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Species inventory and distribution patterns of freshwater amphipods in Moldova

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Abstract. Amphipod fauna of Moldova remains one of the least known in Europe with the most recent data upon species distribution being already almost 50 years old. In this paper, we summarize the knowledge upon the distribution of amphipods in Moldovan inland waters based on literature survey combined with our new original data and present a comprehensive checklist of recorded amphipod species. The new original data come from samples collected in 2012 at 25 sites across Moldova from a variety of freshwater habitats, ranging from springs and streams to rivers and artificial lakes. In the collected material, we identified only 4 species of gammarids – one, *Gammarus kischineffensis*, belonging to family Gammaridae and three species of Pontogammaridae: *Pontogammarus robustoides*, *Obesogammarus crassus* and *Dikerogammarus haemobaphes*. Presence of all these species has already been reported from Moldova. This number is surprisingly low if compared to the total number of amphipod species known to occur in the country, which is 18. However, 14 of these species are Ponto-Caspian elements and were reported only from the largest Moldovan rivers, Dniester and Prut. Further 12 Ponto-Caspian amphipod species may likely occur in the Moldovan section of the Dniester as they were found before in the lowest run of the river, already on the Ukrainian territory. Leaving out the Ponto-Caspian fauna, only five typically freshwater species were reported from Moldova so far: *G. kischineffensis*, *G. balcanicus*, *Synurella ambulans*, *Niphargus birsteini* and *N. yaroshenkoi*. This poverty is striking if compared to surrounding countries. Interpreting these results within a geological and palaeogeographical framework, we may suppose that it is due to the low landscape complexity combined with the relatively young age of the Moldavian Plateau and its hydrological network.

Key words: Amphipoda, Gammaridae, Pontogammaridae, inland waters, Ponto-Caspian fauna, biogeography.

Introduction

Due to their wide geographical distribution, usually high abundance and peculiar position in the food web, amphipods are referred to as important keystone species in aquatic ecosystems of temperate climate zone (Väinölä et al. 2008). Being sensitive to a wide range of pollutants, they are used as bioindicators in water quality assessment as well as standard test organisms in ecotoxicity testing (Gerhardt et al. 2011). A new Organization for Economic Co-operation and Development (OECD) guideline for testing of chemicals is under construction, which will consist of a variety of in situ and ex situ ecotoxicological studies upon gammarids based on various measurement parameters (Gerhardt et al. 2011). Thus, knowledge upon distribution of freshwater amphipods in particular countries is an initial step to implement any policy related to such ecotoxicity tests. Europe holds a large part of freshwater amphipod diversity in the Palearctic realm, hotspots in the Iberian, Apennine and Balkan peninsulas and also the Ponto-Caspian region (Väinolä et al. 2008, Hou et al. 2011).

Assuming the generally poor knowledge and lack of any recent information upon the amphipod fauna of Moldova, the aim of our study was to summarize the information upon the distribution of freshwater amphipods based on the literature survey combined with our new original data and present a comprehensive checklist of amphipod species recorded from Moldova. The results are confronted with the knowledge upon amphipod fauna of neighbouring countries and discussed within the framework of the palaeogeographical and geological history of the area.

Materials and methods

Study area

The area of Moldova belongs entirely to the Black Sea basin and almost all of its territory covers the drainage systems of Dniester and Prut rivers (Fig. 1). Dniester is the largest river in the western Ukraine and Moldova. Of its total length of 1.380 km, 652 km lie within the borders of Moldova. The area of the Dniester Basin is 72.100 km² with 19.400 km² (26.9 %) in the territory of Moldova. Unlike the other sections of the Basin, located partially in the Carpathian Mountains, the topography of Lower Dni-

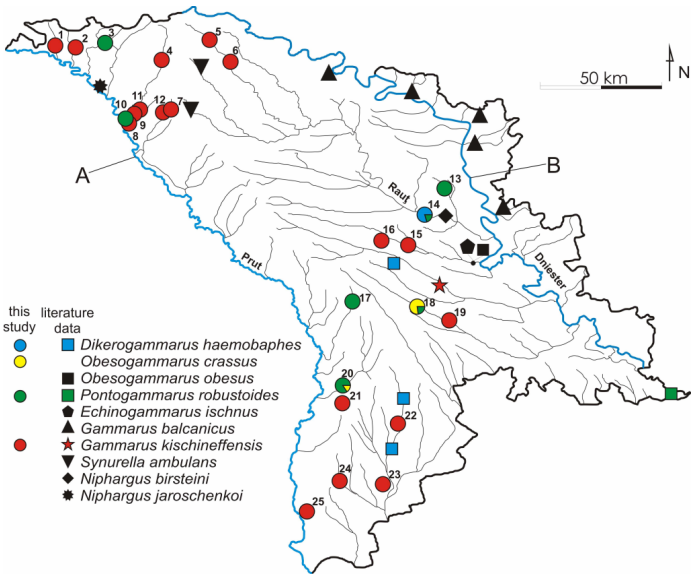

Figure 1. Distribution of amphipods in Moldova. Circles – records from this study. Various symbols – records from literature (only if the localities were specified). In case of *Gammarus kischineffensis* only locus typicus is illustrated as the species was reported to occur in numerous places across Moldova. Species found in Prut (A) and Dniester (B) are specified in Table 2.

ester Basin located in Moldova is rather plain (OSCE/UNECE 2005). Prut River is also one of the largest rivers in western Ukraine, Moldova and Romania. It has the length of 967 km and drainage area of 27.540 km², of which 7710 km² (28 %) is in the territory of Moldova. The absolute maximum elevation of the basin is 429.5 m, and the minimum 2.6 m (EPIRB 2013). Both of these rivers are facing severe environmental problems due to pointed sources of pollution and anthropogenic impacts associated with i.e. unregulated discharge of municipal wastes, storage of pesticides and chemicals or agriculture (OSCE/UNECE 2005, EPIRB 2013).

Sampling

The samples of gammarids from Moldovan inland waters were collected by the third author in August 2012 from 25 sites across the country (Figs 1 and 2). Quantitative sampling was conducted using rectangular kick sample nets (aperture 25x25 cm and 0.5 mm mesh size). The GPS coordinates are given for each locality and Gauss-Krüger coordinates were determined for each sampling site and the data were mapped using DIVA-GIS program package. A vast variety of freshwater habitats were sampled, ranging from springs, streams to rivers and artificial lakes. Within each site, water temperature and electrical conductivity were measured with the WTW Multi 350i probe (Table 1). Identification of amphipods was done according to Mordukhaj-Boltovskoj et al. 1969, Karaman and Pinkster (1977, 1987). The list of amphipods recorded during the survey is provided in Table 1.

In order to provide the complete list of amphipod species recorded so far from the inland waters of Moldova, we have surveyed all the available historical sources containing information upon amphipods from the inland waters of the present state territory. These sources included not only papers published in journals but also all kind of "grey literature" such as local monographs and technical reports. The checklist of amphipod species found so far in the Moldovan waters is provided in Table 2. Distribution of species for which the locality data were provided in the literature is illustrated in Fig. 1.

The material was collected on 25 sampling sites all around Moldova, differing in altitude, water temperature and its electrical conductivity (Table 1). All the sampling sites were placed in lowland areas, from 16 m.a.s.l. in Manta (site MD25) to 187 m.a.s.l. in Colicăuți (site MD3). They were characterized mostly by lentic conditions and even in lotic sites, the current was usually slow. The temperature between sites, measured while sampling, varied from 14.0 °C in Văratic (site MD11) up to 30.5 °C in Costești (site MD18). The conductivity values varied from 0.37 mS/cm in an artificial lake near Duruitoarea Nouă (site MD10) up to 4.25 mS/cm, in the artificial reservoir in Sărata Nouă area (site MD20).

Results

Literature survey

The first information upon freshwater amphipods of Moldova was provided by Schellenberg (1937) who described *Gammarus kischineffensis* (Schellenberg, 1937) from a stream in vicinity of Chişinău (Kishiniev), the present capital of Moldova. It is worth to comment here on Karaman and Pinkster (1977) citing Schellenberg (1937) as a sole source of information upon presence of *Gammarus komareki* Schäferna, 1922 in Moldova, in the mouth of Rybniza River. That was a clear mistake. Rybniza (with various spelling) is a common toponym and

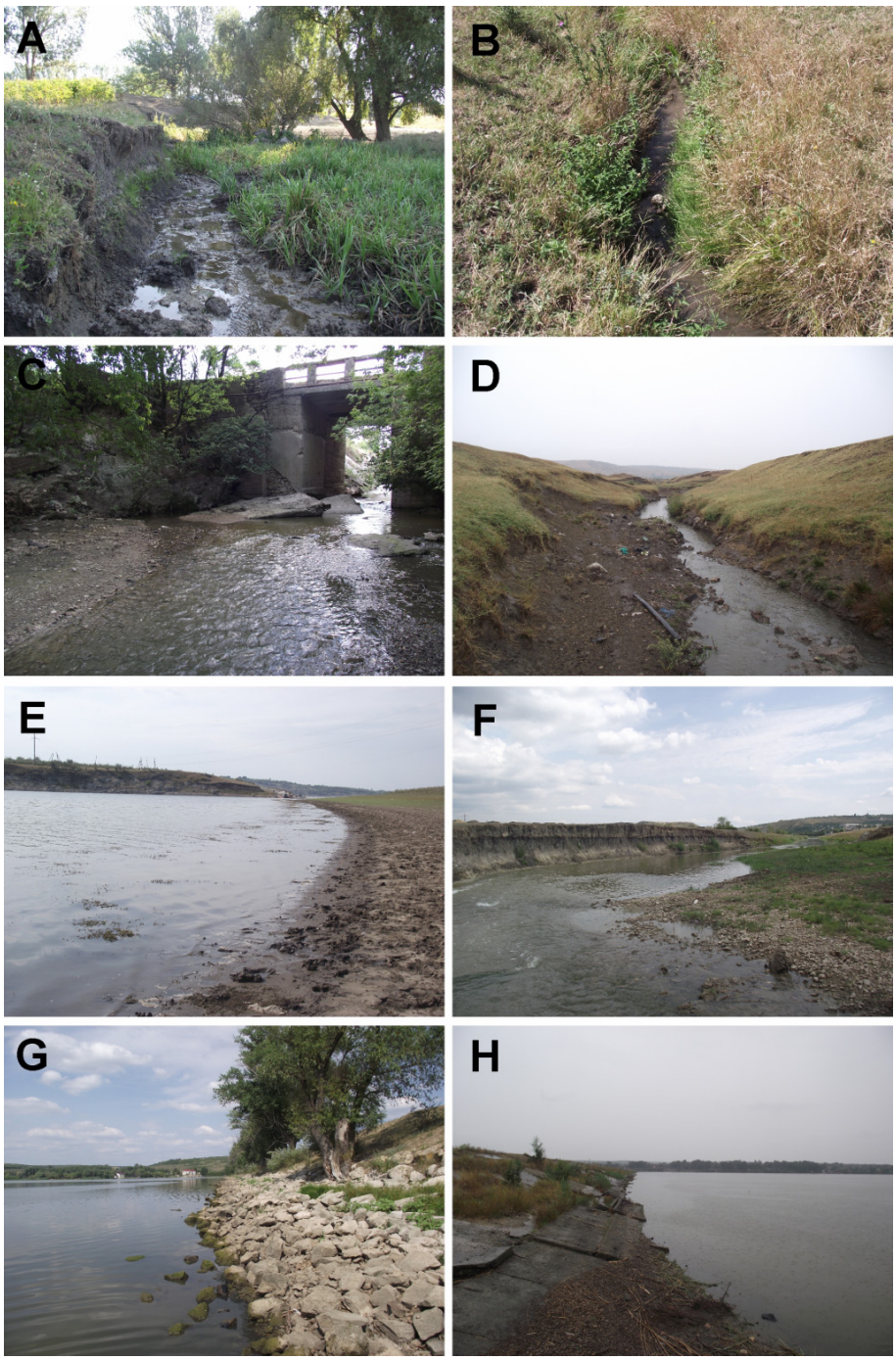

Figure 2. Habitats of gammarids in Moldova: A - river near Beleavinti (MD2), B - stream near Goleni (MD4), C - river near Maramonowka (MD6), D - river near Cuporani (MD21), E - artificial reservoir near Duruitoarea Nouă (MD10), F - river near Orgiejów (MD14), G - artificial reservoir near Costești (MD18), H - artificial reservoir near Sarata Nouă (MD20).

Table 1. Characteristics of site sampled during the field survey with list of recorded species. Water body: (R) river, (S) stream, (A) artificial reservoir, (Lhs) limno-helocrene spring; Bottom type: (Md) mud, (St) stones, (Gr) gravel, (Sd) sand, (Sv) submerged vegetation; Banks: (Tr) trees, (Gs) grass, (Gr) gravel, (Cb) concrete blocks, (Rd) reeds, (Ev) emerged vegetation other than reeds; Gammarid species: *Gkis* – *Gammarus kischineffensis*, *Dhae* – *Dikerogammarus haemobaphes*, *Ocra* – *Obesogammarus crassus*, *Prob* – *Pontogammarus robustoides*.

Site no.	Locality	GPS Coordinates	Alt. (m asl)	Temp (°C)	Conductivity (mS/cm)	Water body	Bottom type	Bank type	*Gkis*	*Dhae*	*Ocra*	*Prob*
MD1	Hlina	N48°29', E26°87'	160	24.6	1.113	S	Md, St	Tr, Gs	420	-	-	-
MD2	Beleavinti	N48°27', E26°98'	164	18.5	0.800	R	Md	Rd	84	-	-	-
MD3	Colicauti	N48°29', E27°14'	187	26.4	0.742	R	Md	Ev, Rd	-	-	-	134
MD4	Goleni	N48°21', E27°43'	156	28.5	2.580	S	Md	Ev	182	-	-	-
MD5	Mosana	N48°32', E27°67'	168	28.0	1.722	S	Md	Ev	773	-	-	-
MD6	Maramonowka	N48°20', E27°78'	147	26.6	0.953	R	Sd, Gr, St	Tr	66	-	-	-
MD7	Balanul Nou	N47°95', E27°48'	139	25.1	1.558	R	Md, Gr, St	Rd	94	-	-	-
MD8	Duruitoarea Nouă	N47°87', E27°26'	89	19.1	0.935	S	Sv	Gs	93	-	-	-
MD9	Varatic	N47°92', E27°28'	93	24.8	1.055	S	Md, St	Gs	471	-	-	-
MD10	Duruitoarea Nouă	N47°88', E27°25'	97	26.8	0.368	A	Md	Ev	-	-	-	34
MD11	Varatic	N47°94', E27°32'	155	14.0	1.089	Lhs	Sd, Gr	Ev	151	-	-	-
MD12	Stureni	N47°93', E27°43'	112	26.0	1.047	S	Md	Gs	275	-	-	-
MD13	Biesti	N47°51', E28°89'	129	25.6	1.082	A	Sd, Md	Gs	-	-	-	52
MD14	Orgiejów	N47°37', E28°80'	37	25.5	2.030	R	Md, St	Gr, Gs	-	114	-	29
MD15	Miclesti	N47°21', E28°70'	63	23.7	1.391	S	Md	Rd	487	-	-	-
MD16	Zubresti	N47°24', E28°57'	93	22.3	1.573	S	Md	Ev	237	-	-	-
MD17	Lapusna	N46°91', E28°40'	70	28.7	1.854	A	Md, St	Gs	-	-	-	25
MD18	Costeşti	N46°88', E28°75'	76	30.5	1.261	A	Md, St	Cb, Gr	-	-	37	11
MD19	Horesti	N46°81', E28°91'	48	21.4	1.955	S	Md	Ev	167	-	-	-
MD20	Sarata Nouă	N46°48', E28°39'	38	21.8	4.250	A	Md	Cb, Rd	-	-	14	75
MD21	Cuporani	N46°37', E28°36'	69	20.8	2.220	R	Md	Gs	125	-	-	-
MD22	Chirsova	N46°26', E28°65'	60	19.6	3.610	R	Md	Rd	350	-	-	-
MD23	Balabanu	N45°94', E28°57'	65	19.2	3.670	S	Md	Ev	357	-	-	-
MD24	Bucuria	N45°96', E28°35'	70	22.3	1.286	R	Sd	Gs	26	-	-	-
MD25	Manta	N45°79', E28°18'	16	18.1	1.062	R	Md, St	Ev	256	-	-	-

hydronym in Slavic languages, indicating a place/water body where fish is abundant. In his paper, on page 505, Schellenberg (1937) clearly stated that one of the analysed samples of *G. komareki* was from Bulgaria (not Moldova) and on page 506 he specified that it was collected from a river in "Rybniza bei Philippopel". Philippopel is an old German name for Plovdiv – a large city in south-western Bulgaria, where *G. komareki* is known to occur (Karaman and Pinkster 1977, Grabowski, unpublished data). So far, there have been no other original reports on the presence of *G. komareki* in Moldova. Thus we did not include this species in the checklist. Later, the fauna of large and small rivers, streams, ponds and dam lakes in Moldova was extensively studied in the years 1945-1964, mainly by Dedju (1960, 1961, 1962a, 1962b, 1963a, 1963b) and Jaroshenko (1956, 1957, 1959, 1964). However, the above mentioned publications containing original data on the distribution and localities of particular species are written exclusively in Russian and published as very local monographs. Thus, they belong to the so called "grey literature" and are almost unknown to a wider audience. The above papers were summarized later by Dedju (1967, 1980), who discussed the overall patterns of amphipod distribution in the region. However, in most cases he did not provide detailed locality information upon particular species. Generally, he concluded that small rivers and streams all over the country, and locally also some artificial reservoirs, are inhabited commonly by the *G. kischineffensis*. Interestingly, according to the above author, *Gammarus balcanicus* Schäferna, 1922 is present locally in some Dniester affluents (such as Molochişul, Camenca, Rybniţa, Yahorlyk, Soroca) but absent from the Moldovan part of the Prut system. On the other side, Mushchinskij (1964) provided information on the presence of that species in the Prut river and its tributaries in the vicinity of Şirauţi village (northern Moldova). Only two species found usu-

Table 2. Checklist of amphipod species recorded from Moldova. A star indicates reports from the section of Dniester and Prut outside of the Moldovan territory, excluding the brackish Dniester liman (see explanation in the text). (A.- Ashevskij, B.- Behning, C.- Cărăusu, D.- Dedju, I.- Ioffe, J.- Jalynskaja, Jr.- Jaroshenko, Jz.- Jażdżewski, J&K.- Jażdżewski & Konopacka, M.- Markovskij, Mu.- Mushchinskij, MB&co.- Mordukhaj-Boltovskoj et al., S.- Schellenberg, Z.- Zhuravel, Th.s.- this study).

Species	Dniester	Prut	artificial reservoirs, ponds, lakes	small rivers	springs, wells
Pontogammaridae					
Dikerogammarus haemobaphes (Eichwald, 1841)	C. 1943, M. 1953, J. 1965, D. 1967, 1980, MB&co. 1969, I. 1973, Jz. 1980, J&K. 1988	D. 1967, 1980	D. 1980	Th.s.	-
Dikerogammarus villosus (Sowinskyi, 1894)	C. 1943, M. 1953, J. 1965, D. 1967, 1980, MB&co. 1969, I. 1973, Jz. 1980, J&K. 1988	-	-	-	-
Dikerogammarus bispinosus Martynov, 1925	C. 1943, M. 1953, J. 1965, D. 1967, 1980, MB&co. 1969, I. 1973, Jz. 1980, J&K. 1988	-	-	-	-
Dikerogammarus aralensis (Uljanin, 1874)	* D. 1967, 1980	-	-	-	-
Pontogammarus robustoides (Grimm, 1894)	C. 1943, M. 1953, Z. 1963, 1965, D. 1980, MB&co. 1969, Jz.1980	D. 1967, 1980	J&K. 1988, Th.s.	Th.s.	-
Obesogammarus crassus (Grimm, 1894)	B. 1928, C. 1943, M. 1953, D. 1967	-	D. 1980 after A. 1973, Th.s.	-	-
Obesogammarus obesus (Sars, 1925)	C. 1943, D. 1967, 1980, J&K. 1988	-	D. 1967, 1980, J&K. 1988,	-	-
Obesogammarus olvianus (Sowinskyi, 1904)	* D. 1967	-	-	-	-
Pontogammarus abbreviatus (Sars, 1894)	*D. 1967, 1980	-	-	-	-
Pontogammarus sarsi (Sowinskyi, 1898)	*D. 1967, 1980	-	-	-	-
Stenogammarus macrurus	*D. 1967, 1980	-	-	-	-
Stenogammarus compressus (Sars, 1896)	*M. 1953, *Jr. 1957,* D. 1961, 1967, 1980	-	-	-	-
Stenogammarus similis (Sars, 1896)	*D. 1967, 1980	-	-	-	-
Stenogammarus carausui (Derzhavin & Pjatakova, 1962)	*D. 1967	-	-	-	-
Iphigenella acanthopoda	*C. 1943, D. 1967, 1980	-	-	-	-
Gmelina pusilla Sars, 1896	*D. 1967, 1980	-	-	-	-
Gmelina costata Sars, 1894	*D. 1967, 1980	-	-	-	-
Gmelinopsis tuberculata Sars, 1896	*D. 1967, 1980	-	-	-	-
Corophiidae					
Chelicorophium chelicorne (G. O. Sars, 1895)	D. 1967, 1980, J&K. 1988	-	-	-	-
Chelicorophium maeoticum (Sowinsky, 1898)	C. 1943, D. 1967, 1980, J&K. 1988	-	-	-	-
Chelicorophium nobile (G. O. Sars, 1895)	D. 1967, 1980, J&K. 1988	-	-	-	-
Chelicorophium robustum (G. O. Sars, 1895)	D. 1967, 1980, J&K. 1988	-	-	-	-
Chelicorophium curvispinum (G. O. Sars, 1895)	D. 1967, 1980, I. 1973	-	-	-	-
Chelicorophium sowinskyi (Martynov, 1924)	J&K. 1988	-	-	-	-

Continued on the next page

Table 2. (continued).

Species	Dniester	Prut	artificial reservoirs, ponds, lakes	small rivers	springs, wells
Gammaridae					
Gammarus balcanicus Schäferna, 1922	*D. 1967, 1980	D. 1967, 1980, Mu. 1964	-	D. 1962b, 1967, 1980, *J&K. 1988	D. 1967, 1980
Gammarus kischineffensis Schellenberg, 1937	-	D. 1967, 1980	D. 1967	S. 1937, D. 1967, 1980, J&K. 1988, Th.s.	D. 1967, 1980, Th.s.
Echinogammarus ischnus (Stebbing, 1899)	C. 1943, D. 1967, 1980, J&K. 1988	*Mu. 1964	-	-	-
Chaetogammarus warpachowskyi Sars, 1897	I. 1973, D. 1967, 1980	-	-	-	-
Crangonyctidae					
Synurella ambulans (Müller 1846)	-	-	-	-	D. 1967, 1980
Niphargidae					
Niphargus valachicus Dobreanu & Manolache, 1933	*D. 1967, 1980	-	*D. 1967, 1980	-	-
Niphargus birsteini Dedju, 1963	-	-	-	D. 1967, 1980	-
Niphargus jaroschenkoi Dedju, 1963	-	-	-	-	D. 1967, 1980
Niphargus corinae Dedju, 1963	*D. 1967, 1980	-	-	-	*D. 1967, 1980
Niphargus hoverlicus Dedju, 1963	*D. 1967, 1980	-	-	-	*D. 1967, 1980

ally in underground or interstitial waters were reported from Moldova by Dedju (1967, 1980). One of them was *Synurella ambulans* (Müller 1846) present in wells in northern Moldova (regions of Râşcani and Donduşeni), both in the Prut and Dniester basins. Another was *Niphargus birsteini* Dedju, 1963, found in the Răut River (Dniester basin) near the Piatra village in the Orhei region while the other, *Niphargus jaroschenkoi* Dedju, 1963, was recorded in a spring on the bank of the Prut River in Bâdragii Noi village in the Edineţ region. More detailed data are available on the amphipod fauna of the Dniester, its oxbow lakes and the artificial reservoir "Dubossarskoje Vodokhranilishche" constructed on Dniester below Dubossary in the early 1950s. Information on these, predominantly Ponto-Caspian amphipods, have been provided by many zoologists (Sovinsky 1904, Behning 1928, Cărăuşu 1943, Markovskij 1953, Jalynskaja 1965, Dedju 1967, 1980, Mordukhaj-Boltovskoj et al. 1969, Ioffe 1973, Jażdżewski 1980, Jażdżewski and Konopacka 1988), however it is worth to note that even the most recent of the above publications was based upon material collected in the first half of the 20th century. According to the above mentioned authors, amphipods in the Moldovan part of Dniester are represented by 14 species belonging to three families – Corophiidae are represented by: *Chelicorophium chelicorne* (Sars, 1895), *Chelicorophium maeoticum* (Sowinsky, 1898), *Chelicorophium nobile* (Sars, 1895), *Chelicorophium robustum* (Sars, 1895), *Chelicorophium curvispinum* (Sars, 1895), *Chelicorophium sowinskyi* (Martynov, 1924); Pontogammaridae by: *Dikerogammarus haemobaphes* (Eichwald, 1841), *Dikerogammarus villosus* (Sowinsky, 1894), *Dikerogammarus bispinosus* Martynov, 1925, *Pontogammarus robustoides* (Sars, 1894), *Obesogammarus crassus* (Sars, 1894), *Obesogammarus obesus* (Sars, 1894); and Gammaridae by *Echinogammarus ischnus* (Stebbing, 1899) and *Chaetogammarus warpachowskyi* Sars, 1897. A comment is needed on *Dikerogammarus fluviatilis* Martynov, 1919, whose presence in the Dniester was reported by a few authors (Cărăuşu 1943, 1955, Dedju 1967, 1980, Jażdżewski and Konopacka 1988). Examination of the original description of that species by

Martynov (1919) based on samples collected in the Don River, revealed that none of the provided features can be used to differentiate *D. fluviatilis* from *D. haemobaphes*. Only a study of the type or topotypical material could reveal the real identity of the species in question. Thus, there is no proof that individuals from the Dniester and from the Danube defined as *D. fluviatilis* by Cărăuşu (1943, 1955) have anything in common with the species described by Martynov (1919). In consequence, we have decided to exclude *D. fluviatilis* from the checklist and treat all its records from the Dniester as belonging to *D. haemobaphes*. In the Moldovan section of the river Prut, Mushchinskij (1964) and Dedju (1967, 1980) reported the presence of five amphipod species: *G. balcanicus* Schäferna, 1922, *G. kischineffensis*, *D. haemobaphes*, *P. robustoides*. *D. haemobaphes* was introduced by Dedju (1980) into three small dam reservoirs: Gidigichskoje (Lacul Ghidighici), Kongazskoje (Lacul Kongaz), Komratskoje (Lacul Comrat). In the same work, Dedju (1980) cited Ashevskij (1973) who introduced *O. crassus* to several ponds in southern Moldova but without providing exact localities. Summarizing, based on the literature sources reviewed above and on the own records, we can build a checklist of 18 amphipod species living in Moldovan waters (Table 2). They belong to five families: Gammaridae (four species), Pontogammaridae (six spp.), Corophiidae (six spp.), Crangonyctidae (1 sp.) and Niphargidae (2 spp.). Dniester, the longest Moldovan river, is inhabited by 14 species, while only five species were found so far in Prut which is the second-longest river in the country (Table 2). Only five species were found to live in smaller rivers and streams (Table 2). Artificial reservoirs and ponds were reported as habitat for four species. Another four species were reported from springs and wells (Table 2).

Field survey

In the collected material, we identified 4 species of gammarids – one, *Gammarus kischineffensis*, belonging to family Gammaridae and three species, *Pontogammarus robustoides*, *Obesogammarus crassus* and *Dikerogammarus haemobaphes* of Pontogammaridae (Table 1). Among them, in small rivers, streams and springs, despite the altitude and physical-chemical parameters of water, we found only *G. kischineffensis*. Usually, the species was abundant at the collecting sites and it did not co-occur with any amphipods. It was also the only gammarid to live in the coldest place, the limnohelocrene spring near Văratic (site MD14) where the water temperature was only 14 °C. Generally, *G. kischineffensis* inhabited only natural water bodies, regardless of the presence of emerging vegetation, stones or reeds. It was not present in any of the artificial reservoirs. The latter were inhabited exclusively by *P. robustoides* and *O. crassus*. The second species was found only at two sampling sites. Both sites were artificial reservoirs characterized by high water conductivity. Their banks were fastened with large stones or concrete blocks among which the species were collected. Concerning the occupied habitats, *P. robustoides* was the most eurytopic and euryoecious species, inhabiting both natural and anthropogenic sites, with or without vegetation and with various bottom substrate. It was found in sites with water conductivity ranging from 368 µS/cm (site MD10) to 4.25 mS/cm (site MD20). This species was present also in the Răut river, a direct tributary of the Dniester, the only site with fast current. Another pontogammarid, *D. haemobaphes*, we found only in the Răut river.

Discussion

In the material collected in Moldova in 2012, we have found only four amphipod species belonging to two families. This is surprisingly low number if compared to the list of 18 species belonging to five families, based on the literature reports from Moldova (Sowinsky 1904, Behning 1928, Cărăuşu 1943, Markovskij 1953, Mushchinskij 1964, Jalynskaja 1965, Dedju 1967, 1980, Mordukhaj-Boltovskoj et al. 1969, Ioffe 1973, Jażdżewski 1980, Jażdżewski and Konopacka 1988). One clear explanation of this difference is the fact that our survey focused exclusively on small water bodies such as springs, streams, small rivers and small artificial reservoirs. On the contrary, most of the previously reported species had been found in the two largest rivers in Moldova (Dniester and Prut, see references above). We have completely gave up with sampling in these rivers due to security reasons – one of them (Dniester) is a state border with the breakaway state of Transnistria and the other one (Prut) is the state border with Romania.

Gammarus kischineffensis was the only species identified by us in all of the surveyed habitat types, a finding that is coherent with literature data. Dedju (1967, 1980) reports it as the most common species in the area and generally its oc-

currence is restricted to the drainages of Dniester, Prut and Siret rivers (Jażdżewski and Konopacka 1988, Petrescu 2000, Grabowski, unpublished data). The only other species of *Gammarus* reported from Moldova is *Gammarus balcanicus*, found by Mushchinskij (1964) in the Moldovan section of the Prut river and in a few small tributaries of the Dniester by Dedju (1962b, 1967, 1980). Generally, the species is very common in mountainous areas, e.g. in the Carpathians and foothills, where it can be encountered in streams from deciduous forests (Cărăuşu et al. 1955, Jażdżewski and Konopacka1988, Petrescu 2000, Grabowski, unpublished data). We may suspect that its occurrence in Moldova is a result of downstream migration in the Dniester from the Carpathian Mountains. It is quite rare in Moldova probably due to deficiency of suitable habitats, as most of the local running waters are lowland, slowly flowing and highly eutrophic streams and rivers in grasslands. It occurs also in similar habitats on isolated localities in southern Ukraine (Martynov 1931, Karaman and Pinkster 1987, Grabowski, unpublished data). Another amphipod, *Synurella ambulans*, is widely distributed in Europe (Karaman 1974, Holsinger 1977, Konopacka and Błażewicz-Paszkowycz 2001). The species lives usually in interstitial waters. It occurs also in muddy rivers with slow current and rich vegetation, buried in the fine substrate. As its habitat and lifestyle is different from freshwater gammarids, the species is often overlooked during field surveys. However, taking into account the wealth of favourable habitats, we can expect that its distribution in Moldova is much wider that reported in the literature and that could be re-evaluated based on our survey. Also *Niphargus birsteini*, as all representatives of its genus and the family Niphargidae, is predominantly a subterranean species (Väinöla et al. 2008). Thus, a survey focused on hypogean waters would probably provide not only more records of *N. birsteini* but could also reveal the presence of several other species of *Niphargus* in Moldova. For example, *Niphargus valachicus* (Dobreanu and Manolache, 1933), was reported from three Ukrainian lakes (Beloe, Shirokoe, Batlanitsa) of the lowest Dniester alluvial plain (Dedju, 1967, 1980). Other reports of this species come from the Danube Delta and from the Galaţi area in Romania (Petrescu 2000). Another widely distributed species, *Niphargus hrabei* S. Karaman, 1932, has also been found in the Danube Delta (Petrescu 2000). On the other side, Dedju (1967, 1980) reported the presence of two species, *Niphargus hoverlicus* Dedju, 1963 and *N. corinae* Dedju, 1963, from the uppermost part of the Prut river in Hoverla Massif in Ukraine. All these localities are in proximity to the Moldovan border and/or belong to the drainages or Dniester and Prut so we cannot exclude the presence of these species in Moldova.

Compared to Moldova, the amphipod fauna of streams and small rivers of the neighbouring countries such as Romania or Ukraine is much more diverse. For example, in Romania, there are eight formally recognised species of *Gammarus* living in such habitats (Petrescu 2000, Papp and Kontschán 2011, Copilas-Ciocianu 2013), and the number doubles if the new, yet undescribed species are taken into account (Copilas-Ciocianu, unpublished data, Grabowski, unpublished data). In Ukraine, streams and small rivers are inhabited by at least nine species of *Gammarus* (Grabowski et al. 2012a). The difference is even more striking in case of Niphargus, with 39 species reported from Romania and 12 from Ukraine (Dedju 1967, 1980, Fišer, in litteris).

Concerning the Ponto-Caspian amphipods inhabiting Moldovan waters, the highest number, 14 species belonging to three families, inhabit the Dniester, which is the only large river in the country draining directly to the Black Sea, via a system of lagoons and limans being a refugium for the wealth of Ponto-Caspian fauna (Dedju 1967, 1980, Cărăuşu 1943). Thus, it is not surprising that 12 more species belonging to the so-called Ponto-Caspian complex, were reported from the lowest section of the river in the Ukrainian territory (Table 2). Upstream colonisation of a river, from its mouth, is a quite common phenomenon for Ponto-Caspian amphipods (Jażdżewski 1980), so we include these taxa in our checklist as their finding in the Moldovan part of the Dniester cannot be excluded in the future. In contrary, in the Prut, which is the second largest Moldovan river, only three Ponto-Caspian amphipods belonging to two families were found. This poverty may be explained by the fact that the Prut is a tributary of the Danube and does not have a direct connection to the liman system from the lowest part of the Danube. On the other side, it is of more upland type if compared to the Dniester (EPIRB Report 2013), which makes it less favourable for the Ponto-Caspian amphipods, which prefer lowland water bodies with higher water temperatures, rich vegetation and elevated ionic content (Grabowski et al. 2007).

Presence of *P. robustoides* and *O. crassus* in several ponds and dam reservoirs built on various small rivers is most likely due to intentional introductions. Both species belong to the so called Ponto-Caspian species complex and occur naturally in limans, estuaries and lower courses of rivers emptying to the Black Sea (Cărăuşu 1943, Cărăuşu et al. 1955, Mordukhaj-Boltovskoj et al. 1969). From Dedju (1980) it is known that Ashevskij (1973) introduced *O. crassus* to several ponds in southern Moldova. No localities were cited and we could not find the work by Ashevskij (1973) yet we may expect that both reservoirs are among the ponds where the introductions were done. We could not find any reports on the introductions of *P. robustoides* in Moldova, yet translocations of Ponto-Caspian gammarids to numerous artificial reservoirs in order to enrich the food base for fish production was a very popular practice in the former Soviet Union (Zhuravel 1963, 1965, 1968, Gasjunas 1965, 1968, Ioffe 1973, Karpevich 1975, Jażdżewski 1980). Also, we cannot exclude ectozoochory as an additional factor enhancing secondary spread of the species among reservoirs. Amphipods are known to cling to legs and feathers of waterfowl feeding or resting in shallow water (Rosine 1962, Green and Figuerola 2005) and several studies have indicated that birds may be responsible for the spread of native and alien species (e.g. Rachalewski et al. 2013, Vainio and Väinöla 2003). River Rauţ, which was the only locality where we found *D. haemobaphes* accompanied by *P. robustoides*, is a tributary of the Dniester, where from the species were reported before (Jażdżewski and Konopacka 1988). Thus, Dniester was most likely the source for the upstream migration of both species to Rauţ. Jażdżewski and Konopacka (1988) reported presence of other Ponto-Caspian species, *E. ischnus* and *O. obesus*, in the oxbow lake of the Rauţ River.

Summarising, such a distribution pattern with excess of Ponto-Caspian taxa and a relative poverty of typically freshwater *Gammarus* fauna in Moldova (namely in the drainage systems of the Dniester and Prut rivers) may be difficult to understand. Taking into account that the Moldavian Plateau was free from ice during the Pleistocene, one could expect much higher diversity as in other parts of Southern Europe (Väinöla et al. 2008). However opposite to the neighbouring areas, the Moldavian Plateau is of relatively recent origin – its final terrestrialization begun only in the Miocene, ca. 7 Mya due to the regression of the Eastern Paratethys and subsequent gradual uplift (Popov et al. 2004, 2006). In late Pliocene, ca. 3 Mya, the area was covered by a large alluvial lake, gathering water and sedimentary material dragged by the proto-Prut and proto-Dniester from the Carpathian Mountains (Popov et al. 2006, Cerbari and Leah, 2010). Only in the Pleistocene, the more pronounced tectonic movements finally lifted up the area covered with alluvial deposits and shaped the hydrographic network of this area as we know it today (Cerbari and Leah, 2010). Apparently, such geological history did not create opportunity for past fragmentation and long term isolation of water bodies that would lead to substantial differentiation as it happened with gammarids e.g. in the Carpathians or in the Balkan Peninsula (Mamos et al. 2014). The origin and phylogenetic associations of *G. kischineffensis*, which is the only common and widespread gammarid species in Moldovan waters, remains a mystery. Yet, taking into account its high tolerance to increased water salinity we may expect that the species represents a lineage evolving in the brackish waters of Eastern Paratethys and finally colonising the newly emerged Moldavian Plateau. The authors plan to verify that hypothesis in the future within a framework of a wider study upon molecular phylogeny of European freshwater gammarids.

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