

UDC 595.34

## FAUNISTICAL OVERVIEW OF CALANOID COPEPODS (CRUSTACEA) FROM CONTINENTAL WATERS OF UKRAINE

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Received 29 September 2010  
Accepted 30 March 2011

**Faunistic Overview of Calanoid Copepods (Crustacea) from Continental Waters of Ukraine. Samchyshyna L.** — Faunistic overview together with updated checklist, comprising 38 species and 2 subspecies of calanoid copepods inhabiting fresh and brackish Ukrainian waters classified in three families and twelve genera is provided. The only freshwater calanoid species endemic to Ukraine is *Speodiantomus birsteini* Borutzky, 1962, a stygobiont found once in an underground lake in the Skels'ka Cave (Crimean Peninsula). Two species, *Hemidiaptomus (Hemidiaptomus) rylovi* Charin, 1928 and *S. birsteini* are included as a threatened species in the Red Book of Ukraine. Dubious records and distribution patterns of some calanoid taxa are discussed. The calanoid fauna of Ukraine is compared with those of adjacent countries.

**Key words:** faunistical overview, Calanoida, fresh and brackish waters of Ukraine, faunal similarities, adjacent countries.

**Фаунистический обзор каланоидных копепод (Crustacea) континентальных вод Украины. Самчишина Л.** — Представлен фаунистический обзор с обновленным списком, состоящий из 38 видов и 2 подвидов, относящихся к трем семействам и двенадцати родам каланоидных копепод, обитающих в пресных и солоноватых водах Украины. *Speodiantomus birsteini* Borutzky, 1962, единственный пресноводный вид каланоид — эндемик Украины, стигобионт найденный однажды в Скульской пещере Крымского полуострова. Два вида — *Hemidiaptomus (Hemidiaptomus) rylovi* Charin, 1928 и *S. birsteini* — в настоящее время занесены в Красную книгу Украины. Обсуждаются распространение каланоидных копепод, а также сомнительные находки некоторых видов в Украине. Фауна каланоид Украины сравнивается с таковой соседних стран.

**Ключевые слова:** фаунистический обзор, Calanoida, пресные и солоноватые воды Украины, фаунистическое сходство, соседние страны.

### Introduction

Siewerth (1927) provided the first inventory of continental calanoid copepods of Ukraine. His list included only seven calanoid species: *Diaptomus castor* (Jurine, 1820), *Eudiaptomus coeruleus* (Fischer, 1853), now considered a junior synonym of *Eudiaptomus transylvanicus* (Daday, 1890), *Eudiaptomus gracilis* (G. O. Sars, 1863), *Hemidiaptomus amblyodon* (Marenzeller, 1873), *Eurytemora velox* (Lilljeborg, 1853), *Heterocope caspia* G. O. Sars, 1897 and *Heterocope saliens* Lilljeborg, 1863. Records of calanoid copepods increased rapidly thereafter, particularly in the second half of the 20th century, due to taxonomical and hydrobiological investigations of inland waters in Ukraine (Pidgajko, 1957; Tseeb, 1961; Konenko, et al. 1965; Monchenko et al., 1974). I believe it timely to provide an updated checklist of calanoid copepod species found in fresh and brackish waters of Ukraine and a preliminary analysis of calanoid taxa hitherto found in Ukraine and neighboring Eastern European countries.

### Materials and methods

The checklist was compiled mostly from primary literature sources and supplemented with my personal records. The calanoid classification schemes given by Kiefer (1978) and Borutzky et al. (1991) are fol-

lowed. The zoogeographic divisions of European aquatic basins follow those of Starobogatov (1986) and zoogeographic subzones of Ukraine by Lan'ko et al. (1969). Relative faunal similarities of calanoid copepod assemblages between Ukraine and neighboring Romania (Damian-Georgescu, 1966, Demeter, Maronne 2009), Slovakia (summarized from Brtek (1977) and Terek (1983, 1999 a), Turkey (Ustaoglu 2004), Russia (Borutzky et al., 1991), Belarus (Vezhnovets, 2005) and Poland (Biedzki, pers. comm.) are expressed as Sørensen Index calculated by means of PAST software (Hammer et al. 2001).

## Results and discussion

Thirty-eight species and two subspecies, classified in three families and twelve genera, of calanoid copepods have been collected thus from aquatic habitats of Ukraine (table 1). Siewerth (1927) excluded Belousov's (1908) records of *Arctodiaptomus wierzejskii* (Richard, 1888), *Hemidiaptomus (Gigantodiaptomus) superbus* (Schmeil, 1895) and *Eudiaptomus zachariasi* (Poppe, 1886) from his list as doubtfully present in Ukraine. These taxa are now included in the present checklist, as they have been found repeatedly in Ukraine (Ulomskij, 1955; Tseeb, 1961). The record of *Heterocope borealis* (Fischer, 1851) from Berda River, southern Ukraine (Polischuk, 1980), is doubtful and highly unlikely as that species is regarded as a cold-loving, stenothermic species with a purely boreal distribution (Rylov, 1930). Quite probable is a misidentification of *Heterocope caspia* G. O. Sars, 1897, a species common in southern Ukraine, by Polischuk as *H. borealis*. Zhuravel's (1948a, b) findings of *Diaptomus mirus* Lilljeborg, 1889 in the Samara River are also doubtful, as this species is considered to be confined within Siberia and the Far East (Borutzky et al., 1991); those calanoids most likely were *Diaptomus (Chaetodiaptomus) falsomirus* Kiefer, 1972 given that this species was originally found in Bulgaria and was recently recorded for the first time from Ukraine in a pond between the Horol and Psel Rivers (Samchyshyna, 2005). Among the three calanoid families inhabiting Ukrainian continental waters, the Diaptomidae is the best represented by nine genera and 31 species, followed by Temoridae with two genera, six species and two subspecies. The family Pseudodiaptomidae is represented by a single species in Ukraine (table 1). The only freshwater calanoid species endemic to Ukraine is *Speodiaptomus birsteini* Borutzky, 1962, a stygobiont found only in an underground lake in the Skels'ka Cave of the Crimean Peninsula (Borutzky, 1962). The remaining calanoid taxa inhabit various zoogeographic subzones in Ukraine. The majority of the taxa (54%), *Mixodiaptomus tatricus* (Wierzejski, 1883) for example, occur in only one zoogeographic subzone (Mykytchak, Ivanetc, 2006), whereas 46% (18/39), *Eudiaptomus graciloides* (Lilljeborg, 1888) for instance, occur in two or more zoogeographic subzones.

The temorid calanoid, *E. velox*, is considered to be a recent immigrant into fresh waters given that it occurs typically in brackish waters of the Black Sea coast but has been collected recently in the middle parts of the Dnieper and Dniester Rivers (and their tributaries around 1200 km far from the sea), in the Carpathian Mountains (three lakes of the Tysmenitsa River basin) and in the Salgir River at the central part of the Crimean peninsula (Samchyshyna, 2000, 2007, 2008).

Two species, *Hemidiaptomus (Hemidiaptomus) rylovi* Charin, 1928 and *S. birsteini* are included as a threatened species in the new edition of the Red Book of Ukraine (Samchyshyna, 2009). The last species was recommended as the expanding speleotourism industry in Crimea has a negative impact on the inhabitants of the Skels'ka Cave.

Ten of the 40 calanoid taxa included in this checklist reach their geographical range limit in Ukraine. Thus, *D. (C.) falsomirus*, *E. zachariasi*, *Mixodiaptomus kupelwieseri* (Brehm, 1907) and *M. tatricus* attain their eastern limit, while *Arctodiaptomus (Arctodiaptomus) dentifer* (Smirnov, 1928), *Arctodiaptomus (Rhabdodiaptomus) acutibatus* (G. O. Sars, 1903) and *Metadiaptomus asiaticus* (Uljanin, 1875) reach their western limit in Ukraine. For *Arctodiaptomus (Arctodiaptomus) mucronatus* (Rylov, 1927)

Table 1. List of calanoid copepods recorded from fresh and brackish waters of Ukraine

Таблица 1. Список каланоидных копепод найденных в пресных и солоноватых водах Украины

Taxon	Zoogeographic subzone*	Author
Class Maxillopoda Dahl, 1956		
Subclass Copepoda Milne-Edwards, 1840		
Order Calanoida G. O. Sars, 1901		
<b>Family Diaptomidae</b> G. O. Sars, 1903		
<b>Subfamily Diaptominae</b> G. O. Sars, 1903		
<i>Acanthodiaptomus denticornis</i> (Wierzejski, 1887)	Az-BI	3
<i>Arctodiaptomus</i> ( <i>A.</i> ) <i>byzantinus</i> Mann, 1940	CrM	21
<i>A. (A.) dentifer</i> (Smirnov, 1928)	S, Az-BI	10, 20
<i>A. (A.) dudichi</i> Kiefer, 1932	S	10
<i>A. (A.) mucronatus</i> (Rylov, 1927)	CrM, S	4, 4
<i>A. (A.) pectinicornis</i> (Wierzejski, 1887)	CrM, S	11, 4
<i>A. (A.) similis</i> (Baird, 1859)	Az-BI, S	20, 4
<i>A. (A.) wierzejskii</i> (Richard, 1888)	W-S, CrM, Az-BI, S	1, 21, 20, 4
<i>A. (Rhabdodiaptomus) acutilobatus</i> (G. O. Sars, 1903)	CrM, W-S, S	21, 4, 4
<i>A. (R.) bacillifer</i> (Koelbel, 1885)	S, Az-BI	10, 5
<i>A. (R.) salinus</i> (Daday, 1885)	S, Az-BI, CrM	21, 5, 21
<i>A. (R.) spinosus</i> (Daday, 1891)	S	7
<i>Diaptomus</i> ( <i>Chaetodiaptomus</i> ) <i>charini</i> Siewerth, 1928	S	16
<i>D. (C.) falsomirus</i> Kiefer, 1972	S	14
<i>D. (Diaptomus) castor</i> (Jurine, 1820)	P, S	17, 7
<i>Eudiaptomus arnoldi</i> (Siewerth, 1928)	S, P	16, 19
<i>E. gracilis</i> (G. O. Sars, 1863)	P, W-S, S, CarpM, Az-BI	9, 1, 4, 4, 20
<i>E. graciloides</i> (Lilljeborg, 1888)	P, W-S, CrM, Az-BI	9, 4, 21, 20
<i>E. transylvanicus</i> (Daday, 1890)	P, W-S, S, Az-BI	9, 4, 4, 20
<i>E. vulgaris</i> (Schmeil, 1898)	P, W-S, S, CarpM, CrM, Az-BI	9, 4, 4, 18, 13, 5
<i>E. zachariasi</i> (Poppe, 1886)	W-S	1
<i>Hemidiaptomus</i> ( <i>Gigantodiaptomus</i> ) <i>amblyodon</i> (Marenzeller, 1873)	P, S	17, 4
<i>H. (G.) hungaricus</i> Kiefer, 1933	S	10
<i>H. (G.) superbus</i> (Schmeil, 1895)	W-S	1
<i>H. (Hemidiaptomus) rylovi</i> Charin, 1928	S	10
<i>Mixodiaptomus incrassatus</i> (G. O. Sars, 1903)	CrM	21
<i>M. kupelwieseri</i> (Brehm, 1907)	Az-BI	14
<i>M. tatricus</i> (Wierzejski, 1883)	CarpM	18
<b>Subfamily Speodiaptominae</b> Borutzky, 1962		
<i>Speodiaptomus birsteini</i> Borutzky, 1962	CrM	2
<b>Subfamily Paradiaptominae</b> Sars, 1903		
<i>Metadiaptomus asiaticus</i> (Uljanin, 1875)	S, Az-BI	4, 5
<i>Neolovenula alluaudi</i> (Guerne & Richard, 1890)	W-S, S, CrM, Az-BI	4, 10, 21, 20
<b>Family Pseudodiaptomidae</b> G. O. Sars, 1903		
<i>Calanipeda aquaeduleis</i> Kristchagin, 1873	Az-BI	13
<b>Family Temoridae</b> Sars, 1903		
<i>Eurytemora affinis affinis</i> (Poppe, 1880)	Az-BI	6
<i>E. affinis hirundooides</i> (Nordquist, 1888)	Az-BI	8
<i>E. grimmi</i> (G. O. Sars, 1897)	Az-BI	6
<i>E. lacustris</i> (Poppe, 1887)	Az-BI	8
<i>E. velox</i> (Lilljeborg, 1853)	P, S, CarpM, Az-BI	19, 4, 15, 20
<i>Hetercope appendiculata</i> G. O. Sars, 1863	P	12
<i>H. caspia</i> G. O. Sars, 1897	Az-BI	20
<i>H. saliens</i> (Lilljeborg, 1863)	P	17

Key for numerical references: 1 — Belousov, 1908; 2 — Borutzky, 1962; 3 — Grimalskij, 1968; 4 — Konenko et al. 1965; 5 — Krazhan, 1971; 6 — Markovskij, Myroshnychenko 1927; 7 — Mel'nikov, 1934; 8 — Monchenko, 1967; 9 — Monchenko et al. 1974; 10 — Pidgajko, 1957; 11 — Rylov, 1930; 12 — Samchyshyna, 2001 b; 13 — Samchyshyna, 2001 a; 14 — Samchyshyna, 2005; 15 — Samchyshyna, 2008; 16 — Siewert, 1928; 17 — Sovinskij, 1891; 18 — Terek, 1998; 19 — Travyanko, Tseeb, 1967; 20 — Tseeb, 1961; 21 — Ulomskij, 1955.

\* P — Polissya, W-S — Wood-and-Steppe, S — Steppe, CarpM — Carpathian Mountains, CrM — Crimea Mountains, Az-BI — Azov-Black Sea coast.

and *Arctodiaptomus* (*Arctodiaptomus*) *byzantinus* Mann, 1940, Ukraine is the northern limit of their ranges. A permanently reproducing population of the boreal species *Heterocope appendiculata* G. O. Sars, 1863 was found recently in the deep karstic lake Pischne (the Shatski Lakes group) at the north-western Ukraine (Samchyshyna, 2001 a). This finding indicates that the Shatski Lakes: a) belong to the Baltic Zoogeographical Province of the North-European Superprovince rather than to the Middle–Dnieper Province of the Black–Sea Superprovince, and b) represent the most southern range limit for *H. appendiculata*. It must be noted, however, that *H. appendiculata* individuals in Ukraine can be transported occasionally from the north in meltwater to as far south as the middle Dnieper River during the spring season (see Gusynskaya (1967) and Travyanko, Tseeb (1967)).

Copepod faunal similarities, as estimated by Sørensen Index (table 2; fig. 1), between Ukraine and neighboring Romania, Slovakia, Turkey, Russia, Belarus and Poland revealed that Ukraine shares the most calanoid species with Romania and Slovakia. Indeed, all calanoid taxa of those countries, except for *Diaptomus* (*Chaetodiaptomus*) *serbicus* Gjorgewic, 1907 and *Arctodiaptomus alpinus* (Imhof, 1885), respectively, reported from Romania and Slovakia also occur in Ukraine. Moreover, the last species is expected to be found in the Carpathian lakes in thorough sampling from the Ukrainian site of mountains (Terek, 1999b). Further, *D. (C.) serbicus* is morphologically very similar to the Ukrainian *Diaptomus* (*Chaetodiaptomus*) *charini* Siewerth, 1928 (Borutzky et al., 1991). In Ukraine and Romania, the temperate and Mediterranean calanoid forms dominate, as both countries are intersected by the Carpathian Mountains and belong to the northern Black Sea basin.

All calanoids, except the glacial relict centropagid copepod *Limnocalanus macrurus* Sars, 1863 and cold-water stenotherm *Mixodiaptomus theeli* (Lilljeborg in Guerne and Richard, 1889), reported from Belarus, also occur in Ukraine. As with Ukraine, *E. velox* is also considered a recent invasive species in Belarus (Karatayev et al. 2007). Nonetheless, the calanoid fauna of Belarus and Poland are quite similar, particularly considering that their territories are confined to one geographic zone and most of their aquatic habitats lie in the Baltic Sea basin. Nineteen calanoid species are shared between Ukraine and Poland. Russia, a considerably larger country lying in different climatic zones as compared to Ukraine, shares 30% calanoid species with Ukraine. *H. (G.) superbus*, *D. (C.) falsomirus*, *D. (C.) charini*, *E. zachariasi*, *A. (A.) mucronatus*, *A. (A.) byzantinus*, *Arctodiaptomus* (*Rhabdodiaptomus*) *spinosus* (Daday, 1891), *M. taticus*, *M. kupelwieseri* and *S. birsteini*, which occur in Ukraine, have not been recorded in Russia yet. About 54% of the continental calanoid copepod species of Turkey (marine genus *Acartia* is not considered here) occur in Ukraine, especially the Crimean Peninsula (32%), while others as defined as semi-arid and arid species are absent in Ukraine. The cluster groupings provided in this study will most likely be revised after

**Table 2. Relative faunal similarity of calanoid copepods from continental waters calculated using Sørensen's Index. Bold numbers indicate species numbers (incl. subspecies) for each country**

Таблица 2. Относительное фаунистическое сходство каланоидных копепод континентальных вод по индексу Соренсена. Цифры жирным шрифтом обозначают количество видов (включая подвиды) для каждой страны

Country	Ukraine	Belarus	Russia	Romania	Turkey	Poland	Slovakia
Ukraine	<b>40</b>	0.44	0.48	0.69	0.48	0.54	0.59
Belarus	0.44	<b>15</b>	0.30	0.46	0.13	0.58	0.49
Russia	0.48	0.30	<b>85</b>	0.35	0.26	0.38	0.29
Romania	0.69	0.46	0.35	<b>24</b>	0.47	0.56	0.76
Turkey	0.48	0.13	0.26	0.47	<b>31</b>	0.30	0.33
Poland	0.54	0.58	0.38	0.56	0.30	<b>30</b>	0.54
Slovakia	0.59	0.49	0.29	0.76	0.33	0.54	<b>18</b>

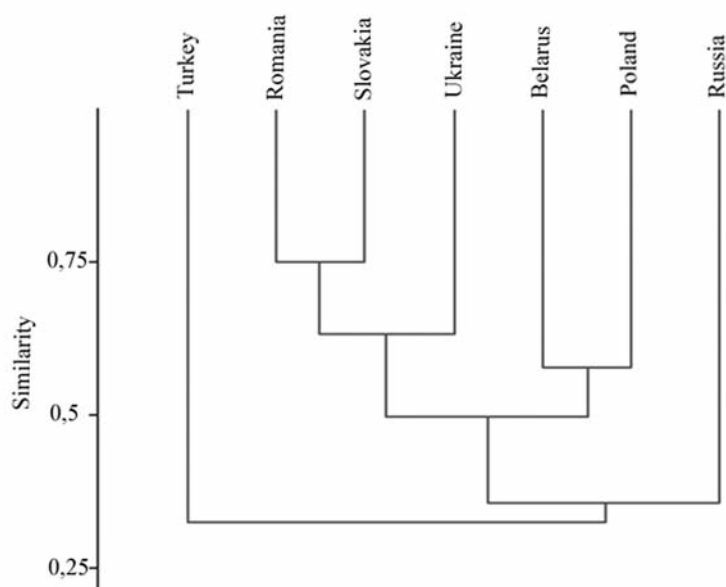


Fig. 1. Paired group cluster analysis based on Sorenson's index of calanoid copepod faunas of inland waters of Ukraine, Belarus, Poland, Romania, Russia, Slovakia and Turkey.

Рис. 1. Парный групповой кластерный анализ фаун каланоидных копепод внутренних вод Украины, Беларуси, Польши, Румынии, России, Словакии и Турции основываясь на индексе Соренсена.

the calanoid assemblages from additional countries such as Moldova and Hungary are determined.

I thank Dr. Maria Hołyńska (Museum and Institute of Zoology, PAS) and Prof. Vladyslav Monchenko (Schmalhausen Institute of Zoology, NASU) for critical reviewing this paper. Dr. Vasily Vezhnovets (Belarusian State University), Dr. Leszek Błędzki (Mount Holyoke College), and Jozef Terek (University of Prešov) kindly provided me recent calanoid copepod lists of Belarus, Poland, and Slovakia, respectively. I am particularly indebted to Dr. Danny Tang for his helpful comments, suggestions on the manuscript and improving of English.

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