, D4, D5, D6, D7, D19, D29, D39, D49, D59;
139. LITHIUM BENZOICUM (Fh 1649) D2;
140. LITHIUM CARBONIC (Fh 1650 to Fh 1653) Tr.1, D2, C4, C5;
141. MAGN. BAROCITOIC (Fh 1688 to Fh 1692) Ɵ, D1, D5, D7, D9;
142. MG. CARBONIC (Fh 1693) C29;
143. MAGNES CHLORAT (Fh 1694 and Fh 1695) D1, D2;
144. MAGNES FORMIC (Fh 1696) D1;
145. MAGNES PHOSPH. (Fh 1697 to Fh 1704) Tr.1, Tr.3, D5, Tr. 6, D8, D9, D11, D28;
146. MANGAN. ACET. (Fh 1706 to Fh 1710) D3, D4, D5, D6;
147. MANGAN. SULFURIC (Fh 1711 to Fh 1714) Ɵ, D5, D7, D9;
148. MERCUR AURANTUS (Fh 2885) D2;
149. MERCUR BIJODAT (Fh 1753 and Fh 1754, Fh 2886) D3, C28, C29;
150. MERCUR CHLOROJODAT (Fh 1851) Ɵ;
151. MERCUR COROSIV. (Fh 1755 to Fh 1772, Fh 2887 to Fh 2891) D=Ɵ, D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D14, D19, D29, D49, D59;
152. MERCUR CROMIC OXYD (Fh 1773 and Fh 1852) D1, D3;
153. MERCUR CYANAT (Fh 1774 to Fh 1781, Fh 2892) D3, C4, D4, D5, C5, D6, C28, C29;
154. MERCUR JODAT. FLAX. (Fh 2893 and Fh 2894) T1, D3;

155. MERCUR OXIDAT RUBRUM (Fh 2895 and Fh 2896) D1, D3;
156. MERCUR PHOSPHORIC (Fh 2897 to Fh 2899) D1, D3;
157. MERCUR SOLUBIL (Fh 1782 to Fh 1786, Fh 2900 and Fh 2901) D2, D6, D16, D22, C28, D29, C198;
158. MERCURIUS VIVUS (Fh 1787 to Fh 1805, Fh 2902) D1, D2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, D15, D16, D19, D29, D39, D49, D59;
159. NAFTALIN (Fh 1858 to Fh 1865) Ɵ, D4, D6, D8, D9, D11, C28, C29;
160. NASTURAN (Fh 1866 and Fh 1867) D3, D29;
161. NATRIUM CARBONIC (Fh 1868 to Fh 1878) D1, D3, D4, D5, D7, D9, D11, C20, C25, D30;
162. NATRIUM CHLORAT (Fh 1879 to Fh 1888) D2, D3, D9, D10, D11, D12, Tr. 12, D13, D14, D15;
163. NATRIUM FLUORAT (Fh 1889 to Fh 1893) D3, D5, D7, D9, D11;
164. NATRIUM MURIATIC (Fh 1894 to Fh 1914) D1, D3, D4, Tr. 6, Tr. 7, Tr. 8, Tr. 9, D6, D11, D12, D15, D20, D25, D30, D40, D50, C198, C999, C1000;
165. NATRIUM NITRIC (Fh 1915 to Fh 1918) D1, D2, D3;
166. NATRIUM PHOSPHORIUM (Fh 1919 to Fh 1926) T1, D2, D4, D7, D8, D9, D10, D11;
167. NATRIUM SALICYLIC (Fh 1927) T2;
168. NATRIUM SULFURIC (Fh 1928 to Fh 1943, Fh 2829) D2, D4, D5, D8, D11, D18, D22, D26, D29, D39, D49, D59, D60, C198, C199, T2;
169. NATRIUM VANADIC (Fh 1944);
170. OXALIS ACID (Fh 2006 and Fh 2007) Ɵ, D3;
171. PALADIUM (Fh 2013 to Fh 2015) D4, C28, C29;
172. PETROLEUM (Fh 2029 to Fh 2043) Ɵ, D3, D4, D5, D6, D8, D9, D10, D11, D19, C28, C29, C30;
173. PHOSPHOR (Fh 2046 to Fh 2053) D6, C198, C199;
174. PICRON ACID (Fh 2064) Ɵ;
175. PLATINA (Fh 2077 to Fh 2086) D3, C5, D4, D5;
176. PLATIN MUR. (Fh 2830 to Fh 2834) D2, T3, D4, D6;
177. PLUMBUM (Fh 2087 to Fh 2090) C28, C29, C198, C199;
178. PLUMBUM ACETIC (Fh 2091 and Fh 2092) D6, D7;
179. PLUMBUM JODAT (Fh 2093 and Fh 2094) D2, T5;
180. PLUMBUM METALIC (Fh 2095 to Fh 2098) D3, D6, C12, D20;
181. PLUMBUM PRAEP. (Fh 2099) D20;
182. PYRETUM (Fh 2158) Ɵ;
183. PYRIT (Fh 2159 to Fh 2162) Ɵ, D1, D3;
184. QUARTZ (Fh 2175 to Fh 2185, Fh 2805) D6, D7, D8, D10, D12, D14, D15, D20, D22, D24;
185. QUARTZOL 1% (Fh 2186 to Fh 2188);
186. RADIUM BROMATE (Fh 2192 and Fh 2193) D17, D28;
187. SELENIUM (Fh 2350 to Fh 2359) D4, D6, D8, D9, D10, D12, D14, C29, C100, C149;
188. SILICEA (Fh 2393 to Fh 2412) D1, D2, D3, C4, D4, D5, D6, D8, D9, Tr. 5, Tr.7, Tr. 9, D11, D28, D29, D39, D49, C198, C199;
189. SILICEA OLIGOPLEX (Fh 2413) D3;
190. STANNUM (Fh 2450 to Fh 2458) D2, D4, D8, D9, D11, D12, D14, D28;
191. STANNUM METALL COLL. (Fh 2459 and Fh 2460) D6, D7;
192. STANNUM JODAT. (Fh 2461 and Fh 2462) D3;
193. STANNUM METALL. (Fh 2463 to Fh 2467) D1, D7, D8, D9, D10;
194. STIBIUM ARSENICOS (Fh 2905 and Fh 2906) D4;
195. STIBIUM PRAEP. (Fh 2484 to Fh 2486) D6;
196. STIBIUM SULFUR. AUR. (Fh 2487 to Fh 2489) D3, D4;
197. STRICNINUM PHOSPH. (Fh 2907) D3;
198. SULFUR (Fh 2512 to Fh 2540) D2, Ɵ=D4, Tr. 5, Tr. 8, Tr. 9, Tr. 11, Tr. 13, Tr. 15, Tr. 17, Tr. 18, D6, D12, D15, D28, D29, D100, C195, C198, C199;

199. SULFUR COLOID. (Fh 2541) D3;
200. SULFUR JODAT (Fh 2542 to Fh 2557) Ɵ, D1, C4, D4, D5, Tr. 5, D6, D11, D12, D19, C28, D29, C29, C198, C199, C200;
201. TARTARUS EMETIE (Fh 2632 and Fh 2633) D5, D6;
202. TARTARUS STIBIAT (Fh 2634 to Fh 2645) D1, D2, D3, D4, D5, D6, D7;
203. TELURIUM (Fh 2646) D3;
204. THALLIUM ACET. (Fh 2661 to Fh 2664) D4, D6;
205. THALLIUM PHOSPHOR. (Fh 2665) D5;
206. URANIUM NITRIC. (Fh 2730 to Fh 2736) Ɵ, D2, D3, C28, C29, C198, C199;
207. ZINCUM (Fh 2790 to Fh 2792) C28, C29, C30;
208. ZINCUM CYANATI (Fh 2908 and Fh 2909) D3, D8;
209. ZINCUM METALLIC (Fh 2793);
210. ZINCUM PICRINIC (Fh 2794) D3;
211. ZINCUM PHOSPHOR. (Fh 2910) D2;
212. ZINCUM SULFURIC. (Fh 2795) D4;
213. ZINCUM VALERIANIC (Fh 2796 to Fh 2799) D2, D3, T4, D6;
214. ZINNOBER (Fh 2806) D20;

Discussions

Following the inventory, we can assert that in our museum collection are found all of Scholten's groups of homeopathic mineral remedies and thus enhancing its importance for future studies and references.

According to the names of the remedies we have listed 214 substances of various mineral origins.

Following the study performed on groups of mineral remedies, it can be seen that the highest number of dilutions are found in the group of Calcium and Potassium; they represent 13% of all remedies. Also in quite high percentages are found the remedies from the group of Mercury - 12% and from the group of Sodium - 11%. The Sulfur group also has numerous dilutions, but in a lower percentage of 7%, the group is followed by that of Iron which represents 6% of the total remedies. The least dilutions are found in the groups: Barium group - 4%, Gold group 3% and Zinc group 2%, and Iodine Group have dilutions in proportion of 1% (Tutelea 2018, 48).

REFFERENCES

Dannenfeldt, 1984 — Dannenfeldt Karl H., *The introduction of a new sixteenth-century drug: Terra Silesiaca*. In: *Medical History*, 28 (1984), pp. 174-188.

Duffin, 2006 — Duffin Christopher J., *Stones for the Stone: minerals and fossils in the treatment of renal calculi*. In: *Pharmaceutical Historian, British Society for the History of Pharmacy*, Vol. 36, no. 4, Leicester (2006), pp. 56-60.

Duffin *et al*., 2013 — Duffin Christopher J., Moody R.T.J., Gardner-Thorpe C., *A history of Geology and Medicine*. Geological Society of London (2013), p. 512.

Duffin, 2014 — Duffin Christopher J., *The pharmaceutical use of Lapis Lazuli in the Ancient East*. In: *Pharmaceutical Historian, British Society for the History of Pharmacy*, Vol. 44 No. 4, Leicester (2014), pp. 84-87.

Duffin, 2016 — Duffin Christopher J., *Amber as a component of palaeontological pharmacology*. In: *Polyakova, I. A., Duffin, C. J. & Suvorova, T. J. eds. Amber in the history of medicine: Proceedings of the International Conference*. *Kaliningrad Regional Amber Museum* (2016), pp. 95-132.

Duffin, 2018 — Duffin Christopher J., *The Historical Roles of Mineral Materials in Folk Medicine and the Development of the Materia Medica*. Abstract of Ph.D. Thesis, University of Kingston, London (2018), p. 47.

Duffin, 2019 — Duffin Christopher J., *British eighteenth century Materia Medica collections*. In: *Collection in the space of culture: Proceedings of the International Conference* / eds. I. A. Polyakova, Ch. J. Duffin, T. J. Suvorova ; Kaliningrad Regional Amber Museum. — Kaliningrad (2019), p. 105-125.

Duffin, 2020 — Duffin Christopher J., *Fifteenth century magico-medicinal minerals*. https://depositsmag.com/2020/05/30/fifteenth-century-magico-medicinal-minerals/?subscribe=success.

Hendriksen, 2018 — Hendriksen Marieke M. A., *Boerhaave's Mineral Chemistry and Its Influence on Eighteenth-Century Pharmacy in the Netherlands and England*, In: *Ambix*, 65:4 (2018), pp. 303-323, DOI: 10.1080/00026980.2018.1488099.

Laudato *et al*., 2013 — Laudato Massimiliano, Pescitelli Luigi and Capasso Raffaele, *Natural Products of Mineral Origin*. In: *Natural Product Communications* Vol. 8, no. 3 (2013), pp. 419-423.

Lockie, 2006 — Lockie Andrew, *Encyclopedia of Homeopathy*, D. Kindersley Pub. (2006), p. 336.

Oliveira *et al*., 2015 — Oliveira Rui, Ferraz André, Pinto Andreia, Gonçalves Carlos, Valério José, Aguiar Rodrigo, Almeida Sara, Velez Zéli, *Insights of the Sensation in Homeopathic Mineral Kingdom*. In: *International Journal of Homeopathy & Natural Medicines*. Vol. 1, No. 2 (2015), pp. 22-27. DOI: 10.11648/j.ijhnm.20150102.11

Scholten, 2013 — Scholten Jan, *Homeopathy and Minerals*. Alonnissos Verlag, Germany (2013), pp. 1-296.

Spałek and Spielvogel, 2019 — Spałek Krzysztof and Spielvogel Izabela, The Use of Medicinal Clay from Silesia "Terra sigillata Silesiaca", Central Europe - A New Chance for Natural Medicine?. In: Biomedical, Journal of Scientific and Technical Research, Vol. 20, Issue 3 (2019), BJSTR. MS.ID.003457.

Tutelea, 2018 — Tutelea Carmen-Maria, *Remedii homeopatice de natură minerală, din colecția Muzeului de Istorie a Farmaciei din Sibiu* (2018), lucrare de licență (Universitatea "Lucian Blaga" din Sibiu, Facultatea de Medicină "Victor Papilian",

specializarea Farmacie), pp. 1-75.

Venieri *et al*., 2020 — Venieri Danae, Gounaki Iosifina, Christidis George E., Knapp Charles W., Bouras-Vallianatos Petros, Photos-Jones Effie, *Bridging the Gaps: Bole and Terra Sigillata as Artefacts, as Simples and as Antibacterial Clays*. In: *Minerals*, 10, 348 (2020), pp.1-11, www.mdpi.com/journal/minerals.

LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1- 4: Wooden pharmaceutical jar dated 18th century: 1- including Lapis Lazuli remedy (inventory number F 1494), 2 - including Terra Sigillata remedy (inventory number F 580), 3 - including Terra Tripolit remedy (inventory number F 832), 4 - including *Terra Lemnia* remedy (inventory number F 805).,

a.

b.

c.

d.

Fig. 5 (a, b, c, d). Vials from the museum homeopathic collection.

BENEFICIAL INSECTS IN PEST CONTROL FROM THE NATURAL HISTORY MUSEUM OF SIBIU ENTOMOLOGICAL COLLECTIONS

Iulia MUNTEAN*

Abstract. *Beneficial insects acting as biological control agents are very useful for organic agriculture and maintaining biocenotic balances. These insect species act as predators to eliminate natural pests. In this way, they help maintain healthy and well-balanced ecosystems. There are specimens of these species in Entomological Collections from the Natural History Museum of Sibiu, namely: Calosoma sycophanta (Linnaeus, 1758), Nebria brevicollis (Fabricius, 1792), Abax parallelepipedus (Piller & Mitterpacher, 1783), Amara aenea (De Geer, 1774), Thanasimus formicarius (Linnaeus, 1758), Coccinella septempunctata Linnaeus, 1758, Mantis religiosa, Megascolia maculata flavifrons (Fabricius, 1775) and Formica rufa Linnaeus, 1761. The present paper contains a check-list with 9 beneficial insects, accompanied by a description of what they are useful for, what species and agricultural crops are protected, what species are attacked and their presence in entomological collections.*
Keywords*: beneficial insects, predators, pests, check-list, Entomological Collections, Sibiu.*

Rezumat. *Insectele benefice, acționând ca agenți de control biologic, sunt foarte utile pentru agricultura ecologică și menținerea echilibrelor biocenotice. Aceste specii de insecte sunt prădători care elimină dăunătorii naturali. În acest fel, ele ajută la menținerea ecosistemelor sănătoase și bine-echilibrate. Există exemplare ale acestor specii în Colecțiile Entomologice ale Muzeului de Istorie Naturală din Sibiu, și anume: Calosoma sycophanta (Linnaeus, 1758), Nebria brevicollis (Fabricius, 1792), Abax parallelepipedus (Piller & Mitterpacher, 1783), Amara aenea (De Geer, 1774), Thanasimus formicarius (Linnaeus, 1758), Coccinella septempunctata (Linnaeus, 1758), Mantis religiosa (Linnaeus 1758), Megascolia maculata flavifrons (Fabricius, 1775) și Formica rufa (Linnaeus, 1761). Prezenta lucrare conține o listă de verificare a 9 specii de insecte benefice, însoțită de descriere pentru utilitatea lor, speciile sau culturile agricole protejate, speciile atacate, prezența lor în colecțiile entomologice.*
Cuvinte cheie: *insecte benefice, prădători, dăunători, listă de verificare, Colecțiile Entomologice, Sibiu*

Introduction

Global agricultural systems feed over 7 billion people. They, also, generate multiple causes of environmental degradation: being responsible for 25 - 33% of greenhouse gases (Steinfeld *et al.* 2006, Edenhofer *et al*. 2014, Tubiello *et al.* 2014); occupying 40% of the land area (FAO 2016a); representing >70% of freshwater withdrawals (Molden 2007). Moreover, they cause also deforestation and habitat fragmentation (Ramankutty, Foley 1999) and biodiversity loss (IUCN 2016).

Organic agriculture has a lower impact on the environment compared to conventional systems, including through natural pest control methods (Clark, Tilman 2017). Biological control is used in management strategy for reduction of pest populations by natural enemies (Waller, 2006).

* Brukenthal National Museum, Natural History Museum, Sibiu, Romania, iuliamaria.muntean@yahoo.com

This natural control is also made by insect species such as predators, parasitoids and pathogens (Eilenberg *et al.*, 2001).

Insecta (Arthropoda: Hexapoda) represents the largest and the most diverse group of animals, comprised of over 1 million species (Chapman 2006). They can be found in almost all environments. Insects offer various benefits for human societies: they are pollinators (Wratten *et al.* 2012), producing honey and silk (Ratcliffe *et al.* 2011), they are a source of nutrients (Williams *et al.* 2016), preying on different pests, especially insects (Getanjaly *et al.* 2015).

Insects can act as biological control agents in agricultural systems to eliminate natural pests (Getanjaly *et al.* 2015). Insects function as predators, they hunt, attack, kill, and consume harmful species (James 2014). Beneficial insects help to maintain healthy biological systems, functioning efficiently. A healthy biological systems is defined by high biodiversity (Walker

1992), a balanced biotope-biocenosis interaction, basic elements (producers, consumers, decomposers), rich agricultural production, freshwater resources, minimal anthropogenic impact, natural control of pests, (Assessment 2005), homeostasis (Costanza, Mageau 1999), energy flow (Odum 1971).

Beneficial Insects Used As Biological Control Agents

Calosoma sycophanta (Linnaeus, 1758) (Coleoptera: Carabidae) (Fig. 1.) is an important predator in European countries. Populations of this species are numerous during caterpillar invasions (Gîdei, Popescu 2012). *Calosoma sycophanta* feeds on *Lymantria dispar* (Linnaeus, 1758) and *Euproctis chrysorrhoea* (Linnaeus, 1758) in larval and pupal stages, which are polyphagous pests (Burgess 1911). They consume leaves from *Malus pumila* Mill. 1768, *Acer platanoides* L. and *Quercus robur* L.,1753. In New England, *Calosoma sycophanta* was successfully introduced 13 adults and 14 larval colonies from 1906 to 1908 by Dr. L. O. Howard and Mr. W. F. Fiske (Burgess, Collins 1917). This beetle is used for biological control of Lepidoptera pests.

Nebria brevicollis (Fabricius, 1792) (Coleoptera: Carabidae) (Fig. 2.) lives in wetlands, in hilly or plain areas. The species is nocturnal predatory, feeding on earthworms, mites, Opiliones, spiders, Collembola, various small insects, including Coleoptera (Elateridae), Diptera (Anthomyiidae), Lepidoptera (small caterpillars). This carabid is present in crops in the autumn and winter in significant numbers (Desender, Pollet 1987). The predatory power of this beetle is currently evaluated in terms of the proportion of a population consuming prey and the quantity of prey consumed per predator (Garcia *et al.* 2000). *Nebria brevicollis* can colonize rapidly and massively new habitats, even in transformed habitats such as parks, gardens, hedges, degraded postindustrial areas and field (Radawiec, Aleksandrowicz 2016).

Abax parallelepipedus (Piller & Mitterpacher, 1783) (Coleoptera: Carabidae) (Fig. 3.) can be biological control agent. This polyphagous carabid beetle decreases the populations of slugs like as *Deroceras reticulatum* (O. F. Müller, 1774), *Limax* sp., *Arion hortensis* Férussac, 1819 (Symondson, Liddell 1993). The slugs attack a variety of vegetables (*Daucus carota, Pisum sativum, Brassica oleracea*), fruits (*Fragaria* sp., *Malus pumila* Mill, 1768) and flowers (*Leucanthemum vulgare* Lam., *Iris* L., 1753). This beetle has effects of crop development; it is capable of controlling agricultural pests (Symondson 1993).

Amara aenea *(*De Geer, 1774) (Coleoptera: Carabidae) (Fig. 4.) or common sun beetle is a heliophilous species, inwellind in sunny areas. *A. aenea* is often seen on bare ground, which is found in dry habitats, including gardens, wasteland and grassland. The species is one of the most frequent predator of the apple maggot (Allen, Hagley 1990), *Rhagoletis pomonella* (Walsh, 1867) (Diptera: Tephritidae). The apple maggot is a harmful of many types of fruits (mainly apples), considered pest by the agriculture industry. Also, the carabid is predatory on egg populations of *Sitona hispidus* (Fabricius, 1776) (Coleoptera: Curculionidae), the larvae of this species feeding on the root of *Medicago sativa* L., 1753 (Quinn, Hower 1987).

Thanasimus formicarius (Linnaeus, 1758) (Coleoptera: Cleridae) (Fig. 5.) or ant beetle is one of the best known predators of bark beetles (Weslien, Regnander 1992). The source of the name is the resemblance to the shape and color of the ant body of the genus *Mutilla* Linnaeus1 1758; which are known for painful stings. The species indwells in coniferous forests, under the trees bark. Cleridae family includes the most important bark beetles predators (Costello 2003). *T. formicarius* are used as biological control agents for harmful forest beetles (Curculionidae: Scolitynae). The ant beetle responds to racemic ipsdienol and ipsenol and (S)-cis-verbenol; which are the pheromones of *Ips typographus* (Linnaeus, 1758) (Bakke, Kvamme 1981). Predators beetles have a an important impact on bark beetle populations, thus decreasing the number of infested trees.

Coccinella septempunctata Linnaeus, 1758 (Coleoptera: Coccinellidae) (Fig. 6.) or lady bird beetle is considered to be an important predator for aphids, white flies, jassids and small Lepidoptera larvae (species harmful to agricultural crops). Lady bird beetle, native of Asia, is a natural enemy of aphids which cause strong infestation of plants. *C. septempunctata* is used as biological control agent for controlling aphid populations (Zhu, Park 2005). This aphidophagous species is common in agricultural habitats, it feeds on aphids before laying eggs (Lebusa 2004). Individual variation within populations of lady bird beetles ensures success on aphid population dynamics in both native and introduced habitats (Hodek, Michaud 2013).

Mantis religiosa (Linnaeus, 1758) or European mantis (Mantodea: Mantidae) (Fig. 7.) has extremely voracious predatory behavior. *M. religiosa* has a special feature: it can turn its head at 180 degrees to increase the field of attack. Camouflage expert, *M. religiosa* feeds on species of the order Orthoptera (*Melanoplus femurrubrum* (De Geer 1773)), Lepidopdera (*Lymantria dispar* (Linnaeus, 1758) caterpillar) and of superfamily Apoidea. *Mantis religiosa* limits the spread of harmful insects from agricultural crops. This species polygamous is known for cannibalism of the female towards the male, the consequences depend on whether this takes place before or after mating (Prokop, Vaclav 2005).

Megascolia maculata flavifrons (Fabricius, 1775) (Hymenoptera: Scoliidae), (Fig. 8.), known as the mammoth wasp, is the largest wasp in Europe. The subspecies is frequently found in the Mediterranean basin. The social wasps are effective predators that can control pests of crops (Gomes, Noll 2009), for example for *Zea mays* L. and *Saccharum officinarum* L. Dr. Robin Southon (UCL Centre for Biodiversity & Environmental Research) is of the opinion that they can be used on farms against agricultural pests, less damage occurred when wasps were present. The use of native species tends to be more sustainable, as it preserves local biodiversity (Prezoto, Nascimento 1999). Dr. Seirian Sumner (UCL Center for Biodiversity & Environment Research) stated that "*By using chemicals to kill pests, we're often also killing the very insects that can provide us with natural forms of pest control, and that's what social wasps are doing. It's about making the most of what you already have around you*."

Formica rufa Linnaeus, 1761 (Red Wood Ant) *(*Hymenoptera*:* Formicidae) (Fig. 9.) indwells in forest habitats, they have red head and thorax. Predators *F. rufa* control the populations of forest pests. *Formica rufa* groups attack defoliators (*Operophtera brumata* L.), aphid species (*Drepanosiphum platanoidis* Schr.; *Periphyllus testudinaceus* Fernie), Diptera (mainly Bibionidae) (Skinner, Whittaker 1981). *Formica rufa* has an aggressive behavior, it hunts in trees and on the forest floor. Red Wood Ants, a prominent group in the boreal forests of Eurasia, use honeydew and insects and small invertebrates as their food source (Kilpeläinen *et al.* 2007). *Formica rufa* groups build large aboveground mounds using organic floor material and resin. Thus, the mound material will provide nutrients in forest floor (Domisch *et al.* 2008), withal it has a role in aerating the soil.

Material

The work is based to material of Entomological Collections from the Natural History Museum of Sibiu The list of the beneficial insects in agricultural systems from the Entomological Collections is given bellow.

Calosoma sycophanta (Linnaeus, 1758):
Transylvanian Society for Natural Sciences collection

1 spec as *Calosoma sycophanta* L. (Inventory no 323 – 386), Sibiu, 1898, leg. v. Kimakowicz; 1 spec as *Calosoma sycophanta* L. (Inventory no 324 – 387), Sibiu, leg. Kimakowicz; 1 spec as *Calosoma sycophanta* L. (Inventory no 325 – 388), Kr. Hangestein, Kronstadt (Brașov), leg. Deubel; 1 spec as *Calosoma sycophanta* L. (Inventory no 326 – 389), Reghin (Sz. Reg.), leg. Birthler; 1 spec as *Calosoma sycophanta* L. (Inventory no 327 – 390), Reghin (Sz. Reg.), 1886; 1 spec as *Calosoma sycophanta* L. (Inventory no 328 – 391), Mehadia; 1 spec as *Calosoma sycophanta* L. (Inventory no 329 – 392), Movila, 15.07.1925, leg. Silbernagel; 1 spec as *Calosoma sycophanta* L. (Inventory no 330 – 393), Dobrogea, Kavarna, Mihalbeital (Valea Mihalbei), April 1924, leg. Lepsi.

Dr. Eugen Worell Entomological collection

2 specs as *Calosoma sycophanta* L., Hst Vf., 7.6.55; 3 specs as *Calosoma sycophanta* L., Hst Vf., 07.05.1955; 5 specs as *Calosoma sycophanta* L., Dobrudscha, Tekirghiol (Techergiol), 06.1932, leg. Dr. E. Worell; 1 spec as *Calosoma sycophanta* L., Herkules Bad (Herculane), 06.1928; 1 spec as *Calosoma sycophanta* L., Mehadia; 1 spec as *Calosoma sycophanta* L., Kousol; 1 spec as *Calosoma sycophanta* L., Herkules Bad (Herculane), 06.1927; Grădină Sibiu, 29.06.1956, leg. Dr. Worell.

Dr. Karl Petri collection of Palaearctic and exotic beetles

1 spec as *Calosoma sycophanta* L., 1891, leg. Csernovitz; 1 spec as *Calosoma sycophanta* L., Mehadia, 1891; 2 specs as *Calosoma sycophanta* L., KauKasus (The Caucasus); Siechenno, 06.1892.

Dr. Eckbert Schneider Entomological collection
1 spec as *Calosoma sycophanta* L., Sibiu, Dumbrava, 30.05.1968/1, leg. E. Schneider; 1 spec as *Calosoma sycophanta* L., Mt Buila – Vânt (The Buila-Vânturarita Massif), 6-10.07.1964, leg. E. Schneider.

Nebria brevicollis (Fabricius, 1792)

Transylvanian Society for Natural Sciences collection

2 specs as *Nebria brevicollis* (Inventory no 1775 – 2108, 1779 – 2109), Bohemia (C.S.S.R.), 1895, leg. Birthler; 1 spec as *Nebria brevicollis* (Inventory no 1777 – 2110); 3 specs as *Nebria brevicollis* (Inventory no 1778 – 2111, 1779 – 2112, 1780 – 2113); Tavarnok – comună (Ungaria), leg. Kelecsenyi; 1 spec as *Nebria brevicollis* (Inventory no 1781 – 2114), Banat, 1895, leg. Birthler; 1 spec as *Nebria brevicollis* (Inventory no 1782 – 2115), 1890, leg. Deubel; 1 spec as *Nebria brevicollis* (Inventory no 1783), Crimea (U.R.S.S.), 10.09.1942, leg. Buertmes.

Dr. Eugen Worell Entomological collection

21 specs as *Nebria brevicollis*; 4 specs as *Nebria brevicollis*, Gotzenberg, 07.1925; 5 specs as *Nebria brevicollis*, Landskrone, Talmesch, 04.1925

Abax parallelepipedus (Piller & Mitterpacher, 1783)

Transylvanian Society for Natural Sciences collection

1 spec as *Abax ater* (Inventory no 5342 – 5048), Germania, det. Birthler 1895; 1 spec as *Abax ater* (Inventory no 5343 – 5049), Silezia, 05.05.1889, leg. v. Kimakowicz 1895; 1 spec as *Abax ater* (Inventory no 5344 – 5050), Silezia, 05.1889, leg. V. Kimakowicz 1895; 1 spec as *Abax ater* (Inventory no 5345 – 5051), Silezia, 1891, leg. V. Kimakowicz 1895; 1 spec as *Abax ater* (Inventory no 5346 – 5052), Austria inferioară, 07.1890, leg. V. Kimakowicz 1895; 1 spec as *Abax ater* (Inventory no 5347 – 5053), Austria superioară, 10.10.1890, leg. V. Kimakowicz 1895; 1 spec as *Abax ater* (Inventory no 5348 – 5054), Aufsee (Austria), det. Birthler 1895; 1 spec as *Abax ater* (Inventory no 5349 – 5055), Pecs; 1 spec as *Abax ater* (Inventory no 5350 – 5056), Mehadia, det. Birthler 1895; 1 spec as *Abax ater* (Inventory no 5351 – 5057), Transilvania, 1858, leg. E. A. Bielz; 1 spec as *Abax ater* (Inventory no 5352 – 5058), Transilvania, 1858, leg. E. A. Bielz; 1 spec as *Abax ater* (Inventory no 5353 – 5059), Turda, 10.08.1889, leg. V. Kimakowicz 1895; 1 spec as *Abax ater* (Inventory no 5354 – 5060), Tușnad, 08.1889, leg. V. Kimakowicz 1895; 1 spec as *Abax ater* (Inventory no 5355 – 5061), Vârghiș, leg. F. Deubel; 1 spec as *Abax ater* (Inventory no 5356 – 5062), Vârghiș, leg. F. Deubel; 1 spec as *Abax ater* (Inventory no 5357 – 5063), Brașov, det. Birthler 1895; 1 spec as *Abax ater* (Inventory no 5358 – 5064), Brașov, det. Birthler 1895; 1 spec as *Abax ater* (Inventory no 5359 – 5065), Postăvarul, 30.06.1900, leg. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5360 – 5066), Postăvarul, leg. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5361 – 5067), Postăvarul, leg. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5362 – 5068), Postăvarul, leg. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5363 – 5069), Munții Bucegi, Valea Jeppi, 1900, leg. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5364 – 5070), Munții Bucegi, Valea Jeppi, 1900, leg. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5365 – 5071), Munții Bucegi, Valea Jeppi, 1900, leg. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5366 – 5072), Munții Bucegi, Valea Jeppi, 1900, leg. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5367 – 5073), Munții Bucegi, leg. R. Albrecht; 1 spec as *Abax ater* (Inventory no 5368 – 5074), Munții Bucegi, leg. R. Albrecht; 1 spec as *Abax ater* (Inventory no 5369 – 5075), Munții Bucegi, leg. R. Albrecht; 1 spec as *Abax ater* (Inventory no 5370 – 5076), Munții Buzăului, Valea Doblen, 1889; 1 spec as *Abax ater* (Inventory no 5371 – 5077), Cârțișoara, 1889, leg. V. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5372 – 5078), Negoi, 08.1890, leg. V. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5373 – 5079), Munții Făgărașului, leg. R. Albrecht; 1 spec as *Abax ater* (Inventory no 5374 – 5081), Măgura Cisnădiei, leg. V. Kimakowicz; 1 spec as *Abax ater* (Inventory no 5375 – 5082), Preșba, leg. V. Kimakowicz.

Dr. Eugen Worell Entomological collection

1 spec as *Abax ater*; 4 specs as *Abax ater*, Rosenauer Burg, 04.05.1943, leg. Worell; 13 specs as *Abax ater*.

Dr. Karl Petri collection of Palaearctic and exotic beetles

3 specs as *Abax ater*, Wessphablen, Schenbel, 06.1892; 1 spec as *Abax ater*, Bistra, Muhlbach, 06.1907, leg. Petri.

Dr. Eckbert Schneider Entomological collection

5 specs as *Abax ater*, Șura Mare, Sibiu, 19.04.1972, leg. Schneider; 4 specs as *Abax ater*, Șura Mare, Sibiu, 30.04.1972, leg. Schneider; 2 specs as *Abax ater*, Șura Mare, Sibiu, 14.05.1972, leg. Schneider; 1 spec as *Abax ater*, Moldova merid., Tecuci, 10.05.1975; 1 spec as *Abax ater*, Trans. Merid., Șura Mare, 28.07.1972; 1 spec as *Abax ater*, Șura Mare, Sibiu, 07.08.1972, leg. Schneider; 1 spec as *Abax ater*, Moldova merid., Tecuci, 30.05.1975;

Amara aenea *(*De Geer, 1774)

Transylvanian Society for Natural Sciences collection

1 spec as *Amara aenea* (Inventory no 5085 – 4805), Italia (Lombardia), 1858, leg. E. A. Bielz; 1 spec as *Amara aenea* (Inventory no 5086 – 4806), Italia (Lombardia), 1858, leg. E. A. Bielz; 1 spec as *Amara aenea* (Inventory no 5087 – 4807), Italia (Lombardia), 1858, leg. E. A. Bielz; 1 spec as *Amara aenea* (Inventory no 5088 – 4808), Bohemia, det. Birthler 1895; 1 spec as *Amara aenea* (Inventory no 5089 – 4809), Banat, det. Birthler 1895; 1 spec as *Amara aenea* (Inventory no 5090 – 4810), Transilvania, 1858, leg. E. A. Bielz; 1 spec as *Amara aenea* (Inventory no 5091 – 4811), Transilvania, 1858, leg. E. A. Bielz; 1 spec as *Amara aenea* (Inventory no 5092 – 4812), Cehul Silvaniei, leg. Dr. E. Kiss; 1 spec as *Amara aenea* (Inventory no 5093 – 4813), Zalău, leg. Dr. E. Kiss; 1 spec as *Amara aenea* (Inventory no 5094 – 4814), Hodod, leg. Dr. E. Kiss; 1 spec as *Amara aenea* (Inventory no 5095 – 4815), Reghin, leg. Birthler; 1 spec as *Amara aenea* (Inventory no 5096 – 4816), Brașov, 1889, leg. V. Kimakowicz; 1 spec as *Amara aenea* (Inventory no 5097 – 4817), Brașov, 1889, leg. V. Kimakowicz; 1 spec as *Amara aenea* (Inventory no 5098 – 4818), Hărman, leg. F. Deubel; 1 spec as *Amara aenea* (Inventory no 5099 – 4818), Hărman, leg. F. Deubel; 1 spec as *Amara aenea* (Inventory no 5100 – 4819), Măeruș, 1886, leg. Dr. K. Petri; 1 spec as *Amara aenea* (Inventory no 5101 – 4820), Sighișoara, 1898, leg. Dr. K. Petri; 1 spec as *Amara aenea* (Inventory no 5102 – 4821), Sighișoara, 09.06.1889, leg. V. Kimakowicz 1895; 1 spec as *Amara aenea* (Inventory no 5103 – 4821), Sighișoara, 09.06.1889, leg. V. Kimakowicz 1895; 1 spec as *Amara aenea* (Inventory no 5104 – 4822), Sibiu, 1883, leg. V. Kimakowicz 1895; 1 spec as *Amara aenea* (Inventory no 5105 – 4823), Sibiu, 25.05.1887, leg. V. Kimakowicz 1895; 1 spec as *Amara aenea* (Inventory no 5106 – 4824), Ocna Sibiului, leg. R. Albrecht.

Dr. Eugen Worell Entomological collection

2 specs as *Amara aenea*, Hermannstadt, 05.1924, leg. Worell, det. Hieke 1973; 16 specs as *Amara aenea*, Hermannstadt (Sibiu), 1923, leg. Worell, det. Hieke 1973; 3 specs as *Amara aenea*, Hercules-Bad (Herculane), 06.1929, leg. Worell, det. Hieke 1973; 8 specs as *Amara aenea*, Chișinău, leg. Worell, det. Hieke 1973; 1 spec as *Amara aenea*, Hermannstadt (Sibiu), 05.1932, leg. Worell, det. Hieke 1973; 3 specs as *Amara aenea*, Sibiu, leg. Worell, det. Hieke 1973; 5 specs as *Amara aenea*, Dobrudscha, Carmen Sylva, Juni 1931, leg. Worell, det. Hieke 1973.

Dr. Karl Petri collection of Palaearctic and exotic beetles

1 spec as *Amara aenea*, Retjezat (Retezat Mountains), 1894, leg. Petri; 1 spec as *Amara aenea*, Retjezat (Retezat Mountains), 1894, leg. Petri, det. Hieke 1973; 1 spec as *Amara aenea*, Schassbg., leg. Petri, det. Hieke 1973; 1 spec as *Amara aenea*, Schassbg. (Sighișoara), 29.06.1900, leg. Petri, det. Hieke 1973; 1 spec as *Amara aenea*, Urals, Russia, leg. Petri, det. Hieke 1973; 1 spec as *Amara aenea*, Maros-Ujvar (Ocna Mureș), 1907, leg. Petri, det. Hieke 1973.

Thanasimus formicarius (Linnaeus, 1758)

Transylvanian Society for Natural Sciences collection

1 spec as *Thanasimus formicarius* L. (Inventory no 17.010), Bușteni, leg. Deubel; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.011), Bușteni, leg. Deubel; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.012), Bușteni, leg. Deubel; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.013), Bușteni, leg. Deubel; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.014), Rareul (Rarău Mountains); 1 spec as *Thanasimus formicarius* L. (Inventory no 17.015), 08.1887; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.016), Pietrosul; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.017), Siebenburgen (Transilvania), Fogarascher Geb., leg. R. Albrecht; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.018), Germ., leg. Birthler 1895; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.019), Ban, 30.03.1884, leg. Birthler 1895; 1 spec as *Thanasimus formicarius* L. (Inventory no 17.020), Ban.

Dr. Karl Petri collection of Palaearctic and exotic beetles

1 spec as *Thanasimus formicarius* L., Ritivoi, 1892, det. Kurzeluk; 1 spec as *Thanasimus formicarius* L., Bistra, 07.1907, det. Kurzeluk; 3 specs as *Thanasimus formicarius* L., Schassbg. (Sighișoara), 10.05, det. Kurzeluk; 1 spec as *Thanasimus formicarius* L., Sb. Scheuereberg, 23.05.1896; 1 spec as *Thanasimus formicarius* L., Sb., 06.1867.

Coccinella septempunctata *Linnaeus, 1758*

Transylvanian Society for Natural Sciences collection

3 specs as *Coccinella septempunctata* L. (Inventory no 19.801 – 19.803), Artek - Jalta, Krim., 13.05.943, H. Buerues; 1 spec as *Coccinella septempunctata* L. (Inventory no 19.804), Hammersdorf (Gușterița), 03.05.1889, leg. Kimakowicz; 1 spec as *Coccinella septempunctata* L. (Inventory no 19.805), Hammersdorf (Gușterița), 09.05.1889, leg. Kimakowicz.

Dr. Eugen Worell Entomological collection
6 specs as *Coccinella septempunctata* L., Sibiu; 11 specs as *Coccinella septempunctata* L., Buller Tal, 08.1925; 1 spec as *Coccinella septempunctata* L., Împrejurimile Sibiului; 4 specs as *Coccinella septempunctata* L., Constanța, 10.1925; 3 specs as *Coccinella septempunctata* L., Împrejurimile Sibiului, 24.05.1953; 3 specs as *Coccinella septempunctata* L., Împrejurimile Sibiului, 4.11.1948.

Dr. Karl Petri collection of Palaearctic and exotic beetles

1 spec as *Coccinella septempunctata* L., Thorda; 1 spec as *Coccinella septempunctata* L., Bohmen, Franzmsbad; 1 spec as *Coccinella septempunctata* L., Klausenberg, Marzloff; 1 spec as *Coccinella septempunctata* L., Nussbach, 1886; 1 spec as *Coccinella septempunctata* L., Sighișoara; 1 spec as *Coccinella septempunctata* L., Munții Rodnei.

Mantis religiosa *(Linnaeus, 1758)*

Transylvanian Society for Natural Sciences collection

1 spec as *Mantis religiosa* L., Drăgănești, 25.10.1932; 1 spec as *Mantis religiosa* L., Dunele Ivești, 28.08.1932; 3 specs as *Mantis religiosa* L., Budapest, Kamaraerdoe, 07.09.1927, leg. A. Muller; 1 spec as *Mantis religiosa* L., Brunner, Kophalonia, leg. v. Oertzen; 1 spec as *Mantis religiosa* L., Zante, leg. v. Oertzen; 1 spec as *Mantis religiosa* L., Dobrogea, Agigea, 07.1931, leg. Galinescu; 1 spec as *Mantis religiosa* L., Morea, Olympia, leg. v. Oertzen; 1 spec as *Mantis religiosa* L., Morea, leg. v. Oertzen; 1 spec as *Mantis religiosa* L., Morea; 1 spec as *Mantis religiosa* L., Graecia, Attika, leg. v. Oertzen.

Megascolia maculata flavifrons (Fabricius, 1775)
Transylvanian Society for Natural Sciences collection
1 spec as *Scolia flavifrons*, Langental, 4-15.07.1933, leg. A. Muller; 4 specs as *Scolia flavifrons*, Dobrudscha, Carmen Sylva, Juni 1931, leg. Worell; 1 spec as *Scolia flavifrons*, 15.07.1925; 1 spec as *Scolia flavifrons*, Tecuci; 1 spec as *Scolia flavifrons*, Dobrudscha, Tekirghiol (Techerghiol), Juni 1932, leg. Worell; 1 spec as *Scolia flavifrons*, Bogsan, 28.06.1930; 3 specs as *Scolia flavifrons*, Dobrogea, 07.1927, Spiess; 1 spec as *Scolia flavifrons*, Dobrogea, Kavarna, Mihalbeital, April 1924, leg. Lepsi; 1 spec as *Scolia flavifrons*, Dobrogea, 28.07.1926, leg. A. Muller; 1 spec as *Scolia flavifrons*, Tecuci, Mai 1934, leg. E. Branda; 1 spec as *Scolia flavifrons*, Tecuci, 25.08.1933.

Formica rufa Linnaeus, 1761
Transylvanian Society for Natural Sciences collection

7 specs as *Formica rufa* L., Pokaspass, 3.08.1924, leg. A. Muller; 4 specs as *Formica rufa* L., Petersberg, 17.05.1921; 3 specs as *Formica rufa* L., Hermanstadt (Sibiu), 09.1915, leg. A. Muller; 1 spec as *Formica rufa* L., Retezat Gbg., Riu Maretaler, 20 – 29.08.1930, leg. A. Muller; 1 spec as *Formica rufa* L., Valare, Resinar (Rășinari), 25.05.1930, leg. A. Muller; 1 spec as *Formica rufa* L., Gatzenberg, 03.05.1923, leg. A. Muller; 1 spec as *Formica rufa* L., Hermanstadt (Sibiu), 15.05.1924, leg. A. Muller; 1 spec as *Formica rufa* L., Hermanstadt (Sibiu), 04.1910, leg. A. Muller; 1 spec as *Formica rufa* L., Gatzenberg, 01.04.1921.

Discussions

There are 9 species of beneficial insects used as biological control agents in the entomological collections of the Natural History Museum of Sibiu. These species are found in 4 entomological collections: Transylvanian Society for Natural Sciences collection, Dr. Eugen Worell Entomological collection, Dr. Karl Petri collection of Palaearctic and exotic beetles, Dr. Eckbert Schneider Entomological collection.

Transylvanian Society for Natural Sciences collection contains all 9 species. The best represented species is *Abax parallelepipedus* with 71 specimens. Most of the material was collected from Romania (especially from the south of Transylvania, but also from Dobrogea), Germany, Hungary and Austria.

The nine insects species belongs to three orders: Coleoptera (Carabidae, Cleridae and Coccinellidae families), Mantodea (Mantidae family), Hymenoptera (Scoliiidae and Formicidae families). In the museum's collection, 2 of the species appear with an old name: *Abax*

parallelepipedus (Piller & Mitterpacher, 1783) as *Abax ater* Vill. and *Megascolia maculata flavifrons* (Fabricius, 1775) as *Scolia flavifrons.*

The insects from this work are beneficial for gardens, wasteland, grassland, autumn and winter crops, agricultural crops, agricultural farms, trees and forest floor (Tab. 1.). Using these insects, agricultural practices can cause a lower impact on the environment. At the same time, the products of agricultural crops will be as aiding as possible. In this way, ecological systems continue their natural course: each species fulfills its role.

Acknowledgments

We would like to thank Dr. Florin Prunar for his usefull comments which improved the manuscript. I am grateful for beneficial advices of Ioan Tăușan in writing this paper. Also, special thanks go to Milan Kudlička, František Spilka, Lubomír Klátil, Josef Dvořák, Miroslav Fiala, Louis Laisné, Milan Kořínek for the permission of using their photographs of the species.

REFFERENCES

Allen, Hagley 1990 — Allen, W. R., Hagley, Elmer, *Epigeal arthropods as predators of mature larvae and pupae of the apple maggot (Diptera: Tephritidae)*. In: *Environmental entomology* 19.2 (1990), p. 309-312.

Assessment 2005 — Assessment, Millennium Ecosystem, *Ecosystems and human well-being*, In: *DC: Island press* (2005) Washington , Vol. 5, p. 563

Bakke, Kvamme 1981 — Bakke, Alf, Torstein, Kvamme, *Kairomone response inThanasimus predators to pheromone components ofIps typographus.* In: *Journal of Chemical Ecology* 7.2 (1981), p.305-312.

Burgess 1911 — Burgess, Albert Franklin, *Calosoma sycophanta: its life history, behavior, and successful colonization in New England*. In: *US Department of Agriculture, Bureau of Entomology* (1911)

Burgess, Collins 1917 — Burgess, Albert Franklin, Collins, Charles Walter, *The Genus Calosoma: Including studies of seasonal histories, habits, and economic importance of American species north of Mexico and of several introduced species*. No. 417. In *US Government Printing Office* (1917)

Chapman 2006 — Chapman, Arthur, *Numbers of living species in Australia and the World*. In: *Canberra: Australian Biological Resources Study* (2006).

Clark, Tilman 2017 — Clark, Michael, David Tilman, *Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice.* In: *Environmental Research Letters* 12.6 (2017): 064016.

Costanza, Mageau 1999 — Costanza, Robert, Michael, Mageau, *What is a healthy ecosystem?.* In: *Aquatic ecology* 33.1 (1999): p. 105-115.

Costello 2003 — Costello, Sheryl, *Clerid beetles-voracious predators*. In: *Colorado State University Department of Entomology* (2003): p. 1-15.

Desender, Pollet 1987 — Desender, K., Pollet, M., *Life cycle strategies in the most abundant ground beetles from a heavily grazed pasture ecosystem.* In: *Mededelingen van de Faculteit Landbouwwetenschappen van de Rijksuniversiteit Gent* 52 (1987), p. 191-199.

Domisch *et al*. 2008 — Domisch, Timo, et al., *Decomposition of organic matter and nutrient mineralisation in wood ant (Formica rufa group) mounds in boreal coniferous forests of different age*. In: *Biology and Fertility of soils* 44.3 (2008), p. 539-545.

Edenhofer *et al*. — Edenhofer, Ottmar, ed. *Climate change 2014: mitigation of climate change*. In: *Cambridge*

2014 *University Press* (2015).

Eilenberg *et al.* 2001 Eilenberg, J., A. Hajek, C. Lomer, *Suggestions for unifying the terminology in biological control.*In: *BioControl* 46.4 (2001), p. 387-400.

FAO 2016a FAO 2016a www.faostat.fao.org

Garcia *et al.* 2000 Garcia, Avelina Fernandez, Georgianne Griffiths, George Thomas, *Density, distribution and dispersal of the carabid beetle Nebria brevicollis in two adjacent cereal fields*. In: *Annals of Applied Biology* 137.2 (2000), p. 89-97.

Getanjaly *et al.* 2015 Getanjaly, Vijay Laxmi Rai, Preeti Sharma, Ranjit Kushwaha, *Beneficial insects and their value to agriculture*. In: *Research Journal of Agriculture and Forestry Sciences ISSN* 2320 (2015), 6063.

Gîdei, Popescu 2012 Gîdei, Paul, Popescu, Irinel, *Ghidul coleopterelor din România I*, Ed. *PIM*, (2012) Iaşi.

Gomes, Noll 2009 Gomes, Bruno, Noll, Fernando B., *Diversity of social wasps (Hymenoptera, Vespidae, Polistinae) in three fragments of semideciduous seasonal forest in the northwest of São Paulo State, Brazil.* In: *Revista Brasileira de Entomologia* 53.3 (2009), p. 428-431.

Hodek, Michaud 2013 Hodek, Ivo, Michaud, J. P., *Why is Coccinella septempunctata so successful?(A point-of-view).* In: *EJE* 105.1 (2013), p. 1-12.

IUCN 2016 IUCN 2016 IUCN Red List Threat. Species Version 2016-5

James 2014 James, David G., *Beneficial insects, spiders, and other mini-creatures in your garden: who they are and how to get them to stay* (2014).

Kilpeläinen *et al.* 2007 Kilpeläinen, Jouni, *et al., Carbon, nitrogen and phosphorus dynamics of ant mounds (Formica rufa group) in managed boreal forests of different successional stages.* In: *Applied Soil Ecology* 36.2-3 (2007), p. 156-163.

Lebusa 2004 Lebusa, Makuena Margrett, *Suitablilty of Greenbugs ('Schizaphis Graminum') Parasitized by'Lysiphlebus Testaceipes' as a Food Source for Predatory Coccinellidae:'Coccinella Septempunctata'and'Hippodamia Convergens'*. In: *Diss* (2004).

Molden 2007 Molden, David, ed. *Water for food water for life: A comprehensive assessment of water management in agriculture*. In: *Routledge* (2013).

Odum 1971 Odum, Howard Thomas, *Environment, power and society Wiley* (1971).

Prezoto, Nascimento 1999 Prezeto, Fabio, Nascimiento, Fabio Santos, *Nota sobre a ocorrência de usurpação de um ninho de Mischocyttarus cassununga por Polistes versicolor (Hymenoptera, Vespidae).* In: *Revista de Etologia* 1.1 (1999), p. 69-71.

Prokop, Vaclav 2005 Prokop, Pavol, Vaclav, Radovan, *Males respond to the risk of sperm competition in the sexually cannibalistic praying mantis, Mantis religiosa*. In: *Ethology* 111.9 (2005), p. 836-848.

Quinn, Hower 1987 Quinn, M. A., Hower, A., *Predation of eggs ofSitona hispidulus [Col.: Curculionidae] in alfalfa*. In: *Entomophaga* 32.1 (1987), p. 3.

Radawiec, Aleksandrowicz 2016 Radawiec, Brygida, Aleksandrowicz, Oleg, *Habitat preferences and demographic parameters of Nebria brevicollis (Fabricius, 1792) population in an agricultural landscape*. In: *Periodicum biologorum* 118.3 (2016).

Ramankutty, Foley 1999 Ramankutty, Navin, Foley, Jonathan, *Estimating historical changes in global land cover: Croplands from 1700 to 1992.* In: *Global biogeochemical cycles* 13.4 (1999), p. 997-1027.

Ratcliffe *et al.* 2011 Ratcliffe, Norman, *et al., Insect natural products and processes: new treatments for human disease.* In: *Insect biochemistry and molecular biology* 41.10 (2011), p. 747-769.

Skinner, Whittaker 1981 Skinner, G. J., Whittaker, J. B., *An experimental investigation of inter-relationships between the wood-ant (Formica rufa) and some tree-canopy herbivores*. In: *The Journal of*

Animal Ecology (1981), p. 313-326.

Steinfeld *et al.* 2006 — Steinfeld, Henning, *et al., Livestock's long shadow: environmental issues and options*. In: *Food & Agriculture Org.* (2006).

Symondson 1993 — Symondson, W. O. C., *The effects of crop development upon slug distribution and control by Abax parallelepipedus (Coleoptera: Carabidae)*. In: *Annals of Applied Biology* 123.2 (1993), p. 449-457.

Symondson, Liddell 1993 — Symondson, W. O. C., Liddell, J. E., *A monoclonal antibody for the detection of arionid slug remains in carabid predators.* In: *Biological Control* 3.3 (1993), p. 207-214.

Tubiello *et al.* 2014 — Tubiello, F. N., Salvatore, M. *Condor Golec, RD Ferrara, A. Rossi, S. Biancalani, R. Federici, S. Jacobs, H. Flammini, A* (2014), p. 1990-2011.

Walker 1992 — Walker, Brian, *Biodiversity and ecological redundancy*. In: *Conservation biology* 6.1 (1992), p. 18-23.

Waller 2006 — Waller, Peter, *Sustainable nematode parasite control strategies for ruminant livestock by grazing management and biological control*. In: *Animal Feed Science and Technology* 126.3-4 (2006), p. 277-289.

Weslien, Regnander 1992 — Weslien, J., Regnander, J., *The influence of natural enemies on brood production inIps typographus (Col. Scolytidae) with special reference to egg-laying and predation byThanasimus formicarius (Col.: Cleridae).* In: *Entomophaga* 37.2 (1992), p. 333-342.

Williams *et al.* 2016 — Williams, J. P., *et al., Nutrient content and health benefits of insects. Insects as sustainable food ingredients*. In: *Academic Press* (2016), p. 61-84.

Wratten *et al.* 2012 — Wratten, Stephen, *et al., Pollinator habitat enhancement: benefits to other ecosystem services.* In: *Agriculture, Ecosystems & Environment* 159 (2012), p. 112-122.

Zhu, Park 2005 — Zhu, Junwei, Park, Kye-Chung, *Methyl salicylate, a soybean aphid-induced plant volatile attractive to the predator Coccinella septempunctata*. In: *Journal of chemical ecology* 31.8 (2005), p. 1733-1746.

LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Fig.1. *Calosoma sycophanta* (Linnaeus, 1758)
(Source https://www.biolib.cz/cz/taxonimage/id220821/?taxonid=81; Milan Kudlička, 2013)

Fig. 2. *Nebria brevicollis* (Fabricius, 1792)
(Source: https://www.biolib.cz/en/taxonimage/id335364/?taxonid=3736; photo: František Spilka)

Fig. 3. *Abax parallelepipedus* (Piller & Mitterpacher, 1783)
(Source: https://www.biolib.cz/en/taxonimage/id266734/?taxonid=4138; Lubomír Klátil, 2015)

Fig. 4. *Amara aenea* (De Geer, 1774)
(Source: https://www.biolib.cz/cz/taxonimage/id246422/?taxonid=4227, photo: Josef Dvořák)

Fig. 5. *Thanasimus formicarius* (Linnaeus, 1758)
(Source: https://www.biolib.cz/en/taxonimage/id82417/?taxonid=9999; Miroslav Fiala, 2008)

Fig. 6. *Coccinella septempunctata* Linnaeus, 1758
(Source: https://www.biolib.cz/en/image/id71185/?galhidden=1; photo: Miroslav Fiala, 2008)

Fig. 7. *Mantis religiosa (Linnaeus, 1758)*
(Source: https://www.biolib.cz/en/taxonimage/id99388/?taxonid=402; photo: Miroslav Fiala, 2009)

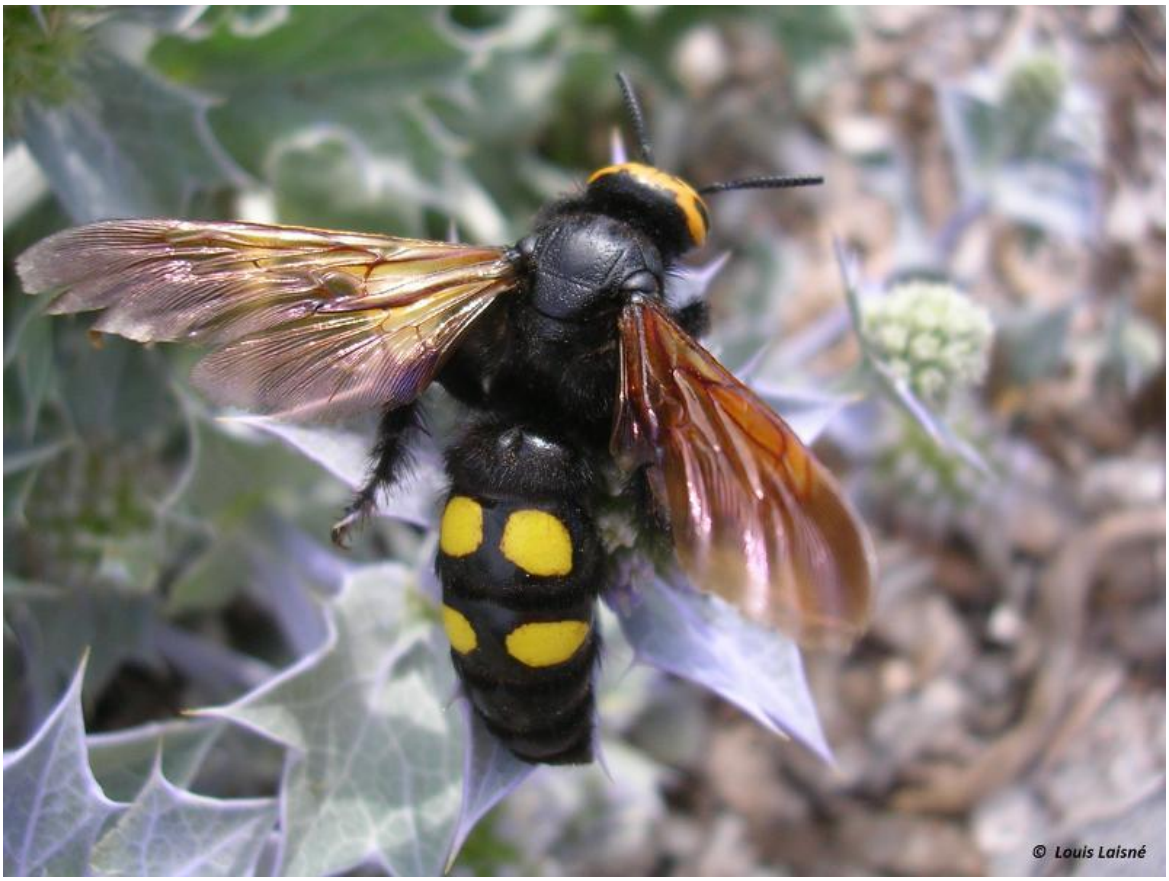


Fig. 8. *Megascolia maculata flavifrons* (Fabricius, 1775)
(Source: inpn.mnhn.fr/espece/cd_nom/231728?lg=en; photo: Louis Laisné)

Fig. 9. *Formica rufa* Linnaeus, 1761
(Source: https://www.biolib.cz/en/taxonimage/id69867/?taxonid=69722; photo: Milan Kořínek, 2008)

Tab. 1. Biological control agents for agricultural pets

Predator	Group	Pest atatcked	Beneficial for
Calosoma sycophanta (Linnaeus, 1758)	Coleoptera: Carabidae	*Lymantria dispar* (Linnaeus, 1758) *Euproctis chrysorrhoea* (Linnaeus, 1758)	*Malus pumila* Mill., 1768 *Acer platanoides* L., 1753 *Quercus robur* L.,1753
Nebria brevicollis (Fabricius, 1792)	Coleoptera: Carabidae	Coleoptera *(*Elateridae*)* Diptera *(*Anthomyiidae*)* Lepidoptera (small caterpillars) arthworms, mites, Opiliones, spiders, Collembola	Autumn and winter crops Gardens, hedges, degraded postindustrial areas
Abax parallelepipedus (Piller & Mitterpacher, 1783)	Coleoptera: Carabidae	*Deroceras reticulatum* (Müller) *Milax* Gray, 1855 *Arion hortensis* Férussac	*Daucus carota* *Brassica oleracea* *Fragaria* sp. *Malus pumila* Mill, 1768 *Iris* L., 1753
*Amara aenea (*De Geer, 1774) / Common sun beetle	Coleoptera: Carabidae	*Rhagoletis pomonella* (Walsh, 1867) *Sitona hispidus* (Fabricius, 1776)	Gardens, wasteland, grassland *Medicago sativa* L., 1753

Thanasimus formicarius (Linnaeus, 1758) /Ant beetle	Coleoptera: Cleridae	*Ips typographus* (Linnaeus, 1758) Bark beetles	Forest species
Coccinella septempunctata Linnaeus, 1758 / Lady bird beetle	Coleoptera: Coccinellidae	*Aphis* Linnaeus, 1758	Agricultural crops
Mantis religiosa (Linnaeus, 1758) / European mantis	Mantodea: Mantidae	*Lymantria dispar* (Linnaeus, 1758) suprafamily Apoidea	Agricultural crops, trees
Megascolia maculata flavifrons (Fabricius, 1775) / Mammoth wasp	Hymenopter: Scoliidae	Harmful to crops of *Zea mays* L. and *Saccharum officinarum* L.	Agricultural farms, agricultural crops
Formica rufa Linnaeus, 1761 /Red Wood Ant	Hymenoptera: Formicidae	*Operophtera brumata* L. *Drepanosiphum platanoidis* Schr. *Periphyllus testudinaceus* Fernie Diptera (mainly Bibionidae)	Trees and forest floor

A MIDDLE MIOCENE SHARK FROM BUITURI, ROMANIA

Nicolae TRIF *
Vlad CODREA **

Abstract*. This paper reports a Middle Miocene large shark tooth found in Buituri, Hunedoara County, Romania. Its importance arises from the rarity of the Badenian fish remains in Romania, but also from its discovery performed by one of the pioneers of Transylvanian paleontology, Johan Ludwig Neugeboren. We add comments on the forerunners' fish discoveries in Buituri area who surveyed the Badenian fossiliferous outcrops located nearby the city of Hunedoara.*
Keywords*: Late Badenian, Chondrichthyes, teeth, Hunedoara County, J. L. Neugeboren.*

Rezumat. *Acest articol semnalează dintele unui rechin fosil de dimensiuni mari găsit la Buituri, județul Hunedoara, România. Importanța sa constă atât în faptul că rechinii badenieni în România sunt rari cât și în faptul că acesta a fost descoperit de unul dintre pionierii paleontologiei transilvane, Johan Ludwig Neugeboren. Adăugăm și comentariile înaintașilor săi care au semnalat resturi de pești fosili în timpul cercetărilor pe care le-au făcut în aflorimentle fosilifere din apropierea orașului Hunedoara*
Cuvinte cheie: *Badenian Superior, Chondrichthyes, dinți, județul Hunedoara, J. L. Neugeboren*.

Geological context and history of research

The marine Badenian locality Buituri is located in the south-west of Romania, on the right bank of Cerna Valley. It used to be a distinct locality, but now it is part of Hunedoara town, as a north-eastern neighborhood (Fig. 1).

Geologically, this territory is located near the western margin of the Strei sedimentary sub-basin, which is in fact an embayment of the Transylvanian Basin towards south-west. The Neogene filling sediments started to accumulate in the Middle Miocene (Badenian) due to transgressions. In the Buituri area, these sediments are laying directly on the metamorphic rocks of the Poiana Ruscă Mountains (Mureșan et al., 1980). There, the base of the Badenian deposits is an illustrative case of unconformity, marking the beginning of a distinct sedimentary mega-sequence. A regional study of middle Miocene bivalve faunas indicates for Buituri an Upper Badenian age (Studencka, 1989).

* Natural History Museum, Brukenthal National Museum, Sibiu, nicolae.trif@gmail.com
** Department of Geology, Faculty of Biology and Geology, Babeș-Bolyai University, Cluj-Napoca, codrea_vlad@yahoo.fr

As far as the geology of the whole basin is concerned, the knowledge is still full of gaps. Basically, in the central part of the basin, the presence of the Upper Cretaceous, Paleogene and Lower Miocene deposits could be logical, but evidence based on borehole or geophysical data is still unavailable. There is a rather big difference between the Strei sub-basin and the Hațeg basin, where boreholes were drilled (Stancu et al., 1980). But even in this latter basin, the presence of Paleogene deposits is not supported by clear paleontological evidence (Stilla, 1985). According to Moisescu (1955), in the Buituri area the lithology of the Badenian deposits is not very diverse. It consists predominantly of sand, but also sandy marl. There are also limestones on the Cărpiniș Hill, but these beds are less than one meter thick.

There are a few localities in Transylvania and Banat that yielded Middle Miocene mollusks. From a paleontological point of view, the most iconic ones are Coșteiu de Sus and Nemeșești in the Timiș County and Lăpugiu de Sus and Buituri in the Hunedoara County. The geologic fame of the latter locality is obvious, Buituri being well known since the 18th century. It is among the first known Badenian localities from our country, due to Fichtel's (1780) work concerning the mineralogy and paleontology of Transylvania. Apart from reporting invertebrates, Fichtel is the first author who also reported fish teeth from Peștișu Mare, a locality situated very close to Buituri: 'Fish teeth: examples of this fossil are excessively rare here, but I did, in addition to two

single teeth, find a piece of jaw with three teeth, of which the middle tooth is much bigger than the other two.' This is probably the first report of fossil fish teeth in Romania.

After Fichtel, a lot of other geologists and paleontologists showed interest in studying the Badenian mollusks from Buituri. In the majority of these contributions we can notice either just a mention of this locality, or only a list of species devoid of detailed descriptions or illustrations. Lillienbach & Boué (1833, p. 73), in the analysis of the notes from a geological trip diary in the Carpathian chain, Bucovina, Transylvania and Maramureș, refer to the close by locality, Peștișu Mare, mentioning that 'À une demi-lieue à l'est de Unter-Peștiș, des pétoncles sont épars dans les marnes et les sables inférieurs, tandis que plus haut apparaissent dans les marnes jaunes des cérithes, des ovules, des bucardes, etc.' From the list of species mentioned on the same page we can easily recognize illustrative Badenian taxa like *Arca*, *Pectunculus*, *Venericardia* etc. They also expressly mentioned Fichtel's observations on the presence of vertebrates, like fish teeth ('dents de poisson'), and also that of turtles ('de tortues') in the fossil assemblage. On the other hand, at Peștișu Mare, they also talk about Sarmatian mollusks. Their presence is credible, as the geological map 1: 50000 illustrates large Sarmatian exposures in the area (Mureșan et al., 1980). In fact, the mollusk list from Buituri was based on Deshayes' assignations, as Boué (1833) specified resuming this list in his paper. It is important to keep in mind that 'Les autres genres de fossiles énumérés dans ma liste précédente existent dans l'ancienne collection de M. Fichtel, à la bibliothèque de Kronstadt en Transylvanie' (p. 128). As far we know, this collection is actually lost.

In the mid-19th century in Transylvania there have already been created collections with rich samples of mollusks from Buituri. The collecting works probably started at least a few years before these data issued in publications, in the first half of the century. Such a collection was Michael Ackner's in Gușterița (=Hammersdorf). A large majority of his mid-Miocene mollusks originated either from Lăpugiu de Sus, or from Buituri (Anonymous, 1850).

In their turn, Zikeli & Mannlicher (1851) build up some brief considerations about the Buituri mollusk taxa and the ones found elsewhere in Europe. In a rather short scientific letter-like report addressed to Beyrich, Neugeboren (1853) mentioned Buituri as an outstanding paleontological locality, but he mainly focused on the Lăpugiu de Sus locality. Later, Neugeboren (1859) discovered the new Badenian mollusk locality, Batiz and he published a brief note creating a parallel between it and Buituri. However, a more extended work on the Buituri mollusks issued only one year later (Neugeboren, 1860).

A brief mention of the Miocene mollusk localities from Hunedoara County was included in the first geological monograph of Transylvania (Hauer & Stache, 1863). These geologists used mainly Neugeboren's paleontological data.

Nemes (1888) achieved a large list (365 taxa) of various invertebrate taxa (i.e. protozoans, echinoderms, bryozoans, mollusks) found in Buituri, but some aspects of his work were soon criticized by Franzenau (1890), who put the novelty of some taxa under question.

Other various geologists added data about the geology of this region, paying special attention to the fossils from Lăpugiu de Sus and Buituri (Stur, 1863) or to some invertebrates other than mollusks (e.g. bryozoans in Héjjas, 1894 and references therein). A really extended study on various invertebrates originating from Buituri belongs to Mártonfi (1893). In fact, his work took forward previous research he had started earlier on this locality, when he had focused only on foraminifers (Mártonfi, 1886). He gave detailed descriptions for some taxa, but he didn't illustrate his text with drawings, nor did he add photographs. However, he brought an important detail about vertebrates, mentioning the presence of shark remains ('Selachiusok'; p. 143) together with three other unidentified fish teeth. A detailed and extended list of invertebrate species found in Buituri can be found in Koch's (1900) geological monograph of the Transylvanian basin. This geologist and paleontologist also mentioned Mártonfi's contributions.

Overviewing the research on the Buituri Badenian fauna carried out until the boundary between the 19th and the 20th century, one may consider that it was a time of a "fossil rush": a lot of scientists tried to accumulate their own collections of fossils, as large as possible. A lot of these fossils have been collected by the scientists themselves, some of them have been obtained through donations, but a large part have been bought from local people. Illustrative for these aspects is Ádám Buda's letter to Antal (Anton) Koch, which includes a paragraph that refers to a sample of mollusks from Lăpugiu de Sus that Buda

suggested should be included in the collection of the Cluj university (Codrea & Venczel, 2016). It is not clear if he intended to sell or to donate them. There were institutional collections that increased their number of specimens too, as it was the case for the natural sciences museum of Aiud, the oldest of this kind in Romania (Codrea & Morărescu, 2008). There, some Transylvanian students that worked with the Protestant Bethlen Gábor College, increased the number of items from the sample from Buituri as it is registered in this collection: István Csató (1833-1913), Károly Herepei (1807-1904) or Károly Elekes (1844-1922). In brief, it was a time when all the students tried hard to acquire as many specimens as possible, in order to make larger and larger lists of taxa. But with a few exceptions, they paid little attention to the local geology. That explains why, in most cases, the single specification labeled on samples resume plain and simple to: Buituri.

Halaváts (1904) carried out a regional survey in Hunedoara County, but he only reported the presence of the 'mediterranean' deposits without giving too many paleo-faunal details. Zalányi (1913), surveyed the outcrops from Buituri once more, but in his report, aside from invertebrates, he only mentioned otoliths and no other vertebrate remains.

After the First World War, the interest of geologists and paleontologists on Buituri decreased for many decades. Only after a pretty long time Moisescu (1955) published her results on the Buituri mollusks in a monograph, adding valuable data on the lithology of some of the fossiliferous outcrops. Among these ones, Fântâna lui Ion (John's Well), also known as Pârâul lui Ion (John's Brook), was the most illustrative. Afterwards, the site was visited by several geologists who collected mollusks, but the majority of the fossils collected during this time have been stored in personal collections and remained unknown to the scientific community. In the present days the majority of the outcrops are covered by soil and it is extremely difficult, if not impossible, to establish their ancient locations. In such context, it is rather unclear which is the level from where the shark teeth of the Sibiu collection originated from.

The latest piece of information about Buituri can be found in Rado & Pană (1968) and it illustrates (in a poor printed plate, unfortunately) two shark teeth assigned to Caracharinidae (*sic!*) (Pl. III, figs. 4, 4a) and another tooth (probably Teleostei indet.) (Pl. III, fig. 2). Apart from their origin – the 'Tortonian' (former name for the Badenian in Romania) deposits of Buituri – there is no other additional data on them.

Methodology

The described material is stored at the Brukenthal National Museum, Natural History Department, Sibiu collection (herein abbreviated NHMS). The photographs have been captured with a Nikon D3500 camera mounted on a tripod and a 105 mm macro Sigma lens. For the upper taxonomy we follow Cappetta, 2012. For the genus content we follow EHRET *et al.*, 2012.

Systematic paleontology

Superorder: Galeomorphii COMPAGNO 1973

Order: Lamniformes BERG 1958

Family: Lamnidae MÜLLER AND HENLE 1838

Genus: *Carcharodon*, SMITH *in* MÜLLER & HENLE, 1838, *sensu* EHRET *et al.*, 2012.

Carcharodon hastalis (AGASSIZ 1838)

Material: One tooth (NHMS - 24560, from Buituri, Hunedoara County, Romania), Fig. 2

Description: The figured specimen is a medium to large sized tooth. It measures 42 mm in length and 2.8 mm in width. The crown has an almost perfect triangular shape with a very slight deviation of the tip in the distal direction. The crown is strongly compressed in labio-lingual direction. In distal view it can be noticed that the tooth is slightly recurved in labial direction. The enamel is smooth on both crown faces. Both cutting edges are smooth but slightly chipped. The root did not preserve, it was broken away. The tooth also preserves marks caused by hydrotaphonomy, mainly by the waves' action. We assign the specimen to an upper central position.

Diagnosis of genus: '*The teeth of the genus are rather flattened labia-lingually. The crown is triangular, broad near the base and sometimes narrows rapidly toward the apex in lateral files; the labial face is flat, the lingual one slightly convex often with a median flattening.*' (Cappetta, 2012, p. 210-211). The serration caracter from the diagnosis of Cappetta, '*The cutting edges bear strong and irregular serrations.*', was removed on the consideration that the succesion *C. hastalis-C hubbelli-C. carcharias* is an example of chronospecies, exhibiting morphological gradation of dental characteristics (see for the complete discussion Ehret et al., 2012, p. 1148) and that the serration is not a genus distinguishing character as it is the case also for *Xiphodolamia* or *Peseudocorax*.

Discussions: *Carcharodon hastalis* teeth have been found in most of the Miocene deposits from Central Paratethys, as they are extensively distributed worldwide. The species is also known in references under the names of *Isurus hastalis* (e.g. Schultz, 1971), *Cosmopolitodus hastalis* (e.g. Bor et al., 2012; Šoster & Mikuž, 2013) or *Oxyrhina hastalis* (e.g. Steininger, 1966; Schultz, 1969). As we have previously discussed (Trif & Codrea, 2017), the taxonomy of this species used to be widely disputed over time, but we agree with its present assignment to the genus *Carcharodon* (Ehret et al., 2012). We think it reflects better its phylogeny, because the serration is not a distinctive feature of the genus. A similar reassessment has been done for several species of the genus *Otodus* (see Cappetta, 2012, p. 224). *Carcharodon hastalis* has also been found in the Badenian deposits from Hungary (Szabó & Kocsis, 2016; 2020), Czech Republic (Brzobohatý & Schultz, 1978; Schultz et al., 2010), Slovakia (Holec & Sabol, 1996; Holec, 2001), Austria (Schultz, 1969, 1971; Steininger, 1966, Hiden, 1995), Poland (Radwanski, 1965) etc.

In Romania the species has been reported in the western side of the Middle Miocene Transylvanian Basin (Noszky, 1925; Szabó & Kocsis, 2016; Trif & Codrea, 2017).

Conclusions

In the last 240 years several fish teeth have been discovered in the Buituri locality, but only one of them has been kept in a Romanian collection until today. The one that we describe herein is hosted by the historical collection of Transylvanian paleontologist J. L. Neugeboren and it is identified as belonging to the species *Carcharodon hastalis*, one of the ancestors of today's great white shark, *Carcharodon carcharias*. This discovery comes to add a contribution to the study of Badenian fish which are still very poorly known in Romania.

Acknowledgements.

Authors thank Iulia Ștefănescu and Ramona Mărginean, curators at the Natural Sciences Museum of Aiud, for their kind collegial help related to the Buituri mollusk collection. The authors are also very grateful to Ms. Aurelia Fuciu for the proofreading of the manuscript and to Rudolf Zechner (Graz University) for his help in translating fragments from Fichtel's text.

REFFERENCES

Agassiz 1833-1843 — Agassiz Louis, *Recherches sur les poissons fossiles, (Contenant l'Histoire des Cycloides).* Imprimerie de Petitpierre. Neuchatel, (1833-1843), 390 pp.

Anonymous 1850 — Anonymous, *Siebenbürgische Petrefacten in der Sammlung des Herrn Michael Ackner, Pfarer in Hammersdorf*. In: *Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt*, 10, (1850), p. 150-162; 171-175.

Berg 1958 — Berg Lev Semenovich, *System der Rezenten und Fossilen Fischartigen und Fische*. Hochschulbücher für Biologie, Berlin, (1958), 310 pp.

Bor *et al.*, 2012 — Bor Taco, Reinecke Thomas, Verschueren, Sylvia, *Miocene Chondrichthyes from Winterswijk - Miste, the Netherlands*, In: *Palaeontos*, 21, (2012), p. 1-136.

Boué 1833 — Boué A., *Mollusques tertiaries de Transylvanie*. In: *Bulletin de la Société Géologique de la France*, 3, (1833), p. 127-128.

Bronn, 1837 — Bronn H.G., *Notizen über das Vorkommen der Tegel-Formation und ihrer Fossil reste in Siebenbürgen und Galizien*. In: *Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde,* (1837), p. 654-664.

Brzobohatý, Schultz 1978 — Brzobohatý Rostislav, Schultz Ortwin, *Die Fischfauna des Badenien.* In: Papp, A., Cicha, I., Seneš, J., Steininger, F., (Eds): *M4, Badenien. Chronostratigraphie und Neostratotypen*, , 6, (1978), p. 441-465.

Cappetta, 2012 — Cappetta Henri, *Handbook of Paleoichthyology. Vol. 3E: Chondrichthyes. Mesozoic and Cenozoic Elasmobranchii: Teeth*. Verlag Dr. Friedrich Pfeil. München, (2012), 512 pp.

Codrea, Morărescu, 2008 — Codrea Vlad, Morărescu Gabriela, *Catalogus Raritatum et Benefactorum, A Representative Manuscript from the Beginnings of the Museum of Natural Sciences in Aiud*. In: *Philobiblon*, 13, (2008), p. 583-593.

Codrea, Venczel, 2016 — Codrea Vlad, Venczel Márton, *A Middle Miocene rhinoceros find in Transylvania: 19th century forgotten correspondence*. In: *Studia Universitatis Babes-Bolyai, Geologia*, (2016), 60(1), p. 43-47.

Compagno 1973 — Compagno Leonard, *Interrelationships of living elasmobranchs*. In: *Zoological Journal of the Linnean Society*, 53 (Supplement 1), (1973), p. 15-61.

Ehret *et al.*, 2010 — Ehret Dana, MacFadden Bruce, Jones Douglas, Devries Thomas, Foster David, Salas-Gismondi Rodolfo, *Origin of the white shark Carcharodon (Lamniformes: Lamnidae) based on recalibration of the Upper Neogene Pisco Formation of Peru*. In: *Paleontology*, 55(6), (2010), p. 1139-1153.

Fichtel 1780 — Fichtel Johann Ehrenreich, *Des Herrn Johann Ehrenreich von Fichtel Beytrag zur Mineralgeschichte von Siebenbürgen Nachricht von den Versteinerungen des Grossfürstenthums Siebenbürgen - mit einem Anhange und beygefügter Tabelle über die sämmtlichen Mineralien und Fossilien dieses Landes*, Vol 1. Verlag der Raspischen Buchhandlung, Nürnberg, (1780), 158 pp

Franzenau 1890 — Franzenau Ágoston, *Bujtur fossil foraminiferái*. In: *Természetrajzi Füzetek*, 13(4), (1890), p. 95-109.

Halaváts 1902 — Halaváts Julius, *Tiber den geologischen Bau der Umgebung von Vajdahunyad*. In: *Jahresbericht der ungarischen Geologischen Anstalt*, (1902), p. 93-100.

Hauer, Stache 1863 — Hauer Franz Ritter, von Stache Guido, *Geologie Siebenbürgens*. Wilhelm Braumüller, Wien, (1863), 636 pp.

Héjjas 1894 — Héjjas Imre, *Adatok Erdély Tertiär Bryozoa-Faunájához*. In: *Értesitő az Erdélyi Múzeum-Egylet Orvos-Természettudományi Szakosztályából. II Természettudo-mányi Szak*, Kolozsvár, 16(2), (1894), p. 113-152.

Hiden 1995 — Hiden Hartmut R., *Elasmobranchier (Pisces, Chondrichthyes) aus dem Badenium (Mittleres Miozän) des Steirischen Beckens (Österreich)*. In: *Mitteilungen der Abteilung für Geologie und Paläontologie am Landesmuseum Joanneum*, 52/53, (1995), p. 41-109.

Holec, Sabol 1996 — Holec Peter, Sabol Martin, *The Tertiary Vertebrates from Devínska Kobyly*. In: *Mineralia Slovaca*, 28, (1996), p. 519-522.

Koch 1900 — Koch Anton, *Az Erdélyrészi medencze harmadkori képződményei. II. Neogen csoport.* Magyar Akadémia és a Királyi Természettudományi társulat támogatásával kiadta a Magyarhoni földtani társulat, Budapest, (1900), 329 pp.

Lillienbach, von Boué 1833 — Lillienbach Lill, von Boué, A., *Journal d'un voyage géologique fait à travers toute la chaîne des Carpathes, en Bukowine, en Transylvanie et dans le Marmarosch*. Observations mises en ordre et accompagnées de Notes par M. A. Boué. In: *Mémoires de la Société géologique de France*, 1(1), (1833), p. 237-316.

Mártonfi 1886 — Mártonfi Lajos, *Adatok a Bujturi mediterrán homok Foraminifera faunához*. In: *Értesitő az Erdélyi Múzeum-Egylet Orvos-Természettudományi Szakosztályából. II Természettudományi Szak*, 11, (1886), p. 294-296.

Mártonfi 1893 — Mártonfi Lajos, *Adatok Bujtur fossil faunájahoz*, In: *Értesitő az Erdélyi Múzeum-Egylet Orvos-Természettudományi Szakosztályából. II Természettudományi Szak*, 18(2), (1893), p. 141-158.

Moisescu 1955 — Moisescu, Gertruda, *Stratigrafia și fauna de moluște din depozitele Tortoniene și Sarmațiene din regiunea Buituri*, Republica Populară Română, Editura Academiei Republicii Populare Române, București, (1955), 221 pp.

Müller, Henle 1938 — Müller J., Henle F. G. J., *On the generic characters of cartilaginous fishes, with descriptions of new genera.* In*: Magazine of natural history and journal of zoology, botany, mineralogy, geology and meteorology*, 2, (1838), p. 33-37; 88-91.

Mureșan *et al.*, 1980 — Mureșan M., Mureșan G., Kräutner H.G., Kräutner F., Țicleanu Nicolae, Stancu Josefina, Popescu A., Popescu Gheorge, *România, Harta geologică scara 1:50000, folio 89d Hunedoara, L-34-82-D*, Institutul de Geologie și Geofizică București, (1980).

Nemes 1888 — Nemes D. Felix, *Újabb adatok a Bujturi Mediterrán rétegek faunájának ismeretéhez*. In: *Értesitő az Erdélyi Múzeum-Egylet Orvos-Természettudományi Szakosztályából. II Természettudományi Szak*. Kolozsvár, 13(1), (1888), p. 19-32.

Neugeboren 1853 — Neugeboren Johann Ludwig, *Herr Neugeboren an Herrn Beyrich. Tertiärbildungen bei Ober-Lapugy*. In: *Zeitschrift der Deutschen geologischen Gesellschaft*, 5, (1853), p. 672-677.

Neugeboren 1859 — Neugeboren Johann Ludwig, *Der Wald bei Batiz, ein neue Fundstätte von Tertiär-Conchylien*. In: *Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt*, 10, (1859), p. 257-258.

Neugeboren 1860 — Neugeboren Johann Ludwig, *Systematisches Verzeichniss der in den Sraten bei Bujtur auf Unter-Pesteser Dorfs-Gebiet unweit Vajda-Hunyad vorkommenden fossilen Tertiär-Mollusken-Gehäuse*. In: *Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt*, 11, (1860), p. 19-28.

Noszky 1925 — Noszky Jenő, *Adalékok a magyarországi Lajtameszek faunájához*. In: *Annales Musei Nationalis Hungarici*, 22, (1925), p. 230-280.

Radwanski 1965 — Radwanski Andrjez, *A contribution to the knowledge of Miocene Elasmobranchii from Pinczow (Poland)*. In: *Acta Palaeontologica Polonica*, 10(2), (1965), p. 267-279.

Schultz 1969 — Schultz Ortwin, *Die Selachierfauna (Pisces, Elasmobranchii) aus den Phosphoritsanden. (Untermiozän) von Plesching bei Linz, Oberösterreich*. In: *Naturkundliches Jahrbuch der Stadt Linz*, 14, (1969), p. 61-103.

Schultz 1971 — Schultz Ortwin, *Die Selachier-Fauna (Pisces, Elasmobranchii) des Wiener Beckens und seiner Randgebiete im Badenien (Miozän)*. In: *Annalen des Naturhistorischen Museums in Wien*, 75, (1971), p. 311-341.

Schultz *et al.*, 2010 — Schultz Ortwin, Brzobohatý Rostislav, Kroupa Oldřich, Fish teeth from the Middle Miocene of Kienberg at Mikulov, Czech Republic, Vienna Basin. Annalen des Naturhistorischen Museums in Wien, 112(A), (2010), p. 489–506.

Šoster, Mikuž 2013 — Šoster Ales, Mikuž Vasja, *Ostanki rib iz miocenskih plasti Višnje vasi blizu Vojnika [Fish remains from Miocene beds of Višnja vas near Vojnik, Slovenia]*, In: *Geologija*, 56 (1), (2013), p. 73-86.

Stancu *et al.*, 1980 — Stancu J., Baltreș, A., Cioflica, G., Ghețа, N., Moisescu, V., Papaianopol I., Popescu D., Popescu G., *Contribuții la studiul petrographic și paleontologic al depresiunii Hațeg pe baza unor foraje*. In: *Dări de Seamă ale Ședințelor Institutului de Geologie și Geofizică*, 67, (1980), p. 115-136.

Steininger 1966 — Steininger Friedrich, *Über eine Fossilien Sammlung aus dem Stadtbereich von Linz*, In: *Naturkundliches Jahrbuch der Stadt Linz (Linz)*, 12, (1966), p. 7-10.

Stilla 1985 — Stilla A., *Géologie de la région de Haţeg-Cioclovina-Bănița (Carpates Méridionales).* In: *Anuarul Institutului de Geologie și Geofizică*, 66 (1985), 91-179.

Studencka 1998 — Studencka, Barbara, Gontsharova Irina A., Popov, Serghey V., 1998. *The bivalve faunas as a basis for reconstruction of the Middle Miocene history of the Paratethys*. In: *Acta Geologica Polonica*, 48(3): 285-342.

Stur 1863 — Stur Dionysius, *Bericht über die geologische Uebersichtsaufnahme des südwestlichen Siebenbürgen im Sommer 1860.* In: *Jahrbuch der kaiserlich-königlichen Geologischen Reichsanstalt*, 13(4), (1863), p. 33-120.

Szabó, Kocsis 2016 — Szabó Márton, Kocsis László, *A new Middle Miocene selachian assemblage (Chondrichthyes, Elasmobranchii) from the Central Paratethys (Nyirád, Hungary): implications for temporal turnover and biogeography.* In: *Geology of the Carpathian Region*, 67(6), (2016), p. 573-594. https://doi.org/10.1515/geoca-2016-0036

Szabó, Kocsis 2020 — Szabó Márton, Kocsis László, Supplementary data on the Middle Miocene (Badenian) fish assemblage of Nyirád (Hungary): revision and new results on faunal composition and paleoenvironment. Palaeontographica Abteilung A, 315(5-6), (2020), p. 121-191. https://doi.org/10.1127/pala/2020/0094

Trif, Codrea 2017 — Trif Nicolae, Codrea Vlad, *Some Badenian fish teeth from western Transylvania (Romania).* In: *Oltenia. Studii şi comunicări. Ştiinţele Naturii*, 33(1), (2017), p. 7-17.

Zalányi 1913 — Zalányi, Béla, *Neue Beiträge zut obermediterranen Fauna von Bujtur*. in: *Jahresbericht der Königlich ungarischen Geologischen Anstalt*, 1913(2), (1913), p. 605-611.

Zekeli, Mannlicher 1851 — Zekeli Friedrich, Mannlicher Gustav, *Tertiärfossilien aus Siebenbürgen*. In: *Jahrbuch der kaiserlich-königlichen Geologischen Reichsanstalt*, 2(2), (1851), p. 173-174.

LIST OF ILLUSTRATIONS

Fig. 1 A. Location of Buituri in Romania; B. Geological map of the Buituri area (after the geological map of the Institute of Geology of Romania 1:50.000, *folio* Hunedoara, modified and simplified).

Fig. 2 *Carcharodon hastalis* (NHMS - 24560, Buituri, Romania); a - lingual view; b- labial view; c - lateral view.

LISTA ILUSTRAȚIILOR

Fig. 1 A. Poziția localității Buituri în România; B. Harta geologică a zonei Buituri (după harta geologică a Institutului Geologic al României 1:50.000, *folio* Hunedoara, modificată și simplificată).

Fig. 2 Fig. 2. *Carcharodon hastalis* (NHMS - 24560, Buituri, Romania); a - vedere lingual; b - vedere labială; c - vedere laterală.

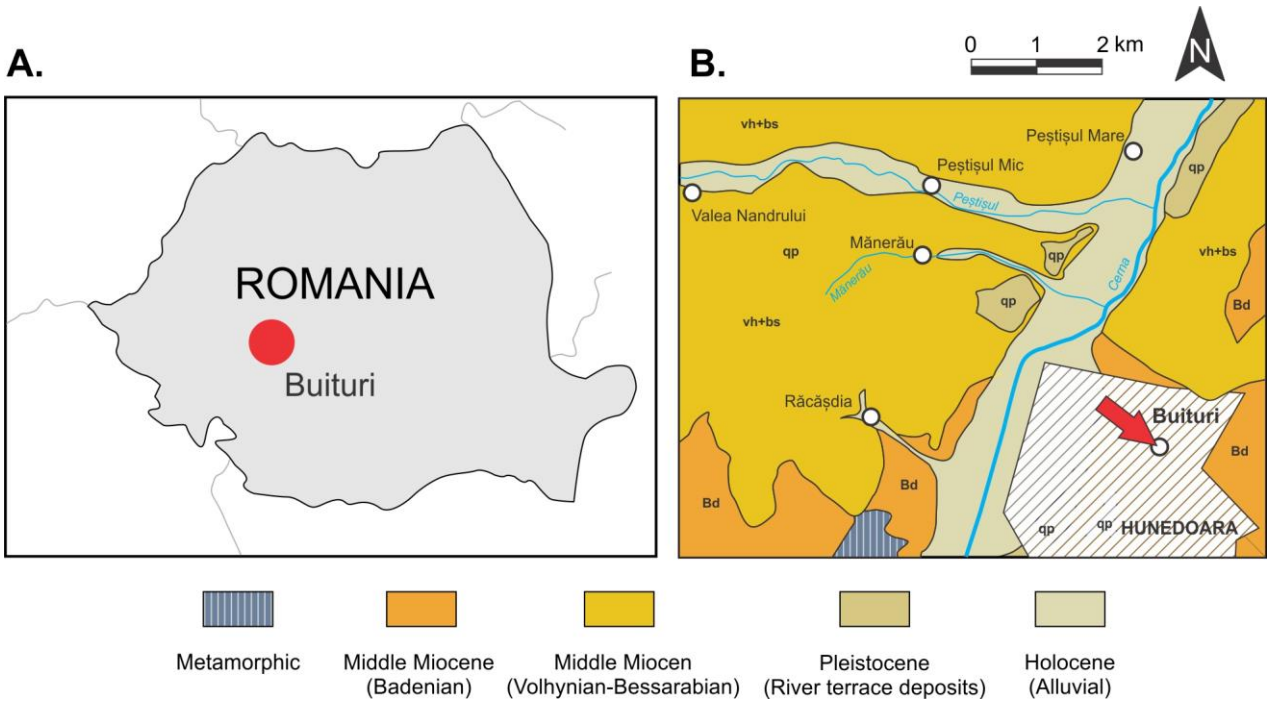


Fig. 1. A. Location of Buituri in Romania; B. Geological map of the Buituri area (after the geological map of the Institute of Geology of Romania 1:50.000, folio Hunedoara, modified and simplified).

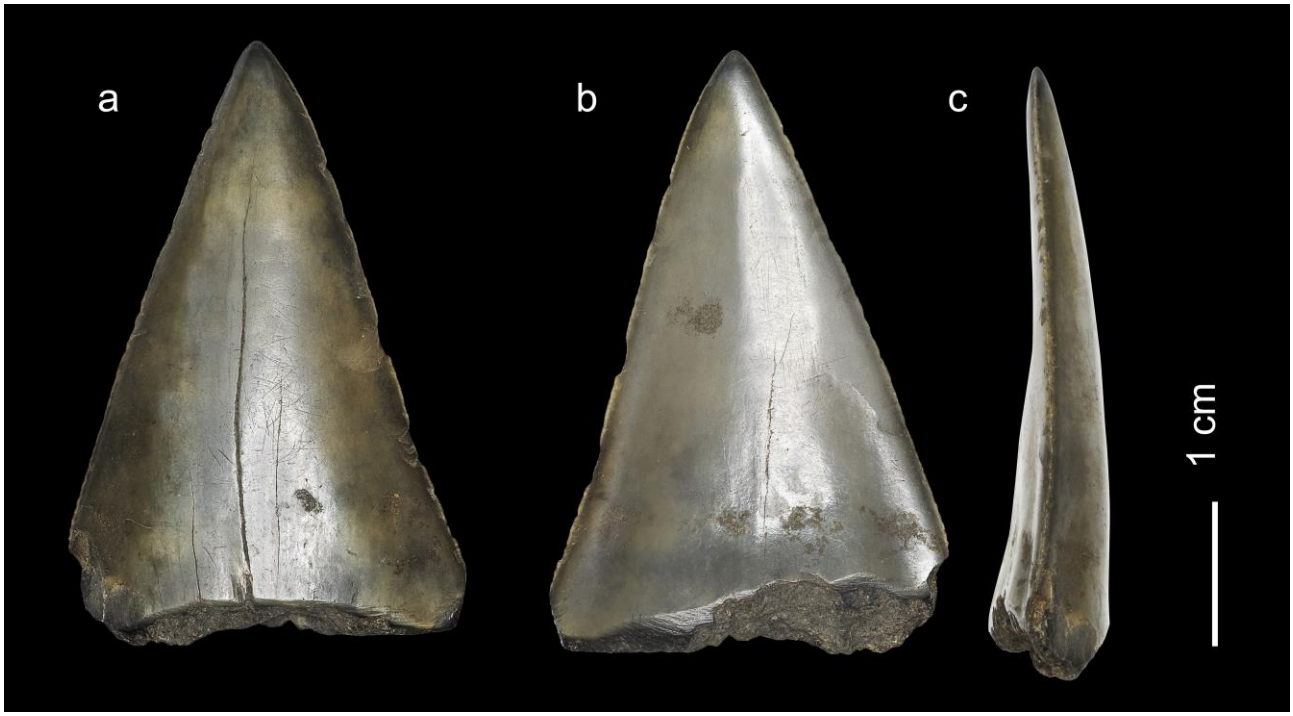


Fig. 2 *Carcharodon hastalis* (NHMS - 24560, Buituri, Romania); a - lingual view; b- labial view; c - lateral view.

EVALUATION METHODOLOGY OF WET PRESERVED SPECIMENS WITH EXEMPLIFIED DEGRADATIONS ON MUSEUM COLLECTIONS

Maria Iulia SASU*
Radu Ștefan PANĂ**
Petre Bogdan MATEI***

Abstract. *The conservation of natural history specimens depends on several factors, including: the properties of the constituent material, the freshness, the morphological and the chemical integrity of the piece at the time of its initial preparation, the use of the specimen, the size and species of which the specimen belongs, the knowledge and the experience of the person carrying out the process of preservation, the quantity, the quality and the availability of the used preservatives. The chosen methods must always ensure an efficient and long-term preservation. Skipping some of the preparation stages or an incorrect association of the preservatives with the biochemical composition of the piece, can lead, in time, to irreparable degradation of the processed piece. In time, the knowledge of the specialist and the preservation methods improve once the experience is gained. The Museum of Natural History from Sibiu keeps in the collections specimens preserved since the middle of the 19th century. They need conservation and in some cases restoration. Thus, we decided to present the evaluation of the specimens kept in preservative liquids, the first step in the process of conservation. Some types of degradation have been exemplified on several specimens belonging to the Zoological Collection. This paper shows a working protocol necessary to establish an evaluation methodology for collecting useful information that can be used for further preservation. Following some general themes (location, identification, conservation status and photography), we will get an overview of the conservation status of the piece at the time of evaluation. An accurate evaluation is the way towards the elaboration of a correct conservation or restoration methodology, suitable for the specimen.*
Keywords*: conservation, methodology, preservative liquid, organic material, museum, zoology.*

Rezumat. *Conservarea specimenelor de istorie naturală depinde de mai mulți factori, printre care se numără: proprietățile materialului constituent, gradul de prospețime și de integritate morfologică și chimică a piesei în momentul preparării inițiale a acesteia, valorificarea exemplarului, dimensiunea și specia căreia aparține exemplarul, cunoștințele și experiența celui care realizează activitatea, disponibilitatea cantitativă și calitativă a substanțelor conservante folosite. Întotdeauna metodele alese trebuie să asigure o conservarea eficientă și pentru timp îndelungat. Omiterea unor etape de preparare sau asocierea incorectă a substanțelor conservante în raport cu compoziția biochimică a piesei supuse conservării, pot duce în timp la degradări iremediabile ale piesei prelucrate. Cunoștințele preparatorului și metodele de preparare se îmbunătățesc în timp odată cu acumularea experienței. Muzeul de Istorie Naturală din Sibiu păstrează specimene conservate încă de la jumătatea secolului al XIX-lea. Acestea au nevoie de conservare și în unele cazuri de restaurare. Astfel, am decis să prezentăm primul pas în conservarea specimenelor păstrate în lichide conservante, adică evaluarea. Unele tipuri de degradări au fost exemplificate pe câteva specimene care aparțin Colecției Zoologice. Lucrarea de față prezintă un protocol de lucru, acesta fiind necesar pentru stabilirea unei metodologii de evaluare pentru colectarea informațiilor necesare obiectivului propus. Urmând câteva teme generale (localizarea, identificarea, starea de conservare și fotografierea), vom obține o imagine de ansamblu asupra stării de conservare a piesei la momentul evaluării. Claritatea evaluării este calea spre întocmirea unei metodologii de conservare sau restaurare corecte, potrivite preparatului.*
Cuvinte cheie: *conservare, metodologie, lichid conservant, material organic, muzeu, zoologie.*

Introduction

The museum collections of natural sciences are constituted as a result of field collections, donations, acquisitions or inter-institutional exchanges (Ciobanu *et al.* 2004, 13). Specimens are preserved using various methods and techniques of preparation. They are chosen according to the properties and nature of the

* Brukenthal National Museum, mariasasu2016@gmail.com
** Grigore Antipa National Museum of Natural History, Bucharest, Romania, raduspana@yahoo.com
*** Grigore Antipa National Museum of Natural History, Bucharest, Romania, bogdan_mateizoobucuresti@yahoo.com

component materials, the object of research, the use of the specimen, the species to which it belongs, the possibility of preserving the specimen at that time and the knowledge of the person who carries out the activity. In every cases, the chosen methods will ensure an efficient, long time conservation. In the following, we will briefly exemplify the above ideas.

Specimens can have components of organic nature (vegetable origin - fibers, dyes; animal - skin, fur) or inorganic nature (mineral origin - metal, stone, glass, pigments). We will exemplify two conservation methods that have been chosen depending on the properties and nature of the constituent materials: the case of a jellyfish (Class Scyphozoa) and the case of a skeletal fragment (a bone). The jellyfish has a gelatinous body with 95% water content. It is preserved in liquid (formaldehyde solution or ethyl alcohol) because the use of a dry preparation method leads to loss of properties and characteristics specific to the specimen (shape, characteristic appearance, colour, texture). A bone contains about 25% water and 75% dry residue. The bone consists of a solid organic matrix made up of collagen, which is hardened by mineral substances (calcium, phosphorus). It can also be preserved by drying, as the component materials will allow it to retain its characteristic structure, especially at medium and large pieces.

The valorification of the specimen is done through research or by public exhibiting. A jellyfish preserved in liquid can be presented to the public in a museum exhibition, or it can be used for anatomical and morphological studies. However, a jellyfish preserved by drying can only be used in limited studies.

The way of preparing the specimen for research can be achieved by: preparing bones or skeletons for osteological collections, preparing the skin for leather/skin collections or making anatomical preparations for collections of comparative anatomy.

The method of preparation depends on the methods by which the specimens will be studied in the future. For example: preparation of bones or skeletons for osteological collections, preparation of skin for collections of skins/stuffed animals or preservation of anatomical parts (organs, limbs, bones, teeth, etc.) for collections of comparative anatomy.

Some specimens intended for study will be better preserved in liquid (insects, organs), but it will also take into account the species to which they belong. Thus, depending on the species of which the specimen belongs, the methods chosen depends on the biochemical composition and the size of the specimen, the availability of preservatives, containers or storage boxes, storage space and the availability of qualified personnel to perform these procedures. For example, small specimens (insects), are preserved in liquid or by drying (entomological needle mounting), but a large mammal skin (bear, deer) will obligatory be prepared by the taxidermy technique (Patchett 2010, 94).

When discussing the possibility of preserving the specimen at a certain time and the knowledge of the person performing the activity, it is important to remember that various methods require different materials that are more or less found in the laboratories, some of which are difficult to purchase or expensive.

Conservation methods evolve over the years, simultaneously with the new theoretical and practical knowledge in the field. New, more efficient chemical compounds are discovered and legislative changes are made on the use of some high risk preservatives for human health and/or the environment. Also, the knowledge of the specialist improves in time as he gains experience. For a long time extremely toxic substances have been used in taxidermy, both for humans and for the environment. Nowadays these substances are considered poisonous, carcinogenic or persistent organic pollutants (POPs) (Stockholm Convention 2001). These substances such as formaldehyde (used in wet conservation and for mummification of specimens), arsenic (arsenical soap applied to the inner side of specimen skin has been used for skin preservation and as a repellent against harmful insects) (Marte *et al*. 2006, 143) or organochlorine insecticides (such as dichloro-diphenyl-trichloroethane or DDT and gamma-hexachloro-cyclohexane) were largely used. Due to the negative health effects, attempts are currently being made to monitor the pieces which contain toxic compounds (Found, Helwig 1994, 6) and to remove these substances from collections. In order to prevent the biological attacks and biodegradation, in specialized laboratories currently are used substances based on natural pyrethrins and synthetic pyrethroids (Linnie 1994, 262), which have lower toxicity and are considered to be more "friendly" to the environment.

The Museum of Natural History from Sibiu owns specimens preserved heterochronously. The collections began to form since the founding of

the Transylvanian Society of Natural Sciences from Sibiu/Siebenbürgischer Verein für Naturwissenschaften zu Hermannstadt (1849), a period preceding the opening of the museum as a public institution (1895). New pieces were added to the collections until the last decade. Continuing the idea of the founders of the museum, today's museum team aims to research, preserve, restore and exhibit the preserved heritage, in order to educate and to entertain the audience.

Conservation and restoration include all the activities regarding the preservation of all the specimens from exhibitions and storages, in one word the museum patrimony (Mihalcu 1970, 214). Conservation aims to prolong the existence of cultural assets through specific activities and to counteract the action of all factors that lead to deterioration, ensuring preventive conservation (Moldoveanu 2009, 21). Curative conservation and restoration define the study of causes and mechanisms responsible for degrading the object; the application of prevention methods and the treatment of stopping the degradation, aiming to bring the object to a state as close as possible to the initial one.

Preservation is dependent on the stability of the component materials (Mârza 2004, 137). In order to preserve an aspect as close as possible to the original one, it is necessary to have some essential knowledge related to the structure of the objects, the nature, the chemical, the physical and the mechanical properties of the component materials, the environmental factors involved. Due to the nature of the materials, biological collections contain complex materials (Simmons, Muñoz-Saba 2005, 54). Most are composed of different types of tissue and each reacts differently to environmental factors. Proteins usually found in a variety of specimens are not very stable, tending to decompose. Thus, biological collections face special problems, the first step in their conservation is to achieve, from the beginning, a correct preservation in terms of its preparation techniques: the correct usage of adequate preservatives both quantitatively and qualitatively, being essential. Regardless of how to prepare a piece from a collection (dry/wet), a piece preserved correctly from the beginning will greatly reduce the subsequent conservation-restoration activity (Fig. 1). The second step, extremely important, is the evaluation of biological preparations from the point of view of conservation status. Since in Romania the scientific literature in the field of conservation - restoration of natural history specimens is scarce, it is necessary to develop a set of research methods to establish the data that will be collected during the evaluation to know the state of health of the preparation at a certain time.

This paper offers a set of guidelines for evaluation methodology applied to specimens kept in preservative liquids. Also, in order to facilitate the understanding of the methodology, the types of degradations found in these preparations will be exemplified in this paper. As the museum's collections are being inventoried and evaluated, a number of 25 pieces which belong to the Zoological Collection of the Museum of Natural History in Sibiu have been selected for examples.

Methodology

The specimen evaluation methodology follows 4 general criteria: location, identification, conservation status and photographic documentation of the object. Each of these will be briefly described below.

I. Data regarding the storage place of the piece

1. Date of evaluation.
2. Data about the place of the subject in the storage:
- deposit number/showcase name;
- cabinet number;
- drawer/shelf number;
- row number;

3. Storage conditions:
- temperature value (ºC);
- the value of relative humidity (%);
- light intensity value (lux).

II. Object identification data

1. Data from the inventory register:
- inventory number - old and/or new;
- name;
- place of collection;
- who collected *(legit.);*
- who determined;
- date of collection;
- the value (monetary);
- year of collection/registration;
- other data.

2. Data collected from labels or notations:
- inventory numbers/other numbers;
- name;
- place of collection;
- who collected (*legit*.);
- who determined;
- date of collection;
- other data.

3. Other visual observations of identification.

4. Published literature containing references to the specimen in question.

III. Data on the state of conservation of the object

To evaluate a specimen preserved in liquid, visual observations from the outside to the inside (container, label, seal, preservative and specimen) will be started, following the identification of the component materials and their state of preservation.

1. General state of preservation - the observation follows the general aspect of the object: good to be showcased/damaged.
2. Condition of the container and its lid:
- constituent material (glass/plastic/metal/others);
- dimensions (length/width/height/diameter/volume);
- deposits: present/absent, located on the outside/inside, appearance, color, other;
- state of preservation: good/damaged (cracks, manufacturing defects, fragmentation, missing parts - Fig. 12 A, corrosion, other);
- location of degradation.

3. Label(s) status:
- constituent material (paper/cardboard/plastic/other);
- location (arranged inside/applied on the outside/without label/label without data);
- notation (with pencil/ink/print; it is legible/illegible);
- dimensions (length/width);
- state of preservation: good/damaged (ruptures, missing parts, fragmentation, chemical degradation);
- location of degradation.

4. Outer seal condition:
- constituent material (cellophane/waxed cellophane/organic membrane/waxed organic membrane/without outer seal);
- state of preservation: good/damaged.

5. The condition of the inner seal:
- constituent material (wax-based putty/other mixtures/without external seal);
- state of preservation: good/damaged.

6. State of the preservative liquid:
- identification of the preservative liquid (ethyl alcohol/formaldehyde/mixtures of preservative liquids) - data will be taken from the labels/from the inventory register or specific chemical investigations will be used (within an investigation laboratory);
- liquid concentration - specific chemical investigations will also be used;
- liquid pH (in this case the measurement method is specified: specialized apparatus or pH bands);
- liquid level (above the piece level - normal/at the piece level/below the piece level - low/completely evaporated;
- color of the liquid (transparent and clear - normal/yellow/other);
- residual deposits (present/absent), their appearance (residues/fat).

7. The condition of the specimen describes the following aspects:
- display mode (free in the container/arranged on a support plate made of glass/plastic, tied with cotton/nylon thread);
- condition of the support plate (cracks/other);
- number of samples;
- state of preservation: good/damaged;
- degree of damage: less than 25% - slightly dehydrated, has missing parts, fragments detached/less than 50% - dehydrated, extremely dehydrated, deformed/over 50% - decomposed, the constituent material has lost its morphological properties or functional characteristics of the species;
- specimen's color (normal/discolored).

8. Pests:
- absent/present;
- biological agents: bacteria/fungi/insects/others;
- location of degradation.

IV. Photographic documentation

To draw it up, many types of images will be captured, specifying the equipment used. It may also include microscopic captures.

1. Overviews;
2. Detail images;
3. Microscopic images;
4. Equipment used.

Discussion

This presentation aims to help those working in the field of conservation and restoration of natural history specimens and seeks to design a methodology model applied to liquid preserved specimens.

During the evaluation of a specimen, visual observations will be made to determine the state of conservation of the pieces, measurements with devices used to assess microclimatic conditions (thermometer, hygrometer, thermohygrometer, luxmeter, etc.) and chemical investigations to identify the qualitative and quantitative composition of substances/liquids used (densimeter, pH-meter, liquid chromatograph, etc.).

Data on the storage location of the object include environmental factors. Among the most important factors affecting organic materials are humidity, temperature, light and pollution (Baer, Banks 1994, 9). The above-mentioned factors may have a greater or lesser impact in the case of specimens preserved in liquid, but may play a decisive role in the preservation and unaltered conservation of containers and lids in which such preparations are kept, seals and external labels: the high degree of humidity facilitates the installation of microbiological attacks and induce chemical degradations of: seals (Fig. 2 B, C, Fig. 3 A, B), lids (Fig. 2 A) and external labels (Fig. 4 A, B) Those can degrade due to chemical reactions and/or biological degradations can occur following the appearance, installation and development of cultures of bacteria or mold on the same components. Humidity values must be correlated with temperature values. The ambient temperature above the limits of the conservation regulations of cultural goods can lead to an increase in the speed of chemical reactions, also increasing the rate of damage. Thermal variations above the limits lead to chemical degradation of the wet preparation or even to a degradation of the container used. This container degradation can be physical in nature (matting, cracks in the walls of the vessel or glass lid – Fig. 1 A, B) or chemical (often invisible to the naked eye - structural cracks - which can lead to brittleness of those containers). Light energy is absorbed, resulting in chemical reactions capable of transforming materials such as cellulose, wood, textiles, leather or parchment. The light is being recognized as an extremely destructive external factor especially for cultural goods of an organic origin. The transformation is manifested by the accelerated change of color (yellowing, discoloration - Fig. 4 B), decomposition of materials (breaking of the fibers, etc.) (Fig. 4 C).

Last but not least on the external environmental factors, pollution, can also play a particularly harmful role for the wet preserved collections. At a glance, we could divide this factor into two major subcategories: biological pollution and chemical pollution. We have already mentioned some of the biological factors when we referred to the harmful activity of an excessively high humidity (bacteria, fungi, mold – Fig. 12). In addition to the above, it is necessary to mention as biological pollutants some species of insects (familis Dermestidae, Blatidae), which can damage the outer labels or seals made of membranes of animal origin, either by consuming them or by contaminating them with feces that can affect the legibility of the writing on the labels (Fig. 4 A) or create a culture medium for various species of mold (fungi). Also in this category, as potential biological pollutants must be mentioned some species of birds from the family Columbidae and some species of mammals belonging to the order Rodentia, often found near human settlements, which, if they find a temporary or permanent way of access to deposits, can cause damage either by demolishing and breaking small-medium sized containers or by contaminating labels, containers, racks and floors with dejections. Chemical pollution, a less common factor, it is represented by liquid chemical compounds, but especially gaseous, which can have a corrosive-destructive effect, especially on external seals and labels (Fig. 2, Fig. 3), having as adjuvant agent the presence of a high level of relative ambient humidity.

In parallel with these changes due to the influence of environmental factors, we must mention the effects of the preservative solutions on specimens (Fig. 6, Fig. 8, Fig. 11). Wet preservation is done with the help of chemicals in the form of a solution (Papadopol 1964, 8). The chemicals are used simple (ethyl alcohol, formaldehyde, sodium chloride solution, acetic acid) or in combination with various other compounds (copper acetate, copper sulfate, magnesium sulfate, lactophenol, glycerin). They come with a number of advantages and disadvantages. For example, we will observe in the evaluated specimens that formaldehyde discolors, stiffens and destroys the genetic material of a specimen (Fig. 7, Fig. 10). In part this is also the case for the ethyl alcohol that causes color changes due to the contraction, oxidation and extraction of the soluble pigments (Fig. 5) (Simmons, Snyder 2012, 118). To counteract some of those effects, the literature mentions the use of certain combinations of chemical compounds. For example, some combinations can preserve the colors in certain fungi, plants or animals while others can neutralize the acidic pH of formaldehyde in the case of preserved mollusks or crustaceans (Nadra 1955, 91), but they are not effective in all the cases.

Preservative solutions are intended to stabilize those parts of the specimen that tend to disintegrate. Therefore, it is important to know the concentration and properties of the liquid in which the specimen is stored. The optimum concentration in preservation in ethyl alcohol is 70%, but there are cases where the specimens are kept at a concentration of less than 70%, for

example in the case of some nematode species (60-65%) or in the first stage of preparation for some species (initial fixation). If the purpose is to preserve genetic material, it will be used a higher concentration of ethanol (ethyl alcohol 96%). The use of low concentrations leads to an accelerated decomposition, as in the case of the specimens from Fig. 13 A-C.

In the case of formaldehyde, the concentrations differ depending on the species from 2 to 7%. In this type of preservative, specimens that have calcareous parts can not be kept because its acidity dissolves calcium carbonate, as it can be seen in Fig. 9. The answers to this issues were found in time, from experience. In literature we find combinations of solutions that try to remove the disadvantage of formaldehyde for example, as is the addition of sodium carbonate in order to preserve the shell of mollusks or the addition of glycerin in shellfish preservation (Handrea 1957, 271).

Regarding the way of describing the degradations, they can be expressed proportionally, depending on the severity. In some cases it is possible that the degradations are irreversible (Fig. 13 A, B) and no intervention helps the object to return to a shape or condition close to the original one. An example of irreversible damage is seen in the specimens of *Sardinia* sp., which turned into an organic paste (Fig. 13 C).
We mention that this evaluation is prior to the elaboration of the restoration methodology. This is a guide to the next steps. Following this evaluation, it will be established according to the legislation in force (H.G. 1546/2003) whether the object will follow an itinerary through the investigation and restoration laboratories.

The topics that we addressed outline the aspects to be followed during the evaluation, but there may be other observations that are more than welcome for the subsequent establishment of the restoration methodology. To complete these observations, in the next step of the evaluation, laboratory investigations will be performed (physical analysis, chemical - chemical tests, microscopic examinations, etc.) and subsequently a correlation of all the knowledge about the specimen.

A clear and correct assessment of the state of conservation will help us to identify the causes and mechanisms that act in the degradation of objects and choose the right method of treatment.
In this paper, the pictures of the objects were taken with the Nikon D5300 camera and the data on the name of the pieces were taken from the inventory register of the Museum of Natural History.

Acknowlegdements

Thanks to Dr. Nicolae Trif (Natural History Museum from Sibiu), for his contribution to the photographic documentation of this article and for his suggestions. Also, we greatly appreciate the useful comments and corrections of Miss Alexandra Maria Gălăbuț (Brukenthal National Museum), Dr. Gabriel Bogdan Chișamera (”Grigore Antipa” National Museum of Natural History, Bucharest) and Dr. Mirel-Vasile Bucur (Lucian Blaga University of Sibiu) which improved our manuscript.

REFFERENCES

Baer, Banks 1994 — Baer Norbert, Banks Paul, *Indoor air pollution: effects on cultural and historical materials*, In Care of Collections, London (1994), 331 pp.

Ciobanu *et al*. 2014 — Ciobanu Rodica, Păpureanu Ana-Maria, Cuzepan Gabriela, Vonica Ghizela, Popa Tudor, Proiectul traseul cultural - *Drumul Colecțiilor Muzeului de Istorie Naturală*, Sibiu (2014), 70 pp.

Found, Helwig 1994 — Found Christine, Helwig Kate, *The reliability of spot tests for the detection of arsenic and mercury in natural history collections: a case study*, In Collection Forum, (1994), 11(1), p. 6-15.

Handrea 1957 — Handrea Iustin, *Muzeul școlar*, București (1957), 702 pp.

H.G. 1546 / 2003 — Hotărârea nr. 1546 din 18 decembrie 2003 pentru aprobarea Normelor de conservare și restaurare a bunurilor culturale mobile clasate.

Linnie 1994 — Linnie Martyn, *Pest control in museums: the use of chemicals and associated health problems*, In Care of Collections, London (1994), 331 pp.

Marte *et al*. 2006 — Marte Fernando, Pequignot Amandine, von Endt David W., *Arsenic in taxidermy collections: history, detection and management*, In Collection Forum, (2006), 21(1–2): 143-150.

Mârza 2004 — Mârza Eva, *Muzeologie generală*, Alba Iulia (2004), 210 pp.

Mihalcu 1970 — Mihalcu Mihai, *Conservarea obiectelor și a monumentelor istorice*, București (1970), 307 pp.

Moldoveanu 2009 — Moldoveanu Aurel, *Conservarea preventivă a bunurilor culturale*, București (2009), 581 pp.

Nadra 1955 — Nadra Emil, *Colectarea, conservarea și naturalizarea vertebratelor pentru muzee*, Timișoara, (1955).

Papadopol 1964 — Papadopol Aurel, *Confecționarea materialului didactic pentru științele naturii*, București (1964).

Patchett 2010 — Patchett Merle, *Putting animals on display: geographies of taxidermy practice*, Faculty of Law, Business and Social Sciences, University of Glasgow, (2010), PhD thesis.

Simmons, Muñoz-Saba 2005 — Simmons John, Muñoz-Saba Yaneth, Historia de las colecciones biológicas, In *Conservacion Internacional*, (2005), 1: 31-43.

Simmons, Snyder 2012 — Simmons John, Snyder Julianne, *Observation and Distillation—Preservation, Depiction, and the Perception of Nature*, In Bell, C. J., The Herpetological Legacy of Linnaeus: A Celebration of the Linnaean Tercentenary, Bibliotheca Herpetologica (2012), 9(1–2): 115–134.

Stockholm Convention 2001 — Stockholm Convention on persistent organic pollutions (POPs), Stockholm, Sweden (2001), Regulamentul (CE) nr. 850/2004 al Parlamentului European și al Consiliului (www.pops.int).

LIST OF ILUSTRATIONS

Fig. 1. Degradation of the container followed by dehydration of the specimen in the case of *Eledone moscata* - no inventory number: A - broken container at the base, absence of the preservative liquid and slightly dehydrated specimen, B - appearance of the cracked jar after moving the specimen, C - appearance of the specimen after rehydration, replacement of the liquid and of the container.

Fig. 2. Degradation on several types of lids: A - corrosion at the inside of a metal cover, *Phoxinus phoxinus, Sabanejewia aurata* - inv. no. P598-599, B - fragmentation of the external seal made of painted cellophane, *Arenicola marina* - inv. no. V33, C - fragmentation of an external organic membrane seal, *Amphisbaena* sp. - inv. no. R64.

Fig. 3. Degradation of the outer seal of glass containers: A - fragmentation of the external seal made of cellophane, *Dentex dentex* - inv. no. P360, B - fragmentation of the external seal made of organic membrane, *Hemidactylus turcicus* - inv. no. R23.

Fig. 4. Degradations of the paper labels: A - stains and dirt on a label from 1896 applied on the outside of the container, *Vipera berus* - inv. no. R232/2739, B - yellowing on a label applied on the outside of the jar, *Pelobates fuscus* - inv. no. Ab50, C - fragmentation of a label from a container with completely evaporated liquid, *Lacerta viridis* - inv. No. R77.

Fig. 5. Changes in the normal aspect of the preservative liquid (70% ethyl alcohol): A - colouring of the liquid (yellowing), *Psammechinus lividus* - inv. no. E78, B, C - colouring and turbidity of the liquid with grease floating on the surface, *Lota lota* - inv. no. P213 and *Leuciscus cephalus* - inv. no. P140

Fig. 6. Changes in the normal aspect of the preservative liquid (unknown concentration of formaldehyde): A - after evaporation the level of the liquid falls below the level of the pieces, *Engraulis encrasicolus ponticus* - inv. no. P51, B - evaporation and colouring of the liquid (yellowing), *Vipera berus* - inv. No. R232 / 2739.

Fig. 7. Reversibility of complete dehydration in the case of small size fishes samples (less than 10 cm long) preserved in formaldehyde, *Phoxinus phoxinus*, *Sabanejewia aurata* - inv. no. P598-599: A - dehydrated, deformed, partially discolored specimens, with white deposits (precipitated salts) on the skin and rust deposits from inside the container, B - appearance of specimens after restoration works (rehydration).

Fig. 8. Aspects of complete evaporation of the preservative liquid (formaldehyde), A – *Aspro vulgaris* - inv. no. P346, B – *Amphibolurus muricatus* - no inventory number, C – *Natrix natrix* - inv. no. R357; manifested by drying, stiffening (A, B, C), total discoloration (A) or partial discoloration (B) of the specimens, appearance of deposits (B - precipitated salts on the skin of the specimen), appearance of deposits on the inside and bottom of the container (C).

Fig. 9. Shell disintegration due to the acidity of formaldehyde, *Rapana venosa* - no inventory number: A- cloudy appearance of the liquid, B - the presence of deposits, mattification of the shell and fading of colors.

Fig. 10. Aspects of complete dehydration: A - cracked skin and detached scales on *Hemidactylus turcicus* - inv. no. R77, B - discoloration and loss of morphological characteristics at *Pipistrellus pipistrellus* - inv. no. M80, C - deformation of intestinal parasitic nematodes specimens from *Tetrao urogallus* - inv. no. V68.

Fig. 11. Deposits on the skin surface formed after the specimen dehydration and complete evaporation of the preservative liquid in the case of two species of amphibians: A - *Bombina variegata* - no inventory number, B - *Pelobates fuscus* - inv. no. Ab50.

Fig. 12. Biodegradation caused by a fungal attack on a blackbird juvenile, *Turdus merula* - no inventory number: A - general appearance - cracked container without lid, liquid with color changes and fat deposits, B - detailed appearance of the specimen, C - macroscopic

appearance of the mold deposited on the specimen.

Fig. 13. Cases of decay at biological material: A - the lower half of the body is covered by a white mucilaginous layer (putrefaction) at a specimen which belong to the family Soricidae - no inventory number, B - partial decomposition due to inefficient preservation (low concentration of the liquid) at a specimen belonging to the order Chiroptera - no inventory number, C - irreversible damage, transformation of the specimen into an organic paste (total disintegration), *Sardinia pilchardus* - inv. no. P45.

LISTA ILUSTRAŢIILOR

Fig. 1. Degradarea recipientului urmată de deshidratarea specimenului în cazul lui *Eledone moscata* – fără număr de inventar: A – recipient spart la bază, fără lichid conservant și exemplar deshidratat ușor, B – aspect al borcanului spart după mutarea specimenului, C – aspect al specimenului după rehidratare, înlocuirea lichidului și a recipientului.

Fig. 2. Degradări la mai multe tipuri de capace: A – coroziune pe interiorul unui capac metalic la *Phoxinus phoxinus, Sabanejewia aurata* – nr. inv. P598-599, B – fragmentare la un sigiliu extern din celofan vopsit la *Arenicola marina* – nr. inv. V33, C – fragmentare la un sigiliu extern din membrană organică la *Amphisbaena sp.* – nr. inv.. R64.

Fig. 3. Degradări ale sigiliului exterior al recipientelor de sticlă: A – fragmentare la învelișul din celofan al capacului la *Dentex dentex* – nr. inv. P360, B – fragmentare la învelișul extern din membrană organică la *Hemidactylus turcicus* – nr. inv. R23.

Fig. 4. Degradări ale etichetelor de hârtie: A – pete și murdărie pe o etichetă din 1896 aplicată pe exteriorul recipientului la *Vipera berus* – nr. inv. R232/2739, B – îngălbenire la o etichetă aplicată pe exteriorul borcanului la *Pelobates fuscus* – nr. inv. Ab50, C – fragmentarea unei etichete dintr-un recipient cu lichid evaporat complet la *Lacerta viridis* – nr. inv.. R77.

Fig. 5. Modificări ale aspectului normal al lichidului conservant (alcool etilic 70%): A – colorarea lichidului (îngălbenirea) la *Psammechinus lividus* – nr. inv. E78, B, C – colorarea și tulburarea lichidului (grăsime care plutește la suprafața lichidului) la *Lota lota* – nr. inv. P213 și *Leuciscus cephalus* – nr. inv. P140

Fig. 6. Modificări ale aspectului normal al lichidului conservant (formaldehidă de concentrație necunoscută): A – scăderea lichidului sub nivelul pieselor la *Engraulis encrasicolus ponticus* – nr. inv. P51, B – evaporarea și colorarea lichidului (îngălbenirea) la *Vipera berus* – nr. inv. R232/2739.

Fig. 7. Reversibilitatea deshidratării complete în cazul unor specimene de pești *Phoxinus phoxinus, Sabanejewia aurata* – nr. inv. P598-599, de dimensiuni mici (sub 10 cm lungime) conservați în formaldehidă: A – specimene deshidratate, deformate, decolorate parțial, cu depuneri (precipitat) cu culoare albă pe tegument și depuneri de rugină în recipient, B – aspectul unor exemplare după lucrări de restaurare (rehidratare).

Fig. 8. Aspecte ale evaporării complete a lichidului conservant (formaldehidă) la *Aspro vulgaris* – nr. inv. P346, *Amphibolurus muricatus* – no inventory number și *Natrix natrix* – nr. inv. R357, manifestate prin uscarea, rigidizarea (A, B, C), decolorarea totală (A) sau parțială (B) a exemplarelor, apariția depunerilor (B – săruri precipitate pe tegumentul exemplarului), apariția depunerilor pe interiorul și la fundul recipientului (C).

Fig. 9. Dizolvarea cochiliei datorată acidității formaldehidei la *Rapana venosa* – fără număr de inventar : A- aspect tulbure al lichidului, B – prezența depunerilor, matifierea cochiliei și estomparea culorilor.

Fig. 10. Aspecte ale deshidratării complete: A – tegument cu fisuri, solzi desprinși la *Hemidactylus turcicus* – nr. inv. R77, B - decolorare și pierderea caracteristicilor morfologice la *Pipistrellus pipistrellus* – nr. inv. M80, C – deformarea specimenelor de viermi paraziți la *Tetrao urogallus* – nr. inv. V68.

Fig. 11. Aspectul depunerilor la suprafața tegumentului apărute în urma deshidratării și a evaporării complete a lichidului conservant în cazul a două specii de amfibieni: A – *Bombina variegata* – fără număr de inventar , B – *Pelobates fuscus* – nr. inv. Ab50.

Fig. 12. Biodegradare produsă de un atac fungic la un juvenil de mierlă *Turdus merula* - fără număr de inventar: A - aspect general - recipient crăpat, fără capac, lichid cu modificări de culoare și depuneri de grăsime, B - aspect detaliat al specimenului, C - aspect macroscopic al mucegaiului depus pe specimen.

Fig. 13. Cazuri de descompunere a materialului biologic : A – jumătatea inferioară a corpului este acoperită de un strat mucilaginos de culoare albă la un exemplar din familia Soricidae – fără număr de inventar, B – descompunere parțială datorată conservării ineficiente (concentrație scăzută a lichidului) a unui specimenului din ordinul Chiroptera - fără număr de inventar, C – deteriorarea ireversibilă, transformarea specimenului într-o pastă organică la *Sardinia pilchardus* – nr. inv. P45.

Fig. 1. Degradation of the container followed by dehydration of the specimen in the case of *Eledone moscata* - no inventory number: A - broken container at the base, absence of the preservative liquid and slightly dehydrated specimen, B - appearance of the cracked jar after moving the specimen, C - appearance of the specimen after rehydration, replacement of the liquid and of the container.

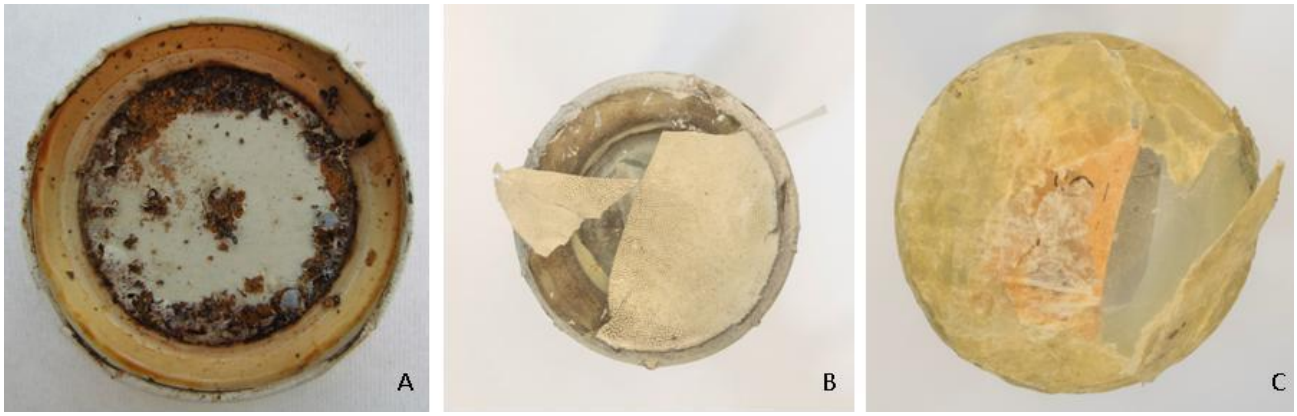


Fig. 2. Degradation on several types of lids: A - corrosion at the inside of a metal cover, *Phoxinus phoxinus, Sabanejewia aurata* - inv. no. P598-599, B - fragmentation of the external seal made of painted cellophane, *Arenicola marina* - inv. no. V33, C - fragmentation of an external organic membrane seal, *Amphisbaena* sp. - inv. no. R64.

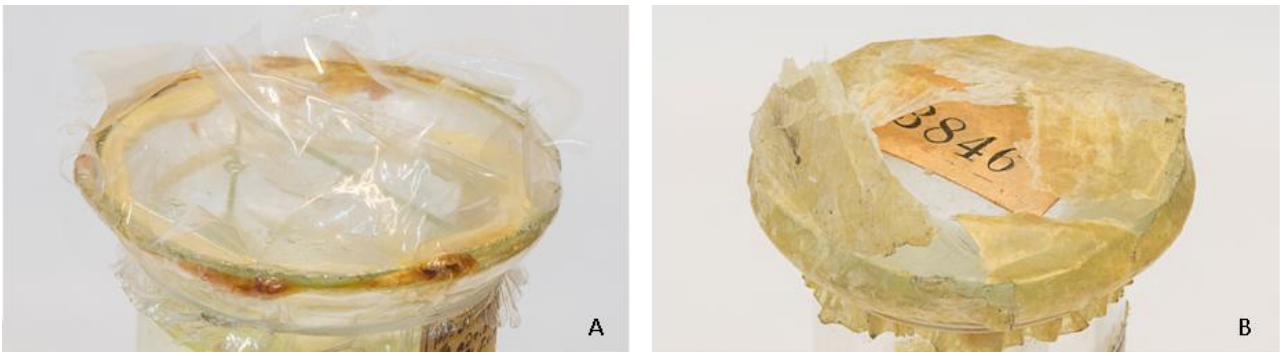


Fig. 3. Degradation of the outer seal of glass containers: A - fragmentation of the external seal made of cellophane, *Dentex dentex* - inv. no. P360, B - fragmentation of the external seal made of organic membrane, *Hemidactylus turcicus* - inv. no. R23.

Fig. 4. Degradations of the paper labels: A - stains and dirt on a label from 1896 applied on the outside of the container, *Vipera berus* - inv. no. R232/2739, B - yellowing on a label applied on the outside of the jar, *Pelobates fuscus* - inv. no. Ab50, C - fragmentation of a label from a container with completely evaporated liquid, *Lacerta viridis* - inv. no. R77.

Fig. 5. Changes in the normal aspect of the preservative liquid (70% ethyl alcohol): A - colouring of the liquid (yellowing), *Psammechinus lividus* - inv. no. E78, B, C - colouring and turbidity of the liquid with grease floating on the surface, *Lota lota* - inv. no. P213 and *Leuciscus cephalus* - inv. no. P140

Fig. 6. Changes in the normal aspect of the preservative liquid (unknown concentration of formaldehyde): A - after evaporation the level of the liquid falls below the level of the pieces, *Engraulis encrasicolus ponticus* - inv. no. P51, B - evaporation and colouring of the liquid (yellowing), *Vipera berus* - inv. no. R232/2739.

Fig. 7. Reversibility of complete dehydration in the case of small size fishes samples (less than 10 cm long) preserved in formaldehyde, *Phoxinus phoxinus*, *Sabanejewia aurata* - inv. no. P598-599: A - dehydrated, deformed, partially discolored specimens, with white deposits (precipitated salts) on the skin and rust deposits from inside the container, B - appearance of specimens after restoration works (rehydration).

Fig. 8. Aspects of complete evaporation of the preservative liquid (formaldehyde), A – *Aspro vulgaris* - inv. no. P346, B – *Amphibolurus muricatus* - no inventory number, C – *Natrix natrix* - inv. no. R357; manifested by drying, stiffening (A, B, C), total discoloration (A) or partial discoloration (B) of the specimens, appearance of deposits (B - precipitated salts on the skin of the specimen), appearance of deposits on the inside and bottom of the container (C).

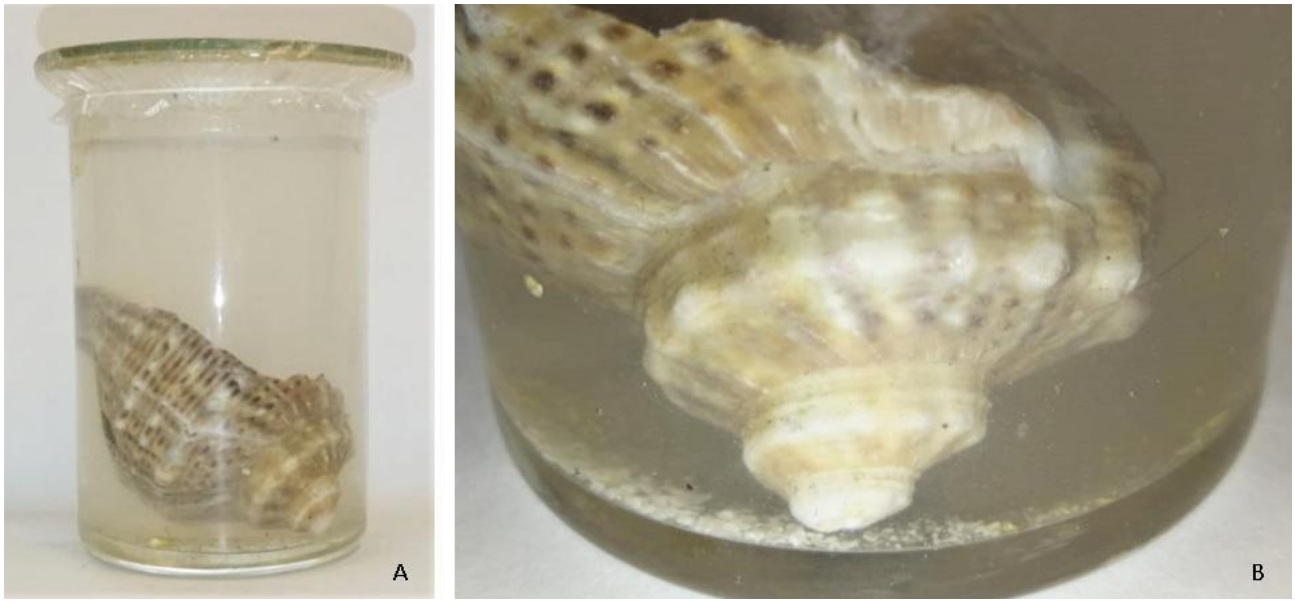


Fig. 9. Shell disintegration due to the acidity of formaldehyde, *Rapana venosa* - no inventory number: A - cloudy appearance of the liquid, B - the presence of deposits, mattification of the shell and fading of colors.

Fig. 10. Aspects of complete dehydration: A - cracked skin and detached scales on *Hemidactylus turcicus* - inv. no. R77, B - discoloration and loss of morphological characteristics at *Pipistrellus pipistrellus* - inv. no. M80, C - deformation of intestinal parasitic nematodes specimens from *Tetrao urogallus* - inv. no. V68.

Fig. 11. Deposits on the skin surface formed after the specimen dehydration and complete evaporation of the preservative liquid in the case of two species of amphibians: A - *Bombina variegata* - no inventory number, B - *Pelobates fuscus* - inv. no. Ab50.

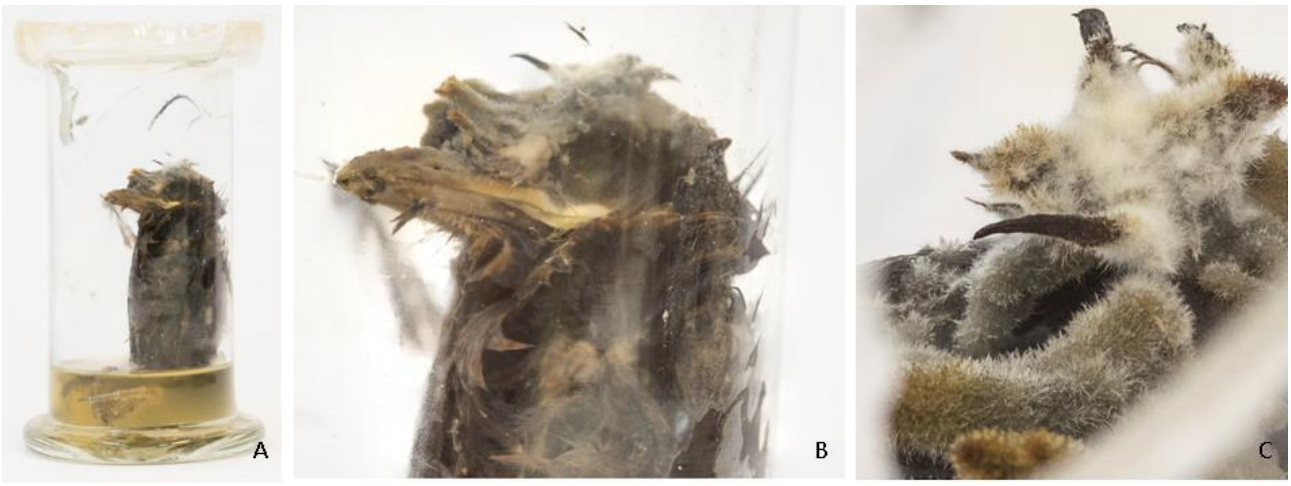


Fig. 12. Biodegradation caused by a fungal attack on a blackbird juvenile, *Turdus merula* - no inventory number: A - general appearance - cracked container without lid, liquid with color changes and fat deposits, B - detailed appearance of the specimen, C - macroscopic appearance of the mold deposited on the specimen.

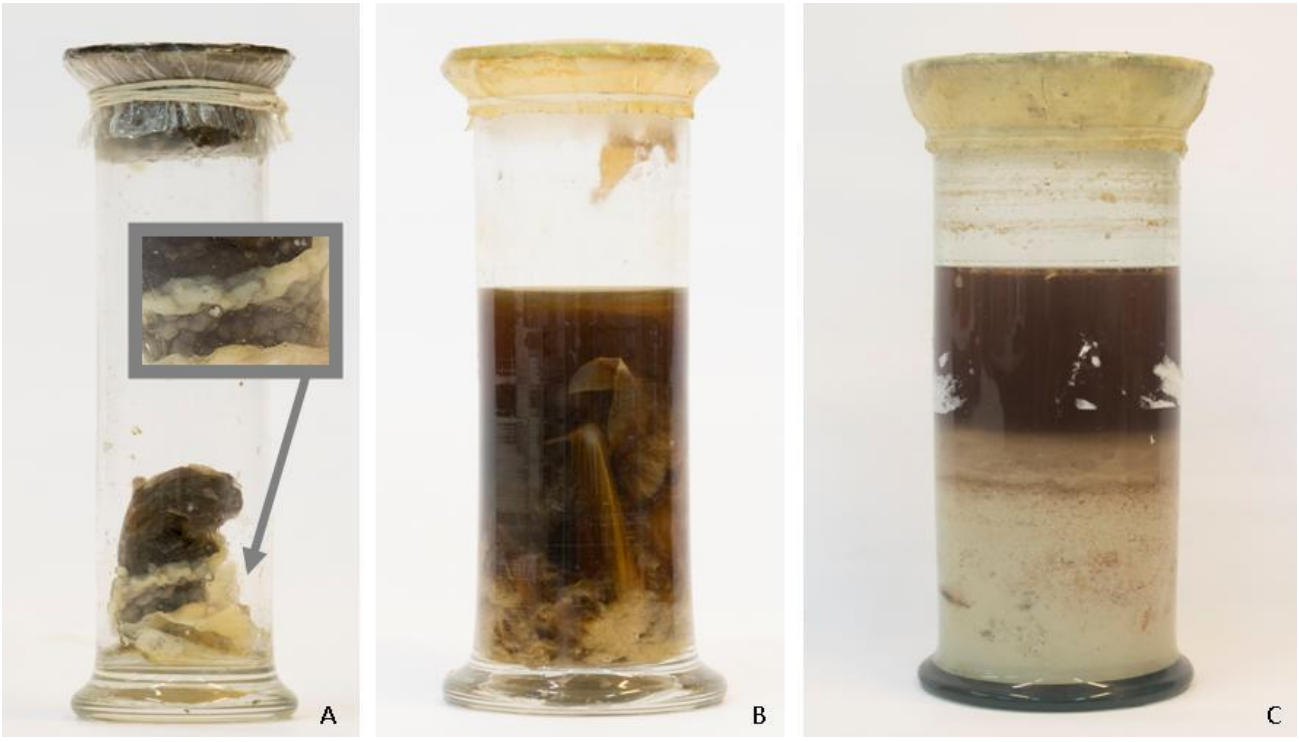


Fig. 13. Cases of decay at biological material: A - the lower half of the body is covered by a white mucilaginous layer (putrefaction) at a specimen which belong to the family Soricidae - no inventory number, B - partial decomposition due to inefficient preservation (low concentration of the liquid) at a specimen belonging to the order Chiroptera - no number inventory, C - irreversible damage, transformation of the specimen into an organic paste (total disintegration), *Sardinia pilchardus* - inv. no. P45.

GENUS *Centaurea s. l.* IN THE NATURAL HISTORY MUSEUM FROM SIBIU

Ghizela VONICA*

Abstract. *The paper includes the redetermination of specimens from the genus Centaurea s.l., belonging to the botanical scientific heritage of the Natural History Museum, an integral section of the Brukenthal National Museum from Sibiu. The specimens were checked and classified according to the current nomenclature accepted by specialists from worldwide. Only the specimens of the Centaurea subgenus and the Lopholoma subgenus were discussed in this paper. The subgenus Cyanus being excluded in the results of this paper because on european level it is recognized as a genus.*
Keywords*: Centaurea s.l. genus, Cyanus genus, Lopholoma and Centaurea subgenus, botanical museum heritage.*

Rezumat. *Lucrarea cuprinde redeterminarea specimenelor din genul Centaurea s.l., aparținând patrimoniului științific botanic al Muzeului de Istorie Naturală, secție integrantă a Muzeului Național Brukenthal din Sibiu. Specimenele au fost verificate și încadrate conform nomenclaturii actuale acceptate de specialiști la nivel mondial. Doar specimenele care aparțin subgenului Centaurea și subgenului Lopholoma au fost discutate în lucrarea de față. Subgenul Cyanus fiind exclus în rezultatele acestei lucrări deoarece la nivel European acesta este recunoscut ca gen.*
Cuvinte cheie: *Genul Centaurea s.l., genul Cyanus, subgenul Lopholoma și Centaurea, patrimonial muzeal botanic.*

Introduction

The genus *Centaurea* s.l. into Flora Europaea-(RBGE) has been one of the largest and taxonomically most difficult genera of the *Asteraceae* Families. According to the used classification, the genus comprises between 200 and 700 species predominantly distributed in Europe (Bancheva, Greilhuber 2006; Greuter 2006). The Mediterranean area and Balcan Peninsula are important centres of *Centaurea* origin and diversity (Bancheva, Greilhuber 2006; Wagenitz, Hellwig 1996). The delimitation of *Centaurea* genus is problematical, because it is a non-monophyletic group (Boršič *et al*. 2011; Hilpold *et al*. 2014, Susanna, Garcia-Jacas 2007). Therefore, since modern genetical analysis there is increased interest in the phylogeny and evolution of *Centaurea* traits, including morphological traits (Bancheva, Greilhuber 2006; Hilpold *et al*. 2014; Koutecký 2007; Vonica, Cantor 2011; Vonica *et al*. 2013).

Regarding the infrageneric systematics, it is not possible to specify exactly which sections and subsections are part of it, because there are very slightly differences between the type of classification systems adopted.

* Brukenthal National Museum, Natural History Museum, Sibiu, Romania ghizela.vonica@brukenthalmuseum.ro

Morphological analyses performed at European level in corellation with genetic analyses (Bancheva, Greilhuber 2006), palynological and geographical distribution revealed within the genus, three subgenera: *Centaurea* senso stricto, *Lopholoma* and *Cyanus* (Boršič *et al*. 2011; Susanna, Garcia-Jacas 2007). Sections and subsections included in this genus also underwent changes in composition, in the same way of the classification system splitted (Hilpold *et al*. 2014).

Actually in Romania, there is no clear and updated classification system, which takes into account recent molecular studies, or biogeographic studies. So, this study will adopt the systematic classification proposed by Hilpold *et al*. (2014) which largely overlaps with the classification provided by Susanna and Garcia-Jacas 2007, Vonica *et al*. (2013) and Wagenitz and Hellwig (1996) (Tab. 1).

The systematics of the genus and the affiliation of museum specimens to this genus represent an important stage in the management and scientifical use of the botanical heritage. The dryed plant collection of the Natural History Museum is part of the scientific heritage of the Brukenthal National Museum which has an invaluable historical value at national level. The *Centaurea* genus, an integral part of this heritage

is very well represented in the museum's collections, most of them being collected from the Transylvania area but also from other parts of Romania (approximate 70%). Most specimens are collected by famous botanists (M. Fuss, G. Baumgarten, F. Porcius, E.I. Nyárády etc.) and a small part comes from their exchanges with other botanists of Europe. Herbal material is an excellent source of phyto-geographical (chorological) documentation or an important source of comparison in diagnostic or systematic studies.

Material and methods

The dryed plants collection of the Natural History Museum from Sibiu includes over 2500 *Centaurea* specimens from different collections: Fuss Herbarium, Barth Herbarium, Baumgarten Herbarium, Herbarium of the Transylvanian Society of Natural Sciences at Sibiu / Hermannstadt, Kayser Herbarium, Kisch Herbarium, E. I. Nyárády Herbarium, Ioan Pop Herbarium, Porcius Herbarium, Ungar Herbarium, Untchj Herbarium, Herbarium Normale Florae Transylvaniae etc. The specimens are archived and their taxonomy revised periodically according Euro+Med Plant Base (2006), T*he Plant List (2013)*, IPNI (2008) and Hilpold *et al.* (2014) (see Tab. 2). The systematic splitted was made with the necessary observations according to the last accepted systems.

The *Centaurea* specimens from Transylvania territory were verified by multivariate statistical analyzes performed on the basis of morphometric measurements of the preserved material (Vonica *et al*. 2013). For some of these, the material was redetermined in early works, where macroscopically it was not possible. For each specimen was noted the collecting area, current scientific name and initial identification from the museum specimen label, inventory number, collecting date (Contry, area, county or district and place), date of collecting, Name of collector and the name of herbarium collection.

Genus *Centaurea* sensu stricto

Sect. *Centaurea*

1. C. besseriana DC.

(*C. virgata* Besser, *Acosta besseriana* (DC.) Soják, C. *ovina* subsp. *besseriana* (DC.) Dostál)
Collecting area: RO, CT, Dobrogea, Cernavodă, inventory no. 82.825 (Herbar Fuss Annex), date: 5.07.1872, collected by Zanlea;

2. C. diffusa Lam.
Collecting area: RO, Dobrogea, inventory no. 53.545 (H. Barth), date: 1.07.1884, collected by Isăcescu;

Collecting area: RO, CT, Mamaia Seaside, inventory no. 105.326 (H. Pop), date: 25.08.1950, collected by I. Pop; Vama Veche, inventory no. 105.327 (H. Pop), date: 18.08.1967, collected by I. Pop; Medgidia, Basarabi Hill, inventory no. 105.328 (H. Pop), date: 17.07.1963, collected by I. Pop; Vasile Roaită, inventory no. 115.362 (H. Nyárády), date: 1.10.1917, collected by E.I. Nyárády;

Collecting area: RO, TL, I. G. Duca, Surighiol, inventory no. 115.360 (H. Nyárády), date: 26.07.1949, collected by E.I. Nyárády; Bestepe, between Mahmudia and Beștepe, inventory no. 115.361 (H. Nyárády), date: 27.07.1949, collected by E.I. Nyárády;

Collecting area: RO, CS, Iron Gate, Virciorova, inventory no. 115.351 (H. Nyárády), date: 16.07.1928, collected by E.I. Nyárády;

Collecting area: RO, MH, Gura Văii, Train Station, inventory no. 115.358 - 115.359 (H. Nyárády), date: 1.07.1928, collected by E.I. Nyárády;
Collecting area: RO, HR, Odorheiu Secuiesc inventory no. 25.090 (H. Fuss - *C. paniculata* L.) date: -, collected by Szabo;

Collecting area: RO, HD, Orăștie, inventory no. 25.091 (H. Fuss - *C. paniculata* L.), date: -, collected by Unverricht;

Collecting area: RO, SB, Nou, inventory no. 25.092 (H. Fuss - *C. paniculata* L.), date: 27.07.1840, collected by M. Fuss; Șura Mare, inventory no. 5.093 (H. Fuss - *C. paniculata* L.), date: 20.07.1856, collected by M. Fuss;

3. C. jurineifolia Boiss.

(incl. ***Centaurea pseudobovina*** **Hayek**)
Collecting area: RO, TL, Ciolănești, Manafu Forest, inventory no. 115.520 (H. Nyárády - FRE 2699), date: 17.08.1944, collected by Morariu; Babadag Forest, inventory no. 115.523 (H. Nyárády), date: 14.07.1931, collected by E.I. Nyárády;

Collecting area: RO, GR, Frasin Forest, Giurgiu, inventory no. 115.521 - 115.522 (H. Nyárády), date: 29.06.1928, collected by E.I. Nyárády;

4. C. reichenbachii DC.
(*Acosta calvescens* (Pančić) Holub; *Acosta reichenbachioides* (Hayek) Holub; *C. calvescens* Pančić, *C. dacica* Borza; *C. reichenbachioides* Hayek, *C. stoebe* subsp. *calvescens* (Pančić) Hayek)

Collecting area: RO, AB, Piatra Caprii, inventory no. 70.021 (H. Untchj), date: 15.07.1883, collected by Csató; Poșaga, Belioara Gorge, inventory no. 115.904 (H. Nyárády - *C. dacica* Borza, *C. calvescens* Pančić), date: 27.07.1920, collected by A. Borza; Runc, Poșovaliște Valley, inventory no. 115.905 (H. Nyárády - *C. dacica* Borza, *C. reichenbachioides* Hayek), date: 13.07.1911, collected by E.I. Nyárády; inventory no. 115.906 (H. Nyárády, *C. dacica* Borza, *C. stoebe* subsp. *calvescens* (Pančić) Hayek), date: 13.07.1911, collected by E.I. Nyárády;

Collecting area: RO, SB, Sibiu, inventory no. 25.046 (H. Fuss - *C. maculosa micranthos* (Gmel) Gugl.), date: 18.07.1867, collected by M. Fuss; Ocna Sibiului, inventory no. 25.047 (H. Fuss - *C. maculosa micranthos* (Gmel) Gugl.), date: 6.10.1859, collected by M. Fuss; Șura Mare, inventory no. 25.048 (H. Fuss - *C. maculosa micranthos* (Gmel) Gugl.), date: 25.07.1859, collected by M. Fuss;

Collecting area: RO, CS, Banat, Cioclovina, inventory no. 115.281 (H. Nyárády - *C. calvescens* Pančić), date: 21.07.1906, collected by Wagner;

5. C. stoebe L.

Collecting area: RO, Transylvania, inventory no. *hiouzdidt*35.030 (Flora Transsilvanica - *C. rhenana* Boreau), date: -, collected by Lerchenfeld; inventory no. 47.422 (Society Herbarium - *C. rhenana* Boreau), date: -, collected by Kladny; inventory no. 25.053 (H. Fuss - *C. maculosa rhenana* Gugler), date: 21.07.1876, collected by M. Fuss;

Collecting area: RO, BV, Brașov, inventory no. 95.683 (H. Heltmann - *C. rhenana* Boreau), date: 14.08.1962, collected by H. Heltmann;
Collecting area: RO, AB, on way Cristești, inventory no. 115.910 (H. Nyárády - *C. rhenana* Boreau), date: 9.08.1960, collected by A. Nyárády; Aiud, inventory no. 70.019 (H. Untchj - *C. maculosa* Lam.), date: 10.08.1883, collected by Csató;

Collecting area: RO, CJ, Turda Gorge, inventory no. 115.911 (H. Nyárády - *C. rhenana* Boreau), date: 8.09.1933, collected by E.I. Nyárády; inventory no. 115.912 (H. Nyárády - *C. rhenana* Boreau), date: 15.07.1934, collected by E.I. Nyárády; inventory no. 115.913 (H. Nyárády - *C. rhenana* Boreau), date: 17.09.1933, collected by E.I. Nyárády; on roky slope near Porlic place, on calc. soil, inventory no. 115.914 (H. Nyárády - *C. rhenana* Boreau), date: 19.08.1933, collected by E.I. Nyárády; on medows near train station, inventory no. 115.919 (H. Nyárády - *C. rhenana* Boreau), date: 04.08.1947, collected by E.I. Nyárády; Cojocna, inventory no. 115.915 (H. Nyárády - *C. rhenana* Boreau), date: 1.08.1911, collected by E.I. Nyárády; Făget, inventory no. 115.921 (H. Nyárády - *C. rhenana* Boreau), date: 28.07.1923, collected by E.I. Nyárády;

Collecting area: RO, BN, Forțata, inventory no. 115.917 (H. Nyárády - *C. rhenana* Boreau), date: 14.08.1948, collected by I. Morariu;

Collecting area: RO, CV, Căpeni, on Olt Valley, inventory no. 115.920 (H. Nyárády - *C. rhenana* Boreau), date: 19.08.1925, collected by E.I. Nyárády;

Collecting area: RO, SB, Sibiu, inventory no. 47.421 (Society Herbarium - *C. rhenana* Boreau), date: -, collected by Sill; inventory no. 25.043, (H. Fuss - *C. maculosa* Lam., *C. rhenana* Boreau), date: 25.07.1863, collected by M. Fuss; inventory no. 95.404 (H. Gündisch - *C. stoebe* L.), date: 10.08.1952, collected by Fr. Gündisch; inventory no. 32.494 (H. Kayser - *C. maculosa* Lam.), date: 1.07.1874, collected by Kayser; sandy places, inventory no. 79.053 - 79.054 (H. Kisch - *C. maculosa* Lam.), date: 26.07.1910, collected by A. Schuller; Avrig, inventory no. 25.044 (H. Fuss - *C. maculosa* Lam., *C. coziensis* Nyár.), date: 26.07.1867, collected by M. Fuss; Mohu, inventory no. 25.045 (H. Fuss - *C. maculosa* Lam.), date: 18.07.1867, collected by M. Fuss; Bradu, inventory no. 25.049 (H. Fuss - *C. maculosa rhenana* Gugler), date: 2.08.1872, collected by M. Fuss; inventory no. 25.054 (H. Fuss - *C. maculosa rhenana* Gugler), date: -, collected by M. Fuss; Gușterița, inventory no. 25.050 (H. Fuss - *C. maculosa rhenana* Gugler), date: -, collected by Goeblet; Șura Mare, inventory no. 25.051 - 25.052 (H. Fuss - *C. maculosa rhenana* Gugler), date: 25.07.1859, collected by M. Fuss;

Collecting area: RO, BH, Rodereni, train station, inventory no. 105.366 (H. Pop - *C. rhenana* Boreau), date: 16.09.1951, collected by I. Pop;

Collecting area: RO, VL, Coziei Mt., inventory no. 115.297, 115.299 (H. Nyárády - *C. cirrata* Rchb.), date: 20.06.1950, collected by E.I. Nyárády; inventory no. 115.301 - 115,302 (H.

Nyárády - *C. coziensis* Nyar.), date: 19.08.1950, collected by E.I. Nyárády; Foarfeca Mt., Lotru, inventory no. 115.298, 115.300 (H. Nyárády - *C. coziensis* Nyar.), date: 13.06.1951, collected by E.I. Nyárády;

Collecting area: RO, TL, Marile Hîrtoape, between Duca and Mahmudia, inventory no. 115.907 (H. Nyárády - *C. rhenana* Boreau), date: 27.07.1949, collected by E.I. Nyárády;

Collecting area: RO, CS, Buziaș, inventory no. 115.908 (H. Nyárády - *C. rhenana* Boreau), date: 26.06.1907, collected by E.I. Nyárády; inventory no. 115.918 (H. Nyárády - *C. rhenana* Boreau), date: 26.06.1907, collected by Prodan;

6. C. tauscheri A. Kern

Collecting area: RO, SJ, Bocșa, inventory no. 116.283 (H. Nyárády - *C. x tauscheri* Kern. hybrid), date: 7.07.1900, collected by Polgar;
Collecting area: RO, CJ, Lomb Mt., inventory no. 116.309 (H. Nyárády - hybrid between *arenaria x micranthos*), date: 28.07.1948, collected by E.I. Nyárády;

7. C. triniifolia Heuff.

Collecting area: RO, CS, Drencova, inventory no. 116.312 (H. Nyárády - *C. triniaefolia* Heuff.), date: 1.08.1905, collected by J. Wagner; between Berzoșca and Iurinica, inventory no. 116.313, 116.317 - 116.318 (H. Nyárády - *C. triniaefolia* Heuff.), date: 27.06.1907, collected by Nyárády & Wagner; Treșcovăț Mt., inventory no. 116.314 - 116.316 (H. Nyárády - *C. triniaefolia* Heuff.), date: 1.06.1951, collected by E.I. Nyárády;

Collecting area: RO, VL, Călimănești, Turnu Monastery, inventory no. 116.319 (H. Nyárády - *C. triniaefolia turnurosae* Nyar.), date: 21.08.1950, collected by E.I. Nyárády; between Turnu and Călimănești, inventory no. 116.321 (H. Nyárády - *C. triniaefolia turnurosae* Nyar.), date: 21.08.1950, collected by E.I. Nyárády; inventory no. 116.320 (H. Nyárády - *C. triniaefolia turnurosae* Nyar.), date: 19.08.1950, collected by E.I. Nyárády;

8. C. affinis Friv.

Collecting area: RO, GJ, Beleț Gorge, by Polovragi, inventory no. 115.024 - 115.025 (H. Nyárády - *C. affinis* Friv.), date: 22.06.1951, collected by E.I. Nyárády;

C. aggregata Fisch. & C. A. Mey. ex DC. (redeterminated as *C. stoebe* subsp. *australis* (A. Kern.) Greuter)

Collecting area: RO, SB, Cibin, inventory no. 47.416 (Society Herbarium - *C. chrysolopha* Boiss.), date: 6.07.1853, collected by M. Fuss;

9. C. arenaria M. Bieb. ex Willd.

Collecting area: RO, TM,Timiș - Deliblat, inventory no. 115.059 (H. Nyárády), date: 1.07.1898, collected by Wagner; Deliblat I,II, inventory no. 115.058, 115.060 (H. Nyárády - FEAH 3434), date: -, collected by Hayek;

Collecting area: RO, CT, Mamaia Seaside, inventory no. 105.293 (H. Pop), date: 17.07.1963, collected by I. Pop; inventory no. 115.057 (H. Nyárády - FRE 491), date: 1.07.1923, collected by Borza & Prodan; Euforie, inventory no. 115.061 (H. Nyárády), date: 30.07.1952, collected by E.I. Nyárády; Agigea, inventory no. 115.062 (H. Nyárády), date: 23.05.1958, collected by E.I. Nyárády; Vasile Roaită Village, inventory no. 115.063 (H. Nyárády), date: 30.09.1957, collected by E.I. Nyárády; Agigea Town, inventory no. 115.064 (H. Nyárády), date: 1.09.1957, collected by E.I. Nyárády;

10. C. stoebe subsp. *australis* (A. Kern.) Greuter

(*C. biebersteinii* subsp. *australis* (A. Kern.) Dostál**;** *C. micranthos* (Griseb.) Hayek [non *C. micrantha* Hoffmanns. & Link 1825]; *C. stoebe* subsp. *micranthos* (Griseb.) Hayek**)**

Collecting area: RO, Transylvania, inventory no. 47.435 (Society Herbarium - *C. spinosa* Koch), date: -, collected by Kladny;

Collecting area: RO, SB, Ocna Sibiului, inventory no. 77.091 (H. Ormay - *C. bibersteinii* DC), date: 13.08.1884, collected by Ormay; inventory no. 25.047 (H. Fuss - *C. maculosa micranthos* (Gmel) Gugl.), date: 6.10.1859, collected by M. Fuss; Șeica Mare, inventory no. 162.323 (H. Schneider - *C. micranthos* Gugl.), date: 27.07.1975, collected by E. Schneider; Bradu, inventory no. 77.092 (H. Ormay - *C. bibersteinii* DC), date: 19.10.1882, collected by Fuss; Sibiu, Șesul Măcelarilor, inventory no. 77.093 (H. Ormay - *C. bibersteinii* DC), date: 30.09.1882, collected by Ormay; inventory no. 77.293 (H. Ormay - *C. bibersteinii* DC), date: -, collected by Ormay; inventory no. 25.046 (H. Fuss - *C. maculosa micranthos* (Gmel) Gugl.), date: 18.07.1867, collected by M. Fuss; Turnișor, inventory no. 162.320 (H. Schneider - *C. micranthos* Gugl.), date: 4.09.1969, collected by E. Schneider; Gușterița, inventory no. 53.543 (H. Barth - *C. micranthos* Gugl.), date: 15.08.1905, collected by J. Barth; inventory no. 80.779 - 80.780 (H. Krauss, Hergotta, Klotz - *C. micranthos* Gugl.), date: 18.08.1868, collected by

Bielz; inventory no. 162.322 (H. Schneider - *C. micranthos* Gugl.), date: 4.07.1963, collected by E. Schneider; inventory no. 162.324 (H. Schneider - *C. micranthos* Gugl.), date: 8.08.1963, collected by E. Schneider; Șura Mare, inventory no. 25.048 (H. Fuss - *C. maculosa micranthos* (Gmel) Gugl.), date: 25.07.1859, collected by M. Fuss; Cristian, inventory no. 101.056 (H. Doltu - *C. micranthos* Gugl.), date: 15.07.1965, collected by M. Doltu; Râu Sadului, inventory no. 79.055 (H. Kisch - *C. biebersteinii* DC), date: 22.07.1907, collected by Kisch; between Ludoș and Bogatu, inventory no. 115.630 (H. Nyárády - *C. micranthos* Gugl.), date: 29.07.1911, collected by E.I. Nyárády; Talmaciu, Podu Olt, inventory no. 162.317, (H. Schneider - *C. micranthos* Gugl.), date: 6.06.1979, collected by E. Schneider; inventory no. 162.318, (H. Schneider - *C. micranthos* Gugl.), date: 4.07.1967, collected by E. Schneider; Cisnădioara, inventory no. 162.319 (H. Schneider - *C. micranthos* Gugl.), date: 5.07.1970, collected by E. Schneider;

Collecting area: RO, Lotru Mt., inventory no. 80.7812 (H. Krauss, Hergotta, Klotz - *C. micranthos* Gugl.), date: 8.08.1873, -, collected by Bielz;

Collecting area: RO, HD, Hațeg Valley, inventory no. 53,474 (H. Barth- *C. micranthos* Gugl.), date: 6.08.1889, collected by J. Barth;

Collecting area: RO, HD, Lancram, inventory no. 105.345 (H. Pop - *C. micranthos* Gugl.), date: 10.07.1951, collected by I. Pop; between Sebeș and Orăștie, inventory no. 115.609 - 115.610 (H. Nyárády - *C. micranthos* Gugl.), date: 19.08.1962, collected by A. Nyárády; Târnava de Criș, inventory no. 115.638 610 (H. Nyárády - *C. micranthos* Gugl.), date: 23.08.1911, collected by E.I. Nyárády;

Collecting area: RO, BN, Ștefănești Stone, inventory no. 115.610 - 115.611 (H. Nyárády - *C. micranthos* Gugl.), date: 20.07.1949, collected by E.I. Nyárády & A. Nyárády;

Collecting area: RO, AB, Valea Lungă, inventory no. 53.552 (H. Barth - *C. biebersteinii* DC.), date: 15.07.1903, collected by J. Barth; Blaj, Lupan Well, inventory no. 115.624 (H. Nyárády - *C. micranthos* Gugl.), date: 10.08.1922, collected by E.I. Nyárády; Ciumbrud, inventory no. 115.619 - 115.620 (H. Nyárády - *C. micranthos* Gugl.), date: 8.07.1911, collected by E.I. Nyárády; Rahău, inventory no. 115.628 (H. Nyárády - *C. micranthos* Gugl.), date: 15.07.1935, collected by E.I. Nyárády, Cenade, inventory no. 162.321 (H. Schneider - *C. micranthos* Gugl.), date: 16.07.1976, collected by E. Schneider;

Collecting area: RO, BV, Ghimbav, inventory no. 95.403 (H. Gündisch - *C. biebersteinii* DC), date: 11.07.1954, collected by Fr. Gündisch; Târnpa, inventory no. 70.018 (H. Untchj - *C. biebersteinii* DC), date: 1887, collected by Römer;

Collecting area: RO, CJ, Maior Village, inventory no. 115.613 (H. Nyárády - *C. micranthos* Gugl.), date: 9.08.1916, collected by Polgar; Botanical Garden, inventory no. 115.614 (H. Nyárády - *C. micranthos* Gugl.), date: 25.08.1923, collected by E.I. Nyárády; inventory no. 115.625, 115.629, 115.632 (H. Nyárády - *C. micranthos* Gugl.), date: 16.08.1932, collected by E.I. Nyárády & A. Nyárády; inventory no. 115.637 (H. Nyárády - *C. micranthos* Gugl.), date: 14.07.1947, collected by E.I. Nyárády; Moldovenești, inventory no. 115.618 (H. Nyárády - *C. micranthos* Gugl.), date: 12.07.1911, collected by E.I. Nyárády; Lungești, inventory no. 115.621 (H. Nyárády - *C. micranthos* Gugl.), date: 12.07.1911, collected by E.I. Nyárády; between Someșeni and Cluj, inventory no. 115.626 (H. Nyárády - *C. micranthos* Gugl.), date: -, collected by A. Nyárády; Turda, inventory no. 115.627 (H. Nyárády - *C. micranthos* Gugl.), date: 15.07.1934, collected by E.I. Nyárády; between Apahida and Corpade, inventory no. 115.631, 115.635 (H. Nyárády - *C. micranthos* Gugl.), date: 1.08.1911, collected by E.I. Nyárády; Someș, inventory no. 115.636 (H. Nyárády - *C. micranthos* Gugl.), date: 27.08.1946, I. Prodan; Cojocna, inventory no. 115.639 (H. Nyárády - *C. micranthos* Gugl.), date: 1.08.1911, collected by E.I. Nyárády;

Collecting area: RO, AR, Arad, inventory no. 115.616 (H. Nyárády - *C. micranthos* Gugl.), date: 1.08.1907, collected by J. Wagner;

Collecting area: RO, MS, Sovata Bath, inventory no. 115.612 (H. Nyárády - *C. micranthos* Gugl.), date: 5.09.1943, collected by E.I. Nyárády; Tg. Mureș, 115.622 (H. Nyárády - *C. micranthos* Gugl.), date: 30.09.1912, collected by E.I. Nyárády; inventory no. 115.623 (H. Nyárády - *C. micranthos* Gugl.), date: 26.08.1912, collected by E.I. Nyárády;

12. *C. kanitziana* Janka ex D. Brândză,

Collecting area: RO, TL, Măcin, between Vraja Mt. and Duluc, inventory no. 115.519 (H. Nyárády - *C. kanitziana* Janka), date: 19.07.1929, collected by E.I. Nyárády;

Genus *Centaurea* sensu stricto
Calcitrapa Section

1. C. calcitrapa L.

Collecting area: RO, Transylvania, inventory no. 35.021 (Flora Transsilvanica), date: -, collected by Lerchenfeld;

Collecting area: RO, SB, Făgăraș Mt., Poiana Neamșului, inventory no. 25.014 (H. Fuss), date: 21.08.1868, collected by M. Fuss;

Collecting area: RO, AR, Arad, inventory no. 115.273 - 115.274 (H. Nyárády), date: 1.07.1906, collected by Wagner;

Collecting area: RO, CJ, Feleac, inventory no. 115,275-115,276 (H. Nyárády), date: 15.08.1956, collected by A. Nyárády;

Collecting area: RO, CJ, Șerpuita str., inventory no. 105.321 (H. Pop), date: 24.07.1958, collected by I. Pop; Cetățuie place, inventory no. 105.322 – 105.323 (H. Pop), date: 24.07.1958, collected by I. Pop;

Collecting area: RO, Orșova, inventory no. 25.013 (H. Bielz), date: 01.08.1846, collected by Fuss;
Collecting area: RO, CT, Vama Veche, inventory no. 105.319 (H. Pop), date: 14.08.1967, collected by I. Pop; inventory no. 105.320 (H. Pop), date: 14.08.1967, collected by I. Pop;

Collecting area: RO, GL, Galați, Piscu place, inventory no. 105.324 (H. Pop), date: 5.06.1956, collected by E. Turenschi;

Collecting area: RO, B, Pantelimon, inventory no. 115.270 (H. Nyárády FRE 2099), date: 26.07.1940, collected by Forstner;

2. C. iberica Trevir. ex Spreng.

Collecting area: RO, SB, Poiana Neamțului, inventory no. 42.841 (H. Ungar - *Calcitrapa iberica* (Trevir. ex Spreng.) Schur), date: 21.08.1868, collected by M. Fuss;

Collecting area: RO, Transylvania, inventory no. 69.991 (H. Untchj - *C. iberica* Trev.), date: 1.09.1897, collected by Untchj;

Collecting area: RO, BR, Brăila, on field, inventory no. 105,331 (H. Pop *C. iberica* Trev.), date: 13.07.1952, R. Schuller;

Collecting area: RO, TL, beteen trail station Duhaț and Pârlita, inventory no. 115.483 (H. Nyárády - *C. iberica* Trev.), date: 27.07.1949, collected by E.I. Nyárády;Collecting area: RO, CT, Constanța, inventory no. 115.484 (H. Nyárády - *C. iberica* Trev. FRE 839), date: 30.06.1923, collected by Borza & Prodan;
Collecting area: RO, CJ, Gherla, inventory no. 115.485 (H. Nyárády - *C. iberica* Trev.), date: 04.08.1910, collected by Nyárády;

Collecting area: RO, MH, Caraș Severin, Orșova, inventory no. 115.486 (H. Nyárády - *C. iberica* Trev. FEAH 3436), date: -, collected by Degen;

3. C. pontica Nyar et Prod.
Collecting area: RO, TL, Sulina, Dunăre seaside, inventory no. 115.800 (H. Nyárády), date: 16.07.1923, collected by E.I. Nyárády; inventory no. 115.801 (H. Nyárády), date: 17.07.1923, collected by E.I. Nyárády;

4. C. solsitialis L.

Collecting area:RO, Transylvania, inventory no. 73.895 (H. Ungar - *C. rupestris L.* redeterminated), date: -, collected by Baumgarten; inventory no. 25.189 (H. Fuss), date: 15.08.1859, collected by Fronius; inventory no. 35.031 (Flora Transsilvanica), date: -, collected by Lerchenfeld; inventory no. 47.432 (Society Herbarium), date: -, collected by Neugeboren;

Collecting area: RO, SB, Apoldu de Sus, inventory no. 25.186 – 25.187 (H. Fuss), date: 29.08.1861, collected by M. Fuss; inventory no. 42.857 (H. Ungar), date: 29.08.1861, collected by M. Fuss; Șura Mare, inventory no. 25.188 (H. Fuss), date: 24.07.1855, M. Fuss; Miercurea Bath, inventory no. 25.190 – 25.191 (H. Fuss), date: -, collected by Unvericht; Bazna, inventory no. 25.192 (H. Fuss), date: 1.08.1845, collected by Kayser; inventory no. 32.477 – 32.478 (H. Kayser), date: 1.08.1845, collected by Kayser; inventory no. 42.858 (H. Ungar), date: -, collected by Kayser; Cibin River, inventory no. 42.856 (H. Ungar), date: 1.10.1925, collected by Schullerus; Sibiu Garden, inventory no. 77.075 – 77.076 (H. Ungar), date: -, collected by Baumgarten; Gușterița, inventory no. 101.060 – 101.061 (H. Doltu), date: 20.09.1965, collected by M. Doltu; between Ludoș and Bogatu, inventory no. 116.064, 116.067 – 116.070 (H. Nyárády), date: 25.07.1911, collected by E.I. Nyárády; inventory no. 116.058 (H. Nyárády), date: 29.07.1911, collected by E.I. Nyárády;

Collecting area: RO, AB, Sebeș, inventory no. 47.433 (Society Herbarium), date: 1.09.1837, collected by Kladny; Sebeș – on Royal way, inventory no. 77.073 – 77.074 (H. Ungar), date: -, collected by Baumgarten; Aiud, inventory no. 73.886 (H. Ungar), date: 1.07.1821, collected by

Baumgarten; inventory no. 77.117 (H. Ungar), date: 1.07.1821, collected by Baumgarten;

Collecting area: RO, CJ, Boju Mare, inventory no. 79.056 – 79.057 (H. Kisch), date: 17.07.1910, collected by A. Schuller; Turda, inventory no. 116.061 (H. Nyárády), date: 21.07.1947, collected by E.I. Nyárády;

Collecting area: RO, MS, Chețani, inventory no. 116.062 (H. Nyárády), date: 1.08.1903, collected by E.I. Nyárády;

Collecting area: RO, CS, between Vârciorova and Orșova, inventory no. 116.056 (H. Nyárády), date: 07.07.1949, collected by E.I. Nyárády & A. Nyárády;

Collecting area: RO, BT, Ștefănești Stone, inventory no. 116.057 (H. Nyárády), date: 20.07.1949, collected by E.I. Nyárády;

Collecting area: RO, TM, on field (Wiesen), inventory no. 116.060 (H. Nyárády), date: 1.07.1906, collected by Wagner;

Collecting area: RO, DJ, Craiova, inventory no. 95.682 (H. Heltmann), date: 3.07.1866, collected by H. Heltmann;

Collecting area: RO, CT, Agigea Research Center, inventory no. 116.065 (H. Nyárády), date: 7.07.1939, collected by A. Nyárády; Constanța, Lazu, inventory no. 116.071 (H. Nyárády), date: 22.05.1958, collected by E. I. Nyárády;

Genus *Centaurea sensu stricto*

***Phalolepis* Section**

1. C. splendens L

(redeterminated as hybrid between *C. indurata* x *pugioniformis*),

Collecting area: RO, Transylvania, inventory no. 73.889 (H. Ungar - *C. splendens* L., *C. margaritacea* Ten.), date: 1825, collected by Baumgarten;

Collecting area: RO, AB, Intregalde, inventory no. 115.565 (H. Nyárády - *C. leucolepis* DC.*)*, date:1.09.1918, collected by J. Wagner;

***Centaurea s. stricto* genus**
***Phrygia* Section**

1. C. macroptilon Borbás

(incl. *C. degeniana* J. Wagner),

Collecting area: RO, CS, Topolnița Valley, between Mudrga and Virciorova, inventory no. 115.327 (H. Nyárády - *C. degeniana* Wagn.), date: 6.07.1949, collected by A. Nyárády; Vârciorova Orșova, inventory no. 115.330 (H. Nyárády - *C. degeniana* Wagn.), date: 6.08.1909, collected by I. Prodan;

Collecting area: RO, IS, Pașcani, inventory no. 115.328 (H. Nyárády - *C. degeniana* Wagn.), date: 19.07.1947, collected by I. Prodan & E. I. Nyárády:

Collecting area: RO, BC, Pirlipata Hill, Gura Văii, inventory no. 115.329 (H. Nyárády - *C. degeniana* Wagn.), date: -, collected by I. Prodan;

Collecting area: RO, Coziei Mt., inventory no. 115.331 (H. Nyárády - *C. degeniana* Wagn.), date: 20.06.1950, collected by E.I. Nyárády;

Collecting area: RO, HR, Highis Mt., inventory no. 115.332 (H. Nyárády - *C. degeniana* Wagn.), date:5.08.1911, collected by E.I. Nyárády;

2. C. jacea subsp. *banatica* (Roch.) Hayek
(*C. banatica* Hayek; *Jacea banatica* (Hayek) Soják; *C. rocheliana* (Heuff.) Dostál;
C. jacea var. *rocheliana* Heuff.)

Collecting area: RO, SB, on meadow Lazaret near Brick Factory, inventory no. 53.459 (H. Barth - *C. banatica* Roch, *C. rocheliana* (Heuff.) Dostál), date: 23.08.1905, collected by J. Barth; inventory no. 53.461 – 53.462 (H. Barth - *C. banatica* Roch., *C. jacea* var. *rocheliana* Heuff,), date: 28.06.1906, collected by J. Barth;

Collecting area: RO, TM, Vârșeț „Virșec”, inventory no. 53.460 (H. Barth - *C. banatica* Roch.), date: 1.07.1905, collected by J. Wagner; inventory no. 70.009 (H. Untchj - *C. banatica* Roch.), date: 1.09.1903, collected by Wagner; Timișoara, inventory no. 115.209 (H. Nyárády - *C. banatica* Roch.), date: 3.05.1913, collected by J. Wagner; Green House, inventory no. 115.213 (H. Nyárády - *C. banatica* Roch. FRE 2098b), date: 4.09.1941, collected by Pescovschi;

Collecting area: RO, AR, Arad, Cladovei Valley, inventory no. 105.318 (H. Pop - *C. banatica* Roch. *fimbriata* Nyar.), date: 6.09.1949, collected by I. Prodan; inventory no. 115.214 (H. Nyárády - *C. banatica* Roch. FRE 2698a), date: 10.09.1941, collected by Al. Borza; inventory no. 115.215 (H. Nyárády - *C. banatica* Roch. FEAH 3420.), date:, collected by Simonkay;

Collecting area: RO, MM, Maramureș, inventory no. 115.203 (H. Nyárády.- *C. banatica* Roch.), date: 1934, collected by Balla;

Collecting area: RO, CJ, Apahida, inventory no. 115.204 (H. Nyárády - *C. banatica* Roch.), date: 27.07.1942, collected by E.I. Nyárády; Făget,

inventory no. 115.205 – 115.206 (H. Nyárády - *C. banatica* Roch.), date: 19.07.1942, collected by E.I. Nyárády; inventory no. 115.217 (H. Nyárády - *C. banatica* Roch.), date: 06.08.1932, collected by A. Nyárády; Lomb Mt., inventory no. 115.210 (H. Nyárády - *C. banatica* Roch.), date: 28.07.1946, collected by E.I. Nyárády; Turda Gorge, inventory no. 115.216 (H. Nyárády - *C. banatica* Roch.), date: 28.07.1940, collected by E.I. Nyárády; inventory no. 115.218 (H. Nyárády - *C. banatica* Roch.), date. 26.07.1936, collected by E.I. Nyárády;

3. C. jacea L.

Collecting area: RO, Transylvania, inventory no. 35.023 – 35.024 (Flora Transsylvanica), date: -, collected by Lerchenfeld;

Collecting area: RO, SB, Tălmaciu, inventory no. 25.036 (H. Fuss), date: 17.07.1850, collected by M. Fuss; inventory no. 162.301 (H. Schneider), date: 16.09.1970, collected by E. Schneider; Bradu, inventory no. 25.037 (H. Fuss), date: 26.07.1867, collected by M. Fuss; Sibiu, inventory no. 32.502 (H. Kayser), date. 1.06.1864, collected by Kayser; Field with lilien (Lilienfeld), inventory no. 32.503 (H. Kayser), date: 1.08.1864, collected by Kayser; Subarini Park, inventory no. 32.504 – 32.505 (H. Kayser), date: -, collected by Kayser; Cărămidăriei str., inventory no. 42.842 (H. Ungar), date: 23.08.1905, collected by J. Barth; inventory no. 47.418 (Society Herbarium), date: -, collected by Kladny; Viile Sibiului, inventory no. 162.302 (H. Schneider), date: 10.07.1970, collected by E. Schneider; Șopa Forest, inventory no. 162.303 (H. Schneider), 162.307.-.162.308, date: 17.10.1969, collected by E. Schneider; Rusciori, inventory no. 162.299 (H. Schneider), date: 3.07.1970, by E. Schneider; inventory no. 162.300 (H. Schneider), date: 23.06.1968, collected by E. Schneider; Șura Mica, inventory no. 162.297 (H. Schneider), date: 8.10.1968, collected by E. Schneider; on Șura Mică way, inventory no. 162.304 (H. Schneider), date: 7.07.1970, collected by E. Schneider; inventory no. 162.305 – 162.306 (H. Schneider), date: 03.07.1970, collected by E. Schneider;

Collecting area: RO, BN, Bilac, inventory no. 42.843 (H. Ungar), date: 16.08.1895, collected by J. Barth; Bistrița, inventory no. 42.844 (H. Ungar), date: -, collected by Hașog; Fundul Bârgăului, inventory no. 115.466 (H. Nyárády), date: 22.09.1923, collected by E.I. Nyárády;
Collecting area: RO, MM, Maramureș, inventory no. 115.473 (H. Nyárády), date: 1.08.1930, collected by Balea;

Collecting area: RO, AB, Bilac, inventory no. 53.464 (H. Barth), date: 10.07.1895, collected by J. Barth;

Collecting area: RO, MS, between Ogra Valley and Sânpaul, inventory no. 115.441 (H. Nyárády), date: 8.08.1949, collected by E.I. Nyárády; Sovata Bath, inventory no. 115.448 (H. Nyárády), date: 17.07.1943, collected by E.I. Nyárády; Târgu Mureș, inventory no. 115.454 – 115.457; 115.461 (H. Nyárády), date: 18.09.1920, collected by E.I. Nyárády; inventory no. 115.462 (H. Nyárády), date: 30.09.1912, collected by E.I. Nyárády; inventory no. 115.463 (H. Nyárády), date: 30.07.1917, collected by E.I. Nyárády;

Collecting area: RO, SV, Strigoaia Train Station, inventory no. 115.442 (H. Nyárády), date: 22.07.1949, collected by A. Nyárády; Pojorîta, Eva Mt., inventory no. 115.443 (H. Nyárády), date: 17.07.1949, collected by A & E.I. Nyárády; Cacica, inventory no. 115.444 (H. Nyárády), date: 6.10.1949, collected by E.I. Nyárády;

Collecting area: RO, AR, Ineu, Rovina Lake, inventory no. 115.445 (H. Nyárády), date: 23.08.1949, collected by E.I. Nyárády;

Collecting area: RO, CJ, Botanical Garden, inventory no. 115.446 (H. Nyárády), date: 16.08.1944, collected by E.I. Nyárády; inventory no. 115.474 (H. Nyárády), date: 14.07.1947, collected by E.I. Nyárády; Cluj Meadows, inventory no. 115 478 (H. Nyárády), date: 28.06.1932, collected by A. Nyárády; Fenești Săsesc, inventory no. 115.449 (H. Nyárády), date: 31.07.1942, collected by E.I. Nyárády; Făget, inventory no. 115.450 (H. Nyárády), date: 19.07.1942, collected by E.I. Nyárády; inventory no. 115.464 – 115.465 (H. Nyárády), date: 21.07.1946, collected by E.I. Nyárády; inventory no. 115.479 (H. Nyárády), date: 16.08.1932, collected by A. Nyárády; Lomb Mt., inventory no. 115.470 (H. Nyárády), date: 23.07.1946, collected by E.I. Nyárády; inventory no. 115.472 (H. Nyárády), date: 28.06.1946, collected by E.I. Nyárády; Turda, inventory no. 115.458 – 115.459 (H. Nyárády), date: 8.09.1918, collected by E.I. Nyárády; Turda Gorge, inventory no. 115.477 (H. Nyárády), date: 24.09.1933, collected by E.I. Nyárády; Căpușu Mic, inventory no. 115.480 (H. Nyárády), date: 1.09.1961, collected by A. Nyárády;

Collecting area: RO, BV, Stupini, inventory no. 162.298 (H. Schneider), date: 17.07.1956, collected by H. Heltmann;

4. C. jacea subsp. *angustifolia* (DC.) Gremli
(*C. pannonica* (Heuff.) Simonk.)

Collecting area: RO, SB, Sibiu, Trinbach River, inventory no. 77.094 (H. Ormay - *C. pannonica* Heuff.*)*, date: 7.10.1882, collected by Ormay;

Collecting area: RO, BH, Salonta on meadows, inventory no. 105.349 (H. Pop - *C. pannonica* Heuff.), date: 20.08.1959, collected by I. Pop; Mărțihaz, inventory no. 105.350 – 105.351 (H. Pop - *C. pannonica* Heuff.), date: 5.08.1952, collected by I. Pop;cyiuifgvy

Collecting area: RO, CJ, Turda, inventory no. 115.779 – 115.781 (H. Nyárády - *C. pannonica* (Heuff.) Simonk, *C. jacea pannonica* (Heuff.) Hayek), date: 21.07.1947, collected by E.I. Nyárády; inventory no. 115.785 (H. Nyárády), date: 24.08.1925, collected by A. Borza & I. Prodan; Gherla, Cămăraș, inventory no. 115.784 (H. Nyárády - *C. pannonica* (Heuff.) Simonk), date: 30.08.1912, collected by Lany; Botanical Garden,Cluj-Napoca, inventory no. 115.788 – 115.792 (H. Nyárády), date: 16.08.1944, collected by E.I. Nyárády; inventory no. 115.797 (H. Nyárády), date: 23.08.1933, collected by E.I. Nyárády & A. Nyárády; inventory no. 116.246 (H. Nyárády), date: 7.08.1947, collected by E.I. Nyárády; Lomb Mt., inventory no. 115.795 – 115.796 (H. Nyárády), date: 28.07.1946, collected by E.I. Nyárády;

Collecting area: RO, AR, Bega Riverside, inventory no. 115.786 (H. Nyárády), date: 1.09.1906, collected by Wagner;

Collecting area: RO, SM, Carei, inventory no. 115.787 (H. Nyárády), date: 25.09.1942, collected by F. Balazs; Foieni, inventory no. 115.793 (H. Nyárády), date: 25.09.1942, collected by F. Balazs;

*5. C. microptilon (*Godr.) Godr. & Gren.

Collecting area: RO, SB, meadows, inventory no. 32,430 (H. Kayser), date: 1.06.1846, collected by Kayser; Bazna, inventory no. 132,431 (H. Kayser), date: 1.08.1845, collected by Kayser; Sibiu, inventory no. 32,432 (H. Kayser), date: 1.07.1846, collected by Kayser; Subarini Park, inventory no. 32,433 (H. Kayser), date: 1.07.1844, collected by Kayser; inventory no. 32,434 (H. Kayser), date: 1.06.1874, collected by Kayser; Seviș, inventory no. 77,095 (H. Ormay), date: 7.08.1883, collected by Ormay;

6. C. nervosa Willd.
(*C. uniflora nervosa* (Willd.) Bonnier & Layens, *C. cirrata* Rchb.*,*
C. plumosa A. Kern., nom. illeg.)

Collecting area: RO, Făgăraș Mt., inventory no. 25.074 (H. Fuss), date: 1831, collected by F. Schur; inventory no. 32.457 – 32.460 (H. Kayser), date: 1.08.1850, collected by Kayser; inventory no. 162.325 (H. Schneider), date: 30.08.1972, collected by E. Schneider; Arpașu de Sus, inventory no. 25.065 (H. Fuss), date: 14.08.1861, collected by M. Fuss; inventory no. 32.435 – 32.456 (H. Kayser), date: 1.07.1850, collected by Kayser; Cârțișoara, inventory no. 25.066 (H. Fuss), date: 14.08.1861, collected by M. Fuss; Fundul Bâlea, inventory no. 25.068 (H. Fuss), date: 28.08.1863, collected by M. Fuss; Turnu Roșu, inventory no. 35.029 (Flora Transsylvanica), date: -, collected by Lerchenfeld; inventory no. 47.428 (Society Herbarium), date: -, collected by Schur; inventory no. 25.064 (H. Fuss - *C. plumosa* A. Kern.), date: 20.07.1865, collected by M. Fuss; Avrig, Podrăgel Valley, inventory no. 47.429 (Society Herbarium), date: -, collected by Kladny; inventory no. 25.069 (H. Fuss), date: 7.08.1857, collected by M. Fuss; inventory no. 25.075(H. Fuss), date: 18.07.1840, collected by Kladny; Ciortea Peak, inventory no. 25.073 (H. Fuss), date: 7.08.1870, collected by M. Fuss; Porumbacu de Sus, inventory no. 25.077 (H. Fuss), date: 1844, collected by M. Fuss; Negoiu Peak, Strunga Dracului, inventory no. 79.052 (H. Kisch - *C. plumosa* Lam.), date: 1.08.1907, collected by K. Ungar; between Negoi and Paltin, inventory no. 105.348 (H. Pop), date: 19.08.1953, collected by I. Pop; Avrig Lake, inventory no. 80.784 – 80.785 (H. Bielz, Krauss, Hergotta, Klotz), date: 18.08.1874, collected by Bielz; Suru Peak, inventory no. 80.786 (H. Bielz, Krauss, Hergotta, Klotz), date: 18.08.1867, collected by Bielz; Capra Lake, inventory no. 95.6181 H. Heltmann; Negoiu Peak, inventory no. 47.426 (Society Herbarium), date: -, collected by Neugeboren; inventory no. 115.685 (H. Nyárády.- *C. plumosa* Lam.), date: 5.08.1921, collected by K. Ungar; inventory no. 162.327 (H. Schneider), date: 8.08.1973, collected by E. Schneider; Doamnei Valley, inventory no. 115.687 (H. Nyárády - *C. plumosa* Lam.), date: 14.08.1936, collected by A. Nyárády; inventory no. 115.689 (H. Nyárády - *C. plumosa* Lam.), date: 27.08.1939, collected by E.I. Nyárády; Piscului Peak, inventory no. 115.688 (H. Nyárády - *C. plumosa* Lam.), date:, 27.08.1939, collected by E.I. Nyárády;

Collecting area: RO, SB, Șura Mare, inventory no. 32.484 – 32.488 (H. Kayser - *C. cirrata* Rchb.), date: 1.07.1846, collected by Kayser; Apoldu de

Sus, inventory no. 32.489 – 32.492 (H. Kayser - *C. cirrata* Rchb.), date: 1.09.1874, collected by Kayser; Sibiu, inventory no. 32.483 (H. Kayser - *C. cirrata* Rchb.), date: 1.06.1866, collected by Kayser; inventory no. 32.491 (H. Kayser.- *C. cirrata* Rchb.), date: 1.09.1874, collected by Kayser; Sibiu, mountain region, inventory no. 80.782 (H. Bielz, Krauss, Hergotta, Klotz.- *C. cirrata* Rchb.), date: -, collected by Sill; Păltiniș Mt., inventory no. 78.006 (H. Ungar - *C. plumosa* Lam.), date:-, collected by K. Ungar; Rășinari, inventory no. 25.062 (H. Fuss - *C. cirrata* Rchb.), date: 18.07.1848, collected by M. Fuss; Tomnatic Glade, inventory no. 25.072 (H. Fuss), date:, -, collected by Schur; Gura Râului, inventory no. 25.063 (H. Fuss - *C. uniflora nervosa* (Willd.) Bonnier & Layens), date: 7.09.1852, collected by M. Fuss;

Collecting area: RO, BV, Ghimbav, inventory no. 25.067 (H. Fuss), date: 26.07.1863, collected by M. Fuss; Bucegi Mt., Caraiman Peak, Brana Mare place, inventory no. 162.326 (H. Schneider), date: 27.07.1970, collected by E. Schneider;

Collecting area: RO, HD, Straja Mt., inventory no. 25.079 (H. Fuss), date: -, collected by Baumgarten; inventory no. 77.641 (H. Baumgarten), 7.01.2124, collected by -; Petroșani, Prislop, inventory no. 53.501 (H. Barth - *C. plumosa* Lam.), date: 15.08.1888, collected by J. Barth; Lapusnicul Valley, inventory no. 115.682 (H. Nyárády - *C. plumosa* Lam.), date: 21.08.1909, collected by E.I. Nyárády,

Collecting area: RO, Parang Mt., Ieșului Peak, inventory no. 80.787 (H. Bielz, Krauss, Hergotta, Klotz), date: 18.08.1875, collected by -; inventory no. 25.076 (H. Fuss), date: 17.07.1881, collected by Barth;

Collecting area: RO, CS, Semenic Mt., inventory no. 115.681 (H. Nyárády), date: 21.08.1941, collected by Al. Borza;

Collecting area: RO, Retezat Mt., Slăvicul place, inventory no. 115.684, 115.686 (H. Nyárády), date: 21.07.1909, collected by E.I. Nyárády; Bucura Valley, inventory no. 115.689 (H. Nyárády - *C. plumosa* Lam.), date: 10.08.928, collected by E.I. Nyárády;

C. nigra L.
(redeterminated as *C. nigrescens* Willd.)

Collecting area: RO, CJ, Cluj, inventory no. 73.904 (H. Ungar - *C. nigra uniflora*), date: 1823, collected by -;

Collecting area: RO, SB, Swimming Schol str., inventory no. 80.788 (H. Bielz, Krauss, Hergotta, Klotz - *C. nigra* L.) date: 4.07.1867, collected by - ; Subarini Park, inventory no. 80.789 (H. Bielz, Krauss, Hergotta, Klotz - *C. nigra* L), date: 26.06.1867, collected by -;

7. C. nigrescens Willd.

Collecting area: RO, CJ, Cluj, inventory no. 42.849 (H. Ungar), date: 17.09.1920, collected by Boso; Hoia Forest, inventory no. 115.715 (H. Nyárády), date: 19.08.1932, collected by A. Nyárády; Gherla, inventory no. 115.716 (H. Nyárády), date: 12.08.1939, collected by E. I. Nyárády; Căpuțu Mic Village, inventory no. 115.718 (H. Nyárády), date: 01.09.1961, collected by A. Nyárády;

Collecting area: RO, BN, Năsăud Valley, inventory no. 115.717 (H. Nyárády), date: 19.08.1950, collected by A. Nyárády;

8. C. macroptilon Borbás

(incl. *C. jacea oxylepis* (Wimm. & Grab.) Hayek), *C. macroptilon oxylepis (Wimm. & Grab.) Soó*,
Collecting area: RO, SB, Viile Sibiului Village, inventory no. 162.328 (H. Schneider - *C. oxylepis* (Wimm. & Grab.) Hayek), date: 10.07.1970, collected by E. Schneider;

9. C. phrygia subsp. *erdnerii* (preliminary accepted as subspecies) (*C. x erdneri* Wagn., *C. austriaca* x *pseudophrygia*)

Collecting area: RO, CJ, Cluj Meadows, inventory no. 105.312 (H. Pop), date: 7.07.1949, collected by I. Pop; Sheepfold, inventory no. 105.329 (H. Pop), date: 10.08.1949, collected by I. Prodan; Morii Valley, inventory no. 115.391 (H. Nyárády), date: 2.07.1936, collected by E.I. Nyárády;

Collecting area: RO, HR, Lăzarea, Gurghiu Mt., inventory no. 115.371 (H. Nyárády), date: 15.07.1948, colected by E.I. Nyárády; Harghita Mt., inventory no. 115.377 (H. Nyárády), date: 1.07.1942, collected by E.I. Nyárády; inventory no. 115.394 (H. Nyárády), date: 10.07.1928, collected by E.I. Nyárády; Joseni, inventory no. 115.378 – 115.379 (H. Nyárády), date: 8.08.1941, collected by E.I. Nyárády; Vlăhița, inventory no. 115.396 (H. Nyárády), date: 3.08.1949, collected by E.I. Nyárády; Homorod Bath, inventory no. 115.395 (H. Nyárády), date: 8.08.1949, collected by E.I. Nyárády; Tușnad Bath, inventory no. 115.403 – 115.404 (H. Nyárády), date: 8.09.1953, collected by E.I. Nyárády; inventory no. 115 373 (H. Nyárády - FEAH 3423), date: -, collected by Nyárády

Collecting area: RO, HD, Nucșoara Valley, Fagi, inventory no. 115.405 – 115.406; 115 408 A\B (H. Nyárády), date: 28.08., collected by E.I. Nyárády; Bucoșul Mic Valley, inventory no. 115.407 (H. Nyárády), date: 10.07.1938, collected by E.I. Nyárády; Șerel, inventory no. 115.393 (H. Nyárády), date: 31.07.1929, collected by E.I. Nyárády; Săcărâmb, inventory no. 115.372 (H. Nyárády), date: -, collected by Kiss Josef;

Collecting area: RO, AB, Zlatna Town, inventory no. 115.374 (H. Nyárády), date: 23.08.1907, collected by E.I. Nyárády; Gârda de Sus, Scărișoara, inventory no. 115.375 – 115.376 (H. Nyárády), date: 25.08.1946, collected by M. Ghiuță; Poșaga, inventory no. 115.387 (H. Nyárády), date: 26.07.1920, collected by A. Borza;

Collecting area: RO, BH, Tinca, inventory no. 115.380 (H. Nyárády), date: 1.07.1924, collected by E.I. Nyárády;

Collecting area: RO, BV, Mălăești Valley, inventory no. 115.382 (H. Nyárády), date: 28.07.1906, collected by E.I. Nyárády; Predeal, inventory no. 115.397 (H. Nyárády), date: 18.07.1950, collected by E.I. Nyárády; Zărnești Crack Stone, inventory no. 115.398 (H. Nyárády), date: 17.07.1950, collected by E.I. Nyárády;

Collecting area: RO, MS, between Deda and Retiș, inventory no. 115.385 (H. Nyárády), date: 3.07.1921, collected by E.I. Nyárády; inventory no. 115.389 (H. Nyárády FRE 98 b), date: 1.07.1924, collected by E.I. Nyárády & I. Prodan; between Deda and Retiș, inventory no. 115.390 (H. Nyárády), date: 1.07.1925, collected by E.I. Nyárády; Mureș Spring, inventory no. 115.392 (H. Nyárády), date: 1.07.1924, collected by E.I. Nyárády;

Collecting area: RO, PH, Sinaia, inventory no. 115.399 (H. Nyárády), date: 15.08.1912, collected by E.I. Nyárády; Doftana Valley, inventory no. 115.400 (H. Nyárády), date: 21.07.1953, collected by E.I. Nyárády; Peleș Valley, inventory no. 115.401 (H. Nyárády), date: 19.07.1953, collected by E.I. Nyárády; Sinaia, Cumpatu Place, inventory no. 115.402 (H. Nyárády), date: 23.07.1953, collected by E.I. Nyárády;

10. C. phrygia L.

Collecting area: RO, Transylvania, inventory no. 32.426 (H. Kayser - *C. austriaca* Willd), date: -, collected by Kayser; inventory no. 25.096 (H. Fuss), date: -, collected by Ed. Josch.; inventory no. 32.427 (H. Kayser - *C. austriaca* Willd), date:-, collected by Kayser; inventory no. 35.020 (Flora Transsylvanica- *C. austriaca* Willd.), date: -, collected by Lerchenfeld; inventory no. 47.414 (Society Herbarium - *C. austriaca* Willd), date: -, collected by Kladny;

Collecting area: RO, Bucegi Mt., inventory no. 73.924 (H. Ungar), date: 10.08.1813, collected by Baumgarten; Bucșoi, inventory no. 77.644 (H. Baumgarten - *C. austriaca* Willd.), date: 10.08.1827;

Collecting area: RO, Retezat Mt., inventory no. 73.925 (H. Ungar), date: 1822, Baumgarten;

Collecting area: RO, Vidra, Arieșul Mic inventory no. 77.096 (H. Ungar - *C. austriaca* L.), date: 17.07.1882, collected by Simkovics;

Collecting area: RO, Făgăraș Mt., Tarnița, inventory no. 77.643 (H. Baumgarten), date: 13.08.1822, collected by Baumgarten; inventory no. 47.415 (Society Herbarium - *C. austriaca* Willd.), date: 1839, collected by Kladny;

Collecting area: RO, Apuseni Mt., Băișoarei Mt., inventory no. 105.308 (H. Pop - *C. austriaca* Willd), date: 14.09.1952, collected by I. Pop;

Collecting area: RO, MM, Vișeu Mt., Clearing Forest, inventory no. 115.115 (H. Nyárády - *C. austriaca* Willd), date: 1.09.1907, collected by E.I. Nyárády;

Collecting area: RO, HR, Homorod Bath, inventory no. 53.475 (H. Barth - *C. conglomerata* C.A.Mey.), date: 30.08.1900, collected by J. Barth; inventory no. 115.117 (H. Nyárády - *C. austriaca* Willd FEAH 97b), date. 13.07.1924, collected by I. Prodan; inventory no. 115.119 – 115.120 (H. Nyárády - *C. austriaca* Willd), date: 8.08.1949, collected by E.I. Nyárády; Harghitei Mt., Vlăhița Mt., inventory no. 115.121 (H. Nyárády - *C. austriaca* Willd), date: 9.08.1949, collected by E.I. Nyárády; ”Borbegyes” Peak, inventory no. 105.307 (H. Pop - *C. austriaca* Willd), date: 22.07.1959, collected by I. Pop;

Collecting area: RO, Rodnei Mt., Rodna, inventory no. 73.898 (H. Ungar), date: 18.07.1822, collected by - ; Anieș Valley, inventory no. 115.122 (H. Nyárády - *C. austriaca* Willd), date: 11.08.1938, collected by E.I. Nyárády; Rodnei Mt., Crăciunel, Vinului Valley, inventory no. 115.125 – 115.127 (H. Nyárády - *C. austriaca* Willd), date: 22.07.1923, collected by Borza & Prodan; Coronghiș, inventory no. 25.100 (H. Fusss), date: -, collected by Porcius;

Collecting area: RO, MS, Sighișoara, inventory no. 25.099 (H. Fuss), date: -, collected by Baumgarten; inventory no. 77.648 (H.

Baumgarten), date: 14.08.1838; Sovata Bath, inventory no. 115.124 (H. Nyárády - *C. austriaca* Willd), date: 25.07.1943, collected by Borza & Prodan; Sovata Bath, inventory no. 115.128 – 115.129 (H. Nyárády- *C. austriaca* Willd), date: 20.07.1943, collected by Borza & Prodan; inventory no. 115.130 (H. Nyárády - *C. austriaca* Willd), date: 7.09.1943, collected by Borza & Prodan; inventory no. 115.135 (H. Nyárády - *C. austriaca* Willd), date: 28.07.1943, collected by E.I. Nyárády; inventory no. 115.136 (H. Nyárády - *C. austriaca* Willd), date: 3.09.1943, collected by E.I. Nyárády; inventory no. 115.137 (H. Nyárády - *C. austriaca* Willd), date: 26.07.1943, collected by E.I. Nyárády; inventory no. 115.132 (H. Nyárády - *C. austriaca* Willd), date: 24.07.1943, collected by E.I. Nyárády; between Sovata and Sânpetru, inventory no. 115.246 (H. Nyárády - *C. austriaca* Willd), date: 18.07.1943, collected by E.I. Nyárády; Mureș Riverside, inventory no. 115.318 (H. Nyárády - *C. austriaca* Willd), date: 20.08.1912, collected by E.I. Nyárády; Târgu Mureș, inventory no. 115.323 (H. Nyárády - *C. austriaca* Willd), date: 31.08.1949, collected by E.I. Nyárády;

Collecting area: RO, HD, Vulcan, inventory no. 73.899 (H. Ungar), date: 1822, collected by Baumgarten; Vulcan, inventory no. 115.133 (H. Nyárády - *C. austriaca* Willd), date: 9.09.1910, collected by S. Banyai;

Collecting area: RO, PH, Sinaia, Doftanei Valley, ”Colțul lui Iepure” place, inventory no. 115.138 (H. Nyárády - *C. austriaca* Willd), date: 21.07.1953, collected by E.I. Nyárády;

Collecting area: RO, CV, Întorsura Buzăului, Ghilcoș Hill, inventory no. 115.139 – 115.140, 115.324 (H. Nyárády - *C. austriaca* Willd), date: 30.07.1953, collected by E.I. Nyárády;

Collecting area: RO, BV, between Perșani and Brădeni, inventory no. 115.141 (H. Nyárády - *C. austriaca* Willd), date: 1.08.1955, collected by E.I. Nyárády;

Collecting area: RO, BN, Sângiorz Bath, inventory no. 115.143 (H. Nyárády - *C. austriaca* Willd), date: 15.08.1958, collected by E.I. Nyárády;

Collecting area: RO, Sebeșului Mt., Secuiului Stone, inventory no. 77.068 (H. Ungar - *C. austriaca* Willd), date: 1822, collected by Baumgarten; Alba Iulia, inventory no. 25.108 (H. Fuss - *C. austriaca* Willd), date: -, collected by P. Fronius; Aiud, inventory no. 77.069 (H. Ungar), date: 1.08.1839, collected by Baumgarten; between Vulcan and Abrud, inventory no. 115.144 (H. Nyárády - *C. austriaca* Willd), date: 18.08.1937, collected by E.I. Nyárády; Gârda, by Scărișoara Ice Cave, inventory no. 115.134 (H. Nyárády - *C. austriaca* Willd), date: 25.08.1946; Arieșeni Village, on Arieșul Mare riverside, inventory no. 115.116 (H. Nyárády - *C. austriaca* Willd), date: 19.07.1912, collected by E.I. Nyárády; Gârda de Sus, Scărișoara, inventory no. 115.320 (H. Nyárády - *C. austriaca* Willd), date: 25.08.1946;

Collecting area: RO, CJ, Huedin, inventory no. 105.309 (H. Pop - *C. austriaca* Willd), date: 18.09.1948, collected by I. Prodan; Făget Forest, inventory no. 115.114 (H. Nyárády - *C. austriaca* Willd), date: 21.07.1943, collected by E.I. Nyárády; Belioara, inventory no. 115.123 (H. Nyárády - *C. austriaca* Willd), date: 25.07.1920, collected by Borza & Prodan; Căpușu Mic, inventory no. 115.145 (H. Nyárády - *C. austriaca* Willd), date: 1.09.1961, collected by A. Nyárády; Feleac Hill, inventory no. 115.142 (H. Nyárády - *C. austriaca* Willd), date: 5.08.1933, collected by A. Nyárády; Ordeașului Valley, Vidolm Village, inventory no. 115.146 (H. Nyárády - *C. austriaca* Willd), date: 21.07.1959, collected by A. Nyárády & C. Váczy; Runc, on meadows, inventory no. 115.147 (H. Nyárády - *C. austriaca* Willd), date: 29.07.1954, collected by A. Nyárády; Apahida and Corpade, inventory no. 115.317 (H. Nyárády - *C. austriaca* Willd), date: 1.08.1911, collected by E.I. Nyárády; Cluj, inventory no. 115.322 (H. Nyárády - *C. austriaca* Willd), date: 2.08.1947, collected by E.I. Nyárády; City Park, on Someș Riverside, inventory no. 115.131 (H. Nyárády - *C. austriaca* Willd), date: 1927, collected by I. Prodan; Botanical Garden, inventory no. 115.325 (H. Nyárády - *C. austriaca* Willd), date: 30.07.1934, collected by A. Nyárády; RO, Rodnei Mt., inventory no. 115.321 (H. Nyárády - *C. austriaca* Willd), date: 3.08.1947, collected by F. Porcius; Vinului Valley, inventory no. 115.326 (H. Nyárády - *C. austriaca* Willd), date: 8.08.1957, collected by A. Nyárády;

Collecting area: RO, SB, Sibiu, inventory no. 25.111 (H. Fuss - *C. austriaca* Willd), date: 19.09.1851, collected by M. Fuss; inventory no. 25.094 (H. Fuss), date: 23.08.1848, collected by M. Fuss; inventory no. 80.783 (H. Kisch), date: 21.08.1874, collected by Kisch; Șura Mare, inventory no. 25.095 (H. Fuss), date: 2.08.1857, collected by M. Fuss; Turnu Roșu, inventory no. 25.112 (H. Fuss - *C. austriaca* Willd), date: 9.07.1851, collected by M. Fuss; Nou, inventory no. 25.116 (H. Fuss - *C. austriaca* Willd), date:

19.10.1847, collected by M. Fuss; Apoldu de Sus, inventory no. 32.428, 32.499, date: 1.09.1861, collected by Kayser; Șelimbăr, inventory no. 53.482 (H. Barth - *C. conglomerata* C.A.Mey.), date: 26.08.1904, collected by J. Barth; Cacova, inventory no. 53.491 – 53.493 (H. Barth - *C. austriaca* Willd), date: 11.07.1908, collected by J. Barth; Păltiniș on ”Felsenberg”, inventory no. 78.007 (H. Ungar), date: -, collected by K. Ungar; Dumbrava, inventory no. 79.035 (H. Ungar), date: 1.08.1907, collected by K. Ungar; Cisnădioara, inventory no. 25.110 (H. Fuss - *C. austriaca* Willd), date: 14.09.1844, collected by M. Fuss; Cisnădie, inventory no. 79.041 (H. Kisch - *C. austriaca* Willd), date: 24.06.1906, collected by Kisch; between Cisnădie and Tocile, inventory no. 162.287 (H. Schneider - *C. austriaca* Willd), date: 03.07.1969, collected by E. Schneider; Tocile Valley, on way, inventory no. 162.288 (H. Schneider - *C. austriaca* Willd), date: 04.07.1969, collected by E. Schneider; Crinț, Savoi Hill, inventory no. 95.405 (H. Gündisch), date: 30.08.1954, collected by Fr. Gündisch; Cacova, inventory no. 95.406 (H. Gündisch), date: 10.08.1952, collected by Fr. Gündisch; Zackel Hill, inventory no. 95.407 – 95.408 (H. Gündisch), date: 15.08.1955, collected by Fr. Gündisch; Leșului River Meadow, inventory no. 162.285 (H. Schneider - *C. austriaca* Willd), date: 30.06.1970, collected by E. Schneider; Rusciorului River Meadow, inventory no. 162.286 (H. Schneider - *C. austriaca* Willd), date: 02.07.1969, collected by E. Schneider;

C. phrygia subsp. *salicifolia* (Willd.) Mikheev (redeterminated as hybrid of *C. phrygia*),

Collecting area: RO, SB, Field of Măcelarilor, inventory no. 53.540 (H. Barth - *C. salicifolia* MB), date: 21.08.1905, collected by J. Barth; Cisnădie, inventory no. 79.040 (H. Kisch - *C. salicifolia* MB), date: 24.06.1906, collected by Kisch;

Collecting area: RO, BV, Timișul de Sus, inventory no. 53.455 (H. Barth - *C. salicifolia* MB), date: 20.08.1880, collected by J .Barth;

11. C. phrygia subsp. *ratezatensis* (Prodan) Dostál,

Collecting area: RO, Retezat Mt., Gura Apii, Fața Fetii Mt., inventory no. 115.902 (H. Nyárády - *C. ratezatensis* Prod.), date: 7.08.1925, collected by E.I. Nyárády; inventory no. 115.900 (H. Nyárády - *C. ratezatensis* Prod.), date: 6.08.1925, collected by E.I. Nyárády;

12. C. phrygia subsp.*indurata* (Janka) Stoj. & Acht. (syn. *C. indurata* Janka)

Collecting area: RO, AB, Valea Lungă ˙(Blaj), inventory no. 69.970 – 69.971 (H. Untchj), date: 4.09.1899, collected by J. Barth; Piatra Secuiului, Trascău Mt., inventory no. 69.972 (H. Untchj), date: 3.08.1884, collected by Csató; Colțești, inventory no. 115.518 (H. Nyárády), date: 23.09.1960, collected by Pázmany;

Collecting area: RO, Rodnei Mt., inventory no. 81.493 (H. Porcius), date: -, collected by Porcius; Vinului Valley, inventory no. 105.332 (H. Pop), date: 29.08.1955, collected by I. Pop;

Collecting area: RO, SM, Ardud, inventory no. 115.494 (H. Nyárády), date: 13.09.1942, collected by F. Balász, ;

Collecting area: RO, CJ, Cluj - Napoca, inventory no. 115.495 (H. Nyárády), date: 21.07.1946, collected by E.I. Nyárády; Făget, inventory no. 115.496 – 115.497 (H. Nyárády), date: 21.07.1946, collected by E.I. Nyárády; inventory no. 115.498 – 115.499 (H. Nyárády), date: 21.07.1946, collected by E.I. Nyárády; inventory no. 115.500 (H. Nyárády), date: 16.08.1932, collected by A. Nyárády; inventory no. 115.502 – 115.503, 115.515 (H. Nyárády), date: 5.09.1939, collected by E.I. Nyárády; inventory no. 115.506 – 115.507, 115.509 (H. Nyárády), date: 06.08.1932, collected by A. Nyárády; Hoia Forest, Cluj-Napoca, inventory no. 115.501, 115.505 (H. Nyárády), date: 19.08.1932, collected by E.I. Nyárády; inventory no. 115.516 (H. Nyárády), date: 19.08.1932, collected by A. Nyárády;

Collecting area: RO, CV, Ozunca Bath, inventory no. 115.508 (H. Nyárády), date: 6.07.1935, collected by A. Nyárády; Întorsura Buzaului, Ghilcoș Hill, inventory no. 115.512 (H. Nyárády), date: 30.07.1953, collected by E.I. Nyárády;

Collecting area: RO, AR, between Gurahonț and Bălteni, inventory no. 115.488 – 115.490 (H. Nyárády), date: 24.08.1949, collected by E.I. Nyárády; inventory no. 115.492 – 115.493 (H. Nyárády), date: 1.07.1906, collected by J. Wagner;

Collecting area: RO, CS, Reșița, inventory no. 162.295 (H. Schneider), date: 28.09.1980, collected by Goga; Reșița on way to forest, inventory no. 162.296 (H. Schneider), date: 3.08.1980, collected by Goga;

Collecting area: RO, BV, between Perșani and Brădet, inventory no. 115.510 – 115.511 (H. Nyárády), date: 11.08.1955, collected by E.I.

Nyárády; inventory no. 115.513 – 115.514 (H. Nyárády), date: 7.08.1953, collected by E.I. Nyárády;

Collecting area: RO, HD, Săcărâmb, inventory no. 115.491 (H. Nyárády), date: 1.09.1923, collected by Kiss Josef; Geoagiu Bath, inventory no. 115.517 (H. Nyárády), date: 19.08.1962, collected by A. Nyárády;

Collecting area: RO, SB, Dumbrava Forest, inventory no. 79.045 (H. Kisch), date: 1.08.1905, collected by Kisch; inventory no. 53.452 – 53.453 (H. Barth), date: 20.08.1907, collected by J. Barth; Way on Poplacii str., inventory no. 53.451 (H. Barth), date: 9.08.1906, collected by J. Barth; between Cârțișoara and Arpaș, inventory no. 115.504 (H. Nyárády), date: 15.07.1936, collected by E.I. Nyárády & A. Nyárády; Tălmaciu, inventory no. 162.290 (H. Schneider), date: 3.07.1967, collected by E. Schneider; between Cisnădie and Sadu, inventory no. 162.291 (H. Schneider), date: 3.07.1969, collected by E. Schneider; Noiștat Mounds, inventory no. 162.292 – 162.293 (H. Schneider), date: 22.07.1981, collected by E. Schneider, Valea Sadului, Tălmaciu, inventory no. 162.294 (H. Schneider), date: 18.07.1970, collected by E. Schneider;

13. C. phrygia subsp. *stenolepis* (A. Kern.) Gugler,

Collecting area: RO, HD, Retezat Mt., Gura Zlata, inventory no. 116.111 (H. Nyárády - *C. cirrata* Rchb.), date: 11.08.1950, collected by E.I. Nyárády;

14. C. phrygia subsp. *pseudophrygia* (C.A.Mey) Gugler (syn. *C. pseudophrygia*),

Collecting area: RO, HD, Vulcani, near Abrud, inventory no. 115.825 (H. Nyárády), date: 18.08.1937, collected by E.I. Nyárády & A. Nyárády; inventory no. 115.833 (H. Nyárády), date: 18.08.1937, collected by Ianos Banyai;

Collecting area: RO, HR, Homorod Bath, near Odorhei, inventory no. 115.832 (H. Nyárády), date: 8.08.1949, collected by A. Nyárády; Sâncrăieni, inventory no. 115.835 (H. Nyárády), date: 5.08.1941, collected by E.I. Nyárády;

Collecting area: RO, CV, Uzunca Bath, inventory no. 115.826 (H. Nyárády), date: 11.07.1956, collected by E.I. Nyárády;

Collecting area: RO, PH, Sinaia, Peleș Valley, inventory no. 115.827 (H. Nyárády), date: 19.07.1953, collected by E.I. Nyárády; Doftana Valley ”Cotu' lui Iepure” place, inventory no. 115.828 – 115.830 (H. Nyárády), date: 21.07.1903, collected by E.I. Nyárády;

15. C. macroptilon Borbás (incl. *C. pugioniformis* Nyár.)

Collecting area: RO, AR, Ineu, Rovina Lake, inventory no. 115.840 (H. Nyárády), date: 23.08.1949, collected by E.I. Nyárády;

Collecting area: RO, BN, Figo, inventory no. 115.873 (H. Nyárády), date: 1.07.1942, collected by E.I. Nyárády;

Collecting area: RO, BN, Sângiorz Bath, inventory no. 115.892 (H. Nyárády), date: 15.08.1958, collected by E.I. Nyárády;

Collecting area: RO, BV, Făgăraș, on meadow near Perșani, inventory no. 115.877 (H. Nyárády), date: 07.08.1953, collected by E.I. Nyárády;

Collecting area: RO, Rodnei Mt., in Cobășel Valley, near Rodna Nouă village, inventory no. 115.880 (H. Nyárády), date: 03.09.1948, collected by A. Nyárády;

Collecting area: RO, SB, Tălmaciu, inventory no. 162.332 (H. Schneider), date: 11.07.1970, collected by E. Schneider;

Collecting area: RO, CJ, on way to Hoia Forest, inventory no. 105.357 (H. Pop), date: 1950, I. Prodan; Cluj Meadows, inventory no. 105.358 (H. Pop), date: 29.06.1950, collected by I. Pop; inventory no. 115.856 – 115.857 (H. Nyárády), date: 26.08.1940, collected by E.I. Nyárády & A. Nyárády; spontaneous in garden, inventory no. 115.850, 115.863 (H. Nyárády), date: 4.08.1923, collected by E.I. Nyárády; Botanical Garden, inventory no. 115.859 – 115.861 (H. Nyárády), date: 23.08.1933, collected by A. Nyárády; inventory no. 116.232 (H. Nyárády), date: 17.08.1947, collected by E.I. Nyárády; inventory no. 116.233 – 116.235 (H. Nyárády), date: 29.07.1947, collected by E.I. Nyárády; inventory no. 116.236 – 116.243 (H. Nyárády), date: 07.09.1946, collected by E.I. Nyárády; Cluj Meadows, by ”Copârșaie” place, inventory no. 115.841 – 115.843, 115.852 (H. Nyárády), date: 2.08.1947 and 16.08.1942, collected by E.I. Nyárády; inventory no. 115.884 (H. Nyárády), date:. 31.07.1942, collected by E.I. Nyárády; on Cluj-Napoca Hills, inventory no. 115.864 (H. Nyárády), date: 21.06.1942, collected by E.I. Nyárády; Făget Forest, inventory no. 115.844 (H. Nyárády), date: 19.07.1942, collected by E.I. Nyárády; Lomb Hill, in hedges, near forest, inventory no. 115.845 – 115.846, 115.848, 115.862 (H. Nyárády), date: 28.08.1946, collected

by E.I. Nyárády; inventory no. 115.865, 115.867 – 115.868, 115.886 – 115.889, 115.871 – 115.872, 115.875 – 115.876, 115.879, 115.882 – 115.883 (H. Nyárády), date: 28.07.1946, collected by E.I. Nyárády; inventory no. 115.870 (H. Nyárády), date: 21.07.1946, collected by E.I. Nyárády; inventory no. 116.231 (H. Nyárády), date: 07.09.1946, collected by E.I. Nyárády; Vadu Miresei, in beech forest, inventory no. 115.847, 115.851 (H. Nyárády), date: 19.07.1942, collected by E.I. Nyárády; inventory no. 115.890 (H. Nyárády), date: 19.07.1942, collected by E.I. Nyárády; Florești, inventory no. 115.849 (H. Nyárády), date: 31.07.1942, collected by E.I. Nyárády; Hojongard, inventory no. 115.853, 115.866 (H. Nyárády), date: 17.08.1944, collected by E.I. Nyárády; inventory no. 115.855, 115.881 (H. Nyárády), date: 12.08.1932, collected by A. Nyárády; inventory no. 115.858 (H. Nyárády), date: 30.07.1934, collected by A. Nyárády; inventory no. 115.885 (H. Nyárády), date: 16.08.1944, collected by E.I. Nyárády; inventory no. 115. 874 (H. Nyárády), date: 14.07.1947, collected by E.I. Nyárády; inventory no. 115.869, 115.878 (H. Nyárády), date: 17.08.1944, collected by E.I. Nyárády; Pietroasa, inventory no. 115.854 (H. Nyárády), date: 6.08.1936, collected by E.I. Nyárády; near Aghireșu, inventory no. 115.891 (H. Nyárády), date: 04.08.1947, collected by E.I. Nyárády; between Ocoliș and Vidolm, inventory no. 115.893 (H. Nyárády), date: 20.07.1959, collected by A. Nyárády & C. Vaczy;

C. rhaetica Moritz. (redeterminated as *C. nervosa* Willd.)

Collecting area: RO, SB, Șura Mare, inventory no. 25.125 (H. Fuss), date: 27.07.1855, collected by M. Fuss; Sibiu, inventory no. 25.129 (H. Fuss), date: 21.09.1846, collected by M. Fuss; Gușterița, inventory no. 25.130 (H. Fuss), date: -, collected by Goeblet; Cisnădie, inventory no. 25.128 (H. Fuss), date: 6.09.1852, collected by M. Fuss;

Collecting area: RO, BT, Bistrița, inventory no. 25.131 (H. Fuss), date: 14.07.1858, collected by Herzog;

Collecting area: RO, HD, Orăștie, inventory no. 25.127 (H. Fuss - *C. austriaca cirrata (*Rchb.) Nyman), date: -;

16. C. simonescui J.Wagner & Prodan (preliminary accepted)

Collecting area: RO, TL, Comănești Forest, ”Hegi-ghiol” place, inventory no. 116.027 (H. Nyárády), date: 28.07.1949, collected by E.I. Nyárády;

C. thuillieri J. Duvign. & Lambinon (redeterminated as hybrid of *C. jacea*)

Collecting area: RO, SB, Șura Mare, inventory no. 25.119 – 25.121 (H. Fuss), date: -, collected by M. Fuss;

17. C. nigrescens Willd.

Collecting area: RO, AR, Pleșcuța, inventory no. 115.700 (H. Nyárády), date: 24.08.1949, collected by E. I. Nyárády; Aciuța, inventory no. 115.703 (H. Nyárády), date: 24.08.1949, collected by E. I. Nyárády;

Collecting area: RO, MS, Târgu Mureș, inventory no. 115.701 (H. Nyárády), date: 30.09.1912, collected by E. I. Nyárády;

Collecting area: RO, CJ, City Park, inventory no. 115.702 (H. Nyárády), date: 13.08.1946, collected by I. Prodan & E. I. Nyárády; Cojocna, inventory no. 115.707 (H. Nyárády), date: 17.09.1920, collected by A. Borza & I. Prodan;

Collecting area: RO, HR, Becaș, inventory no. 115.709 – 115.710 (H. Nyárády), date: 26.08.1941, collected by E. I. Nyárády;

Collecting area: RO, BV, between Perșani and Brădet, inventory no. 115.711 – 115.712 (H. Nyárády), date: 07-08-1953, collected by E. I. Nyárády;

Collecting area: RO, VL, Govora Bath, inventory no. 115.713 – 115.714 (H. Nyárády), date: 25.08.1957, collected by E. I. Nyárády;

Collecting area: RO, B, București, Dâmbovița Riverside, inventory no. 115.708 (H. Nyárády-FRE 96), date: 17.08.1943, collected by Gușuleac

18. C. phrygia subsp. *rarauensis* (Prodan) Dostál.
Collecting area: RO, HR, Homorod Bath, on meadows with slope, near forest, inventory no. 115.898 – 115.899 (H. Nyárády - *C. rarauensis* Prod . and *C. salonitana* Vis.), date: 8.08.1949, collected by E.I. Nyárády & A. Nyárády;

19. C. phrygia subsp. *carpatica* Dostál. (syn. *C. carpatica* Porcius, *C. plumosa* var. *carpatica* Porcius)

Collecting area: RO, BN, Rodna Veche, inventory no. 53.476 (H. Barth), date: 5.08.1907, collected by K. Ungar; Rodnei Mt., between Rodna Veche village and Vinului Valley, inventory no. 115.286 (H. Nyárády), date: 20.08.1923, collected by E.I. Nyárády; Corongiș Peak, inventory no. 115.283 (H. Nyárády), date: 17.08.1918, collected by E.I. Nyárády; Crăciunel Peak, inventory no. 81.526 – 81.527 (H. Porcius - *C. plumosa* var. *carpatica* Porcius), date: -, collected by Porcius; Vinului

Valley, inventory no. 115.284 (H. Nyárády), date: 22.08.1923, collected by E.I. Nyárády; inventory no. 115.285 (H. Nyárády FEAH 3424), date: -, collected by F. Porcius; inventory no. 115.288, 115.292 (H. Nyárády), date: 19.07.1932, collected by E.I. Nyárády & A. Nyárády; Muncel Peak, inventory no. 115.287 – 115.291 (H. Nyárády), date: 10.08.1918, collected by E.I. Nyárády;

20. C. phrygia subsp. *melanocalathia* (Borbás) Dostál (syn. *C. melanocalathia* Borb, *C. banatica* x *stenolepis*= *C.* x *markiana*.)

Collecting area: RO, Bucegi Mt., Babele Plateau, inventory no. 105.341 (H. Pop), date: 1.07.1953, collected by I. Pop;

Collecting area: RO, Rodnei Mt., Anieș Valley, inventory no. 115.603 – 115.604 (H. Nyárády), date: 30.07.1948, collected by E.I. Nyárády & A. Nyárády;

Collecting area: RO, HR, Odorhei, Homorod Bath, inventory no. 115.189 (H. Nyárády), date: 8.08.1949, collected by A. Nyárády; inventory no. 115.598 (H. Nyárády), date: 8.08.1949, collected by A. Nyárády; Joseni, inventory no. 115.578 (H. Nyárády), date: 11.07.1921, collected by E.I. Nyárády; Madaraș, on way Căpâlnița, inventory no. 115.581 (H. Nyárády), date: 16.06.1916, collected by E.I. Nyárády; Lăzarea, Gurghiu Mt., inventory no. 115.590 (H. Nyárády), date: 16.07.1948, collected by E.I. Nyárády; Ciumărei, inventory no. 115.601 (H. Nyárády), date: 1.07.1942, collected by E.I. Nyárády;

Collecting area: RO, PH, Sinaia, Cumpătu, inventory no. 115.190 (H. Nyárády), date: 28.07.1963, collected by E.I. Nyárády;

Collecting area: RO, BV, Satulung Săcele, inventory no. 115.582 (H. Nyárády), date: 25.07.1911, collected by E.I. Nyárády; Tohanul Dochii, inventory no. 162.316 (H. Nyárády), date: 03.08.1957, collected by H. Heltmann;

Collecting area: RO, CJ, Ordeiașului Valley, Vidolm, inventory no. 115.191 (H. Nyárády), date: 21.07.1959, collected by E.I. Nyárády & Vaczy; Turda, inventory no. 115.579 (H. Nyárády), date: 11.07.1921, collected by E.I. Nyárády; Făget, inventory no. 115.583 (H. Nyárády), date: 25.07.1946, collected by E.I. Nyárády; RO, CJ, Lomb Mt., inventory no. 115.605 (H. Nyárády), date: 28.07.1946, collected by E.I. Nyárády; Botanical Garden, inventory no. 115.593 (H. Nyárády), date: 17.07.1940, collected by E.I. Nyárády & A. Nyárády;

Collecting area: RO, MS, Sovata Bath, inventory no. 115.573 (H. Nyárády), date: 20.07.1943, collected by E.I. Nyárády; inventory no. 115.602 (H. Nyárády), date: 17.07.1943, collected by E.I. Nyárády, between Deda and Răstolnița, inventory no. 115.580 (H. Nyárády), date: 03.07.1921, collected by E.I. Nyárády;

Collecting area: RO, AB, Abrud, Vulcan, inventory no. 115.591 (H. Nyárády), date: 18.08.1937, collected by E.I. Nyárády;

Collecting area: RO, SB, Vurpăr, inventory no. 115.592 (H. Nyárády), date: 22.07.1932, collected by E.I. Nyárády & A. Nyárády;

Collecting area: RO, BN, between Rodna Veche and Vinului Valley, inventory no. 115.599 (H. Nyárády), date: 20.08.1923, collected by E.I. Nyárády; Sângiorz Bath, inventory no. 115.604 (H. Nyárády), date: 15.08.1958, collected by E.I. Nyárády;

Collecting area: RO, SV, Pojorâta, Eva Mt., inventory no. 115.595 (H. Nyárády), date: 17.07.1949, collected by E.I. Nyárády & A. Nyárády;

21. C. phrygia subsp. *pseudophrygia* (C.A.Mey.) Gugler, (syn. *C. pseudophrygia* C.A.May)

Collecting area: RO, SB, Rășinari, inventory no. 162.331 (H. Schneider), date: 5.07.1970, collected by E. Schneider;

Collecting area: RO, HD. Vulcani near Abrud city, inventory no. 115.825 (H. Nyárády), date: 18.08.1937, collected by E.I. Nyárády & A. Nyárády; inventory no. 115.833, (H. Nyárády), date: 09.09.1910, collected by Banyai János;

Collecting area: RO, CV, Uzunca Bath, inventory no. 115.826 (H. Nyárády), date: 11.07.1956, collected by E.I. Nyárády;

Collecting area: RO, PH, Sinaia, Peleș Valley, inventory no. 115.827 (H. Nyárády), date: 19.07.1953, collected by E.I. Nyárády; Doftana Valley, "Cotul lui Iepure" place, inventory no. 115.828 – 115.830 (H. Nyárády), date: 21.07.1903, collected by E.I. Nyárády;

Collecting area: RO, HR, Homorod Bath, near Odorhei city, inventory no. 115.832 (H. Nyárády), date: 8.08.1949, collected by A. Nyárády; Sâncrăieni, inventory no. 115.835 (H. Nyárády), date: 5.08.1941, collected by E.I. Nyárády;

22. C. phrygia subsp. *stenolepis* (A.Kern.) Gugler (syn. *C. stenolepis* subsp. *bansagensis* (H.Wagner)

Soó; *C. stenolepis* Kern.*; C. stenolepis* var. *cetia* Hayek,),

Collecting area: RO, SB, Bradu, inventory no. 25.101 (H. Fuss), date: 2.08.1872, collected by M. Fuss; inventory no. 25.107 (H. Fuss), date: 20.07.1867, collected by M. Fuss; Sibiu, inventory no. 47.436 (Society Herbarium), date: -, collected by Sill; inventory no. 47.437 (Society Herbarium), date: -, collected by Kladny; on Trinkbach riverside, inventory no. 77.099 (H. Ormay), date: 18.10.1882, collected by Ormay; Tălmaciu, inventory no. 53.466 (H. Barth), date: 1.08.1906, collected by J. Barth; Ocna Sibiului, inventory no. 101.064 (H. Doltu), date: 26.07.1955, collected by M. Doltu;

Collecting area: RO, HD, Orăștie, "Piatra Mijlocie", inventory no. 105.379 (H. Pop), date: 16.06.1958, collected by I. Pop; on field between Clopotina and Grădiște, inventory no. 116.112 – 116.113 (H. Nyárády), date: 14.08.1950, collected by E.I. Nyárády; on field near Pui Village, inventory no. 116.115 (H. Nyárády), date: 31.07.1938, collected by E.I. Nyárády; Șerel Village, Culmea Mt., on meadow with *Poaceae* sp., inventory no. 116.120 (H. Nyárády), date: 31.07.1929, collected by E.I. Nyárády; Retezat Mt., by Gura Zlata place, inventory no. 116.123 (H. Nyárády), date: 11.08.1950, collected by E.I. Nyárády; Nucșoara Valley, Fagi region, inventory no. 116.134 (H. Nyárády), date: 28.08.1933, collected by E.I. Nyárády;

Collecting area: RO, TM, Lugoj, Cerga Valley, inventory no. 116.114 (H. Nyárády), date: 19.08.1942, collected by A. Borza;

Collecting area: RO, CS, Baziaș, inventory no. 116.116 (H. Nyárády), date: 26.06.1907, collected by E.I. Nyárády; Herculane Bath, on Cerna Riverside, inventory no. 116.126 (H. Nyárády), date: 31.07.1950, collected by E.I. Nyárády; Ciorici Mt., inventory no. 116.129 (H. Nyárády), date: 23.07.1950, collected by E.I. Nyárády; in forest, inventory no. 116.125 (H. Nyárády), date: 27.07.1950, collected by E.I. Nyárády;

Collecting area: RO, AR, Drăuț and Highiș, inventory no. 116.122, 116.124 (H. Nyárády), date: 05.08.1951, collected by E.I. Nyárády; Highiș Mt. on nordic slope, near Drăuț Lake, inventory no. 116.127 (H. Nyárády), date: 05.08.1951, collected by E.I. Nyárády;

Collecting area: RO, AB, Piatra Cetii Mt., near Gâlda de Sus Village, inventory no. 116.118 – 116.119, 116.128 (H. Nyárády - *C. stenolepis cetia* Hayek), date: 21.07.1938, collected by E.I. Nyárády;

Collecting area: RO, GJ, Ciumbara Forest, Tehomir, inventory no. 116.121 (H. Nyárády), date: 19.07.1951, collected by A. Borza;

Collecting area: RO, VL, Govora Bath, in forest, inventory no. 116.130 (H. Nyárády), date: 4.09.1957, collected by E.I. Nyárády; inventory no. 116.133, date: 4.05.1917, collected by E.I. Nyárády; inventory no. 116.131 – 116.132 (H. Nyárády), date: 28.08.1957, collected by E.I. Nyárády; Cozia Mt., Berbece Valley, inventory no. 116.136 (H. Nyárády), date: 20.09.1961;
Collecting area: RO, CJ, Hajongard place, inventory no. 116.139 (H. Nyárády), date: 25.08.1963, collected by E.I. Nyárády;

23. C. trichocephala subsp. simonkaiana (Hayek) Dostál (syn. *C. simonkaiana Hayek*)

Collecting area: RO, Arad, Gurahonț, inventory no. 53.490 (H. Barth), date: 1.07.1905, collected by J. Wagner; inventory no. 116.054 (H. Nyárády FRE 2072), date: 15.07.1931, collected by Lupei & Laszlo; inventory no. 116.055 (H. Nyárády FRE 2073), date: 1.08.1906, collected by Wagner; Arad city, inventory no. 116.052 – 116.053 (H. Nyárády), date: 1.07.1905, collected by Simonkay / Wagner;

C. reichenbachioides Schur. (incl. *C. subjacea* (Beck) Hayek) (redeterminated as *C. macroptilon* Borbás)

Collecting area: RO, AB, Cetii Stone, inventory no. 70.020 (H. Untchj - *C. reichenbachioides* Schur.), date: 4.031905, collected by J. Barth; Glade of Brigand, inventory no. 115.903 (H. Nyárády - *C. reichenbachioides* Schur FEAH 3480.), date: -, collected by Csató;

Subgenus *Lopholoma,* *Acrocentron* Sect., Sect. *Stephanochilus*

1. C. scabiosa subsp. *fritschii* (Hayek) Hayek
Collected area: RO, SB, Tălmaciu city, inventory no. 42.840 (H. Ungar), date: 1.08.1906, collected by J. Barth.

2. C. scabiosa L.

Collecting area: RO, SB, Șura Mare, inventory no. 25.143 – 25.144 (H. Fuss), date: 22.08.1850; inventory no. 25.156 – 25.158 (H. Fuss), date 14.07.1855, collected by M Fuss; inventory no. 42.853 (H. Ungar), collected by M Fuss; Zackel Hill, inventory no. 95.394 (H. Gündisch), date: 15.08.1954, collected by Fr. Gündisch; inventory no. 95.396 (H. Gündisch), data: 15.08.1954,

collected by Fr. Gündisch; inventory no. 95.398 (H. Gündisch), data: 15.08.1954, collected by Fr. Gündisch; Gușterița, inventory no. 25.150 (H. Fuss), date: -, collected by Goebel; inventory no. 80.795 (H. Bielz, Krauss, Hergotta, Klotz), date: 1.07.1875, collected by Kladny; inventory no. 80.797 (H. Bielz, Krauss, Hergotta, Klotz), data: 1.07.1873, collected by: Kladny; inventory no. 80.798 (H. Bielz, Krauss, Hergotta, Klotz), data: 16.09.1874, collected by: Kladny; inventory no. 162.333 (H. Schneider), date: 4.07.1963, collected by E. Schneider; Ocna Sibiului, inventory no. 95.395 (H. Gündisch), date: 8.07.1956, collected by Fr. Gündisch; inventory no. 95.397 (H. Gündisch), date: 08.07.1956, collected by Fr. Gündisch; Nou, inventory no. 25.152 – 25.155 (H. Fuss), date: -, collected by M. Fuss;

Collecting area: RO, HD, Orăștie, inventory no. 25.149 (H. Fuss), date:.-, collected by Unvericht; inventory no. 42.854 (H. Ungar), date:.-, collected by Unvericht; inventory no. 25.159 (H. Fuss.- *C. scabiosa albiflora* Schur), date: -, collected by Unvericht;

Collecting area: RO, BN, Bistrița, inventory no. 25.151 (H. Fuss), date: -, collected by Herzog;

Collecting area: RO, HR, Homorod Bath, inventory no. 42.852 (H. Ungar), date: 18.07.1899, collected by J. Barth; inventory no. 53.525 (H. Barth), date: 18.07.1899, collected by J. Barth; inventory no. 115.948 (H. Nyárády), date: 08.08.1949, collected by A. Nyárády; inventory no. 115.950 (H. Nyárády), date: 08.08.1949, collected by A. Nyárády; inventory no. 115.965 (H. Nyárády), date: 08.08.1949, collected by E.I. Nyárády; Remetea, inventory no. 77.612 (H. Baumgarten), date: 1.07.1821, collected by: K. Ungar;

Collecting area: RO, BV, Brașov, inventory no. 42.855 (H. Ungar), date: 23.07.1880, collected by J. Barth; inventory no. 47.431 (Society Herbarium), RO, Transylvania, date; -, collected by Sill;

Collecting area: RO, CJ, Lomb Hills, inventory no. 105.367 (H. Pop), date: 14.06.1950, collected by I. Pop; inventory no. 105.368 (H. Pop), date: 14.06.1950, collected by, I. Pop; Florești, inventory no. 115.961 – 115.963 (H. Nyárády), date:1.08.1942, collected by E.I. Nyárády;

Collecting area: RO, CS, Herculane Bath, inventory no. 115.966 (H. Nyárády), date: 25.07.1950, collected by E.I. Nyárády; Reșița on Valea Mare, inventory no. 162.334 (H. Schneider), date: 1.07.1977, collected by Goga;

Collecting area: RO, Transylvania, inventory no. 80.796 (H. Bielz, Krauss, Hergotta, Klotz), date: -, collected by Kladny;

3. C. scabiosa subsp. *spinulosa* (Spreng.) Arcang.

Collecting area: RO, MS, Sighișoara, Boiu village, inventory no. 77.615 (H. Baumgarten - *C. coriaceus* Baumg., *C. stereophylla* Griseb.), data: 1.07.1820, collected by Baumgarten;
Collecting area: RO, CJ, Cluj Meadows „Fânațele Clujului", inventory no. 105.373 (H. Pop.- *C. pseudospinulosa*), date: 05.07.1949, collected by I. Pop;

C. scabiosa subsp. *alpestris* (Hegetschw.) Nyman (redeterminated as C. kotschyana Heuff.)

Collecting area: RO, Făgăraș Mt., inventory no. 25.160 (H. Fuss.- *C. scabiosa alpestris* Hayek, *C. alpestris* Hegetschw.), date: 16.08.1831, collected by Schur; inventory no. 25.167 (H. Fuss), date: 8.08.1856, collected by M. Fuss;

Collecting area: RO Transylvania, inventory no. 25.161 (H. Fuss - *C. scabiosa alpestris* Hayek), date: -, collected by Baumgarten; inventory no. 25.162 (H. Fuss), date: -, date: -, collected by T. Kotschy; inventory no. 25.163 (H. Fuss), date: 27.07.1850, collected by Kladny;

Collecting area: RO, Rodnei Mt., Coronghiș, inventory no. 25.164 (H. Fuss), date: -; collected by Rupert; inventory no. 25.165, date: 5.08.1858, collected by Herzog; inventory no. 25.166 (H. Fuss), date: -, collected by Herzog;

4.C. scabiosa subsp. *spinulosa* (Spreng.) Arcang.

Collecting area: RO, Banat, inventory no. 25.178 (H. Fuss), date: -, collected by Heuffel;

Collecting area: RO, SB, Bradu, inventory no. 25.179 (H. Fuss - *C. apiculata* subsp. *spinulosa* (Spreng.) Dostál, *C. scabiosa spinulosa* Rochel), date: 6.07.1866, collected by M. Fuss; inventory no. 25.180 (H. Fuss), date: -, collected by M. Fuss; inventory no. 25.181 (H. Fuss), date: -, collected by M. Fuss; inventory no. 25.182 (H. Fuss) date: -, collected by M. Fuss; Șura Mare, inventory no. 25.183 (H. Fuss), date: -, collected by M. Fuss; inventory no. 25.184 (H. Fuss), date: -, collected by M. Fuss; inventory no. 25.185 (H. Fuss - *C. scabiosa spinulosa* Rochel), date: 29.09.1881, collected by M. Fuss; inventory no. 77.097 (H. Ormay), date: 19.10.1882, collected by Ormay; Gușterița, inventory no. 77.098 (H. Ormay.-.*C. scabiosa spinulosa* Rochel), date: 10.07.1884, collected by Ormay;

5. C. scabiosa L. subsp. *scabiosa*
Collecting area: RO, CJ, Făget, inventory no. 115.973, (H. Nyárády - *C. pseudospinulosa* Borbás, FRE 847), date: 1.07.1921, collected by I. Prodan

C. scabiosa subsp. *cephalariifolia* (Willk.) Greuter, (redeterminated as *C. scabiosa* subsp. *spinulosa* (Spreng.) Arcang.)

Collecting area: RO, SB, Nou, inventory no. 25.171 (H. Fuss - *C. scabiosa coriacea*), date: 17.10.1845, collected by. Fuss; Apoldu de Sus, inventory no. 32.475 (H. Kayser - *C. spinulosa* Roch.), date: 1.09.1874, collected by Kayser; Ochsenweg, inventory no. 42.859 (H. Ungar - *C. spinulosa* Roch.), date: 03.08.1907, collected by J. Barth; Sibiu, inventory no. 42.860 (H. Ungar.- *C. spinulosa* Roch.), date: 25.08.1906, collected by K. Ungar; inventory no. 42.862 (H. Ungar.- *C. spinulosa* Roch.), date: 24.06.1905, collected by K. Ungar; Guștereița, inventory no. 42.861 (H. Ungar - *C. spinulosa* Roch.), date: 2.08.1906, collected by K. Ungar; Slimnic, inventory no. 101.062 (H. Doltu - *C. spinulosa* Roch.), date: 2.06.1956, collected by M. Doltu; Șura Mare, inventory no. 42.863 (H. Ungar - *C. spinulosa* Roch.), date: 29.08.1879, collected by M. Fuss; between Ludoș and Bogatu, inventory no. 116.072 (H. Nyárády - *C. spinulosa* Roch.), date: 8.08.1949, collected by A. Nyárády; near Ludoș, inventory no. 116.081 (H. Nyárády - *C. spinulosa* Roch.), date: 09.08.1907, collected by E. I. Nyárády; Târnava Mică, inventory no. 116.078 – 116.080 (H. Nyárády - *C. spinulosa* Roch.), date: 23.08.1911, collected by E. I. Nyárády;

Collecting area: RO, BV, Stupini, inventory no. 70.038 (H. Untchj - *C. spinulosa* Roch.), date: 1.07.1884, collected by J. Römer;

Collecting area: RO, CJ, Cluj, inventory no. 95.681 (H. Heltmann - *C. spinulosa* Roch), date: 1.07.1954, collected by H. Heltmann; inventory no. 116.101, 116.103, 116.103 A (H. Nyárády - *C. spinulosa* Roch.), date: 10.08.1932, collected by A. Nyárády; inventory no. 62.335 (H. Schneider - *C. spinulosa* Roch.), date: 1954, collected by H. Heltmann; Lomb Mt., inventory no. 105.370 (H. Pop - *C. spinulosa* Roch.), date: 14.06.1950, collected by I. Pop; inventory no. 116.087 (H. Nyárády - *C. spinulosa* Roch.), date: 28.07.1946, collected by E. I. Nyárády; Hoia Meadow, inventory no. 105.372 (H. Pop - *C. spinulosa* Roch.), date: 15.06.1950, collected by I. Pop; Făget, inventory no. 116.096 (H. Nyárády - *C. spinulosa* Roch.), date: 21.07.1946, collected by E. I. Nyárády; Aghireșu, inventory no. 116.088 – 116.089, 116.099 – 116.100 (H. Nyárády - *C. spinulosa* Roch.), date: 4.08.1947, collected by E. I. Nyárády; near Cirisei Forest, Pața Village, inventory no. 116.090 (H. Nyárády.- *C. spinulosa* Roch.), date: 4.07.1947, collected by E. I. Nyárády; Florești, inventory no. 116.092 (H. Nyárády - *C. spinulosa* Roch.), date: 31.07.1942, collected by E. I. Nyárády; between Apahida and Cojocna, inventory no. 116.093 (H. Nyárády - *C. spinulosa* Roch.), date: 01.08.1911, collected by E. I. Nyárády; Ilei Valley, near Cluj- Napoca town, inventory no. 116.095 (H. Nyárády - *C. spinulosa* Roch.), date: 1.06.1947, collected by E. I. Nyárády; Florilor Valley, inventory no. 116.074 (H. Nyárády - *C. spinulosa* Roch.), date: 18.07.1914, collected by E. I. Nyárády; inventory no. 116.075 (H. Nyárády - *C. spinulosa* Roch.), date: 1.08.1911, collected by E. I. Nyárády; inventory no. 116.085 (H. Nyárády - *C. spinulosa* Roch.), date: 15.08.1942, collected by E. I. Nyárády; between Suatu and Mociu, inventory no. 116.086 (H. Nyárády - *C. spinulosa* Roch.), date: 00.08.1924, collected by I. Prodan;

Collecting area: RO, Apuseni Mt., Băișoarei Mt., inventory no. 105.371 (H. Pop - *C. spinulosa* Roch.), date: 14.09.1952, collected by I. Pop;

Collecting area: RO, MS, Tg. Mureș, inventory no. 116.073 (H. Nyárády - *C. spinulosa* Roch.), date: 16.07.1917, collected by E. I. Nyárády; Chețani, inventory no. 116.077 (H. Nyárády - *C. spinulosa* Roch.), date: 12.07.1903, collected by E. I. Nyárády;

Collecting area: RO, SM, Moroieni, inventory no. 116.076 (H. Nyárády - *C. spinulosa* Roch.), date: 19.08.1912, collected by E. I. Nyárády;

Collecting area: RO, AB, Aiud, inventory no. 116.083 (H. Nyárády - *C. spinulosa* Roch.), date: -, collected by Csato; Gârda de Sus, inventory no. 116.084 (H. Nyárády - *C. spinulosa* Roch.), date: 1.08.1933, collected by I. Prodan;
Collecting area: RO, BC, near town, inventory no. 116.094 (H. Nyárády - *C. spinulosa* Roch.), date: 8.08.1911, collected by Prodan;
Collecting area: RO, MH: between Vârciorova and Orșova, inventory no. 116.091 (H. Nyárády - *C. spinulosa* Roch.), date: 7.07.1949, collected by E.I. Nyárády & A. Nyárády;

Collecting area: RO, CS, Câlnic, near Reșița town, inventory no. 116.102 (H. Nyárády - *C. spinulosa* Roch.), date: 9.07.1952, collected by E.I Nyárády;

6. C. scabiosa subsp. *adpressa* (Ledeb.) Gugler
Collecting area: RO, Bucovina, Cuciurul Mare, inventory no. 115.971 (H. Nyárády - *C. adpressa* Ledeb FRE 300), date:- ; collected by Gușuleac;

Collecting area: RO, TL, Pădurea Letea, inventory no. 115.974 (H. Nyárády - *C. adpressa* Ledeb FRE 300B), date: 18.07.1923, collected by A. Borza & E.I. Nyárády; inventory no. 115.975 (H. Nyárády - *C. adpressa* Ledeb FRE 300B), date: 18.07.1923, collected by A. Borza & E.I. Nyárády; inventory no. 115.976 (H. Nyárády - *C. adpressa* Ledeb. FRE 300B), date: 18.07.1923, collected by E.I. Nyárády;

Collecting area: RO, IS, Soldana, near train station, inventory no. 115.977 (H. Nyárády - *C. adpressa* Ledeb- FRE 300B), date: 9.07.1956, collected by Dobrescu;

7. C. stereophylla Besser

Collecting area: RO, TL, between Duca and Mahmudia, inventory no. 116.140, (H. Nyárády), date: 27.07.1949, collected by E.I. Nyárády;

Collecting area: RO, IL: Dilga, inventory no. 116.141(H. Nyárády FRE 84), date: 20.06.1924, collected by I. Prodan;

Collecting area: RO, CT: Movila, inventory no. 116.142 (H. Nyárády FRE 841b), date: 20.07.1922, collected by Borza & Gürtler;

C. scabiosa subsp. *badensis* (Tratt.) Gugler
(redeterminated as *C. scabiosa* L.)

Collecting area: RO, BV, Brașov, inventory no. 53.516 (H. Barth - *C. badensis* Tratt.), date: 23.07.1880, collected by J. Barth;

8. C. calocephala Willd.
(incl. *C. globurensis* Nyar.*)*

Collecting area: RO, CS, Globurău, Plugova Mt., inventory no. 115.432 (H. Nyárády - *C. globurensis* Nyar.), date: 22.06.1930, collected by E.I. Nyárády;

Results and disscusions

The species of *Centaurea* s.l. identified in the botanical scientific heritage (2544 specimens) belong to 3 subgenera and the rest of the material was systematically distributed to other genera from *Centaurinae* (Fig.1). In Romania there are few studies on the systematic division of this genus, because of its controversial studies conflict at the worldwide level. The information of systematical divisions being taken, most of the times, from few studies conducted at European level.

The inventory of the *Centaurea* genus includes species from all over Europe, out of 2544 of the total specimens, 1767 specimens being represented by all sections of the genus (the rest of specimens belonging to other genera): *Calcitrapa* (*C. iberica* Trevir. ex Spreng., *C. calcitrapa* L., *C. melitensis* L., *C. solsitialis* L, *C. verutum* L., *C. aspera* L., *C. dichroantha* A. Kern., *C. sicula* L., *C. sphaerocephala* L.), *Chartolepis* (*C. glastifolia* L.), *Colimbada* (*C. salonitana* Vis.), *Phrygia* (*C. phrygia* subsp. *salicifolia* (Willd.) Mikheev, *C. rhaetica* Moritz., *C. debeauxii* Godr. & Gren., *C. decipiens* Thuill., *C. involucrata* Desf., *C. pectinata* L.), *Melanoloma* (*C. pullata* L.), *Phalolepis* (*C. alba* L., *C. caliacrae* Prodan, *C. margaritacea* Ten., *C. deusta* Ten., *C. diomedea* Gasp., *C. margaritacea* Ten., *C. tenoreana* Willk), *Wilkommia* (*C. resupinata* subsp. *lagascae* (Nyman) Fern.Casas & Susanna, *C. boissieri* DC., *C. monticola* Boiss. ex DC., *C. pinnata* Pau ex Vicioso).

The species of the subgenus *Lopholoma*, transformed into a genus after some studies, was only preliminary accepted by the researcher. In this paper, has been preserved the subgenus status and the species belonging to it, are: *C. calocephala* Willd. (syn. C. atropurpurea Waldst.), *C. kotschyana* Heuff., *C. granatensis* Boiss. ex DC., *C. scabiosa* L., *C. spinulosa* Roch.) The other part of *Centaurea* s.l. genus switched to *Cyanus* genus (preliminary accepted), with both section: *Cyanus* (*Cyanus segetum* Hill= *Centaurea cyanus* L.) and *Perennes* (*Cyanus cheiranthifolius* (Willd.) Soják, *Cyanus lugdunensis* (Jord.) Fourr., *Cyanus mollis* J.Presl & C. Presl, *Cyanus montanus* (L.) Hill, *Cyanus semidecurrens* (Jord.) Holub, *Cyanus triumfettii* (All.) Dostál ex Á.Löve & D.Löve).

REFFERENCES

Bancheva, Greilhuber 2006	Bancheva Svetlana, Greilhuber J., *Genome size in Bulgarian Centaurea s.l. (Asteraceae*). In: *Plant Systematics and Evolution* 257 (2006), p. 95 – 117. DOI: 10.1007/s00606-005-0384-7
Boršič *et al*., 2011.	Boršič, I., A. Susanna, Svetlana Bancheva, Nuria Garcia-Jacas, *Centaurea sect. Cyanus: Nuclear Phylogeny, Biogeography and Life-Form Evolution*. In: *International Journal of Plant Sciences* 172 (2), (2011), p., 238 - 249.
Greuter *et al.* 2001	Greuter, W., G. Wagenitz, Mariam Agababian, F. H. Hellwig, *Proposal to conserve the name Centaurea (Compositeae) with a conserved type*. In: *Taxon* 50, (2001), p. 1201 - 1205.
Greuter 2006–2009.	Greuter, W., *Compositae* (pro major parte). – In: Greuter W. & Von Raab-Straube E. (eds), *Compositae*. (2006–2009), Euro+Med Plantbase – the information resource for Euro - Mediterranean plant diversity, URL:[http://ww2.bgbm.org/EuroPlusMed, accessed 12 July 2020].
Hilpold *et al*. 2014	Hilpold Andrea, Garcia-Jacas Nuria, Vilatersana Roser, Susanna Alfonso, *Taxonomical and nomenclatural notes on Centaurea: A proposal of classification, a description of new sections and subsections and species list of the redefined section Centaurea*. In: *Collectanea Botanica* 33**,** (2014), e001.
Koutecký 2007	Koutecký, P., *Morphological and ploidy level variation of Centaurea phrygia agg. (Asteraceae) in the Czech Republic, Slovakia and Ukraine*. In: *Folia Geobotanica* 42, (2007), p.77-102.
Koutecký 2013	Kouteký, P., *A revision of the endemic species Centaurea carpatica.* In: *Acta Biologica Cracoviensia*, Poland, 55 (1), (2013), P.52.
Susanna, Garcia-Jacas, 2007	Susanna, Alfonso, Núria Garcia-Jacas, *Tribe Carduae.* In: Kadereit, J.W. &C. Jeffrey, (Eds.), *The Families and Genera of Vascular Plants*, vol.8, Flowering Plants. Eudicots. *Asterales*, Springer, Berlin & Heidelberg, (2007), p. 123 - 146.
Vonica, Cantor 2011	Vonica, Ghizela, Maria Cantor, *Some issues of Centaurea species determination.* In: *Brukenthal Acta Musei*, Sibiu, VI. 3, (2011), p. 61 - 68.
Vonica *et al*. 2013	Vonica, Ghizela D., J. P. Frink, Maria Cantor, *Taxonomic revision of some taxa of Jacea - Lepteranthus group (Centaurea genus) based on morphometric analysis*. In: *Brukenthal Acta Musei*, Sibiu, VIII.3, (2013), p. 567 - 584.
Wagenitz, Hellwig 1996	Wagenitz, Gerhard, E.H. Hellwig, *Eine neue und eine verschollene Centaurea-Art aus der Türkei und eine neue Volutaria-Art (Compositae-Cardueae).* In: *Annales Naturhistorische Museum,* Wien 98 B Suppl, (1996), p. 175 - 181.
T*he Plant List 2013*	***, *The Plant List,* Version 1.1. Published on the Internet; http://www.theplantlist.org/***(2013)*** (accessed 16 July 2020)**.**
Flora Europaea-RBGE	***, *Flora Europaea* – (http://rbg-web2.rbge.org.uk, 16 July 2020). Data extracted from the digital version of the Flora Europaea. Royal Botanic Garden Edinburgh, United Kingdom.
IPNI 2008	***, *IPNI- The International Plant Names Index*, Published on the Internet http://www.ipni.org , (2008), [accessed 1 Juny 2020].
Euro+Med, 2006	***, *Euro+Med PlantBase* – the information resource for Euro-Mediterranean plant diversity. Available http://ww2.bgbm.org/EuroPlusMed/ , (2006), [16 Juny 2020].

LIST OF ILLUSTRATIONS

LISTA ILUSTRAȚIILOR

Tab. 1. Systematic classification of *Centaurea* species from Transylvania (after Vonica *et al.* 2013)

Subgenus	***Section***	***Subsection***	***Species***
Centurea s.str.	*Acrolophus* (*Acrolophus, Willkommia, Phalolepis*)	*Maculosae*	*C. stoebe* subsp. *stoebe* subsp. *micranthos* *C. reichenbachii* *C. triniifolia*
		Cylindraceae	*C. diffusa?*
	Jacea	*Jacea* (Juss.) Koch	*C. jacea* subsp. *angustifolia* subsp. *bannatica*
		Nigrescentes	*C. nigrescens*
	Lepteranthus (DC.) D.C.	*Phrygia*	*C. phrygia* subsp. *phrygia* subsp. *erdneri* subsp. *pseudophrygia* subsp. *indurata* subsp. *carpatica* subsp. *ratezatensis* subsp. *rarauensis* *C. stenolepis* subsp. *razgradensis* subsp. *stenolepis* *C. uniflora* subsp. *nervosa* *C. macroptilon* subsp. *oxylepis*
	Calcitrapa	*Eucalcitrapa*	*C. calcitrapa* *C. iberica*
		Mesocentron	*C. solstitialis*
	Cnicus	-	*C. benedicta*
Cyanus	*Cyanus*	-	*C. cyanus*

	Protocyanus		*C. triumfetti* subsp. *axillaris* subsp. *triumfetti* subsp. *adscendens* subsp. *stricta* subsp. *pinnatifida* *C. mollis* subsp. *mollis*
Lopholoma	*Acrocentron*	*Acrocentron*	*C. atropurpurea*
		Lopholoma	*C. orientalis* *C. kotschyana* *C. scabiosa* subsp. *spinulosa*

Tab. 2. Taxonomical classification of genus *Centaurea* s. str. (after Hilpold *et al.* 2014)

***Centaurea* L. Genus**		
LOPHOLOMA Subgenus (Cass.) Dobrocz.	Sect. *Acrocentron* (Cass.) DC.	Subsect. *Chamaecyanus* (Willk.)
		Subsect. *Acrocentron*
	Sect. *Stephanochilus* (Coss. & Durieu ex Benth. & Hook. f.) O. Hoffm.	
CYANUS (Mill.) Subgenus Cass. ex Hayek	Sect. *Cyanus*	Subsect. *Cyanus*
		Subsect. *Perennes* Boiss.
CENTAUREA Subgenus	Eastern Mediterranean Clade (EMC)	
	Sect. *Calcitrapa* DC. [incl. sects. *Seridioides* DC. and sect. *Tetramorphaea* (DC.) Boiss.]	
	Sect. *Chartolepis* (Cass.) DC.	
	Sect. *Cheirolepis* (Boiss.) O. Hoffm. [incl. sect. *Plumosipappus* (Czerep.) Wagenitz, sect. *Pseudoseridia* Wagenitz *p. p.* and sect. *Pteracantha* Wagenitz]	
	Sect. *Cynaroides* Boiss. ex Walp. [incl. sect. Paraphysis (DC.) Wagenitz]	
	Sect. *Grossheimia* (Sosn. & Takht.) Dittrich	
	Sect. *Microlophus* (Cass.) DC.	
	Sect. *Phaeopappus* (DC.) O. Hoffm.	
	Sect. *Pseudophaeopappus* Wagenitz	
	Sect. *Ptosimopappus* (Boiss.) O. Hoffm.	
	Sect. *Rhizocalathium* Tzvelev (incl. sect. Pseudoseridia Wagenitz p. p.)	
	Western Mediterranean Clade (WMC)	
	Sect. *Hymenocentron* (Cass.) DC.	
	Sect. *Melanoloma* (Cass.) DC. (incl. sect. *Gymnocyanus* Maire)	
	Sect. *Mesocentron* (Cass.) DC.	
	Sect. *Seridia* (Juss.) DC.	
	Circum-Mediterranean Clade (CMC)	
	Sect. *Centaurea*	
		Subsect. *Centaurea*

		Subsect. *Phalolepis* (Cass.)
		Subsect. *Willkommia* (Blanca)
	Sect. *Akamantis*	
	Sect. *Ammocyanus* Boiss.	
	Sect. *Cnicus* (L.)	
	Sect. *Hieropolitaae*	
	Sect. *Phrygia Pers.*	
		Subsect. *Phrygia*
		Subsect. *Exarata*
		Subsect. *Jacea* (L.)
		Subsect. *Subtilis*

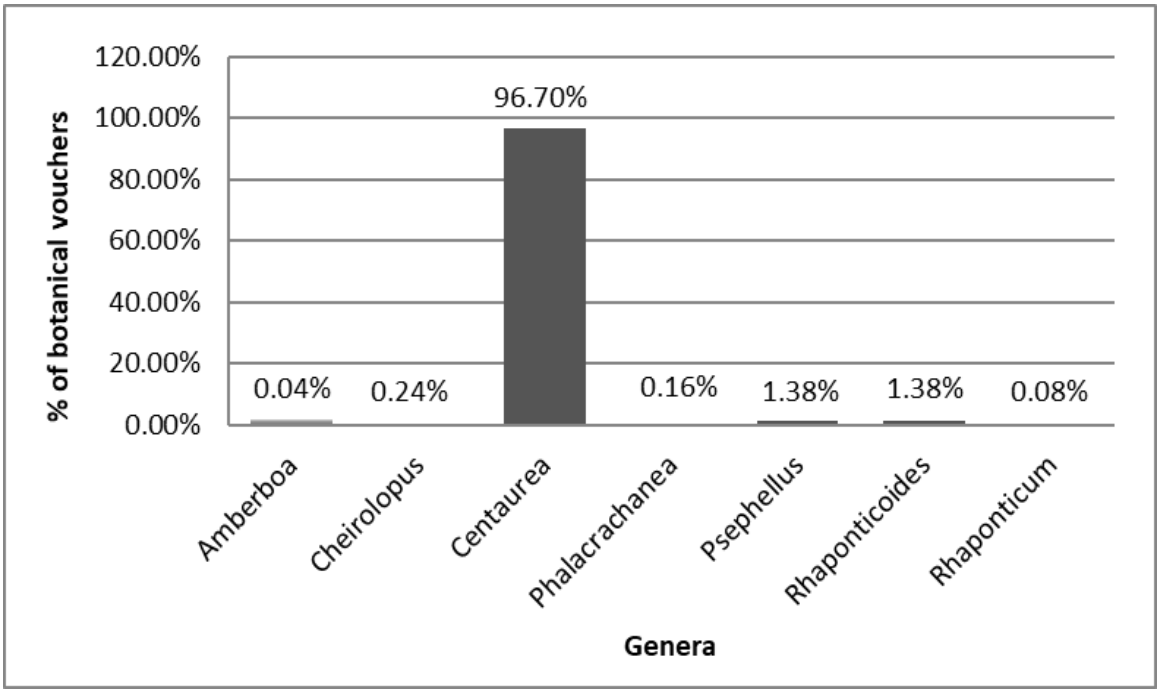


Fig. 1. Species distribution of *Centaurea s*. l. genus on different genera provided from this (the data were taken from inventory of Natural History Museum)

BRUKENTHAL NATIONAL MUSEUM IN 2019: A CHRONICLE OF NATURAL HISTORY EXHIBITIONS AND EVENTS

Dana Roxana HRIB*

Abstract: *The present study is a synthetic presentation of Brukenthal National Museum's cultural offer in the field of natural history during 2019.*
Keywords: *Brukenthal National Museum, natural history, 2019.*

Rezumat: *Articolul de față constituie o prezentare sintetică a ofertei culturale a Muzeului Național Brukenthal în domeniul istoriei naturale, pe parcursul anului 2019.*
Cuvinte cheie: *Muzeul Național Brukenthal, istorie naturală, 2019.*

1. Permanent exhibitions[1]

_ *Permanent exhibition dedicated to Ionel Pop* (the "August von Spiess" Museum of Hunting, 18.05)**:** the exhibition presents personal items, trophies, manuscripts or vestiges of the Frumoasei Valley, belonging or related to Ionel Pop, and the places where he was active. The exhibition project was carried out through a partnership between the Brukenthal National Museum and the Sibiu collector Alexandru Bârsan, who made available the objects on display and supported the design and room furbishing. (Fig. 1)

2. Temporary exhibitions[2]

a. Exhibitions at the museum locations:

Out of the 38 temporary exhibitions that were organized at the Museum's premises during 2019, 9 exhibitions displayed selections of exhibits in various fields of natural history.

_*"Birds of Heaven" Photo exhibition in memoriam Marian Huc and Mircea Radu Achim* (Museum of Natural History, Multimedia Hall, 26.01 – 31.03): the exhibition was dedicated to photographers Marian Huc and Mircea Radu Achim and presented some of the bird images they have captured over time. Marian Huc, a biologist, was enthusiastic about nature and creatures. For over 10 years on his travels through Romania, he has begun to notice especially birds. Because it is a universal language that can be understood by anyone, photography helped Marian to meet people and discover new things. Mircea Radu Achim photographed over 300 species of birds in Romania, his passion being turned into pursuit of the rarities or those who were in transit here. He was the founder of SOR Sibiu, a part of the Romanian Ornithological Society, and in this way managed to unite nature lovers and photographers, taking various actions together for the benefit of the birds in the area.

_*Nature's Kitchen* (Museum of Natural History, 19.04 – 09): there are culinary traditions in the world that, for some of us, are unimaginable. The exhibition issued an invitation to the discovery of unique "ingredients", from the collections of the Museum of Natural History: palm fruits, monkey-pots, baobab fruits and more!

_*Mineralia – Summer Edition* (Brukenthal Palace, Temporary Exhibition Hall, 14 – 16.06): the first 2019 edition of the largest exhibition dedicated exclusively to fine stones, precious stones and crystals, organized by geologist Andrei Gorduza, presented hundreds of mineral species in collector samples, fossil rocks, meteorites and crystals of natural forms, carved rocks and decoration items of agate, jasper, limestone, jade or malachite. Mineral enthusiasts found gemstones of superior aesthetic qualities, in polished forms that reveal beauty, colors or transparency. The mineral highlighted on the occasion of present edition was the ruby.

_*August von Spiess – the naturalist* (the "August von Spiess" Museum of Hunting (27.06 – 07): the exhibition invited general public to discover the work of August von Spiess in protecting the natural environment through the archive photos. Few know that August R. von Spiess has had a complex activity

* Brukenthal National Museum / Muzeul Naţional Brukenthal, dana.hrib@brukenthalmuseum.ro
[1] The short descriptions of permanent exhibitions are selected from the texts given by the curators for public information.
[2] The short descriptions of temporary exhibitions are selected from the texts given by the curators for public information.

regarding nature conservation as increasing the number of national parks and taking action against poachers. August R. von Spiess considered that protecting nature and fauna are two inseparable notions: "if the forest is protected, the vegetation grows and the deforestation is stopped, then animals will have what to eat and where to shelter." After studying the rich ornithological fauna from the Danube Delta, Spiess initiated an ornithological section of the Royal Hunting Division and in 1931 he contributed to the establishment of the Romanian Ornithological Observatory.

_*Mauritius von Kimakowicz (1849-1921) – the collector of natural history* (Museum of Natural History, 25.07): on the occasion of the commemoration of 170 years since the birth of naturalist Mauritius Hieronymus von Kimakowicz-Winnicki in Sibiu, the program of activities carried out in his honor included the display of the specific materials from the Kimakowicz malacological collection and the revealing of a bas-relief made by the Mexican artist Carlos Marin.

_*Aromatic plants – culinary tradition and health* (Museum of Natural History, Multimedia Hall, 1.10.2019 – 1.04.2020): the first herbariums contained aromatic plants meant to facilitate the work of pharmacists in plant recognition for the preparation of various remedies. Besides the herbalists, the pharmacists had in their kits and containers, vials with various parts of plants that they used in the composition of medicines. A selection of items from the herbarium of the Natural History Museum and from the bottle collection of the Museum of Pharmacy was presented as witness to the early times of natural remedies.

_*Contemporary Natural Therapies* (Museum of Natural History in Sibiu, Multimedia Hall, 5.10.2019 – 4.04.2020): organized in partnership with "Lucian Blaga" University of Sibiu and the History of Pharmacy Romanian Society, Sibiu section, the exhibition and its catalog were dedicated to complementary and alternative therapeutic doctrines, which have played an important role throughout the millennia in the history of medicine and pharmacy. The Museum of Natural History through its collections of botany (medicinal herbs) and the collections of the Museum of Pharmacy documentary attests the historical importance of natural therapies throughout the development of pharmaceutical sciences in Transylvania and beyond. The exhibition displayed the herbarium made by Johann Georg Baußner, in 1735, the oldest herbarium in Romania, the collection of medicinal plants made by the physician Joseph Sadler, collected from Transylvania between 1823 and 1825 and sheets from the herbarium of the pharmacist, chemist and botanist Gustav Adolph Kayser, founder of the Natural History Museum in Sibiu.

_*Mineralia* – Autumn Edition (Brukenthal Palace, Temporary Exhibition Hall, 22 – 24.11): organized by geologist Andrei Gorduza, the exhibition presented raw minerals in their natural state, perfect crystals in the most diverse forms, agates, geodes and collection samples, decorative objects carved in limestone, agate, chalcedony, jasper, aragonite, malachite or jade. Also on display were jewelries created exclusively from fine or precious stones (turquoise, garnet, aquamarine, tourmaline, fluorine, tanzanite, emerald, sapphire or ruby) along with amber necklaces, natural pearls and coral.

_*Live reptiles* (Blue House, basement, 1.01 – 31.12): organized together with Gabonica, the exhibition presented a large variety of reptiles.

b. Travelling exhibitions presenting Brukenthal National Museum's collections[3]

_*History and Natural History from the collections of Brukenthal National Museum* (Călimănești Convention and Exhibition Center, 20.05-31.12.2019): the project in partnership with Vâlcea County Council and Călimănești City Hall aimed to display the pieces until now in storages through the means of temporary and thematic exhibitions at partner museums, one of them being the County Museum Aurel Sacerdoțianu in Vâlcea; as result of this joint venture, a new concept of visiting storage was launched at the Center for Conferences and Exhibitions in Călimănești. (Fig. 2)

3. Events

_Conference: "Healthy culinary herbs from the Transylvanian cuisine" by Dr. Ladislau Rosenberg (19.04)

_Commemorative event: Mauritius von Kimakowicz (1849-1921) – the Natural History Collector (Museum of Natural History Sibiu, 25.07): in 2019, the Museum of Natural History in Sibiu commemorated 170 years since the birth of Mauritius Hieronymus von Kimakowicz-Winnicki (1849-1921), one of the greatest naturalists from Sibiu. The program included thematic lectures, materials from the Kimakowicz Malakological Collection and the unveiling of a bas-relief by Mexican artist Carlos Marin, representing Mauritius von Kimakowicz. (Fig. 3)

_Book launch: "From Ardeal to Kilimanjaro" by August von Spiess (the "August von Spiess" Museum of Hunting, 10.10)

[3] The short descriptions of the temporary traveling exhibitions are selected from the texts given by the curators for public information.

4. Projects

_*Sibiu Pharmaceutical Traditions*

Since 2016, Brukenthal National Museum, through the Pharmacy Museum, is partner of the Romanian Society of Pharmacy History (Sibiu) in the development of the cultural and educational project "Sibiu Pharmaceutical Traditions". Thematic lectures and various activities were held monthly in the Multimedia Room of the Museum of Natural History or within the Museum of Pharmacy.

Scientific symposiums

5. Scientific symposiums

_*National Symposium on Contemporary Natural Therapies* (Blue House, 4 – 5.10): more than 30 specialists from Romania and abroad participated in the symposium, one of the guests of honor being Denise Straiges CCH RSHom (NA) PCH, President, Clinical Director-Academy of Homeopathy Education NYC | World, Homeopath, Lecturer and Researcher. The symposium addressed the role and place of complementary and alternative therapies in the 3rd millennium medicine. A particular emphasis was drawn on the possibility of using herbal medicine, apitherapy, aromatherapy, homeopathy, dietotherapy, balneotherapy and other traditional therapeutic methods in the prevention and treatment of certain clinical conditions. (Fig. 4)

REFERENCES

_Raport Muzeul National Brukenthal 2019 http://www.brukenthalmuseum.ro/despre_noi/rapoarte.html
_http://www.brukenthalmuseum.ro/index2.php/virtuale
_http://www.brukenthalmuseum.ro/index2.php/ro/expo
_http://www.brukenthalmuseum.ro/publicatii/index.html

LIST OF ILLUSTRATIONS

Fig. 1. Permanent exhibition dedicated to Ionel Pop (the "August von Spiess" Museum of Hunting)

Fig. 2. History and Natural History from the collections of Brukenthal National Museum (Călimănești Convention and Exhibition Center)

Fig. 3. Commemorative event: Mauritius von Kimakowicz (1849-1921) – the Natural History Collector (Museum of Natural History)

Fig. 4. National Symposium on Contemporary Natural Therapies (Blue House)

LISTA ILUSTRAȚIILOR

Fig. 1. Expoziție permanentă, dedicată lui Ionel Pop (Muzeul Cinegetic „August von Spiess")

Fig. 2. Istorie și Istorie Naturală din colecțiile Muzeului Național (Centrul de Convenții și Expoziții Călimănești)

Fig. 3. Eveniment comemorativ: Mauritius von Kimakowicz (1849-1921) – Colecționarul de Istorie Naturală (Muzeul de Istorie Naturală)

Fig. 4. Simpozionul Național de Terapii Naturale în Actualitate (Casa Albastră)

Fig. 1 Permanent exhibition dedicated to Ionel Pop (the "August von Spiess" Museum of Hunting)

Fig. 2 History and Natural History from the collections of Brukenthal National Museum (Călimănești Convention and Exhibition Center)

Fig. 3 Commemorative event: Mauritius von Kimakowicz (1849-1921) – the Natural History Collector (Museum of Natural History)

Fig. 4 National Symposium on Contemporary Natural Therapies (Blue House)

MUZEUL NAȚIONAL BRUKENTHAL

PUBLICAȚIILE PERIODICE APĂRUTE DE-A LUNGUL TIMPULUI
(INCLUSIV PRECURSORII)

CRONOLOGIE	ISTORIE, ARHEOLOGIE	ARTA PLASTICĂ	ȘTIINȚELE NATURII	RESTAURARE	ETNOGRAFIE
Ante 1950		Mitteilungen aus dem Baron von Brukentalischen Museum 1931-1937 - Neue Folge I-VII 1941 - Neue Folge I-VIII 1944 - Neue Folge IX-X 1946-1947 - Neue Folge XI-XII	Verhandlungen und Mitteilungen der siebenbürgischen Vereins für Naturwiessenschaften zu Hermannstadt 1849-1945 95 de numere		
1959-1989	Studii şi comunicări Muzeul Brukenthal, Sibiu 1956, nr. 1 1965, nr. 12 1967, nr. 13 Volum omagial, Anuarul Muzeului Brukenthal, 1817-1967 1969, nr. 14 1973, nr. 18 1975, nr. 19 1977, nr. 20 1981, nr. 21	Studii şi comunicări Muzeul Brukenthal, Sibiu 1956, nr. 4, 5 1956, nr. 7 Istoria culturii 1978, nr. 1 1979, nr. 2	Studii şi comunicări Muzeul Brukenthal, Sibiu 1958, nr. 10, 11 1970, nr. 15 1971, nr. 16 1972, nr. 17 1973, nr. 18 1975, nr. 19 1976, nr. 20 1977, nr. 21 1978, nr. 22 1979, nr. 23 1980, nr. 24 + Supliment 1983, nr. 25 + Supliment 1984, nr. 26 1998, nr. 27 2003, nr. 28 2004, nr 29 + Supliment		Studii şi comunicări Muzeul Brukenthal, Sibiu 1956, nr. 2, 3, 6 1958, nr. 8, 9 Cibinium, Studii şi materiale privind Muzeul tehnicii populare din Dumbrava Sibiului, Sibiu 1966, vol I 1967/68, vol II 1969/73, vol III 1974/78, vol IV 1979/83, vol V
După 1989	2006, I, 1 2007, II, 1 2008, III, 1 2009, IV, 1 2010, V, 1 2011, VI, 1 2012, VII, 1 2013, VIII, 1 2014, IX, 1 2015, X, 1 2016, XI, 1 2017, XII, 1 2018, XIII, 1 2019, XIV, 1	2006, I, 2 2007, II, 2 2008, III, 2 2009, IV, 2 2010, V, 2 2011, VI, 2 2012, VII, 2 2013, VIII, 2 2014, IX, 2 2015, X, 2 2016, XI, 2 2017, XII, 2 2018, XIII, 2 2019, XIV, 2	2006, I, 3 2007, II, 3 2008, III, 3 2009, IV, 3 2010, V, 3 2011, VI, 3 2012, VII, 3 2013, VIII, 3 2014, IX, 3 2015, X, 3 2016, XI, 3 2017, XII, 3 2018, XIII, 3 2019, XIV, 3	2010, V, 4 2011, VI, 4 2012, VII, 4 2013, VIII, 4 2014, IX, 4 2015, X, 4 2016, XI, 4 2017, XII, 4 2018, XIII, 4 2019, XIV, 4	

EDITURA MUZEUL NAȚIONAL BRUKENTHAL