First record of *Dikerogammarus bispinosus* Martynov, 1925 in Kazakhstan: invasive or overlooked native in the Caspian Sea basin?

Denis Copilaş-Ciocianu¹,* and Kęstutis Arbačiauskas¹,²

¹Nature Research Centre, Akademijos Str. 2, LT-08412 Vilnius, Lithuania
²Department of Zoology, Institute of Biosciences, Vilnius University, Saulėtekio Ave. 7, LT-10257 Vilnius, Lithuania

Author e-mails: denis.copilas-ciocianu@gamtc.lt (DCC), arbas@ekoi.lt (KA)

*Corresponding author

Received: 8 May 2018 / Accepted: 14 July 2018 / Published online: 31 July 2018

Handling editor: Karolina Bącela-Spychalska

Abstract

The Ponto-Caspian amphipod *Dikerogammarus bispinosus* is regarded as a native species throughout the lower stretches of rivers that drain into the Black Sea. Its occurrence in the Caspian Sea basin was uncertain due to conflicting reports. Here, we provide the first conclusive evidence for its presence in this basin. Individuals of both sexes, including ovigerous females, were collected in May 2000 from the Ural River in Kazakhstan, suggesting full establishment. If it was a recent invasion, the most probable dispersal pathway into the Caspian basin would have been via the Volga-Don canal as *D. bispinosus* was reported in the early 2000s from the lower Don River and the Saratov reservoir on the Volga River. However, given that until relatively recently *D. bispinosus* was considered a subspecies of *D. villosus*, we cannot rule out that it has been overlooked in earlier reports from the Caspian Sea basin by being mentioned as *D. villosus* or even *D. haemobaphes*. We also provide new data on the distribution of *Gammarus lacustris*, *Obesogammarus platycheir*, *Pontogammarus abbreviatus*, *P. robustoides*, *Turcogammarus aralensis* and *Wolgagammarus dzjubani* in western Kazakhstan and southwestern Russia.

Key words: Amphipoda, distribution, Ponto-Caspian, Ural River

Introduction

Gammaridean Ponto-Caspian amphipods represent a diverse evolutionary radiation with many euryhaline species, some of which have considerably extended their ranges in the last 60 years (Bij de Vaate et al. 2002; Cristescu et al. 2004). These range expansions occurred as a result of human activity in which species where either deliberately or unintentionally released, passively introduced via shipping, or have naturally spread through man-made canals which connected isolated basins (Grigorovich et al. 2002; Arbačiauskas et al. 2011). However, these range expansions seem asymmetrical because there are more documented cases throughout the Black Sea basin with further westward dispersal in comparison to the Caspian basin (Grigorovich et al. 2002, 2003).

The Caspian basin harbors approximately 70 Ponto-Caspian amphipod species (Gammaridae and Corophiidae) most of which are native to the sea itself and the deltas and lower stretches of the major rivers, Volga and Ural (Mordukhai-Boltovskoi 1979; Pjatakova and Tarasov 1996). Seventeen of these species are known to have spread upstream through the Volga and Ural rivers and are considered non-native in these upper regions (Pjatakova and Tarasov 1996; Zinchenko and Kurina 2011; Takhteev et al. 2015). These are *Chaetogammarus warpachowskyi* (Sars, 1894), *Chelicorophium curvispinum* (Sars, 1895), *Dikerogammarus caspius* (Pallas, 1771), *D. haemobaphes* (Eichwald, 1841), *D. villosus* (Sowinsky, 1894), *Echinogammarus ischnus* (Stebbing, 1899), *Iphigenella acanthopoda* Sars, 1896, *Paraniaphargoides motasi* (Carausu, 1943), *Pontogammarus abbreviatus* (Sars, 1894), *P. maeoticus* (Sowinsky, 1894), *P. robustoides* (Sars, 1894), *P. sarsi* (Sowinsky, 1898), *Obesogammarus obesus* (Sars, 1894), *Shallogammarus shablensis* Carausu, 1943, *Stenogammarus*
Table 1. Sampling localities (RU–Russia, KZ–Kazakhstan) from the current study and collected amphipod species.

| Code | Locality    | Water body | Latitude  | Longitude | Date       | Species                  | Status  |
|------|-------------|------------|-----------|-----------|------------|--------------------------|---------|
| 1    | Zam’yany    | Volga River| 46.825    | 47.605    | 05.05.2000 | Obesogammarus platycheir (1♂) | Native  |
|      |             |            |           |           |            | Pontogammarus abbreviatus (1♂, 3♀) | Native  |
|      |             |            |           |           |            | Pontogammarus robustoides (2♂, 2♀) | Native  |
|      |             |            |           |           |            | Wolgagammarus dzjubani (1♀)     | Native  |
| 2    | Zelenoe     | Ural River | 48.166    | 51.525    | 26.05.2000 | Dikerogammarus bispinosus (1♂, 4♀) | Non-native |
| 3    | Kulsary     | Zhem River | 47.051    | 54.060    | 25.05.2000 | Turcogammarus aralensis (4♂, 2♀, 1 juv) | Non-native |
| 4    | Shetpe      | spring     | 44.100    | 52.210    | 11.05.2000 | Gammarus sp. (2♂, 1♀)         | Native  |
| 5    | Aktau       | Caspian Sea| 43.627    | 51.175    | 12.05.2000 | Dikerogammarus sp. (fragmented material) | –      |

There are reports of an additional invasive species in the Caspian basin, Dikerogammarus bispinosus Martynov, 1925. It was first mentioned from the Saratov reservoir (Volga River, Russia) by Voronin and Yermokhin (2004) between 2002 and 2003. However, Filinova and Sonina (2012) mention that this species appeared in the Saratov reservoir only in 2006, whereas Zinchenko and Kurina (2011) do not even report it from this reservoir. Likewise, this species was never reported from the Ural River, and thus Kazakhstan (Mordukhai-Boltovskoi 1964; Tarasov 1995; Pjatakova and Tarasov 1996). This conflicting evidence means the presence of D. bispinosus in the Caspian Sea basin remains uncertain.

Here, we report D. bispinosus for the first time from Kazakhstan and thus confirm its presence in the Caspian basin. This is the second locality where this species is mentioned in this basin and the easternmost point of its entire distribution range.

Material and methods

Samples were collected during May 2000 with a hand net and/or by visual inspection of submerged substrates from five localities throughout the northern and northeastern Caspian basin: the Volga River close to Zam’yany (Russia), the Ural River at Zelenoe, the Zhem (Emba) River at Kulsary, springs in Shetpe, and the Caspian Sea at Aktau (the last four sampling points are located in Kazakhstan) (Table 1). Animals were fixed in 96% ethanol. Individuals were examined under a Nikon SMZ1000 stereomicroscope and identified using the keys in Cărăuşu et al. (1955), Stock (1974), Karahan and Barnard (1979), Stock et al. (1998) and Özbek and Özkan (2011). Total length was measured with Digimizer software (https://www.digimizer.com/) following the landmarks in Fišer et al. (2009). Occurrence data for D. bispinosus was collected from the literature in order to provide an up to date overview of its distribution (Martynov 1925; Yaroshenko 1957; Dudich 1947; Dedyu 1967; Jazdzeński and Konopacka 1988; Eggers and Martens 2001; Müller and Schramm 2001; Brtek 2001; Müller et al. 2002; Sayapin 2003; Voronin and Yermokhin 2004; Tischikov and Tischikov 2005; Kley and Maier 2005; Žganec et al. 2009; Son et al. 2010; Labat et al. 2011; Filinova and Sonina 2012; Lipták 2013; Borza et al. 2015, 2017; Gallardo and Aldridge 2015).

Results

A total of nine taxa were identified (Figure 1): Zam’yany – Obesogammarus platycheir (Sars, 1896), Pontogammarus abbreviatus, P. robustoides and Wolgagammarus dzjubani; Kulsary – Turcogammarus aralensis (Uljanin, 1875); Shetpe – Gammarus lacustris Sars, 1863 and Gammarus sp. (unknown species); Aktau – Dikerogammarus sp. (specimens were damaged and further identification was not possible). Details are provided in Table 1.

One male (14.3 mm) and four ovigerous female (10.7–13.7 mm, 46–114 eggs) D. bispinosus were collected from the Ural River in the vicinity of the settlement Zelenoe, Kazakhstan. The identified specimens exhibited the usual morphological characteristics of this species. Diagnostic features are presented in Figure 2.

The compilation of own and literature data indicated that D. bispinosus has a broad geographical distribution (> 3000 km), being encountered from the Rhine estuary, throughout the lower Rhine (North Sea basin), Danube, Dniester, lower Dnieper and lower Don rivers (Black Sea basin) and reaches the middle Volga and lower Ural rivers (Caspian Sea basin) (Figure 3, Table 2). The record from this study represents the easternmost point of the species range (Figure 3).
Figure 1. Habitus of amphipod species collected in the N and NE Caspian Sea basin in 2000.
A) Dikerogammarus bispinosus, male; 
B) *D. bispinosus*, female; 
C) Gammarus sp., male; 
D) *G. lacustris*, female; 
E) Obesogammarus platycheir, male; 
F) Turcogammarus aralensis, male; 
G) Wolgogammarus dzjubani, female; 
H) Pontogammarus abbreviatus, male; 
I) *P. robustoides*, male.
Scale bar = 1 mm.
Photographs by Denis Copilaş-Ciocianu.

Discussion

*Dikerogammarus bispinosus* was described by Martynov (1925) from the lower Dnieper and appears to be native to the Black Sea basin (Cărăuşu et al. 1955; Jazdżewski and Konopacka 1988). In Western Europe it has spread throughout the southern invasion corridor reaching the Rhine estuary via the Rhine-Main-Danube canal (Bij de Vaate et al. 2002). This wide-ranging dispersal is contrasted by its considerable decline during recent decades in its native region in the lower Danube and also in Lake
Figure 2. Appendages of *Dikerogammarus bispinosus*, collected from the Ural River in the vicinity of settlement Zelenoe in 2000. A, B) antenna I; C, D) antenna II; E) epimeral plate II; F) telson; G, H) pereopod VII; I) uropod III; J, K) gnathopod II. Scale bar = 1 mm. Photomicrographs by Denis Copilaș-Ciocianu.

Figure 3. Geographic distribution of *Dikerogammarus bispinosus* and years of first reports. Localities from the current study are shown with triangles. Red triangle indicates the locality where *D. bispinosus* was collected. Question mark in SW Belarus is an unconfirmed/doubtful record and the black star indicates the position of the Volga-Don canal. See Table 2 for references.
**Table 2.** Regions where *Dikerogammarus bispinosus* has been recorded and years of first report. Localities marked with an asterisk need further confirmation.

| Region                  | Country          | Year | Basin     | Latitude | Longitude | Reference                                      |
|-------------------------|------------------|------|-----------|----------|-----------|------------------------------------------------|
| Lower Rhine             | Netherlands      | 2008 | North Sea | 51.96    | 4.14      | (Labat et al. 2011; Gallardo and Aldridge 2015) |
| Upper Rhine             | France           | 2008 | North Sea | 47.68    | 7.51      | (Labat et al. 2011)                            |
| Upper Danube            | Germany          | 1998 | Black Sea | 48.80    | 12.97     | (Eggers and Martens 2001)                      |
|                         | Austria          | 1998 | Black Sea | 48.31    | 14.32     | (Müller and Schramm 2001; Borza et al. 2015)   |
| Middle Danube           | Hungary          | 1926 | Black Sea | 47.56    | 19.06     | (Dudich 1947; Borza et al. 2015)               |
|                         | Slovakia         | 1953 | Black Sea | 47.81    | 18.82     | (Brick 2001; Borza et al. 2015)                |
| Lower Danube            | Croatia          | 2009 | Black Sea | 45.72    | 18.90     | (Zganec et al. 2009)                           |
| Lake Balaton            | Hungary          | 1950 | Black Sea | 46.91    | 17.89     | (Muskó 1994; Müller and Schramm 2001)          |
| Upper Dniester          | Ukraine          | 1928 | Black Sea | 48.51    | 26.50     | (Jazdzevski and Konopacka 1988)                |
| Lower and middle Dniester| Moldova/Ukraine  | 1945–50| Black Sea | 46.71    | 29.96     | (Yaroshenko 1957; Dedyu 1967)                  |
| Odessa Gulf             | Ukraine          | 2009 | Black Sea | 46.55    | 30.81     | (Son et al. 2010)                              |
| Bug*                    | Belarus          | 2005 | Baltic Sea| 52.07    | 23.65     | (Tischikov and Tischikov 2005)                 |
| Lower Dnieper           | Ukraine          | 1925 | Black Sea | 46.62    | 32.63     | (Martynov 1925)                                |
| Lower Don               | Russia           | 2003 | Black Sea | 47.57    | 40.84     | (Sayapin 2003)                                 |
| Middle Volga            | Russia           | 2002 | Caspian Sea| 52.05    | 47.80     | (Voronin and Yermokhin 2004)                   |
| Lower Ural              | Kazakhstan       | 2000 | Caspian Sea| 48.166   | 51.525    | This study                                     |

Balaton where it was introduced in 1950 (Borza et al. 2015, 2017). In European Russia it could have spread from the Black Sea to the Caspian basin through the northern corridor via the Volga-Don canal. This dispersal route is supported by the first reports from the Caspian basin in the Saratov reservoir (Volga River) between 2002 and 2006 (Voronin and Yermokhin 2004; Filinova and Sonina 2012) and throughout the lower Don (Black Sea basin) in 2003 (Sayapin 2003). In the present work, *D. bispinosus* was collected several years earlier and at a significant eastward distance from the Volga-Don canal (Ural River, > 800 km along the waterline), implying dispersal through the Caspian Sea. Furthermore, Tarasov (1995) does not mention this species in the Ural River several years earlier. The fact that all collected females from the Ural River were ovigerous suggests that the species was already established by the year 2000 in this area. Thus, overall the evidence indicates that invasion of the Caspian basin by *D. bispinosus* might have occurred sometime at the end of the 1990s. It seems that this species was never deliberately introduced into the Caspian basin. The only documented deliberate introduction of *Dikerogammarus* species took place between 1955 and 1959 from the Simferopol reservoir (Crimian Peninsula) to canals and reservoirs of Ukraine in the Black Sea basin (Grigorovich et al. 2002 and references therein). However, undocumented or unintentional introductions cannot be completely excluded either (Grigorovich et al. 2002). This further suggests that the species could have dispersed naturally via the Volga-Don canal or was passively introduced through shipping activity.

On the other hand, it is also possible that *D. bispinosus* reached the Caspian basin earlier than the 1990s given that the Volga-Don canal was opened in 1952. Moreover, *D. bispinosus* was considered for a long time as a subspecies of *D. villosus* and only relatively recently was elevated to specific status based on mitochondrial and nuclear genetic markers (Müller and Schramm 2001; Müller et al. 2002). In addition, Pjatakova and Tarasov (1996) considered *D. villosus* (and consequently *D. bispinosus*) as a synonym of *D. haemobaphes*, so they may have overlooked *D. bispinosus* in the Caspian basin (Tarasov 1995). Similarly, it is likely that other authors did not distinguish *D. bispinosus* from *D. villosus* due to its subspecific status until 2002. Nevertheless, it appears that neither *D. villosus* is native to the Caspian basin (Mordukhai-Boltovskoi 1979), where it has been reported at least since 1964 (Mordukhai-Boltovskoi 1964), suggesting a similar dispersal route as for *D. bispinosus*. It is important to keep in mind that *Dikerogammarus* species are some of the most successful Ponto-Caspian invaders, being highly capable of dispersal in anthropogenic landscapes (Rewicz et al. 2014, 2015; Sidagytė et al. 2017). The only *Dikerogammarus* species that is most likely native to both basins is *D. haemobaphes* since it was described from the Black Sea but has been reported from the Caspian Sea since 1880 (Sars 1894), well...
before the construction of the Volga-Don canal. In contrast, *D. caspius*, a native Caspian species, has spread into the Black Sea basin in recent times (Sayapin 2003). Thus, according to the available data, we tentatively conclude that even if *D. bispinosus* has been overlooked, it appears that it is not a native species in the Caspian basin and that it reached it between 1952 and late 1990s. Of course, at present, we also cannot completely rule out the possibility that it might be a native Caspian species. Phylogeography could prove invaluable in illuminating its origin and dispersal pathways. So far, *D. bispinosus* and *Shablogammarus shablensis* appear to be the only Black Sea native amphipod species that have spread into the Caspian basin (Grigorovich et al. 2002). Further upstream dispersal of *D. bispinosus* along the Volga and Ural rivers may be expected given its rheophilous affinity (Borza et al. 2017).

**Acknowledgements**

We are grateful to Nadezhda Berezina, Dmitry Sidorov and Péter Borza for very helpful information and literature. Eglė Šidagytė and three anonymous referees are thanked for their useful comments that improved the manuscript.

**References**

Arbačiauskas K, Višniškiene G, Smilgevičienė S, Rakauskas V (2011) Non-indigenous macroinvertebrate species in Lithuanian fresh waters, part 1: distributions, dispersal and future. Knowledge and Management of Aquatic Ecosystems 402: 1–18, https://doi.org/10.1001/kmae.2011.075

Bij de Vaate A, Jazdzeewski K, Ketelaars HM, Gollasch S, Velde G Van der (2002) Geographical patterns in range extension of Ponto-Caspian macroinvertebrate species in Europe. Canadian Journal of Fisheries and Aquatic Sciences 59: 1159–1174, https://doi.org/10.1139/f02-234

Borza P, Csányi B, Huber T, Leitner P, Remund N, Graf W (2015) Longitudinal distributional patterns of Peracarida (Crustacea, Malacostraca) in the River Danube. Fundamental and Applied Limnology / Archiv für Hydrobiologie 187: 113–126, https://doi.org/10.1327/fal.2015.0760

Filinova EI, Sonina EE (2012) Gamarids of the floodplain areas of the Volgograd Reservoir. Actual Problems of Studying Crustaceans of Continental Waters: International Conference of the Institute of Biology of Inland Waters I.D. Papanin. Borok, pp 303–306 [In Russian]

Füßer C, Trontelj P, Luštrik R, Sket B (2009) Toward a unified taxonomy of *Niphargus* (Crustacea: Amphipoda): a review of morphological variability. Zoosysta 2001: 1–22

Gallardo B, Aldridge DC (2015) Is Great Britain heading for a Ponto-Caspian invasion meltdown? Journal of Applied Ecology 52: 41–49, https://doi.org/10.1111/1365-2664.12348

Grigorovich IA, Maclsaac HJ, Shadrin NV, Mills EL (2002) Patterns and mechanisms of aquatic invertebrate introductions in the Ponto-Caspian region. Canadian Journal of Fisheries and Aquatic Sciences 59: 1189–1208, https://doi.org/10.1139/f02-088

Grigorovich IA, Therriault TW, Maclsaac HJ (2003) History of aquatic invertebrate invasions in the Caspian Sea. Biological Invasions 5: 103–115, https://doi.org/10.1023/A:102450824073

Jazdzeewski K, Konopacka A (1988) Notes on the Gammaridean Amphipoda of the Dniester River Basin and Eastern Carpathians. Proceedings of the Vth International Colloquium on Amphipod Crustaceans, Ambleuteuse, France, 28 June-3 July 1985, pp 72–89

Karaman GS, Barnard JL (1979) Classificatory Revisions In Gammaridean Amphipoda Crustacea 1. Proceedings of The Biological Society of Washington 92(1): 106–165

Kley A, Maier G (2005) An example of niche partitioning between *Dikerogammarus villosus* and other invasive and native gammarids: A field study. Journal of Limnology 64: 85–88, https://doi.org/10.4039/jlimm.2005.85

Labat F, Fiscart C, Fontan B (2011) First records, pathways and distributions of four new Ponto-Caspian amphipods in France. Limnologica 41: 290–295, https://doi.org/10.1016/j.limn.2010.12.004

Lipták B (2013) Non-indigenous invasive freshwater crustaceans (Crustacea: Malacostraca) in Slovakia. Water Research and Management 3(3): 21–31

Martynov AV (1925) Gammaridean Fauna of the Lower Leufes of the Dniepr. Trudy Azovsko-Chernomorsko nauchno-promyshlennoi ekspeditsii 5: 135–153

Mordukhai-Boltovskoi (1964) Caspian Fauna Beyond the Caspian Sea. Internationale Revue der gesamten Hydrobiologie und Hydrographie 49: 139–176, https://doi.org/10.1002/irh.19640490105

Mordukhai-Boltovskoi PD (1979) Composition and Distribution of Ponto-Caspian macroinvertebrate species in the Light of Modern Data. Internationale Revue der gesamten Hydrobiologie und Hydrographie 64: 1–38, https://doi.org/10.1002/irh.19790640102

Müller J, Schramm S (2001) A third *Dikerogammarus* invader is located in front of Vienna. Lauterbornia 41: 49–52

Müller JC, Schramm S, Seitz A (2002) Genetic and morphological differentiation of *Dikerogammarus* invaders and their invasion history in Central Europe. Freshwater Biology 47: 2039–2048, https://doi.org/10.1046/j.1365-2427.2002.00944.x

Muskó IB (1994) Occurrence of Amphipoda in Hungary since 1853. Crustacea 66(2): 144–152

Ozblek M, Ozkan N (2011) *Dikerogammarus istanbulesis* sp. n., a new amphipod species (Amphipoda: Gammaridae) from Turkey with a key for the genus. Zootaxa 64(2813): 55–64

Pjatakova GM, Tarasov AG (1996) Caspian Sea amphipods: biodiversity, systematic position and ecological peculiarities of some species. International Journal of Salt Lake Research 5: 63–79, https://doi.org/10.1007/BF01996036

Popescu-Maresucu V, Nastasea M, Marinescu C, Cutas F, Neagu E (2001) Amphipoda (Gammaridae and Corophiidae) from the Romanian stretch of Danube before and after the construction of the Iron Gates 1 damlake. Travaux du Muséum National d’Histoire Naturelle “Grigore Antipa” 43: 347–366

Rewicz T, Grabowski M, Macneil C, Karolina B (2014) The profile of a “perfect” invader – the case of killer shrimp. Aquatic Invasions 9: 267–288, https://doi.org/10.3391/ia.2014.9.3.04
Dikerogammarus bispinosus in Kazakhstan

Rewicz T, Wattier R, Grabowski M, Rigaud T, Bacela-Spychalska K (2015) Out of the Black sea: Phylogeography of the invasive killer shrimp *Dikerogammarus villosus* across Europe. *PLoS ONE* 10: 1–20, https://doi.org/10.1371/journal.pone.0118121

Sars GO (1894) *Crustacea caspia*. Contributions to the knowledge of the Carcinological Fauna of the Caspian Sea. *Bulletin de l’Academie Imperiale des Sciences de St-Petersbourg* 2: 179–223

Sayapin VV (2003) Amphipoda (*Crustacea, Amphipoda*), as a component of the biological resources of the Lower Don. Dissertation, Kuban State University, Krasnodar, Russia [In Russian]

Šidagytė E, Solovjova S, Šniaukštaitė V, Šiaulys A, Olenin S, Arbačiauskas K (2017) The killer shrimp *Dikerogammarus villosus* (*Crustacea, Amphipoda*) invades Lithuanian waters, South-Eastern Baltic Sea. *Oceanologia* 59: 85–91, https://doi.org/10.1016/j.oceano.2016.08.004

Son MO, Koshelev AV, Kudrenko SA (2010) Features of colonization and occurring of marine and brackishwater invertebrates in the contour habitats “small stream sea”. *Morskij ekologichnyj zhurnal* 3: 78–82 [In Russian]

Stock JH (1974) The systematics of certain Ponto-Caspian Gammaridae (*Crustacea, Amphipoda*). *Mitselungen aus dem Hamburgischen Zoologischen Museum und Institut* 70: 75–95

Takhteev VV, Berezina NA, Sidorov DA (2015) Checklist of the Amphipoda (*Crustacea*) from continental waters of Russia, with data on alien species. *Arthropoda Selecta* 24(3): 335–370

Tarasov AG (1995) *Crustacea fauna (Malacostraca)* of the Ural River. *Zoologichesky Zhurnal* 74(3): 24–34 [In Russian]

Tischkov GM, Tischkov IG (2005) Taxonomic composition of macrozoobenthic communities in the Zapadny Bug and Narev rivers’ basins. Proceedings of the 7th National Scientific Conference “Use of the Rivers Narev and Bug in the Context of Sustainable Development.” Warsaw-Debe, pp 175–191

Voronin MY, Yermokhin MV (2004) Stability of the ontogenesis of amphipods (*Crustacea, Amphipoda*) and the outlook of its usage for biomonitoring of the ecosystems of cooling reservoirs of nuclear power stations. *Povolzhsky Ekologichesky Zhurnal* 2: 123–131 [In Russian]

Yaroshenko MF (1957) Hydrofauna of the Dniestr. Nauka, Moskow, 1–169 pp [In Russian]

Žganec K, Gottstein S, Hudina S (2009) Ponto-Caspian amphipods in Croatian large rivers. *Aquatic Invasions* 4: 327–335, https://doi.org/10.3391/ai.2009.4.2.4

Zinchenko TD, Kurina EM (2011) Distributional patterns of alien species in the open shallow areas of the Saratov Reservoir. *Russian Journal of Biological Invasions* 2: 183–190, https://doi.org/10.1134/S2075117110030209