

## The Enchytraeid fauna of Romania

Gergely Boros<sup>1\*</sup> and Klára Dózsa-Farkas<sup>2</sup>

<sup>1</sup> Lendület Ecosystem Services Research Group, MTA Centre for Ecological Research, 2163 Vácrátót, Alkotmány u. 2-4, Hungary

<sup>2</sup> Eötvös Loránd University, Department of Systematic Zoology and Ecology, 1117 Budapest, Pázmány Péter sétány 1/c, Hungary

\* Corresponding author, e-mail: boros.gergo@okologia.mta.hu

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### Abstract

Within a project aiming to study ecosystem services in Transylvania, qualitative soil samples were collected to explore the enchytraeid fauna in the area. Completed these results with data from Dózsa-Farkas' earlier Romanian collections between 2005 and 2011, 55 species from 10 genera were found from which 1 genus and 36 species were new to the fauna Romania and 3 *Fridericia* species were to science. Most frequent species were *Enchytraeus buchholzi* sensu lato, *Enchytronia christenseni*, *Fridericia nemoralis*, *Buchholzia appendiculata* and *F. galba*. Reviewing the publications of former Romanian zoologists we summarized the known enchytraeid fauna of Romania.

**Keywords** Enchytraeidae | Oligochaeta | Transylvania | Carpathians | new species

### 1. Introduction

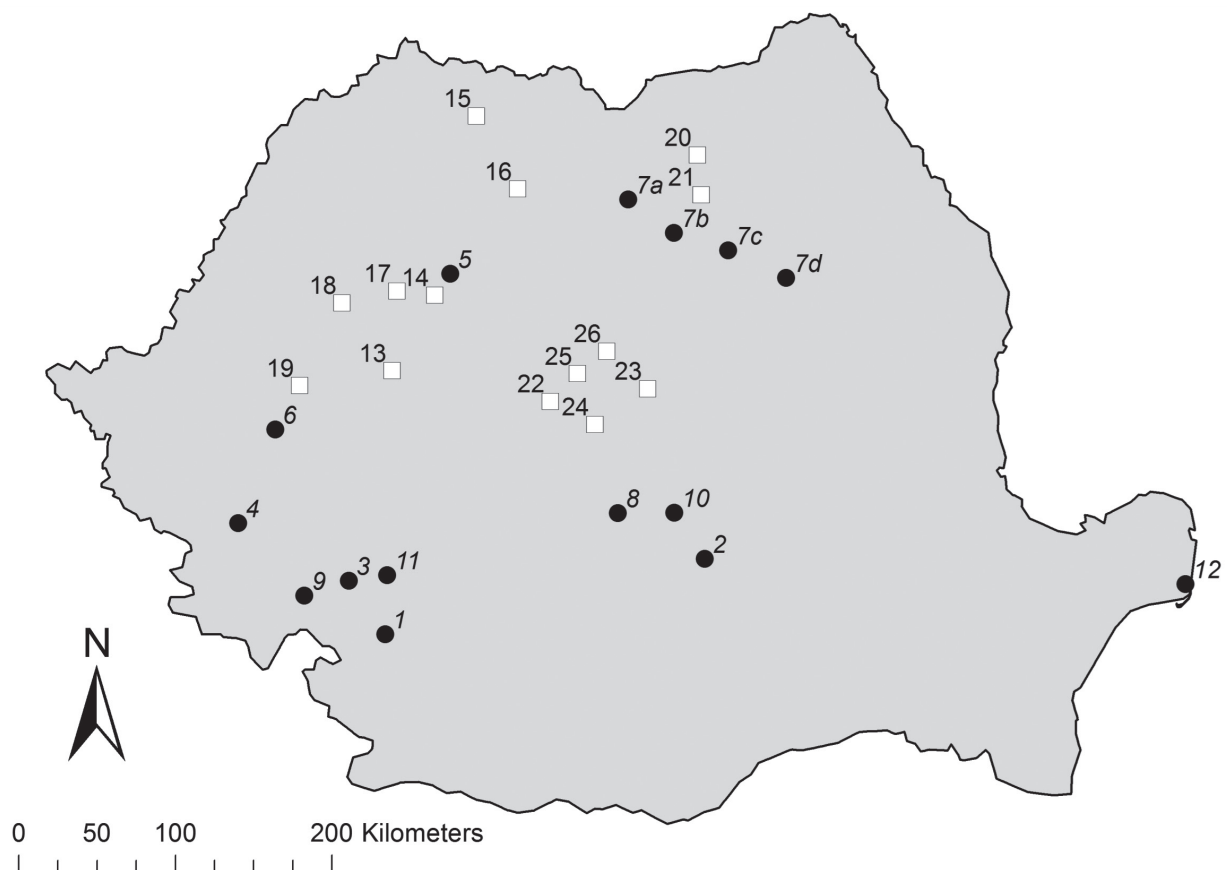
In recent years, a number of social-ecological investigations were performed in rural areas of Transylvania, Romania, addressing extensive land use, land abandonment, agricultural intensification, and ecosystem services (Babai & Molnár 2013 a,b, Hanspach et al. 2014, Fenesi et al. 2015). The 'Lendület' Ecosystem Service Research Group (Centre for Ecological Researches, Hungary) participated in some of these studies. The fieldwork in Transylvania gave us the opportunity to collect additional soil samples in meadows and pastures to explore the enchytraeid fauna of this region, which is poorly investigated in comparison to other regions in Romania.

In previous studies in the country several species were found in a range of sites (Fig. 1). Apart from other oligochaete families, Botea (1962a) reported 9 enchytraeid species from a riverbank in Motru Valley (Gorj and Mehedinți Counties, South West Romania) (Fig. 1, No. 1). Since this was the first paper on enchytraeids in Romania, all species records were new to the fauna of the country. In the same year, Botea (1962b) published another study about aquatic worms from underground

waters in the Prahova river valley (Prahova County, South East Romania) (Fig. 1, No. 2) with 4 enchytraeid species, 2 of them new to Romania. Botea also studied caves, and he reported 11 species with 3 being new to the country in a cave close to Baia-de-Aramă, Oltenia (Mehedinți County, Southern Carpathians, South West Romania) (Fig. 1, No. 3) (Botea 1963) and further 7 species from 4 genera, all classified as 'eutroglophil', from a cave near the Reșița, Anina and Coronini communities (Banat region, Caraș-Severin County, South East Romania) (Fig. 1, No. 4) (Botea 1965). In the following years Radu & Ștefan continued faunistic work in Romania and published their results in a series of papers as 'Contributions to the study of Enchytraeids in soil' (1967a, b, 1968a, 1969). They reported 17 species (11 new to the Romanian fauna) mainly from brown earth soil of beech forests and pastures around Cluj city (Cluj County, Transylvania, Central Romania) (Fig. 1, No. 5). Strange to say, Radu & Ștefan did not consider the results of Botea and mentioned 'new species' to the country's fauna in two cases which were already published. Radu & Ștefan also published the results of their studies on enchytraeids connection with some ecological factors (1968b). 20 species from 5 genera are reported in this work from a pasture (Făget, Timiș

County, West Romania) (Fig. 1, No. 6) and from 'under wheat' from Dealul Craiului (unable to identify). In 1970, Botea summarized 22 enchytraeid species from Romania, mainly from caves (Botea 1970), but it was an incomplete list for the known taxa. A new species of *Fridericia* and two other species new to the fauna of Romania were also described. In the same year, Ștefan published further 6 species from 4 genera new to the fauna (Ștefan, 1970) from Popii Valley (Cluj County, Central Romania) (Fig. 1, No. 5). Botea (1973) brought out his next paper as the second part of his previous summarizing work; it included short species descriptions and illustrations. One species and one subspecies were described as new. In 1975 Ștefan published the geographical distribution of enchytraeids in the Eastern Carpathians (Ștefan 1975) and listed 28 species from 55 sites, which ranged from the city of Sighetu Marmăției (Maramureș County) as the northernmost part to the village of Putna (Vrancea County) as the southernmost (Fig. 1, No. 7 a–d). In

1976 Botea published two new *Fridericia* species from the riverbanks of Râușorul (Argeș County, Southern Carpathians) (Fig. 1, No. 8). Ștefan (1977) collected in 22 different biotopes (sic!) in the National Park Domogled, Cerna valley (Caraș-Severin County, West Romania) (Fig. 1, No. 9). He recorded 27 species and published the similarity degree of his study sites based on vegetation and soil type. Zamfirescu & Botea (1978) found 7 species in two biotopes of *Pinus mugo* at Piatra Arsă (Bucegi Mountains, Prahova, Brașov and Dâmbovița Counties, South Carpathians) (Fig. 1, No. 10). They also published numerical and relative abundances as well as spatial distribution. *Marionina serbui* was described from guano in cave Gura Plaiului (between the town Târgu-Jiu and commune Tismana, Gorj County, South West Romania) (Fig. 1, No. 11) by Botea (1984). Ten years later Ștefan (1994) published the results of his study in the Danube delta Biosphere Reserve (Tulcea County, South East Romania) (Fig. 1, No. 12). He mentioned 33 enchytraeid



**Figure 1.** Sampling sites in Romania. Romanian authors' sites (marked with ●) are estimated by the published settlement names due to lack of coordinates (1) Motru Valley; (2) Prahova Valley; (3) Baia-de-Aramă; (4) Reșița, village; (5) Cluj city and Popii Valley; (6) Făget; (7a–d) Eastern Carpathians; (8) Râușorul river; (9) Domogled NP; (10) Bucegi Mts.; (11) Plaiului cave; (12) Danube Delta. Authors' sampling sites (marked with □): (13) Bihor Mts.; (14) Săvădisla; (15) Gutâi Mts.; (16) Spermezeu; (17) Mărișel; (18) Uvala Bălileasa; (19) Cobești; (20) Slătioara; (21) Brosteni; (22) Alma Vii; (23) Beia, Palos and Drauseni villages; (24) Cincu and Dealu Frumos villages; (25) Malancrav, Laslea, Prod and Valchid villages; (26) Vidacut.

species from 8 genera from wet sandy sea shore and forest habitats. Two years later he published his results from the same area in English, but mentioned 44 species this time (Ștefan 1996) (Fig. 1, No. 12).

To summarize, enchytraeids in Romania have been studied in a number of regions, but due to wide variety of habitats this country is definitely worth further investigations. We have information only from 17 out of 41 counties: there are absolutely no data near the southernmost part of the country or near the Moldavian border, North East Romania. In addition, the previous authors used the works of Nielsen & Christensen (1959, 1961, 1963) for the identification of specimens, and since then the taxonomy of enchytraeids has progressed a lot (new characters, revisions of species, molecular analyses etc.). Furthermore, since Romanian authors did not adopt *in vivo* identification and used acid treatment instead (Ștefan 1996), their species descriptions may be inadequate as well.

Our collection effort was meant to somehow compensate for this absence of knowledge. In the following we combine our results with data from papers published by former Romanian zoologists, thus giving an up-dated account of the present state of knowledge of the known enchytraeid fauna of Romania.

(This study excludes Romanian authors' papers on ecotoxicology (Radu & Ștefan 1970, Radu et al. 1970, Popovici et al. 1977).

## 2. Materials and methods

In Transylvania (Brașov, Sibiu and Harghita counties, Transylvanian Plateau) 17 localities in about 11 villages were sampled on two occasions (17–18.09.2013 and 15–16.10.2013) (Tab. 1, Fig. 1. No. 22–26). Three samples per locality and date summed up to 102 soil samples altogether. Sampling sites near the villages were mainly rural habitats (pastures and meadows). In Gutâi Mts. (Maramureș County, Inner Eastern Carpathians) six samples were collected (17–20.09.2005) from 4 localities in beech forest, hydrophilous tall herb fringe and fens near brookside (Fig. 1, No. 15). Three samples were collected in beech forests in Bihor Mts. from 2 localities (Fig. 1, No. 13) and also from an oak forest close to Săvădisla (Fig. 1, No. 14) (Alba and Cluj counties, Apuseni Mountains, Western Romanian Carpathians). Further samples were collected near Spermezeu (Bistrița-Năsăud County, Transylvania) (Fig. 1, No. 16) (17–20.09.2005); Mărișel (Cluj County, Gilău Mts.) (Fig. 1, No. 17), Uvala Bălileasa

(Bihor County) (Fig. 1, No. 18) and Cobești (Arad County, Metalliferous Mts.) (Fig. 1, No. 19) (24–27.10.2009); Slătioara (Fig. 1, No. 20) and Broșteni (Fig. 1, No. 21) (Suceava County, Outer Easter Carpathians) (03.11.2011) (Tab. 1).

All soil samples were qualitative and taken with a hand shovel at 0–15 cm soil depth. Animals were extracted from the soil by the wet funnel method (O'Connor 1962). Enchytraeids were observed and measured alive according to the monograph of Schmelz (2003) and the guidebook of Schmelz & Collado (2010). Concerning nomenclature of *Chamaedrillus* / *Cognettia* the results of Martinsson et al. (2015) were considered. Worms were anaesthetized in ca. 15% ethanol and subsequently preserved in 70% ethanol. Some of the specimens were stained with boraxcarmin, and then passed through an ethanol (70% to absolute) dehydration series, mounted temporarily in clove oil, than permanently in Euparal between two coverslips. All important morphological characters were recorded *in vivo*, drawn and photographed (Axio Imager.A2 microscope with DIC (differential interference contrast) illumination, AxioCam MRC 5 digital camera (Carl Zeiss AG, Oberkochen, Germany), Axiovision software). The whole mounted specimens were reinvestigated and photographed, too.

The reference collection of species is deposited in the collection of the Department of Systematic Zoology and Ecology, Eötvös Loránd University, Budapest.

## 3. Results

We found 55 species from 10 genera: 1 genus and 36 species were new to the Romanian fauna (Tab. 2) and 3 *Fridericia* species were new to science (Boros & Dózsa-Farkas 2015). Together with the literature records, this sums up to 87 enchytraeid species, if the *nomina dubia* and further doubtful records are excluded (Tab. 2, marked with hashtags). The species numbers of the sampling sites varied considerably, from 17 (Malancrav), 15 (Săvădisla no. 2), 14 (Gutâi Mts. no. 2), 12 (Cincu no. 2), or 10 (Beia no. 2 and Drauseni no. 2) down to only 1 (Prod no. 2) or 2 (Bihor no. 2 and Uvala Bălileasa).

The most frequent species were *Enchytraeus buchholzi* Vejdovský, 1878 *sensu lato* (occurrence at 14 sites), *Enchytronia christenseni* Dózsa-Farkas, 1970 (12 sites), *Fridericia nemoralis* Nurminen, 1970 (11 sites), *Buchholzia appendiculata* (Buchholz, 1862) and *F. galba* (Hoffmeister, 1843) (both on 10 sites). 19 species were found at not more than one site.

**Table 1.** Investigated localities by the authors with habitats, sampling dates and recorded species. Collectors were Dózsa-Farkas, K. (17–20.09.2005), Csuzdi, Cs., Kontschán, J., Popp, V.V., Ujvári, Zs (24–27.10.2009, 03.11.2011) and Boros, G. and Bereczki, K. (17–18.09.2013, 15–16.10. 2013).

<p><b>Bihor Mts.</b>, N46.20944° E23.12111°, 840 m a.s.l., 17-20.09. 2005. (Site No. 13 in Fig. 1.)</p> <p><b>a:</b> Beech forest. <i>Buchholzia appendiculata</i>, <i>Enchytronia christenseni</i>, <i>Fridericia benti</i>, <i>F. maculata</i>, <i>F. sylvatica</i>, <i>Achaeta</i> sp.</p> <p><b>b:</b> Beech forest, decayed wood. <i>Chamaedrillus</i> (=Cognettia) <i>glandulosus</i> s.l., <i>Fridericia</i> cf. <i>crassiductata</i></p>
<p><b>Sävädöla</b>, N46.64889° E23.46222°, 605 m a.s.l., 17-20.09. 2005. (Site No. 14 in Fig. 1.)</p> <p><b>a:</b> Oak forest. <i>Buchholzia appendiculata</i>, <i>Enchytraeus christenseni</i>, <i>E. lacteus</i>, <i>Enchytronia parva</i>, <i>En. christenseni</i>, <i>Fridericia auritoides</i>, <i>F. bisetosa</i>, <i>F. connata</i></p> <p><b>b:</b> Clearing near oak forest. <i>Enchytraeus buchholzi</i>, <i>E. bulbosus</i>, <i>E. varithecatus</i>, <i>Enchytronia christenseni</i>, <i>En. parva</i>, <i>Fridericia benti</i>, <i>F. bisetosa</i>, <i>F. cylindrica</i>, <i>F. dura</i>, <i>F. galba</i>, <i>F. paroniana</i>, <i>F. ratzeli</i>, <i>F. semisetosa</i>, <i>Henlea perpusilla</i>, <i>Marionina communis</i></p>
<p><b>Gutâi Mts.</b>, N47.68111° E23.78722°, 698 m a.s.l., 17-20.09. 2005. (Site No. 15 in Fig. 1.)</p> <p><b>a:</b> Beech forest, brookside. <i>Cernovitiella tatrensis</i>, <i>Chamaedrillus</i> (=Cognettia) <i>glandulosus</i> s.l., <i>Mesenchytraeus armatus</i></p> <p><b>b:</b> Beech forest. <i>Buchholzia appendiculata</i>, <i>Chamaedrillus</i> (=Cognettia) <i>glandulosus</i> s.l., <i>Enchytronia christenseni</i>, <i>En. parva</i>, <i>Fridericia benti</i>, <i>F. cf. crassiductata</i>, <i>F. connata</i>, <i>F. cylindrica</i>, <i>F. maculata</i>, <i>F. nemoralis</i>, <i>F. sylvatica</i>, <i>Henlea perpusilla</i>, <i>Mesenchytraeus armatus</i>, <i>Mes. glandulosus</i></p> <p><b>c:</b> Beech forest, hydrophilous tall herb fringe. <i>Achaeta eiseni</i>, <i>Buchholzia appendiculata</i>, <i>Chamaedrillus</i> (=Cognettia) <i>glandulosus</i> s.l., <i>Enchytraeus buchholzi</i>, <i>Enchytronia christenseni</i>, <i>Fridericia cylindrica</i>, <i>F. dura</i>, <i>F. paroniana</i>, <i>F. transylvanica</i></p> <p><b>d:</b> Beech forest, brookside, fens. <i>Enchytraeus christenseni</i>, <i>Fridericia bulboides</i>, <i>F. perrieri</i>, <i>Henlea perpusilla</i>, <i>Marionina argentea</i></p>
<p><b>Spermezeu</b>, N47.26361° E24.15556°, 295 m a.s.l., 17-20.09. 2005. (Site No. 16 in Fig. 1.)</p> <p>Beech, hazel and birch. <i>Buchholzia appendiculata</i>, <i>Enchytronia christenseni</i>, <i>Fridericia benti</i>, <i>F. cf. crassiductata</i>, <i>F. galba</i>, <i>F. paroniana</i>, <i>Henlea nasuta</i>, <i>H. perpusilla</i></p>
<p><b>Mărişel</b>, N46.66843° E23.14530°, 900 m a.s.l., 24-27.10. 2009. (Site No. 17 in Fig. 1.)</p> <p>Beech forest. <i>Buchholzia appendiculata</i>, <i>Enchytronia parva</i>, <i>Fridericia auritoides</i>, <i>F. benti</i>, <i>F. bisetosa</i>, <i>F. cylindrica</i>, <i>F. maculata</i>, <i>Henlea perpusilla</i>, <i>Achaeta</i> sp. juv., <i>Mesenchytraeus</i> sp. juv.</p>
<p><b>Uvala Bălileasa</b>, N46.59140° E22.69162°, 1215 m a.s.l., 24-27.10. 2009. (Site No. 18 in Fig. 1.)</p> <p>Beech forest. <i>Buchholzia appendiculata</i>, <i>Fridericia galba</i>, <i>Achaeta</i> sp. juv.</p>
<p><b>Cobeşti</b>, N46.10907° E22.35983°, 335 m a.s.l., 24-27.10. 2009. (Site No. 19 in Fig. 1.)</p> <p>Beech-alder. <i>Buchholzia appendiculata</i>, <i>Enchytraeus buchholzi</i>, <i>Fridericia galba</i>, <i>F. hegemon</i>, <i>F. maculata</i>, <i>F. sylvatica</i></p>
<p><b>Slătioara</b>, N47.48262° E25.65670°, 845 m a.s.l., 03.11. 2011. (Site No. 20 in Fig. 1.)</p> <p>Beech-coniferous. <i>Buchholzia appendiculata</i>, <i>Fridericia benti</i>, <i>F. cylindrica</i>, <i>F. maculata</i>, <i>F. paroniana</i>, <i>Henlea glandulifera</i></p>
<p><b>Brosteni</b>, N47.32068° E25.71562°, 1010 m a.s.l., 03.11. 2011. (Site No. 21 in Fig. 1.)</p> <p>Beech-coniferous, brookside. <i>Chamaedrillus</i> (=Cognettia) <i>sphagnetorum</i>, <i>Enchytraeus buchholzi</i>, <i>Enchytronia parva</i>, <i>Fridericia waldenstroemi</i>, <i>Henlea nasuta</i></p>
<p><b>Alma Vii</b>, N46.06403° E24.46967°, 525 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 22 in Fig. 1.)</p> <p>Pasture, meadow. <i>Enchytraeus norvegicus</i>, <i>Enchytronia parva</i>, <i>Fridericia bisetosa</i>, <i>F. connata</i>, <i>F. nemoralis</i></p>
<p><b>Beia (1)</b>, N46.13109° E25.18178°, 580 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 23 in Fig. 1.)</p> <p>Pasture, meadow. <i>Enchytraeus buchholzi</i>, <i>Fridericia deformis</i>, <i>F. dura</i>, <i>F. galba</i>, <i>F. gamotheca hungarica</i>, <i>F. nemoralis</i>, <i>Henlea perpusilla</i>, <i>Marionina communis</i></p>

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- Beia (2)**, N46.13445° E25.18995°, 590 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 23 in Fig. 1.)  
Pasture, meadow. *Enchytraeus buchholzi*, *E. bulbosus*, *Enchytronia christenseni*, *Fridericia longeurita*, *F. bulboides*, *F. ratzeli*, *F. nemoralis*, *Henlea perpusilla*, *H. ventriculosa*
- 
- Cincu (1)**, N45.92150° E24.81661°, 485 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 24 in Fig. 1.)  
Pasture, meadow. *Achaeta eiseni*, *Enchytronia christenseni*, *Fridericia bisetosa*, *F. christeri*, *F. connata*, *F. deformis*, *Enchytraeus* sp. juv.
- 
- Cincu (2)**, N45.89052° E24.78019°, 600 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 24 in Fig. 1.)  
Pasture, meadow. *Enchytraeus buchholzi*, *E. bulbosus*, *E. lacteus*, *Enchytronia parva*, *Fridericia bulboides*, *F. connata*, *F. gyromonodactyla*, *F. maculata*, *F. nemoralis*, *F. ratzeli*, *F. sylvatica*, *F. transylvanica*
- 
- Drauseni (1)**, N46.12765° E25.29346°, 515 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 23 in Fig. 1.)  
Pasture, meadow. *Enchytraeus bulbosus*, *F. connata*, *F. nemoralis*, *F. rendsinata*, *Enchytraeus* sp. juv.
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- Drauseni (2)**, N46.13004° E25.29701°, 525 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 23 in Fig. 1.)  
Pasture, meadow. *Enchytraeus buchholzi*, *Fridericia bulboides*, *F. dura*, *F. galba*, *F. nemoralis*, *F. ratzeli*, *F. rendsinata*, *F. tubulosa*, *Henlea perpusilla*, *H. ventriculosa*
- 
- Dealu Frumos (1)**, N45.99669° E24.68888°, 530 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 24 in Fig. 1.)  
Pasture, meadow. *Achaeta danica*, *Enchytraeus buchholzi*, *Enchytronia christenseni*, *Fridericia galba*, *F. ratzeli*, *F. rendsinata*, *Henlea ventriculosa*, *Enchytraeus* sp. juv.
- 
- Dealu Frumos (2)**, N46.00665° E24.69933°, 525 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 24 in Fig. 1.)  
Pasture, meadow. *Fridericia dura*, *F. galba*, *F. maculatiformis*, *F. nemoralis*, *F. paroniana*, *F. perrieri*, *Marionina argentea*
- 
- Valchid**, N46.19353° E24.58786° 355 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 25 in Fig. 1.)  
Pasture, meadow. *Enchytraeus buchholzi*, *E. norvegicus*, *Enchytronia christenseni*, *Fridericia maculatiformis*, *Henlea ventriculosa*
- 
- Laslea**, N46.19273° E24.67141° 390 a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 25 in Fig. 1.)  
Pasture, meadow. *Enchytraeus buchholzi*, *Fridericia bisetosa*, *F. nemoralis*, *F. ratzeli*, *F. schmelzi*
- 
- Mălâncrav**, N46.14613° E24.63541° 435 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 25 in Fig. 1.)  
Pasture, meadow. *Achaeta affinis*, *A. eiseni*, *Enchytraeus buchholzi*, *E. bulbosus*, *E. lacteus*, *Enchytronia baloghi*, *En. parva*, *Fridericia bisetosa*, *F. bulboides*, *F. connata*, *F. dura*, *F. galba*, *F. gyromonodactyla*, *F. longeurita*, *F. nemoralis*, *F. paroniana*, *F. ratzeli*
- 
- Vidacut**, N46.34762° E24.88900°, 510 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 26 in Fig. 1.)  
Pasture, meadow. *Achaeta iberica*, *Buchholzia appendiculata*, *Enchytraeus buchholzi*, *E. bulbosus*, *Enchytronia christenseni*, *Fridericia bulboides*, *F. maculatiformis*
- 
- Palos (1)**, N46.12968° E25.21118°, 525 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 23 in Fig. 1.)  
Pasture, meadow. *Achaeta pannonica*, *Fridericia maculatiformis*, *F. nemoralis*, *Henlea ventriculosa*, *Enchytraeus* sp. juv.
- 
- Palos (2)**, N46.13808° E25.21243°, 515 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 23 in Fig. 1.)  
Pasture, meadow. *Enchytraeus buchholzi*, *Fridericia bulboides*, *F. perrieri*, *Henlea perpusilla*, *Marionina argentea*
- 
- Prod (1)**, N46.26288° E24.64488°, 415 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 25 in Fig. 1.)  
Pasture, meadow. *Enchytronia christenseni*, *Fridericia bisetosa*, *F. esieni*, *Enchytraeus* sp. juv.
- 
- Prod (2)**, N46.26586° E24.65022°, 370 m a.s.l., 17-18.09. and 15-16.10. 2013. (Site No. 25 in Fig. 1.)  
Pasture, meadow. *Enchytraeus bulbosus*
-

**Table 2.** All known enchytraeid species from Romania. Species in bold are new to the Romanian fauna, found by Boros & Dózsa-Farkas. Nomina dubia are marked with #. ('This study' includes the work of Boros and Dózsa-Farkas (2015) where the species new to science are described.)

Species	This study	Previous finds	Comments
<i>Achaeta affinis</i> Nielsen & Christensen, 1959	+	Ştefan (1996)	
<i>Achaeta bohémica</i> (Vejdovský, 1879)			= <i>A. vesiculata</i> Nielsen & Christensen, 1959 (Schmelz & Collado 2010)
<i>Achaeta bohémica</i> (Vejdovský, 1879) sensu Nielsen & Christensen (1959)			Schmelz & Collado (2010): an hitherto unnamed species different from <i>A. bohémica</i> (Vejd.)
<i>Achaeta camerani</i> (Cognetti, 1899)		Ştefan (1977, 1994, 1996)	
<i>Achaeta danica</i> Nielsen & Christensen, 1959	+	Ştefan (1994, 1996)	
<i>Achaeta eiseni</i> Vejdovský, 1878	+	Botea (1973), Ştefan (1977, 1994, 1996)	
<i>Achaeta iberica</i> Graefe, 1989	+		
<i>Achaeta pannonica</i> Graefe, 1989	+		
<i>Achaeta vesiculata</i> Nielsen & Christensen, 1959		Ştefan (1996)	= <i>A. bohémica</i> (Vejd.) (Schmelz & Collado 2010)
<i>Bryodrilus librus</i> (Nielsen & Christensen, 1959)		Ştefan (1975, 1977)	as <i>Marionina libra</i>
<i>Buchholzia appendiculata</i> (Buchholz, 1862)	+	Ştefan (1977, 1996)	
<i>Buchholzia fallax</i> Michaelsen, 1887		Ştefan (1994, 1996)	
<i>Buchholzia simplex</i> Nielsen & Christensen, 1963		Botea (1984)	as <i>Marionina serbui</i> sp. nov.; junior synonym of <i>B. simplex</i> (Schmelz & Collado 2010)
<i>Cernosvitoviella atrata</i> (Bretscher, 1903)		Ştefan (1975, 1977)	
<i>Cernosvitoviella immota</i> (Knöllner, 1935)		Ştefan (1977)	
<i>Cernosvitoviella tatrensis</i> (Kowalewski, 1916)	+		
<i>Chamaedrillus</i> (= <i>Cognettia</i> ) <i>glandulosus</i> (Michaelsen, 1888) s.l.	+		
<i>Chamaedrillus</i> (= <i>Cognettia</i> ) <i>sphagnetorum</i> s.l. (Vejdovský, 1878)	+		Four different species according to Martinsson et al. (2015)
<i>Enchytraeus albidus</i> Henle 1837		Botea (1970, 1973); Ştefan (1996); Zamfirescu & Botea (1978)	
<i>Enchytraeus buchholzi</i> s.l. Vejdovsky, 1878	+	Botea (1962b, 1963, 1965, 1970); Radu & Ştefan (1968b, 1969); Ştefan (1975, 1977)	
<i>Enchytraeus bulbosus</i> Nielsen & Christensen, 1963	+		
<i>Enchytraeus christenseni</i> Dózsa-Farkas, 1992	+		
<i>Enchytraeus coronatus</i> Nielsen & Christensen, 1959		Radu & Ştefan (1968b), Ştefan (1970, 1996)	
<i>Enchytraeus lacteus</i> Nielsen & Christensen, 1961	+		
<i>Enchytraeus norvegicus</i> Abrahamsen, 1969	+		
<i>Enchytraeus varithecatus</i> Bouguenec & Giani 1987	+		
<i>Enchytronia baloghi</i> Dózsa-Farkas, 1988	+		
<i>Enchytronia christenseni</i> Dózsa-Farkas, 1970	+		
<i>Enchytronia parva</i> Nielsen & Christensen, 1959	+	Ştefan (1994, 1996)	
<i>Fridericia alata</i> Nielsen & Christensen, 1959		Radu & Ştefan (1968a,b); Ştefan (1975, 1977, 1994, 1996)	
# <i>Fridericia aurita</i> Issel, 1905		Radu & Ştefan (1967a, 1968b); Ştefan (1975, 1977, 1996)	Schmelz (2003): unconfirmed record. Possibly identical with <i>F. auritoides</i>
<i>Fridericia auritoides</i> Schmelz, 2003	+		

# <i>Fridericia balsae</i> Botea, 1976		Botea, 1976	Nomen dubium (Schmelz 2003)
<b><i>Fridericia benti</i></b> Schmelz, 2002	+		
<i>Fridericia bisetosa</i> (Levinsen, 1884)	+	Botea (1962a,b, 1963, 1965, 1970, 1973); Radu & Ștefan (1967b, 1968b); Ștefan (1975, 1977, 1994, 1996)	
<i>Fridericia bulboides</i> Nielsen & Christensen, 1959	+	Botea (1970, 1973)	
# <i>Fridericia bulbosa</i> (Rosa, 1887)		Botea (1962a, 1963, 1970, 1973); Radu & Ștefan (1968a,b); Ștefan (1975, 1996); Zamfirescu & Botea (1978)	Schmelz (2003): nomen dubium. Rota (2015): revalidated. Identity of Romanian records uncertain.
# <i>Fridericia callosa</i> (Eisen, 1878)		Botea (1962a, 1963, 1970, 1973); Radu & Ștefan (1968b, 1969); Ștefan (1975, 1977, 1996); Zamfirescu & Botea (1978)	Schmelz (2003): record unconfirmed, probably a different species
<b><i>Fridericia christeri</i></b> Rota & Healy, 1999	+		
<b><i>Fridericia connata</i></b> Bretscher, 1902	+		
<b><i>Fridericia cf. crassiductata</i></b> Dózsa-Farkas & Cech, 2006	+		
<b><i>Fridericia cylindrica</i></b> Springett, 1971	+		
<b><i>Fridericia deformis</i></b> Möller, 1971	+		
<b><i>Fridericia dura</i></b> (Eisen, 1879)	+		
<i>Fridericia galba</i> (Hoffmeister, 1843)	+	Botea (1970, 1973); Radu & Ștefan (1967a, 1968b); Ștefan (1975, 1977, 1994, 1996); Zamfirescu & Botea (1978)	
<b><i>Fridericia gamotheca hungarica</i></b> Dózsa-Farkas, 2013	+		
<b><i>Fridericia gyromonodactyla</i></b> Boros & Dózsa-Farkas, 2015	+		
<i>Fridericia hegemon</i> (Vejdovský, 1878)	+	Botea (1970, 1973); Radu & Ștefan (1967a, 1968b); Ștefan (1975, 1994, 1996)	
<i>Fridericia lenta</i> Schmelz, 2003		Botea (1965, 1970, 1973); Radu & Ștefan (1967b, 1968b); Ștefan (1975, 1977, 1994, 1996)	as <i>F. leydigii</i> (Vejdovský, 1878)
<b><i>Fridericia longaurita</i></b> Boros & Dózsa-Farkas, 2015	+		
<i>Fridericia maculata</i> Issel, 1905	+	Radu & Ștefan (1968b), Ștefan (1970, 1975, 1977, 1996)	
<b><i>Fridericia maculatiformis</i></b> Dózsa-Farkas, 1972	+		
<i>Fridericia magna</i> Friend, 1899		Botea (1970); Ștefan (1994, 1996); Zamfirescu & Botea (1978)	
# <i>Fridericia magna carpathica</i> Botea, 1973		Botea (1973)	Nomen dubium (Schmelz 2003)
<i>Fridericia minor</i> Friend, 1913	+	Ștefan (1994, 1996)	as <i>F. gracilis</i> v. Bülow, 1957
<b><i>Fridericia nemoralis</i></b> Nurminen, 1970	+		
# <i>Fridericia orghidani</i> Botea, 1970		Botea (1970, 1973)	Nomen dubium (Schmelz 2003)
<i>Fridericia paroniana</i> Issel, 1904	+	Radu & Ștefan (1967b, 1968b); Ștefan (1975, 1977, 1994, 1996)	Identity of literature records uncertain (Schmelz 2003)
<i>Fridericia perrieri</i> (Vejdovský, 1878)	+	Botea (1962b, 1963, 1965, 1970, 1973); Radu & Ștefan (1968a, 1968b); Ștefan (1975, 1977, 1994, 1996)	
# <i>Fridericia popi</i> Botea, 1976		Botea (1976)	Nomen dubium (Schmelz 2003)
<i>Fridericia ratzeli</i> (Eisen, 1872)	+		sensu stricto (Schmelz & Collado 2010) = <i>F. eiseni</i> Dózsa-Farkas, 2005)
# <i>Fridericia ratzeli</i> (Eisen, 1872)		Botea (1963, 1970, 1973); Radu & Ștefan (1967a, 1968b); Ștefan (1975, 1977, 1994, 1996); Zamfirescu & Botea (1978)	sensu lato, could be <i>F. ratzeli</i> , <i>F. dura</i> or <i>F. crassiductata</i>
# <i>Fridericia uniampullata</i> Backlund, 1946		Ștefan (1977, 1996)	Junior synonym of <i>F. ratzeli</i> (Schmelz 2003)
<i>Fridericia regularis</i> Nielsen & Christensen, 1959		Botea (1970); Radu & Ștefan (1968a,b); Ștefan (1975, 1994, 1996)	

Continued **Table 2** (previous page).

Species	This study	Previous finds	Comments
<i>Fridericia rensinata</i> Dózsa-Farkas, 1972	+		
<i>Fridericia schmelzi</i> Cech & Dózsa-Farkas, 2005	+		
<i>Fridericia semisetosa</i> Dózsa-Farkas, 1970	+		
# <i>Fridericia simeani</i> Botea, 1973		Botea (1973)	Nomen dubium (Schmelz 2003)
<i>Fridericia striata</i> (Levinsen, 1884)		Botea (1962a, 1963, 1965, 1970, 1973); Radu & Ştefan (1969); Ştefan (1975)	
<i>Fridericia sylvatica</i> Healy, 1979	+		
<i>Fridericia transylvanica</i> Boros & Dózsa-Farkas, 2015	+		
<i>Fridericia tubulosa</i> Dózsa-Farkas, 1972	+		
<i>Fridericia waldenstroemi</i> Rota & Healy, 1999	+		
<i>Henlea gladulifera</i> Nurminen, 1970	+		
<i>Henlea</i> cf. <i>heleotropha</i> Stephenson, 1922		Radu & Ştefan (1968b), Ştefan (1996)	
<i>Henlea jutlandica</i> Nielsen & Christensen, 1959		Ştefan (1994, 1996)	
<i>Henlea nasuta</i> (Eisen, 1878)	+	Ştefan (1975, 1994, 1996)	
<i>Henlea perpusilla</i> Friend, 1911	+	Radu & Ştefan (1969); Ştefan (1975, 1994, 1996)	
<i>Henlea similis</i> Nielsen & Christensen, 1959		Ştefan (1970), 1996	
<i>Henlea ventriculosa</i> (d'Udekem, 1854)	+		
<i>Lumbricillus buelowi</i> Nielsen & Christensen, 1959		Ştefan (1977, 1994, 1996)	
<i>Lumbricillus kaloensis</i> Nielsen & Christensen, 1959		Ştefan (1977)	
<i>Lumbricillus pagenstecheri</i> (Ratzel, 1869)		Botea (1962a, 1963, 1970, 1973); Ştefan (1994, 1996); Zamfirescu & Botea (1978)	
<i>Lumbricillus tuba</i> Stephenson, 1911		Radu & Ştefan (1968b), Ştefan (1994, 1996)	
<i>Marionina argentea</i> (Michaelsen, 1889)	+	Botea (1965, 1970, 1973); Ştefan (1977, 1994, 1996)	Sensu lato. Four different species according to Rota (2013)
<i>Marionina communis</i> Nielsen & Christensen, 1959	+	Ştefan (1977, 1994, 1996)	
<i>Marionina filiformis</i> Nielsen & Christensen, 1959		Radu & Ştefan (1968b), Ştefan (1994, 1996)	
<i>Marionina riparia</i> Bretscher, 1899		Botea (1970, 1973); Radu & Ştefan (1967b, 1968b); Ştefan (1975, 1977, 1994, 1996)	
<i>Marionina simillima</i> Nielsen & Christensen, 1959		Ştefan (1977, 1994, 1996)	
<i>Marionina spicula</i> (Leuckart, 1847)		Botea (1973); Ştefan (1975, 1977, 1994, 1996)	
<i>Marionina vesiculata</i> Nielsen & Christensen, 1959		Ştefan (1977, 1994, 1996)	
<i>Mesenchytraeus armatus</i> (Levinsen, 1884)	+		
<i>Mesenchytraeus beumeri</i> (Michaelsen, 1886)		Botea (1970, 1973); Ştefan (1975)	
<i>Mesenchytraeus flavus</i> (Levinsen, 1884)		Botea (1970, 1973)	
<i>Mesenchytraeus glandulosus</i> (Levinsen, 1884)	+		
<i>Mesenchytraeus pelicensis</i> Issel, 1905		Ştefan (1975, 1977)	
<i>Oconnorella tubifera</i> (Nielsen & Christensen, 1959)		Radu & Ştefan (1968b), Ştefan (1975, 1994, 1996)	as <i>Marionina tubifera</i>



## 4. Discussion

*Fridericia balsae* Botea, 1976; *F. orghidani* Botea, 1970; *F. popi* Botea, 1976; *F. simeani* Botea, 1973 and *F. magna carpathica* Botea, 1973 were considered as nomina dubia in Schmelz (2003) due to inadequate descriptions and missing type materials. The Romanian records of *Fridericia bulbosa* (Rosa, 1887) and *Fridericia callosa* (Eisen, 1878) are also doubtful. *F. bulbosa* as recorded by Botea (1962a, 1963, 1968, 1970, 1973), Ștefan (1975, 1996) and Zamfirescu & Botea (1978) may be identical with *F. benti* Schmelz, 2002, a species we also have found in several sampling sites (e.g. Bihor and Gutâi Mts., Spermezeu, Slătioara) or with Rota's reaffirmed *F. bulbosa* s.s. (Rota 2015); however, Romanian authors did not specify characters sufficiently to decide. *F. callosa* from Romania is presumably not identical with the Siberian type accepted by Schmelz (2003) from tundra and taiga habitats. Specimens from the Danube Delta Biosphere Reserve might be *F. parathalassia* Schmelz, 2002, however, these were found in forest soil (Ștefan 1996) not exactly in marine coastal habitat. Further uncertain literature records of *F. paroniana*, which probably refer to a species different from *F. paroniana* Issel (Schmelz 2003).

*Fridericia* cf. *crassiductata* Dózsa-Farkas & Cech, 2006 from Gutâi and Bihor Mts. differs from the original description in the following: 1) occasionally 58–64 segments instead of 40–56; 2) no subneural glands (however, Dózsa-Farkas & Cech (2006) originally described 3 small subneural glands); 3) ectal glands smaller (70–80  $\mu\text{m}$  vs. 80–130  $\mu\text{m}$ , *in vivo*) and without brownish colour; 4) ectal duct width around 20  $\mu\text{m}$  (vs. 35–48  $\mu\text{m}$ , *in vivo*), 5) coelomo-mucocytes a-type (Schmelz 2003) in Romanian specimens.

The occurrences of *Fridericia* species new to science from Transylvania are different: only *F. transylvanica* Boros & Dózsa-Farkas, 2015 has a wider range in the Carpathians (found in Gutâi Mts., Inner Eastern Carpathians; Transylvanian Plateau, Central Romania; North East Romania; Djerdap National Park, Southern Carpathians, Serbia). The two other species, *F. gyromonodactyla* Boros & Dózsa-Farkas, 2015 and *F. longaurita* Boros & Dózsa-Farkas, 2015 are known only from their collection sites (Saxon Transylvania, Central Romania).

*Achaeta iberica* (Graefe, 1989) was recorded only in Spain and Italy until now (Schmelz & Collado 2010). In Romania this species was found in a grassland-like pasture habitat on a southern slope. The occurrence of this species may be hypothesized in the southern part of the country but it is probably rare. *Cernosvitoviella tatrensis* (Kowalewski, 1916) was found in Gutâi Mts., Inner

Eastern Carpathians, which is the southern continuation of the Western Carpathian mountain belt where this species was described from (lakes in High Tatra Mts., Poland) (Kowalewski 1917). This species is also known from Sudeten Mts. (Dumnicka 2000). We did not find *C. tatrensis* in other highland regions. *Chamaedrillus* (= *Cognettia*) *sphagnetorum* s. l. (Vejdovský, 1878) occurs regularly in acidic organic soils (peat, bog, moore, raw humus etc.) (Schmelz & Collado 2010), we found it in a brookside, beech-coniferous forest soil, Brosteni, Bukovina.

*Enchytronia baloghi* Dózsa-Farkas, 1988 was known only from Morocco until now, but 4 specimens of this species were found this time in Romania, close to Malancrav village (pasture, meadow). *Henlea* cf. *heleotropha* was published by Ștefan (1996) from the Danube Delta Biosphere Reserve without explanation what *confer* means.

The conspicuous differences in species numbers can partly be explained by the different habitats. On the other hand, there were large differences in samples from the same habitat type (e.g. 17 species from Malancrav and only 1 species from Prod no. 2, both are pastures). We do not have soil property data for every sampling site, albeit pH, soil organic matter or moisture could explain the variations.

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