

Dendrobaena attemsi (Michaelsen, 1902) (Clitellata, Megadrili) on the Balkan Peninsula and Anatolia: distribution and biogeographical significance

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Abstract. In this paper we summarize the knowledge on the presence of *Dendrobaena attemsi* (Michaelsen, 1902) on the Balkan Peninsula and Anatolia. The aim of this paper is to present new data on *D. attemsi* and, by analyzing the new and literature records, to establish the first complete list of its records on the Balkan Peninsula and Anatolia. The list provided a general overview of its current distribution and zoogeographical position. *D. attemsi* is distributed from the Pyrenees through the Central Europe, Balkan Peninsula and Anatolia to the Caucasus. It is common in the Balkan Peninsula, but in Turkey it was rarely found, only in the northern part of the Country. The most important distribution centre of the species in Europe is situated in the Balkanic-Alpine area where it was registered in the largest number of its records. Summarizing all the data reported so far, it can be concluded that *D. attemsi* in its native range (southern Eurasia) shows a Trans-Aegean distribution.

Keywords. Oligochaeta, Lumbricidae, Trans-Aegean Distribution, Earthworms, Fauna of Turkey.

INTRODUCTION

Dendrobaena attemsi is distributed from the Pyrenees through the Balkans and Anatolia to the Caucasus. It was described from Austria (Michaelsen 1902), and later reported from Central, Southern, East and Northern Europe, and as well, from the northern part of Turkey and the Caucasus (Michaelsen 1902, Černosvitov 1934, 1938, Pop 1938, Omodeo 1952, Plisko 1963, Zicsi 1981, 1994, Alvarez 1977, Bouché 1972, Šapkarev 1978, Zicsi & Michalis 1981, Kvavadze 1985, Pizl 1986, Omodeo & Rota 1989, 1991, Mršić 1991, Pavliček *et al.* 2010, Szederjesi 2017, Stojanović *et al.* 2018). Until present, the northernmost record of the species is in Sweden (Rota & Erseus 1997), England (Sims & Gerard 1983), Ireland (Schmidt *et al.* 2015), Germany (Lechmit *et al.* 2014) Canada and USA (Fender 1985).

D. attemsi is an epigeic species present in acid and sandy soils rich in organic matter (Bouché 1972), mainly in forests and meadows, under moss, logs and in the litter (Sims & Gerard 1999).

It shows high morphological variation. According to the morphometric study based on adult worms from three countries Rota & Erseus (1997) reported variation of body morphology (coloration and the position of the first dorsal pore) in four populations of *D. attemsi*. Subsequently, other scientists have worked on this problem as well (Sims & Gerard 1999, Szederjesi 2017). What is particularly interesting is that the position of tubercles also varies; from 30–31, 1/n32, ½32, 32 (Szederjesi 2017).

The aim of this paper is to present new data on the distribution of *D. attemsi* and, by analyzing the new reports together with literature records, to

establish the first complete list of its occurrence on the Balkan Peninsula and Anatolia. This list provides a general overview of the current distribution and zoogeographical position of this species.

MATERIAL AND METHODS

Data on the species were obtained from the literature and from fieldwork. The data from several authors were used to complete the distribution maps of *D. attemsi* in the World and Anatolia (Fig. 1 and Fig. 2). Over the last study period, from all over the investigated region we have collected earthworms from various habitats which included natural and urban biotopes as well.

Unfortunately, only one specimen of *D. attemsi* was registered in Turkey, while on the Balkans from the last six years of investigations we did not register it. Therefore, in the data analyzed we have included the unpublished data from the Balkans from 1997 to 2019 as well.

The earthworms were collected by digging and hand-sorting complemented with the diluted formaldehyde method (Raw 1959). The specimens were killed in 70% ethanol in the field. After 15 minutes, they were transferred to 96% ethanol. Specimens were described and dissected under stereomicroscope. Species identification was done in accordance with Csuzdi & Zicsi 2003, Blakemore 2008, Mršić 1991, Zicsi 1982 and Šapkarev 1978. The collected species were identified in the laboratory of Faculty of Science in Kragujevac, Serbia and in Faculty of Science in Eskisehir, Turkey

TAXONOMY

Dendrobaena attemsi (Michaelsen, 1902)

Helodrilus (Dendrobaena) attemsi Michaelsen, 1902: 47.

Dendrobaena alpina: Pop 1972: 40 (part.); Pop 1997: 225 (part.).

Dendrobaena octaedra: Pop 1947: 108 (part.).

Dendrobaena attemsi: Omodeo 1952: 12.

Dendrobaena attemsi: Šapkarev 1989: 39; Šapkarev 2002: 295; Mršić 1991: 604; Stojanović & Karaman 2005: 129; Milutinović *et al.* 2010: 630; Csuzdi 2012: 97; Csuzdi & Pop 2006: 39; Csuzdi & Pop 2008: 147; Szederjesi 2013: 66; Stojanović *et al.* 2013: 637; Perel 1979: 236; Pop *et al.* 2012: 62.

Dendrobaena attemsi: Omodeo & Rota 1989: 191.

Dendrobaena attemsi: Omodeo & Rota 1991: 180.

Dendrobaena jastrebensis: Mršić 1991: 584; Stojanović & Karaman 2003: 56; Milutinović *et al.* 2010: 630; Stojanović & Milutinović 2013: 152; Stojanović *et al.* 2013: 637; Trakić *et al.* 2016: 261.

Dendrobaena macedonica Mršić, 1991: 587. Šapkarev 1997: 105. Trakić *et al.* 2016: 262; Szederjesi 2017: 12.

Dendrobaena vranicensis Mršić, 1991: 588. Šapkarev 1997: 105. Trakić *et al.* 2016: 263; Szederjesi 2017: 12.

Dendrobaena grmecensis: Mršić, 1991: 593. Šapkarev 1997: 105; Szederjesi 2017: 12.

Dendrobaena attemsi: Szederjesi *et al.* 2014: 94; Szederjesi *et al.* 2017: 62

Dendrobaena attemsi: Tavuç *et al.* 2018: 150.

Dendrobaena attemsi: Mısırlıoğlu 2018: 143.

Dendrobaena attemsi: Stojanović *et al.* 2018: 135.

Dendrobaena attemsi: Szederjesi 2019: 27.

Distribution on the Balkan Peninsula. Serbia. Suva planina Mt., Jastrebac, Užice (Šapkarev 1989, Mršić 1991; Stojanović & Karaman 2005, Milutinović *et al.* 2010); Cave Rajkova pećina, Vidojevica Mt., Pasjače Mt., Kukavica Mt., Homolj Mts., Bešnjaja (Karaman & Stojanović 2002); Jastrebac Mt., Stolovi Mt. (Stojanović & Karaman 2005, Milutinović *et al.* 2010); Jabučko Ravnište, Golema reka, Babin Zub, Lom (Stojanović *et al.* 2013); Đerdap Mts., between Majdanpek and Donji Milanovac (Szederjesi 2013); Kragujevac, Gledić Mts., Goč (Mršić & Šapkarev 1987, Stojanović *et al.* 2008); Čemernik, Vlasina, Stara planina Mt. (Karaman and Stojanović 2002); Đerdap (Szederjesi 2013).

New records in Serbia. Usovica 03.04.2003, 12 ex.; Kraljevo 03.10.2002, 1 ex. Đulica 15.04.2000, 2 exemplars. Voljevica Mt. 21.04.2007. 1 ex. Ražanj Mt. 01.05.1997. 1 ex.

Romania. Maramureş Mts.-Baile Borşa-Vf Cearcanul, Maramureş basin-Rona de Sus Hera, Gutai Mts. Budeşti, Lapuş Mts.-Leorda, Gutai Mts.-Valea Roşie-Nedeia Taranului, Rodnei Mts.-Cornaia-Valea Vinului (Csuzdi & Pop 2006);

Munții Maramureșului (Máramarosi-havasok)-Petrova, Munții Rodnei (Radnai-havasok), Borșa - Stațiunea Borșa (Borsa – Borsafüred), Munții Rodnei (Radnai-havasok), Borșa – Stațiunea Borșa (Borsa – Borsafüred), Munții Maramureșului (Máramarosi-havasok)-Poienile de sub Munte (Havasmező)-Budescu valley, Munții Maramureșului (Máramarosi-havasok) – Poienile de sub Munte (Havasmező) – Socolău valley, Munții Maramureșului (Máramarosihavasok) – Poienile de sub Munte (Havasmező) – Lutoasa valley, Depresiunea Maramureșului (Máramarosi-medence) – Rona de Sus (Felsőróna) – Héra, Munții Oaș (Avas), Piatra (Kövesláz) – Munții Maramureșului (Máramarosi-havasok) – Borșa – Băile Borșa (Borsa – Borsabánya) – Vinișor valley, Munții Rodnei (Radnai-havasok) – Săcel (Izaszacsal) – Iza Spring in spruce forest, Munții Rodnei (Radnai-havasok)-Săcel (Izaszacsal), Munții Maramureșului (Máramarosi-havasok) – Vișeu de Sus (Felsővisó) – Șuligu de Sus (Csuzdi & Pop 2008); Retezat – Lapusnic Valley – Stanulet Fagaras, Mts. Balea – Rodnei Mts. – Sacel above the Iza Spring, Maramureș, Mts.-Șuligu de Sus, Maramureș Mts. – Mihoia Valley, Maramures, Mts. – Vasser Valley – above Faina (Csuzdi *et al.* 2011); Apuseni Mts. – Vlădeasa Mt. (Pop *et al.* 2012); Bucovina – Iedu, Bucovina – after Stratioara, Banat – Cerna Sat, Maramureș Mts. Borșa – Băile Borșa – Vinișor valley, Maramureș Mts, Borșa – Băile Borșa, Maramureș Mts. – Poienile de sub Munte – Budescu valley, Maramureș Mts. – Poienile de sub Munte – Socolău valley, Maramureș Mts. – Poienile de sub Munte-Lutoasa valley, Maramureș Mts. – Borșa – Băile Borșa – Vulcănescu Brook, Băile Herculane (Szederjesi *et al.* 2014).

Bulgaria. Rhodiopi Mt. (Černosvitov 1937), Rila Mt. (Zicsi & Csuzdi 1986); Balkan Mt. (Plisko 1963); Kărdžhali province, Zălti Djal Mts., Sedlarci, Smoljan province, Perelik Mts., Smoljan (Szederjesi 2012a).

Greece. Mainland: Vermion (Černosvitov 1938). Florina (Michalis 1975). Ano Kleinae, Foteina (Zicsi & Michalis 1981). Ano Kalesmeno, Timfristos, Angistrou, Vrontous Mts, Orvilos Mts, Kalikarpos, Florina, Metsovo (Szederjesi and Csuzdi 2012b). Chaliki (Szederjesi 2015). Athos

(Michalis 1977). Lesvos: Mytilini (Zicsi and Michalis 1981). Naxos: Koronidha (Szederjesi 2015).

Albania. Krej-Lurë, Gropë Mts, Pezë Mts, Qafëmollë, Mirditë district (Szederjesi & Csuzdi 2012a); Tiranë, Gropë Mts (Szederjesi & Csuzdi 2015); Kukës district, Turaj (Szederjesi 2019).

Croatia. Bijele stijene, Jasenak (Mršić 1986, Hackenberger and Hackenberger 2013).

Bosnia & Herzegovina. Zelengora Mt. (Szederjesi 2013).

Montenegro. Biogradska Gora (Stojanović and Karaman 2003).

Macedonia. Trpeica, Nidže Mt. (Šapkarev 1978); Ohrid, Galičica Mts, Gostivar, Ogrožden Mts, Peštani (Szederjesi 2013).

New Records in Macedonia. Mavrovo, 16.10.2012, 1 exemplar; Galičica Mt. 14.10.2012, 1 ex.

Distribution in Anatolia. **Turkey.** Polonezköy (Omodeo 1952); Bursa Uludağ, Giresun Görele, Trabzon Maçka, Artvin Cankurtaran pass, Bolu Boludağı Geçidi (Omodeo & Rota 1989); Bilecik 75 km. E of Bursa, Bursa N face of Uludağ (Omodeo & Rota 1991); Akçaören-Düzce, Hopa-Artvin (Szederjesi *et al.* 2018); Türkmen Dağı (Tavuç *et al.* 2018); road entry to Hüseyinalan and Tuzaklı Village, Hüseyinalan Village-Uludağ (Mısırlioğlu 2018).

New record for Turkey. Eskişehir Province, Vişnelik Quarter, Kanlıkavak Promenade area, the edge of the Porsuk River, 25.02.2018, 1 ex.

Zoogeographical distribution. *D. attemsi* is a Trans-Aegean species, it is distributed in: Caucasia, Russia, Southern Europe, Carpatho-Balkan Peninsula, Austria, Northern Italy, Central and Southern France, Britain, Norway, Ireland and Germany (Perel 1997, Rota & Erseus 1997, Sims & Gerard 1999, Csuzdi & Zicsi 2003, Csuzdi *et al.* 2011, Lechmit *et al.* 2014, Schmidt *et al.* 2015, Mısırlioğlu 2017, Szederjesi 2017, Szederjesi *et al.* 2017, 2018, Stojanović *et al.* 2018).

Remarks. *D. attemsi* is widely distributed in Romania, however in the older literature it was reported under the name *D. alpina* (Rosa, 1884) or *D. octaedra* (Savigny, 1826) (Csuzdi *et al.*

2005, Pop *et al.* 2007) therefore, only the recent records were included in the present study.

DISCUSSION

Dendrobaena is the most speciose genus on the Balkan Peninsula and Anatolia; and half of its species are endemics (Trakić *et al.* 2016, Mısırlıoğlu *et al.* 2019). So far, 92 species have been described in the genus *Dendrobaena* (Csuzdi 2012), of which 23 are exclusive endemics on the Balkan Peninsula (Trakić *et al.* 2016), while 12 species are endemic to Anatolia (Szederjesi *et al.* 2014). Due to the marked diversity of the genus *Dendrobaena* in the Balkans, Omodeo & Rota (2008) considered it to be of European origin. Today, the Balkan Peninsula and Anatolia are separated by sea, but the paleogeographic scenario from the Oligocene, when these land systems were connected into a single land mass (Aegean land mass), contributed to the extension of this genus from Europe to the territory of Anatolia. Based on the number of endemic *Dendrobaena* species on the Balkans and Anatolia, it is clear that these areas are the most important centres of diversity of this genus.

On the Balkans, *D. attemsi* is the most widespread in the Serbia (central, southern and eastern parts), Macedonia, Greece and Bulgaria. It is less frequent in Albania, Croatia, Montenegro

Bosnia & Herzegovina and Romania but this may also be due to less work done on earthworms in some of the mentioned countries. In previous studies from Anatolia, *D. attemsi* was recorded from North-Anatolia, the Aegean and Marmara regions of Turkey. In this study it was recorded from the Inner Anatolia as well.

The northernmost records (Sweden, Ireland, England) of *D. attemsi* raise the serious question, *i.e.* is it native or introduced to the fauna. According to Omodeo (1952), it spreads from the Caucasian area towards Romania and from there migrated to the Balkan Peninsula and, across the Dinaric range, to Austria. Following this view and, as well, based on their investigation, Rota & Erseus (1997) considered that *D. attemsi* has two core areas of distribution. The centre of its western distribution is France, and from there it spreads towards Italy, Spain and, as well, to the north into Great Britain and Ireland. Therefore, Rota & Erseus (1997) assume that all records from sandy woodland soils from England and Sweden most likely indicate post-glacial expansion of *D. attemsi*. This is also supported by Bouché (1972) who pointed out that *D. attemsi* lives naturally in organic rich woodland soils. However, in northern countries it has a very restricted distribution in natural biotopes and is generally considered rare in those areas (Schmidt *et al.* 2015).



Figure 1. Distribution of *D. attemsi* in the world.

Moreover, England was connected to Europe after the Ice Age just for some 5.000 years (Sims & Gerard 1985). Considering that earthworms' natural range expansion capability is 60–100 km per 10.000 years (James 1998), it is a very short time for earthworms to reach the British Islands and highly questionable that during this time it could have reached England by natural way. Furthermore, approximately 12000 years ago Ireland was cut off totally from England so before the establishment of the England Europe connection (Devoy 2015). So, it seems to be impossible for *D. attemsi* to reach Great Britain and Ireland during this short period and most probably Ireland's and Great Britain's populations are not autochthonous but introduced by man.

The eastern area of this species is larger and seems to be ancient covering the Balkans, Anatolian and the Caucasus regions. Several records of *D. attemsi* can be connected with human activities and, therefore, some researchers consider that it may belong to semiperegrine species (Szederjesi & Csuzdi 2012). Namely, the presence of the species in anthropogenic biotopes (greenhouses, gardens) indicates the possibility of human introduction of this species with imported plant mate-

rial, as is the case in North America (Fender 1985), New Zealand's North Island (Blakemore 2012) and in Russian Kamchatka (Shekhovtsov *et al.* 2014).

On the other hand, Eggleton *et al.*'s (2009) research suggests that it should not be neglected that *D. attemsi* has a Balkan origin and has greater ability than the northern European species *D. octaedra* to tolerate dry and warm summers. Therefore, this ability of *D. attemsi* could also allow its certain invasiveness towards the northern regions under the influence of current climate change.

Until about fifteen years ago, *D. attemsi* was classified to Trans-Aegean distribution type (Csuzdi *et al.* 2006) which has wider distribution in Central Europe and, as well, occupies smaller areas around the eastern and southern coasts of the Black Sea (Mısırlıoğlu 2008). However, the most important distribution centre of *D. attemsi* in Europe is situated in the Balkanic-Alpine area where the largest number of its records are registered. This was the reason for researchers to classify the species into the Balkanic-Alpine distribution type (Csuzdi *et al.* 2011, Valchovski

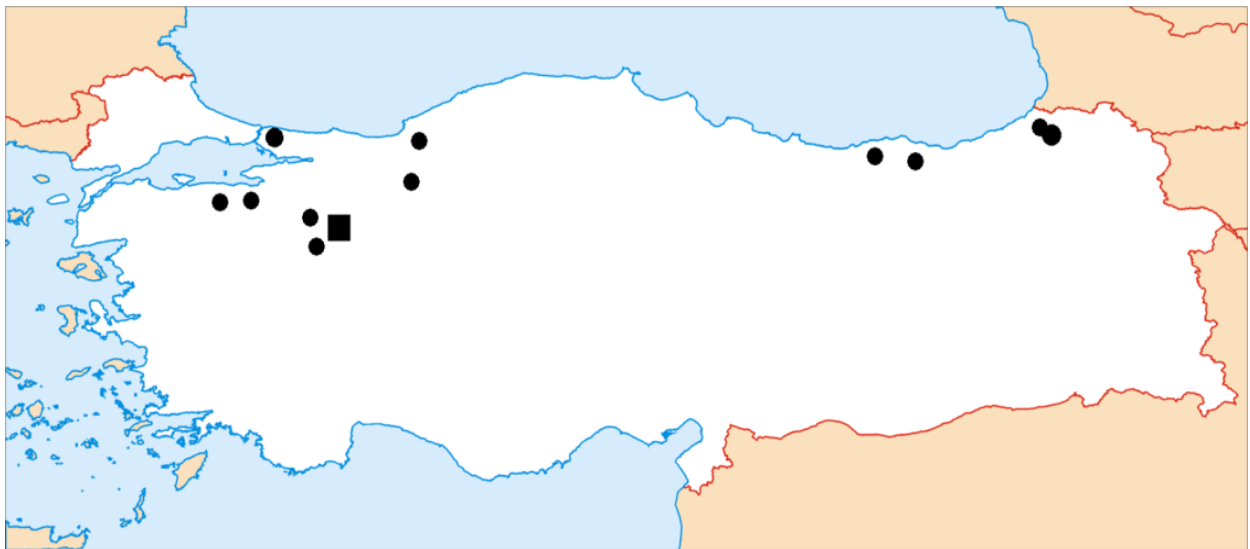


Figure 2. Distribution of *D. attemsi* in Turkey (Black square shows the new record of the species).

2012, Hackenberger & Hackenberger 2013, Szederjesi 2012b, Szederjesi, *et al.* 2017, Stojanović *et al.* 2018). However, its presence in Anatolia and the Caucasus rather shows a Trans-Aegean distribution. Based on all findings so far, it could be concluded that *D. attemsi* in its native range (southern Eurasia) belongs to the Trans-Aegean distribution type.

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