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EARLY SPRING LEPIDOPTERA (INSECTA: LEPIDOPTERA) FROM DOBROGEA (SOUTH-EASTERN ROMANIA)

Levente SZÉKELY*

Abstract. *Dobrogea is probably the most intensely studied region in Romania as far as Lepidoptera fauna is concerned. The number of reported Macrolepidoptera species reaches approximately 1000 species. Most of the data published until now cover the period May-November, and thus the early spring fauna (February-April) is still poorly known based on sporadic records that are almost completely lacking prior to 1990. This work is a contribution to the knowledge of the early spring Lepidoptera fauna of Dobrogea, and presents a series of rare species that have not been collected and reported for several decades in Romania, such as: Ocnogyna parasita (Hübner, 1790), Asphalia rificollis (Denis & Schiffermüller, 1775) Lithophane semibrunnea (Hawort, 1809). Six species are new for the fauna of Dobrogea: Nola cicatricalis (Treitschke, 1835) (Fam. Noctuidae, Nolinae), Lithophane semibrunnea (Hawort, 1809) (Fam. Noctuidae, Xyleniae), Cerastis leucographa ([Denis & Schiffermüller], 1775) (Fam. Noctuidae, Noctuinae), Semioscopis avellanella (Hübner, 1793) (Fam. Depressaridae), Phaneta pauperana (Duponchel, 1843) (Fam. Tortricidae) and Gravitarmata margarotana (Heinemann, 1863) (Fam. Tortricidae) (Reported in the Romanian fauna only before 1980).*
Key words: *Insects, Lepidoptera, faunistics, early spring, Dobrogea, Romania.*

Rezumat. *Dobrogea este probabil cea mai intens cercetată regiune din România sub aspectul faunei de lepidoptere. Numai Macrolepidopterele însumează în jur de 1000 de specii semnalate şi publicate. Majoritatea datelor publicate până în prezent acoperă perioada mai-noiembrie, fauna de lepidoptere de la începutul primăverii (februarie-aprilie) fiind puțin cunoscută pe baza unor date sporadice care lipsesc aproape in totalitate inainte de 1990. Această lucrare reprezintă o contribuție la cunoaşterea faunei de lepidoptere de început de primăvară din Dobrogea, şi prezintă câteva specii rare şi puțin cunoscute din România, care nu au fost colectate de câteva decenii, de exemplu: Ocnogyna parasita (Hübner, 1790), Asphalia ruficollis ([Denis & Schiffermüller], 1775), Lithophane semibrunnea (Hawort, 1809). Şase specii sunt noi pentru fauna Dobrogei: Nola cicatricalis (Treitschke, 1835) (Fam. Nolidae), Lithophane semibrunnea (Hawort, 1809) (Fam. Noctuidae, Xyleninae), Cerastis leucographa ([Denis & Schiffermüller], 1775) (Fam. Noctuidae, Noctuinae), Semioscopis avellanella (Hübner, 1793) (Fam. Depressaridae), Phaneta pauperana (Duponchel, 1843) (Fam. Tortricidae) şi Gravitarmata margarotana (Heinemann, 1863) (Fam. Tortricidae) (Semnalată în fauna României numai înainte de 1980).*
Cuvinte cheie: *Insecte, lepidoptere, începutul primăverii, Dobrogea, România.*

Introduction

Dobrogea is one of the most interesting regions of Romania in terms of entomofauna. The Lepidoptera fauna is particularly well known and the Macrolepidoptera alone amount to approximately 1000 published species (Székely 2012). The most active lepidopterologists of Romania have been collecting in this region for more than 150 years, starting in 1865 with the research of Joseph Mann (Mann 1866). These studies covered almost all year, but to a lesser extent the aspects of early spring.

Collecting and observations were made mainly in the period May-November and especially in summer, during the seaside season. The data concerning early spring are rare and sporadic ones and they are lacking almost completely prior to year 1990. The unstable weather conditions of the period February-April often made collecting impossible. In the years 1992–1994, the first effective March-April collecting was successfully completed with the help of Alexandru Mîner, an inhabitant of Băneasa, who collected with good results in Canaraua Fetii (Székely 1994; Bálint, Székely 1995; Rákosy, Székely 1996). The data presented in this work are mostly based on collecting done by the author during 2015 and

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2016, specifically 15th – 17th of April 2015, and 30th of March – 3rd of April 2016.

Material and methods

The material was collected using 125 W mercury vapour bulbs placed in front of a white sheet, powered by a portable gasoline generator. In parallel, 3-4 light traps with 8W black and white UV tubes were used every night. An entomological net was used for butterflies.

List of localities with geographical coordinates:

Tulcea County:
Babadag (44°53′36″N, 28° 42′43″E),
Slava Rusă (44°51′1″N, 28°36′20″E),
Enisala (44°52′42″N, 28°49′7″E),
Luncavița (45°15′51″N, 28°18′20″E),
Cetățuia (45°14'56"N, 28°16'55"E),
Turcoaia (45°07′12″N, 28°12′01″E),
Beştepe (45°05′32″N, 29°00′53″E),
General Praporgescu (45°0′51″N, 28°22′31″E),
Celic Dere (45°15′38″N, 28°37′11″E).

Constanța County:
Allah Bair (44°29′05″N, 28°07′31″E),
Gura Dobrogei (44°28′52″N, 28°31′39″E),
Cheile Dobrogei (44°29′42″N, 28°27′08″E),
Esechioi (44°1′53″N, 27°25′16″E),
Ion Corvin (44°06′20″N, 27°48′12″E),
Canaraua Fetii (44°03′12″N, 27°40′27″E),
Băneasa (44°4′12″N, 27°42′0″E),
Ostrov (44°06′07″N, 27°24′06″E),
Bugeac (44°5′51″N, 27°25′58″E),
Cochirleni (44°16′27″ N, 27°59′55″E),
Constanța (44°10′24″ N, 28°38′18″E)..

Discussion

There are 85 Lepidoptera species listed in this work. The list of the presented species is not high, but it includes numerous rare species, six of which are recorded for the first time in Dobrogea.

The most notable records from 2015-2016 are briefly presented below.

Asphalia ruficolis (Denis & Schiffermüller 1775) (Fam. Thyatiridae) (Fig. 3) extremely rare and local in Romania, known from Banat, Satu-Mare and south-western Transilvania. It has previously been recorded in Dobrogea only from Canaraua Fetii (Bálint, Székely 1995).

Ocnogyna parasita (Hübner, 1790) (Fam. Erebidae, Arctiinae) (Fig. 6) – the discovery of a vigorous population at Cetatea Enisala (Enisala Fortress), confirms that in Dobrogea may exist numerous populations of this rare and local species. *Ocnogyna parasita* was collected for the last time in Romania in 1965 (Timişoara), and the only report in the last 50 years is a photograph of a female specimen found in central Dobrogea (Gura Dobrogei) (Manci, Rákosy 2013).

Nola cicatricalis (Treitschke, 1835) (Fam. Nolidae) (Fig.14) – very local, reported in Romania only from Banat, northern Moldova, Oltenia - Râmnicu Vâlcea (Fleck 1902) and Transilvania (Cheile Turzii) (Rákosy, Székely 1994). First record for the fauna of Dobrogea.

Lithophane semibrunnea (Hawort, 1809) (Fam. Noctuidae, Xyleninae) (Fig. 13) – a very rare species in Romania, known only from Banat, Crişana and from southern Moldova (old data over 50 years ago) (Rákosy 1996). First record for the fauna of Dobrogea.

Cerastis leucographa ([Denis & Schiffermüller], 1775) (Fam. Noctuidae, Noctuinae). First record for the fauna of Dobrogea.

Semioscopis avellanella (Hübner, 1793) (Fam. Depressaridae). First record for the fauna of Dobrogea.

Phaneta pauperana (Duponchel, 1843) (Fam. Tortricidae). First record for the fauna of Dobrogea.

Gravitarmata margarotana (Heinemann, 1863) (Fam. Tortricidae). First record for the fauna of Dobrogea. Reported from Romania only before 1980 (Rákosy *et al.* 2003).

Other rare and local species for the fauna of Dobrogea and Romania:

Phyllodesma ilicifolia (Linnaeus, 1758) (Fig. 1), *Saturnia pavonia* (Linnaeus, 1758) (Fig. 2), *Cilix asiatica* Bang-Haas, 1908, *Dasycorsa modesta* (Staudinger, 1879) (Fig. 4), *Apocheima hispidaria popovi* Vojnits, 1972 (Fig. 5), *Arctia festiva* (Hufnagel, 1766) (Fig. 16), *Simyra dentinosa* Freyer, 1839 (Fig .9), *Nola confusalis* (Herrich-Schäffer, [1847]) (Fig. 15), *Panolis flammea* ([Denis & Schiffermüller], 1775) (Fig. 8), (species introduced in Dobrogea with the pine plantations), *Euchloe ausonia* (Hübner, [1804]) (Fig. 11), *Pseudophilotes bavius egea* (Herrich-Schäffer, 1852), *Nymphalis polychloros* (Linnaeus, 1758) (Fig.12). Although no adults of the species *Simyra dentinosa* have been collected, numerous larvae were found in April-May at Babadag Forest, Cheile Dobrogei and Gura Dobrogei (Fig. 9). This species might fly at the beginning of March in Dobrogea, a period during which collecting has never been made. A similar situation might aply

to the "Natura 2000" species *Erannis ankerania* (Staudinger, 1861). This species has been erroneously included (it has never been recorded from Dobrogea) in the standard forms of some "Natura 2000" sites from southern Dobrogea (Hagieni-Cotu Văii, Canaraua Fetii-Iortmac, Urluia-Dumbrăveni). In fact, the presence of this species in Romania has not been confirmed, and it is based only on three specimens recorded from southern Moldova 70 years ago, from the period 1933-1945 (Alexinschi *et al.* 1963). Consequently, the possibility of the presence of *E. ankeraria* in Dobrogea seems rather low, but further research is needed to clarify this aspect.

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); leg. = legit (collected by); ex larva = specimens in larva stage.

Suprafam. BOMBYCOIDEA Latreille, [1803]

Fam. LASIOCAMPIDAE Harris, 1841
Phyllodesma ilicifolia (Linnaeus, 1758)
- Babadag, 15-17.IV.2015 (4♂); Canaraua Fetii, 2.IV.2016 (1♂) - First record for Southern Dobrogea.
- Published records for Dobrogea: Babadag (Székely 2012)

Fam. SATURNIIDAE Boisduval, [1837] 1834
Saturnia pavonia (Linnaeus, 1758) /
? *Saturnia pavoniella* (Scopoli, 1763)
- Babadag, 16.IV.2015(1♀)
- Published records: Canaraua Fetii, 5.III-10.IV.1993 / leg. A. Mîner (Rákosy, Székely 1996); Greci (Rákosy, Wieser 2000)

Very rare in Dobrogea. Published so far only as *S. pavonia*. The population from Canaraua Fetii is closer to *S. pavoniella*. The situation of the two species in Dobrogea is not clarified now.

Fam. DREPANIDAE Meyrick, 1895
Watsonalla binaria (Hufnagel, 1766):
- Babadag, 15-17.IV.2015 (R).
- Common throughout Dobrogea in 2-3 generations per year.

Cilix asiatica Bang-Haas, 1908
- Babadag, 15-17.IV.2015 (2♂)
- Published records: Hagieni, Canaraua Fetii (Székely, Dincă 2008); Cheile Dobrogei, Gura Dobrogei (Székely 2012).

Cilix glaucata (Scopoli, 1763)
- Enisala, 30.III.2016 (1♂)
- Common throughout Dobrogea in 2-3 generations per year.

Fam. THYATIRIDAE Smith, 1893
Subfam. Polyplocinae Meyrick, 1895
Polyploca ridens (Fabricius, 1787)
- Babadag, 15-17.IV.2015 (VC), 30-31.III.2016 (C); Esechioi, 1.IV.2016 (C).
- Published records: Greci, Horia, Babadag (Rákosy, Wieser 2000); Babadag, (Székely 2012)

Asphalia ruficollis ([Denis & Schiffermüller], 1775)
- Babadag, 31.III.2016 (2♂, 1♀)
- Published records: Canaraua Fetii (Bálint, Székely 1995) – the only previous record for Dobrogea.

Suprafam. GEOMETROIDEA Leach, [1815]

Fam. GEOMETRIDAE Leach, [1815]
Subfam. Alsophilinae Herbulot, 1962
Alsophila aescularia ([Denis & Schiffermüller], 1775)
- Babadag, Enisala, 15-17.IV.2015 (C); Babadag, 31.III.2016 (4♂)
- Published records: Canaraua Fetii (10-12.IV.1992) (Rákosy, Székely 1996); Greci, Horia, Babadag (Rákosy, Wieser 2000)

Subfam. Larentiinae Duponchel, 1845
Costaconvexa polygrammata (Borkhausen, 1794)
- Babadag, Enisala, 30-31.III.2016 (R); Esechioi, 1.IV.2016 (R); Bugeac, 1.IV.2016 (1sp.).

Eupithecia virgaureata Doubleday, 1861
- Babadag, 30-31.III.2016 (C); Esechioi, 1.IV.2016 (C); Canaraua Fetii, 2.IV.2016 (R)

Asthena albulata (Hunagel, 1767)
- Esechioi, 1.IV.2016 (1sp.)

Subfam. Ennominae Duponchel, 1845
Dasycorsa modesta (Staudinger, 1879)
- Babadag,15-17.IV.2015 (6♂, 1♀), 30-31. III.2016 (7♂); Canaraua Fetii, 2. IV. 2016 (1♀)
- Published records: Canaraua Fetii, 15.III-1.V / leg. A. Mîner (Székely 1994; Bálint, Székely 1995; Rákosy, Székely,1996); Agigea, Comorova, Hagieni (Popescu-Gorj, Drâghia 1964, 1967); Agigea (Székely, Cernea 2007); Greci (Rákosy, Wieser 2000); Gura Dobrogei (Székely 2012)

Lycia hirtaria (Clerck, 1759)

- Babadag, 14.III.2015 (1♂ / leg. M. Skolka); Babadag, Enisala, 15-17.IV.2015 (C), 30-31.III.2016 (C); Esechioi, 1.IV.2016 (C).
- Published records: Canaraua Fetii (15.III-15.IV / leg. A. Mîner) (Rákosy, Székely 1996); Greci, Horia (Rákosy, Wieser 2000); Babadag (Székely 2012)

Biston strataria (Hufnagel, 1767)
- Babadag, 30-31.III.2016 (4♂); Esechioi, 1.IV.2016 (7♂)
- Published records: Canaraua Fetii (1.IV.1993/ leg. A. Mîner) (Rákosy, Székely, 1996); Comorova, 25.IV (Popescu-Gorj, Drâghia 1967); Greci, Horia (Rákosy, Wieser 2000)

Apocheima hispidaria popovi Vojnits, 1972
- Babadag, 31.III.2016 (1♂)
- Published records: Canaraua Fetii, 12-20.III.1994 / leg. A. Mîner (Rákosy, Székely 1996); Greci, Horia (Rákosy, Wieser 2000)

Apocheima pilosaria ([Denis & Schiffermüller], 1775)
- Babadag, 28.II.2015 (1♂/ leg. M. Skolka).
- Published records: Canaraua Fetii, 12-20.III.1994 / leg. A. Mîner (Rákosy, Székely 1996); Comorova (Popescu-Gorj, Drâghia 1967); Greci, Horia (Rákosy, Wieser 2000)

Agriopis marginaria (Fabricius, 1776)
- Luncavița, Cetățuia, 28.II.2015 (2♂/ leg. M. Skolka).
- Published records: Canaraua Fetii, 5.III-10.IV / leg. A. Mîner (Rákosy, Székely 1996); Greci, Horia (Rákosy, Wieser 2000)

Agriopis leucophearia ([Denis & Schiffermüller], 1775)
- Muntele Consul - Tulcea, 28.II.2015 (1♂ / leg. M. Skolka)
- Published records: Canaraua Fetii, 5.III-10.IV / leg. A. Mîner (Rákosy, Székely 1996); Greci, Horia (Rákosy, Wieser 2000).

Cleora cinctaria ([Denis & Schiffermüller], 1775):
- Babadag, 15-17.IV.2015 (C)

Ematurga atomaria (Linnaeus, 1758)
- Canaraua Fetii, 2.IV.2016 (2♂)

Suprafam. NOCTUOIDEA Latreille,1809

Fam. EREBIDAE (Leach, [1815])
Subfam. Arctiinae Leach, 1815
Diaphora mendica (Clerck, 1759)
- Enisala, 17.IV.2015 (1♂)

Ocnogyna parasita (Hübner, 1790)
- Cetatea Enisala, 30-31.III.2016 (8♂)
- Published records: Tulcea (Mann 1866); Agigea, III.1963 (2sp.) (Nemeş, Voicu, 1973); Gura Dobrogei, 10.IV.2013 (1♀) (Manci, Rákosy 2013).

Arctia festiva (Hufnagel, 1766)
- Turcoaia, Beştepe, General Praporgescu (15-30.IV, 2000-2009 / leg. P. Haneschläger).Published records: Tulcea (Mann 1866); Eforie Sud (Caradja, 1930); Canaraua Fetii, (IV.1993-1994 / leg. A. Mîner), Hagieni (Bálint, Székely 1995; Rákosy, Székely 1996); Canaraua Fetii, 22.IV.1989 (7♂) (Burnaz, 1993); Letea (Popescu-Gorj, 1985); Greci (Rákosy, Wieser 2000); Babadag, Beştepe (Székely 2012).

Fam. NOTODONTIDAE Stephens, 1829
Subfam. Dicranurinae Duponchel, [1845]
Harpyia milhauseri (Fabricius, 1775)
- Babadag, 15-17.IV.2015 (R); 31.III.2016 (1♂); Esechioi, 1.IV.2016 (4♂)

Dicranura ulmi ([Denis & Schiffermüller], 1775)
- Babadag, 15-17.IV.2015 (VC)
- Published records: Greci, Horia, Babadag, Cerna (Rákosy, Wieser 2000); Babadag, Gura Dobrogei (Székely 2012); Agigea (Popescu-Gorj, Drâghia 1964)

Subfam. Notodontinae Stephens, 1829
Pterostoma palpina (Clerk, 1759)
- Babadag, 16.IV.2015 (1♂)
- Common throughout Dobrogea in 2 generations per year.

Drymonia ruficornis (Hufnagel, 1766)
- Babadag, 16.IV.2015 (1♂)

Drymonia dodonaea (Denis & Schiffermüller, 1775)
- Babadag, 17.IV.2015 (2♂)

Notodonta tritophus ([Denis & Schiffermüller], 1775)
- Babadag, 17.IV.2015 (2♂)

Peridea anceps (Goeze, 1781)

Babadag, 15-17.IV.2015 (5♂)

Fam. NOLIDAE Bruand, 1846
Nola cicatricalis (Treitschke, 1835)
- Babadag, 30-31.III.2016 (C) - First record for the fauna of Dobrogea.

Nola confusalis (Herrich-Schäffer, [1847])
- Babadag, 15-17.IV.2015 (VC), 30-31.III.2016 (VC); Esechioi, 1.IV.2016 (C)
- Published records: Greci, Horia (Rákosy, Wieser 2000)

Fam. NOCTUIDAE Latreille, 1809
Subfam. Acronictinae Heinemann, 1959
Simyra dentinosa Freyer, 1839
- Gura Dobrogei, 29-30.IV.2012 (ln larva stage)
- Published records: Techirghiol (Caradja 1929); Babadag (Székely 2012)

Acronicta rumicis (Linnaeus, 1758)
- Esechioi, 1.IV.2016 (1♂)

Acronicta auricoma ([Denis & Schiffermüller], 1775)
- Babadag, 31.III.2016 (1♂)

Subfam. Cucullinae Herrich-Schäffer, 1850
Cucullia verbasci (Linnaeus, 1758)
- Canaraua Fetii, 10-11.IV.1992 (2 sp.)
- Published with the wrong data (10-11.VI.1992) (Rákosy, Székely 1996)

Calocucullia celsiae (Herrich-Schäffer, 1850)
- Published records: Canaraua Fetii, IV.1993 / leg. A. Mîner (Bálint, Székely 1995; Rákosy, Székely 1996; Rákosy 1996)

Subfam. Pantheinae Smith, 1898
Colocasia coryli (Linnaeus, 1758)
- Babadag, Enisala 15-17.IV.2015 (C); Canaraua Fetii, 2.IV.2016 (5♂)
- Common throughout Dobrogea in 2-3 generations per year.

Subfam. Xyleninae Guenée, 1837
Lithophane semibrunnea (Hawort, 1809)
- Babadag, 31.III.2016 (1♂) – after wintering specimen. - First record for the fauna of Dobrogea.

Lithophane ornitopus (Hufnagel, 1766)
- Babadag, Enisala 15-17.IV.2015 (R) - in after wintering specimens.

Eupsilia transversa (Hufnagel, 1766)
- Babadag, Enisala 15-17.IV.2015, 30-31.III.2016 (R) - in after wintering specimens.

Conistra vaccinii (Linnaeus, 1761)
- Babadag, Enisala 15-17.IV.2015 (R) - in after wintering specimens.
- Published records for Dobrogea: Canaraua Fetii, Albe□ti (Rákosy, Székely 1996)

Conistra erythrocephala ([Denis & Schiffermüller], 1775)
- Babadag, Enisala, 15-17.IV.2015 (C), 30-31.III.2016 (C); Esechioi, 1.IV.2016 (C) - in after wintering specimens.

Conistra rubiginea ([Denis & Schiffermüller], 1775)
- Babadag, 30-31.III.2016 (R) - in after wintering specimens.
- Published records: Canaraua Fetii (1-20.IV.1993 / leg. A. Mîner) (Rákosy, Székely 1996); Greci, Horia (Rákosy, Wieser 2000)

Conistra rubiginosa (Scopoli, 1763)
- Babadag, 31.III.2016 (1♂) - in after wintering specimens.
- Published records: Horia (Rákosy, Wieser 2000)

Conistra veronicae (Hübner, [1813])
- Bugeac, 1.IV.2016 (1♂) - in after wintering specimens.
- Published redords: Greci, Horia (Rákosy, Wieser 2000)

Subfam. Hadeninae Guenée, 1837
Panolis flammea ([Denis & Schiffermüller], 1775)
- Babadag, 16.IV.2015 (1♂, 1♀), 31.III. 2016 (2♂)
- Published records: Canaraua Fetii, 15.IV.1993 / leg. A. Mîner (Rákosy, Székely 1996)

Orthosia incerta (Hufnagel, 1766)
- Babadag, Enisala 15-17.IV.2015 (VC); Babadag, 30-31.III.2016 (C); Esechioi, 1.IV.2016 (C)
- Published records: Canaraua Fetii, Albesti (Rákosy, Székely 1996); Comorova (Popescu-Gorj & Drâghia, 1967); Greci, Horia, Babadag (Rákosy, Wieser 2000); Babadag (Székely 2012)

Orthosia cruda ([Denis & Schiffermüller], 1775)
- Babadag, Enisala 15-17.IV.2015 (C), 30-31.III.2016 (C), Esechioi, 1.IV.2016 (C)
- Published records: Canaraua Fetii, Albesti (Rákosy, Székely 1996); Greci, Horia, Babadag (Rákosy, Wieser 2000); Babadag (Székely 2012)

Orthosia miniosa ([Denis & Schiffermüller], 1775)
- Babadag, Enisala 15-17.IV.2015 (VC), 31.III.2016 (R)
- Published records for Dobrogea: Greci, Horia, Babadag (Rákosy, Wieser 2000); Babadag (Székely 2012)

Orthosia gothica (Linnaeus, 1758)
- Babadag, Enisala 15-17.IV.2015 (VC), 30-31.III.2016 (VC); Esechioi, 1.IV.2016 (C; Canaraua Fetii, 2.IV.2016 (2♂)
- Published records for Dobrogea: Canaraua Fetii, Albeşti (Rákosy, Székely 1996); Comorova (Popescu-Gorj, Drâghia 1967); Greci, Horia, Babadag (Rákosy, Wieser 2000); Babadag (Székely 2012)

Orthosia cerasi (Fabricius, 1775)
- Esechioi, 1.IV.2016 (R)

- Published records for Dobrogea: Canaraua Fetii (23.III-12.IV / leg. A. Mîner) (Rákosy, Székely 1996)

Anorthoa munda ([Denis & Schiffermüller], 1775)

- Babadag, Enisala 15-17.IV.2015 (R); 30-31.III.2016 (R); Esechioi, 1.IV.2016 (R)
- Published records for Dobrogea: Greci, Horia, Babadag (Rákosy, Wieser 2000); Babadag (Székely 2012)

Egira conspicillaris (Linnaeus, 1758)

- Babadag, Enisala 15-17.IV.2015 (VC), 30-31.III.2016 (C); Esechioi, 1.IV.2016 (VC); Canaraua Fetii, 2.IV.2016 (R)
- Published records for Dobrogea: Canaraua Fetii, Şipote, Albeşti (Rákosy, Székely 1996); Comorova (Popescu-Gorj, Drâghia 1967); Greci, Horia, Babadag (Rákosy, Wieser 2000); Babadag, Gura Dobrogei (Székely 2012)

Subfam. Noctuinae Latreille, 1809

Agrotis ipsilon (Hufnagel, 1766)

- Enisala, 30-31.III.2016 (4 sp.); Esechioi, 1.IV.2016 (3 sp.).

Cerastis rubricosa ([Denis & Schiffermüller], 1775)

- Babadag, Enisala 15-17.IV.2015 (C); 30-31.III.2016 (C); Esechioi, 1.IV.2016 (C)
- Published records for Dobrogea: Greci, Horia, Babadag (Rákosy, Wieser 2000); Babadag (Székely 2012)

Cerastis leucographa ([Denis & Schiffermüller], 1775)

- Babadag, 16-17.IV.2015 (1♂, 1♀) - First record for the fauna of Dobrogea.

Fam. HESPERIIDAE Latreille, 1809

Carcharodus alceae (Esper, [1780])

- Slava Rusă, 31.III.2016 (C)

Fam. PAPILIONIDAE Latreille, [1802]

Iphiclides podalirius (Linnaeus, 1758)

- Gura Dobrogei, 16-17.IV.2015 (R)

Papilio machaon Linnaeus, 1758

- Esechioi, 1.IV.2016 (1sp.)

Fam. PIERIDAE Duponchel, [1835]

Subfam. Dismorphiinae Schatz, [1886]

Leptidea sinapis sinapis (Linnaeus, 1758)

- Babadag, Enisala, Gura Dobrogei, 15-17.IV.2015 (C); Esechioi, 2.IV.2016 (1 sp.)
- Common throughout Dobrogea in 2-3 generations per year.

Subfam. Pierinae Duponchel, [1835]

Pieris napi (Linnaeus, 1758)

- Babadag, Enisala, Gura Dobrogei, 15-17.IV.2015 (C), 30.III-1.IV.2016 (C); Slava Rusă, Ion Corvin, Esechioi, Ostrov, Canaraua Fetii, Băneasa, Cochirleni, 31.III-3.IV.2016 (C).
- Common throughout Dobrogea in 3-4 generations per year.

Pieris rapae (Linnaeus, 1758)

- Babadag, Enisala, Gura Dobrogei, 15-17.IV.2015 (C), 30.III-1.IV.2016 (C); Slava Rusă, Ion Corvin, Esechioi, Ostrov, Canaraua Fetii, Băneasa, Cochirleni, 31.III-3.IV.2016 (C).
- Common throughout Dobrogea in 3-4 generations per year.

Pontia daplidice edusa (Fabricius, 1777)

- Babadag, Enisala, Gura Dobrogei, 15-17.IV.2015 (C), 30.III-1.IV.2016 (C); Slava Rusă, Ion Corvin, Esechioi, Ostrov, Canaraua Fetii, Băneasa, Cochirleni, 31.III-3.IV.2016 (C).
- Common throughout Dobrogea in 3 generations per year.

Euchloe ausonia (Hübner, [1804])

- Gura Dobrogei, 16-17.IV.2015 (C), 1.IV.2016 (C); Allah Bair, 1.IV.2016 (C).
- Published records: Canaraua Fetii, Hagieni (Popescu-Gorj 1959; Popescu-Gorj, Drâghia 1967; Ciochia, Barbu 1980; Stănescu 1995; Bálint, Székely 1995; Rákosy, Székely 1996); Niculițel (Niculescu 1963); Comarova, Oltina (Popescu-Gorj, Drâghia 1967); Tulcea (Mann 1866); Mahmudia-Murighiol (Székely *et al.* 2011); Gura Dobrogei (Dincă *et al.* 2009); Fântânița (Skolka 1994)

Anthocharis cardamines (Linnaeus, 1758)

- Babadag, Gura Dobrogei, 15-17. IV. 2015, 30.III-1.IV.2016 (C); Slava Rusă, Esechioi, Ion Corvin, Canaraua Fetii, Bâneasa, Ostrov, Bugeac, Cochirleni, 31.III-3.IV.2016 (C).
- Common throughout Dobrogea, from late March to mid-May.

Gonepteryx rhamni (Linnaeus, 1758)

- Babadag, Gura Dobrogei, 15-17. IV. 2015, 30. III-1.IV.2016 (R); Slava Rusă, Esechioi, Canaraua Fetii, Băneasa, 31. III-3.IV.2016 (C).
- Common throughout Dobrogea, in after wintering specimens.

Fam LYCAENIDAE [Leach], [1815]

Subfam. Polyommatinae Swainson, 1827

Everes (Cupido) *argiades* (Pallas, 1771)

- Babadag, 16.IV.2015 (1sp.)

Celastrina argiolus (Linnaeus, 1758)

- Gura Dobrogei, 17.IV.2015 (1sp.); Esechioi, 2.IV.2016 (2sp.)

Pseudophilotes bavius egea (Herrich-Schäffer,1852)

- Gura Dobrogei, 17.IV.2015 (2sp.)

Fam. NYMPHALIDAE Swainson, 1827

Subfam. Heliconiinae Swainson, 1827

Issoria lathonia (Linnaeus, 1758)

- Babadag, 31.III.2016 (C); Slava Rusă, 31.III.2016 (C); Gura Dobrogei, Allah Bair, Esechioi, Ostrov, 1-2.IV.2016 (C); Canaraua Fetii, Cochirleni, 2-3.IV.2016 (C)

Subfam. Nymphalinae Swainson, 1827

Nymphalis (Inachis) *io* (Linnaeus, 1758)

- Babadag, Enisala, Gura Dobrogei, 15-17.IV.2015 (R); Slava Rusă, Gura Dobrogei, Esechioi, 1-2.IV.2016 (R); Canaraua Fetii, 2-3.IV.2016 (R)
- Common throughout Dobrogea, in after wintering specimens.

Nymphalis polychloros (Linnaeus, 1758)

- Celic Dere, 28.II.2015 (1♀ / leg. M. Skolka); Babadag, 16.IV.2015 (2 sp.), 31.III.2016 (1sp.).
- Published records: Constanța (Skolka 1994). Rare in after wintering specimens.

Nymphalis (Polygonia) *c-album* (Linnaeus, 1758)

- Babadag, Enisala, Gura Dobrogei, 15-17.IV.2015 (R); Slava Rusă, Enisala, Esechioi, Canaraua Fetii, 31.III-3.IV.2016 (C)
- Common throughout Dobrogea in after wintering specimens.

Vanessa atalanta (Linnaeus, 1758)

- Babadag, Gura Dobrogei, 15-17. IV. 2015, 30.III-1.IV.2016 (C); Slava Rusă, Esechioi, Canaraua Fetii, Cochirleni, 31.III-3.IV.2016 (C).
- Common throughout Dobrogea, in after wintering specimens.

Vanessa cardui (Linnaeus, 1758)

- Constanta,12.II.-15.III.2016 (VC / M. Skolka pers. com.); Babadag, Gura Dobrogei, 15-17. IV. 2015, 30.III-1.IV.2016 (C); Slava Rusă, Enisala, Esechioi, Canaraua Fetii, 31.III-3.IV.2016 (C)
- Common throughout Dobrogea, in after wintering specimens.

Subfam. Satyrinae Boisduval, [1833]

Pararge aegeria tircis (Godart, 1821)

- Ostrov, 1.IV.2016 (1♂)

MICROLEPIDOPTERA:

Fam. ETHMIIDAE Busck, 1909

Ethmia fumidella (Wocke, 1850)

- Esechioi, 1.IV.2016 (1sp.)

Fam. DEPRESSARIDAE Meyrick, 1883

Depressaria ultimella Stainton, 1849

- Babadag, 30-31.III.2016 (3sp.); Esechioi, 1.IV.2016 (2sp.)

Semioscopis avellanella (Hübner, 1793)

- Esechioi, 1.IV.2016 (1sp.) - First record for the fauna of Dobrogea.

Fam. TORTRICIDAE Latreille, 1803

Pseudeulia asinana (Hübner, [1796-99])

- Esechioi, 1.IV.2016 (12sp.)

Phaneta pauperana (Duponchel, 1843)

- Babadag, 30-31.III.2016 (R) - First record for the fauna of Dobrogea.

Gravitarmata margarotana (Heinemann, 1863)

- Babadag, 30-31.III.2016 (C); Esechioi, Bugeac 1.IV.2016 (C) - First record for the fauna of Dobrogea.

Fam. PYRALIDAE Latreille, 1802

Pyralis farinalis (Linnaeus, 1758)

- Bugeac, 1.IV.2016 (1♂)

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SAPROXYLYIC BEETLES (INSECTA: COLEOPTERA) OF COMMUNITY INTEREST IN THE NATURAL HISTORY MUSEUM COLLECTIONS OF SIBIU (ROMANIA)

Gabriela CUZEPAN*
Ioan TĂUŞAN**

Abstract. *The paper presents data regarding several saproxylic beetles preserved in the entomological collections of the Natural History Museum from Sibiu. The saproxilyc coleoptera species: Cerambyx cerdo Linnaeus, 1758, Rosalia (Rosalia) alpina (Linnaeus, 1758), Morimus asper funereus (Mulsant, 1863), Lucanus cervus (Linnaeus, 1758), Rhysodes sulcatus Fabricius, 1787, Cucujus cinnaberinus (Scopoli, 1763) and Phryganophlius ruficollis (Fabricius, 1798) are currently protected species, of main conservation interest in most European countries. In Romania these species are protected through Natura 2000 network for protected areas of community interest.*
Key words: *protected saproxylic beetles, museum collections, conservation.*

Rezumat. *Această lucrare prezintă date cu privire la câteva specii de coleoptere saproxilice conservate în colecția entomologică a Muzeului de Istorie Naturală din Sibiu. Speciile de gândaci saproxilice: Cerambyx cerdo Linnaeus, 1758, Rosalia (Rosalia) alpina (Linnaeus, 1758), Morimus asper funereus (Mulsant, 1863), Lucanus cervus (Linnaeus, 1758), Rhysodes sulcatus Fabricius, 1787, Cucujus cinnaberinus (Scopoli, 1763) şi Phryganophlius ruficollis (Fabricius, 1798) sunt în prezent specii protejate, de interes major în majoritatea țărilor europene. În România, aceste specii, sunt protejate prin intermediul rețelei Natura 2000 pentru protejarea ariilor de interes comunitar.*
Cuvinte cheie: *coleoptere saproxilice protejate, colecții muzeale, conservare.*

Introduction

Numerous protected species of invertebrates are included in the group of saproxylic organisms. Saproxylics are known as organisms that depend during a part of their life cycle on specific habitats: dead wood, dying wood from standing or fallen trees, on upon wood-inhabiting fungi or the presence of other saproxylic organisms (Speight 1989, Groove 2002, Nieto, Alexander 2010, Prunar *et al*. 2013). Beetles make up an important share of these saproxylic organisms, even though that the total number of saproxylic beetle species is not currently known (Nieto, Alexander 2010).
Saproxylic beetles play a considerable role in forest ecosystems, being involved in the decomposition processes and thus in nutrient cycling in ecosystems (Speight 1989, Groove 2002, Nieto, Alexander 2010).

Moreover, they also play an important part in the well being of ecosystems and economy, through pollination, dissemination of other organisms such as mites, nematodes, bacteria and fungi (Nieto, Alexander 2010).

Many of the saproxylic beetles are protected species due to numerous threats. Based on the threats, a clear distinction was made: long and short-term (Nieto, Alexander 2010). The long-term threats are considered the loss of their habitat in relation to logging and wood harvesting, the decline of veteran trees throughout the landscape, the lack of land management targeted at promotion of recruitment of new generations of trees (Nieto, Alexander 2010). Those short-term threats are represented by sanitation and removal of old trees due to (often misconceived) safety constraints, in places heavily influenced by humans (Nieto, Alexander 2010). Their habitat is also threatened due to agricultural expansion, urbanisation, forest fires and climate change (Nieto, Alexander 2010). Temporary wood deposits at the forest edge are also significant threats that have an impact by population decrease, especially by attracting the laying females (Prunar *et al.* 2013) and further on the egg development being stopped. *Rosalia alpina*, is one of the saproxylic beetles with a preference for

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the trees with a high level of sun exposure (Russo 2010), being present in low-density forests or at the edge of the forest avoiding shaded microhabitats (Prunar *et al.* 2013).

At European level biodiversity conservation issues are regulated through the EU Habitats and Birds Directives. Through designated protected areas of Natura 2000 network and future designations sustainable approach of the biodiversity conservation is expected. Saproxylic beetles species are widely distributed in Europe, with high species richness at intermediate latitudes (France, Germany and Slovak Republic) and also in southern Europe areas. However, the Balkan Peninsula is an important area in regard to species richness, being considered a hotspot of biodiversity (Nieto, Alexander 2010). Within the Balkans, in Romania, out of 20 beetle species listed in Annexe II of Habitats Directive 92/43/EEC/2003 and protected concerning Natura 2000 network (Tatole *et al.* 2009), 10 species belong to the saproxylic group.

This paper compiles the existing data on protected saproxylic beetle species, both published and museum collections data contributing to the knowledge of the species in terms of distribution and occurrence.

Material

Data from the museum collection are part of the Entomological collections as follow: Transylvanian Society for Natural Science, "Dr. Eugen Worell", "Dr. Karl Petri", "Rolf Weyrauch", "Heinrich Hann von Hannenheim" and "Dr. Eckbert Schneider" collections. The museum Entomological collection was initiated by the Transylvanian Society for Natural Science from Sibiu (*Siebenbürgischer Verein für Naturwissenschaften zu Hermannstadt*) members, and today is the second largest asset of the museum collection, counting over 260.000 specimens. The number of species and specimens included in, the existing data of the collecting areas, the material analyzed and processed until now are all a valuable data base of what represent today the museum entomological collection. Within the collection, beetles are best represented (reviewed in Cuzepan *et al.* 2015) due to the fact that the main concern in entomology of the Transylvania Society members was the research of beetles fauna from Transylvania and its surroundings, but also from other parts of the world.

Nomenclature and systematical order were complied according to Danilevsky (2016), Bouchard *et al.* (2011), Bartolozzi (2013), Anichtchenko *et al.* (2016), Slipinski (2013), Nikitsky (2013).

The following abbreviations are used in the present paper: AU – Austria, BA – Bosnia and Herzegovina, DE – Germany, HU – Hungary, RO – Romania, Mt/Mts – Mountain/Mountains; spec./specs – specimen/specimens; coll. Transylvanian Society – collection of Transylvanian Society for Natural Science; coll. Petri – collection of Dr. Karl Petri; coll. Schnedier – collection of Dr. Eckbert Schneider; coll. Worell – collection of Dr. Eugen Worell; coll. Weyrauch – collection of Rolf Weyrauch; coll. Hannenheim – collection of Heinrich Hann von Hannenheim; leg. Albrecht – legit Rudolf Albrecht; leg. Bielz – legit Eduard Albert Bielz; leg. Czekelius – legit Dr. Daniel Czekelius; leg. R. Chytil; leg. Hannenheim - legit Heinrich Hann von Hannenheim; leg. Leonhardt; leg.Petri – legit Dr. Karl Petri; leg. Orendi – legit Carl Orendi ; leg. Schnedier – legit Dr. Eckbert Schneider; leg. Stănescu – legit Dr.Carmen Stănescu; leg. Fr. Sontag; leg. Weyrauch – legit Rolf Weyrauch; leg. Worell – legit Dr. Eugen Worell det.– identified by.

List of species

In the entomological collection of the Natural History Museum from Sibiu, the following protected saproxylic beetle species are preserved: *Rhysodes sulcatus* Fabricius, 1787, *Cerambyx cerdo* Linnaeus, 1758, *Rosalia (Rosalia) alpina* (Linnaeus, 1758), *Morimus asper funereus* (Mulsant, 1863), *Cucujus cinnaberinus* (Scopoli, 1763), *Phryganophlius ruficollis* (Fabricius, 1798) and *Lucanus cervus* (Linnaeus, 1758). Data regarding the species *Cerambyx cerdo* Linnaeus, 1758 and *Lucanus cervus* (Linnaeus, 1758) from the collections were prior published (Tăuşan, Bucşa 2010; Cuzepan, Tăuşan 2013).

In addition, the collections contain specimens labelled as *Osmoderma eremita*. However, recent studies (Audisio *et al.* 2007, 2009) suggest that in Eastern Europe only *Osmoderma barnabita* Motschulsky, 1845 occurs whereas the *O. eremita* is distributed in the Western part of Europe. Therefore, the species is not listed in the present paper.

Order Coleoptera Linnaeus, 1758

Family Carabidae Latreille, 1802

Subfamily Rhysodinae Castelnau, 1840
Tribe Rhysodini Laporte, 1840
Genus *Rhysodes* Dalman, 1823

Rhysodes sulcatus Fabricius, 1787

1 spec., Herkulesbad (Băile Herculane, Caraş-Severin County, RO), VI.1929, coll. Worell.

Family Cerambycidae Latreille, 1802
Subfamily Cerambycinae Latreille, 1802
Tribe Cerambycini Latreille, 1802
Genus *Cerambyx* Linnaeus, 1758
Subgenus *Cerambyx* Linnaeus, 1758
Cerambyx cerdo Linnaeus, 1758
Data prior published by Tăuşan, Bucşa 2010

Tribe Compsocerini Thomson, 1864
Genus *Rosalia* Audinet-Serville, 1833
Subgenus *Rosalia* Audinet-Serville, 1833

Rosalia (Rosalia) alpina (Linnaeus, 1758)

1 spec., Kzg (Transylvania, Kerzer Gebrige= Cârţei Mts, Făgăraş Mts), VI.1889, coll. Transylvanian Society; 1 spec., 5.VII.1889, Sn, coll. Transylvanian Society; 1 spec., Siebenburgen Fogarascher Geb (Tranylvania, Făgăraş Mts, RO) leg. Albrecht, coll. Transylvanian Society; 1 spec., Riu Sadu (Râul Sadu, Sibiu County, RO) 28.VII.1925, leg. Czekelius, coll. Transylvanian Society; 1 spec., Hermannstadt (Sibiu, Sibiu County, RO), 10.VII.1921, leg. Czekelius, coll. Transylvanian Society; 1 spec., Rèzbánya (Bihar) (Băiţa, Bihor County, RO). VIII.1922, leg. R.Chytil, coll. Transylvanian Society; 1 spec., Germania (Germany, DE), 1895, leg. Bielz, coll. Transylvanian Society; 1 spec., Mehadia (Caraş-Severin County, RO), 1886, det.Birthler 1895, coll. Tranylvanian Society; 1 spec., Mostar (Hercegovina) (BA), 1908, leg. Orendi coll. Transylvanian Society; 1 spec., Banat (Banat County, RO), leg. Orendi, coll. Transylvanian Society; 1 spec., without other data, coll. Transylvanian Society; 2 specs, Rot Turm, Lauterbach (Turnu Roşu Pass, Lotru Mts, Sibiu County, RO), leg. Petri, coll. Petri; 2 specs, Süd Karpaten (South Carpathian Mts, RO), leg. Leonhardt, coll. Petri; 1 spec., Präsbe (Prejba, Lotrului Mts, RO), 1895, coll. Petri; 1 spec., (syn *R.alpina m. prolonga* Reitter,1900) Schässbg, Schrankel (Sighişoara, Mureş County, RO), 23.VII.1910, leg. Petri, coll. Petri; 1 spec., Hermannstadt Kl Erde (Sibiu, Kleine Erde=Filarmonicii street, Sibiu County, RO), middle of VII.1957 coll. Schneider; 1 spec., H.Rinne (Păltiniş, Sibiu County, RO), 17.VIII.1961, leg. E.Sch., coll. Schneider; 1 spec. Hammersdorf (Guşteriţa, Sibiu County, RO), 29.V.1965, leg. E.Sch., coll. Schneider; 1 spec., Hammersdorf (Guşteriţa, Sibiu County, RO), VI.1964, leg. E.Sch., coll.Schneider; 1 spec., Porceşti, Turnu Roşu, Val. Strâmbă (Sibiu County, RO), VII.1977, leg.E.Sch., coll. Schneider; 1 spec., Rîu Vadului (Vâlcea County, RO), 8.VIII.1970, leg. E.Sch., coll. Schneider; 1 spec., Brezoi, Năruţ (Vâlcea County, RO), 20.VII.1964, leg.E.Sch., coll. Schneider; 3 specs, Mţii Făgăraş, V. Arpăşel (Făgăraş Mts, Arpăşel Valley, RO), 27-30.VII.1976, leg.E.Sch, coll.Schneider; 1 spec., Orşova (Mehedinţi County, RO), 10.VIII.1955 leg. H.H, coll. Hannenheim; 1 spec., without other data coll. Hannenheim; 5 specs, Domogled (Domogled Mts, RO), 20.VII.1962, leg.Weyrauch, coll. Weyrauch; 1 spec., Snagov (Ilfov County, RO); 2.VIII.1957, leg.Weyrauch, coll. Weyrauch; 1 spec. Colibiţa (Colibiţa Lake, Bistriţa-Năsăud County, RO), 22.VII.1970, leg. Weyrauch, coll. Weyrauch; 1 spec., Herkulöesbad Elisab bahe (Băile Herculane, Culmea Elisabetei, Caraş-Severin County, RO), 24.VII.1967, leg. Weyrauch, coll. Weyrauch; 1 spec., B.Herkul (Băile Herculane, Caraş-Severin County, RO), 21.VII.1962, leg. Weyrauch, coll. Weyrauch; 1 spec., V.Fratelui (Valea Fratelui River, Vâlcea County, RO), 24.VIII.1955, leg. Weyrauch, coll. Weyrauch; 1 spec., Domogled (Domogled Mts, RO), 13.VII.1967, leg. Weyrauch, coll. Weyrauch; 1 spec., Mühlbach (Sebeş; Alba County, RO), VIII.1955, leg. Weyrauch, coll. Weyrauch; 1 spec., Bredet (Brădet, Fântânele Cindrel Mts, RO), 26.VII.1954, leg. Weyrauch, coll. Weyrauch. 2 specs, Lotrul (Lotrului Mts, RO), VI.1951, leg. Weyrauch, coll. Weyrauch; 1 spec., Bicaz (Neamţ County, RO), 29.VI.1954, leg. Weyauch, coll. Weyrauch; 1 spec. Şugag (Alba County, RO) 12.IX.1976, leg. Weyrauch, coll.Weyrauch; 1 spec., Berg Cozia Călimăneşti (Călimăneşti, Cozia Mts, RO), 8.VIII.1943, leg. Worell, coll. Worell; 1 spec., Berg Cozia Călimăneşti (Călimăneşti, Cozia Mts, RO), VIII.1943, leg. Worell, coll. Worell; 2 specs, Berg Cozia Călimăneşti (Călimăneşti, Cozia Mts, RO), 13.VIII.1943, leg. Worell, coll. Worell; 1 spec., Herkulesbad (Băile Herculane, Caraş-Severin County, RO), 9.VI.1974, leg. Worell, coll.Worell; 1 spec., Sibenbürgen Shürdúk P. (Transylvania, Surduc Pass, RO), 1917, leg. Major Prall, coll. Worell; 1 spec., Götzenberg Hermannstadt (Măgura Cisnădiei, Sibiu, Sibiu County, RO),

30.VII.1947, leg. Worell, coll.Worell; 9 specs, HerkulesB (Băile Herculane, Caraş-Severin County, RO) VI.1927, coll. Worell; 1 spec., Götzenberg (Măgura Cisnădiei, Sibiu County, RO), VI.1923, coll. Worell; 1 spec., Majavica Bosnia (Majevica Mts, BA), leg. Zoufal, coll. Worell; 1 spec., Zeidner Berg (Măgura Codlei Mt, RO), VII.1923, coll.Worell; 1 spec., Băile Herculane (Caraş-Severin County, RO), leg. Worell, coll.Worell; 14 specs, without other data, coll. Worell; 1 spec. (syn *R.alpina m.parvonotata* Reitter, 1900), Berg Cozia, Călimăneşti (Călimăneşti, Cozia Mts, RO), 19.VII.1946, coll.Worell; 1 spec. (syn *R.alpina m.parvonotata* Reitter, 1900), HerkulesB (Băile Herculane, Caraş-Severin County, RO), VIII.1927, coll. Worell; 1 spec. (syn *R.alpina m.parvonotata* Reitter, 1900), HerkulesBad (Băile Herculane, Caraş-Severin County, RO), coll. Worell;

Subfamily Lamiinae Latreille, 1825
Tribe Phrissomini Thomson, 1860
Genus *Morimus* Audinet-Serville, 1835
Species *Morimus asper* (Sulzer, 1776)
Morimus asper funereus (Mulsant, 1863)

2 specs, Rp (Rp=Roterturmpass – Turnul Roşu Pass, Sibiu County, RO), 1888, coll.Transylvanian Scoiety; 1 spec., Kirvadia (Crivadia, Hunedoara County, RO), 1898, leg.Petri, coll. Transylvanian Society; 2 specs, Negoi (Negoi Peak, Făgăraş Mts, RO), 1898, leg. Petri, coll. Transylvanian Society; 1 spec., Karlsberg/Karlsburg (Alba Iulia, Alba County, RO), 1898, coll. Transylvanian Society; 2 specs, Siebenbürgen Cibin Gebirge (Transylvania, Cibin Mts, RO), leg. Albrecht, coll. Transylvanian Society; 1 spec., Gb (Gb=Götzenberg – Măgura Cisnădiei, Sibiu County, RO), 18.VI.1889, coll. Transylvanian Society; 1 spec., Siebenbürgen Fogarascher Geb. (Transylvanian, Făgăraş Mts, RO), leg. Albrecht, coll. Transylvanian Society; 2 specs, Zibins Geb. Czoodtal (Cibin Mts, Valea Sadu, RO), leg. Orendi, coll. Transylvanian Society; 1 spec., Ban (Ban=Banat, Banat Region RO), 1895, leg.Birthler, coll. Transylvanian Society; 1 spec., Caracal (Olt County, RO), 17.VIII.1924, leg.Bespaldz?, coll. Transylvanian Society; 1 spec., 1 spec., Sibenburgen, Cibin (Transylvanian, Cibin Mts, RO), coll. Transylvanian Society; 1 spec., Karlb (Karlb = Karlsburg – Alba Iulia, Alba County, RO), 1889, coll. Transylvanian Society; 1 spec., Mehadia (Caraş-Severin County, RO), coll.Petri; 1 spec., Schassbg (Schassbg = Sighişoara, Mureş County, RO), 1886, leg. Petri, coll. Petri; 3 specs, Bosnien (Bosnien = Bosnia, BA), 1892, coll. Petri; 1 spec., Rot.Turm (Turnu Roşu, Sibiu County, RO), leg. Petri, coll. Petri; 1 spec., V. Lotrului (Lotrului Mts, RO), 8.VII.1953, leg. Schneider, coll.Schneider; 1 spec., Siria (Şiria, Arad County, RO), 22.V.1960, leg. Schneider, coll. Schnedier; 1 spec., Retezat (Retezat Mts, RO), 24.V.1957, leg. Schneider, coll.Schneider; 1 spec., Mt.Cozia (Cozia Mts, RO), 22.VII.1956, leg. Schneider, coll. Schnedier; 3 specs, Doborgea, M-rea Cocoşi (Dobruja, Cocoş Monastery, Tulcea County, RO), 29.VI.1972, leg. Schneider, coll.Schneider; 1 spec., Mt.Cozia 800m (Cozia Mts, RO), 17-20.VI.1969, leg. Schneider, coll.Schnedier; 1 spec., Cisnădioara (Sibiu County, RO), V.1978, leg. Schneider, coll.Schneider; 1 spec., Grădiştea M., Orăştie (Grădiştea Munceului, Hunedoara County, RO), 24.VI.1978, leg.Stănescu, coll.Schneider; 1 spec. Valea Sadu, Tălm-Sadu (Sadu Valley, Sibiu County, RO), 11.VII.1980, leg. Stănescu, coll.Scneider; 1 spec., V.Cernei (Cerna Vally, RO), 12,VI.1977, leg. Schneider, coll.Schneider; 1 spec., Vînturariţa (Buila-Vânturariţa Mts, RO), 15.VII.1960, leg. Schneider, coll.Schnedier; 1 spec., Mt Buila Vînturariţa (Buila-Vânturariţa Mts, RO), 6-10.VII.1964, coll.Schnedier; 1 spec., Dobrogea, Babadag (Dobruja, Babadag, RO), 6-7.V.1971, leg. E.Sch, coll. Schneider; 1 spec., Mţii Cibin, Valea Sibielului (Cibin Mts, Sibielului Valley, RO), 2.V.1977, leg. E.Sch, coll. Schneider; 1 spec., Mţii Orăştie, Val. Gădiştei, 5.VIII.1974, leg. E.Sch., coll. Schneider; 1 spec., Bredet (Brădet, Fântânele Cindrel Mts, RO), 19.VI.1958, leg. Hannenheim, coll.Hannenheim; 2 specs, Crinzi (Crinţ, Sibiu County, RO), 5.VI.1956, leg. Kluaus Niedermaier, coll. Hannenheim; 1 spec., Herkulesbad (Băile Herculane, Caraş-Severin County, RO), 5.VII.1971, leg. Weyrauch, coll. Weyrauch; 1 spec., Hstdf (= Hermannstaddorf - Dealul Guşteriţei, Sibiu County, RO), 12.VII.1963, coll. Weyrauch; 1 spec., Herkbd (Herkbd = Băile Herculane, Caraş-Severin County, RO), 19.V.1970, coll. Weyrauch; 1 spec., Grosspold (Apoldu de Sus, Sibiu County, RO), leg.Weyrauch, coll.Weyrauch; 1 spec., Herkbad (Herkbd = Băile Herculane, Caraş-Severin County, RO), 3.VI.1970, leg. Weyrauch, coll. Weyrauch; 1 spec., B.Herkul (Băile Herculane, Caraş-Severin County, RO), 21.VII.1962, leg. Weyrauch, coll. Weyrauch; 2 specs, Grossp (Apoldu de Sus, Sibiu County, RO), VI.1950, leg. Weyrauch, coll. Weyruach; 2 specs, Herkulesbd (Băile Herculane, Caraş-Severin County, RO), 12.VI.1970, leg. Weyrauch, coll. Weyrauch; 1 spec., Talmesch (Tălmaciu, Sibiu County, RO), 4.IX.1955, leg. Weyrauch, coll. Weyrauch; 1

spec., H.B. (H.B.= Băile Herculane, Caraş-Severin County, Sibiu), 6.VI.1954, leg. Weyrauch, coll.Weyrauch; 2 specs, without other data, coll. Weyrauch; 1 spec., Herkbd. (Băile Herculane, Caraş-Severin County, RO), 16.V.1970, leg. Weyrauch, coll.Weyrauch; 1 spec., Hstdf (Hstdf = Hermannstadtdorf – Dealul Guşteriţei, Sibiu County, RO), 12.VII.1954, leg. Weyrauch, coll. Weyrauch; 1 spec., Herkbd. (Herkbd.=Herkulesbad – Băile Herculane, Caraş-Severin County, RO), VI.1957, leg. Weyrauch, coll.Weyrauch; 1 spec., Herkbd. (Herkbd.=Herkulesbad – Băile Herculane, Caraş-Severin County, RO), 15.V.1970, leg. Weyrauch, coll.Weyrauch; 1 spec., Domogl. (Domogl.=Domogled Mts, RO), 12.VII.1967, leg. Weyrauch, coll.Weyrauch; 1 spec., Hstdf (Hstdf = Hermannstadtdorf – Dealul Guşteriţei, Sibiu County, RO), 16.VI.1955, leg. Weyrauch, coll. Weyrauch; 1 spec., Hermannstadt JungenWald (Sibiu, Dumbrava Forest, Sibiu County, RO), 4.IV.1939, leg. Worell, coll. Worell; 2 specs, Cozia (Cozia Mts, RO), V.1926, coll. Worell; 1 spec., Împrejurimile Sibiului (Sibiu suroundings, Sibiu County, RO), leg. Worell, coll. Worell; 1 spec., Junger Wald Hermannstadt (Dumbrava Forest, Sibiu, Sibiu County, RO), V.1932, leg. Worell, coll. Worell; 23 specs, without other data, coll. Worell.

Family Cucujidae Latreille, 1802
Tribe
Genus *Cucujus* Fabricius, 1775

Cucujus cinnaberinus (Scopoli, 1763)

1 spec., Hungarien, Com. Krassö (Hungary, Krassö Village, HU), coll. Petri; 1 spec., Schässbg. (Sighişoara, Mureş County, RO), 1886, leg. Petri, coll. Petri; 1 spec., Außsee (Außee, AT), coll. Tranylvanian Society., 4 specs without other data, coll. Soc.; 1 spec., Majevica Bosna (Majevica Mts, BA), VI leg. Zoufal, coll. Worell; 1 spec., Götzenberg (Măgura Cisnădiei, Sibiu County, RO), V.1925, leg. Fr. Sontag, coll. Worell.

Family Melandryidae Leach, 1815
Genus Phryganophilus C.Sahlberg, 1833

Phryganophlius ruficollis (Fabricius, 1798)

1 spec., Liener (Tirol) (Tirol, AU), 1908, leg. Worell, coll. Worell.

Family Lucanidae Latreille, 1804
Subfamily Lucaninae MacLeay, 1819
Tribe Lucanini MacLeay, 1819
Genus *Lucanus* Scopolii, 1763
Subgenus *Lucanus* Scopolii, 1763
Lucanus cervus (Linnaeus, 1758)
Data prior published by Cuzepan, Tăuşan (2013)

Habitat preferences

Rhysodes sulcatus is a stenotopic, silvicolous, saproxylic and corticolous species. It inhabits old coniferous and deciduous trees (Jurc et al. 2008). The larvae grow under the bark *Fagus sylvatica* and *Quercus sp* (Koch 1989a), preferring a wood in an advanced state of decay (Alexander 2012). Indicatory species for a stable virgin mixed forest with large quantities of dead wood (Jurc *et al.* 2008). Based on Speight (1989) the species is heavily threatened in Europe.

Cucujus cinnaberinus is a stenotopic, saproxylic, silvicolous and corticolous species (Jurc et al. 2008).

According to several studies (reviewed in Horák *et al.* 2012) the species exhibits an opportunistic host-tree selection strategy, being able to exploit many tree species. Larval development takes place under the bark of the dead wood whereas adults emerge in late summer and early autumn, overwinter, and reproduce under the bark in spring (Horák, Chobot 2011, Horák *et al.* 2012). *C. cinnaberinus* is considered to be even a relic of primeval forests (Speight 1989).

Rosalia alpina is a stenotopic, silvicolous, xylodetriticolous, lignicolous, xylophagous and saproxylic species (Jurc et al. 2008). It inhabits mainly old beech forests. Egg development takes place in a sunny position on beech trees with rotten wood (Koch, 1992). Recent studies (Simandl, 2002; Cizek et al, 2009) indicate that the spectrum of host plants exploited by *R. alpina* is wider then expected. The development can take place in several distantly related families (e.g. Aceraceae, Betulaceae, Fagacease, Tiliacea).

Phryganophilus ruficollis is a saproxylic, stenotopic, silvicolous and xylodetriticolous species. It inhabits mostly old deciduous forests, especially *Quercus sp*, or *Fagus sylvatica* trees in different stages of decay. Indicatory species for a virgin forest (Jurc *et al.* 2008).

Moriumus asper funereus is a stenotopic, silvicolous, xylodetriticolous, xylophagous and saproxylic species (Jurc *et al.* 2008). The species is attracted to fresh deadwood at ground level (fallen logs, stumps or other wood), where it lays eggs (Vrezec *et al.* 2010). Because of their

inability to fly, adults of the genus *Morimus* are poor dispersers and therefore they suffer particularly from habitat fragmentation (Thomas 2000).

Cerambyx cerdo is a stenotopic, pholeophilic, xylodetriticolous, lignicolous, xylophagous, succicolous and saproxylic species (Jurc *et al.* 2008). It prefers old deciduous forests, particularly oaks forests. The larvae develop in an old decaying solitary *Quercus,* particularly in a rough bark. Larval development takes three or more years (Sama 2002). It is considered an ecosystem engineer (Buse *et al.* 2008a) and, together with the stag beetle (*Lucanus cervus*) serve as umbrella species representing a diverse and highly endangered fauna associated with old oaks (Buse *et al.* 2008b).

Lucanus cervus is a pholeophilic, at times silvicolous, xylodetriticolous, succicolous and saproxylic species (Jurc *et al*. 2008). It prefers similar habitats of *Cerambyx cerdo*. The larvae develops in big roots and old stumps of deciduous trees *as Quercus, Fagus, Salix, Populus, Tilia, Aesculus* or in fruit trees in orchards, sporadically in conifers or in compost (Koch 1989b).

Discussions

In Romania, among the beetle species of community interest whose conservation requires designation of special areas of conservation listed in Annex II of EU Habitats Directive, there are 10 species belonging to the saproxylic group that are protected through Natura 2000 network for protected areas. In the museum collection the following 7 protected saproxylic beetle species were indentified: *Rhysodes sulcatus* Fabricius, 1787, *Cerambyx cerdo* Linnaeus, 1758, *Rosalia (Rosalia) alpina* (Linnaeus, 1758), Morimus *asper funereus* (Mulsant, 1863), *Cucujus cinnaberinus* (Scopoli, 1763), *Phryganophlius ruficollis* (Fabricius, 1798) and *Lucanus cervus* (Linnaeus, 1758). Among these, the species *Cerambyx cerdo, Cucujus cinnaberinus, Phryganophilus ruficollis* and *Rosalia alpina* are named also on the Annexe IV of EU Habitats Directive as species of community in need of strict protection.

Based on IUCN Red List of Threatened Species: *Morimus asper funereus*, *Rosalia alpina* and *Cerambyx cerdo* are listead as vulnerable species (World Conservation Monitoring Centre 1996). Near threatened are *Lucanus cervus*, *Phryganophilus ruficollis* and *Cucujus cinnaberinus* (Nieto, Alexander 2010; Nieto *et al.* 2010). The wrinkled bark beetle *Rhysodes sulcatus* is listed data deficient (Nieto, Alexander 2010).

Their status, in Romania as protected species through Natura 2000 network, is listed as VU (Vulnarable) with the exception of the stag beetle *Lucanus cervus* that has the status of NT (near threaten) (Tatole *et al.* 2009).

According with the Summary Report regarding the conservation status of the species and habitats of community interest in Romania (Mihăilescu *et al.* 2015), complied by the Institute of Biology – Romanian Academy (2015) as a result of the *Monitoring the conservation status of species and habitats in Romania under Article 17 of the Habitats Directive* Project, their general assessment of the conservation status in Romania varies. The stag beetle *Lucanus cervus* and great Capricorn beetle *Cerambyx cerdo* have an unfavourable state with unknown tendencies. The species *Cucujus cinnaberinus, Morimus asper ssp funereus* and *Rosalia alpina* have a inadequate state with unknown trend. *Rysodes sulcatus* is listed with an unknown state and the species *Phryganophlius ruficollis* has a unevaluated state.

Based on the data retrieved from the collection we can assess the distribution of *Rosalia alpina* and *Morimus asper*. This species was collected in many sites especially from Romania. *Rosalia alpina* (Fig. 1) was collected especially in the center part of the country in the mountain region. Other sampling sites include the Banat region and the Eastern Carphatians. In the case of *Morimus asper*, a similar pattern was observed (Fig. 2). In addition, the species was also sampled in Dobrogea region.

Few specimens were collected from outside Romania: Tirol (Austria), Majavica Mountains (Bosnia and Herzegovina) and Germany.

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The authors would like to thank for the help offered by Dr. Erika and Dr. Eckbert Schneider in the identification of collection labels. We thank Dr. Adrian Ruicănescu for his constructive comments which improved the quality of our manuscript. .

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Fig. 1. Romanian distribution of *Rosalia alpina* based on museum collection data

Fig. 2. Romanian distribution of *Morimus asper funereus* based on museum collection data

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Fig. 1. Distribuția speciei *Rosalia alpina* în România pe baza datelor din colecțiile muzeale

Fig. 2. Distribuția speciei *Morimus asper funereus* în România pe baza datelor din colecțiile muzeale

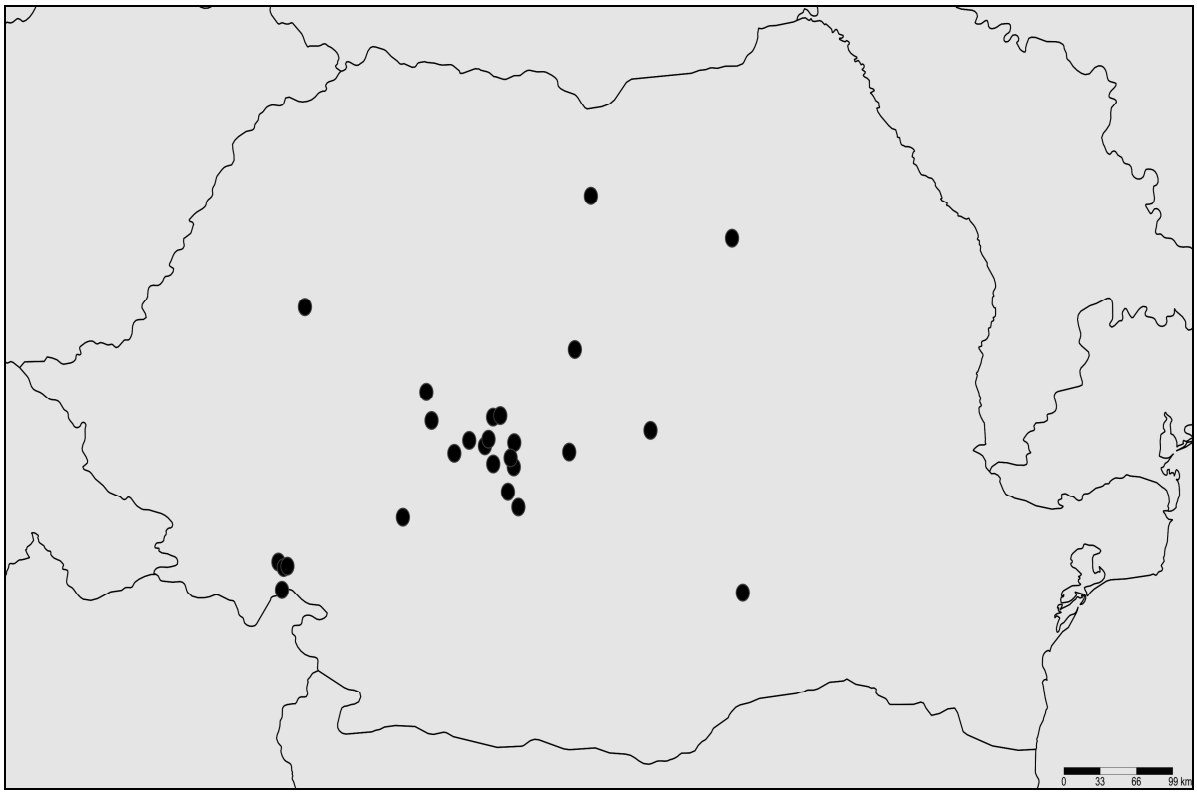

Fig. 1. Romanian distribution of *Rosalia alpina* based on museum collection data

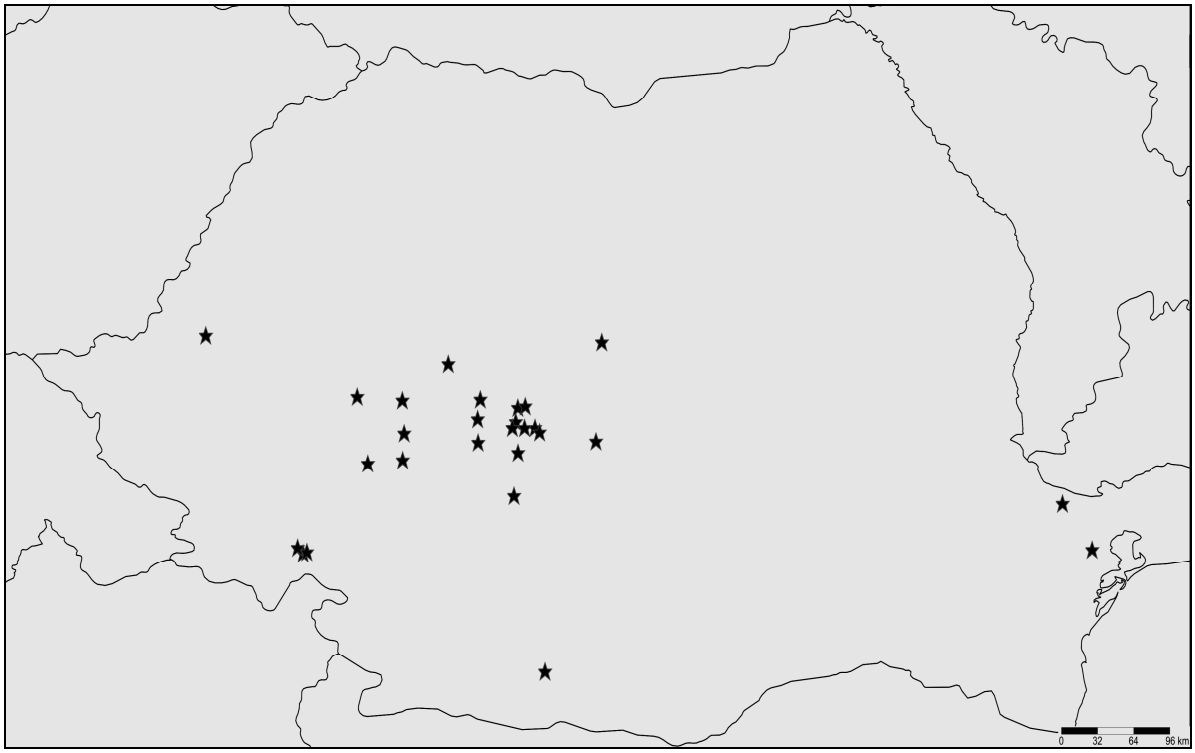

Fig. 2 Romanian distribution of *Morimus asper funereus* based on museum collection data

FIRST RECORD OF *CAMPONOTUS LATERALIS* (OLIVIER, 1792) (HYMENOPTERA: FORMICIDAE) FROM DOBROGEA (ROMANIA)

Ioan TĂUŞAN*

Abstract. *The ant fauna of Romania is still poorly known and scarce data is avalaible for many species. Faunistical investigations may increase the knowledge on the current species number and improve the data on their distribution. Herein we report the first record of Camponotus lateralis (Olivier, 1792) from Dobrogea.*
Key words: *ants, faunistics, Măcin Mountains.*

Rezumat. *Mirmecofauna României este în continuare puțin cunoscută, iar pentru multe specii există puține date privind distribuția. Studiile faunistice pot să contribuie la o mai bună cunoaştere a distribuției speciilor şi la creşterea numărului de specii de furnici cunoscute din România. În prezenta lucrare este redată prima semnalare a speciei Camponotus lateralis (Olivier, 1792 pentru Dobrogea.*
Cuvinte cheie: *furnici, faunistică, Munții Măcin România.*

Introduction

In the last decade, in Romania, intense myrmecological studies were undertaken (Markó *et al.* 2006; Ionescu-Hirsch *et al.* 2009; Markó *et al.* 2009; Czekes *et al.* 2012; Tăuşan, Rădac 2014; Tăuşan, Pintilioaie 2016). The current checklist contains 112 ant species. However, the number is consider low, due to the fact that neighbouring countries share a higher number of species: Hungary – 125 species (Csősz *et al.* 2011), Bulgaria – 163 species (Lapeva-Gjonova *et al.* 2010), and Ukraine – 134 (Czechowski *et al.* 2012). Moreover, many regions from Romania, such as Dobrogea, Banat and Moldova are poorly known from a faunistical point of view.

Thus, for many ant species data regarding the distribution is scarce or lacking (see Markó *et al.* 2006, Markó *et al.* 2009; Czekes *et al.* 2012).

Dobrogea hosts a high diversity of ant species (Markó *et al.* 2006; Markó *et al.* 2009; Moscaliuc 2009; Czekes *et al.* 2012). More than 60 ant species are known from this region and the number could easily increase if similar studies will follow.

Faunistical surveys may increase the knowledge on this matter. In the frame of this context we investigated different habitats in Northern Dobrogea in May 2016.

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Among the ant genra, *Camponotus* is represented in Romania by 11 species: *C. herculeanus* (Linnaeus, 1758), *C. ligniperda* (Latreille, 1802), *C. vagus* (Scopoli, 1763), *Colobopsis truncata*, (Spinola, 1808), *C. atricolor* (Nylander, 1849), *C. dalmaticus* (Nylander, 1849), *C. fallax* (Nylander, 1856), *C. lateralis* (Olivier, 1791), *C. piceus* (Leach, 1825), *C. tergestinus* Müller, 1921 and *C. aethiops* (Latreille, 1798) (Markó *et al.* 2009).

Within these species only *C. ligniperda, C. herculeanus, C. vagus, C. piceus* and *C. aethiops* are known from many sites. Distribution data on the rest of the species is lacking (Markó *et al.* 2009). Herein we report the first record of *Camponotus lateralis* from Dobrogea.

Material

Workes were collected from Consulul Hill (N 45.029949, E 28.506002, 300 m a.s.l.) from Măcin Mountains. The habitat is characterized by south exposed grassalands with sparse deciduous trees (Fig. 1).

Recognition

According to Ionescu-Hirsch (2009) *C. lateralis* is characterized by a deep metanotal groove and a flat or concave propodeal dorsum posteriorly. The petiolar scale is strongly convex anterodorsally and flat posteriorly. The body is feebly sculptured and shiny. The pilosity on the dorsum of the propodeum consists of a transversal row of six

erect setae at the junction with declivity and short apressed pubescence (Fig. 2).

C. lateralis has a weak ground sculpture, is mostly shiny, and has yellowish-brown head and mesosoma, occasionally reddish-brown to dark blackish-brown, and black gaster. *C. lateralis* is similar to *C. dalmaticus* except for its head being paler than gaster, as opposed to the head equally dark as the gaster (Ionescu-Hirsch 2009).

Habitat preferences and distribution

C. lateralis is an arboreal species that inhabits warm, xerotherm areas; nests are mostly built in dead wood (Markó *et al.* 2009).

The species is widespread from the Iberian Peninsula to western Anatolia, and in NW Africa (Rigato, Toni 2011). In Romania, *C. lateralis* is known from several sites (see Markó *et al.* 2009) (Fig. 3). *Camponotus lateralis* may have a wider distribution, although the available data are scattered and scarce (Fig. 3).

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Special thanks to Liviu Aurel Moscaliuc and Ionuț Ştefan Iorgu for their help in the field. I am also grateful to AntWeb team (www.antweb.org) for their huge work and personally to April Nobile for photos of *Camponotus lateralis* used in our work.

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Fig. 3. Known distribution map of *Camponotus lateralis* (black circles – published records; red star – new record)

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Fig. 2. Lucrătoare de *Camponotus lateralis*, modificat după www.AntWeb.org, (CASENT0080857), **a**. capul - vedere frontală; **b.** vedere dorsală; **c.** vedere laterală (fotografii de April Nobile)

Fig. 3. Distribuția cunoscută a speciei *Camponotus lateralis* (cerc negru – date din literatură; stea roşie – date noi)

Fig. 2 *Camponotus lateralis* habitat in Consul Hill (Măcin Mountanins)

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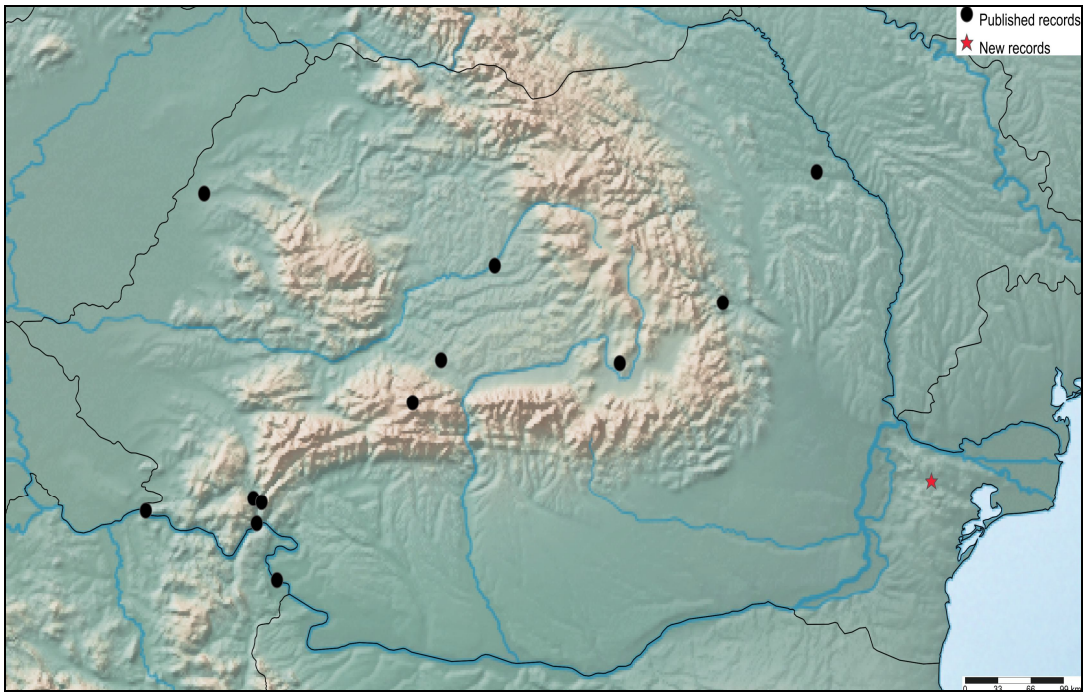

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INFLUENCE OF HABITAT, TIME AND HOST VARIABLES ON THE PREVALENCE OF PARASITIC ARTHROPODS IN THE BANK VOLE, *MYODES GLAREOLUS* (SCHREBER, 1780) IN TRANSYLVANIA (ROMANIA)

Ana Maria BENEDEK*
Ioan SÎRBU*

Abstract. *In Transylvania the bank vole (Myodes glareolus) is a typical forest species, characteristic especially for montane wooded habitats. In lowlands its distribution is limited to humid areas with rich herbaceous vegetation in forests and especially at their edges. The aims of the present study were to detect possible patterns of spatial and temporal distribution for the taxa of parasitic arthropods infesting this species, to test the influence of some variables on the prevalence of external parasite taxa and to assess the similarity between these models and those of another forest species, the yellow-necked mouse (Apodemus flavicollis). Data on ectoparasites hosted by M. glareolus were collected from 205 animals captured in several areas across Transylvania. Prevalence of ectoparasites was 90.7%. Three taxa were identified, namely Acarina (including Ixodidae) (mites and hard ticks), Siphonaptera (fleas) and Anoplura (lice). Among them mites were most common. The influence of habitat, time and host variables was tested*
Key words: *bank vole, harvest mites, fleas, seasonality, altitudinal pattern.*

Rezumat. *Şoarecele scurmător (Myodes glareolus) este o specie tipică de pădure, caracteristică în special pentru habitate montane cu vegetație lemnoasă. În zonele joase distribuția sa este limitată la zone cu umiditate ridicată şi vegetație ierboasă bogată din păduri şi mai ales de la marginile lor. Scopul acestei lucrări a fost cel de a detecta posibilele modele de distribuție spațială şi temporală ale grupelor de paraziți externi care infestează această specie, de a testa influența unor variabile asupra prevalenței acestor taxoni şi de a evalua similitudinea între aceste modele şi cele ale unei alte specii pădure, şoarecele gulerat (Apodemus flavicollis). Datele privind ectoparaziții de pe M. glareolus au fost colectate de la 205 indivizi capturați în mai multe zone din Transilvania. Prevalența ectoparaziților a fost de 90.7%. Au fost identificate trei grupe taxonomice, şi anume Acarina (inclusiv Ixodidae) (acarieni, inclusiv căpuşe), Siphonaptera (pureci) şi Anoplura (păduchi). Dintre aceşti taxoni acarienii au avut cea mai ridicată prevalență. Influența unor variabile de mediu şi timp dar şi ale gazdelor asupra prevalenței totale şi a fiecărui grup a fost testată.*
Cuvinte cheie: *şoarecele scurmător, acarieni, pureci, variație sezonieră, model altitudinal.*

Introduction

In Transylvania the bank vole *Myodes glareolus* (Schreber, 1780) is characteristic for mountain forests, regardless of their tree species structure. In hilly and plateau areas its distribution is related mostly to forest edges and riverine forests, with high humidity and rich herbaceous and shrubby vegetation, while in plain woodlands the bank vole is usually absent (Benedek 2014). Often the bank vole reaches high abundances in montane forests, being the dominant species in the small mammal communities, being favoured especially by the richness of the herbaceous vegetation layer, as the bank vole feeds mainly on herbs (leaves, grass, fruits, and seeds). In some habitats (especially along the water courses) the dominance within the community is taken over by the yellow necked mouse *Apodemus flavicollis* (Melchior, 1834).

However, there is a significant dynamics of the small mammal community structure in mountain forests, shifting from the dominance of the vole to the dominance of the mouse or even to that of the common shrew, *Sorex araneus* (Linnaeus, 1758) (idem).

Many studies on parasites of rodents in Romania were carried out in the southern part of the country, mainly in Dobrogea and the Danube Delta, where *M. glareolus* is not present. The most important paper concerning the ectoparasites of the bank vole was published in 1979 by Suciu and Popescu, who drew up a synthesis on the external parasites and commensals of this species based on data collected from voles captured in several location, mainly in the southern part of the Carpathian Mountains (Suciu, Popescu 1979).

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Other old papers contain scattered faunistical information from Transylvania. Negoescu (1975) presents data on the Gamasida mites from various areas in Romania, including Transylvania. The catalogue of fleas from Romania was published by Suciu (1973). Data on the parasites of rodents appear also in the volume of "Fauna României" concerning rodents (Popescu, Murariu 2001). Due to the epidemiological importance of ticks as vectors of several pathogens causing serious diseases in humans and domestic animals, there was an intensification of the studies concerning this taxon during the last years. Several studies were carried out, yielding a series of papers on ticks from Romania (Coipan *et al.* 2011, Mihalca *et al.* 2012 a, b). Recently we published two papers concerning the parasitic arthropods of two *Apodemus* species, namely *Apodemus flavicollis* (Melchior, 1834) and *Apodemus agrarius* (Pallas, 1771) in Transylvania, in relation to their spatial and temporal distribution (Gheoca *et al.* 2013, Gheoca, Benedek 2014). In other countries ectoparasite communities hosted by the bank vole or its nests are much better known. For example, in Poland there are known 142 arthropod species associated with *M. glareolus* (Haitlinger 1983) and several papers focus on their spatial and temporal patterns (Haitlinger 1975, Haitlinger 1976 a, b).

The aims of the present study were to detect possible patterns of spatial and temporal distribution for the taxa of external parasites infesting the bank voles in Transylvania, to test the influence of some space (area and type of forest), time (year and season), and host (age and sex) variables on prevalence of external parasite taxa and to assess the similarity between these models and those for another characteristic forest species, the yellow-necked mouse

Study areas and Methods

The field data were collected from several mountain areas in Transylvania. Most of the examined bank voles were trapped in the mixed forest in Lotrioara Valley (110 individuals), where a long term survey of the small mammal communities was carried out between 2000 and 2010, and Retezat Mountains National Park (45), where an extensive study took place in several habitats at different altitudes. Other data come from a few bank voles captured in Râu Şes River Basin and Apuseni Mountains Nature Park, but also in a few lowland areas, like Hârtibaciu Plateau or Sibiu Depression.

Voles were captured by live trapping, using Polish, Fitch and Sherman traps set either in line or in net, depending on the habitat. The captured specimens were weighted, sex and age category (subadults and adults) were determined and ectoparasites were collected, being stored in 80% ethanol. The voles were released on their trapping site. The parasites are considered according to their taxonomic framing, three taxa being distinguished: Acarina (mites), Siphonaptera (fleas) and Anoplura (lice). Due to their importance as vectors for various diseases hard ticks (Ixodidae), although part of Acarina, are considered as a separate taxon. Prevalence is expressed as the ratio between number of specimens hosting parasites and the total number of examined specimens.

The influence of different variables on the prevalence of the ectoparasite taxa was tested using Pearson χ^2 test of independence or, when its employment conditions were not met, Yates' corrected χ^2 test or Fisher's exact test. Significant results were considered for $p < 0.05$. Research area, forest type, season, year, host age category and sex were the considered variables.

Results

Total infestation

During the study external parasites were collected from 205 bank voles. The total prevalence was 90.7%. This value is significantly higher (χ^2 = 10.887, degrees of freedom (d.f.) = 1, p = 0.001) compared to the total prevalence of 78.09% found in *A. flavicollis* (Gheoca *et al.* 2013).

We found a significant difference (χ^2 = 13.426, d.f. = 1, p = 0.001) in total prevalence between the two mountain areas where most of the data comes from, in Lotrioara Valley the total prevalence reaching 96.3%. *M. glareolus* occurs mostly in mountains and only a few examined specimens were captured in lowland areas, but the total prevalence there didn't differ significantly from that in the montane areas (χ^2 = 0.037, d.f. = 1, p = 0.847). However, we tested the effect of habitat type, considering broadleaf, mixed and coniferous forests, and the results were very significant ($p < 0.001$), voles from coniferous forests having a lower prevalence (75% compared to over 90% in forests situated at lower altitudes).

In the same two areas the prevalence proved to be significantly dependent (χ^2 = 15.874, d.f. = 4, p = 0.003) on the year, during the period between 2004 and 2008, when most voles were examined,

varying between 73.1% in 2004 and 100% in 2008. The voles captured in winter were scarce, so we tested the influence of season on the prevalence during the rest of the year and although there was a decrease in prevalence from spring to autumn, this model is not significant (χ^2 = 3.012, d.f. = 2, p = 0.222).

There was no significant dependence of prevalence on the two considered host variables, namely age (χ^2 = 1.654, d.f. = 1, p = 0.198) and sex (χ^2 < 0.001, d.f. = 1, p = 0.992).

Among the parasite taxa (considering hard ticks and other Acarina separately), mites had the highest prevalence (80.7%), followed by fleas (34.9%) (Fig. 1).

Harvest mites (Trombiculidae)

Among mites the most prevalent were the harvest mites (Trombiculidae), and especially the larvae of *Neotrombicula* genus. They were present usually in large numbers especially in the ear or on its margin. 93% of the examined bank voles had *Neotrombicula* larvae only in the ear, while only 1.9% (three voles) had larvae only on other parts of the body, mainly around the genitalia.

During the period between 2004 and 2008 the prevalence of harvest mites was significantly dependent on year (χ^2 = 14.5, d.f. = 4, p = 0.006), varying between 59% in 2004 and 91% in 2006 and 2008. Prevalence was highest in summer, although the seasonal pattern was not significant (χ^2 = 3.371, d.f. = 2, p = 0.185). Comparing the two main research areas, prevalence was significantly higher in Lotrioara Valley than in Retezat Mountains National Park (χ^2 = 4.645, d.f. = 1, p = 0.031). This result was probably influenced by the significant dependence of the prevalence on the forest type (broadleaf, mixed, coniferous) (χ^2 = 7.962, d.f. = 2, p = 0.019), being lower (65.9%) in forests at high altitudes (spruce forests), which were surveyed especially in Retezat Mountains.

Prevalence of harvest mites was found not to be significantly dependent on the host variables, neither on sex (χ^2 = 0.085, d.f. = 1, p = 0.771), nor on age (χ^2 = 1.418, d.f. = 1, p = 0.234), although adults had a higher prevalence than subadults (82.2% compared to 73.6%).

Hard ticks (Ixodoidea)

Tick prevalence was found to be independent of season (χ^2 = 1.965, d.f. = 2, p = 0.374), and the maximum value was calculated for summer (13.3%), not spring (7.1%), as in the *Apodemus* species. Because of the low number of infested voles, the influence of year could not be tested.

Ticks had a significantly higher prevalence in areas situated at lower altitudes compared to montane survey areas (χ^2 = 17.218, d.f. = 1, p < 0.001). This pattern is significant also when forest types are considered (p = 0.036), the highest prevalence being found in broadleaf forests (13.3%) (Fig. 2).

Prevalence of ticks was not dependent on host age (χ^2 = 0.061, d.f. = 1, p = 0.804) or sex (χ^2 = 0.026, d.f. = 1, p = 0.871).

Lice (Anoplura)

Both the lice and the lice eggs were found only on voles captured in autumn. In case of the eggs, the seasonal pattern was significant at p = 0.1 (χ^2 = 5.535, d.f. = 2, p = 0.063). Due to the low prevalence, influence of year could not be tested, neither on lice, nor their eggs. Although the two bank voles hosting lice were captured in montane areas, lice eggs were found mostly on voles captured in lowland areas (χ^2 = 62.590, d.f. = 1, p < 0.001) and considering the forests, they had a significantly higher prevalence in broadleaf forests (p < 0.001) (Fig. 2).

Fleas (Siphonaptera)

During our study prevalence of fleas on *Myodes glareolus* was found to be independent of most of the considered variables, except survey area, their prevalence being significantly higher on Lotrioara Valley compared to Retezat Mountains (χ^2 = 6.035, d.f. = 1, p = 0.014).

Discussions

The flea assemblages of the bank vole in Romania are relatively rich, in total 19 species were mentioned in the literature, most of them from localities in the Carpathians (especially Retezat and Bucegi Mountains) (Suciu 1973, Suciu, Popescu 1979). Among these species, *Amphipsylla sibirica* Wagner, 1930 is a typical microtine flea preferring species of *Microtus*, although collected regularly from *Myodes* (Brinck-Lindroth, Smit 2007). In Romania this species is known only from only one female of *M. glareolus* (Suciu 1973). Compared to our data Suciu and Popescu (1979) found a slightly higher total prevalence of fleas - 44.5%, varying between 37.5% and 83.3%.

Up to the present only one species of hard ticks was mentioned in the literature on the bank vole in Romania, namely *Ixodes ricinus* (Linnaeus, 1758) (Mihalca *et al*. 2012 a), the most frequent and abundant tick species from Romania, especially in forest habitats (Mihalca *et al*. 2012 b), parasitizing a great number of hosts. Rodents are usually parasitized by larvae and nymphs, the presence of adults being mostly accidental (Krasnov, 2008). Thus, the tick maturation from spring to autumn is correlated with a constant decrease of their prevalence in most rodents. Unlike other species, the bank vole lacks a significant seasonal pattern of tick prevalence. However, similarly to the yellow-necked-mouse, it is significantly lower at higher altitudes, indicating a preference of this taxon for lowlands.

Lice are seldom encountered on *M. glareolus*. Two species, *Polyplax serrata* (Burmeister, 1839) and *Hoplopleura edentula* (Fahrenholz, 1916) are mentioned in the literature infesting bank voles from Romania, cited from several locations in the Carpathians (Suciu, Popescu 1979). Their total prevalence (10.3%) was significantly higher compared to our results ($Z = 4.027$, $p < 0.001$), even considering the eggs ($Z = 2.202$, $p = 0.027$).

Leptinus testaceus Müller, 1817 (Coleoptera, Leptinidae) is the only beetle known to parasitize the rodents in Romania, some authors considering it as a commensal (Suciu, Popescu 1979). Interestingly, this species was cited in the literature only from the bank vole (idem), but was not found by us on any of the captured specimen although several yellow-necked mice, in mountain areas hosted *L. testaceus* (Gheoca *et al*. 2013). In Great Britain this species was mentioned from *M. glareolus*, *Microtus agrestis* (Linnaeus, 1761), and *Apodemus sylvaticus* (Linnaeus, 1758), but was more frequent on the latter (Buckle 1976).

When comparing the bank vole to the other typical forest rodent, the yellow necked mouse, frequently codominant in mountain forests, the two species present some similarities but also a series of differences in what the prevalence of ectoparasites is concerned.

The spatial and temporal patterns of total prevalence in the bank vole were driven mainly by the prevalence of mites, and especially by harvest (or chigger) mites (family Trombiculidae), the most frequent and abundant ectoparasite group infesting this species. Many *Neotrombicula* species are strongly associated with forest habitats (Haitlinger 1983) and individual species may reach up to 75% prevalence, like *Neotrombicula zachvatkini* (Schluger, 1948) in the district of Sofia (Kolebinova 1974). In open habitats harvest mites are scarce, and may even be absent on mice and voles, like in the survey carried out in a town near Düsseldorf, Germany, where no trombiculid mite was found on *M. glareolus* (Klimpel et al. 2007), *A. flavicollis* and *A. sylvaticus* (Klimpel et al. 2006). In the yellow-necked mouse on the other hand, although the prevailing parasite group were also the mites, the species of Laelapidae family had the highest prevalence (Gheoca *et al*. 2013). Moreover, harvest mite larvae have different behaviour towards the two hosts. In the bank vole they feed mostly inside the ear, and in lower numbers on the ear margin, while in the yellow-necked mouse they attach themselves mainly around the genitalia, around skin injuries and on the ear margin, but not inside the ear. All these yield in different patterns of mite prevalence in the two rodent species.

Unlike the yellow-necked mouse, in the bank vole the total prevalence, but also that of different taxa, was not dependent on the host age or sex. It might be that considering the parasite species separately, the results were different, as some studies indicate higher prevalence and infestation intensities of certain parasite species on male or female bank voles (Haitlinger 1983).

Compared to *Apodemus* species the temporal patterns of ectoparasite taxa prevalence in the bank vole are not well expressed, although annual variations may be significant. One cause could be the greater numerical stability of its populations, both from year to year - compared to the yellow-necked mouse in montane areas, where it presents two-year variations (Benedek 2014), and during the year - compared to the striped field mouse, which records a strong populational increase from spring to autumn (idem). More important seem to be the spatial variables, and especially the forest type (related to the altitude), all taxa having a lower prevalence in coniferous forests

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Fig. 1. Prevalence of the parasites taxa

Fig. 2. Habitat variation of ectoparasites' prevalence in bank voles in Transylvania

LISTA ILUSTRAŢIILOR

Fig. 1. Prevalența grupelor taxonomice de ectoparaziți

Fig. 2. Variația în tipurile de habitat a prevalenței ectoparaziților la şoarecele scurmător în Transilvania

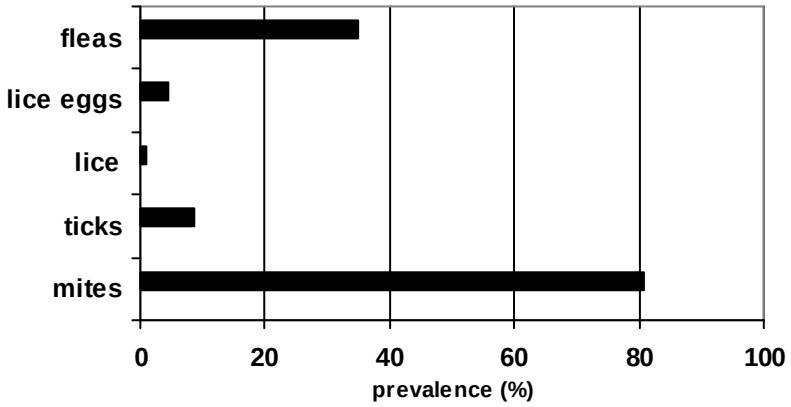

Fig. 1. Prevalence of the parasite taxa

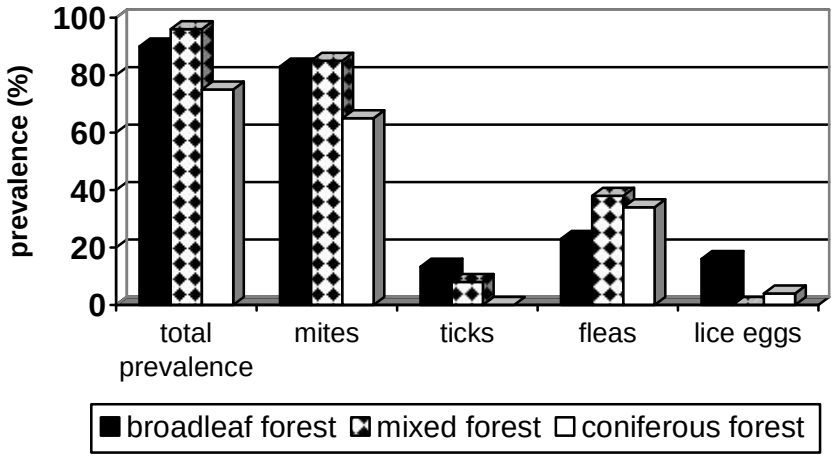

Fig. 2. Habitat variation of ectoparasites' prevalence in bank voles in Transylvania

ASPECTS OF PAIR BEHAVIOR IN THE WHITE STORK (*CICONIA CICONIA)*

Miruna GRITU*

Abstract. *Even though the white stork (Ciconia ciconia) is one of the most known and most beloved species of birds, its nesting behavior is not fully known in Romania. The aim of this paper is to deepen the knowledge of the pair's behavior during nesting and to identify any differences that may arise in behavioral manifestations of both sexes. The data was collected between 2007-2014, by monitoring a white stork nest located in Cristian village, Sibiu County. Cristian village is known for its large number of storks that came here, for example in 2015 being identified 33 nests. During this study, 15 behavioral acts have been identified. Quantitative and qualitative histograms, for both male and female, were drawn showing behavioral differences between the sexes at the nest.*
Key words: *white stork, pair behavior, behavioral act*

Rezumat. *Cu toate că barza albă (Ciconia ciconia) este una dintre cele mai cunoscute şi mai iubite specii de păsări din avifauna ţării noastre comportamentul acesteia la cuib nu este pe deplin cunoscut. Scopul acestei lucrări este de a aprofunda cunoaşterea comportamentului perechii la această specie pe perioada de cuibărire şi de a identifica eventualele diferenţe ce pot apărea în manifestările comportamentale ale celor două sexe. Datele au fost colectate pe perioada 2007-2014, prin monitorizarea unui cuib de barză albă din localitatea Cristian, judeţul Sibiu. Aceasta este cunoscută prin numărul mare de berze ce cuibăresc aici, la recensământul din anul 2015 fiind înregistrate 33 de cuiburi. În cadrul comportamentului studiat au fost identificate 15 acte comportamentale şi s-au realizat histograme cantitative şi calitative atât pentru mascul, cât şi pentru femelă. Rezultatele au evidenţiat diferenţe comportamentale între cele două sexe în cadrul comportamentului perechii de berze albe la cuib.*
Cuvinte cheie*: barza albă, comportamentul perechii, act comportamental.*

Introduction

The White Stork (*Ciconia ciconia*) is a widespread species in Romania. It prefers low plains or wetlands located along large rivers and are rarely seen in high altitude areas. The presence of the white stork was recorded at 1000 m altitude, in Malul Dornei (near Vatra Dornei), this being the highest record of the white stork in Romania (Papadopol 1957). At national level, a particular importance was given for the censuses (Klemm 1975, 1982, Sárkány-Kiss 1990, Weber 1994, 1996, 1999, Kósa 2001). The highest number of white storks pairs was recorded in Cristian, Sibiu County and Sânsimion, Harghita County. In addition to the data obtained through censuses, there are studies on the distribution and the population dynamics (Philippi, Popa 1990, Kósa *et al.* 1998, Kósa *et al.* 2002).

There are also studies regarding the stork habitat (Filipaşcu 1968) or its migration (Mătieş 1971, Munteanu 1969). Representative studies regarding the white stork behavior are the ones published by Kahl (1972) and Schulz (1998). The aim of this paper was to deepen the knowledge on the white stork nesting behavior.

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Material and Methods

The study on the white stork's behavior took place in Cristian, Sibiu County. Cristian village is located in the Cibin meadow at 444 m altitude. The storks usually return to the village at mid-March and remain in place until the end of August. The behavior of one pair of storks from Cristian was monitored throughout the nesting period. The data was collected during 2007-2014. For this purpose, a Canon camera was mounted on the nest located on XVI Street, No. 17 that filmed the nest between March and August, each year. The camera worked from early morning until late evening. The type of camera didn't allow overnight recording.

InterVideo Win DVD Creator program was used for processing the records and permitted the segmentation of the videos. Each recording was tracked in real time to identify the main types of behavior. In some situations, both partners were present at the nest. They either had the same

behavior or exhibited different ones (while one is taking care of the clutch, the other can have characteristic movements of comfort behavior). These reactions have been observed in parallel, following the ways they provoke or respond to the partner's acts.

Each behavior was split into behavioral acts. The behavioral act is the smallest unit of behavior that can be described and recognized each time it occurs. Each act received a code. The numbering of acts was done within a larger study, for all the behavior types, in the order of their deployment. This is the reason why acts of the pair's behavior are not in chronological order. It followed the sequence, duration and intensity of behavioral acts that were written down into a working protocol. During these observations, both qualitative (considering the number of acts) and quantitative (considering frequency, time of acts) principles are followed, resulting qualitative and quantitative histograms, separate for male and female. The sexes were distinguished based on their appearance. Males are comparatively larger and have thicker bills. When the bird was alone in the nest its sex was confirmed when the partner arrived at the nest.

Results

During the study period, the storks returned here in the second half of March until the end of April. As soon as the first arrived stork chose the nest it chased away other birds that found shelter here during winter and began cleaning the nest. In the beginning of nesting, the stork rarely left the nest and it did it only for short periods. When it returned to the nest, it clattered and widely opened the wings, regardless the gender. During the study, the arrival of the female was recorded before the arrival of the male in 2008, 2010 and 2013.

In the pair behavior 12 behavioral acts were identified. They are briefly described below:

a13. Behavioral act common to both sexes. The stork leaves back its head while sitting down in the nest while the partner arrives.

a148. Sitting down in the nest, the stork leaves back its head and widely opens its beak. The act is common to both sexes and joint motion that precedes the clattering.

a149. Behavioral act common to both sexes. Sitting down in the nest without open wings, it clatters.

a153. Behavioral act, common to both sexes. The stork is standing in the nest, flings the head back and opens the hose nozzle (this movement precedes the clattering, being followed by a hiss).

a154. Behavioral act characteristic to both sexes. The stork is standing in the nest and clatters without opening the wings.

a159. Behavioral act, common to both sexes. The stork arrives at the nest while it clatters.

a170. Behavioral act characteristic to the male. He stands, claps the wings and jumps on the female.

a171. Behavioral act common to both sexes. Mating.

a172. Behavioral act characteristic to the male. He jumps off the female in the nest.

a174. Behavioral act common to both sexes. With the head bent, the stork nibbles the material from the nest (after it previously clatters).

a180. Behavioral act characteristic to both sexes. The bird sits on the tarsi; it clatters without opening the wings.

a189. Behavioral act common to both sexes. Sitting in the nest on the tarsi, the stork puts its head back. The moving precedes the clattering.

The qualitative and quantitative histograms resulted from the working protocols (Fig. 1, Fig. 2) illustrate the structure of the pair behavior in the two genders. Most of the acts observed in the pair behavior are common to both sexes. The only two acts that are characteristic for one gender, namely for males, are related to mating. A170 (the male stands, claps the wings and jumps on the female) and a172 (he jumps off the female) are deployed while the female is standing in the same position as for mating.

There is a significant difference between the behavior structure in the two sexes in both what the number of acts ($\chi^2 = 87.47$, d.f. = 11, $p < 0.001$) and the duration of different behavioral acts are concerned.

From the qualitative point of view, considering the number of acts, the male's behavior is dominated by the act a154, while the female's by the acts a148 and a149. Comparing acts a149 and a154, when the birds clatter without opening their wings in sitting and respectively standing positions, their proportions are inverse in the two sexes. This indicates that most of the male's behaviour is deployed while standing, while the female's is deployed sitting in the nest, both parteners without open wings.

From the quantitative point of view, considering their duration, two acts characterize the behavior of the genders, namely a171, with a longer duration in the female (due to the lack of the other two acts related to mating deployed only by the male – jumping on and off the female), and a154, with a longer duration in the male.

Act a13, in which the storks sits in the nest at the arrival of the partner has a higher frequency in the female behavior which means that the female spends more time in the nest.

There are no differences between the arrival at the nest of the two partners, and each of the partners may clatter when returning to the nest. It is important to note that the greeting made by the male partner is not accompanied by the wide opening of the wings; this event was not observed in the behavior of the studied pair.

After the pair is formed mutual cleaning of the feathers from the head and neck is common to both partners.

Clattering is an important aspect of stork pair behavior, being part of six of the observed acts, and especially of those that have a longer duration. During the pair formation day, the stork sitting in the nest always greeted the returning partner. From the second day the return of the partner to the nest was not always accompanied by clattering, and during the nesting period the number of situations when the bird sitting in the nest did not greet the returning partner increased.

The pairs from Cristian (both the studied pair and the other pairs from other nests) continued mating after the young have left the nest. Thus before leaving the nesting range such mattings have been often observed in the adult storks. Not all were successful mattings and hadn't been followed by the clattering of the two partners.

Discussions

There are significant differences between the manifestations of the two genders concerning their nesting behavior in the white stork (*Ciconia ciconia*). In Cristian village, the waiting period for the partner to arrive at the nest lasts from one day to 30 days. The 30 days period was recorded in 2016, at the monitored nest. Immediately after the pair formation the first mating occurs but this is not always a successful one. The manner of sex recognition is not yet discovered in storks, but prolonged meetings with females sometimes are misinterpreted as fighting between males. The acceptance of the female is accompanied by the clattering characteristic to storks. The male encounters the female with a movement known in the literature as *Head-shaking Crouch* (Kahl, 1972) dropping to the floor of the nest as if incubating, erecting feathers of neck-ruff fully and shaking head vigorously from side to side. In the specific literature it is noted that "*later mutual greetings expressed by series of Up-downs always follows arrival at nest: returning bird starts in air, few meters from nest, and guard or incubating bird joins in immediately, often while still lying down"* (Cramp, Simmons 1977). However, in the case of the nest monitored in Cristian, there were many situations in which neither the partner that was arriving nor the one sitting in the nest clattered. A higher frequency of the clattering was observed soon after the pair formation. The pairs protect their nest from intruders by clattering, or when they get too close, they are beaten with the wings or with the beak. It is considered that males can conquer a nest while females cannot (Kahl, 1972). But during the study, after arriving first, females defended their nest until the arrival of the partner. In addition they behaved as a true male, clattering and performing the Up- down display. The Up-down display seen in different forms and context can be seen as a warning, threatening or greeting movement (Camani *et al.* 1989).

Before egg laying, the arrival at the nest is accompanied by frequent mating. A successful copulation lasts about 20 s (Schüz, 1934) and there may be as many as 10 per day (Schüz, 1942). Other studies mention copulation with the female sitting on the tarsi or lying down in the nest. These types of behavior were observed in the monitored nest, but not all these mattings were successful. Such post-reproductive behavior was commonly observed in Cristian at the monitored nest and in the nest nearby. Thus, in the second half of August, frequent mattings of the adults were seen, except in 2015 when storks migrated sooner. Mattings took place when adults returned to the nest and the young were not present, feeding on the fields near the village. The adults typically remain in the nest for a longer period. The mattings after raising the nestlings are not documented in the white stork.

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LIST OF ILLUSTRATIONS

Fig. 1. The frequency of acts occurring within the Pair behavior

Fig. 2. The share of acts in time within the Pair behavior

LISTA ILUSTRAȚIILOR

Fig. 1. Frecvența actelor ce apar în cadrul comportamentului perechii

Fig. 2. Ponderea în timp a actelor în cadrul comportamentului perechii

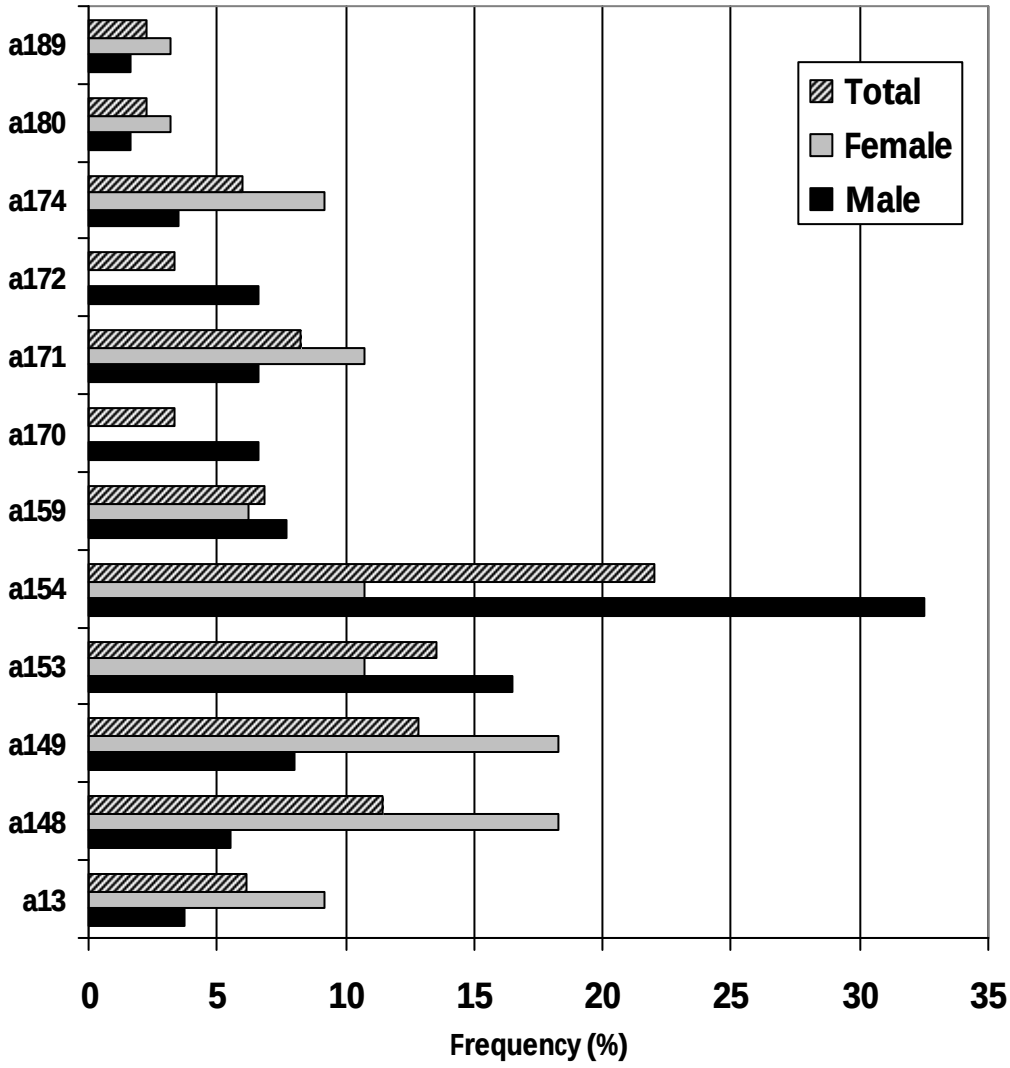

Fig. 1. The frequency of acts occurring within the Pair behavior

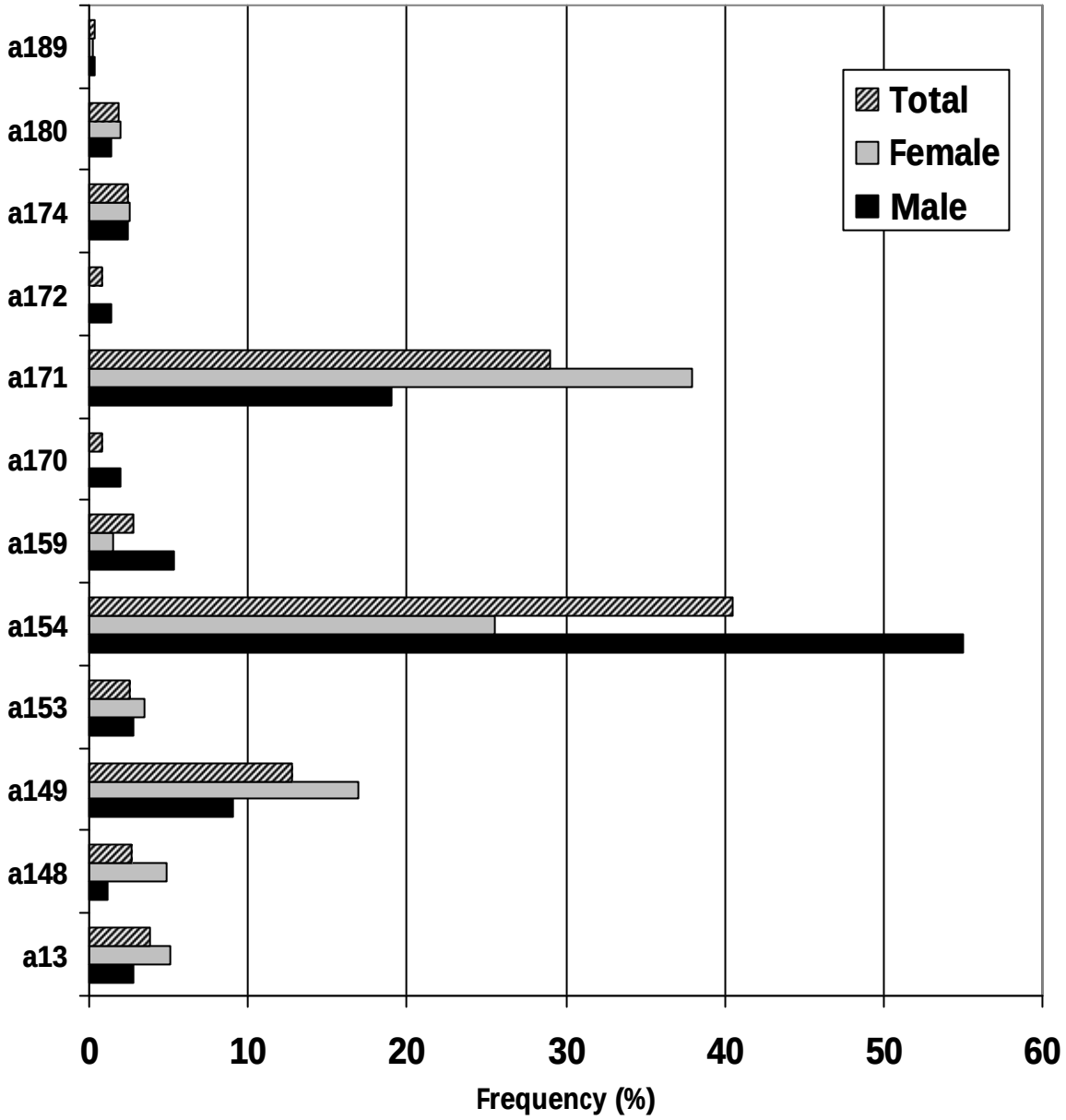

Fig. 2. The share of acts in time within the Pair behavior

EDUCATIONAL POTENTIAL OF THE ORNITHOLOGICAL DIDACTIC COLLECTION FROM BRAŞOV FACULTY OF SILVICULTURE AND FOREST ENGINEERING (ROMANIA)

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Abstract. *The Braşov Faculty of Silviculture and Forest engineering ornithological didactic collection consists of 141 specimens with educational purpose. In addition to the catalogue presentation the evaluation of collection educational potential is also analyzed.*
Key words: *Hausmann, Bârsa, bird specimens, collection catalogue.*

Rezumat. *Colecția didactică de ornitologie a Facultății de Silvicultură şi Inginerie Forestieră din Braşov cuprinde 141 de specimene având rol educațional. Pe lângă prezentarea catalogului colecției, lucrarea evaluează potențialul educațional al colecției.*
Key words: *Hausmann, Bârsa, specimene de păsări, catalogul colecției.*

Introduction

The Braşov Silviculture Institute was established in 1948 with only one Faculty, taking advantage, on one hand of local economic and cultural context but also of the natural environment (Abrudan *et al.* 2008). In 1956 the Silviculture Institute joined the Mechanic Institute and later, in 1971, with the Pedagogic Institute formed Braşov University (Abrudan *et al.* 2008). This institution received, after 1990, the name of "Transilvania" University of which the Faculty of Silviculture and Forest Engineering is now one of the 16 Faculties (Abrudan *et al.* 2008).

In 1949, the goods of "Muzeul Săsesc al Țării Bârsei" (the German Museum of Bârsa Country) which had been confiscated by the state in 1944 from the German community, became property of the new Silviculture Institute (Florian 2011) but also of Honterus, Şaguna and Unirea high schools didactic collections (Ciochia, Barbu 1983). The Faculty of Silviculture and Forest Engineering poses two collections.One of them counts 693 specimens (Ionescu 2010) and has a mainly scientific purpose. The second collection, which is presented in this paper, is smaller, separately exhibited, with specific didactic utility.

We should mention that the German Museum of Bârsa County possesses a part of Hausmann collection which belonged to Wilhem and Ernst Hausmann, ninth century famous naturalists (Ciochia 1983), whom works can also be found in the didactic collection dealt here.

Considering the educational role of this collection our aims are: (i) the catalogue presentation and (ii) the evaluation of collection educative potential, analysing in this way its main purpose.

In this context we established the next questions to be answered forwards: (1) How many taxa from Romanian fauna are represented in the collection? (2) How do differences between the collection and Romanian fauna vary? (3) How equivalent is this taxa represented in the collection, in relation to Romanian fauna?

Methods

We designed the Faculty of Silviculture and Forest Engineering didactic collection catalogue including the next data about each specimen: the species that belongs, the age, the sex, the collection's date and place, the name of the collector and also the inventory number. If the information was not available on the specimen label we conducted biometric measurements which had enabled us to determine it. All specimens have recived a new inventory number which is mention in the catalogue and in the case where it was present, the old one was writen between parantheses.

For species nomenclature we use Illustrated Checklist of the Birds of the World (Hoyo, Collar 2014) and Collins Bird Guide 2nd edition (Svenson

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et al. 2010) and for age, sex and taxa verification we consulted Păsările din R.P.R. (Birds of Romania) (Dombrowsky, Linţia 1946, Linţia 1954, Linţia 1955) and Identification Guide to European Passerines (Svenson 2009)/ Non-Passerines (Baker 1993). For taxa classification we use the Romanian version of Hamlyn guide (Munteanu1999) which was also our source for Romanian bird fauna composition.

Past software was used for statistical analysis such as testing correlations and generating graphs.

Results and discussions

The answer to our first question, establised in the aims of this work, is that the 141 specimens identified in the didactic collection belong to 12 orders, 23 families and 72 species of birds. These numbers signifie 60% in case of orders, 37% in case of families and 19% in case of species reprezented in the collection from all taxa found in the Romaninan bird fauna (Table 2).

We found only 4% from all specimens have information about their provenience. Just 7% of specimen's present data about the locality where they were collected and 4% have information about the date when they were collected (Table 1). This means that the collection has a low scientific value with only one significant positioning in time and space. This is a specimen of *Phalacrocorax pygmaeus* collected at Prejmer in 1875, which proves the existing of this species in the region from past times.

The most important aspect of this collection is the didactic role, on which we focus our analysis further on.

If we look at species distribution related to higher taxa (order) in Romanina bird fauna, we notice a logaritmic distribution (Figure 1 A). In comparisition, the same level distribution of species in collection is more chaotic, still keeping the pattern before observed, but with clear preferences for some groups (Figure 1 B). Even from this primary analysis we can state the collection has a specificity, being less equivalent to the general fauna registered in Romania.

If we analize the variance of diferences between percentage of orders representation in Romanian bird fauna and the ones coresponding to the collection we can see the high standard deviation prooving a considerable variability (Figure 2). The low 3,7% mean demonstrates some sort of equitability in collection coverage of the general bird fauna but the considerable variability is an argument for its specificity.

Analysing the species percentage variance of Romanian fauna orders and the ones found in the collection, we notice almost the same mean value but with higher variation limits and smaller standard deviation in the first case (Figure 3 A) than in the second (Figure 3 B). In consequence the degree of variation in case of the collection is more pronounced and therefore this structure is more heterogenous, concerning species number of each order. This shows a degree of chaotic assembling of the collection because the tendency of preference for some particular groups. This difference of variances between the orders composition in the two situation reflects the artificiality of the collection diversity in the relation with the Romanian bird fauna.

With all the differences, found until this point, between the collection taxa and the one of Romanian fauna we found a high Spermans correlation (Table 4) between the representation in species of orders. This shows a somehow equitable selection of species in the collection regarding the corespondent taxa in Romanian bird fauna. This demonstrate that the artificiality mentioned before is not considerable.

Taking into account the low correlation (Table 5) between the order representation in Romanian fauna and the covering in species by the collection of the same taxa we can clearly state the preferenciality in exhibiting particular species and therefore the collection specificity for a certain fauna composition. In other words the abundance of species in one order in the collection its not related to its abundance in the Romanian bird fauna.

We are now able to answer the third question established in the aims of this paper which deals with the equivalence of Romanian bird fauna representation in the collection. Proved by the correlations we can state that beyond an obvious tendency for prefering some taxa there is still equivalence in representing the general structure of fauna in this didactic collection.

There is a high coverage of Romanian fauna by the collection in case of general forms of birds (more than half of ordes) and considerable covering of the particular ones (more than a third of families) through a low number of species (Table 2), anticipating a high didactic efficiency.

We found a high Spearman's correlation (Table 6) between the species number of an order

represented in the collection and the mean number of specimens belonging to the same assamblage of taxa. In other words we notice a tendency to collect and exhibit much more specimens from species of a prefered group. This correlation clearly certify the tendency to accumulate redundancy by allowing prefered species to be exhibited in greater numbers. We can also observe the mentioned tendency in analysing the number of species in relation to their number of specimens represented in the collection. We notice that the majority of species are represented by 1 or 2 specimens but there are a few, considered preferated, represented by 6, 8 or 9 specimens (Figure 4). The preference tendency of the collection gives it the specificity but also has a great degree of redundancy from which result the low didactic efficiency.

Catalogue presentation

The Faculty of Silviculture and Forest Engineering Didactic Collection includes 141 specimene from the following taxa:

Order Galliformes

Family Phasianidae
Genus *Phasianus* Linnaeus, 1758: *Phasianus colchicus* Linnaeus, 1758 - 4 specimens: 2 adult ♂, 80, 83; adult ♀, 84; juvenile, 82; Genus *Coturnix* Garsault, 1764: *Coturnix coturnix* (Linnaeus, 1758) -1 specimen: juvenile, 81; Genus *Perdix* Brisson, 1760: *Perdix perdix* (Linnaeus, 1758) - 1 specimen: adult ♂, 101; Genus *Tetrao* Linnaeus, 1758: *Tetrao urogallus* Linnaeus, 1758 - 6 specimens: adult ♂, Păpăuţi (Comandău, Covasna), 1889, leg. Kenyere Carol, 79; 3 adult ♂♂, 44, 89, 90; adult ♀, 67; chick, 76; Genus *Lyrurus* Swainson, 1832: *Lyrurus tetrix* (Linnaeus, 1758) - 1 specimen: adult ♂, 88; Genus *Bonasa* Keyserling & Blasius, 1840: *Bonasa bonasia* (Linnaeus, 1758) - 9 specimens: 3 adult ♀♀, 68, 70, 86; adult ♂, 69; 5 chicks, 71, 72, 73, 74, 75; Genus *Lagopus* Brisson, 1760: *Lagopus lagopus* (Linnaeus, 1758) - 2 specimen: adults, Finland, 77, 78;

Order Anseriformes

Family Anatidae

Genus *Gygnus* Garsault, 1764: *Cygnus olor* (Gmelin, 1789) - 2 specimens: adult ♀♀, 55,56; Genus *Anser* Brisson, 1758: *Anser anser* (Linnaeus, 1758) -1 specimen: adult ♀, 109;Genus *Tadorna* Boie, 1822: *Tadorna tadorna* (Linnaeus, 1758) - 1 specimen: juvenile ♀, 93; Genus *Anas* Linnaeus, 1758: *Anas platyrhynchos* Linnaeus, 1758 -1 specimen: adult ♀, 98; *Anas acuta* Linnaeus, 1758 - 1 specimen: adult ♂, 103; Genus *Mareca* Stephens, 1824: *Mareca strepera* (Linnaeus, 1758) - 1 specimen: adult ♂, 100; Genus *Spatula* Boie 1822: *Spatula querquedula* (Linnaeus, 1758) - 4 specimens: 1 adult ♂, inel: Moskwa E2/4980, 85; 1 ♂, 1 ♀, Braşov, 91, 92; 1 juvenile ♂, leg. Hausmann, 94;

Order Podicipediformes

Family Podicipedidae
Genus *Podiceps* Latham, 1787: *Podiceps cristatus* (Linnaeus, 1758) - 1 specimen:adult ♂, 95;

Order Suliformes

Family Phalacrocoracidae

Genus *Phalacrocorax* Brisson, 1760: *Phalacrocorax carbo* (Linnaeus, 1758) - 1 specimen: subadult (1st winter), 111; Genus *Microcarbo* Bonaparte, 1856: *Microcarbo pygmeus* (Pallas, 1773) - 1 specimen:adult ♀, Tarlau (Prejmer), 1875, leg. Hausmann, 105;

Order Pelecaniformes

Family Pelecanidae

Genus *Pelecanus* Rafinesque, 1815: *Pelecanus onocrotalus* Linnaeus, 1758 - 1 specimen: subadult, 57;

Family Ardeidae

Genus *Egretta* Forster, 1817: *Egretta garzetta* (Linnaeus, 1766) - 1 specimen: adult, 115;Genus *Ardea* Linnaeus, 1758: *Ardea purpurea* Linnaeus, 1766 - 1 specimen: juvenile, 110;

Family Threskiornithidae

Genus *Plegadis* Kaup, 1829: *Plegadis falcinellus* (Linnaeus, 1766) - 1 specimen: adult, 108;

Order Accipitriformes

Familiy Accipitridae

Genus *Aegypius* Savigny, 1809: *Aegypius monachus* (Linnaeus 1766) - 1 specimen: juvenile, 40;Genul *Haliaeetus* Savigny, 1809: *Haliaeetus albicilla* (Linnaeus, 1758) - 1 specimen: juvenile, 30;Genul *Circaetus* Vieillot, 1816: *Circaetus gallicus* (Gmelin, 1788) - 3 specimens: juveniles, 28, 41,43; Genus *Buteo* Lacepede, 1799: *Buteo buteo* (Linnaeus, 1758) - 8 specimens: 2 adult ♀♀, 31, 61; adult ♂, 59; 2 nestlings, Săcele, 1929, leg. Hausmann, 34, 35; 2 nestlings, 36, 37; *Buteo lagopus* (Pontoppidan, 1763) - 3 specimens: 2 juveniles, 26, 48; adult, 38; Genus *Pernis* Cuvier, 1816: *Pernis apivorus* (Linnaeus, 1758) - 1 specimen: adult ♂, 33; Genus *Accipiter* Brisson,

1760: *Accipiter gentilis* (Linnaeus, 1758) - 4 specimens: 2 adult ♀♀, 29, 51; adult ♀, 1963, 49; juvenile ♂, 60; *Accipiter nisus* (Linnaeus, 1758) -3 specimens: adult ♀, 54; 2 adult ♂♂, 113, 114; *Accipiter brevipes* (Severtzov, 1850) - 1 specimen: juvenile, 46; Genus *Circus* Lacepede, 1799: *Circus aeruginosus* (Linnaeus, 1758) - 2 specimens: subadult (2nd summer) ♂, 52; adult ♀, 66; *Circus cyaneus* (Linnaeus, 1766) - 2 specimens: adult ♀, 58; adult ♂, 63; *Circus macrourus* (Gmelin, 1770) - 1 specimen: subadult ♂, 65;Genus *Milvus* Lacepede,1799: *Milvus milvus* (Linnaeus, 1758) - 1 specimen: adult ♀, 42;

Family Pandionidae

Genus *Pandion* Savigny, 1809: *Pandion haliaetus* (Linnaeus, 1758) - 1 specimen: adult, 32;

Order Gruiformes

Family Rallidae

Genus *Rallus* Linnaeus, 1758: *Rallus aquaticus* Linnaeus, 1758 - 1 specimen: adult, 128;Genus *Crex* Bechstein, 1803: *Crex crex* (Linnaeus, 1758) - 8 specimens: 2 adults, 134,135; 6 chicks, 136,137,138, 139, 140,141; Genus *Fulica* Linnaeus, 1758: *Fulica atra* Linnaeus, 1758 - 2 specimens: adult ♀, 99; adult, 130;

Order Charadriiformes

Family Recurvirostridae

Genus *Himantopus* Brisson, 1760: *Himantopus himantopus* (Linnaeus, 1758) - 1 specimen: adult ♂, 97 (Muz. Antipa, 6066);

Family Charadriidae

Genus *Vanellus* Brisson, 1760: *Vanellus vanellus* (Linnaeus, 1758) - 2 specimens: adult ♂, 106; subadult ♀, 107;

Family Scolopacidae

Genus *Scolopax* Linnaeus, 1758: *Scolopax rusticola* Linnaeus, 1758 - 1 specimen: adult, 112; Genus *Gallinago* Brisson, 1760: *Gallinago gallinago* (Linnaeus, 1758) - 1 specimen: adult, 133; *Gallinago media* (Latham, 1787) - 2 specimens: 2 adults, 131, 132; Genus *Calidris* Merrem, 1804: *Calidris pugnax* (Linnaeus, 1758) - 1 specimen: adult, 129; Genus *Numenius* Brisson, 1760: *Numenius arquata* (Linnaeus, 1758) - 1 specimen: adult ♂, 102;

Order Columbiformes

Family Columbidae

Genus *Columba* Linnaeus, 1758: *Columba oenas* Linnaeus, 1758 - 2 specimens: adult ♀, 96; juvenile, 119; Genus *Streptopelia* Bonaparte, 1855: *Streptopelia decaocto* (Frivaldszky, 1838) - 1 specimen: adult ♀, 120;

Order Strigiformes

Family Strigidae

Genus *Strix* Linnaeus, 1758: *Strix uralensis* Pallas, 1771 - 6 specimens: 3 adults, 2, 11, 18; 3 nestlings, 9, 12, 16; *Strix aluco* Linnaeus, 1758 - 1 specimen: adult ♀, 8; Genus *Asio* Brisson, 1760: *Asio otus* (Linnaeus, 1758) -1 specimen: juvenile ♂, 17; Genus *Aegolius* Kaup, 1829: *Aegolius funereus* (Linnaeus, 1758) - 2 specimens: 2 adults, 7, 10; Genus *Athene* Boie, 1822: *Athene noctua* (Scopoli, 1769) - 3 specimens: 2 adults, 5, 13; juvenile, 14; Genus *Bubo* Dumeril, 1805: *Bubo bubo* (Linnaeus, 1758) - 4 specimens: 2 adults, 1, 3; juvenile, 4; nestling, 6; *Bubo scandiacus* (Linnaeus, 1758) - 1 specimen: adult ♂, Finland, 27;

Family Tytonidae

Genus *Tyto* Billberg, 1828: *Tyto alba* (Scopoli, 1769) - 1 specimen: juvenile, 15;

Order Coraciiformes

Family Coraciidae

Genus *Coracias* Linnaeus, 1758: *Coracias garrulus* Linnaeus, 1758 - 1 specimen: adult, 87;

Order Falconiformes

Family Falconidae

Genus *Falco* Linnaeus, 1758: *Falco tinnunculus* Linnaeus, 1758 - 1 specimen: juvenile, 53; *Falco vespertinus* Linnaeus, 1766 - 1 specimen: juvenile, 62; *Falco columbarius* Linnaeus, 1758 - 3 specimens: adult ♀, 45; 2 adult ♂♂, 47, 64; *Falco peregrinus* Tunstall, 1771 - 1 specimen: juvenile ♀, 50;

Order Passeriformes

Family Turdidae

Genus *Turdus* Linnaeus, 1758: *Turdus torquatus* Linnaeus, 1758 - 1 specimen: adult ♂, 118; *Turdus viscivorus*Linnaeus, 1758 - 2 specimens: adults, 121, 122; *Turdus pilaris* Linnaeus, 1758 - 1 specimen: adult, 125;

Family Muscicapidae

Genus *Phoenicurus* Forster, 1817: *Phoenicurus phoenicurus* (Linnaeus, 1758) - 1 specimen: adult ♂, 117;

Family Sturnidae

Genus *Sturnus* Linnaeus, 1758: *Sturnus vulgaris* Linnaeus, 1758 - 2 specimens: adults, 123, 124;

Family Corvidae

Genus *Corvus* Linnaeus, 1758: *Corvus corax* Linnaeus, 1758 - 2 specimens: adults, 20, 22; *Corvus cornix* (Linnaeus, 1758) - 1 specimen: adult ♀, 23; *Corvus monedula* (Linnaeus, 1758) - 2 specimen: 2 adult ♀♀, 19, 25; Genus *Nucifraga* Brisson, 1760: *Nucifraga caryocatactes* (Linnaeus, 1758) - 2 specimens: adults, 126,127; Genus *Garrulus* Brisson, 1760: *Garrulus glandarius* (Linnaeus, 1758) - 1 specimen: adult, 104;Genus *Pica* Brisson, 1760: *Pica pica* (Linnaeus, 1758) - 2 specimens: adult ♀, 21; juvenile ♀, 24;

Family Paridae

Genus *Periparus* Longchamps, 1884: *Periparus ater* (Linnaeus, 1758) - 1 specimen: adult ♂, Bucegi, 2008, leg. Ile Cornel, 116;

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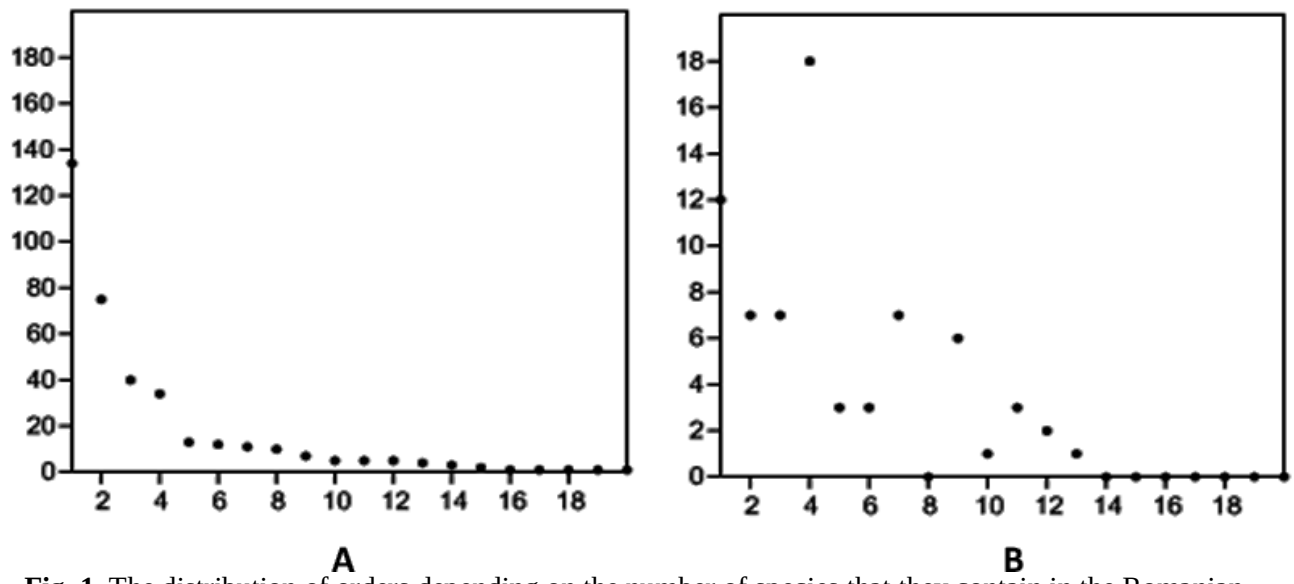

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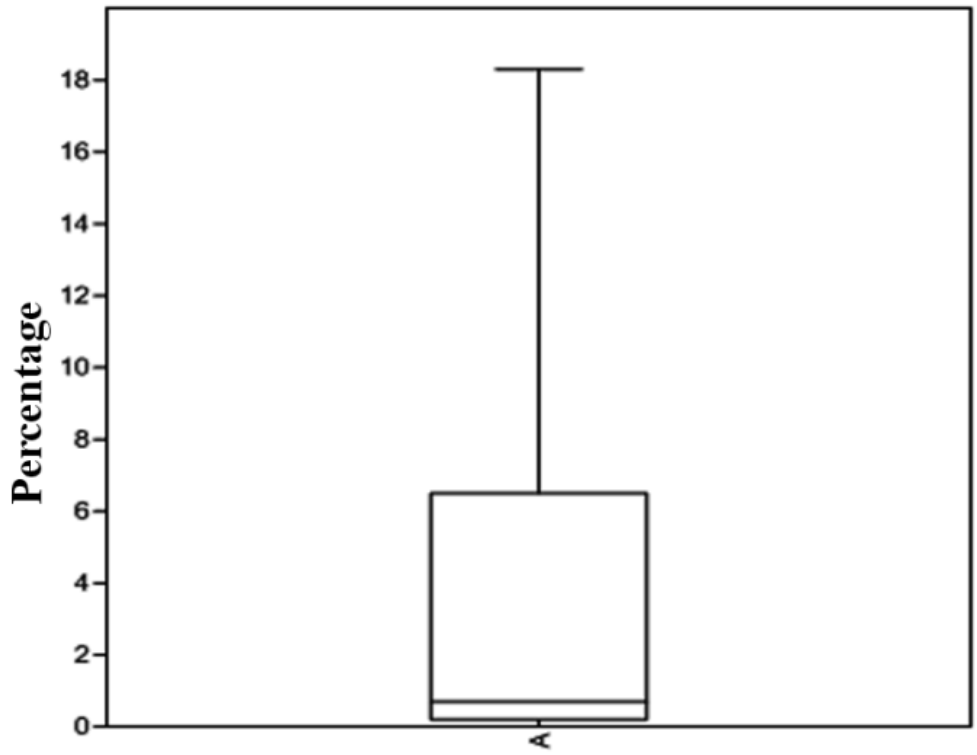

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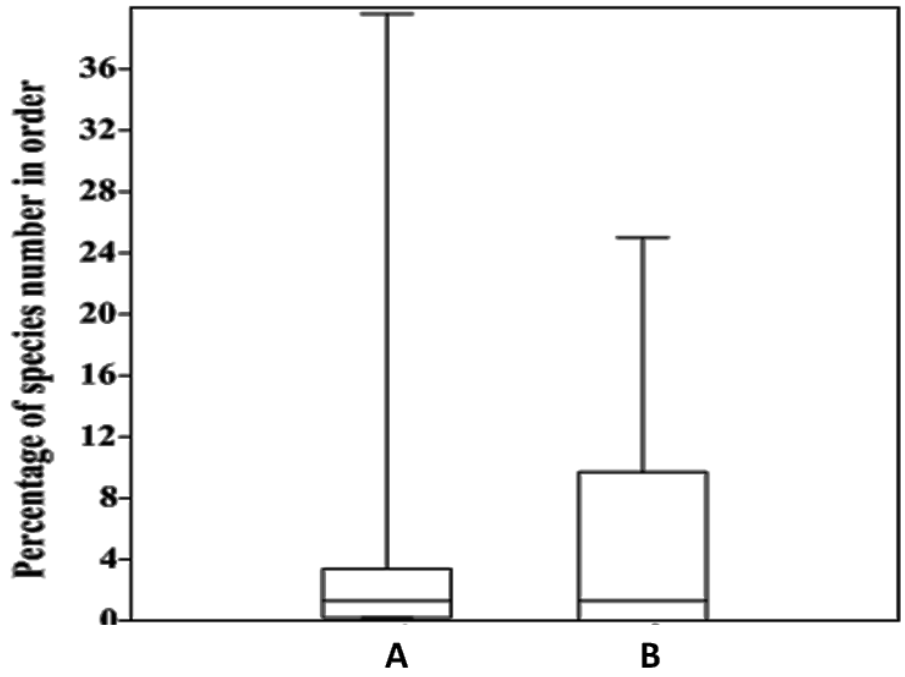

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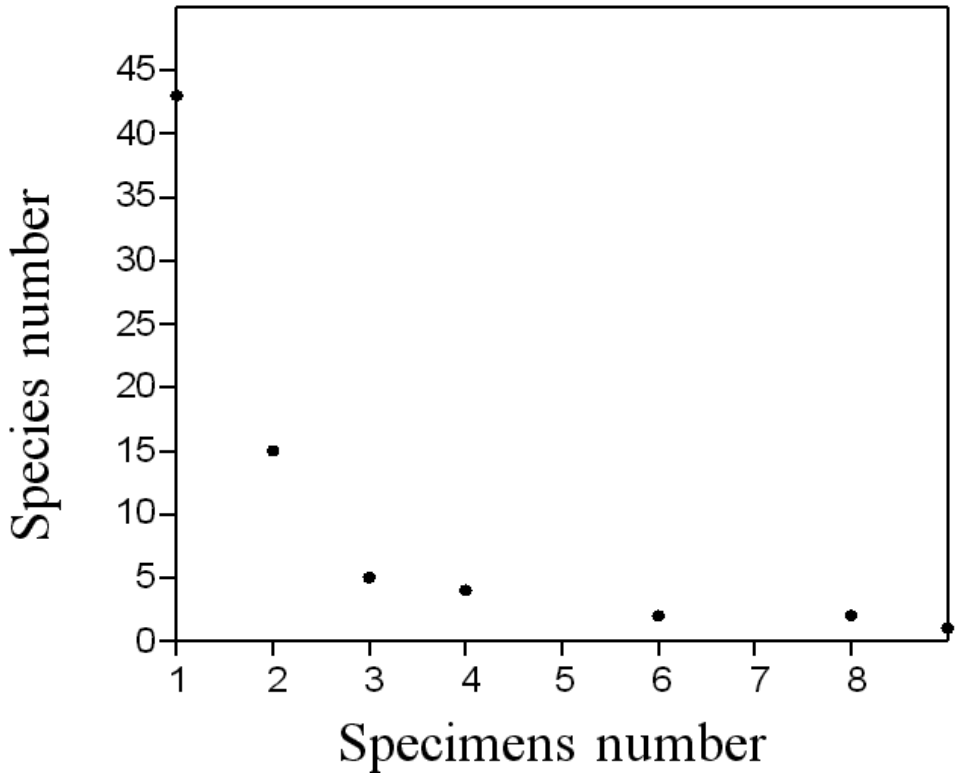

Fig.4. The species number in relation to the number of specimens belonging to one species found in the collection.

Tab.1. Specimens information available in the collection.

	I	II	III	IV	V	VI	VII	VIII	IX	X
Number of specimens	10	131	6	135	1	140	6	135	**6**	**135**
% of all speccimens in collection	7%	93%	4%	96%	1%	99%	4%	96%	**4%**	**96%**

I – locality; II – no data about locality; III – collecting date; IV – no data about collecting date; V – inventory number; VI – no data obout inventory number; VII – collector name; VIII – no data about the collector name; IX – average with data; X – average with no data.

Tab.2. Number and percentage of taxa found in collection and/from the correspondent in Romanian fauna

	Order	Family	Species
Number of taxa in Collection	12	23	72
Number of taxa in Romanian fauna	20	62	383
% taxa found in collection from all in Romanian fauna	60%	37%	19%

Tab.3. The number of species and specimens belonging to order level in the collection and correspondent in Romanian fauna.

Order	I	II	III (%)	IV (%)	V (%)	VI	VII
Gaviiformes	0	3	0,7	0	0	0	0
Podicipediformes	1	5	1,3	20	1,3	1	1
Procellariiformes	0	1	0,2	0	0	0	0
Pelecaniformes	3	5	1,3	60	4,1	3	1
Ciconiiformes	3	13	3,4	23	4,1	3	1
Phoenicopteriformes	0	1	0,2	0	0	0	0
Anseriformes	7	40	10,4	17,5	9,7	11	1,6
Falconiformes	18	34	8,8	52,9	25	38	2,1
Galliformes	6	7	1,8	85,7	8,3	22	3,6
Gruiformes	3	12	3,1	25	4,1	11	3,6
Charadriiformes	7	75	19,5	9,3	9,7	9	1,3
Order	I	II	III (%)	IV (%)	V (%)	VI	VII
Pteroclidiformes	0	1	0,2	0	0	0	0

Columbiformes	2	5	1,3	40	2,7	3	1,5
Cuculiformes	0	1	0,2	0	0	0	0
Strigiformes	7	11	2,8	63,6	9,7	19	2,4
Caprimulgiformes	0	1	0,2	0	0	0	0
Apodiformes	0	2	0,5	0	0	0	0
Coraciiformes	1	4	1	25	1,3	1	1
Piciformes	0	10	2,6	0	0	0	0
Passeriformes	12	134	34,9	8,9	16,6	18	1,5

I – Number of species found in the collection; II – number of species found in Romanian fauna; III – percentage of species found in one order of Romanian fauna from all species found in Romanian fauna; IV – percentage of species found in the collection and belonging to an order from all species found in the same order of Romanian fauna; V – percentage of species found in the collection and belonging to an order from all species found in the collection; VI – number of specimens in each order; VII – mean number of specimens/species in each order.

Tab.4. Spearman's Rank Correlation Coefficient (r) between orders representation in Romanian fauna (A) and in the collection (B)

r	A	B
A		2.7324E-07
B	0.88196	

Tab.5. Spearman's Rank Correlation Coefficient (r) between orders representation in the Romanian fauna (A) and their covering in percentage of species by the collection (B)

r	A	B
A		0.014077
B	0.53955	

Tab.6. Spearman's Rank Correlation Coefficient (r) between orders representation in the collection (A) and number of specimens belonging to the same group (B)

r	A	B
A		1.5499E-07
B	0.88952	

THE VEGETATION OF THE BREITE WOOD-PASTURE (SIGHIŞOARA, ROMANIA) – THE PLANT ASSOCIATIONS AND ECOLOGICAL CHARACTERISTICS IN RELATION WITH MANAGEMENT

Kinga ÖLLERER*

Abstract. *In completion of the previous research on the flora and vegetation, this study aims to present in detail the 17 plant associations identified in the Breite wood-pasture. The ecological characteristics of the ground vegetation are discussed in relation with the humidity regime, abandonment of traditional grazing and mowing, and the ongoing secondary woodland regeneration.*
Key words: *phytosociology, characteristic habitat, grassland ecology indicators, conservation management*

Rezumat. *Ca o completare a cercetărilor anterioare cu privire la flora şi vegetaţia păşunii cu arbori de pe platoul Breite, prezentul studiu urmăreşte prezentarea detaliată a celor 17 asociaţii de plante. Caracteristicile ecologice ale covorului vegetal sunt discutate în relaţie cu regimul hidric, fenomenul abandonării cositului şi păşunatului tradiţional şi succesiunea secundară a vegetaţiei.*
Cuvinte cheie: *fitosociologie, habitat caracteristic, indicatori ecologici ai pajiştilor, managementul biodiversităţii*

Introduction

Wood-pastures, characteristically defined as consisting of an open scatter of trees in a grassland matrix, predominantly pasture, are among the oldest examples of fine-tuned human activities adapted to the landscape (Plieninger *et al*. 2015). Since the Mesolithic, man used forest clearance and wetland drainage to obtain productive grasslands, which were further shaped by grazing, mowing and even burning. The resulting semi-natural systems are nowadays threatened by disrupted continuity of their traditional management regime, i.e abandonment, intensification or change of use (Plieninger *et al*. 2015). In the lack of characteristic management practices, or in the case of changes occurring in the intensity or frequency of these, most of such systems undergo vegetation change (ex. due to secondary succession), resulting at the end in the loss of their specific biodiversity and provided ecosystem services (Bugalho *et al*. 2011). From the perspective of their conservation, the issues that are characteristically addressed target mainly the (veteran, standing or fallen) charismatic trees and the associated flora and fauna. The ground vegetation is however also of considerable significance, increasing the biodiversity of the site, and securing the survival conditions for the trees (Crofts, Jefferson 1999; Plieninger *et al*. 2015).

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In the view of these, the present study aims to complete previous reported research regarding the flora (Öllerer 2012), and the vegetation history and current status of the Breite wood-pasture (Öllerer 2013), by presenting the vegetation relevés. Additionally, the ecological implications of the changes that occurred in the humidity regime and the abandonment of traditional grazing and mowing and the ongoing secondary woodland regeneration are also discussed.

Study area and methods

Description of the study area

The Breite wood-pasture is situated on a 500 m elevation plateau of the Transylvanian Tableland, nearby Sighişoara, Central Romania (centre point coordinates: lat. 46.2011, lon. 24.7606). The 133 ha open area, with scattered or locally grouped mature oaks (*Quercus robur* and *Q. petraea*) is surrounded by a mixed deciduous *Quercus petraea* and *Carpinus betulus* with *Fagus sylvatica* forest. The Breite was a humid, even marshy area in the past, due to the impermeability of the soil and the location on a plateau. This character is kept nowadays only partially due to the significant water loss following the construction of a drainage system in the 1970s, which resulted in the formation of small sites with excessive humidity in the ditches,

at the same time contributing to the overall desiccation of the plateau. In the last decades, several authors have shown that the Breite is furthermore affected by abandonment, occasionally by overgrazing, ruderalisation and woody encroachment. Detailed description of the study area, including previous studies, history, soils and climate was provided in Öllerer (2012; 2013).

Phytosociological study and plant characteristics

Field research was conducted between 2005 and 2014. Relevé sampling was performed according to the methodology of the Central-European Phytosociological School adapted for Romania (Cristea *et al*. 2004). The number and size of relevés was adapted to the local conditions. Species nomenclature follows Flora Europaea (2001). For associations, the International Code of Phytosociological Nomenclature, 3rd ed. was used (Weber *et al*. 2000). Syntaxonomic identification was based on Sanda *et al*. (2008). Data regarding bioforms, geoelements, characteristic habitat and height were obtained from Ciocârlan (2009); ecological parameters (demand for soil humidity – U, air temperature – T and soil reaction – R) from Sanda *et al*. (2003); demand for light from Borhidi (Horváth *et al*. 1995). Ploidy level, and indicator values for grassland species on tolerance against grazing, trampling, mowing, and on foraging value were obtained from the BiolFlor database on biological and ecological traits (Klotz *et al*. 2002, http://www2.ufz.de/biolflor/index.jsp, while attributes for clonality were obtained from the CLO-PLA3 database of clonal growth in plants (Klimešová, de Bello 2009; Klimešová, Klimeš: http://clopla.butbn.cas.cz/).

Classification and ordination

The categorization of ecological data is an important step towards the recognition, differentiation and understanding of processes and phenomena. For the relevé data, the average-linkage and the Sørensen measure were used. The average-linkage or UPGMA (Unweighted Pair Group Method with Arithmetic Mean) is a hierarchical clustering method widely used in ecology for the classification of sampling units on the basis of pairwise similarities in descriptor variables (van Tongeren 1995). The Sørensen's index is considered among the most effective presence/absence similarity measures (Southwood, Henderson 2000). Analysis was performed with the PAST statistics software package, version 2.17c (Hammer *et al*., 2001).

Ordination is a useful tool that results in the arrangement of vegetation samples according to their similarity of species composition and/or associated environmental variables (Kent, Coker 1995). Detrended Correspondence Analysis – DCA searches for variables that best fit the species composition, and was used to identify and interpret the main environmental influences on the vegetation and characterise the study area. The findings are summarised as scatter diagrams in order to deduce the ecological gradients which explain the variation of floristic composition among relevés (Kent, Coker 1995). Ordination of the vegetation data was done using eight indicator values: U, T, R, light, nitrate, and tolerance against grazing, trampling and mowing. For the analysis, the R statistical package, version 3.1.0 (R Core Team 2014) was used, with the 'vegan' 2.0-10 package (Oksanen *et al*. 2013). Prior their introduction in the ordination, environmental variables were tested using modified permutation tests of significance for mean Ellenberg values with 999 permutations using the envfit.iv function.

Results

The plant associations

The 52 relevés were assigned to 17 associations, using Sanda *et al*. (2008). The syntaxonomic checklist was already presented in Öllerer (2013). The five major vegetation categories noted as I–V follow the systematic review of Borhidi (1996). These results contribute with six associations (marked with *) to the syntaxonomic checklist of plant association from the Sighişoara-Târnava Mare SCI Natura 2000 site (Oroian 2009).

I. Water vegetation
Lemnetum minoris Oberd. ex T. Müller et Görs 1960
II. Reed swamp and moor vegetation
Caricetum acutiformis Eggler 1933*
Caricetum vesicariae Chouard 1924*
III. Hayfield and meadow vegetation
Scirpetum sylvatici Ralski 1931
Agrostetum stoloniferae (Ujvárosi 1941) Burduja *et al*. 1956
Cirsio cani-Festucetum pratensis Májovsky ex Ružičková
Arrhenatheretum elatioris Br.-Bl. ex Scherrer 1926
Anthoxantho-Agrostietum capillaris Sillinger 1933
Ranunculetum repentis Knapp ex Oberd. 1957*
Juncetum effusi Soó (1931) 1949
Junco inflexi-Menthetum longifoliae Lohm. 1953
Agrostio-Deschampsietum caespitosae (Soó 1928) Ujvárosi 1947

IV. Anthropogenous vegetation
Bidenti-Polygonetum hydropiperis Lohm. in R. Tüxen 1950
Juncetum tenuis Schwik 1944*
Tanaceto-Artemisietum vulgaris Sissingh 1950*
Urtico-Aegopodietum R. Tüxen ex Görs 1963*
V. Broadleaved forest vegetation
Calamagrostio-Salicetum cinereae Soó et Zólyomi in Soó 1955.

Relevé data are presented in tables 2–17, except for *Agrostio-Deschampsietum caespitosae*. Being the most widespread and characteristic association of the Breite wood-pasture, it was already presented with relevé tables in Öllerer (2013).

Classification and ordination

The dendrogram shows a clear differentiation of *Lemnetum minoris* and the grouping of three ruderal associations (*Tanaceto-Artemisietum*, *Urtico-Aegopodietum* and *Juncetum tenuis*) into a separate cluster (Fig. 1). Because outliers usually present problems, the *Lemnetum minoris* relevés were not included in the ordination. There were also nine species excluded because they lacked data regarding tolerance against mowing/ trampling/ grazing: *Alisma plantago-aquatica*, *Amaranthus powellii*, *Betula pendula*, *Bidens tripartita*, *Coronilla varia*, *Dipsacus laciniatus*, *Echinochloa crus-gallii*, *Galinsoga parviflora* and *Marrubium vulgare*. Ordination of the vegetation data was therefore based on 184 out of the 195 species identified during relevé sampling and the eight indicator values. Ordination biplots where environmental data are also displayed show the trends and strength of environmental factor correlations with the species/relevé data. The DCA ordination biplot and the values of the first axis show that humidity (U: -0.97), temperature (T: 0.94) and mowing (0.75) had the strongest effect (Fig. 2). The DCA results reflected the Borhidi classification only in the less diverse categories, represented by a small number of associations: anthropogenous and swamp vegetation (Fig. 2).

Ecological characteristics

Considering that common species are those that determine the structure and functioning of communities (Gaston 2010), further analyses were based on the most frequently encountered species, noted in at least 20% of the vegetation records (Tab. 1) This analysis revealed that the ground vegetation is dominated by tall competitors, and the overall wood-pasture character of the vegetation, in terms of abundance of species related to forest edge, shrubs and clearings. Additionally, the marshy character of the Breite was also reflected, so as the negative anthropic influence and ruderalisation process (Tab. 1). The analysis of light demand (Borhidi in Horváth *et al.* 1995) of the 15 representative species showed that on the whole the ground vegetation of the Breite is composed of shadow tolerant open habitat species (mean: 7.07, SD: 0.88). For all the 15 species, clonal growth organs (CGO) were potentially present, being necessary for eight species. The species included in the analysis are moderately tolerant to grazing (8 sp.) and trampling (9 sp.), while 13 species are moderately to very tolerant to mowing. Forage value was intermediate (Fig. 3).

Discussions

Despite the richness of the flora, with 476 species (Öllerer 2012), species number per relevé and the number of red-listed species were quite low (Tab. 2–17). In some cases, this is the outcome of the particularities of the associations (e.g. *Lemnetum minoris* or *Ranunculetum repentis* are typically species-poor communities), while in other cases it can be explained by the dominance of a few species (e.g. *Deschampsia caespitosa*, *Juncus effusus*), and as the effect of desiccation, ruderalisation and woody encroachment. From a biodiversity conservation perspective, the most important association is *Arrhenatheretum elatioris*, which has the highest average number of species encountered in a relevé, but also the highest number of red listed species: four (Table 8). This result was to be expected considering that the association corresponds to the Natura 2000 habitat 6510 Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*). The presence of the four anthropogenous associations *(Bidenti-Polygonetum hydropiperis*, *Juncetum tenuis*, *Tanaceto-Artemisietum vulgaris* and *Urtico-Aegopodietum*) shows the negative influence of the ongoing ruderalisation, calling for conservation management interventions.

The ground vegetation is dominated by species preferring wet meadows and forest edges, reflecting the humidity conditions and the fact that the Breite is an open area surrounded by forest. In the areas with greater humidity (especially around temporary ponds and ditches, but zones D-E-F as a whole) *Deschampsia caespitosa* tussocks have a lower density, resulting in higher vegetation diversity, reflected both by the number of plant associations and by their greater floristic richness.

Most of the (meso)hygrophilous species are nowadays limited to these areas. Sedges (*Carex* sp.) are the characteristic and almost monodominant species (up to 60% and 100% of the relevé area) of the temporary ponds, while rushes (*Juncus* sp.) are present mainly in the ditches, contributing to the overall mosaic-like character of the vegetation. The number of plant associations is further increased by the presence of anthropic communities and the secondary association *Calamagrostio-Salicetum cinereae*, reflecting woody encroachment, an outcome of the abandonment of shrub clearing activities that define traditional wood-pasture use (Öllerer 2014).

Light conditions did not prove to have a strong effect, which can be explained by the fact that, despite the presence of the large trees, the vegetation as a whole is constituted of species with similar light requirements. The influence of soil reaction (R) also proved to be statistically insignificant, however, a slight correlation was found with associations usually favoured by the accumulation of dead vegetation matter (*Juncetum inflexi, Bidenti-Polygonetum hydropiperis*). Intensive grazing, trampling, and nitrate deposition are expected to favour the ruderal communities (*Juncetum tenuis* and *Tanaceto-Artemisietum*). The dominant association (*Agrostio-Deschampsietum caespitosae*) proved to be influenced mostly by temperature, therefore it is expected to increase its coverage in the next years as the drought conditions are projected to increase in the region.

The height and life history strategy of the 15 species meets also the assumption that due to the present insufficient grazing, preceded by a longer period of intensive grazing, and complete abandonment of mowing, the ground vegetation would be dominated by tall competitors (Matejkova *et al.* 2003). This is well illustrated by the expansion of the unpalatable *Deschampsia caespitosa,* reaching up to 180 cm in height on the Breite, which is further favoured by changes in the humidity regime caused by the drainage system.

Plant species' survival in managed grasslands is determined also by the capacity of clonal regeneration and growth, lateral clonal growth being the dominant form of reproduction in grasslands (Herben and Huber-Sannwald, 2002). Biomass removal by cutting and/or grazing might impoverish the genetic and species diversity of non-clonal plants, usually forbs, while enhancing the vegetative spread of clonal plants, usually grasses (Herben and Huber-Sannwald, 2002). For this reason, clonality was also analysed. As expected, CGOs were potentially present for all 15 species, mostly grasses, with differences only in their role. For eight species, clonality was compulsory (necessary), meaning that all adult plants in all populations possess a CGO, while for the rest, there was no distinction whether CGOs are necessary or have only an additive role – are not needed for flowering and overwintering and may be absent in some plants or populations (Tab. 1).

The studied species are overall moderately tolerant to grazing and trampling, while their mowing tolerance is higher. These results show the compatibility of the vascular plants from the Breite wood-pasture with the traditional extensive or moderately intensive use, highlighting the importance of mowing, a practice nowadays practically abandoned in the region, as the occasional events do not have an accountable influence on the ground vegetation (Öllerer 2014).

Conclusions

Contrary to previous reports (Akeroyd 2003), the ground vegetation of the Breite wood-pasture proved to be diverse, in terms of floristic richness (Öllerer 2012) and number of plant associations, out of which six are new records for the region. This finding and the occurrence of species like *Gentiana pneumonanthe*, *Succisa pratensis*, *Inula britannica*, *Molinia caerulea* etc., indicating good quality pastures, shows that the ground vegetation of the Breite is valuable, and its state could be further improved by continuing/resuming the traditional management regime applied in wood-pastures, including periodical shrub clearing and extensive grazing, preferably with cattle, in combination with mowing (Öllerer 2014). Considering the dependence of their biodiversity on extensive human activities, the management of wood-pastures should therefore target also the maintenance of their ecological, socio-cultural and socio-economic values, having as main objective the implementation of strategies that support them as multipurpose systems.

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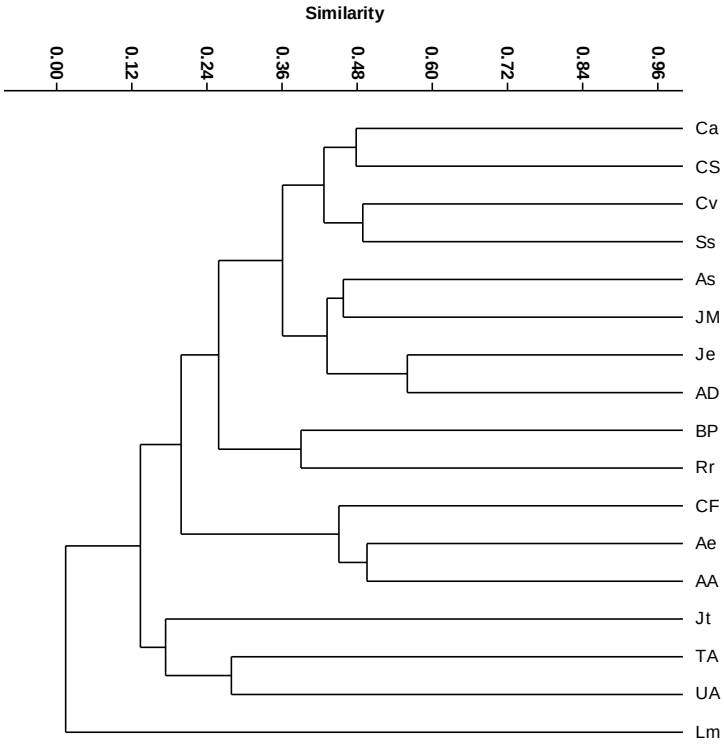

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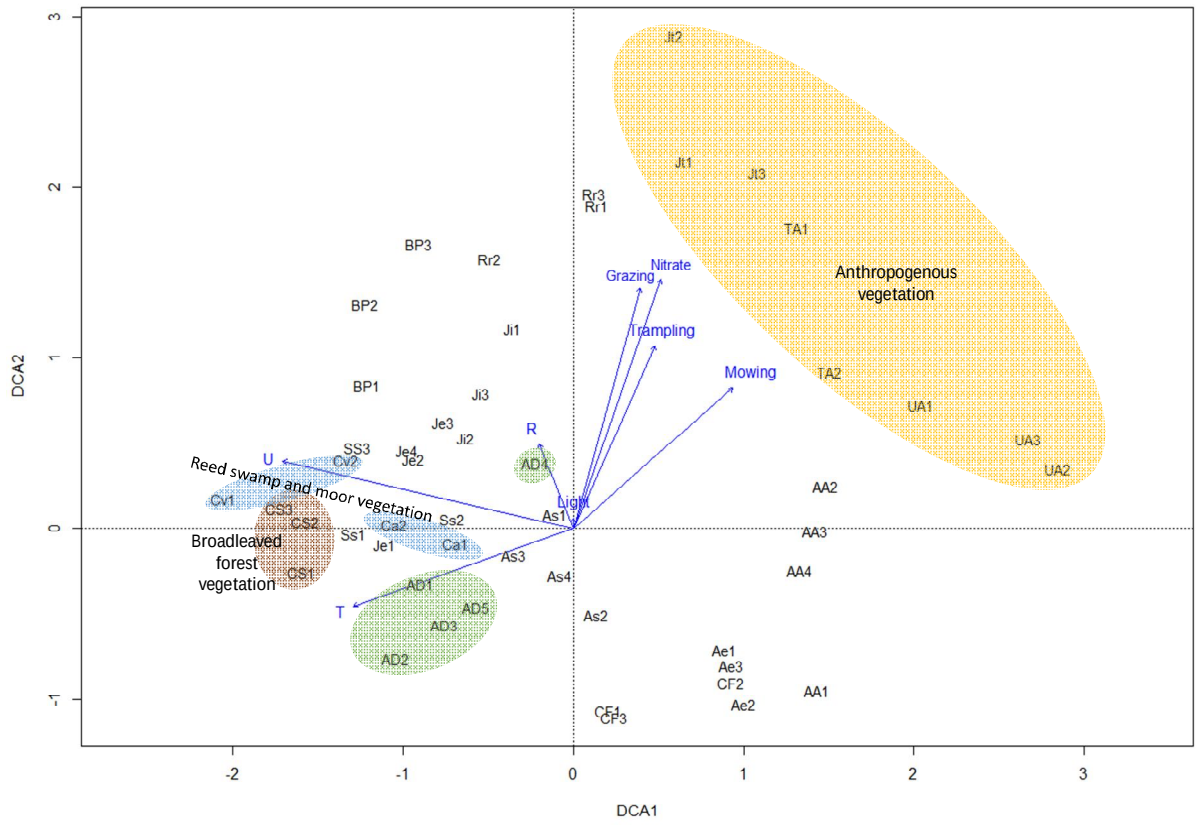

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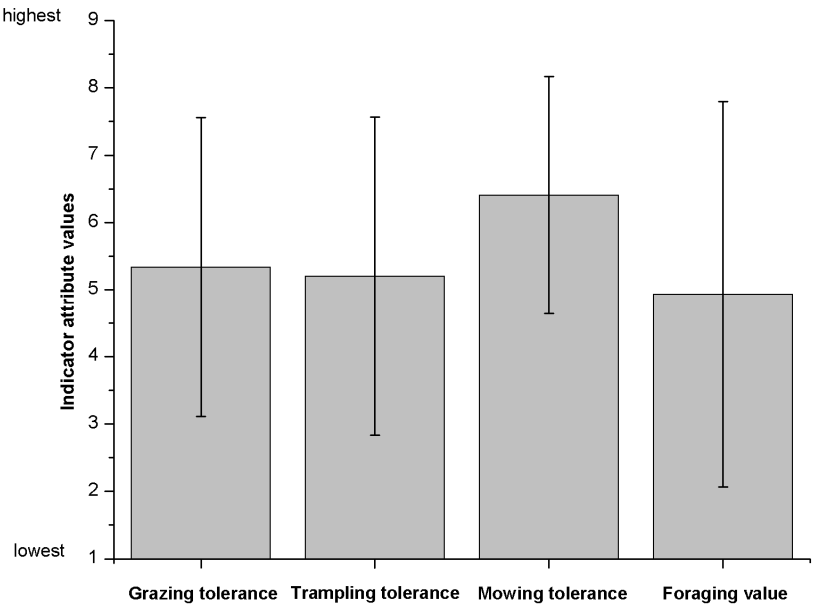

Fig. 3. Mean values of grassland ecological indicators for the 15 vascular plant species with the highest occurrence during vegetation sampling (min. 20% of records) in the Breite wood-pasture. Bars show Standard Deviation
Grazing/trampling/mowing tolerance: 1-intolerant, 5- moderately tolerant, 9-very tolerant (Klotz *et al*. 2002)
Foraging value: 1-poisonous, 5-intermediate forage value, 9-best forage value (Klotz *et al*. 2002)

Table 1. The 15 vascular plant species most frequently encountered during vegetation sampling in the Breite wood-pasture, their demand for light, height, characteristic habitat and clonal growth

Plant species	**frequency (% of relevés)**	**Life history strategy[1] (Klotz et al. 2002)**	**height (cm - Ciocârlan 2009)**	**Demand for light[2]**	**Clonal growth organ[3]**	**Characteristic habitat (Ciocârlan 2009)**
Agrostis stolonifera	65	CSR	30–60	8	n/a	wet meadows
Alopecurus pratensis	21	C	30–100	7	n/a	wet meadows
Dactylis glomerata	21	C	50–100	7	n/a	meadows, forest edges
Deschampsia caespitosa	56	C	20–100	7	n	meadows, forest edges and clearings
Festuca pratensis	25	C	30–100	8	n	meadows
Holcus lanatus	29	C	30–100	7	n/a	meadows, forest edges and clearings
Juncus effusus	52	C	40–80	8	n	wet meadows, ditches
Lysimachia nummularia	46	CSR	10–50	5	n	wet meadows, ditches
Lythrum salicaria	35	CS	30–150	7	n/a	marshy meadows, waterside
Poa pratensis	21	C	20–50	6	n/a	meadows, forest edges, ruderal areas
Ranunculus acris	29	C	30–60	7	n	meadows
Ranunculus repens	46	CSR	20–40	6	n/a	humid areas
Rumex acetosa	23	C	30–100	8	n	meadows, on moist soil
Scirpus sylvaticus	27	CS	30–120	7	n	marshy and shaded areas
Trifolium repens	35	CSR	5–15(40)	8	n	meadows, well drained ruderal areas

[1] C-competitor, S-stress tolerator, R-ruderal
[2] scale 1–9: 1-full shadow species, 5-half-shadow species, 9-light demanding species (Borhidi in Horváth et al. 1995)
[3] n-necessary, a-additive (Klimešová and Klimeš http://clopla.butbn.cas.cz/)

Table 2. ***Lemnetum minoris*** Oberdorfer ex T. Müller et Görs 1960

						Relevé number	Lm1	Lm2
						Vegetation cover (%)	70	60
						Sampling area (m^2)	4	4
Bioform	Geoel	U	T	R	D/P	Species	2	4
Hh	Cosm	6	3	0	P	*Lemna minor*	4-5	4
Hh	Cp	6	0	0	D	*Alisma plantago-aquatica*	+	+
H	Cp	5	0	2	P	*Epilobium palustre*	.	+
H(Hh)	Eua	5	3	0	P	*Glyceria fluitans*	.	+

Place and date of relevés: zone F, May 2009

Table 3. ***Caricetum acutiformis*** Eggler 1933

						Relevé number	Ca1	Ca2
						Vegetation cover (%)	100	90
						Sampling area (m^2)	20	25
Bioform	Geoel	U	T	R	D/P	Species	14	18
G(Hh)	Eua	6	3	4	P	*Carex acutiformis*	4-5	5
H	Eua	4.5	0	2.5	D	*Achillea ptarmica**	.	+
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	.
Ht-H	Eua	4	3	3	D	*Angelica sylvestris*	+	+
H	Eua	3	3	4	P	*Arrhenatherum elatius*	.	+
H	Cp	4	2.5	3	P	*Carex ovalis*	1	.
H	Eua	4	3	4	P	*Carex vulpina*	.	+
Ht	Eua	4.5	3	2.5	D	*Cirsium palustre*	.	+
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	+	+
H	Eua	3.5	2	0	D	*Festuca pratensis* ssp. *pratensis*	+	.
H	Eua	4	2	0	D	*Filipendula ulmaria* ssp. *ulmaria*	+	.
H	Cp	5	3	0	D-P	*Galium palustre*	.	+
H	Cosm	3.5	3	0	D	*Holcus lanatus*	.	+
H	Cp	5	2	0	P	*Juncus articulatus*	+	.
H	Cp	4.5	3	3	P	*Juncus conglomeratus*	.	+
H	Cosm	4.5	3	3	P	*Juncus effusus*	1	+
H	Eua	5	2	0	P	*Lysimachia vulgaris*	.	+
H	Cp	4	2.5	0	P	*Lythrum salicaria*	+	.
H	Eua	5	3	0	P	*Myosotis scorpioides*	.	+
T	Cosm	2.5	0	3	P	*Polygonum aviculare*	+	.
H	Ec	3.5	0	0	D	*Ranunculus acris*	+	1
H	Eua	4	3	0	P	*Rumex crispus*	.	+
G	Cp	4.5	3	0	P	*Scirpus sylvaticus*	+	1
H	Eua	4	2.5	0	D	*Succisa pratensis*	+	.
H	Cosm	3	3	4	P	*Urtica dioica*		+
H(Hh)	Eua	5	3	4	D	*Veronica beccabunga*	.	+

Place and date of relevés: zone D, June 2009

* *Achillea ptarmica* L. (Vulnerable – Oltean et al., 1994; Rare – Negrean, 2001)

Table 4. ***Caricetum vesicariae*** Chouard 1924

						Relevé number	Cv1	Cv2
						Vegetation cover (%)	100	100
						Sampling area (m^2)	25	25
Bioform	Geoel	U	T	R	D/P	Species	14	16
H(Hh)	Cp	5	3	4	P	*Carex vesicaria*	5	5
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	.
H	Eua	4	3	0	P	*Alopecurus pratensis*	.	+
G(Hh)	Eua	6	3	4	P	*Carex acutiformis*	+	+
G	Eua	5	3	3	P	*Carex cespitosa*	+	.
H(Hh)	Eur	6	3	0	P	*Carex elata*	+	+
H	Eua	4	3	4	P	*Carex vulpina*	.	+
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	.	+
H	Cp	5	0	2	P	*Epilobium palustre*	+	.
H	Eua	3.5	2	0	D	*Festuca pratensis* ssp. *pratensis*	.	+
H	Cp	5	3	0	D-P	*Galium palustre*	.	+
H	Cosm	4.5	3	3	P	*Juncus effusus*	+	1
H	Eua	3.5	2.5	0	D	*Lychnis flos-cuculi*	+	.
H	Eua	5	2	0	P	*Lysimachia vulgaris*	+	+
H	Cp	4	2.5	0	P	*Lythrum salicaria*	+	+
H	Cp	5	4	2	P	*Poa palustris*	.	+
T	Cp	5	3	4	D	*Polygonum hydropiper*	+	.
H	C. Eur	3.5	0	0	D	*Ranunculus acris*	+	.
H	Eua	4	0	0	P	*Ranunculus repens*	.	+
G	Cp	4.5	3	0	P	*Scirpus sylvaticus*	+	1
H	Cp	4	3	4	P	*Scutellaria galericulata*	+	.
H	Eua	3.5	0	0	D	*Trifolium repens*	.	+
H	Eua	2	2	2	D	*Valeriana officinalis*	.	+

Place and date of relevés: rel.1 recorded in August 2006 together with A.M. Csergő, rel. 2 recorded by K.Ö. in July 2008, both in zone D

Table 5. ***Scirpetum sylvatici*** Ralski 1931

						Relevé number	Ss1	Ss2	Ss3
						Vegetation cover (%)	70	60	65
						Sampling area (m^2)	12	10	10
Bioform	Geoel	U	T	R	D/P	Species	14	11	16
G	Cp	4.5	3	0	P	*Scirpus sylvaticus*	4	3-4	3-4
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	.	1
H	Eua	4	3	0	P	*Alopecurus pratensis*	.	.	+
H	Eua	4	3	4	D	*Cirsium oleraceum*	+	.	.
H	C. Eur	2.5	3	3	P	*Dactylis glomerata*	.	+	.
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	+	1	.
H	Cp	5	0	2	P	*Epilobium palustre*	+	.	.
H	Eua	3.5	2	0	D	*Festuca pratensis* ssp. *pratensis*	.	+	.
H	Cp	3	0	0	P	*Festuca rubra*	.	+	.
H	Eua	4	2	0	D	*Filipendula ulmaria* ssp. *ulmaria*	+	.	.
H	Cosm	3.5	3	0	D	*Holcus lanatus*	+	.	.
H	Cp	5	2	0	P	*Juncus articulatus*	.	+	.
H	Cosm	4.5	3	3	P	*Juncus effusus*	1	2	+
H	Eua	3	0	0	D	*Leucanthemum vulgare*	+	.	.
H	Eua	3.5	2.5	0	D	*Lychnis flos-cuculi*	.	+	.

Ch	Eua	4	3	3	P	*Lysimachia nummularia*	+	1	+
H	Cp	4	2.5	0	P	*Lythrum salicaria*	+	.	.
H	Eua	5	3	0	P	*Myosotis scorpioides*	.	+	.
T	Cp	5	3	4	D	*Polygonum hydropiper*	.	+	.
H	Eua	4	0	0	P	*Ranunculus repens*	+		.
Ph	Eua	5	3	3	P	*Salix cinerea*	+	.	.
H(Hh)	Eua	5	3	4	D	*Veronica beccabunga*	+	.	+

Place and date of relevés: rel. 1 in zone F and rel. 2 in zone E in July 2007, and rel. 3 in zone E in July 2008

Table 6. ***Agrostetum stoloniferae*** (Ujvárosi 1941) Burduja et al. 1956

						Relevé number	As1	As2	As3	As4
						Vegetation cover (%)	80	90	90	90
						Sampling area (m^2)	25	25	20	25
Bioform	Geoel	U	T	R	D/P	Species	24	31	18	27
H	Cp	4	0	0	P	*Agrostis stolonifera*	4	4-5	4	4-5
H	Eua	3	0	0	P	*Achillea millefolium*	+	.	.	1
H	Eua	4.5	0	4	P	*Agrostis gigantea* ssp. *gigantea*	.	.	.	+
H	Eur	3.5	2.5	0	P	*Ajuga reptans*	.	+	.	.
H	Eua	4	3	0	P	*Alopecurus pratensis*	.	+	.	+
Ht-H	Eua	4	3	3	D	*Angelica sylvestris*	1	.	+	.
H	Eua	0	0	0	P	*Anthoxanthum odoratum*	+	.	.	+
H	Eua	0	3	0	D	*Briza media*	.	+	.	.
T-Ht	Eua	0	3	0	P	*Bromus commutatus*	.	+	.	+
G	Cp	0	3	0	P	*Carex hirta*	+	.	.	+
G	Eua	3	3	0	P	*Carex tomentosa*	.	+	.	.
H	Eur	3	0	0	P	*Centaurea jacea*	.	.	+	+
H	Eua	3	0	3	D	*Cichorium intybus*	.	+	.	+
G	Eua	2.5	3	0	D	*Cirsium arvense*	+	.	1	.
G(H)	Cosm	2.5	3.5	3.5	P	*Convolvulus arvensis*	.	+	.	.
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	1	.	+	+
Ht	Eua	4	3.5	4	D	*Dipsacus laciniatus*	.	+	.	.
H	Eua	2	3	4	D-P	*Euphorbia cyparissias*	.	.	+	+
H	Eur	4	3	4	P	*Festuca arundinacea*	+	+	.	.
H	Eua	3.5	2	0	D	*Festuca pratensis* ssp. *pratensis*	.	+	.	.
H	Cp	3	0	0	P	*Festuca rubra*	+	.	.	.
H	Eua	4	2	0	D	*Filipendula ulmaria*	.	+	+	+
T	Eua	3	2	0	P	*Galeopsis speciosa*	.	+	.	.
H	Cp	5	3	0	D-P	*Galium palustre*	.	.	1	+
Ch	Eur	2.5	3	2	P	*Genista tinctoria*	.	+	.	+
H	Eua	3.5	3	5	P	*Geranium pratense*	.	+	.	+
H	Cosm	3.5	3	0	D	*Holcus lanatus*	1	1	+	.
Ht	Eua	3	3	0	P	*Inula britannica*	+	.	.	.
H	Cp	4.5	3	3	P	*Juncus conglomeratus*	.	1	+	+
H	Cosm	4.5	3	3	P	*Juncus effusus*	.	+	+	+
H	Eua	3	0	0	D	*Leucanthemum vulgare*	.	.	.	+
H	Cosm	3	3	0	D	*Lolium perenne*	+	.	.	.
H	Eua	2.5	0	0	P	*Lotus corniculatus*	.	+	.	.
H	Eua	3.5	2.5	0	D	*Lychnis flos-cuculi*	+	.	.	.
H(Hh)	Eua	5	3	0	D	*Lycopus europaeus*	.	+	+	.
Ch	Eua	4	3	3	P	*Lysimachia nummularia*	1	+	1	.

H	Cp	4	2.5	0	P	*Lythrum salicaria*	+	.	.	+
H	Eua	4.5	3	4	P	*Mentha longifolia*	+	.	.	.
H	Eua	5	3	0	P	*Myosotis scorpioides*	.	.	.	+
H	Eua	2.5	0	4.5	P	*Plantago media*	.	+	.	.
H	Cp	3	0	0	P	*Poa pratensis*	.	+	1	+
T	Cosm	2.5	0	3	P	*Polygonum aviculare*	.	+	+	+
T	Cosm	4.5	3	0	P	*Polygonum persicaria*	1	.	.	.
H	Eua	3.5	4	4	P	*Potentilla reptans*	.	+	.	+
Ph	Eur	3.5	3	0	D	*Quercus robur*	.	+	+	.
H	Cosm	3	3	0	P	*Prunella vulgaris*	+	.	.	.
H	C. Eur	3.5	0	0	D	*Ranunculus acris*	.	+	.	1
H	Eua	4	0	0	P	*Ranunculus repens*	+	.	.	.
T	PoPaB	3	4	0	?	*Rhinanthus rumelicus*	.	+	.	.
H	Eua	4	3	4	P	*Rorippa sylvestris*	+	.	.	.
H	Cosm	3	0	0	D	*Rumex acetosa*	.	+	1	+
H	Eur	2	3	2	P	*Rumex acetosella*	+	.	.	+
Ph	Eua	3	3	4	D	*Salix caprea*	+	.	.	.
H	Adv	3.5	3	3	D	*Solidago canadensis*	.	2	.	.
H	Eua	2.5	2	3	D	*Stellaria graminea*	+	.	+	.
H	Eua	3	0	0	D	*Trifolium pratense*	.	+	.	.
H	Eua	3.5	0	0	P	*Trifolium repens*	+	.	.	+

Place and date of relevés: rel. 1 and rel. 4 in zone E, rel. 2 and rel. 3 in zone D in July 2009

Table 7. ***Cirsio cani-Festucetum pratensis*** Májovsky ex Ružičková

						Relevé number	CF1	CF2	CF3
						Vegetation cover (%)	80	90	90
						Sampling area (m^2)	25	20	25
Bioform	Geoel	U	T	R	D/P	Species	35	29	19
H	Eua	3.5	2	0	D	*Festuca pratensis* ssp. *pratensis*	3	4	3
H	Cp	4	0	0	P	*Agrostis stolonifera*	1	1	+
H	Eua	4	3	0	P	*Alopecurus pratensis*	+	+	.
G	Eua	4.5	3	4.5	D	*Cirsium canum*	+	.	.
H	Eua	3	0	0	P	*Achillea millefolium*	+	+	.
H	Eua	4.5	0	2.5	D	*Achillea ptarmica**	+	.	.
H	Eua	2.5	3	4	P	*Agrimonia eupatoria*	.	1	+
H	Eua	0	0	0	P	*Anthoxanthum odoratum*	.	+	.
H	Eua	0	3	0	D	*Briza media*	.	+	.
Ht	Eur	3	2.5	3	D	*Campanula patula* ssp. *patula*	+	1	+
H	Eua	5	3	0	P	*Cardamine pratensis* ssp. *pratensis*	+	.	.
G	Cp	0	3	0	P	*Carex hirta*	+	+	.
H	Cp	4	2.5	3	P	*Carex ovalis*	.	+	+
H	Eur	3	2.5	3	P	*Centaurea phrygia*	+	.	.
Ht	Eur	3	3	4	P	*Crepis biennis*	.	+	.
H	Eur	3	3	3	D	*Cynosurus cristatus*	+	+	.
H	C. Eur	2.5	3	3	P	*Dactylis glomerata*	.	+	.
G	Eua	4	3	0	P	*Dactylorhiza incarnata**	r	.	.
H	Eur	2	5	5	D	*Dianthus carthusianorum*	+	.	+
H	Eua	2.5	3	4.5	D	*Filipendula vulgaris*	.	+	.
H	Eua	3	2.5	0	D	*Fragaria vesca*	+	.	.
H	Eua	2.5	2.5	0	P	*Galium verum*	1	.	+
T	Eur	2.5	3	0	P	*Geranium pusillum*	.	+	.
H	Eur	3	3	3	P	*Hieracium murorum*	+	.	.

H	Cosm	3.5	3	0	D	*Holcus lanatus*	+	+	2
H	Eua	3	3	0	P	*Hypericum perforatum*	+	1	.
H	Cosm	4.5	3	3	P	*Juncus effusus*	1	.	+
G	Adv	3.5	3	4	P	*Juncus tenuis*	+	.	.
H	Eur	2.5	3	0	D-P	*Knautia arvensis*	+	+	.
H	Eua	3	0	4	D	*Lathyrus pratensis*	.	+	.
H	Eua	3	0	0	D	*Leucanthemum vulgare*	+	.	+
H	Eua	2.5	0	0	P	*Lotus corniculatus*	+	1	.
H	Cp	3	0	3	D	*Luzula campestris*	.	+	.
H	Eua	3.5	2.5	0	D	*Lychnis flos-cuculi*	+	.	+
Ch	Eua	4	3	3	P	*Lysimachia nummularia*	1	+	+
T-H	Eua	2.5	3	4	D	*Medicago lupulina*	.	+	.
H	Eua	0	0	1.5	D	*Nardus stricta*	.	+	.
H	Eua	3	0	0	D	*Plantago lanceolata*	+	.	+
H	Eua	3.5	4	4	P	*Potentilla reptans*	+	+	.
H	Cosm	3	3	0	P	*Prunella vulgaris*	.	.	+
Ph	Eur	3.5	3	0	D	*Quercus robur*	.	.	+
H	C. Eur	3.5	0	0	D	*Ranunculus acris*	1	.	.
H	Eua	4	0	0	P	*Ranunculus repens*	+	.	+
H	Cosm	3	0	0	D	*Rumex acetosa*	.	+	+
H	Eur	2	3	2	P	*Rumex acetosella*	+	+	.
T-H	Eua	3.5	2	3	D	*Silene latifolia* ssp. *alba*	+	.	+
H	Eua	3	3	0	D	*Stachys officinalis*	1	.	.
H	Eua	2.5	2	3	D	*Stellaria graminea*	.	+	.
Ht-H	C. Eur	3	3	4	D	*Tragopogon pratensis* ssp. *orientalis*	+	.	.
H	Eua	3	0	0	D	*Trifolium pratense*	+	.	.
H	Eua	3.5	0	0	P	*Trifolium repens*	+	.	.
H-Ch	Eua	3	0	0	P	*Veronica chamaedrys*	.	+	+

Place and date of relevés: rel. 1 and rel. 2 in zone D, rel. 3 in zone C in July 2009
* *Achillea ptarmica* L. (Vulnerable – Oltean et al., 1994; Rare – Negrean, 2001)
* *Dactylorhiza incarnata* (L.) Soó (Rare – Oltean et al., 1994, Negrean, 2001)

Table 8. ***Arrhenatheretum elatioris*** Br.-Bl. ex Scherrer 1926

						Relevé number	Ae1	Ae2	Ae3
						Vegetation cover (%)	70	85	100
						Sampling area (m^2)	25	25	25
Bioform	Geoel	U	T	R	D/P	Species	35	28	33
H	Eua	3	3	4	P	*Arrhenatherum elatius* ssp. *elatius*	2	2	2-3
H	Eua	3	0	0	P	*Achillea millefolium*	+	.	+
H	Eua	4.5	0	2.5	D	*Achillea ptarmica**	.	.	+
H	Eua	3.5	3	3	P	*Aegopodium podagraria*	+	1	+
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	1	1
H	Eua	0	0	0	P	*Anthoxanthum odoratum*	.	.	+
Ht-H	Eua	3	3	4	D	*Anthriscus sylvestris*	+	.	.
H	Eua	0	3	0	D	*Briza media*	.	+	.
T-Ht	Eua	0	3	0	P	*Bromus hordeaceus*	+	.	.
H	Eua	5	3	3	P	*Calamagrostis canescens**	+	.	.
Ht	Eur	3	2.5	3	D	*Campanula patula* ssp. *patula*	.	+	+
H	Cp	5	3	5	P	*Carex paniculata*	.	+	1
Ht-H	Eua	3.5	3	3	D	*Carum carvi*	+	+	.
H	Eur	3	2.5	3	P	*Centaurea phrygia*	.	.	+
H	Eua	3	0	3	D	*Cichorium intybus*	.	+	.

H	C. Eur	2	3	4	P	*Coronilla varia*	.	1	.
Ht	Eur	3	3	4	P	*Crepis biennis*	.	.	+
H	Eur	3	3	3	D	*Cynosurus cristatus*	+	+	.
H	C. Eur	2.5	3	3	P	*Dactylis glomerata*	1	.	.
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	+	+	1
H	Eua	2	3	4	D-P	*Euphorbia cyparissias*	.	.	+
T	Eur	3	3	3	D	*Euphrasia rostkoviana*	+	.	.
H	Eua	3.5	2	0	D	*Festuca pratensis* ssp. *pratensis*	+	1	1
H	Cp	3	0	0	P	*Festuca rubra*	.	.	+
T	Cp	3	3	3	P	*Galium aparine*	+	.	.
H	Eua	4	3	0	D	*Gentiana pneumonanthe**	+	.	1
H	Eua	3.5	3	5	P	*Geranium pratense*	+	+	+
G	Eur	3.5	2	3	P	*Gymnadenia conopsea**	.	.	r
H	Cosm	3.5	3	0	D	*Holcus lanatus*	+	+	.
H	Eua	3	3	0	P	*Hypericum perforatum*	1	+	+
H	Eur	2.5	3	0	D-P	*Knautia arvensis*	1	+	.
H	Eua	3	0	4	D	*Lathyrus pratensis*	.	.	1
H	Eua	2	3	3	D	*Linaria vulgaris*	+	.	.
H	Cosm	3	3	0	D	*Lolium perenne*	+	.	+
H	Eua	2.5	0	0	P	*Lotus corniculatus*	.	.	+
Ch	Eua	4	3	3	P	*Lysimachia nummularia*	2	.	+
H	Cp	4	2.5	0	P	*Lythrum salicaria*	1	+	.
T-H	Eua	2.5	3	4	D	*Medicago lupulina*	+	+	.
H	Eua	3.5	3	0	P	*Molinia caerulea*	.	.	+
H	Eua	5	3	0	P	*Myosotis scorpioides*	+	.	.
Ht	Eua	3	4	4	D	*Pastinaca sativa*	+	+	.
H	Eua	3.5	0	4	D	*Pimpinella major*	+	.	.
H	Eua	2.5	0	4.5	P	*Plantago media*	.	+	+
H	Cp	3	0	0	P	*Poa pratensis*	+	.	+
H	Eua	3.5	4	4	P	*Potentilla reptans*	.	+	1
H	Cosm	3	3	0	P	*Prunella vulgaris*	.	.	+
Ph	Eur	3.5	3	0	D	*Quercus robur*	.	+	.
H	C. Eur	3.5	0	0	D	*Ranunculus acris*	1	+	+
H	Cosm	3	0	0	D	*Rumex acetosa*	+	+	.
H	Cp	3.5	3	0	P	*Sanguisorba officinalis*	1	+	.
H	Adv	3.5	3	3	D	*Solidago canadensis*	.	.	+
H	Circ	2.5	2	3	D	*Solidago virgaurea*	.	1	.
H	Eua	2.5	2	3	D	*Stellaria graminea*	.	.	+
H	Eua	4	2.5	0	D	*Succisa pratensis*	+	.	+
H	Eua	3	0	0	P	*Taraxacum officinale*	+	.	.
Ht-H	C. Eur	3	3	4	D	*Tragopogon pratensis* ssp. *orientalis*	.	.	+
H	Eua	3	0	0	D	*Trifolium pratense*	1	+	.
H	Eua	0	2	0	P	*Trisetum flavescens*	+	.	.
H-Ch	Eua	3	0	0	P	*Veronica chamaedrys*	.	1	+

Place and date of relevés: rel. 1 in zone F in August 2008, rel. 2 in zone E and rel. 3 in zone D in September 2010

* *Achillea ptarmica* L. (Vulnerable – Oltean et al., 1994; Rare – Negrean, 2001)

* *Calamagrostis canescens* (Weber) Roth (R – Dihoru and Dihoru, 1994)

* *Gentiana pneumonanthe* L. (V – Boşcaiu et al., 1994; Negrean, 2001)

* *Gymnadenia conopsea* (L.) R. Br. (R – Oltean et al., 1994)

Table 9. ***Anthoxantho-Agrostietum capillaris*** Sillinger 1933

						Relevé number	AA1	AA2	AA3	AA4
						Vegetation cover (%)	100	90	100	100
						Sampling area (m^2)	25	25	25	25
Bioform	Geoel	U	T	R	D/P	Species	28	36	23	22
H	Cp	0	0	0	P	*Agrostis capillaris*	3	3	3-4	3
H	Eua	0	0	0	P	*Anthoxanthum odoratum*	1	1-2	+	+
H	Eua	3	0	0	P	*Achillea millefolium*	.	+	+	1
H	Eua	2.5	3	4	P	*Agrimonia eupatoria*	.	+	.	+
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	1	+	+
H	Eur	2	0	4	D	*Anthyllis vulneraria*	.	+	.	.
H	Eua	3	3	4	P	*Arrhenatherum elatius* ssp. *elatius*	+	.	.	.
H	Eur	3	2	0	D	*Bellis perennis*	.	+	2	.
H	Eua	0	3	0	D	*Briza media*	.	+	+	+
Ht	Eur	3	2.5	3	D	*Campanula patula* ssp. *patula*	1	+	.	.
H	Cp	3.5	3	3	P	*Carex pallescens*	.	+	1	+
Ht-H	Eua	3.5	3	3	D	*Carum carvi*	+	.	+	.
H	C. Eur	2	3	4	P	*Coronilla varia*	+	+	.	.
Ht	Eur	3	3	4	P	*Crepis biennis*	.	+	+	.
H	Eua	3	2	2	P	*Cruciata glabra*	.	+	.	.
H	Eur	3	3	3	D	*Cynosurus cristatus*	+	.	+	.
H	C. Eur	2.5	3	3	P	*Dactylis glomerata*	.	+	+	+
Ht	Eua	2.5	3	0	D	*Daucus carota* ssp. *carota*	.	+	.	+
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	+	1	2	+
H	Eur	2	5	5	D	*Dianthus carthusianorum*	+	.	.	.
Ht	Eua	2	3	4	P	*Echium vulgare*	.	+	.	.
G	Med	0	0	0	P	*Elymus repens*	.	+	+	.
T	Eur	3	3	0	P	*Euphrasia stricta*	+	.	.	.
H	Eua	3.5	2	0	D	*Festuca pratensis* ssp. *pratensis*	+	+	.	+
H	Eua	2.5	3	4.5	D	*Filipendula vulgaris*	.	.	+	+
H	Eua	3	2.5	3	D	*Galium molugo*	.	+	.	.
Ch	Eur	2	3	4	D	*Helianthemum nummularium* ssp. *obscurum*	+	.	+	.
H	Eua	3.5	2	4	P	*Hieracium aurantiacum*	+	.	+	.
H	Eua	3	3	0	P	*Hypericum perforatum*	.	+	.	+
H	Eua	3	0	4	D	*Lathyrus pratensis*	+	.	.	.
H	Eua	3	0	0	D	*Leontodon autumnalis* ssp. *autumnalis*	+	1	.	.
G	Eua	4	3	3	D	*Listera ovata**	.	r	.	.
H	Cosm	3	3	0	D	*Lolium perenne*	.	+	+	+
H	Eua	2.5	0	0	P	*Lotus corniculatus*	+	.	.	.
H	Cp	4	2.5	0	P	*Lythrum salicaria*	1	+	.	+
T-H	Eua	2.5	3	4	D	*Medicago lupulina*	+	+	.	+
H	Eua	3.5	3	0	P	*Molinia caerulea*	.	+	.	.
H	Eua	0	0	1.5	D	*Nardus stricta*	+	.	.	.
H	Eua	3.5	0	0	P	*Phleum pratense*	+	.	+	.
H	Eua	2.5	0	3	P	*Pimpinella saxifraga*	.	+	.	.
H	Eua	2.5	0	4.5	P	*Plantago media*	+	.	+	.
H	Cp	3	0	0	P	*Poa pratensis*	.	+	1	+
H	Cosm	3	3	0	P	*Prunella vulgaris*	.	+	.	.
T	Eua	3	0	0	D	*Rhinanthus minor*	.	+	.	+
H	Cosm	3	0	0	D	*Rumex acetosa*	+	.	1	+
H	Eur	2.5	3	5	D	*Salvia pratensis*	+	.	.	.
H	Eua	2.5	2	3	D	*Stellaria graminea*	.	+	.	.

H	Eua	3	0	0	P	*Taraxacum officinale*	+	.	+	.
Ch	C. Eur	2	4	4	P	*Teucrium chamaedrys*	.	+	.	.
H	Eua	3	3	0	P	*Trifolium medium* ssp. *medium*	+	.	.	+
H	Eua	3.5	0	0	P	*Trifolium repens*	+	1	+	1
H	Eua	0	2	0	P	*Trisetum flavescens*	.	+	.	.
H	Eua	2	2	2	D	*Valeriana officinalis*	.	+	.	.
H-Ch	Eua	3	0	0	P	*Veronica chamaedrys*	+	.	.	1

Place and date of relevés: rel. 1 and rel. 3 in zone D, rel. 2 in zone F in August 2009, rel. 4 in zone E in September 2010

* *Listera ovata* (L.) R.Br. (R – Oltean et al., 1994)

Table 10. ***Ranunculetum repentis*** Knapp ex. Oberdorfer 1957

						Relevé number	Rr1	Rr2	Rr3
						Vegetation cover (%)	85	70	70
						Sampling area (m^2)	10	6	8
Bioform	Geoel	U	T	R	D/P	Species	11	9	6
H	Eua	4	0	0	P	*Ranunculus repens*	3-4	4	4
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	+	.
G(H)	Cosm	2.5	3.5	3.5	P	*Convolvulus arvensis*	.	.	+
H	C. Eur	2.5	3	3	P	*Dactylis glomerata*	+	.	.
T	Cosm	4	0	3	P	*Echinochloa crus-galli*	.	+	.
H	Eua	4.5	3	4	P	*Mentha longifolia*	+	+	.
H	Med	3	0	0	D	*Plantago major*	.	+	.
T-H	Cosm	3.5	0	0	P	*Poa annua*	+	.	.
T	Cosm	2.5	0	3	P	*Polygonum aviculare*	+	+	.
H	Eua	3.5	4	4	P	*Potentilla reptans*	.	.	+
H	Eua	4	3	0	P	*Rumex crispus*	1	.	.
H	Eua	2.5	3	3	P	*Senecio jacobaea*	+	+	.
H	Med	4	3	0	P	*Symphytum officinale* ssp. *officinale*	.	.	+
H	Eua	3.5	0	0	P	*Trifolium repens*	+	+	.
H	Cosm	3	3	4	P	*Urtica dioica*	+	1	.
H(Hh)	Eua	5	3	4	D	*Veronica beccabunga*	1	.	+
H	Eua	3	2.5	3	D	*Viola reichenbachiana*	.	.	+

Place and date of relevés: rel. 1 in zone F, rel. 2 in zone E and rel. 3 in zone D in July 2011

Table 11. ***Juncetum effusi*** Soó (1931) 1949

						Relevé number	Je1	Je2	Je3	Je4
						Vegetation cover (%)	70	70	80	90
						Sampling area (m^2)	25	10	25	20
Bioform	Geoel	U	T	R	D/P	Species	18	17	22	19
H	Cosm	4.5	3	3	P	*Juncus effusus*	4	3	4	4
H	Cp	5	0	2	P	*Epilobium palustre*	+	.	+	.
H	Eua	3	0	0	P	*Achillea millefolium*	.	.	+	+
H	Cp	0	0	0	P	*Agrostis capillaris*	.	+	+	+
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	.	1	.
H	Eua	4	3	0	P	*Alopecurus pratensis*	+	.	.	+
H	Cp	4	2.5	3	P	*Carex ovalis*	.	+	+	.
Ht	Eua	4.5	3	2.5	D	*Cirsium palustre*	.	+	.	+
H	Eur	3	3	3	D	*Cynosurus cristatus*	+	.	.	+
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	+	2	+	1
H	Eua	4	2	0	D	*Filipendula ulmaria* ssp. *ulmaria*	+	.	+	.

T	Cp	3	3	3	P	*Galium aparine*	+	+	.	.
H	Cp	5	3	0	D-P	*Galium palustre*	.	.	.	+
H	Cosm	3.5	3	0	D	*Holcus lanatus*	+	.	.	.
H	Cp	5	2	0	P	*Juncus articulatus*	.	.	+	+
H	Cp	4.5	3	3	P	*Juncus conglomeratus*	+	1	+	.
H	Eua	4	4	4	P	*Juncus inflexus*	.	+	+	1
H	Eua	3.5	2.5	0	D	*Lychnis flos-cuculi*	+	.	.	.
H(Hh)	Eua	5	3	0	D	*Lycopus europaeus*	+	.	+	+
Ch	Eua	4	3	3	P	*Lysimachia nummularia*	+	1	+	+
H	Eua	5	2	0	P	*Lysimachia vulgaris*	+	.	.	+
H	Cp	4	2.5	0	P	*Lythrum salicaria*	.	1	.	+
H	Eua	4.5	3	4	P	*Mentha longifolia*	.	.	+	.
H	Eua	5	3	0	P	*Myosotis scorpioides*	+	.	.	+
G	Eua	4	2.5	3	P	*Polygonum bistorta*	1	.	.	.
T	Cp	5	3	4	D	*Polygonum hydropiper*	.	+	.	+
H	Cosm	4	3	4	P	*Potentilla anserina*	+	.	+	.
H	Eua	4	1	0	P	*Potentilla erecta*	.	+	.	.
H	Eua	3.5	4	4	P	*Potentilla reptans*	.	.	+	.
H	C. Eur	3.5	0	0	D	*Ranunculus acris*	.	+	+	.
H	Eua	4	0	0	P	*Ranunculus repens*	+	1	+	+
H	Eua	4	3	0	P	*Rumex crispus*	.	.	+	.
G	Cp	4.5	3	0	P	*Scirpus sylvaticus*	.	.	+	+
H	Eua	2.5	2	3	D	*Stellaria graminea*	.	+	+	.
H	Med	3.5	3	4	D	*Trifolium hybridum*	.	+	.	.
H(Hh)	Eua	5	3	4	D	*Veronica beccabunga*	.	+	1	+

Place and date of relevés: rel. 1 in zone F, rel. 2 and rel. 3 in zone E, rel. 4 in zone D, in July 2008

Table 12. ***Junco inflexi-Menthetum longifoliae*** Lohmeyer 1953

						Relevé number	JM1	JM2	JM3
						Vegetation cover (%)	85	70	70
						Sampling area (m^2)	10	20	16
Bioform	Geoel	U	T	R	D/P	Species	12	16	15
H	Eua	4	4	4	P	*Juncus inflexus*	4	4	3-4
H	Eua	4.5	3	4	P	*Mentha longifolia*	+	+	1
H	Eua	3.5	3	3	D	*Agrostis canina*	+	.	.
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	+	1
H	Eua	4	3	0	P	*Alopecurus pratensis*	.	1	+
G	Cp	0	3	0	P	*Carex hirta*	+	+	.
H	Eur	3	0	0	P	*Centaurea jacea*	.	+	.
H	Eua	3	0	3	D	*Cichorium intybus*	+	.	.
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	.	+	+
H	Eua	4	3	3	D	*Eupatorium cannabinum*	.	.	+
H	Eur	4	3	4	P	*Festuca arundinacea*	.	+	.
H	Cosm	3.5	3	0	D	*Holcus lanatus*	.	+	+
Ht	Eua	3	3	0	P	*Inula britannica*	.	.	+
H	Cosm	4.5	3	3	P	*Juncus effusus*	1	+	+
G	Adv	3.5	3	4	P	*Juncus tenuis*	+	.	+
Ch	Eua	4	3	3	P	*Lysimachia nummularia*	+	2	.
H	Cp	4	2.5	0	P	*Lythrum salicaria*	.	+	.
H	Eua	5	3	0	P	*Myosotis scorpioides*	.	.	+
H	Eua	4	0	0	D	*Poa trivialis*	+	.	.
T	Cosm	2.5	0	3	P	*Polygonum aviculare*	+	.	+

H	Eua	4	1	0	P	*Potentilla erecta*	.	+	.
H	Eua	3.5	4	4	P	*Potentilla reptans*	+	.	+
H	Cosm	3	3	0	P	*Prunella vulgaris*	.	+	.
H	C. Eur	3.5	0	0	D	*Ranunculus acris*	.	.	+
H	Eua	4	0	0	P	*Ranunculus repens*	.	+	+
H	Eua	4	3	0	P	*Rumex crispus*	.	+	.

Place and date of relevés: rel. 1 and rel. 2 in zone D in July 2008, rel. 3 in zone E in August 2008

Table 13. ***Bidenti-Polygonetum hydropiperis*** Lohmeyer in R. Tüxen 1950

						Relevé number	BP1	BP2	BP3
						Vegetation cover (%)	60	75	80
						Sampling area (m^2)	10	10	8
Bioform	Geoel	U	T	R	D/P	Species	13	17	12
T	Eua	4.5	3	0	P	*Bidens tripartita*	+	.	+
T	Cp	5	3	4	D	*Polygonum hydropiper*	3	3	3-4
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	.	+
G(Hh)	Eua	6	3	4	P	*Carex acutiformis*	1	+	+
T	Cosm	4	0	3	P	*Echinochloa crus-galli*	+	.	.
T	Adv	3.5	0	3	D	*Galinsoga parviflora*	1	.	+
H	Cp	5	3	0	D-P	*Galium palustre*	.	+	.
H	Cosm	4.5	3	3	P	*Juncus effusus*	+	+	.
H	Cp	5	0	2	P	*Lycopus europaeus*	.	+	.
Ch	Cp	4	3	3	P	*Lysimachia nummularia*	+	1	+
H	Eua	4.5	3	4	P	*Mentha longifolia*	.	+	+
H	Eua	5	3	0	P	*Myosotis scorpioides*	+	.	.
H	Med	3	3	0	D	*Plantago major*	.	.	+
H	Cp	5	4	2	P	*Poa palustris*	.	+	.
T	Cosm	4	0	3	D	*Polygonum lapathifolium*	+	+	.
H	Cosm	4	3	4	P	*Potentilla anserine*	.	+	+
H	Eua	4	0	0	P	*Ranunculus repens*	1	+	.
H	Eua	4	3	4	P	*Rorippa sylvestris* ssp. *sylvestris*	.	+	.
H	Eur	4	0	3	P	*Rumex obtusifolius*	.	+	+
G	Cp	4.5	3	0	P	*Scirpus sylvaticus*	+	1	.
T-Ht	Cosm	3	0	0	P	*Stellaria media* s.l.	.	+	.
H	Eua	3.5	0	0	D	*Trifolium repens*	.	+	+
H	Cosm	3	3	4	P	*Urtica dioica*	+	.	.
H(Hh)	Eua	5	3	4	D	*Veronica beccabunga*	.	+	+

Place and date of relevés: rel. 1 in zone E, rel. 2 and rel. 3 in zone F in July 2011

Table 14. ***Juncetum tenuis*** (Diemont, Siss. et Westhoff 1940) Schwik. 1944

						Relevé number	Jt1	Jt2	Jt3
						Vegetation cover (%)	80	70	65
						Sampling area (m^2)	6	4	4
Bioform	Geoel	U	T	R	D/P	Species	12	10	7
G	Adv	3.5	3	4	P	*Juncus tenuis*	3	4	3
H	Cp	0	0	0	P	*Agrostis capillaris*	.	.	+
H	Eur	3.5	2.5	0	P	*Ajuga reptans*	+	.	.
T-Ht	Cp	3	3	5	D	*Alopecurus aequalis*	.	+	.
H	Eur	3	2	0	D	*Bellis perennis*	1	.	.
T-Ht	Cosm	3	0	0	P	*Capsella bursa-pastoris*	+	.	+

T	Cosm	4.5	0	3	P	*Juncus bufonius*	.	+	.
H	Eua	4	4	4	P	*Juncus inflexus*	1	+	.
H	Med	3	0	0	D	*Plantago major*	.	+	.
T-H	Cosm	3.5	0	0	P	*Poa annua*	+	.	.
H	Cp	3	0	0	P	*Poa pratensis*	.	+	+
H	Cosm	4	3	4	P	*Potentilla anserina*	+	.	.
H	Cosm	3	3	0	P	*Prunella vulgaris*	+	.	+
H	Eua	4	0	0	P	*Ranunculus repens*	+	+	.
H	Eua	4	3	0	P	*Rumex crispus*	.	+	+
H	Eur	4	0	3	P	*Rumex obtusifolius*	+	.	.
H	Eua	3	0	0	P	*Taraxacum officinale*	+	.	.
H	Eua	3.5	0	0	P	*Trifolium repens*	.	+	+
H	Cosm	3	3	0	D	*Veronica serpyllifolia*	+	+	.

Place and date of relevés: rel. 1 in zone F, rel. 2 in zone E and rel. 3 in zone A in August 2009

Table 15. Tanaceto - *Artemisietum vulgaris* Sissingh 1950

						Relevé number	TA1	TA2
						Vegetation cover (%)	70	65
						Sampling area (m^2)	12	8
Bioform	Geoel	U	T	R	D/P	Species	14	11
H	Cp	2.5	3	4	D	*Artemisia vulgaris*	3	3-4
H	Eua	3	3	4	D	*Tanacetum vulgare*	+	.
H	Eua	3	0	0	P	*Achillea millefolium*	+	.
H	Eua	3.5	3	3	P	*Aegopodium podagraria*	.	1
T	Adv	3	3	0	D	*Amaranthus powellii*	+	+
H	Eua	3	0	3	D	*Cichorium intybus*	+	.
G	Eua	2.5	3	0	D	*Cirsium arvense*	.	+
G(H)	Cosm	2.5	3.5	3.5	P	*Convolvulus arvensis*	+	+
T	Adv	2.5	0	0	D	*Conyza canadensis*	.	1
H	C. Eur	2.5	3	3	P	*Dactylis glomerata*	.	+
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	+	.
Ht	Eua	2	3	4	P	*Echium vulgare*	+	.
G	Med	0	0	0	P	*Elymus repens*	+	.
H	Med	1	4	4	D	*Marrubium vulgare*	+	+
H	Eua	3	0	0	D	*Plantago lanceolata*	.	+
H	Cp	3	0	0	P	*Poa pratensis*	+	.
T	Cosm	2.5	0	3	P	*Polygonum aviculare*	+	+
H	Eua	4	0	0	P	*Ranunculus repens*	.	+
H	Eur	4	0	3	P	*Rumex obtusifolius*	+	.
H	Eua	3.5	0	0	P	*Trifolium repens*	+	.

Place and date of relevés: rel. 1 and rel. 2 in zone A in August 2009

Table 16. *Urtico-Aegopodietum* R. Tüxen ex Görs 1963

						Relevé number	UA1	UA2	UA3
						Vegetation cover (%)	70	80	80
						Sampling area (m^2)	6	10	10
Bioform	Geoel	U	T	R	D/P	Species	13	11	14
H	Cosm	3	3	4	P	*Urtica dioica*	4	4-5	4
H	Eua	3.5	3	3	P	*Aegopodium podagraria*	2	+	2-3
H	Eua	3	0	0	P	*Achillea millefolium*	+	.	+
H	Cp	2.5	3	4	D	*Artemisia vulgaris*	.	+	+

T-Ht	Cosm	3	0	0	P	*Capsella bursa-pastoris*	.	+	+
H	Eua	5	3	0	P	*Cardamine pratensis*	.	.	+
H	C. Eur	3.5	3	3	D	*Chaerophyllum aromaticum*	1	.	+
T	Cosm	3	3	0	P	*Chenopodium album*	.	+	.
T	Adv	2.5	0	0	D	*Conyza canadensis*	+	.	1
H	C. Eur	2.5	3	3	P	*Dactylis glomerata*	+	.	.
H	Cp	3	0	0	P	*Festuca rubra*	.	.	+
T	Cp	3	3	3	P	*Galium aparine*	+	.	.
H(Ch)	Eua	3	3	0	P	*Glechoma hederacea*	.	+	+
H	Eua	3	3	0	D	*Lamium album*	+	.	.
H	Eua	3	0	0	D	*Leontodon autumnalis*	1	+	.
T-Ht	Eua	0	0	3.5	D-P	*Matricaria perforata*	.	+	+
T-H	Eua	2.5	3	4	D	*Medicago lupulina*	+	.	.
H	Eua	3.5	4	4	P	*Potentilla reptans*	.	+	.
H	Cosm	3	0	0	D	*Rumex acetosa*	.	+	+
T-Ht	Cosm	3	0	0	P	*Stellaria media* s.l.	1	.	.
H	Eua	3.5	0	0	P	*Trifolium repens*	+	.	.
H-Ch	Eua	3	0	0	P	*Veronica chamaedrys*	.	+	+
H	Cosm	3	3	0	D	*Veronica serpyllifolia*	+	.	+

Place and date of relevés: rel. 1 and rel. 2 in zone A, rel. 3 in zone B in August 2009

Table 17. *Calamagrostio-Salicetum cinereae* Soó et Zólyomi in Soó 1955

						Relevé number	CS1	CS2	CS3
						Vegetation cover (%)	90	80	80
						Sampling area (m^2)	25	25	25
Bioform	Geoel	U	T	R	D/P	Species	14	10	11
Ph	Eua	5	3	3	P	*Salix cinerea*	4	3	4
H	Eua	5	3	3	P	*Calamagrostis canescens**	+	.	.
H	Cp	4	0	0	P	*Agrostis stolonifera*	+	+	+
Ht-H	Eua	4	3	3	D	*Angelica sylvestris*	1	.	+
Ph	Eua	3	2	2	P	*Betula pendula*	+	.	+
G(Hh)	Eua	6	3	4	P	*Carex acutiformis*	+	+	1
H	Eua	4	3	4	P	*Carex vulpina*	+	.	.
H	Cosm	4	0	0	D	*Deschampsia caespitosa*	+	+	.
H	Eua	4	2	0	D	*Filipendula ulmaria* ssp. *ulmaria*	+	.	.
T	Cp	3	3	3	P	*Galium aparine*	.	+	1
H	Cosm	4.5	3	3	P	*Juncus effusus*	.	+	+
H	Cp	5	0	2	P	*Lycopus europaeus*	.	+	1
Ch	Eua	4	3	3	P	*Lysimachia nummularia*	+	.	.
H	Eua	5	2	0	P	*Lysimachia vulgaris*	.	+	.
H	Cp	4	2.5	0	P	*Lythrum salicaria*	+	.	.
H	Eua	5	3	0	P	*Myosotis scorpioides*		+	.
G	Eua	4	2.5	3	P	*Polygonum bistorta*	1	2	+
G	Cp	4.5	3	0	P	*Scirpus sylvaticus*	+	.	+
H	Eur	3.5	3	3	D	*Stellaria nemorum*	+	.	.
H	Med	4	3	0	P	*Symphytum officinale* ssp. *officinale*	.	.	+

Place and date of relevés: rel. 1 in zone F, rel. 2 and rel. 3 in zone E in September 2010
* *Calamagrostis canescens* (Weber) Roth (R – Dihoru and Dihoru, 1994)

LANDFORMS AND URBAN DEVELOPMENT. AN EXAMPLE OF URBAN GEOMORPHOLOGY FROM ROMANIA (SIBIU, TRANSYLVANIA)

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Abstract. *The landforms are very important in distribution and development of any kind of structures and processes. In this study, the role of the landforms in urban development and spatial evolution of Sibiu city (Romania) was investigated and evaluated. For the multidisciplinary approach in this study, different data, maps and sources were used. The analysis of geological composition, morphometric characteristics and geomorphologic processes reveal that these are, in the same time, favourable and limiting elements in spatial and functional development of the city. The spatial and functional evolution of the Sibiu city is linked to the altitude, stability and accessibility of landforms. The relief played in time multiples roles: a strategic historical role, the basis of development and adaptation of urban structure as well as the role of positioning vector in development of new functional zones. Man is the most important morphogenetic agent; this aspect was revealed by the spatial evolution of the built area correlated with population growth of Sibiu city, with its urban expansion rate and by land use. Such analysis has a very good applicability in urban studies and sustainable territorial planning and also supports local authorities in prevention and management of geomorphologic hazards.*
Keywords: *Landforms, urban geomorphology, spatial and functional dynamic, Sibiu, Romania.*

Rezumat. *Formele de relief sunt foarte importante în distribuția şi dezvoltarea oricăror tipuri de structure şi procese, fie acestea naturale sau antropice. În acest studiu este prezentat rolul reliefului în dezvoltarea urbană şi evoluția spațială a oraşului Sibiu. Abordarea interdisciplinară se bazează pe date statistice şi hărți actuale şi istorice. Analiza compoziției geologice,a caracteristicior morfometrice şi a proceselor geomorfologice relevă că acestea sunt în acelaşi timp factori de favorabilitate dar şi factori limitativi în dezvoltarea spațială şi funcțională a oraşului. Aceasta depinde de altitudine, stabilitatea şi accesibilitatea formelor de relief. Relieful a avut în decursul timpului roluri multiple:rol strategic istoric, bază de dezvoltare şi adaptare a structurii urbane şi rol de vector de poziție în dezvoltarea noilor zone funcționale. Omul este cel mai important agent morfogenetic; acest aspect a fost evidențiat prin analiza evoluției spațiale a zonelor construite corelat cu creşterea populației oraşului Sibiu, prin rata expansiunii urbane şi prin modul de utilizare a terenurilor. Acest tip de analiză are o foarte bună aplicabilitate practică în studiile de urbanism şi planificareşi amenajare teritorială şi constituie un sprijin real pentru autorități în prevenirea şi managementul hazardelor geomorfologice.*
Cuvinte cheie: *Forme de reluef, geomorfologie urbană, dinamică spațială şi funcțională, Sibiu, România.*

Introduction

Practical side of science derives from how scientific research in any field can be used for the benefit of society and sustainable development of the economy. As any science, the geomorphology answers to this desideratum by providing extremely valuable information regarding the landforms, their characteristics and dynamic. Geomorphological analysis is an important step in planning economic and social development, especially in urban development through which human pressure is greatest (Coates 1976; Cooke 1976). In this regard, relief is the reference element, a driver of development (Carmignani, Chowdhury 2012) and also the subject of anthropogenic changes (Cooke 1976; Mulder *et al*. 2001; Cocean 2007) through the habitat potential, the configuration and accessibility of landforms imposed by morphometry (altitudes, slopes, fragmentation, relief energy), through the way in which it responds to anthropogenic pressure through housing development and economic, social and leisure activities (reduction or amplification of geomorphological processes) (McCall *et al.* 1996; Mulder *et al*. 2001).

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In urban areas the man intervened significantly in changing the original characteristics of landforms and geomorphic processes mechanisms, transforming the geomorphological landscape into an anthropogenic landscape called "citiscape" (Bathrellos 2007), in which man holds both functions of modeling agent and control factor of system balance (Bathrellos *et al.* 2005). Therefore, in the current conditions of urban dynamics, viable practical solutions for geomorphological hazards prevention and risk management are constantly seeking (Ianoş 2004; Bathrellos *et al.* 2005; Cocean 2007).

Urban geomorphology through inter- and trans-disciplinary approach of the territory opens up the possibility of interaction of geomorphology with other sciences applied in the urban environment (hydrology, climatology, ecology), well as with other domains such as urbanism (Ianoş 2000; Cocean 2007) and territorial planning (Coates 1984; Mulder *et al.* 2001; Mazilu 2012). It goes without saying that this new approach brings geomorphology, urban geomorphology in this case, to the attention of administrative institutions and organizations at all levels and that the geomorphologist must be consulted and involved in activities of planning and sustainable management of the territory. In this respect, urban geomorphology can come with long-term solutions in the organization, exploitation and capitalization of geographical urban space (Cooke 1976) for reducing the risk, through proper use and conservation of landforms and also through a good planning of the city functions development, proper to the physical characteristics of the land and of the relief (Coates 1974; McCall *et al.* 1996; Mulder *et al.* 2001).

Sibiu is a growing city in terms of economic, social and cultural, which implies new changes of urban border, landscape and also of landforms morphometry and dynamic. In current conditions, it is the 14th city in Romania after the number of resident population (147,245 inhabitants at the 2011 census) and the fourth in Transylvania after Braşov, Cluj and Târgu Mureş. Sibiu has become municipality since 1919 and county residence since 1968, having at the 2010 census an area of 12,180 ha (National Institute of Statistics - NIS 2010).

The geographical position, almost central in the country and in the southern part of Transylvania (Fig. 1) was and still is a favorability factor in urban development and evolution of Sibiu city and, at the same time, a polarization and concentration factor of economical, social and cultural life in this region. According to the low 351/2001, Sibiu city is a second rank urban settlement – municipality with intercounty and county importance and has an equilibrium role in the settlements network form southern Transylvania. Sibiu is linked through roads, railways and airways to the most important cities from the historical Romanian regions. It is also an important node of communications network of national and European interest through the roads (DN1/DN7, DN 14, E68/E81) and railway (thoroughfare 2: Bucureşti – Arad – Curtici) and airways network (international airport).

In the meaning of the above issue, we tried in this study to establish a relationship between Sibiu urban development and relief of Sibiu Depressionary area. From this perspective, landforms and geomorphic processes were analyzed in two aspects: on the one hand as potential resources that can be used in socio-economic development (Pareta, Prasad 2012) and also as potentiating vectors of sustainable functional development (Karaguni 2013), and on the other hand as potential risk factors that may affect the economy and society (Mulder 1992; Bathrellos *et al.* 2005; Bathrellos 2012). These two sides coexist in studied area, one or the other may increase or decrease as appropriate, depending on the degree of human pressure.

Experimental

Our analysis is based on an integrative and diachronic approach, according to which the relief - city assembly is a coherent result of functional systemic mechanisms. The interaction of the two components results in a range of spatial and temporal configurations, charted on historical or current cartographic documents, which can be ranked and characterized by focusing on the dominant class of phenomena, natural or anthropogenic. The latter aims the population dynamics based on the statistical data analyzed from archival documents and censuses (NIS – National Institute of Statistics) and the spatial evolution of the city assessed on the basis of old maps, topographic maps and orthophotoplans.

Analysis and interpretation of old cartographic materials was fundamental in diachronic studies of Sibiu urban geomorphology, but the changes are taking place continuously and at an accelerated rate even under our sight. They are related to the situation found on the latest topographical map (1982) and the current situation from the field which the ortophotoplans have shown, giving the possibility of studying

urban system evolution in time and space. The scale of representation of used cartographic documents is diverse, from large scales 1: 25 000 (topographic map, edition 1982) used in the detailed analysis, in assessing and estimating local changes, to scales of 1: 100 000 (historical maps) and 1: 200 000 (geological map) used in the regional analysis at the relief unit level. The cartographic materials mapped (geomorphological map, map of functional areas and city development maps) summarize a lot of information on the administrative territory of Sibiu and saw the spatial and temporal dynamic of the city.

Results and Discusions

Geological and Geomorphological Features of Study Area

The hearth of Sibiu city is situated in the Sibiului Depression, a submountainous depression developed on the both sides of Cibin river, but the lands and the whole administrative territory are more extended towards east in the Hârtibaciu Tableland and towards south until the contact with the Cindrel Mountains (Fig. 2; Fig. 3).

This makes Sibiu city, from the geological point of view, to be located in a complex region of morphological and structural contact between the Southern Carpathians to the south and Transylvanian Tableland to the north. Epimetamorphic crystalline schists of Southern Carpathians – Cisnădioara series (chlorito-epidote and chlorito-bleached schists) are met in the southern part of Sibiu administrative territory. Over these, upper Cretaceous sedimentary rocks are arranged, made up of: limestone, hard calcareous sandstone and calcareous conglomerates (Ciobanu 2002). The northern – north-eastern part of the administrative territory of the city belong geologically to the Transylvanian Depression and is made by Pannonian sedimentary rocks (gravels, sands, marls, clays and loams) which cover the Badenian (Turnu Roşu) or Sarmatian (Cisnădie – Tocile) deposits (Fig. 2). Quaternary deposits (sands, small and coarse gravels well rounded, clays and loams) make up the terraces and floodplain of Cibin river and its tributaries, which occupy the central part of administrative territory.

The fluvial modeling made by Cibin river and its tributaries: Trinkbach, Hamba Valley and Strâmb Stream led to the current geomorphologic configuration of Sibiu administrative territory, in which an altitudinal succession of landforms can be recognized, developed from south-west to north-east (Bucşa, Costea 2011; Costea 2012) (see Fig. 3):

- the Cisnădioara submountainous Hills – a relief of high hills (500-600 m) with narrow ridges, hillsides with steep slopes and deep valleys;

- Cibin Piedmont – accumulation piedmont with a torrential structure, with large extension, elevation of 470 – 500 m and reduced slopes;

- the 3 terraces of Cibin river - which descends from 475 - 450 m altitude (upper terrace) at 410 - 405 m altitude (lower terrace), have a bilateral development upstream Sibiu and monolateral on the right side in Sibiu and downstream, with terrace′s overheads affected by gravitational processes, runoff and ravening;

- Cibin river floodplain - with asymmetrical development, wider on the right and narrower on the left side at the contact with the plateau, with low slopes which prevent drainage and favor the rivers meandering;

- Hârtibaciu Tableland - hilly relief with moderate altitudes, extended summits which preserve very well the leveling surface (upper leveling surface of ± 600 m and lower leveling surface of ± 550 m), with structural relief (cuesta) and steep slopes.

This geomorphologic and hydrographic matrix was taken, harnessed and transformed into housing and development of residential neighborhoods, for complementary economic activities and development of functional zones of the city, for ensuring linkages within and outside the urban system with neighboring regions. The changes were gradual and followed the general line of the relief, which facilitates landform pattern recognition within the city.

Petrographic complexity of the relief units was and still is a natural potential harnessed by mineral resources exploitation in quarry. Panonian deposits (clays) from tableland are exploited in quarry for brick manufacturing in Guşteriţa neighborhood and sands and gravels from the riverbed or floodplain of the Cibin river have been used since ancient times directly as materials for masonry or courtyards paving.

The Role of Landforms in Urban Development of Sibiu City – Historical and Current Benchmarks

Local landforms have played a central role throughout history in the choice of sites for settlements and their further development has often been influenced by the regional geomorphology (Bathrellos 2007). The

development and spatial evolution of Sibiu city is easy to identify both through urban structure adaptation to relief morphology and through urban toponymy very suggestive for development of the city on different altitudinal levels. Horisontal surfaces of terraces and Cibin floodplain had formed the basis of support and organization of rural and urban ancient hearths that are today part of the city.

Altitude played an important role in urban structure and zoning since historical time. This aspect was also mentioned by Meyer for the American cities (Meyer 1994; Meyer 2000). The "Lower City", situated in the Cibin floodplain and on the first terrace of Cibin river, was the foundation place of settlement (1191). The "Upper City", located on the second terrace of Cibin river, was the place of construction and development in XIII and XIV of the fortress, which becomes city in 1366 under the name *Hermannstadt* and also it was the urban core around which subsequently developed and evolved Sibiu city (Avram, Crişan 1998; Sigerus 2006).

The Turnisor neighbourhood, located in the western part of the city in the floodplain and on the first terrace of Cibin river was a rural settlement (*Neppendorf*, attested from 1336) which today is part of the municipality. Guşterița neighbourhood, also an ancient rural settlement (*Hammersdorf* in german) is nowadays part of the city, being located in the eastern part of the city, in the river floodplain and on the western Hârtibaciului Plateau hillside. Both of these rural settlements became part of Sibiu after 1948 following Romania's land planning after the Second World War.

In time of historical events (Sigerus 2006) the strategic and defense role of the relief has been prefigured and confirmed. This role has been defined by the second terrace altitude (420 - 435 m), the position of the Cibin riverbed to the north and east and the existence of lacustrine basins around the urban core. These geomorphological elements and natural barriers gave "character" to the city (Dovey *et al.* 2009) and have sustained the fortress defense along with the walls of three fortifications belts. The enclosures of fortifications represented by Huet Square, Small Square and later Great Square are located on the second terrace bridge, instead the walls of fortification belts and the connection gates between "Uptown" and "Lower Town" are located on the terrace's forehead or at its base. Urban core zoning, according to altitude in the "Citta Alta" and "Citta Bassa", and cvasicircular ring of lacustrine surfaces from Cibin floodplain in the city outskirts was also recorded by Giovanni Morando Visconti in his map (1699). This map clearly indicates, besides development of the city on the two fluvial landforms, the radial-concentric arrangement of streets in the Upper Town and rectangular arrangements in the Lower Town with connection segments which follow the terrace forehead.

At the same time, the existence of agricultural and aquatic areas outside to the city indicates the diversity of habitats and complementarity of economic functions of the city: in the center "Intra muros" residential, commercial and handicraft functions have predominated, and at the periphery, in the "Extra Muros" area, farming function had prevailed on the cvasiorizontal surfaces of the floodplain and Cibin terraces, function sustained by the autochthonous Romanian population called "măiereni" who migrated from neighboring villages (Avram, Crişan 1998).

Defensive role of the lakes and also of the fortress wall was lost at the end of the XVIIth century - the XVIIIth century, when a series of drainage works and regularization works of the hydrographic network carried out (restricting lake surfaces, regularization of the Cibin river in the Turnişor - Sibiu sector completed in 1706 and regularization works of Seviş river completed in 1721). Relevant aspects concerning urban extension are highlighted on the historical maps (Josephine Map, 1769-1773; Austrian-Hungarian Map 1898) (Fig. 4).

With the development of commercial functions and housing from the end of the XVIIth century and beginning of the XVIII century the city became overcrowded and there were a spatial development of Sibiu through major expansion and through an "overflow" of households on the different directions: towards northeast in Terezian neighbourhood, towards west in Lazaret and towards southwest in Josephine neighborhood (Sigerus 2006). Important transformations of urban areas and benchmarking of planned development and evolution have been realised by adopting the first systematization plan, developed in 1875 by J. Boebl (Sigerus 2006). Measurements made in 1885 have shown an increase of the built area of the city at 562 ha and a total administrative area of 4503 ha. Extending of the city core from an initial surface of 72 ha, to an area of 470 ha in 1480 and then to 562 ha in 1885 (Sigerus 2006), outlines for this time once again the very important role that relief has, as a

position vector of urban development (Cocean 2007). The economical development through agrarian reform (Ciobanu 2001), increase of the population number and mainly the effect of attraction pole of the city for the countryside as a market for agricultural products has led to expansion of Terezian and Lazaret neighborhoods and to the creation of new districts, like Ştefan cel Mare to the end of the XIX century - early XX century.

The urban core with administrative, cultural and residential functions has a central and suspended position due to the second terrace altitude. In defining the urban picture and in construction of economic life of the city helped mainly Saxon population (Ciobanu 2001). New neighborhoods as a peripheral ring were developed, in which the constructed surfaces of working-class neighborhoods alternate with gardens and large green spaces. Outside this ring farmland were grouping. Thus, urban configuration of the Sibiu city at the beginning of XX century had a concentric zone organization according to Burgess model (1925) but influenced by landforms disposal (Meyer 2000).

The spatial evolution of Sibiu city in the second half of the XXth century was done by extending the influence area on the peri-urban spaces, takeover of rural settlements from this area (Gusterița, Turnișor), construction of new neighborhoods (Hipodrom, Strand, Vasile Aron, Valea Aurie) (Fig. 4).

During this period of functional evolution of the city vast changes ocally that modified gradually the geomorphological system (cutting, leveling, terracing) which led to landforms inclusion in the urban space and to adaptation of urban structure to the landforms (Meyer 1994; Bucşa, Costea 2011).

Demographic development and the industrialization before 1989 were the main vectors of this transformation (Lin, 2007) and amplification of residential, commercial and services functions of the city (Ianoş 2004). In the socio-economic conditions of the years 1960 – 1970 – 1980 functional zoning of the city followed the relief characteristics: meadow and terraces bridges provide stability to the all types of industrial structures and to the residential buildings (big and dense houses or collective dwelling) and overheads terrace and narrow bridges were modeled for the location of the neighborhoods of houses and communication routes that link the low side and high side of the city.

In this context the concentric zone model has gradually changed through the radial development of neighborhoods according to the Hoyt model, conditioned by the presence of watercourses and by the developing of the most important transportation routes (the railway and the national roads DN1) (Fig. 4). In addition to horizontal developing evident in the period before 1989, Sibiu has experienced a vertical development. Systematization and urban planning policy began in the 1970s when there were started the construction of collective dwellings needed by the population engaged in industry. Neighborhoods like Hipodrom, Terezian, Vasile Aron, Ştrand and Valea Aurie, which have predominantly residential and commercial functions, have added a new direction of development, a vertical one, of Sibiu city in the conditions of population number growth and depletion of land for construction in the central part (Ianoş 2004; Lin 2007; Pareta, Prasad 2012).

Since 2000 a revival of economic life in Sibiu has showed by attracting foreign investors. At the same time, there was an unprecedented urban expansion by liberalizing the housing market and construction of new neighborhoods such as Tilişca, Reşita, Tineretului, Veterani. The spatial evolution again occurred especially horizontally but also vertically, tending toward a more complicated urban structure that combines the two models mentioned above and has multiple nuclei (Fig. 5).

In this regard we mention the emergence of dispersed urban construction chaotic arranged at the expense of agricultural land from outside the town, the development of new neighborhoods build to the limit of the older and the emergence of oversized construction in the central area for administration, business, tourism and office activities.

The Population and Economic Activities – Vectors of Dynamic in Urban Spatial and Functional Evolution

The geographical position at the crossroads of important communication routes, trade relations between the historical provinces, demographic and economic development were the main vectors of spatial development of the Sibiu city and amplification of its functions: administrative, residential, craft, transport, industrial, services and trade (Ianoş, Heller 2006). These factors have led

to extending of the city hearth from an initial area of 72 ha to 4020.75 ha (Table 1).

The link between the hearth of city surface and the inhabitants' number in historical time (1480 – 2011) is revealed by a direct and strong correlation expressed by a grade 2 equation, the correlation coefficient being of 0.9571. During this historical period the city has been extended with 3550.75 ha, having an average growth rate of 6.69 ha/year, differentiated in time. A significant growth rate (> 36%) of urban areas was recorded in the period between 1960 and 1990, which was caused by city's industrialization during the communist period and the increase of the urban population due to internal migration from rural to urban and demographic policy.

However, the highest growth rate of urban hearth area was recorded during 1992 – 2010, of 43.56%, and was mainly due to the change in type of land ownership (Law 18/1990), opening the city to establish new residences and urban expansion following liberalization of the housing market and the boom in housing demand and construction (Tsai 2015). Although the population decreased after 1992, the urban expansion trend is maintained due to the fact that a person may hold more properties and also due to the decrease of the number of families/ people living in a building. Prior to 1989 they lived in a dwelling at least two families or 4 – 8 people (NIS).

Extending of the city over two relief units (Sibiu Depression and Hârtibaciu Plateau) (Table 2) and the large share of depressionary space has diversified the land use in the administrative limits of Sibiu municipality. Table 3 shows the surface of the administrative territory of Sibiu, composed of hearth of city (intravilan) and outside (extravilan) at the census from 2010 and the share from the total land for various uses. These surfaces include the area of Sibiu city and Paltiniş – mountain resort located at a distance of about 35 km from the city in the Cindrelului Mountains which belongs to Sibiu, but that is not subject to our research. If we refer only to the urban hearth area of Sibiu, it consists of the city itself and several buildings scattered within the administrative territory, which together accounted 3906.38 ha. Land use categories in the administrative area of Sibiu are quite different (agriculture, forestry, construction etc.). Also a great diversity of functions, especially in hearth of city, records as showed in table 3, where the predominant urban functions are administrative, residential, commercial, industry, transport and even agricultural.

These socio-economic conditions required a reconfiguration of the functional zones of Sibiu City and a successive alternant organization (Ianoş 2000) and also tentacular of urban space. Again the relief played a position vector (field line) role through stability and accessibility. Old industrial areas were decommissioned and some factories have been relocated to the periphery along with new industrial objectives (Fig. 5). Thus, were developed two industrial zones: the western industrial area located on the second terrace of Cibin river and the eastern industrial area in the Cibin river floodplain, their position being favored by large extension of landforms, low relief energy and slope, by accessibility and faster connection on communication routes of national and international importance with other urban centers (Mazilu 2012). New investments in the industry are oriented towards heavy machinery, electronic components, industrial robots, auto parts, plastics, industrial chains, medicines etc. These industrial activities have been and still are today, together with the population, a key element in spatial-functional dynamic and organization and territorial planning of Sibiu city. The employment rate in industry in Sibiu has increased due to foreign investment in this area from 36.7% in 2002 to 41% in 2006.

Industrial development and population growth on the one hand and geographical position on the other hand led to the development of commercial function (approx. 14% of total employment) and services (42.5% of the employed population) of the city. The evolution of this economic function leads to new commercial areas developing on the periphery of the historic urban core (which was gradually relieved of this function). The support role and position vector role of relief are highlighted also in this case. It is stand a concentration of commercial structures on law declivity surfaces as Cibin floodplain (in the central part of the city) and second terrace (on the western and ocally outskirts along the main hydrographic network and the roads of national importance). Developing of commercial zones and services is multidirectional from the center to the periphery and alternant and successive to the west, north and south – southeast direction.

The agricultural area has a significant share, of more than 50% of the administrative area. Also, 22.24% of the urban area is represented by zones with agricultural function (Table 3). Arable land is scattered on tabular areas of Cibin terraces (predominantly second and first terraces) and into the Cibin floodplain and pastures, hayfields and

orchards are spread predominantly on the third terrace and in the hills region, on the slopes of different inclinations. However, it is noted a lesser interest of the population for agricultural activities (agricultural lands are not worked or they are worked at a low rate and the number of employed in agriculture decreased from 1449 persons in 1997 to 350 in 2007) and increasing interest in other activities (industrial, commercial, services, real estate, construction etc.). Nowaday, people employed in agriculture represents 0.81% of total employment in Sibiu. This phenomenon is also remarkable in the increase of urban area (intravilan) from the center to the periphery at the expense of agricultural land.

Since historical times, urban growth occurred through conversion of land from rural to urban (Pond, Yates 1994; Whitehead 2003; Talen, Brody 2005; Petrişor *et al.* 2010), the latest examples being Guşterița and Turnişor rural settlements incorporation into the administrative boundaries of Sibiu city.

Nowadays, this trend is still maintained. Proofs are the dispersed groups of housing and technical utilities constructions located far away from the urban hearth limit (into alluvial plain from the north of Sibiu city or on the third terrace towards southwest of Dumbrava – Calea Cisnădiei neighborhoods) and abandonment and farming areas in favor of other activities and functions. Also in the near future the conversion of agricultural land from the Cibin floodplain (Lunca Mare, Câmpuşor) for landscaping with residential and recreational functions will be provided by General Urban Plan (PUG) 2010 – 2019, along with west industrial zone expansion to the detriment of farmland and the conversion of agricultural land between the western industrial area and Ruscior Valley (1726 ha) in urban zone and green areas with residential and recreational functions.

The general urban plan for the period 2010 – 2019 took into account the relief suitability for the city expansion to the west and southwest and functional amplification of the two industrial zones into the context of ring road vicinity. Under this plan, expanding the built area towards west and south is, considered through grubbing up of weak-medium productive agricultural land and deforestation of shrubs. In this way the city's built area will increase to 5160.6 ha (Table 1, Fig. 5).

Economic activities, according to their nature, interfere with geomorphological matrix and determine numerous elementary processes and influence the intensity, duration and frequency in time and space of the current geomorphological processes (Coates 1976; Talen 2005). The most representative complex processes encountered on the administrative territory of Sibiu is diversified by the type of land use: compaction on horizontal surfaces, landslides, collapses, rill and interrill erosion, ravening, torrentiality on the slopes and fluvial processes in the riverbeds. (Table 3, Table 4). The greatest impact of human activities on landforms was made by leveling and reducing of altitudinal diferrences (Meyer 1994; Talen, Brody 2005) between floodplain and first terrace and ocally between the three terraces in the inner city, by channelization of Cibin riverbed and by excavation of the versant of Guşterița Hill in the clay pit area (Csima 2010).

Geomorphologic Conditions as Limiting Factors

Beyond the relief suitability for habitat and location of economic objectives, it should be noted, however, its restrictive role in urban development (Bucşa, Costea 2011). It derives from both the morphology and morphodynamic.

Table 4 presents the relationship between geology, relief and urban features. Geomorphological parameters and rocks play an important role into the favoring of current geomorphologic processes which can produce risks (Whitehead 2003).

The floodplain by deposits of loamy-sands and loamy-clay layers, lack of drainage and direct hydraulic connections with the Cibin river and its tributaries is an area which requires excess moisture mitigation measures and sanogenesis and rehabilitation of buildings, most of them damaged by dampness (Costea 2012).

Terrace forehead with steep slope and relief energy of 20-40 m constitutes a geomorphologic element of discontinuity in the urban system. On the one hand this differentiates altitudinally the city, as we mentioned above, on the other hand requires certain construction conditionalities and spatial planning through terracing, construction of individual housing, presence of gardens and green spaces alternating with built areas. Excavation for foundations and terraces forehead charging with heavy construction (houses with 2-3 floors or apartment buildings with 4-5 floors) determine breaking the balance of terraces deposits (which have a high content of clay) and landslides occurrence. Such of slope processes were mentioned also for other cities as a result of combination of natural factors and irrational antropogenic use land and space intervention (Mulder *et al.* 2001; Talen 2005; Tsai 2015).

Also, the geological and geomorphological features of the plateau constitute limiting factors of urban expansion in this unit (Table 4). The relief energy of about 100-150 m, the high slopes ($25 – 50^{o}$), the presence of clays and gravitational processes are restrictive elements that limit the development eastward and oblige to enlargement of Gușterița neighborhood to the versant bases, according the favorability of geomorphological parameters (Costea 2012).

Conclusions

The analysis of old cartographic documents, of recent maps and comparison with current ortophotoplans using GIS techniques has proven to be very valuable tools in urban geomorphology study of the Sibiu city. Corroborating of information from maps with demographics and land use data has contributed to highlighting the most relevant issues in urban sprawl and functional dynamics of the city. Spatial distribution of the relief, with their favorable elements and dysfunctionality, and their relationship with urban spatial structure (intravilane – hearth of the city and extravilan), require that this natural component must be treated as a key factor of urban planning and spatial evolution.

Following this analysis, the conclusion is that the Sibiu city has a remarkable geomorphological potential in a contact area mountain – plateau, especially a diversity of landforms developed on altitude; this gives a variety of possibilities for the spatial arrangement and development and determine an urbanistic mosaic. The larger development of Cibin river floodplain and terraces through their cvasi-horizontal surfaces and stability ensures the basis to support the urban system.

The current geomorphological processes and overcrowding raises problems in two areas: the foreheads of the Cibin River terrace and the western slope of the Hârtibaciului Tableland on which Gusterita neighbourhood is in continuously expansion. In these circumstances, a good planning of the city development, sustainable management of current functional areas and sustainable policy of environment and constructions is a mandatory triad in the choice of optimization strategies of territorial development. These can not be achieved without the consultation and active involvement in strategy implementation of specialists in many fields, in this case, the geomorphologists, geologists and urban planners.

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Maps and statistics

Morando Visconti map 1699 — Sibiu – Harta Morando Visconti, Muzeul National Brukhenthal, Sibiu (1699).

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http://www.sibiu.ro/ro2/pdf/2012/PUG2012/MEMORIU_GENERAL.pdf

Tab. 4 Geological and geomorphological characteristics and related urban features in Sibiu City area.

Source: Author elaboration; Qh – holocene deposits of sand, silt, small gravels; Qp – Pleistocene deposits of coarse sands and gravels, clay, loamy deposits; Pn – Pannonian deposits consist of clay, marls, loamy and clayey sands, thin horisons of small gravels

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Tab. 3 Utilizarea terenurilor pe suprafața administrativă a municipiului Sibiu şi principalele procese geomorfologice asociate. Sursa datelor de utilizare a terenurilor: http://www.sibiu.ro/ro2/pdf/2012/PUG2012/MEMORIU_GENERAL.pdf

Tab. 4 Caracteristici geologice şi geomorfologice şi particularitățile urbane associate în municipiul Sibiu. Sursa: elaborat de autor. Qh – depozite Holocene mâluri, nisipuri, pietrişuri mărunte; Qp – depozite Pleistocene de nisipuri şi pietrişuri grosiere, argilă şi depozite lutoase; Pn – depozite Pannoniene de argilă, marne, nisipuri lutoase şi argiloase; orizonturi subțiri de pietrişuri mărunte.

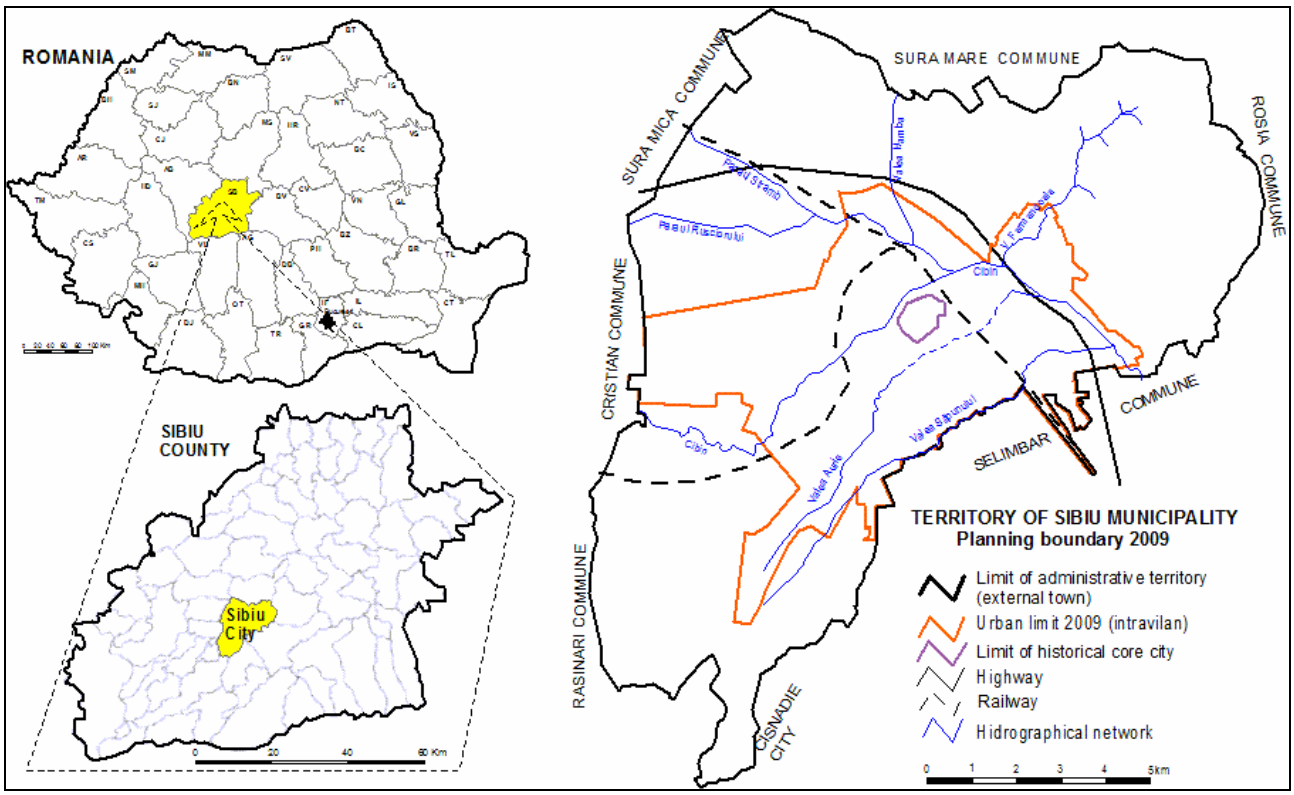

Fig. 1 Localization of study area. Source: Author elaboration.

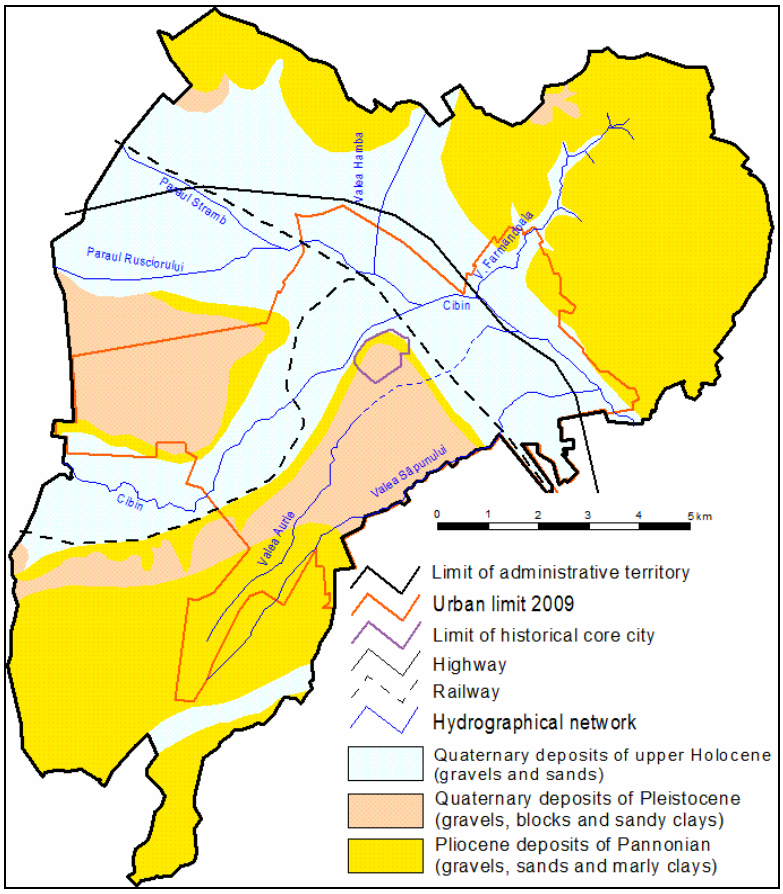

Fig. 2 Geological map of Sibiu City

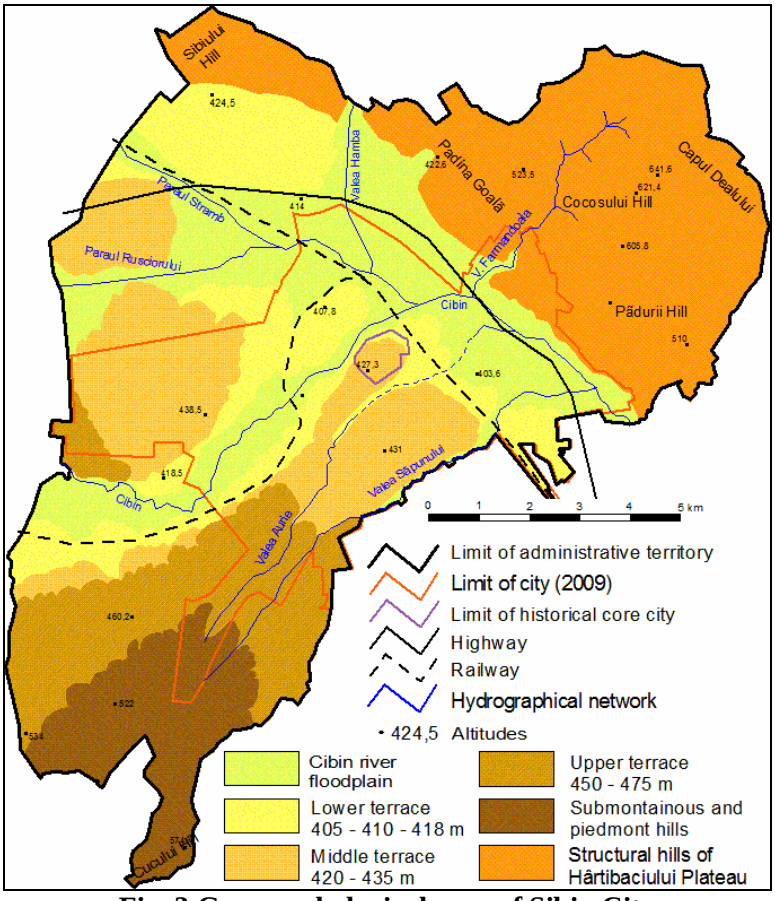

Fig. 3 Geomorphological map of Sibiu City

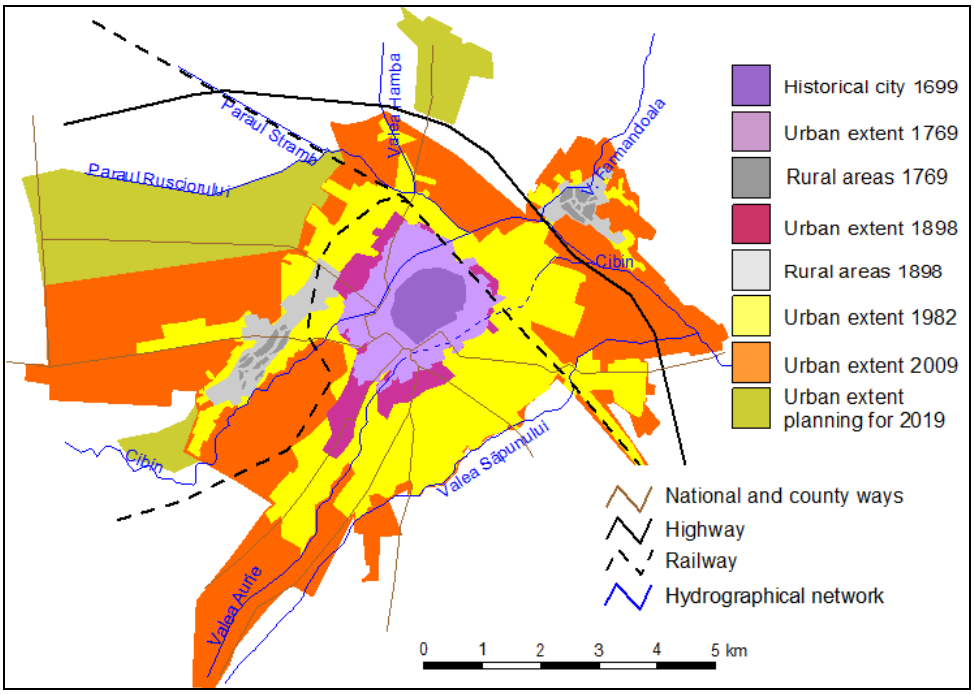

Fig. 4 Sibiu City – spatial evolution

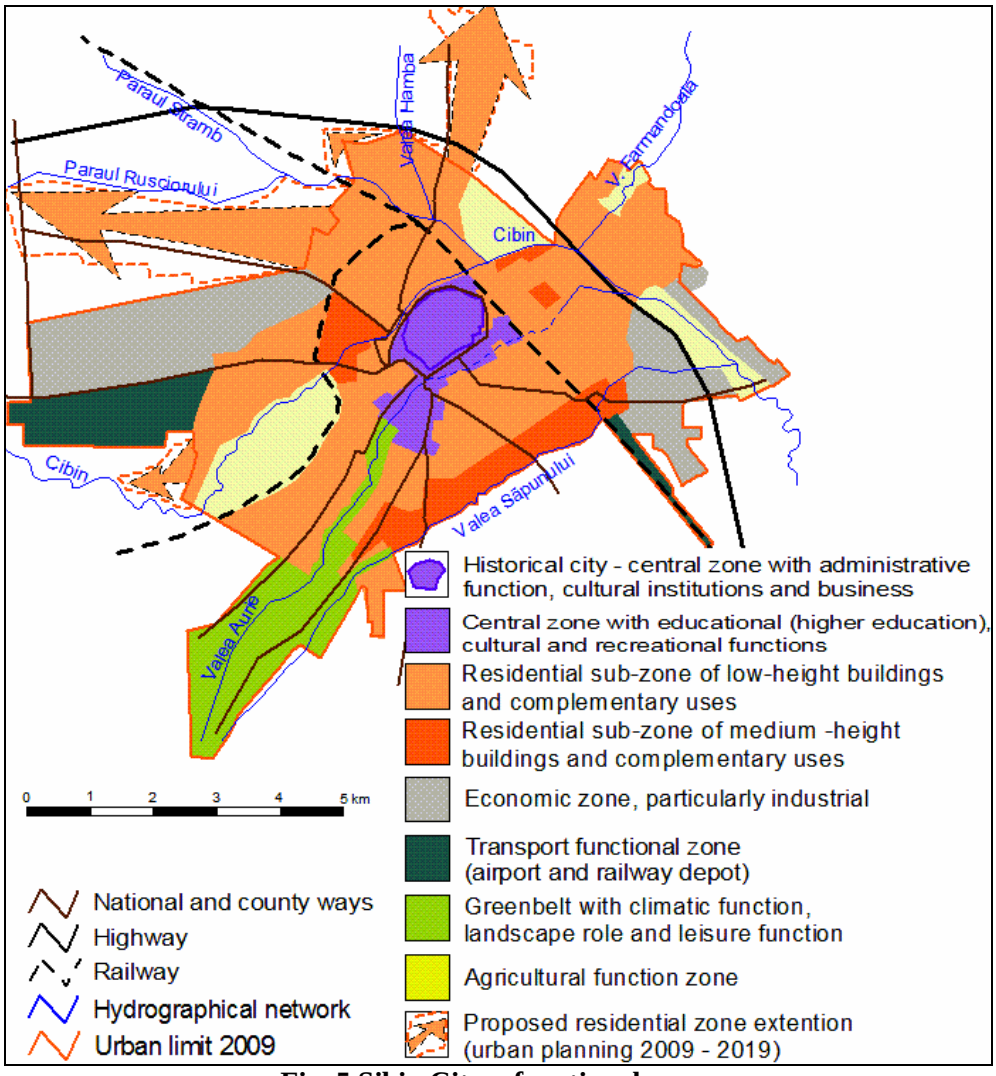

Fig. 5 Sibiu City – functional zones

Tab. 1 The spatial evolution of the built area (intravilane) correlated with population growth of Sibiu city and urban expansion rate

Year	Hearth urban area (ha)	Population (no. inhabit.)	Expansion period	Increase in urban area (ha)	% of urban area increase	Cumulative % of urban area increase
1480	470	4775	1480 - 1885	92	2.59	2.59
1885	562	19446	1885 - 1900	0	0	2.59
1900	562	29577	1900 - 1930	630	17.74	20.33
1930	1192	49345	1930 - 1992	1282	36.11	56.44
1992	2474	169656				
2010	4020.75	154080	1992 - 2011	1546.75	43.56	100
2011	4020.75	147245				
			Total increase 1480 - 2011	3550.75	100	
2019 - Projected urban area 5160.6 ha			Total increase 2010 - 2019	1139.85	22.08	

Source: Author elaboration after raw data provided by recent and historical statistics

Tab. 2 The current distribution of administrative territory of Sibiu Municipality on relief unit and landforms

Relief unit	Landforms	Total surface (ha)	Built up area exclusive Sibiu city (ha)	% from total admin. surface	% from built up area Sibiu (without Păltiniș)
Sibiu Depression	Piedmont	1048.54	165.24	8.62	4.23
	Terraces:	5191.6	2312.97	42.68	59.21
	III rd terrace	1457.25	389.48	11.98	9.97
	II nd terrace	1994.90	1203.55	16.40	30.81
	I st terrace	1739.45	719.94	14.30	18.43
	Cibin floodplain	2684.59	1227.38	22.07	31.42
Hârtibaciu Tableland	Guşterița Hill	3239.27	200.79	26.63	5.14
Total surface (ha)		12164	3906.38	100	100

Source: Data obtained from measurements on general geomorphologic map and administrative map

Tab. 3 Land use on administrative surface of Sibiu Municipality and the geomorphologic processes

Category of use		Surface		Geomorphologic processes	
		ha	%	elementary	complex
Lands with urban uses (intravilane) from which:		4020.75	33.05	Alteration with chemicals from hydrocarbons and household waste	Compactation, suffusion, landslides
- Păltiniş		114.37	0.93		
- Sibiu City		3906.38	32.11		
Functional zones of Sibiu city intravilane (ha and % from total built up area of Sibiu City)	Central Business District	196.29	5.03	Sealing of surfaces Weathering of buildings	Compactation of terraces deposits
	Residential and mixed zone	1117.35	28.60	Local alteration with household waste and hydrocarbons	Local compactation and landslides
	Industrial and storage zone	538.43	13.78	Alteration with chemicals and industrial waste	Compactation, suffosion
	Agricultural zone	868.81	22.24	Weathering and alteration with chemical fertilizers and pesticides	Compactation, suffusion, erosion, landslides
	Communal /technical zone	77.14	1.97	Sealing of surfaces and local alteration	Compactation
	Communication network	603.03	15.44	Alteration with hydrocarbons	Compactation, landslides
	Green zones and forests	210.99	7.20	Moistening, alteration with biological decomposition products	Weak interrill and rill processes
	Hydrographical network	48.91	1.25	Moistening, hydration alteration, infiltration	Fluvial processes in riverbed
	Special uses zones	117.62	3.01	Weathering and alteration	Compactation, suffosion
	Unused land	57.81	1.48		
Agricultural lands		6449.02	53.02	Weathering, alteration with chemical fertilizers	Soil sealing, rill and interril erosion, landslides
Woodlands		1593.14	13.10	Moistening, alteration with biological decomposition products	Weak erosion and superficial landslides, creep
Lands covered by waters		38.88	0.32	Moistening, hydration alteration	Fluvial processes in riverbed
Other uses		62.21	0.51		
Total		12164.00	100		

Source of land use data: http://www.sibiu.ro/ro2/pdf/2012/PUG2012/MEMORIU_GENERAL.pdf

Tab. 4 Geological and geomorphological characteristics and related urban features in Sibiu City area

GEOLOGICAL AND GEOMORPHIC FEATURES			URBAN FEATURES													
			Urban surface				Develop-ment		Conec-tivity		Drai-nage	Risk associated to				
			Continuity	Discontinuity	Stability	Instability	Horisontal	Vertical	Good	Low	Good	Medium-Low	Maximum flow, floods	Gravitation	Hidrogeology	Human actions
Qh – aluvial deposits			x		x		x	x	x			x	x		x	x
Qp – terrace deposits			x		x			x	x		x				x	
Pn – clay, marls, sand				x		x	x			x		x		x	x	x
Floodplain			x		x		x		x			x	x		x	x
Terrace surface (tread)			x		x		x	x	x			x				
Terrace steep slope (risers)				x		x	x			x	x			x		x
Plateau slopes				x		x	x			x	x			x	x	x
Geomorph. processes:	Compactation					x		x				x				x
	Landslides			x		x	x			x		x		x	x	x
	Collapses			x		x	x			x				x		x
	Rill erosion			x		x	x			x	x		x			x
	Torrentiality			x		x	x			x	x		x			
Geomorph. parameters:	Altitude	High	x		x	x	x	x	x		x			x		x
		Low	x		x		x	x	x			x	x			x
	Slope	High		x		x	x			x	x			x		x
		Low	x		x			x	x			x	x			
	Relief energy	High		x		x	x			x	x			x		x
		Low	x		x			x	x			x	x			
	Fragm. density	High		x		x	x		x		x		x			x
		Low	x		x			x		x		x				
	Exposure	Flat	x		x		x	x	x			x	x			x
		Sunny		x		x	x	x			x					x
		Shady		x		x	x					x		x	x	x

Source: Author elaboration; Qh – holocene deposits of sand, silt, small gravels; Qp – Pleistocene deposits of coarse sands and gravels, clay, loamy deposits; Pn – Pannonian deposits consist of clay, marls, loamy and clayey sands, thin horisons of small gravels

THE FIRST RECORD OF THE GIANT SHARK *OTODUS MEGALODON* (AGASSIZ, 1835) FROM ROMANIA

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Rodica CIOBANU*
Vlad CODREA**

Abstract. *Herein, we describe and illustrate two isolated shark teeth that we assign to the species Otodus (Megaselachus) megalodon. The teeth were collected from Lower Badenian sedimentary rocks, from the Mureş seaway and the Transylvanian Basin. We discuss the main scenarios regarding the genus' evolution and the presumed phylogenetic connection with the recent great white shark, Carcharodon carcharias. Using available data and a regression formula based on Shimada (2003) we have reconstructed the size of the sharks from which the teeth originated from. The present record of this species is the first from Romania.*
Keywords: *Middle Miocene, Central Paratethys, Otodus megalodon, Transylvania, Romania.*

Rezumat. *In acest articol descriem si ilustrăm doi dinți izolați de rechin pe care îi alocăm speciei Otodus (Megaselachus) megalodon. Dinții au fost colectați din roci sedimentare aparținând Badenianului inferior din culoarul Mureşului şi din Bazinul Transilvaniei. Discutăm scenariile principale cu privire la evoluția genului şi presupusele conexiuni filogenetice cu marele rechin alb actual, Carcharodon carcharias. Folosind datele disponibile şi o formulă de regresiune bazată pe Shimada (2003) am reconstituit mărimea corpului rechinilor de la care provin dinții. Prezenta semnalare este prima pentru țara noastră.*
Cuvinte cheie: *Miocen mediu, Parathetysul Central, Otodus megalodon, Transilvania, România*

Introduction

Shark remains are quite rarely described from the marine formations in Romania and particularly even less from the Miocene. This comes not only from the fact that the outcrops are poor in such fossils but also from the fact that the finds are often only briefly reported by the authors as "fish teeth" or are even lately lost. The only published paper regarding sharks from the Miocene in Romania concerns the Coruş Formation (Şuraru, *et al.* 1978) that has an Eggenburgian age (Filipescu 2008, p. 59; i.e. the early part of the Burdigalian in the central Paratethys; Steininger, 1999). Taking into account the scarcity of the Miocene shark remains, we think that the discovery of these isolated teeth are a valuable addition to the knowledge of the Miocene shark fauna of Romania.

Otodus megalodon is one of the most famous fossil sharks from all geological history.

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Teeth of this species have been found in most of the countries that are part of the area that was once the Central Parathetys.

In this part of Europe there are records from the Badenian (Langhian + early Serravallian) of Slovenia (Mikuz, Soster, 2013; Mikuz *et al.* 2014), from a number of Badenian sites in Austria (Schultz 1971, 2013; Hiden 1995), from Late Langhian (latest Early Badenian and the Middle Badenian) of Czech Republic (Schultz *et al.* 2010) and from the Late Miocene of Greece (Symeonidis, Schultz 1973). Our find fills a geographic gap in the European distribution of this species.

For a long time, the fossil shark teeth similar to the ones of the extant large white shark *Carcharodon carcharias* were included, all together, in the same single genus *Carcharodon*. In this paper we will use for teeth reported in old issues and from collections that no longer exist (therefore, we cannot consult anymore), "*Carcharodon* type".

In Romania teeth of *"Carcharodon* type" drew the attention of the first fossil vertebrate palaeontologists. As early as 1850, a first issue

concerned the fossil sharks from Turnu Roşu (=Porceşti). The author, Johann Ludwig Neugeboren was the pioneer in the study of fossil sharks in Romania (Ciobanu 1996e). His work "*Die vorweltlichen Squaliden-Zehne aus dem Grobkalke bei Portsesd am Altflus unveit Talmats*" is impressive in the detailed descriptions that he gives to the species of the sharks found. Among the described shark teeth, there are no less than 18 species of "*Carcharodon* type" (Neugeboren 1850, 1851). The descriptions of the shark teeth were done, according to the knowledge of that time without being aware of heterodonty in a shark. Unfortunately, none of his"new" species described are now valid either because of the loss of specimens, or synonymy. Nonetheless it is important to note Neugeboren as the first author that observed the presence of fossil sharks of "*Carcharodon* type" in Romania. Subsequently, just a few other authors mentioned briefly teeth of "*Carcharodon* type", all of these teeth originating from Paleogene deposits (e.g. Koch 1894; Bera 1962; Moisescu 1975). In the 80's, Şuraru, Şuraru, (1987) reported and described briefly among other species of fish a specimen of *Procarcharodon latidens* (Neugeboren) from the Late Eocene (Priabonian) of Cluj Napoca. After him, for long time no other author approach the study of fossil sharks. Still, a brief reference to the presence of the genus in the Cluj Limestone is made by Codrea *et al.* (1997). In 1994, the work on this topic was resumed by the palaeontologist Rodica Ciobanu, with an emphasis on the shark fauna from the Eocene deposits exposed in the area of Turnu Roşu region (Sibiu County; Ciobanu 1994; 1996a; 1996b; 1996c; 1996d; 1997a; 1997b; 1998; 2002; 2006). From these deposits Ciobanu (2002) reports *Carcharocles auriculatus* and *Carcharocles* cf. *angustidens*. The most recent publication (Dica 2005), records five *Carcharocles angustidens* teeth from the Priabonian of Cluj Napoca.

Geological setting

In Middle Miocene, a series of geological events occurred in the Carpathian region. In the Middle Miocene, the region already had a long geological history with a series of convergence and collisions, started since Cretaceous (Royden, Báldi 1988; Royden *et al.* 1983). Around 20-16 my ago, both the Pannonian and Transylvanian basins shared subsiding evolutions, accompanied by fractures and faults (mainly lipstick and strike-slip). In the Pannonian basin extension and subsidence resulted after a syn-rift phase occurred since the lowermost Badenian. A coeval evolution started in the Transylvanian basin too, the lowermost Badenian deposits lying on a wide regional unconformity (Huismans *et al*. 1997), on a sole comprising both older rocks of the Carpathian orogeny and various Paleogene and Early Miocene deposits. Apart these two basins, a series of subsiding blocks issued in the areas of the Carpathians. Those from Apuseni Mountains are significant because they opened seaway connections between the Pannonian and Transylvanian basins (Nicorici 1977). Basically, in Early Badenian times they constituted an archipelago in the Central Paratethys Sea (Rögl, Steininger 1984).

Lăpugiu de Sus (Hunedoara County)

A similar Early Badenian (Moravian) palaeogeography occurred in the so-called Mureş passageway located between the Southern Apuseni and Poiana Ruscă Mountains. The early Badenian waters made a connexion between the Pannonian and Transilvanian basins, including the smaller adjacent basins (Făget and Strei; the age of deposits is documented by the rich nannoplakton assemblages reported by Chira, Mărunțeanu 1999). The exact Badenian paleogeography of this seaway is difficult to reconstruct, because one may presume that at least a part of these deposits were subsequently eroded.
In this marine seaway there are some Moravian deposits containing rich mollusc faunas, the most famous ones being at Lăpugiu de Sus and Coştei. These faunas were initially reported by Bielz some years before the mid-19th century (1845) and continued until today (references in Chira, Voia, 2001). Apart from molluscs, these deposits yielded also other remains, such as vertebrates and plants (Givulescu, Codrea 1997), the latter indicating continental influences into the marine basin.

At Lăpugiu de Sus the Badenian there are deposits exposed in several creeks and valleys (most representatives are Coşului and Lăpugiului; Fig.1). The marine sediments are transgressing the old metamorphic (Gladna Nappe; Balintoni, 1997) and Mesozoic sedimentary rocks of the Poiana Ruscă Mountains or Late Cretaceous-Early Cenozoic magmatic rocks. The lithology is dominated by marls and clays, but in the top of succession there are interbedded sands. Chira *et al.* (1999) mentioned for Lăpugiu "sedimentary sequences bounded by unconformities associated with continental deposits" of which the plant remains mentioned above are clear evidence.

Borzeşti (Cluj County)

The stratigraphic provinance of the BBUPSM specimen (see abbreviations in the material and methods section), originating from the Transylvanian Basin, is a little bit more problematic, as long as it is difficult, if not impossible, to locate exactly the place named "Râtul Pleşilor". The only name resembling this one is "Fântâna Râtului" in the northeastern side of the village. In Chira (2000), at Borzeşti Early Badenian deposits are exposed. The "*Badenian conglomerates with Carcharodon*" as labelled of BBUPSM specimen come from these rocks (Fig. 2), which are are part of the Dej Formation (Early Badenian, i.e. Moravian; Chira 2000).

Material and methods

Herein, we describe and figure two upper teeth, both incomplete, collected, from Lăpugiu de Sus (Hunedoara County) and Borzeşti (Cluj County).

The abbreviations used for the collection names where the two specimens are hosted are: NHMS for the Natural History Museum in Sibiu and BBUPSM for Babeş-Bolyai University Palaeontology-Stratigraphy Museum in Cluj Napoca.

The Lăpugiu specimen (NHMS collection):
A single isolated tooth (Fig.4) was collected from the Coşului Creek, a small left side tributary of the Lăpugiului Valley that flows in Lăpugiu de Sus village. The collecting place is located about 50 m upstream from the cemetery bridge, on the right bank of the creek, from a pink-yellowish sandy layer rich in corals and mollusc fragments. This bearing layer is situated underneath a thick hard grey-blue clay layer, a marker around the whole creek.

The tooth was donated by one of the authors (N.T.) to the NHMS and now is curated into the palaeontological collection.

The Borzeşti specimen (BBUPSM collection no. 22375):

This specimen (Fig. 5) was collected on April 1987 from Râtul Pleşilor, Borzeşti Village (Cluj County), by the former geology student I. Florea. According to label (Fig.3a), the tooth originates from "*Badenian conglomerates with Carcharodon*". From a second label that accompanies the fossil (Fig. 3b) we can deduce that it was handed over to Prof. N. Şuraru that included it in this collection. He assigned this specimen to"*Procarcharodon megalodon*", but it remained unpublished.

The measurements of the fossils were done using a Unior calliper with a measurement error of 0.02 mm. The photos were captured with a Nikon D700 camera and a Sigma lens of 105 mm, using a tripod. Observation of serration was done using an Optika stereomicroscope.
The position of the teeth was considered using the graphic synthetic representation of teeth done by Gottfried *et al*. (1996) and modified by Pimiento (2010b), available at permalink DOI:10.1371/journal.pone.0010552.s001. The identification of the fossils is based on references. Fossil or Recent comparative material for this genus is not available in Romania.
The systematic palaeontology follows Cappetta (1987, p.26, 103) and Cappetta (2012, p.9-30).

Systematic palaeontology

Order Lamniformes Berg, 1958
Family Otodontidae Glikman, 1964
Genus Otodus Agassiz, 1843

Type species: *Otodus auriculatus* (Blainville, 1818)

Diagnose of genus

In order to make a distinction from the teeth of the great white shark from the genus *Carcharodon*, Jordan, Hannibal (1923) erected the new genus *Carcharocles*, based on the presence of lateral cusplets for the teeth of Eocene age. The original diagnose states: "Teeth similar to *Carcharodon* but with a distinct denticle on each side on the base of the crown of the larger teeth, the crown narrower and more recurved than in *Carcharodon*, edges of tooth and usually the denticles also uniformly and rather coarsely serrulate; the broad root extremely lunate in the anterior teeth." (Jordan, Hannibal 1923, p.56).

Casier (1960) was the first to recognise that the *megalodon* and great white shark lineages were distinct. He erected the name *Procarcharodon* for the serrated-toothed members of the *megalodon* lineage, unaware that this had already been done by Jordan, Hannibal (1923).

Cappetta (1987), in the Handbook of Paleoichthyology 3B recognised Jordan & Hannibal's priority and advocated the use of *Carcharocles* for all the serrated-toothed members of what we now refer to as the *megalodon* lineage. Glikman (1964) was the first to refer of all the teeth of "*Carcharocles*" with lateral cusplets to

Otodus. He referred *megalodon* to a new genus *Megaselachus*. His work was largely ignored until resurrected by Zhelezko and Kozlov (1999) and Cappetta (2006, pp. 328, 343)

More recently Cappetta (2012, p.224), in the updated edition of the Handbook of Paleoichthyology, volume 3E, referred *megalodon* to *Otodus*. The lineage was divided up into three subgenera; *Otodus* (*Otodus*) for the unserrated Paleocene and early Eocene species, *Otodus* (*Carcharocles*) for the Palaeogene serrated species and *Otodus* (*Megaselachus*) for the Neogene species, including the giant species, *O. megalodon*.

The transitions between *Otodus* (*Otodus*) *obliquus* and *Otodus* (*Carcharocles*) *aksuaticus* and *Otodus* (*Carcharocles*) *auriculatus* was figured in King *et al.* (2013).

Diagnose of species

The teeth of *Otodus megalodon* are of large size, triangular shape with a broad serrated crown, lingual face convex, labial face flat, large neck, robust, thick, and angled or a more rounded shaped root with dispersed foramina (Pimiento, 2010a). Juvenile teeth of this species usually possess cusplets which are gradually reduced in ontogeny (Ward, Bonavia 2001; Diedrich, 2013). *Otodus megalodon* differs from *Carcharodon carcharias* by lacking a labiolingually flattened crown (Purdy *et al.* 2001), having a larger, massive root and finer, more regular and lobed serrations (Nyberg *et al.* 2006).

Description of specimens:

The Lăpugiu de Sus specimen (Fig.4 d,e,f) has a general triangular shape, almost equilateral. The crown is broad, as is the root and well serrated. The lingual side is convex, while the labial one it is mostly flat and very slightly overhangs the root. The edges have small serrations on their entire length (Fig.4c). The neck (dental band) is preserved, well defined and moderately high. No lateral cusplets are present, but at the base of the crown, just above the root, is chipped, on both sides. The root is incomplete, but the general angled shape can be clearly deduced. Despite the fact that it lacks a part of the root and the very tip of the crown (Fig.4a,b), the tooth does not show much damage due to water transport before burial, the serrated edges being preserved quite sharp.

The tooth is small to medium sized compared to other teeth from this species that can exceed 160 mm (Gottfried *et al.* 1996). The preserved total height of the tooth, root to tip, is of 71 mm. The crown's apex is missing, possible as a result of a functional rupture but the missing part cannot exceed 5-6 mm. The preserved crown height is 51 mm, with an estimated complete height of 57 mm. The tooth being incomplete, we can only deduce the total width by mirroring the preserved left root to the other side. The preserved width is 65 mm, but we calculate an initial probable width of about 77 mm.

As for the tooth position, we think that it represents one of the first three upper lateral teeth because of the almost symmetrical and triangular shape, wider than the one of the lower teeth and with a slightly curved cutting edge.

The Borzeşti specimen (Fig.5d,e,f), preserves only the crown, the whole root is missing. Despite the fact that the tooth is still partially inside the rock matrix and about half of the lingual side is hidden to study, the basic measurements can easily be done. The height of the crown is 74 mm while its width is of 71 mm. The edges are fully serrated from the base to the tip, with an even and small serration (Fig.5 a,b,c). The general shape that is almost perfectly symmetrical and only very slightly distally inclined, less than the other tooth makes us consider it as an upper-anterior tooth, probably A1 to A3 possible position.

Considering the general morphology of the teeth displaying the key morphological characteristics, the geologic settings, but also the faunal assemblages of close areas from the Paratethys Sea we conclude that the teeth can only belong to *Otodus (Megaselachus) megalodon.*

Discussion

The evolutionary lineages were radically changed several times during the past decades. Genera changed and species were raised or rejected. For example no less than 96 nominal species of living and fossil sharks were related to the *Otodus* genus (Purdy *et al*. 2001, p.57). In our discussions we will focus on the phylogenetic lines that we support with the species *Otodus megalodon* as part of genus *Otodus* while reviewing briefly afterwards some of the most known current opinions regarding its ancestry and the current nomenclature of this shark. We will include in our remarks data about the phylogenetic line of the extant *Carcharodon carcharias* to show that it does not shared a common ancestor with *Otodus megalodon*. The main taxonomic steps that support our opinion and lead to the development of the shark that we describe, *Otodus megalodon*

are cited. A more detailed and based on arguments' discussion would be worth having, while performing a general revision of genus *Otodus* in Romania.

Over recent years three opinions regarding the phylogenetic lines, have been debated:

(1) The current conventional opinion (Cappetta 2012, p. 222) proposes that the extinct giant shark *Otodus megalodon* (Otodontidae) and the extant *Carcharodon carcharias* (Lamnidae), the great white shark, belong to different genera and different families with separate evolution lineages. The phylogenetic line of *Carcharodon carcharias* originates in the genus, *Macrorhizodus* Glickman 1964, while the one of *Otodus (Megaselachus) megalodon* originates in the genus *Otodus (Otodus)* (Kent 1994; Ward, Bonavia 2001; Nyberg *et al.* 2006, Pimiento, 2010b) (Fig.6a).

(2) Both the white shark *Carcharodon carcharias* and *Otodus megalodon* should be placed inside the *Carcharodon* genus. The phylogenetic lineage consists of two parallel lines originating in Paleocene (in *Paleocarcharodon orientalis)* one including the so called "small tooth white sharks" and the second one including "big tooth white sharks" (Purdy 1996; Applegate, Espinosa-Arrubarrena 1996; Purdy *et al*. 2001; Gottfried, Fordyce 2001) (Fig. 6b).

(3) The white shark *Carcharodon carcharias* originates in *Paleocarcharodon orientalis* but *Otodus megalodon* originates in the genus *Otodus*. All the species with larger and more massive teeth of *Carcharodon* are included in the genus *Otodus* (Diedrich, 2013) (Fig.6c).

In this article we follow the first opinion by agreeing with the idea that *megalodon* belongs to the genus *Otodus*.

We think that he phylogenetic line of *megalodon* has its roots in the genus *Otodus* (Fig.6a). The succession of species from the Late Paleocene (Thanetian) to early Eocene (Ypresian) layers sequence from Kazakhstan shows that the serration was acquired progressively, starting with *Otodus obliquus* a species without serration, then passing through *Otodus aksuaticus* with faint, incomplete serration and finally reaching *Otodus auriculatus* with a full and clear serrated edge (King *et al*. 2013). A similar succession of species can be also encountered in Uzbekistan where it was actually used as biostratigraphic tool for the Early Eocene. The succession of species is spaned NP 11, NP 12 and a part of NP 13 nannofossil zones (Malyshkina, Ward 2016).

The next step in the lineage following Otodus *auriculatus* is *Otodus sokolovi*, which is restricted to the Late Eocene. This with the succeeding species *Otodus angustidens* (? Priabonian - Oligocene) makes the transition towards the Neogene sharks with a smaller and more uniform serration (Ciobanu, 2002). *Otodus sokolovi* and *Otodus angustidens* also mark an increase in size of teeth and of course of the body length. While *Otodus auriculatus* is estimated to a length of 4 m, the two new species reach at least 6 m (Applegate, Espinosa-Arrubarrena 1996).

The last step before *Otodus megalodon* is the late Oligocene species *Otodus chubutensis*. The species *Otodus subauriculatus* (Agassiz, 1843) is sometimes substituted, however as the type is lost and its provenance unknown, we regard it as a *nomen dubium* (David Ward, pers. comm. July, 2016).

The differences between *Otodus chubutensis* and *Otodus megalodon* (Early Miocene to Mid Pliocene) are very small. The only distinction seems to be that *Otodus chubutensis* still retains reduced and rounded cusplets in the adult stage (Ameghino, 1901, 1906) while *Otodus megalodon* does not. However, in the Miocene juvenile teeth of *Otodus megalodon* retain their lateral cusps, and in ontogeny pass through morphology almost identical to that of *Otodus chubutensis* (Ward, Bonavia 2001; Pimiento *et al.* 2010, Diedrich 2013). Pimiento *et al.* (2013a) tried to give other morphological criteria as a way to separate the *Otodus megalodon* from *Otodus chubutensis* and she mentions that in *Otodus chubutensis* the cusplets are not separated from the crown of the teeth in subadults and adults. We find these characters to be weak, considering the high variability of cusplets morphology in this genus well illustrated in *Otodus angustidens* (Gottfried, Fordyce 2001).

A very strong support for this lineage comes also from Russia where a similar, high resolution transition is reconstructed starting from Paleocene (Late Danian) to Lower Oligocene (Rupelian). The differences from our proposed lineage consist in a few additional species in the Early Paleocene that precede *Otodus obliquus* and several supplementary transitional species and subspecies in the Eocene and Oligocene–(Zhelezko, Kozlov 1999, p.138).

As for the other issue that is debated, the origin of the actual great white shark, the analysis of *Carcharodon carcharias* origins appears to be nowadays clearly not related to *Otodus megalodon*. At the beginning only apparent and supposed (Muizon, Devries 1985) the lineage *Macrorhizodus - Carcharodon* is now unmistakable. The examination of recent published works that include the description of very well preserved and even associated specimens made clear the strong connection between *Macrorhizodus* and *Carcharodon*. This lineage most likely starts from the Paleogene species *Macrorhizodus praecursor* continues with the unserrated Neogene species *Carcharodon hastalis* as non serrated ancestors, probably piscivorous sharks, it passes through the semi serrated *Carcharodon hubbelli* and it ends in the fully serrated *Carcharodon carcharias* (Ehret *et al*. 2009; Ehret *et al.* 2012; Long *et al.* 2014).

The reassessment of the famous, controversial tooth from the National Museum of Natural History from Washington D.C. (USNM no. 336204) seems that settled another dispute regarding the timing of appearance of *Carcharodon carcharias.* This isolated tooth originating in the Middle Miocene formations was considered to be the proof that *Carcharodon carcharias* was older than the supposed transition *Carcharodon hastalis - Carcharodon hubbelli - Carcharodon carcharias* that took place in the uppermost Miocene to lowermost Pliocene time span (Long *et al.* 2014). The tooth is now reassigned from *Carcharodon carcharias* (Gottfried, Fordyce, 2001) to *Otodus megalodon*, based on the presence of a chevron shaped neck, the thickness of the crown and the serration type (Ehret *et al.* 2012).

This relative fast functional-morphological transition took place in the interval 6.9 to 5.3 million years ago (Long *et al.* 2014). The change in diet is the probable control factor that drove this change, *Carcharodon carcharias* becoming a shark with a diet based on marine mammals (Ehret *et al.* 2012).

Supplementary data in the support of this lineage originating in the genus *Macrorhizodus* comes from a meticulously morphological analysis of shape, growth rate and serration in teeth from *Carcharodon carcharias*, *Carcharodon hastalis* and *Carcharocles megalodon*. The result of this comparative analysis demonstrates once more that *Carcharodon carcharias* originates from an "*Isurus*-like" ancestor, probably close to *Isurolamna*, and is not closely related to *Carcharocles megalodon* (Nyberg *et al*. 2006).

From the analysis of available data we think that it is quite clear that serration evolved more than one time and in more than one taxonomic group in a rather fast pace.

The second opinion, states that *O. megalodon* and *C. carcharias* are part of the same genus and closely related, sharing diagnostic characteristics. Purdy (1996) and Applegate, Espinosa-Arrubarrena (1996), constructed similar phylogenetic lineages starting from the Paleocene species *Paleocarcharodon orientalis* with two supposed parallel lineages leading to *Carcharodon carcharias* and *Carcharocles megalodon* (Fig. 6b).

The placement of both *C. carcharias* and *O. megalodon* in the same genus is based on several similarities between the juvenile dentition of *C. carcharias* and fossil species: (a) ontogenetic change of serration in both *Carcharodon carcharias* and *O. megalodon* where the teeth change from having coarse serrations as juvenile to more fine serration as adult; (b) the presence of a narrow neck area in the juvenile dentitions of *Carcharodon carcharias*, similar with the more developed one in *O. megalodon*; (c) similar morphology of juvenile *Carcharodon carcharias* and *Palaeocarcharodon orientalis*. The study of associated fossil dentitions and of extant white shark also revealed common characters not found for example in *Isurus*:

(a) the second upper anterior tooth, rather than the second lower anterior, as in other lamnids, is the largest tooth in the dentition;

(b) the tip of the intermediary tooth is pointed mesially instead of distally;

(c) a very straight second upper anterior tooth (Purdy *et al.* 2001).

It is interesting to note a few points regarding this opinion. For example the transition between the presumed Oligocene *Carcharodon* species and upper Miocene *Carcharodon carcharias* is done through the lower Miocene species *Carcharodon gibbesi* (Michelotti, 1861). This very rare species is erected on a single incomplete lateral tooth missing the apex and part of the distal edge. Also the species *Carcharodon noday* considered by Purdy (1996) as transitional between *Carcharodon auriculatus* and *Carcharodon gibbesi*, in the same reference is considered to be

just a synonym of *Carcharodon auriculatus* (Applegate, Espinosa-Arrubarrena, 1996, p.28).

In the third opinion, Diedrich (2013) makes some interesting assessment on the phylogeny. While Purdy (1996) considers a common ancestor Diedrich's view is different. He considers that some of the curently accepted phylogenies are in fact only morphologic lineages based on serration as main distinctive character. The new phylogenetic lines that he proposed also include the "resurrection" of *Carcharodon orientalis*, previously considered an evolutionary dead end (Dica 2005). This species is now continued by the possible succession *Carcharodon auriculatus* - *Carcharodon subauriculatus* - *Carcharodon gibbesi* and finally *Carcharodon carcharias* (Fig. 6c). Diedrich (2013) claims that the compressed roots of *Carcharodon orientalis* in lateral and posterior teeth is the most important distinctive character in the separation between *Otodus megalodon* (or *Carcharodon megalodon* for Purdy) lineage and *Carcharodon carcharias* lineage. The *Otodus megalodon* lineage Diedrich considers being composed of the following species: *Otodus obliquus* - *Otodus subserratus* - *Otodus sokolowi* - *Otodus angustidens* and finally arriving at *Otodus megalodon*. All his opinions while unusual are based on research relying on a new and vast collection from Germany (ca. 2000 teeth).

We certainly did not have the possibility to examine such large number of teeth but nonetheless some questions marks arise from his argument. The gradual evolution from *Otodus obliquus* to the serrated teeth of *Carcharocles auriculatus* is noted by Diedrich but attributed by him to a "mixed" lineage. His theory comes in great contrast with the current acceptance that two cosmopolitan top predators are unlikely to have being contemporaneous (Ward, Bonavia, 2001). Also the link that Diedrich (2013) does between *Carcharodon orientalis* and *Carcharodon auriculatus* is unclear. *Carcharodon orientalis* (the presumed ancestor of *Carcharodon auriculatus*) it is not reported from the transitional layers, late Palaeocene and early Eocene. We find Diedrich's opinions interesting, but we consider them yet unsubstantiated.

Stratigraphic distribution:

According to some authors *Otodus megalodon* it is found starting from Early Miocene (Yabe *et al.* 2004; Ward, Bonavia 2001) and recent data seems to confirm this fact, lowering the basal boundary of this species from the Middle Miocene, cca. 17 M.a. (Pimiento 2010b; Pimiento *et al.* 2013a; Pimiento, Clements 2014) to cca. 20 M.a. (Pimiento *et al.* 2016). The upper range of its distribution seemingly is the end of Pliocene (Pimiento, Clements 2014) when due to competition from other predators (Pimiento *et al.* 2016) it disappeared. This kind of statistical studies are still inconsistent and the confidence interval is wide (Wang, Marshall 2016) leading to a poor time resolution.

Paleogeography and Paleoecology

Middle Miocene was a time of important changes in the paleogeography of Central Parathetys. While the connections with the Northern Sea are no longer in place, connexions with Mediterranean area and even Eastern Parathetys are still functional (Piller *et al*. 2007). Regional paleogeography (Rögl, Steininger 1984; Roegl 1998) shows that Central Parathetys Sea region was an archipelago of islands (Fig. 7).

Starting with the beginning of Badenian a general transgression occurred together with the installation of a subtropical climate (Filipescu 1996 and references therein).

The palynological data confirms that the climate was warm, subtropical, with an average annual temperatures in the range of 15 to 18°C and 1200 (Țabără, Chirilă 2012 p.200) and 1800-2000 mm rainfall (Chira *et al*. 2000, p.6; Petrescu 2003, p. 168). The occurrence of certain mollusc families and corals indicates that the water temperature might have reached more than 21°C. As for the habitat, the fossil assemblages are indicative for littoral to sublittoral realm and marine water with normal salinity (Chira *et al.* 2000).

Habitat and biology

With a cosmopolitan distribution, *Otodus megalodon* inhabited all the oceans on both hemispheres (Pimiento *et al*. 2016).

Otodus megalodon populated subtropical to temperate waters (Gottfried *et al.* 1996) with a high range of temperatures varying from 12 to 27°C (Pimiento *et al.* 2016). Teeth marks on fossil baleen whale vertebra (Purdy, 1996) and even cetacean bone with embedded shark teeth (Aguillera *et al.* 2008) suggest that this shark preyed on large marine mammals. While a preference for littoral habitats is suggested (Gottfried *et al.* 1996) it is possible that his habitat could extend also to deeper waters.

It is interesting to note that it is considered that the size of the body did not increase through time. This comes in contrast with the trend of increase found in the ancestors (Applegate, Espinosa-Arrubarrena 1996). A possible biological stasis was indicated as reason (Pimiento, Balk 2015). The unclear mechanism involved and the existence of very large teeth found in the basal Pliocene (David Ward, pers. comm., July, 2016) could, however, invalidate this conclusion.

Based on the relation between the height of the crown of the teeth and total length it seems that these sharks could reach 15 to 18 m (Gottfried *et al.* 1996; Pimiento, Balk 2015; Pimiento *et al.* 2016). Shimada (2003), based on the morphometry of *Carcharodon carcharias* created a regression formula in order to calculate the total body length (TL) of *Otodus megalodon*. It is true that the two species are not direct relatives but no other extant species share as many characteristics with *Otodus megalodon* as does the great white shark so, the two species are considered analogues (Pimiento *et al.* 2010; Pimiento, Balk 2015). Shimada (2003) calculated a regression formula for each individual position of the teeth considering also the dignathic heterodonty. Based on his formula we calculated the probable total length (Fig. 8) of the body by measuring the crown height for the two specimens that we discuss. The crown height for the Borzeşti specimen is 74 mm while for the Lăpugiu de Sus specimen is 57 mm (reconstructed size). As Pimiento suggested (Pimiento 2010a) we considered a range of three possible positions of the tooth and we calculated an arithmetic average of the obtained results (Table 1).

The relatively small to medium size of the teeth indicates that our specimens belong to a large juvenile or to an adult shark. It is estimated that a size of less than 4 m belongs to a neonate, a size between 4 and 10 m indicates a juvenile and a reconstructed total length of over 10 m indicates a mature specimen (Gottfried *et al.* 1996; Pimiento *et al.* 2013a). A global research on the body size of *Otodus megalodon* revealed that the most frequent total length value of *Otodus megalodon* it is 10.54 m (Pimiento, Balk 2015). This would suggest that specimens of 10 to 17 m are rare. We consider this result under the possibility of the biased collecting and we take in to consideration that it is based on the modern analogue, *Carcharodon carcharias* so the estimates might not be completely correct. Nonetheless the result is worth mentioning since it is the first such a global study. Further research could refine these results.

Conclusions

This paper describes the first records of *Otodus megalodon* from Romania which complements the European record of this species. It also important to note that this is the first record for the famous locality Lăpugiu de Sus, which while being extremely rich in fossil invertebrates this is the first record of a large sized shark. In our opinion, a revision of the entire *Otodus* genus, based on fossils curated in various collections from Romania and elsewhere is necessary.

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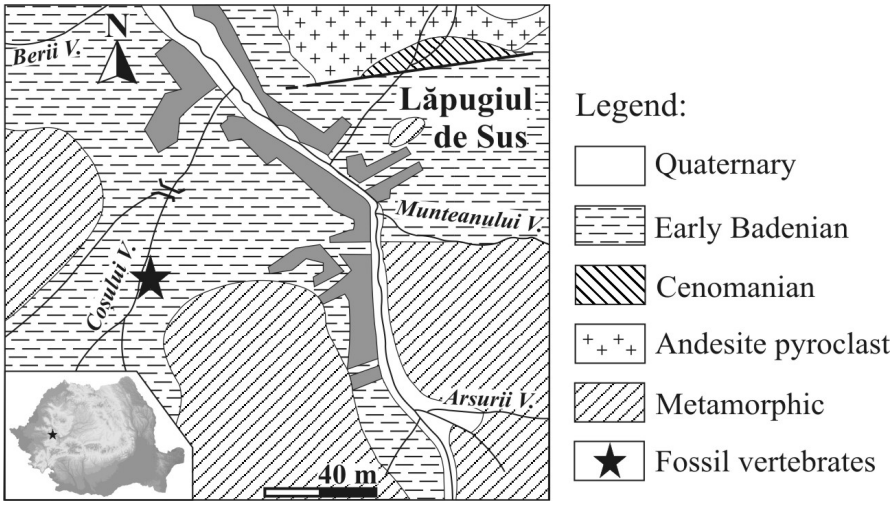

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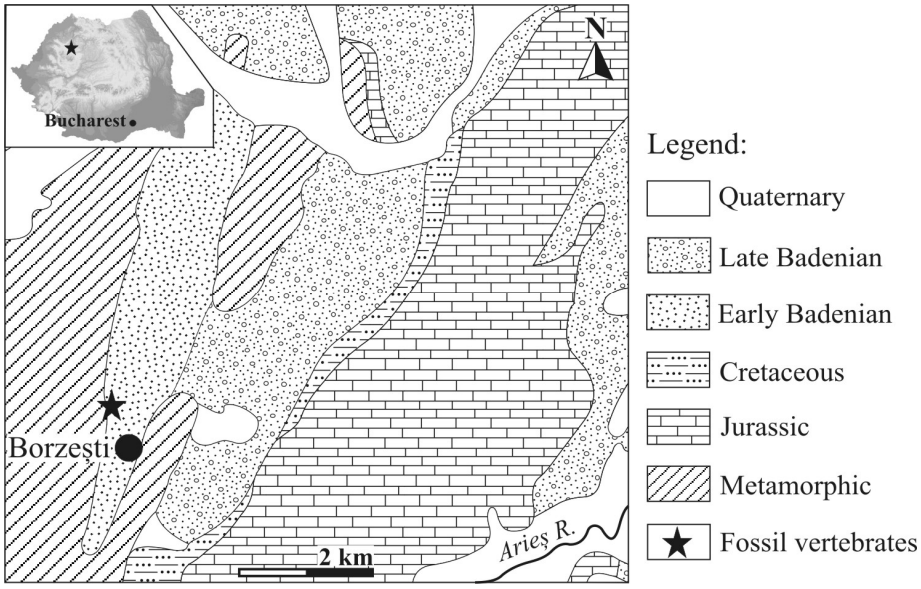

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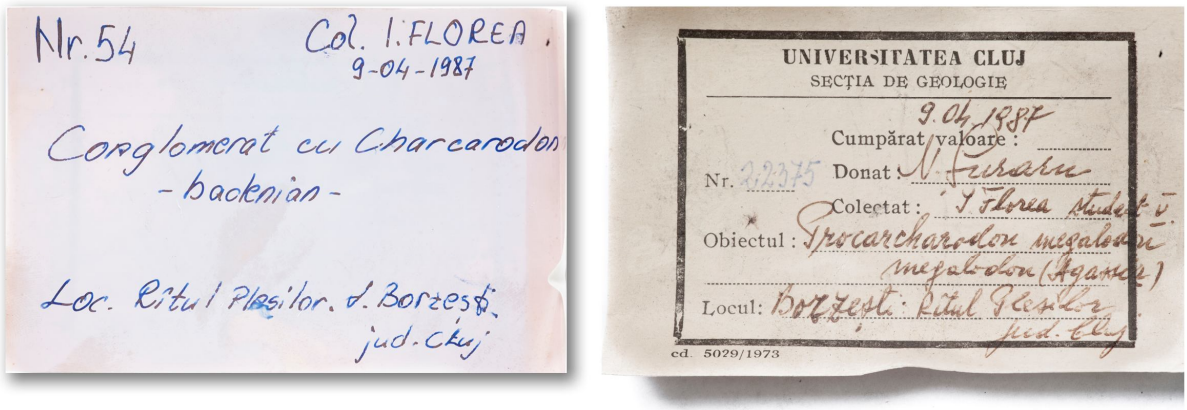
a b



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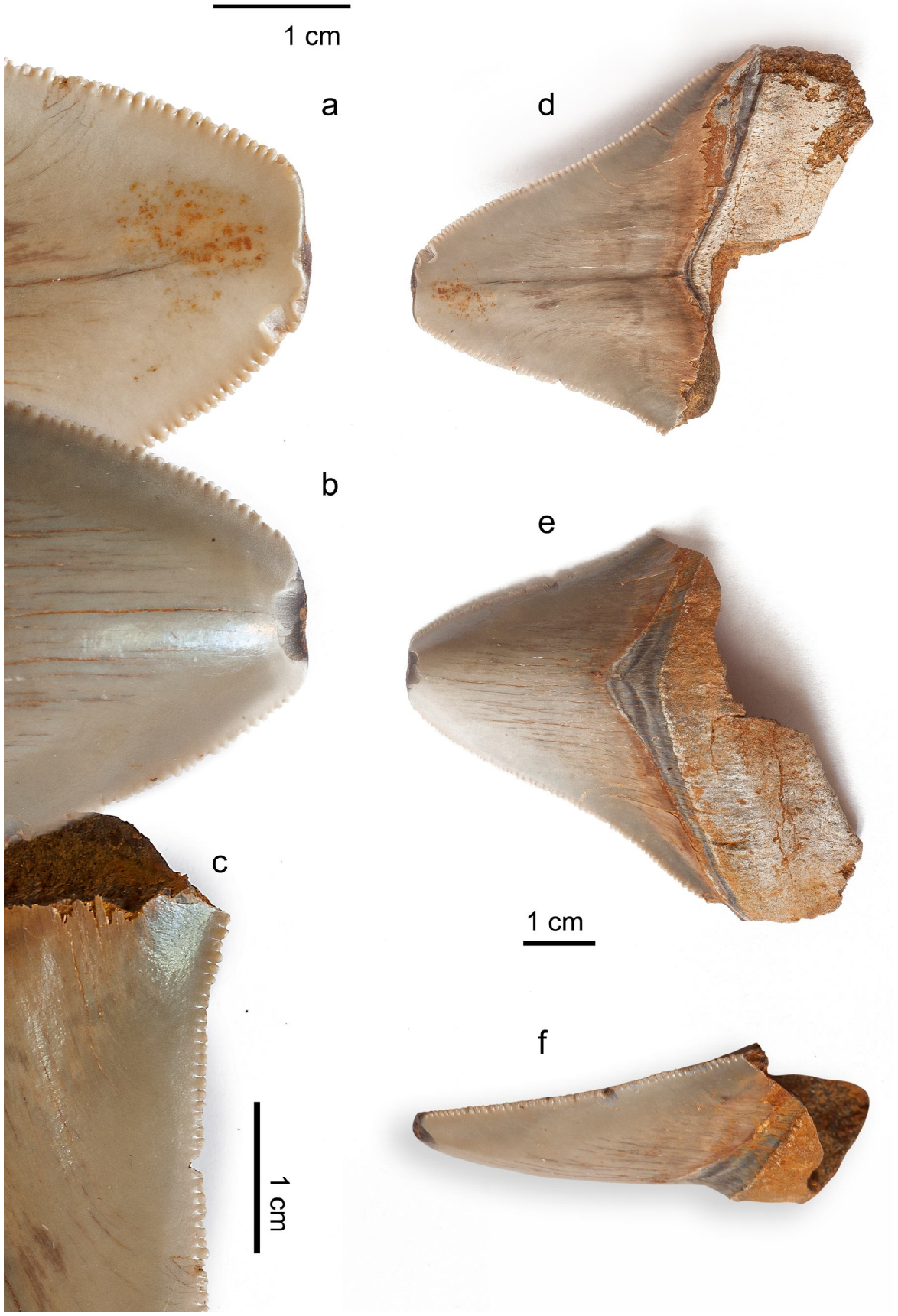

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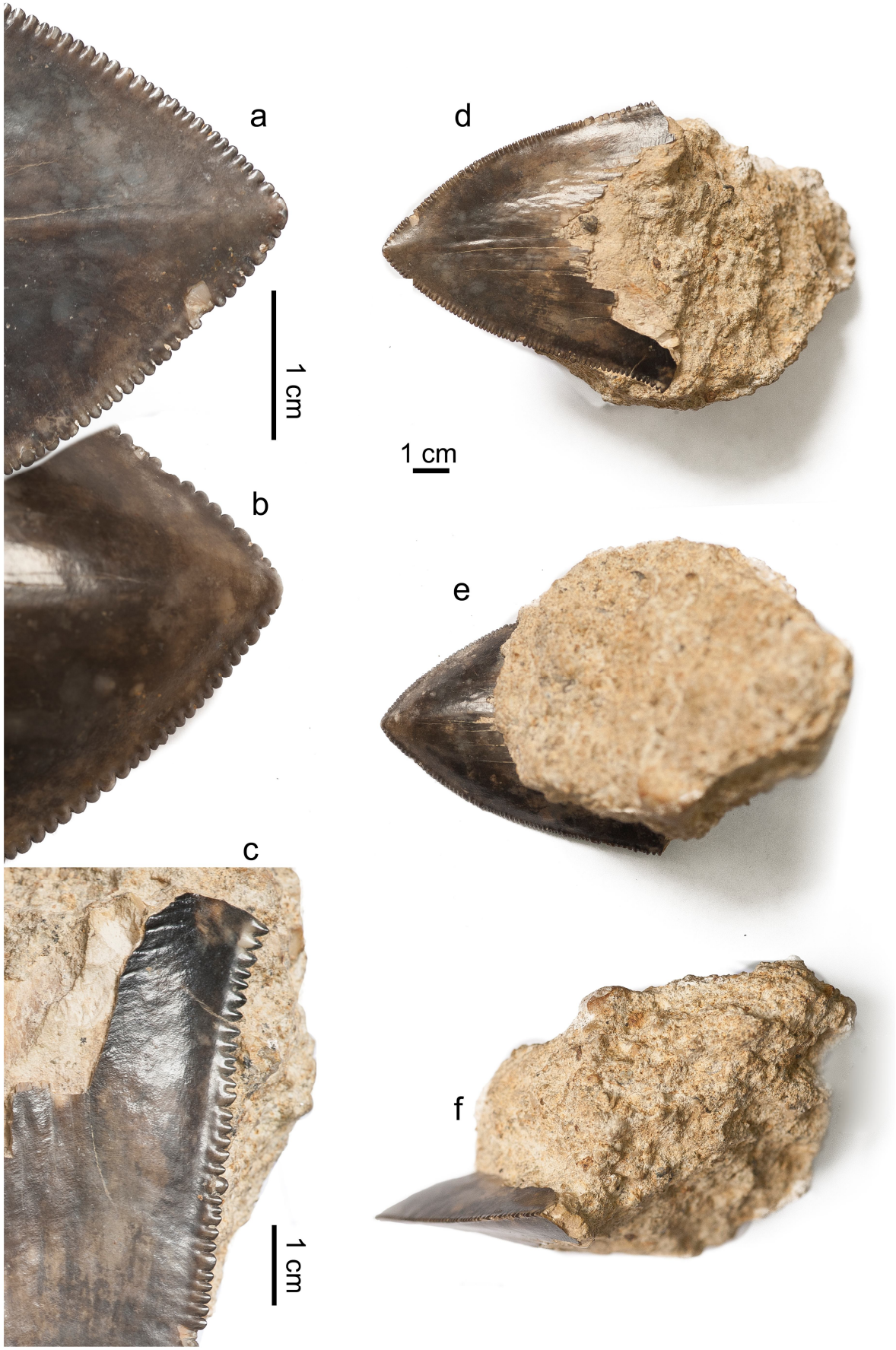

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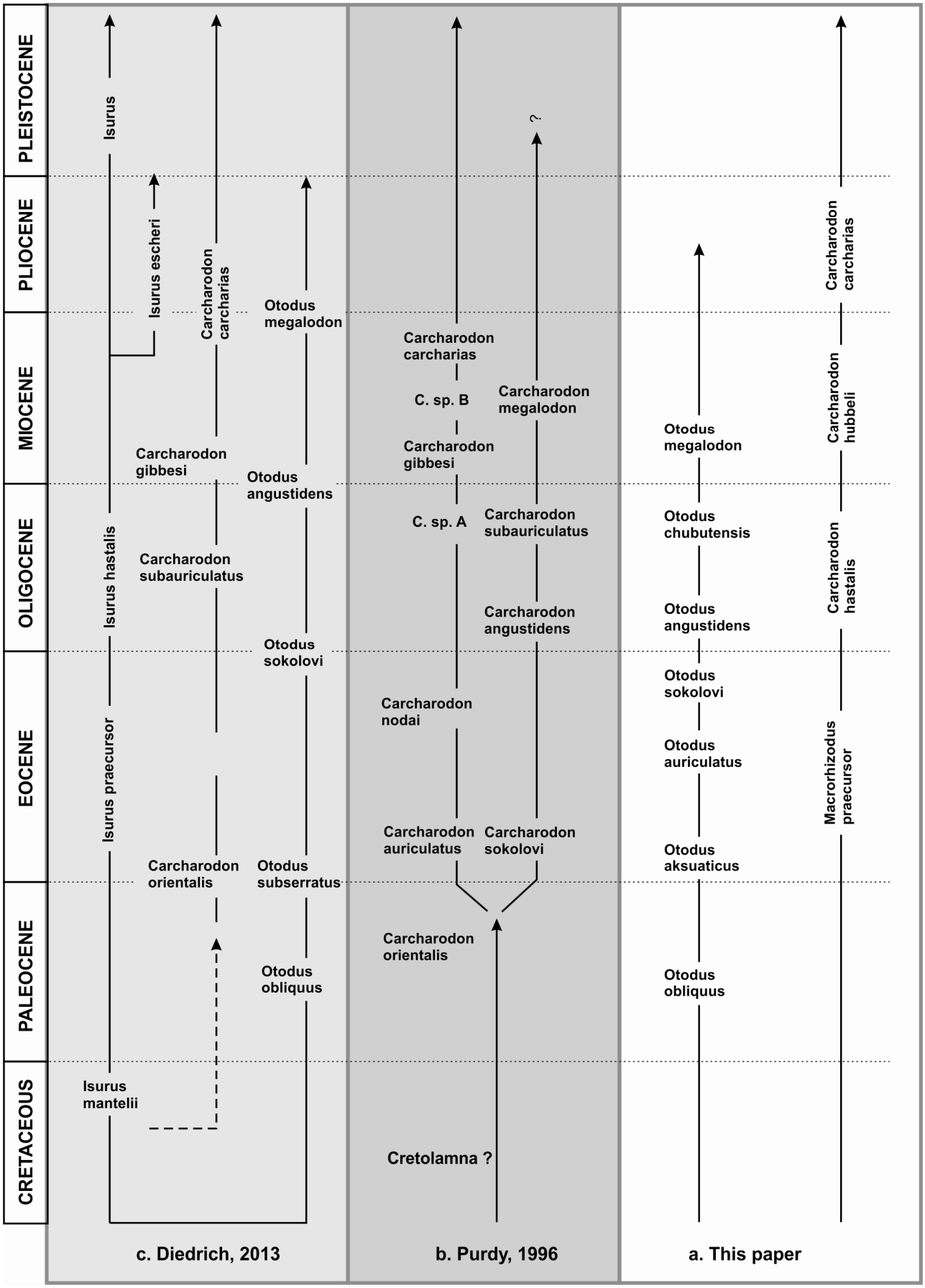

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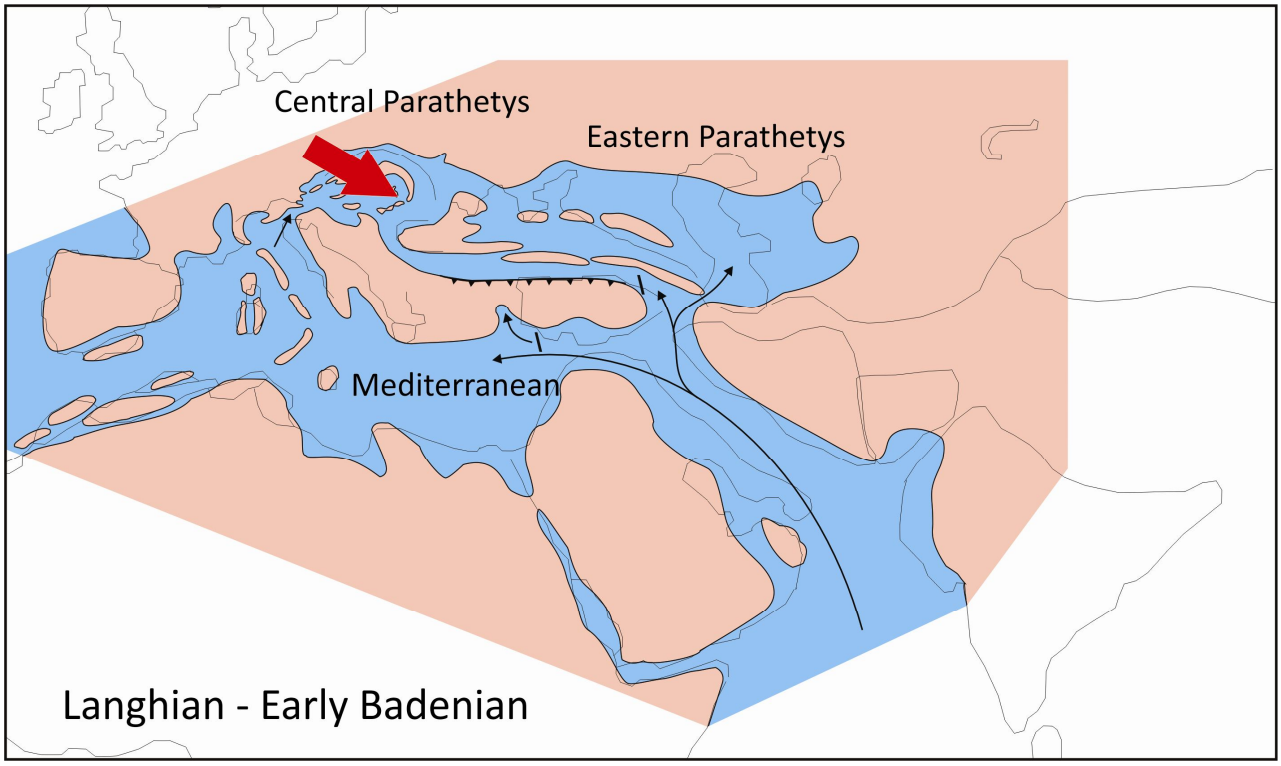

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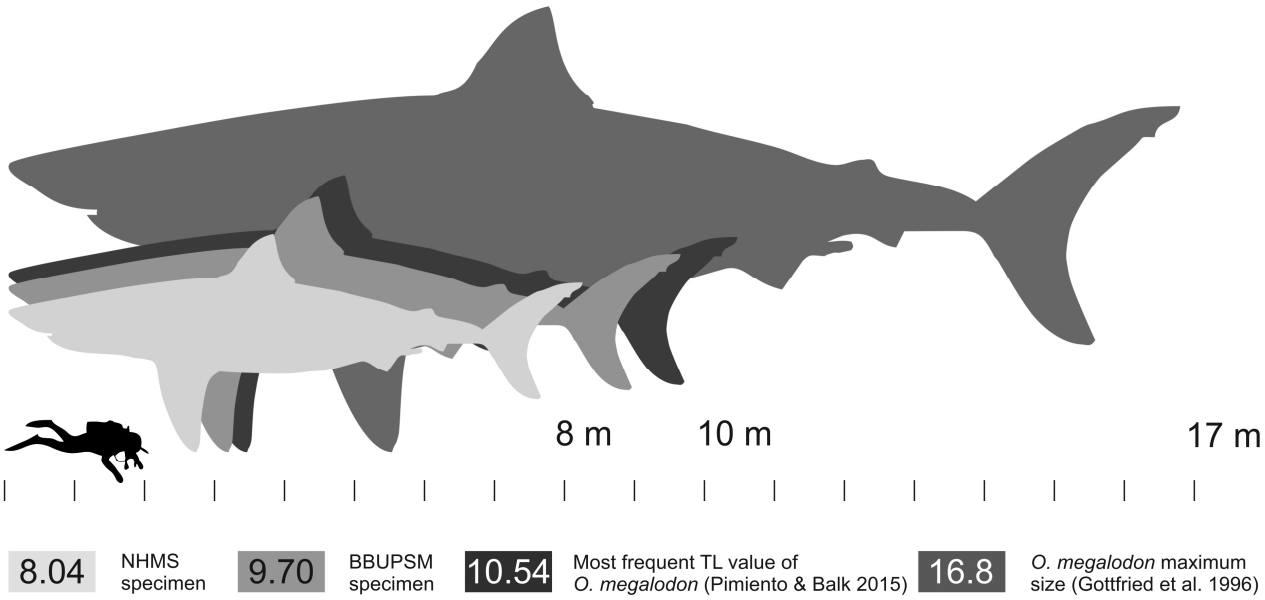


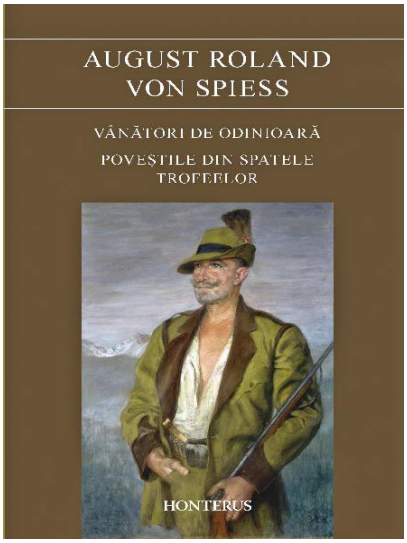
Fig. 8. Total length (TL) body reconstruction

Tab. 1. Calculation of the total length estimation of the two Romanian specimens

Tooth position	Total length (TL) regression formula (Shimada, 2003)	Reconstructed size
A1 BBUPSM specimen	5.234+11.522x74	8.57 m
A2 BBUPSM specimen	-2.16+12.103x74	8.93 m
A3 BBUPSM specimen	19.162+15.738x74	11.8 m
	Arithmetic average result:	**9.7 m**
L1 NHMS specimen	5.540+14.197x57	8.14 m
L2 NHMS specimen	4.911+13.433x57	7.70 m
L3 NHMS specimen	0.464+14.550x57	8.29 m
	Arithmetic average result:	**8.04 m**
* A refers to upper anterior; L refers to upper lateral		

August Roland von SPIESS, *VÂNĂTORI DE ODINIOARĂ. POVEŞTILE DIN SPATELE TROFEELOR*

Aurelian BORDEI*



"Vânători de odinioară - Poveştile din spatele trofeelor" (Old time hunters - The stories behind the trophies), Honterus Publishing House; 170 x 240 mm, hardcover, 280 pages and 166 pages containing tens of photographs (landscapes, scenes from hunting parties, moments from the life of the Spiess family). ISBN 978-606-8573-36-6. Price: 20 Ron.

Ten years after the issue of „Caprele negre din Masivul Retezat" (The chamois from the Retezat mountain) by Spiess (2005), in the fall of the year 2015, the work entitled "Vânători de odinioară - Pove□tile din spatele trofeelor" (Old time hunters - The stories behind the trophies) is published. Several hunting adventures, experienced by Spiess and narrated in German, were gathered and translated into Romanian within the aforementioned work.

The book, printed both in the Romanian language, as well as in the German, comprises 30 hunting stories where there can be found many biographical data about Spiess's activity.

The rich and diverse photographic material gives to present work a distinctive tone and altogether, transforms it in to a real competitor with other books published by prestigious hunting publishing houses, such as Numann-Neudmann.

The volume, whose stories are full thrilling, moments and descriptions of the still wild nature, is composed of three parts .

The first part: *August Roland von Spiess-biographical data.*

In order to understand the activity of this hunter, collector, but also naturalist, alongside the biographical data, the most important stages from the life of this man are presented with knowledge, passion and patience. The military career, the friendship with Andreas Berger, the connection with the Romanian hunters, shepherds and peasants, his position as Keeper of the Royal Hunting, had an important contribution to his make-up as zoologist, hunter and knower of the nature and creatures from Romania.

The second part: *The Museum of Arms and Hunting Trophies - The Exhibition.*

The history of the museum, it's structure with the detailed description of each room, including the storage from the attic, is in fact, a guide for the „August von Spiess" Museum of Arms and Hunting Trophies.

Together with the hunting trophies, (exhibited in each room, as well as in the storage from the attic), a large variety of hunting arms can be found, being completed by a series of hunting accessories, as well as a photographic documentary material.

Behind each trophy, pieces of information are noted concerning the place and date of the capture,

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the calibre of the arm used, as well as the names of those who accompanied him on the hunting parties.

The trophies displayed in the museum represent the fruits of a man's life work which was carried out with knowledge, passion and patience. They stand as testimonies of an abundant and diversified Romanian hunting fund, but also of a superb exotic wildlife which existed over a hundred years ago.

The third part: *Hunting stories.*

With a rich hunting language and a special style of storytelling, Spiess describes nature like no one else does. The stories abound in unpredicted situations and detailed descriptions of the events and landscapes, carrying the reader from the rocky abruptness of the Transylvanian Mountains to the lowest areas from the Danube's grasslands.

Towards the end of the volume, three stories about the two expeditions to East Africa are inserted, stories which can also be found within the book entitled "Din Ardeal in Kilimandjaro. Vânători în Africa" (From Transylvania to Klimandjaro - Hunters in Africa) by Spiess (1942).

Throughout the entire book, there are quotes taken from the articles and publications written by the author, having an informative role regarding the condition of the conservation of the species, but also the role of a warning to those who would shoot anything that came their way.

Time passed, but the facts were left behind. The nature described by the author is no longer the same, a fact which is also valid for today's generations, which have a changed view about hunting.

Although this book appeared in 2015, it does not reflect a current image of nature and of its wilderness.

In conclusion, the present volume describes a past situation, the title of the book being in a perfect accordance with the text.

An essential contribution to the issue of this publication was made by Mrs. Helga Stein, the granddaughter of this classic of the hunting literature, who re-brought to the attention of the readers, places, animals, people and facts from the old Transylvania, but also from other exotic places.

This work constitutes a real use, necessary for the hunting researchers, as well as for the interested public, so that they acquire a close knowledge of the hunting practices.

Two similar reviews (Mija 2015, Hărăgu 2016) highlight the solid contribution of the book to the vernacular hunting literature.

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Alexandru Ioan TATU, *PASIUNEA MEA INSECTELE*

Ioan TĂUŞAN*

"Pasiunea mea insectele" (Insects, my passion), Armanis Publishing House; 170 x 240 mm, hardcover, 318 pages. ISBN 978-606-8595-42-9.

Three years after Alexandru Tatu has left our world, "Pasiunea mea insectele" was published. The book is printed in Romanian and it contains a synthesis of his scientific work during 2010-2013 when he was a biology student at Babeş-Bolyai University of Cluj-Napoca.

The book begins with a foreword written by Alexandru's class master who highlights his personality, character and passion for insects and nature in general.

After this introduction the book comprises different aspects from Alexandru's scientific life: projects and articles.

The article *Comparative analysis of pitfall traps with different liquids for studying ground-dwelling insects with special reference to ant communities* is given in full-text. Alexandru's contribution was very important. He actively participated in the field experiment and in the taxa identification.

One of the Alexandru's first scientific contributions was the paper entitled *Armoured crickets (Orthoptera: Tetigonidae: Bradyporinae) in the Natural History Museum Collections of Sibiu (Romania).*

This article was presented in the Fifth edition of the Zoological Congress held at the Grigore Antipa Museum of Natural History Museum in Bucharest. There he met Dr. Ionuț Ștefan Iorgu, curator of the Orthoptera collection, and his collaboration on the crickets and grasshoppers begun.

His field campaign on crickets started after that meeting and as a result he published an article together with Ionuț Ștefan Iorgu, *First record of the bush-cricket Isophya harzi (Orthoptera: Phaneropteridae) outside its locus typicus.*

Moreover, Alexandru's Bachelor degree thesis (2013) was focussed on the impact of grassland management types on the abundance and diversity of grasshoppers. A synthesis of his results was published after his death, later that year.

In 2013 he started working also on the famous Romanian orthopterologist, Bela Kiss and managed to compile a list consisting of 148 species belonging to the Orthoptera Collection which is deposited in the Zoological Museum in Cluj-Napoca.

An important entomological contribution was the second record of the lace bug *Corythuca ciliata* in Romania, in the paper: *Corythuca ciliata (Say,*

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1832) – second record for the lace bug fauna of Romania.

Besides the scientific articles published in various journals from Romania, the book consists of different projects that Alexandru prepared as a student: Biodiversity conservation and nature protection. Biodiversity hotspots – Case study: Philippines islands; some irregularities identified in Fânațele Clujului Nature reserve; the circulatory system in invertebrates; Invertebrates of the deciduous leaf layer.

In the last part, the book contains the list of books that were donated by Alexandru's family to the Natural History Museum of Sibiu. More than 370 books are now in the museum library, together with his field equipment. Moreover, the guideline for obtaining the "Alexandru Ioan Tatu" scholarship is also given.

The book closes with the *In memoriam* papers (Rákosy 2013; Tăuşan, Iorgu 2014) and a poem written by Gabriela Gâlonța. The book contains all of Alexandru's diplomas and awards, together with a selection of photos.

The book, *Pasiunea mea insectele*, represents a glimpse of what Alexandru Tatu left for us and a way to connect with his love for all living things.

Farewell, my friend!

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THE STORY BEHIND THE "HISTORICAL DIAMONDS" CASSETTE

Nicolae TRIF*

In the spring of 2016 the Natural History Museum of Sibiu had an unexpected visit from the son of the donor of the "Historical Diamonds" cassette, Mr. Alexander Kolomyjczuk. This visit represented the reason of our research of reviving the story behind the donation of this interesting piece.

The cassette was donated to our museum in the year 1963 and ever since it represented a piece of interest in various exhibitions of the museum. The cassette contains a set of replicas of historical diamonds cut in high quality glass representing the most renowned diamonds found until the beginning of the 1900's. Sets of this kind are quite rare, especially complete and in good condition.

The 15 cut stones included in this set are, from left to right, front row to back row (in original writing):

Front row: Der "Florentiner", Osterreich (The "Florentine", Austria), Der "Regent" oder "Pitt", Frankreich (The "Regent" or the "Pitt", France), Der "Jubileums-Diamant" Excelsior (The "Jubilee Diamond" Excelsior), Der "Südstern" (The "South-Star"), Der "Blaue Diamant" (The "Blue Diamond").

On the middle row: Der "Nassak" (The "Nassak"), Der "Kohinoor" alteren Schliffes, England (The "Kohinoor" old cut, England), Der "Gross-Mogul" Russland (The "Grand-Mogul", Russia), Der "Kohinoor" neueren Schliffes, England (The "Kohinoor" new cut, England), Der "Sancy" (The "Sancy").

On the back row: Der "Polarstern" (The "North Star"), Der "Pigott", England (The "Pigott", England), Der "Orloff", Russland (The "Orloff", Russia), Der "Pascha von Egypten" (The "Pascha of Egypt") and finally Der "Schah of Persien" (The "Shah of Persia", Persia).

Displayed in a green velvet material as background, each stone sits in its cut out area, supported by a cotton base. All the pieces are in good condition, not chipped on the edges or cracked. No scratches are present with the exception of the "Kohinoor" piece that has a short and shallow scratch. All the pieces have labels, in gold letters on a dark blue background, fixed on the base with small brass pins.

The cassette originally held a small brochure that gave various details about the stones' origin, weight, owner etc. At a later date the brochure was cut out and parts of it were pinned down as the labels that we see today.

The exterior surface of the entire cassette is bound in a dark green material that imitates the leather. The exterior of the lid has and embossing with the text "Historische Diamanten". The interior of the lid has a silky lining of a light colour, slightly affected by time. A yellow braided cord adorns the lid all around the edge. In the centre of the interior side of the lid a rectangular discoloration betrays the presence of a probable manufacturer label. The exterior measurements of the cassette are 285 mm x 217 mm x 50 mm. A brass clasp in perfect condition closes the cassette.

The dating of the set is difficult since several editions were made. The only clue that we have is linked to the presence in the set of the Jubilee Diamond. This diamond does not appear in sets older than 1897 since it was discovered only in 1895 and cut for the 60th coronation anniversary of Queen Victoria in 1897 (www.etsy.com, 08.06.2016). It is safe to consider a dating of the cassette in the first decades of the 1900's. A similar set is hosted in the Mineralogy Museum of Babes-Bolyai University of Cluj, but it seems that it's not part of the same edition as our set, but probably an earlier one.

A few weeks after Mr. Kolomyjczuk's visit we received a letter from his mother, Ms. Karin Kolomyjczuk (Rohringer), which tells us first-hand the story behind this donation. We reproduce below the original letter and its translation.

"Vielen Dank, dass Sie es möglich gemacht haben, meinem Sohn Axel, die "Diamanten", die ich vor ca 50 Jahren dem Museum geschenkt hatte, zu zeigen. Mehr als auf der Beschreibung in der Kassette steht, kann ich nicht dazu sagen, ich kann nur meine persönliche Geschichte dazu erzählen. Ich bekam die Steine an meinem 18. Geburtstag von meinem Vater geschenkt. Ich hatte schon früher angefangen, Mineralien zu sammeln

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und mein Vater hatte mir wunderbare Holzvitrinen dafür zur Aufbewahrung gemacht. Diese Kassette hatte natürlich alles andere übertroffen. Wo er sie "her gezaubert" hatte kann ich nur vermuten, alle seine Geschwister lebten in Wien und daher hatte er sie wohl irgendwann mitgebracht. Aber das interessierte mich zu dem Zeitpunkt nicht.

Im Jahre1963 kam die Ausreisegenehmigung und es stellte sich die Frage, wohin mit den Kostbarkeiten. In meiner Familie oder Freundeskreis gab es keinen, dem ich sie anvertrauen wollte. Da kam wiederum mein Vater auf die Idee, sie dem Museum zu schenken. Zu diesem Museum hatte ich sowieso ein ganz besonderes Verhältnis. Als Kind ist mein Vater oft am Sonntag mit mir dorthin gegangen und ich war jedes Mal begeistert. Ich war sofort einverstanden. Da waren sie in guten Händen und würden noch vielen Leuten Freude bereiten . Ich hatte mich nicht leicht davon getrennt, aber es war die beste Lösung. Dass ich sie jetzt, mit 75 Jahren noch einmal sehen durfte, wenn auch nur auf Fotos, war ein großes Geschenk für mich (und das wieder an meinem Geburtstag) Danke!
Mit freundlichen Grüßen
Karin Kolo"

"Thank you very much for making it possible to show my son the "diamonds" which I donated to the museum 50 years ago. I cannot say more about them than what is written on the inside of the box, but I can add my personal story. I received the stones on my 18th birthday from my father. I had started collecting minerals at a younger age and my father had given me wonderful wooden display cases to store them in. This box has of course outdone all the others. I can only guess where he "conjured" it from, since all his siblings lived in Vienna and that is where he had probably brought it from. But at the time that did not interest me.

In 1963 we received our exit permits and the question arose what to do with our valuables. There was no one in my family or among our friends to whom I wanted to entrust them. It was my father again who came up with the idea of giving them to the museum. I had a very special connection to this museum anyway. Oftentimes, as a child, my father and I went there on Sundays, and I was excited about it every time. I agreed immediately. They were in good hands there and would bring joy to many people. I did not part easily with them, but it was the best solution. That I could now, at 75, see them again, if only in photographs, was a great gift for me (and on my birthday again). Thank you!

With kind regards,
Karin Kolo"

We would like to thank in the first place to the original owner, Mrs. Karin Kolomyjczuk, for her decision of donating this interesting and valuable piece to the Natural History Museum of Sibiu. Also we would like to thank Mr. Alexander Kolomyjczuk for facilitating the correspondence with Mrs. Kolomyjczuk, to Ms. Lumini□a Zaharia from the Mineralogy Museum of Babes-Bolyai University of Cluj for the information regarding the set of diamond reproductions hosted in the Cluj museum and also, we would like to thank Ms. Ioana Ciobanu for translating the letter of Mrs. Karin Kolomyjczuk in to English.

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Fig. 1e. Aspectul casetei deschise

Fig. 1f. Detaliu al primului rând, cu Diamantul Jubileului

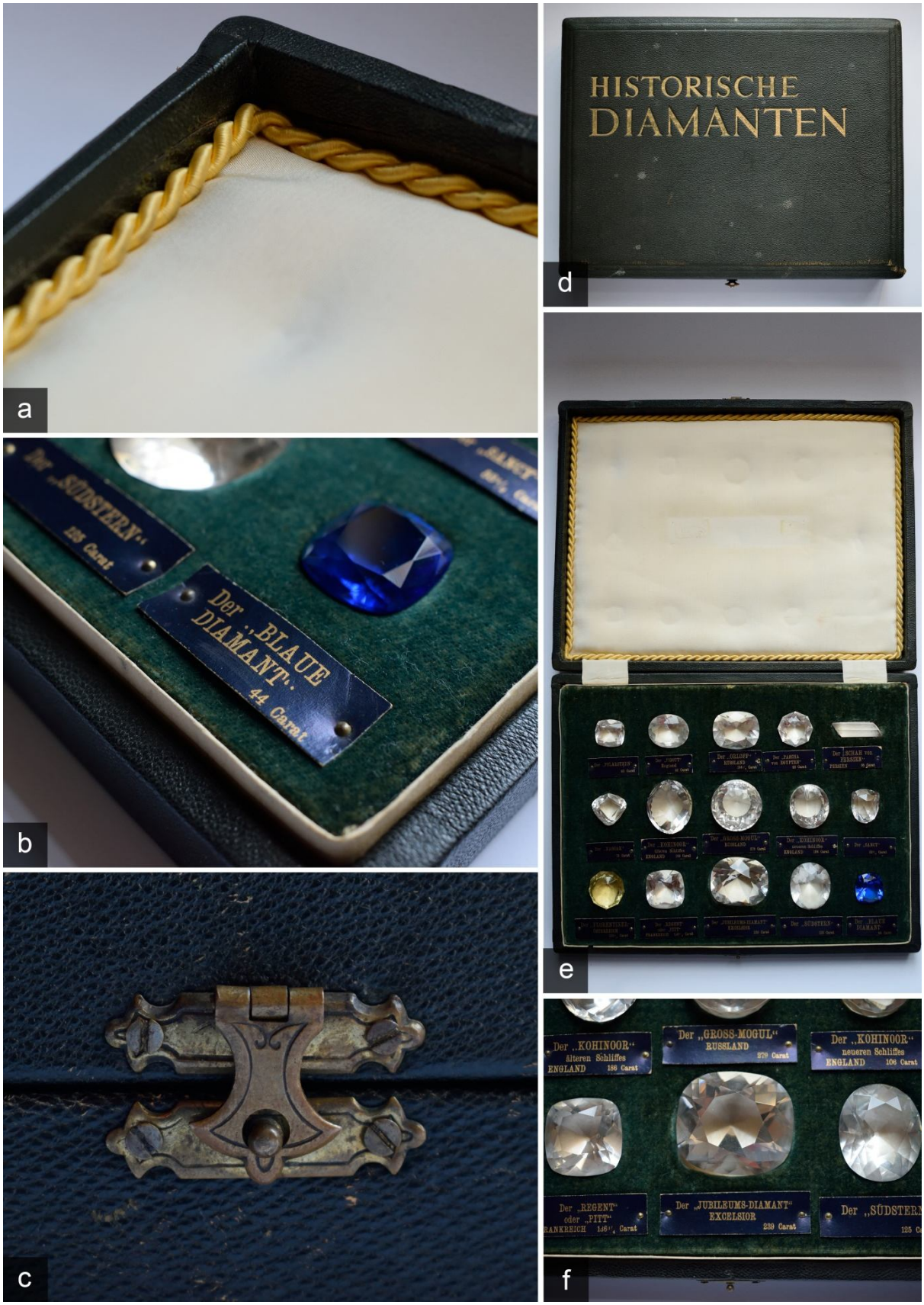

Fig. 1 The Historical Diamonds" Cassette

BRUKENTHAL NATIONAL MUSEUM IN 2015: A CHRONICLE OF NATURAL HISTORY EXHIBITIONS AND EVENTS

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Abstract: *The present study is a synthetic presentation of Brukenthal National Museum's cultural offer in the field of natural history during 2015.*
Keywords: *Brukenthal National Museum, natural history, 2015.*

Rezumat: *Articolul de față constituie o prezentare sintetică a ofertei culturale a Muzeului Național Brukenthal în domeniul istoriei naturale, pe parcursul anului 2015.*
Cuvinte cheie: *Muzeul Național Brukenthal, istorie naturală, 2015.*

1. Temporary exhibitions[1]

Out of the total of 34 temporary exhibitions opened in 2015 at the Museum's locations, 7 displayed selections of exhibits in various fields of natural history. What is to be noted in the exhibition agenda of the Museum of Natural History in 2015 is the diversity of the approached subjects from heritage selections to museum education projects and open air exhibitions.

a. Exhibitions at the Museum's locations:

_*Winter Visitors in the Garden of the Museum of Natural History* (Museum of Natural History, Multimedia Room, 13.02-30.09): the exhibition aimed at introducing 20 bird species to the public, often observed in Romanian cities during winter; 16 of these species were identified in the Museum's garden; were presented on display naturalized birds and documentary photos meant to drawing the attention on the birds usually unnoticed that live around us.

_*Birds Through the Eyes of Children – didactic exhibition* (Museum of Natural History, Multimedia Room, 13.02-30.09): the exhibition presented the outcome of the educational activities based on the "Winter Visitors in the Garden of the Museum of Natural History" main project.

_*120 years since the opening of the Museum of Natural History in Sibiu* (Museum of Natural History, Multimedia Room, 15.05-31.12): the exhibition presented historical documentation and heritage selection illustrative for the evolution of the Museum from its opening to the present.

_*Mineralia* (Brukenthal Palace, Temporary Exhibition Halls, 29-31.05): organized together with Mineralia Association, the exhibition presented collection samples, didactic kits, semiprecious stones, polished gemstones and mineralogy books.

_*Future`s garden in urban spaces* (Museum of Hunting, 17.07-01.11): six types of vertical gardens were built in the Museum of Hunting's courtyard with the financial support of the Științescu Fund; the gardens were set by high school students after attending specialized workshops and by using recycled or low-price materials.

_*Halloween Monsters and Bats – the True Nature* (Museum of Natural History, Multimedia Room, 31.10-8.11): the exhibition aimed to get the visitors acquainted with some of the protagonists of the Halloween night from a biological perspective.

_*Live reptiles* (Casa Albastră/Blue House, 1-12.2015): organized together with Ștefan Steinhubel, the exhibition presented various species of reptiles, most of them of exotic provenance.

b Online exhibitions:

_*120 years since the opening of the Museum of Natural History in Sibiu*
http://www.brukenthalmuseum.ro/index2.php/virtuale/expo_2

2. Natural history events organized and/or hosted by Brukenthal National Museum

_*Earth Hour 2015* (Brukenthal National Museum: all locations, 28.03): as in every year, Brukenthal National Museum joins in the Earth Hour campaign – the biggest voluntary action for the environment in the entire

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[1] The short descriptions of temporary exhibitions are selected from the texts given by the curators for public information.

history, involving 2 billion people. A simple gesture like turning off the lights is the first step in saving natural resources and preventing environmental degradation.
_Conference: *Homeopathy – Perpetual News* (Casa Albastră/Blue House, Multimedia Room (7-9.05): annually organized by the Homeopathy Medical Association of Timisoara, the 2015 international conference was dedicated to the celebration of 260 year since Samuel Hahnemann`s birth, to the 20 year celebration of Alonissos International Academy of Classic Homeopathy and to the International Homeopathy Day- 10th of May.
_*"120 years since the opening of the Museum of Natural History: 1895-2015" commemorative envelope and stamp launching* (Museum of Natural History, 12.05): event organized together with the Philatelists Association (Sibiu County).
_*The Anniversary Symposium "120 years since the opening of the Museum of Natural History"* (Museum of Natural History, 12 – 13.05): organized by Brukenthal National Museum through the Museum of Natural History and Arbeitskreis für Siebenbürgische Landeskunde Heidelberg e.V. (Germany), Sektion Naturwissenschaften, the symposium was held on the origins and emergence of collections of the Museum of Natural History, also including field trips.

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www.brukenthalmuseum.ro

MUZEUL BRUKENTHAL

PUBLICATIILE PERIODICE APARUTE DE-A LUNGUL TIMPULUI
(INCLUSIV PRECURSORII)

CRONOLOGIE	ISTORIE, ARHEOLOGIE	ARTA PLASTICA	STIINTELE NATURII	ETNOGRAFIE	RESTAURARE CONSERVARE
ANTE 1950		Mitteilungen aus dem Baron von Brukenthalischen Museum 1931-1937 – Neue Folge I-VII 1941 – Neue Folge VIII 1944 – Neue Folge IX-X 1946 -1947 – Neue Folge XI-XII	Verhandlungen und Mitteilungen der siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt 1849-1945, 95 de numere		
1950-1989	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	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	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	1998, nr. 27 2003, nr. 28 2004, nr. 29 + Supliment 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		2010, V, 4 2011, VI, 4 2012, VII, 4 2013, VIII, 4 2014, IX, 4 2015, X, 4

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