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Updated checklist and distribution of the inland-water calanoid copepods (Copepoda: Calanoida) of Romania

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Abstract. No recent studies on the distribution of calanoid copepods in Romanian inland-waters are available. During a long-term survey aimed at large branchiopods, we collected two diaptomid species that are new for the fauna of the country, and supplemented the available data on the distribution of other calanoid species with new records. As already observed in the case of large branchiopods, the habitats of the mountain basins of the Eastern Carpathians seem to be characterized by a quite distinct species assemblage. The high calanoid species richness of Romanian inland-waters, and the need for further, more comprehensive surveys aimed at mapping the actual diversity of this order in Romania are stressed.

Key words: calanoid copepods, *Arctodiaptomus belgrati*, *Diaptomus castor*, temporary ponds, Romanian fauna

Introduction

The inland-water calanoid copepod fauna of the Western Palaearctic region includes more than one-hundred species belonging to six families. Among them, the family Diaptomidae, with nearly 90 species, is by far the most species-rich (Dussart & Defaye 2002). Because of their peculiar morphology, life cycle and habitat specialization, calanoid copepods could be used in environmental education and as a flagship group for the conservation of temporary water-bodies in a similar way to large branchiopods (Belk 1998, Eder & Hödl 2002; Eder 2008); in spite of this, and in spite of their ecological importance in the lentic ecosystems (Huy & Boxshall 1991, Dussart & Defaye 2001), no recent data are available on the diversity and distribution of this group in Romania. The last comprehensive study on Romanian inland-water copepods was published about four decades ago (Damian-Georgescu 1966), and very few data have been published after that (e.g. Bănărescu 1996). Based on the work by Damian-Georgescu (1966) and on the world directory of inland-water calanoid copepods (Dussart & Defaye, 2002), 22 calanoid species were known to occur in Romania prior to our survey.

During a sampling survey carried out between 2004 and 2008 aimed at investigating the distribution of large branchiopod

crustaceans in the country, some calanoid specimens were collected and studied. In this note we report these findings, which add original data to the currently available knowledge of the distribution of diaptomid copepods in Romania.

Materials and methods

Four regions of Romania were surveyed: the Banat, the Transylvanian Basin and two tectonic mountain basins of the Eastern Carpathians, focusing especially on the Ciuc Basin (Fig. 1). Samples were collected using a 150 µm mesh-sized towing net, and were stored *in situ* in a solution of 70% ethanol or 4% buffered formaldehyde. Calanoid copepods were sorted, prepared according to Dussart & Defaye (2001), and identified according to Damian-Georgescu (1966), Kiefer (1978), Petkvoski (1983) and Ranga-Reddy (1994).

Results

Calanoid species were recorded from 31 habitats characterized by a temporary hydroperiod (Fig. 1, Tab. 1). In total, nine species belonging to five genera of the subfamily Diaptominae were recorded (Table 2). Two of them, *Arctodiaptomus belgrati* and *Diaptomus castor* are new records for the fauna of Romania.

Arctodiaptomus belgrati was recorded in the Ciuc and Braşov basins from nine temporary pools with an altitude ranging between 520 and 797m (Fig. 2a). This species was described from the Belgrat forest north of Istanbul (Mann 1940) and never collected again after its description. It belongs to the subgenus *Mesodiaptomus*, which is considered by some authors as an intermediate genus between *Arctodiaptomus* and *Mixodiaptomus* (Borutzky et al. 1991; Ranga-Reddy 1994). Because of the novelty and interest of this finding we will deal in detail with this species in a separate paper.

Arctodiaptomus wierzejskii was recorded in the Banat region from four habitats located at 107-169 m altitude (Fig. 2b). This widespread Palaearctic species was already known from the Banat region and the Romanian Plain (Damian-Georgescu 1966).

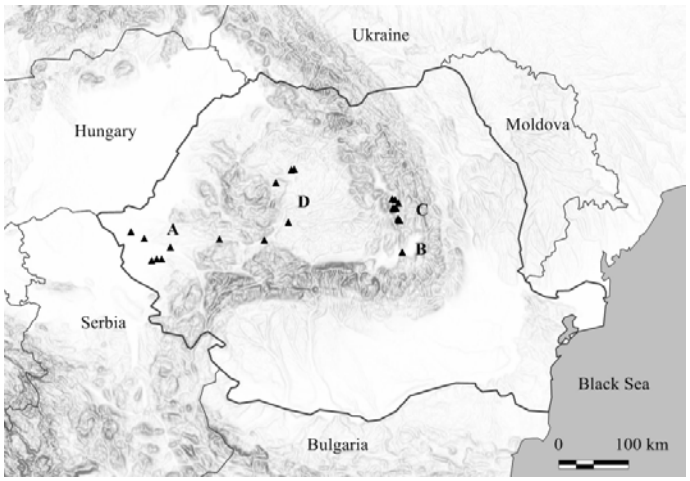

Figure 1. Location of the sampled habitats.
A-Banat, B-Brasov basin, C-Ciuc basin, D-Transylvanian basin.

Table 1. List and location of the sampled habitats.

Habitat code	Region	Latitude (N)	Longitude (E)	Altitude (m a.s.l.)	Sampling date
A1	Banat	45.5875	21.3327	96	12 IV 2005
A2	Banat	45.6139	21.4265	104	12 IV 2005
A3	Banat	45.8690	21.1654	107	16 IV 2005
A4	Banat	45.6169	21.5164	109	12 IV 2005
A5	Banat	45.7772	21.6609	126	12 IV 2005
A6	Banat	45.9200	22.5546	169	12 IV 2005
A7	Banat	45.9375	23.3838	215	17 IV 2005
B1	Brasov basin	45.8342	25.9343	518	26 III 2008
B2	Brasov basin	45.8308	25.9340	520	25 IV 2004
B3	Brasov basin	45.8299	25.9341	522	25 IV 2004
C1	Ciuc basin	46.2497	25.8769	643	29 IV 2006
C2	Ciuc basin	46.2404	25.8820	645	30 IV 2006
C3	Ciuc basin	46.2543	25.8630	651	28 IV 2008
C4	Ciuc basin	46.2668	25.8508	656	21 V 2006
C5	Ciuc basin	46.2599	25.8532	657	13 V 2006
C6	Ciuc basin	46.4056	25.7882	671	28 IV 2006
C7	Ciuc basin	46.4045	25.7898	673	28 IV 2006
C8	Ciuc basin	46.4046	25.7913	674	28 IV 2006
C9	Ciuc basin	46.4149	25.7509	676	06 VI 2008
C10	Ciuc basin	46.3909	25.7500	676	06 VI 2008
C11	Ciuc basin	46.4024	25.7964	678	18 X 2007
C12	Ciuc basin	46.4070	25.8076	694	18 X 2007
C13	Ciuc basin	46.5237	25.7374	703	19 IV 2004
C14	Ciuc basin	46.4707	25.8539	783	02 VI 2008
C15	Ciuc basin	46.5162	25.7909	797	02 VI 2008
D1	Transylvanian basin	45.9409	20.9178	76	16 IV 2005
D2	Transylvanian basin	46.1809	23.8100	241	12 IV 2005
D3	Transylvanian basin	46.8618	23.8263	288	16 III 2008
D4	Transylvanian basin	46.8753	23.8826	359	16 III 2008
D5	Transylvanian basin	46.6897	23.5481	718	16 III 2008
D6	Transylvanian basin	46.6910	23.5494	721	16 III 2008

Diaptomus (*Diaptomus*) *castor* was recorded in the Ciuc basin from a single habitat located at 678 m (Fig. 2c). This is a new species for the fauna of Romania.

Diaptomus (*Chaetodiaptomus*) *serbicus* was recorded in the Banat region from three habitats located at 104-126 m (Fig. 2d). It was already known from the Banat and the

Table 2. List of the recorded taxa and their occurrence sites.

Taxa	Habitats
Diaptomus (Diaptomus) castor	C12
Diaptomus (Chaetodiaptomus) serbicus	A2, A4, A5
Hemidiaptomus (Gigantodiaptomus) amblyodon	C1, C2, C5, C6, C7, C8
Hemidiaptomus (Gigantodiaptomus) hungaricus	B1, B2, B3
Eudiaptomus vulgaris	B3, B4, C6, D5, D6
Arctodiaptomus (Arctodiaptomus) wierzejskii	A3, A4, A5, A6
Arctodiaptomus (Mesodiaptomus) belgrati	B2, B3, C1, C3, C4, C9, C10, C13, C15
Mixodiaptomus tatricus	C14, D6
Mixodiaptomus kupelwieseri	A1, A2, A7, D1, D2, D3, D4

Romanian Plain (Damian-Georgescu 1966).

Eudiaptomus vulgaris was recorded in five habitats located at 520-721 m in the Transylvanian and the Carpathian basins (Fig. 2e). This widely distributed Palaearctic species was already reported for the Transylvanian Basin and the Romanian Plain (Damian-Georgescu 1966). In Romania the closely related species *Eudiaptomus transylvanicus* (Daday, 1890) is also known to occur, but this last taxon was not recorded in our survey.

Hemidiaptomus (*Gigantodiaptomus*) *amblyodon* (Photo 1, 2) was identified in the Ciuc basin from six habitats located between 650-700 m (Fig. 2f). However, according to field observations it is one of the most frequent calanoid copepods in the area (L. Demeter, pers. obs.). It was previously reported from the Transylvanian basin and the Romanian Plain (Damian-Georgescu 1966).

Hemidiaptomus (*Gigantodiaptomus*) *hungaricus* was recorded in the Braşov basin from three habitats at 520 m altitude (Fig. 2g). It was previously known from the Banat and the Romanian Plain (Damian-Georgescu 1966).

Mixodiaptomus kupelwieseri was recorded in the Banat and Transylvanian Basin from seven habitats at 76-359 m (Fig. 2h). It was previously known from the same two regions (Damian-Georgescu 1966).

Mixodiaptomus tatricus was recorded in the Transylvanian Basin and the Ciuc basin from two habitats at 721 and 783 m (Fig. 2i). It was previously known from the Retezat, Bucegi, Rodnei, and Apuseni mountains, the Transylvanian Basin, and from Drobeta Turnu Severin (Iron Gates) (Damian-Georgescu 1966).

Discussion

The presented data supplement the known distribution of calanoid copepods in Romania and increase the number of calanoid copepod species in Romania from 22 to 24 (Tab. 3). *Arctodiaptomus belgrati,* a rare diaptomid species to date known only from its type locality in Belgrat forest (Istanbul, Turkey), proved to be relatively frequent in the Ciuc basin. *Diaptomus castor*, another species new for the Romanian fauna, was

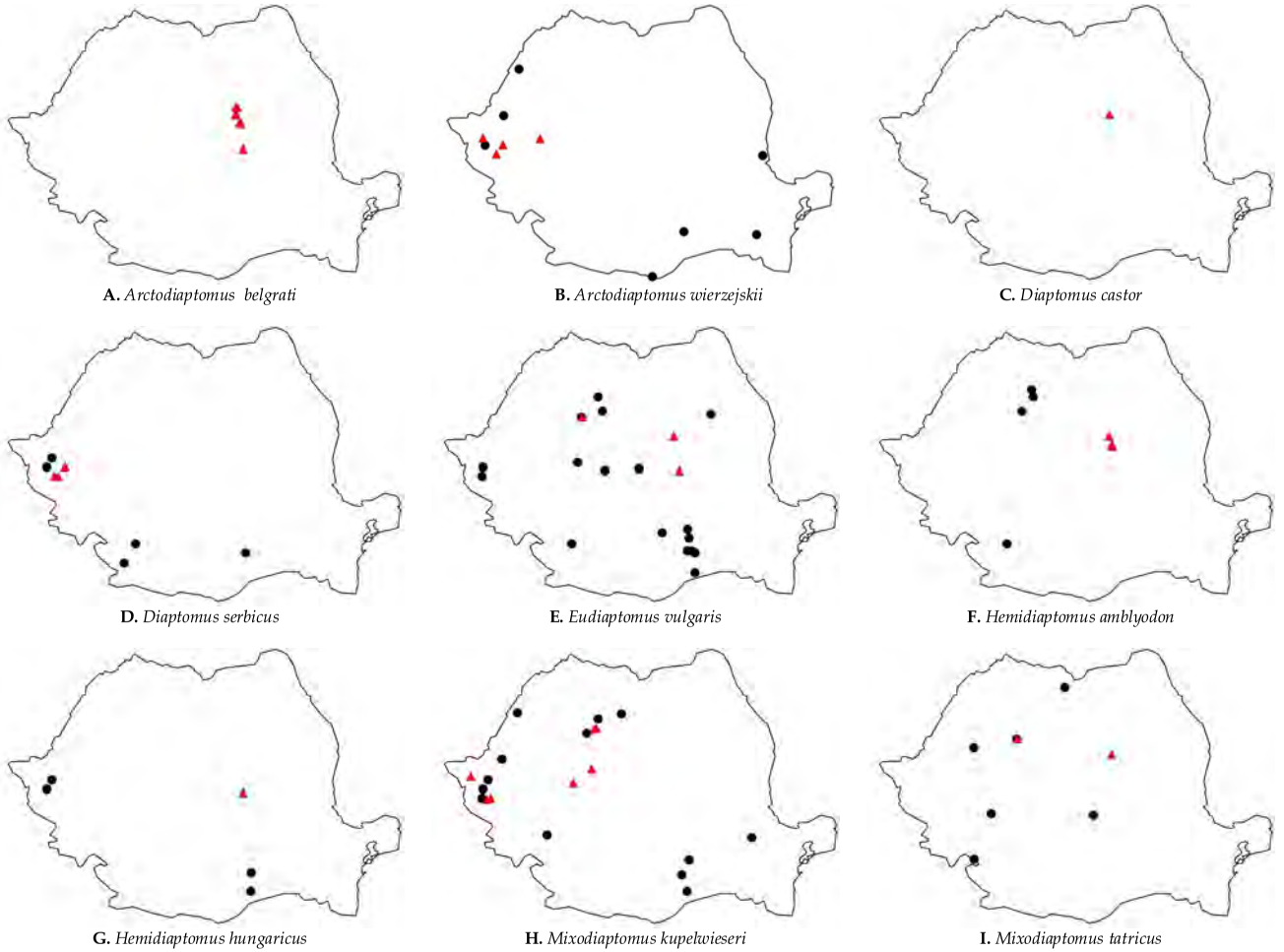

Figure 2. Distribution of the recorded diaptomid species in Romania. Triangles: this study, circles: data from Damian-Georgescu (1966).

Photo 1. *Hemidiaptomus amblyodon* female and *Arctodiaptomus belgrati* subadult from the Ciuc-basin (46.261ºN, 25.8503ºE, 661 m a.s.l.)

Photo 2. *Hemidiaptomus amblyodon* male from the Ciuc basin (same habitat as above)

Table 3. Updated checklist of Romanian inland-water calanoid copepods.
§: First record for Romanian fauna; †Reported as '*Arctodiaptomus dudichi valachicus* Banarescu & Serban, 1954' by Damian-Georgescu (1966); #: Reported as '*Eurytemora hirundoides* Nordquist, 1888' by Damian-Georgescu (1966).

Copepoda, Calanoida
Fam. Diaptomidae Kiefer, 1932
Subfam. Paradiaptominae
Lovenula (Neolovenula) alluaudi (Guerne & Richard, 1890)
Subfam. Diaptominae
§ *Diaptomus* (*Diaptomus*) *castor* (Jurine, 1820)
Diaptomus (*Chaetodiaptomus*) *serbicus* Gjorgjewic, 1907
Hemidiaptomus (*Gigantodiaptomus*) *amblyodon* (Marenzeller, 1873)
Hemidiaptomus (*Gigantodiaptomus*) *hungaricus* Kiefer, 1933
Eudiaptomus vulgaris (Schmeil, 1898)
Eudiaptomus transylvanicus (Daday, 1890)
Eudiaptomus gracilis (G.O. Sars, 1863)
Eudiaptomus graciloides (Lilljeborg, 1888)
Eudiaptomus zachariasi (Poppe, 1886)
Arctodiaptomus (*Arctodiaptomus*) *wierzejskii* (Richard, 1888)
Arctodiaptomus (*Arctodiaptomus*) *pectinicornis* (Wierzejski, 1887)
† *Arctodiaptomus* (*Arctodiaptomus*) *dudichi* (Kiefer, 1932)
Arctodiaptomus (Rhabdodiaptomus) salinus (Daday, 1885)
Arctodiaptomus (Rhabdodiaptomus) bacillifer (Koelbel, 1885)
§ *Arctodiaptomus* (*Mesodiaptomus*) *belgrati* Mann, 1940
Mixodiaptomus tatricus (Wierzejski, 1883)
Mixodiaptomus kupelwieseri (Brehm, 1907)
Acanthodiaptomus denticornis (Wierzejski, 1887)
Fam. Temoridae G.O. Sars, 1903
Eurytemora velox Lilljeborg, 1853
Eurytemora lacustris Poppe, 1887
Eurytemora affinis (Poppe, 1880)
Heterocope caspia Sars, 1897
Fam. Pseudodiaptomidae G.O. Sars, 1903
Calanipeda aquaedulcis Kritschagin, 1873

collected from a single site in Romania, but further sampling will probably widen its known distribution. This species is known to occur in most of the central and eastern European countries (Dussart & Defaye 2002) and its presence in the country was thus expected.

The observed local distribution of some species (i.e. *Arctodiaptomus wierzejskii*, *Diaptomus serbicus* and *Mixodiaptomus kupelwieseri*) is in good accordance with their previously known distribution in the country. Conversely, our data add the mountain basins of the Eastern Carpathians to the known Romanian distribution ranges of *Eudiaptomus vulgaris*, *Hemidiaptomus amblyodon*, *H. hungaricus* and *Mixodiaptomus tatricus*.

Based on the currently updated checklist and focusing on the family Diaptomidae

only (19 species), the calanoid fauna of Romania seems to lack endemics, and the observed species can be ascribed to four broad biogeographical groups:

a) Taxa widespread throughout the Palaearctic region, including 3 species (15.8% of the whole Romanian diaptomid fauna) (*Arctodiaptomus salinus, A. wierzejskii* and *Eudiaptomus vulgaris*);

b) Taxa spread in the temperate areas of the Palaearctic region, including 7 species (36.8%) (*Acanthodiaptomus denticornis*, *Arctodiaptomus bacillifer*, *Diaptomus castor, Eudiaptomus gracilis, E. graciloides, E. transylvanicus* and *Hemidiaptomus amblyodon*);

c) Eastern and south-eastern European taxa, including 7 species (36.8%) (*Arctodiaptomus belgrati, A. dudichi, A. pectinicornis, Diaptomus serbicus, Eudiaptomus zachariasi, Hemidiaptomus hungaricus* and *Mixodiaptomus tatricus*);

d) Southern European or circum-Mediterranean taxa, including 2 species (10.5%) (*Mixodiaptomus kupelwieseri* and *Neolovenula alluaudi*).

The co-existence of these groups confirms that the territory of Romania is a transition area between central and south-eastern European copepod faunas, with the additional presence of some species of southern affinity which seem to be confined to the Romanian lowlands. The relative importance of the eastern group is expected to increase when data from some currently under-sampled areas like the Danube delta and the eastern part of the country will be available.

However, the current picture about the distribution of species listed here is probably strongly biased by an uneven sampling coverage of the territory, and further surveys are needed to get a more complete picture of the actual Romanian calanoid fauna. Some diaptomid species known to occur in most neighbouring countries have never been recorded in Romania, and their absence in the country is probably due to a sampling bias; e.g. *Diaptomus falsomirus* and *Arctodiaptomus byzantinus* are known to occur in Turkey, Bulgaria and Ukraine (Dussart & Defaye 2002), and their occurrence in Romania is thus expected, but to date they have not been reported for the country.

A quite distinct calanoid species composition, characterized by the presence of *Diaptomus castor* and *Arctodiaptomus belgrati*, has been observed in the mountain basins of the Eastern Carpathians. A similar case was observed in Anostraca: at least two species seem to be confined to this region within Romania (Demeter & Hartel 2007, Demeter & Stoicescu 2008). The causes underlying this peculiarity are probably multiple: these mountain basins are characterized by a distinct geomorphology and climate which differentiate them from the rest of the country; furthermore, they are particularly rich in vernal pool habitats, which till recently have been scarcely studied.

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