



Distribution of the Ponto-Caspian Species *Pontogammarus robustoides* (Sars, 1894) (Amphipoda) in the Inland Waters of Turkey

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Abstract: Up to now, thirteen Ponto-Caspian amphipod species belonging to seven genera have been recorded in Turkey. One of them is *Pontogammarus robustoides* which is known as an invasive Ponto-Caspian species in several European countries. The species was reported for the first time in Turkey in 1964, and since then has been found in 12 lakes and dam lakes located in the Marmara, Aegean and Thrace regions. In this study, materials collected during different study periods were examined and *P. robustoides* was detected at eight new localities: the lakes Akgöl and Poyrazlar, the reservoirs Demirköprü, Çayboğazı and Gördes, and the rivers Çekerek, Kocaçay and Bakırçay. In addition, *P. robustoides* is reported for the first time from the Central Anatolia and Mediterranean regions of Turkey. Our results indicate that this species has expanded its distribution area in many freshwater systems in Turkey. However, it has not been reported yet from eastern and southeastern regions of Turkey. Therefore, detailed studies dealing with distribution pattern and population status of this Ponto-Caspian amphipod are needed.

Key words: Invasive species, Crustacea, distribution pattern, brackish, freshwater, Turkey.

Introduction

Ponto-Caspian region, which includes the Black Sea, the Sea of Azov and the Caspian Sea, is a basin system with unique environmental characteristics and paleogeographic history. It is known that there are at least 335 species of metazoan animals in the autochthonous faunistic complex of Ponto-Caspian region, and it is called 'Caspian complex' since more than 80% of those species inhabit the Caspian Sea (MORDUKHAI-BOLTOVSKOI 1964). Although the salinity tolerance of these fauna elements is high, the majority of the Ponto-Caspian species can spread to the affiliated freshwater systems (lakes and rivers). Spread of the Ponto-Caspian fauna even

to remote areas is accelerated by man-made canals between freshwater systems as well as by intentional introductions due to various reasons, such as aquaculture, the improvement of wild stocks, and the control of unwanted organisms (WELCOME 1988, WILLIAMSON 1996).

Turkey is the country which has the longest coastline of the Black Sea (1,650 km out of 8,350 km in total) among the six adjacent countries (Turkey, Bulgaria, Romania, Ukraine, Russia, and Georgia). Such a long coastline includes many habitats (lagoon systems, deltas, coastal lakes, and associated streams), which are naturally different from each other, and even habitats showing the diversity of microhabitats that can be a refugium

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for many aquatic invertebrate species. The Ponto-Caspian region constitutes a spreading area for various invasive species due to both its location and the diversity in aquatic habitats. One of the invasive invertebrate species among amphipods with Ponto-Caspian origin is *Pontogammarus robustoides* (Sars, 1894) (Crustacea: Pontogammaridae) (JAZDZEWSKA & JAZDZEWSKI 2008, KURASHOV & BARBASHOVA 2008).

The natural distribution area of *P. robustoides* includes the lower reaches of the Volga, Don, Dnieper, Dniester, and Danube River systems, as well as the brackish and freshwater lakes adjacent to the Black Sea (JAZDZEWSKI 1980). However, in the 1960s this species was reported from reservoirs in Ukraine, Caucasus, and Lithuania, then penetrated in the Baltic Sea basin, and in the 1990s reached as far as the Gulf of Finland (BEREZINA & PANOV 2003). The presence of *P. robustoides* in Turkey was reported for the first time in 1964 from lakes Apolyont, İznik, Sapanca, and Manyas (MORDUKHAI-BOLTOVSKOI 1964). Later, ÖZBEK (2003) reported *P. robustoides* and *Gammarus balcanicus* Schäferna, 1923 in the materials collected from Karataş Lake in 1999 and 2000, while only *P. robustoides* was reported from the same lake in 2005 (ÖZBEK & USTAOĞLU 2005). *Pontogammarus robustoides* was found in Apolyont and İznik lakes (ÖZBEK et al. 2004c), Buldan Reservoir (BALIK et al. 2004), Tahtalı Reservoir (TAŞDEMİR et al. 2010), Adıgüzel Reservoir (ÖZBEK et al. 2016); and reported again from Buldan, Tahtalı, and Adıgüzel reservoirs by ÖZBEK (2011). Recent records of the species have been published from Durusu Lake (Terkos Lake, Durugol Liman) (REWICZ et al. 2016) in the Thrace region, again from Durusu Lake in 2017 and from Karademir Reservoir (İshakpaşa), Büyük and Küçük Çekmece lakes (ÖZBEK et al. 2017). According to reviewed publications, since 1964, *P. robustoides* has been detected in 12 different natural lakes and reservoirs in the Marmara, Aegean and Thrace regions of Turkey.

Studies on the distribution of Ponto-Caspian amphipods in Turkey largely cover the Marmara and Aegean regions (KOCATAS et al. 2003, ÖZBEK et al. 2004a, b, ÖZBEK 2011, ÖZBEK & ÖZKAN 2010, 2011, ÖZBEK et al. 2017). On the other hand, there are scarcely any studies on their distribution in freshwater systems in Central Anatolia, Eastern and Southeastern Anatolia.

With the present study we aimed to contribute to the knowledge of distribution of the Ponto-Caspian amphipod *P. robustoides* in Turkey.

Materials and Methods

The zoobenthic samples were collected from the lakes Sapanca, Akgöl, and Poyrazlar, the reservoirs Demirköprü, Çayboğazı, and Gördes, as well as the rivers Çekerek, Kocaçay and Bakırçayı, between 2015 and 2018 during different studies. Descriptive information on the sampling stations is provided in Table 1.

In natural lakes and reservoirs, the samples were collected at 100–150 m offshore from the littoral zone with an Ekman grab 225 cm². In rivers, the sampling was done with a hand scoop. The collected samples were sieved in the field (with a 0.5 mm sieve), fixed in 70% ethyl alcohol, and brought to the laboratory. All amphipod samples were stored at the Hydrobiology Laboratory of the Eskişehir Osmangazi University. CĂRĂUŞU (1943) and CĂRĂUŞU et al. (1955) were used for the identification of samples.

Results

A total of 225 individuals of *P. robustoides* were collected during the samplings carried out in nine inland water systems (3 natural lakes, 3 reservoirs and 3 rivers) in Turkey. The location and habitat characteristics of stations where the species was found are summarised in Table 1.

The highest number of individuals was detected in the Bakırçayı River and the lowest number was detected in Gördes Reservoir. Table 1 also shows the dominancy rate of *P. robustoides* as a percentage (%) of the zoobenthic community in the studied water systems.

The current distribution of *P. robustoides* in Turkey based on published records and on records from our study is shown on Fig. 1. *Pontogammarus robustoides* was detected at eight new localities: the lakes Akgöl and Poyrazlar, the reservoirs Demirköprü, Çayboğazı, and Gördes, and the rivers Çekerek, Kocaçay, and Bakırçayı (Table 1, Fig. 1). *Pontogammarus robustoides* that was recorded in Lake Sapanca during the present study has been previously reported from the same lake by MORDUKHAI-BOLTOVSKOI (1964). In addition, in this study *P. robustoides* has been reported for the first time from the Central Anatolia and Mediterranean regions of Turkey.

Discussion

The number of records of *P. robustoides*, which is a typical species in the Ponto-Caspian basin, is

Table 1. Location and habitat characteristics of stations where *Pontogammarus robustoides* was detected. Dominancy rate of *P. robustoides* as a percentage (%) of the zoobenthic community. The first number refers to *P. robustoides*, the numbers in brackets refer to other zoobenthic groups. C: Chironomidae; E: Ephemeroptera; G: Gastropoda; H: Hirudinea; O: Oligochaeta; T: Trichoptera.

	Region	Geographic coordinates	Habitat	Dominancy rate (in %)
Lakes				
Sapanca	Marmara	N 40° 35' 55.24" E 30° 15' 37.58"	Mud, reeds	28 (25O, 20C, 10G, 9E, 8H)
Akgöl	Marmara	N 40° 47' 45.96" E 30° 26' 44.96"	Mud, reeds	36 (24C, 20G, 13O, 4E, 2H, 1T)
Poyrazlar	Marmara	N 40° 45' 39.96" E 30° 32' 56.82"	Mud, reeds	14 (31O, 28C, 25G, 2H)
Reservoirs				
Demirköprü	Aegean	N 38° 31' 5.82" E 28° 23' 31.58"	Gravel	87 (9O, 4G)
Çayboğazı	Mediterranean	N 36° 26' 48.64" E 29° 39' 27.85"	Gravel	90 (3O, 7G)
Gördes	Aegean	N 38° 40' 3.17" E 28° 6' 32.03"	Gravel	63 (4E, 24O, 9G)
Rivers				
Çekerek	Central Anatolia	N 40° 0' 59.16" E 35° 41' 25.96"	Mud, gravel	32 (20G, 19C, 16O, 8E, 5T)
Bakırçayı	Aegean	N 38° 33' 35.23" E 27° 12' 0.11"	Mud	85 (12C, 3O)
Kocaçay	Aegean	N 38° 22' 19.04" E 27° 18' 13.30"	Mud	19 (36C, 22O, 14E, 8G, 1T)



Fig. 1. Current distribution of *Pontogammarus robustoides* in Turkey. The aquatic systems in which the species was previously reported are indicated with yellow fastener: 1: Apolyont Lake, 2: Iznik Lake, 3: Sapanca Lake, 4: Manyas Lake, 5: Karataş Lake, 6: Buldan Reservoir, 7: Tahtalı Reservoir; 8: Adıgüzel Reservoir, 9: Lake Durusu, 10: Lake Büyük Çekmece, 11: Terkos Lake, and 12: Karademir Reservoir (see references in the Introduction); the records of the present study are indicated with red balloons: 13: Gördes Reservoir, 14: Demirköprü Reservoir, 15: Kocaçay River, 16: Bakırçayı River, 17: Poyrazlar Lake, 18: Akgöl Lake, 3': Sapanca Lake; 19: Çayboğazı Reservoir, and 20: Çekerek River.

relatively low in the inland waters of Turkey. When the studies to date were examined, it was found out that the species has been formerly detected in a total of 12 localities in Turkey, including four reservoirs and seven lakes (Fig. 1) (MORDUKHAI-BOLTOVSKOI 1964, ÖZBEK 2003, 2011, BALIK et al. 2004, ÖZBEK et al. 2004c, 2016, 2017, ÖZBEK & USTAOĞLU 2005, TAŞDEMİR et al. 2010, REWICZ et al. 2016). According to literature, the distribution area of the species belongs to the Thrace, Marmara and Aegean regions. Based on the outcomes of this study, eight new localities are added, and *P. robustoides* has been reported from the Central Anatolia and Mediterranean regions for the first time.

The fact that *P. robustoides*, which is quite common in the northern, eastern and western parts of the Ponto-Caspian region, has not been recorded in Turkey for a long period is most probably due to the few studies of the subject and the lack of publications or any records on Amphipoda fauna in the Central Anatolia, Eastern and Southeastern Anatolia regions. The presence of *P. robustoides* in lakes, ponds and brackish waters of the Black Sea coastline of Turkey is expected for a species native to the Ponto-Caspian basin and can be associated with its high ecological tolerance limits. However, the species has also been found in aquatic systems outside the Black Sea coast of Turkey, as in many other European countries. We recorded it from the Marmara Region, which is directly connected with the Black Sea, but also from the Aegean, Central Anatolia and even the Mediterranean region (Table 1, Fig. 1).

The Black Sea Mountains and the Taurus Mountains are isolation barriers for the free penetration of *P. robustoides* into the Mediterranean region, which is located in the south of Turkey and has no freshwater connection with the Black Sea currently. Therefore, the presence of *P. robustoides* outside the Black Sea region in the surface waters of Turkey, with the exception of the Southeastern and Eastern Anatolia regions, in which no record has been reported yet (which are likely to be identified in future studies), is linked to the history of freshwater development in Turkey and (or) anthropogenic factors (possibly both).

The Çekerek Stream has many pollution sources as industry, urban areas, dams, and agricultural wastes. There are three regulators, ten dams and two hydroelectric power plants on the Çekerek Stream (ADIGÜZEL et al. 2007). Furthermore, many water sport and fisheries activities are available at the Bakırçayı and Kocaçay streams and some other sampling stations. These anthropogenic influences

may facilitate the spread of *P. robustoides*. On the other hand, our sampling areas are located on Bird Migration Routes. Birds can also contribute to the spread of this species by carrying it attached to their legs.

As it is known, Anatolia reaches its present height from sea level as a result of an uplift from the Pliocene glacial period (14 million years ago) to the Late Pleistocene (120,000 years ago). In the Miocene, most of Eastern Anatolia is covered with seas and many streams originating from the Sarmatic Depression (the large inland lake with freshwater and sometimes brackish water) that covered the current Black Sea flow towards the Mediterranean Sea, and the fauna elements from this period are the same as the ones of the Black Sea origin (DEMIRSOY 2002). In light of the above information, we may assume that *P. robustoides* has already been present in the surface waters of Turkey as an element of the Sarmatic Depression for thousands of years. Considering also the unintentional transport during fish introduction, anthropogenic interventions in the river systems and artificial channel connections, it is presumed that these factors are likely to accelerate the spread of the species (JAZDZEWSKI 1980, JAZDZEWSKI & KONOPACKA 2000, ARBACIAUSKAS 2002, GRABOWSKI 2011).

It has been reported by many researchers that *P. robustoides*, along with other amphipod species, are aggressive predators, strong enough to alter the existing zoobenthic community structure, or even to be the only species within gammarids (BEREZINA & PANOV 2003, ARBAČIAUSKAS & GUMULIAUSKAITĖ 2007, GRABOWSKI et al. 2007a). Within the scope of this study, no other amphipod species were detected in localities where this species was identified. The situation is similar in the inland waters, where the species has been formerly recorded in Turkey. For instance, it is identified as the only amphipod species in Tahtalı Reservoir (TAŞDEMİR et al. 2010), Buldan Reservoir (BALIK et al. 2004), Adıgüzel Reservoir (ÖZBEK et al. 2016), Karademir Reservoir (ÖZBEK et al. 2017), and Karataş Lake (ÖZBEK & USTAOĞLU 2005). Our results support the literature information. The fact that *P. robustoides* is the dominant or the only gammarid species within the habitats, where it is identified, may possibly be related to its wide range of ecological tolerance. Some studies on life history, reproduction, and feeding of *P. robustoides* show that it is the most fecund amphipod species when compared to other native species (BACELA & KONOPACKA 2005). In addition, due to its traits such as reaching maturity at an early stage, being able to reproduce more than once a year, having a

high number of individuals in each reproductive period, *P. robustoides* is characterised with a high population density and high level of adaptation to changing and deteriorated conditions (BACELA & KONOPACKA 2005, GRABOWSKI et al. 2007b). Certainly, these features bring advantages to the species within the zoobenthic community, and thus, it becomes a dominant species.

When the dominance rates of *P. robustoides* within the zoobenthic community were examined in the natural and artificial aquatic systems studied, *P. robustoides* appeared to form a large part of the zoobenthic community, especially in reservoirs. Furthermore, it was the only amphipod species identified in all aquatic systems sampled in this study. This may be due to the incomplete formation of the zoobenthic fauna resulting from the transformation of a fluvial system into a stagnant water system in reservoirs, and the lack of macrophytes, which form potential habitats of the zoobenthos individuals in the littoral zone of reservoirs. This change in the aquatic system can be considered as a good opportunity for *P. robustoides* to increase its population density. Indeed, the high population density of the species in all three reservoirs sampled, as well as the low level of occurrence and/or absence of even the tolerant taxa (e.g. aquatic Oligochaeta, Chironomidae), which are commonly found in freshwater zoobenthic community, support this assumption (Table 1). The fact that it is an amphipod species, which has a competitive and aggressive effect on native amphipod species and other invertebrate taxa in the aquatic system, in which it is found, and that it can alter the current community structure over a long period of time is parallel to these inferences (GRABOWSKI et al. 2006).

As a result of the currently available information about the distribution of *P. robustoides* in Turkey, the Çayboğazı Reservoir represents the farthest locality to the south, while the Çekerek River is the farthest locality to the east (Fig. 1). However, as mentioned earlier, since there are no studies on Amphipoda fauna in the Southeastern and Eastern Anatolia regions, it is impossible to make any inference regarding the presence of the species and its distribution in the region. In case that the presence of *P. robustoides* in surface waters of Turkey is accepted since the Sarmatic Inland Sea, and previously mentioned factors are taken into account, the presence of the species in these two regions is expected. The key issue is to know the population status and density in the two regions, hence to reveal the impact on both native gammarid species and other zoobenthos groups. Because

these two regions are actually a relatively isolated region of the Sarmatic Inland Sea, starting from the southern border of Anatolia (Hatay Province) and reaching the Black Sea region, and where even today there is no freshwater connection between the eastern and western parts.

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References

- ADIGÜZEL S., ERDEM A. O. & SOLMAZ K. 2007. Water demand and supply balance for Yeşilirmak River Basin. Proceedings of International Congress on River Basin Management, pp. 301–315.
- ARBACIAUSKAS K. 2002. Ponto-Caspian amphipods and mysids in the inland waters of Lithuania: history of introduction, current distribution and relations with native malacostracans. In: LEPPAKOSKI E., GOLLASCH S. & OLENIN S. (Eds.), Invasive Aquatic Species of Europe. Dordrecht, The Netherlands: Kluwer Academic Publishers, pp. 104–115.
- ARBAČIAUSKAS K. & GUMULIAUSKAITĖ S. 2007. Invasion of the Baltic Sea basin by the Ponto-Caspian amphipod *Pontogammarus robustoides* and its ecological impact. In: GHERARDI F. (Ed.), Biological Invaders in Inland Waters: Profiles, Distribution and Threats, Invading Nature. Springer Series in Invasion Ecology 2: 463–477.
- BACELA K. & KONOPACKA A. 2005. The life history of *Pontogammarus robustoides*, an alien amphipod species in Polish waters. Journal of Crustacean Biology 25 (2): 190–195.
- BALIK S., USTAĞOĞLU M. R., ÖZBEK M., TAŞDEMİR A. & YILDIZ S. 2004. Buldan Dam Lake (Denizli, Turkey) benthic fauna. [Buldan Baraj Gölü'nün (Denizli, Türkiye) bentik faunası.] Ege University Journal of Fisheries & Aquatic Sciences 21 (1–2): 139–141. (in Turkish)
- BEREZINA N. A. & PANOV V. E. 2003. Establishment of new gammarid species in the eastern Gulf of Finland (Baltic Sea) and their effects on littoral communities. Proceedings of the Estonian Academy of Sciences, Biology and Ecology 52 (3): 284–304.
- CĂRĂUȘU S. 1943. Amphipods of Romania, I. Caspian Gammarids. [Amphipodes de Roumânie, I. Gammaridés de Type Caspien.] Romanian Fisheries Research Institute [Institutul De Cercetări Piscicole al Romaniei], Bucharest, Monograph 1: 1–293. (in Romanian)
- CĂRĂUȘU S., DOBREANU E. & MANOLACHE C. 1955. Fauna Republicii Populare Romine, Crustacea, Amphipoda. Academia Republicii Populare Romine, IV (4): 1–407. (in Romanian)
- DEMİRSOY A. 2002. General and Turkey Zoogeography. “Animal Geography” [Genel Zoocoğrafya ve Türkiye Zoocoğrafyası “Hayvan coğrafyası”.] Ankara: Meteksan A. S., 1007 p. (in Turkish)
- GRABOWSKI M., KONOPACKA A., JAZDZEWSKI K. & JANOWSKA E. 2006. Invasions of alien gammarid species and retreat of natives in the Vistula Lagoon (Baltic Sea, Poland). Helgoland Marine Research 60: 90–97.

- GRABOWSKI M., JAŹDŹEWSKI K. & KONOPACKA A. 2007a. Alien Crustacea in Polish waters – Amphipoda. *Aquatic Invasions* 2 (1): 25–38.
- GRABOWSKI M., BACELA K. & KONOPACKA A. 2007b. How to be an invasive gammarid (Amphipoda: Gammaroidea) – comparison of life history traits. *Hydrobiologia* 590: 75–84.
- GRABOWSKI M. 2011. NOBANIS – Invasive Alien Species Fact Sheet – *Pontogammarus robustoides*. Online Database of the European Network on Invasive Alien Species – NOBANIS. www.nobanis.org, Date of access 08/08/2020
- JAZDZEWSKA A & JAZDZEWSKI K. 2008. *Pontogammarus robustoides* (G. O. Sars, 1894) (Crustacea, Amphipoda), a new Ponto-Caspian invader in Great Masurian Lakes (NE Poland). *Fragmenta Faunistica* 51 (1): 1–7.
- JAZDZEWSKI K. 1980. Range extensions of some gammaridean species in European inland waters caused by human activity. *Crustaceana* (Supplement) 6: 84–107.
- JAZDZEWSKI K. & KONOPACKA A. 2000. Immigration history and present distribution of alien crustaceans in Polish waters. *Crustacean Issues* 12: 55–64.
- KOCATAS A., KATAGAN T., ÖZBEK M. & SEZGİN M. 2003. A new amphipod species for Turkish fauna: *Pontogammarus maeoticus* (Sowinsky, 1894). *Crustaceana* 76: 879–884.
- KURASHOV E. A. & BARBASHOVA M. A. 2008. First record of the invasive Ponto-Caspian amphipod *Pontogammarus robustoides* G. O. Sars, 1894 from Lake Ladoga, Russia. *Aquatic Invasions* 3 (2): 253–256.
- MORDUKHAI-BOLTOVSKOI F. D. 1964. Caspian fauna beyond the Caspian Sea. *Internationale Revue der gesamten Hydrobiologie und Hydrographie* 49: 139–176.
- ÖZBEK M. 2003. Taxonomical and ecological investigation of lake district inland waters Malacostraca (Crustacea – Arthropoda) fauna. PhD Thesis, Department of Hydrobiology, Institute of Science, Ege University, 238 p. (in Turkish)
- ÖZBEK M., BALIK S. & USTAOĞLU M. R. 2004a. An amphipod species new for the Turkish fauna *Pontogammarus aestuarius* (Derzhavin, 1924). *Zoology in the Middle East* 32 (1): 63–68.
- ÖZBEK M., BALIK S. & USTAOĞLU M. R. 2004b. A new species of corophiid for the Turkish fauna: *Chelicorophium maeoticum* (Sowinsky, 1898) (Amphipoda). *Crustaceana* 77: 1013–1018.
- ÖZBEK M., BALIK S., USTAOĞLU M. R., BERBER S. & TOPKARA E. T. 2004c. Malacostraca (Crustacea) fauna of Apolyont and İznik lakes. [Apolyont ve İznik Gölleri'nin Malacostraca (Crustacea) Faunası Anadolu.] *University Journal of Science and Technology* 5 (2): 291–295. (in Turkish)
- ÖZBEK M. & USTAOĞLU M. R. 2005. Taxonomical investigation of Malacostraca (Crustacea-Arthropoda) fauna in Lake District Inland Waters. [Göller Bölgesi içsularının Malacostraca (Crustacea-Arthropoda) faunasının taksonomik açıdan incelenmesi.] *Ege University Journal of Fisheries & Aquatic Sciences* 22 (3–4): 357–362. (in Turkish)
- ÖZBEK M. & ÖZKAN N. 2010. *Amathillina cristata* Sars 1894, a newly recorded Ponto-Caspian amphipod genus from Turkey (Amphipoda: Gammaridae). *Zoology in the Middle East* 50 (1): 148–150.
- ÖZBEK M. 2011. Distribution of the Ponto-Caspian amphipods in Turkish fresh waters: An overview. *Mediterranean Marine Science* 12 (2): 447–453.
- ÖZBEK M. & ÖZKAN N. 2011. *Dikerogammarus istanbulensis* sp. n., a new amphipod species (Amphipoda: Gammaridae) from Turkey with a key for the genus. *Zootaxa* 2813: 55–64.
- ÖZBEK M., TAŞDEMİR A. & YILDIZ S. 2016. Benthic macroinvertebrate of Adıgüzel Reservoir (Denizli, Turkey). *Ege Journal of Fisheries and Aquatic Sciences* 33 (3): 259–263.
- ÖZBEK M., ÖZKAN N. & ÇAMUR-ELİPEK B. 2017. Freshwater and brackish amphipods (Crustacea: Amphipoda) from Turkish Thrace Region (including Çanakkale Province). *Acta Zoologica Bulgarica* 69 (4): 493–499.
- REWICZ T., KONOPACKA A., BACELA-SPYCHALSKA K., ÖZBEK M. & GRABOWSKI M. 2016. First records of two formerly overlooked Ponto-Caspian amphipods from Turkey: *Echinogammarus trichiatus* (Martynov, 1932) and *Dikerogammarus villosus* (Sovinsky, 1894). *Turkish Journal of Zoology* 40: 328–335.
- TAŞDEMİR A, YILDIZ S., ÖZBEK M., USTAOĞLU R. & BALIK S. 2010. The macrobenthic (Oligocheta, Chironomidae, Amphipoda) fauna of Tahtalı Reservoir (Izmir). *Journal of FisheriesSciences.com* 4 (4): 376–383.
- WELCOME R. L. 1988. International introductions of inland aquatic species. *FAO Fisheries Technical Paper No. 294*, 328 p.
- WILLIAMSON M. 1996. *Biological invasions. Population and Community Biology Series 15*. London: Chapman and Hall, 256 p.