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The Chinese Mitten Crab *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea: Decapoda: Varunidae), a New Invasive Alien Species to the Bulgarian Fauna

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Abstract: The Chinese mitten crab *Eriocheir sinensis* originates in eastern and south-eastern Asia. The species is listed as invasive alien species of the European Union concern. We report the first records of *E. sinensis* from Bulgaria. The species was caught in two localities in the Bulgarian stretch of the Danube River: upstream of the town of Tutrakan and near the village of Botevo. This crab clearly differs from the native species by its morphological and biological traits. The possible pathways of introduction of *E. sinensis* into the Bulgarian stretch of the Danube River are discussed.

Key words: *Eriocheir sinensis*, invasive alien species of EU concern, pathways of introduction, Bulgarian fauna

Introduction

The native range of the Chinese mitten crab, *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea, Decapoda, Varunidae), includes the coastal waters of eastern and south-eastern Asia, from Vladivostok, North Korea, Japan, China to Hong Kong and the island of Taiwan, but sometimes this crab enters to about 1000-1500 km into the rivers (Peters 1933, Panning 1938, 1939, 1952, Gollasch 2011).

The first specimens of *E. sinensis* in Europe were recorded in Germany in 1912, near the confluence of the rivers Weser and Aller (Marquard 1926, Peters 1933). Shipping (ballast water discharge and hull fouling of vessels) was identified as the most probable pathway of introduction, but also such a pathway may be imports of living species for aquaria or human consumption (Marquard 1926, Peters 1933). In 1927, through the Kiel Canal the species reached the Baltic Sea and subsequently spread to the North and Baltic Sea countries in Europe (Peters 1938, Herborg 2003). Through the North Sea *E. sinensis* reached the Atlantic coast and also owing to multiple introduction events (Hänfling et al. 2002) further spread to England, France, Portugal and southern Spain, and entered the Mediterranean (Hoestlandt 1959, Cabral & Costa 1999, Normant et al. 2000, Valovirta & Eronen 2000, Normant & Skora 2002, Herborg et al. 2002, 2003, 2005, Gollasch 2006, 2011, Panov 2006). Recently, it was reported from Ireland (Kelly & Maguire 2009, Gollasch 2011). The first records from the Black Sea were from 2000-2002 (Makarov 2004, Son et al. 2013). There is evidence for the occurrence of the species in the Volga River and the Caspian Sea (Shakirova et al. 2007, Robbins et al. 2009). However, the greatest abundance in Europe was found in estuaries adjacent to the North Sea, i.e. the Ems, Elbe and Weser rivers (Germany), Rhine River (The Netherlands), Thames River (Great Britain) and Vidaa River (Denmark) (Gollasch 2011). The species has been found in Canada and the USA as well (Rudnick et al. 2003,

Veilleux & de Lafontaine 2007).

In the Danube River, *E. sinensis* was reported from Austria (Rabitsch & Schiemer 2003), Hungary (Puky et al. 2005, Puky & Schád 2006), Serbia (Karaman & Machino 2004, Paunovic et al. 2004, Škraba et al. 2013), and Romania (Skolka 1999, Oţel 2004).

Eriocheir sinensis is considered a species with high environmental and economic impact in Europe and since 3 August 2016 *E. sinensis* has been listed as an invasive alien species of the European Union concern according to the EU Regulation 1143/2014 on Invasive Alien Species (EU 2014). The species is an opportunistic omnivore tolerant to a wide range of environmental parameters and its massive development may pose a potential threat to local freshwater and brackish biological communities and ecosystems. As a predator this species also attacks baits and trapped fish in the nets, damaging fishing gear and causing losses to commercial and recreational fishing. Its burrowing activities lead to erosion of river banks and dikes. The abundant occurrence of the species can clog water supply and irrigation facilities and can cause damages to the hydro-technical structures (Rudnick et al. 2000, 2005, Veilleux & de Lafontaine 2007, Gilbey et al. 2008, Dittel & Epifanio 2009, Gollasch 2011). Since its appearance in Germany in 1912 the losses caused by *E. sinensis* to the German economy reached 80 million Euros (Gollasch 2011).

Here we report the first records of *E. sinensis* from Bulgaria, in the Bulgarian stretch of the Danube River.

Materials and Methods

One single crab specimen was recorded in the Bulgarian stretch of the Danube River on 16 September 2005. It was caught by fishermen with gill nets near Radetski Island (436 rkm), upstream of the town of Tutrakan. The standard morphological and diagnostic features of the specimen were studied.

In the period 2015-2016, intensive field surveys related to aquatic invasive alien species were conducted in the Bulgarian stretch of the Danube River and the Danube tributaries, in close collaboration with local environmental authorities. During one of these surveys, experts from the Executive Agency of Fisheries and Aquaculture – Vidin, informed us about a crab specimen attached to the wall of a fishery shop in the village of Botevo. We visited the shop on 9 November 2016 and identified the specimen at the site. Based on information from the owner of the fishery shop, the specimen was caught by fishermen about one kilometre upstream of the village of Botevo (Vidin District) (775 rkm), in the period 2010-2011.

Results

We report the first two records of *Eriocheir sinensis* H. Milne Edwards, 1853 from Bulgaria, in the Bulgarian stretch of the Danube River.

Description

The carapace is markedly convex, almost square and rounded in the rear. Dorsally there is a slight sculpting (Fig. 1A). In the frontal, orbital and hepatic areas it has four acute spines on each side, and a notch between the eyes. The first pair of pereopods has white-tipped chelae (claws) and is covered with a dense mat of dark fine hair (especially the propodite of chelae), which give them a specific view resembling fluffy gloves with cut fingers, hence the name of the crab: mitten crab. The meropodites and carpopodites of the chelae have medially well-developed spines (Fig. 1B). The other four pairs of pereopods (walking legs) are long, with setae on the carpopodites and propodites and well-developed spines in the front distal part of the meropodites (Fig. 1A, C). The colouration is homogeneous, light brown and considerably lighter ventrally. The found live adult is a female specimen with a U-shaped abdomen, which is wide and occupies most of the area of the thorax (Fig. 1C). In males, the abdomen is V-shaped and narrower. The female specimen has a width of the carapace of 88 mm and a length of the legs of about 150 mm. The total size that *E. sinensis* reaches (about 400 mm) defines it as the biggest crab in the Bulgarian fauna.

Distribution

(1) One live female specimen of *E. sinensis* (Fig. 1A, B, C): the Danube River near Radetski Island, upstream of the town of Tutrakan (Tutrakan District) (436 rkm), 16 September 2005, caught by fishermen in gillnets; (2) One dead adult specimen of *E. sinensis* (Fig. 2): the Danube River about one kilometre upstream of the village of Botevo (Vidin District) (775 rkm), most probably in the period 2010-2011, caught by fishermen.

Discussion

The reported records of *E. sinensis* in the Bulgarian stretch of the Danube River are still very rare. The species has also been found randomly upstream and downstream of Bulgaria and reported from most of the Danube countries in different periods since

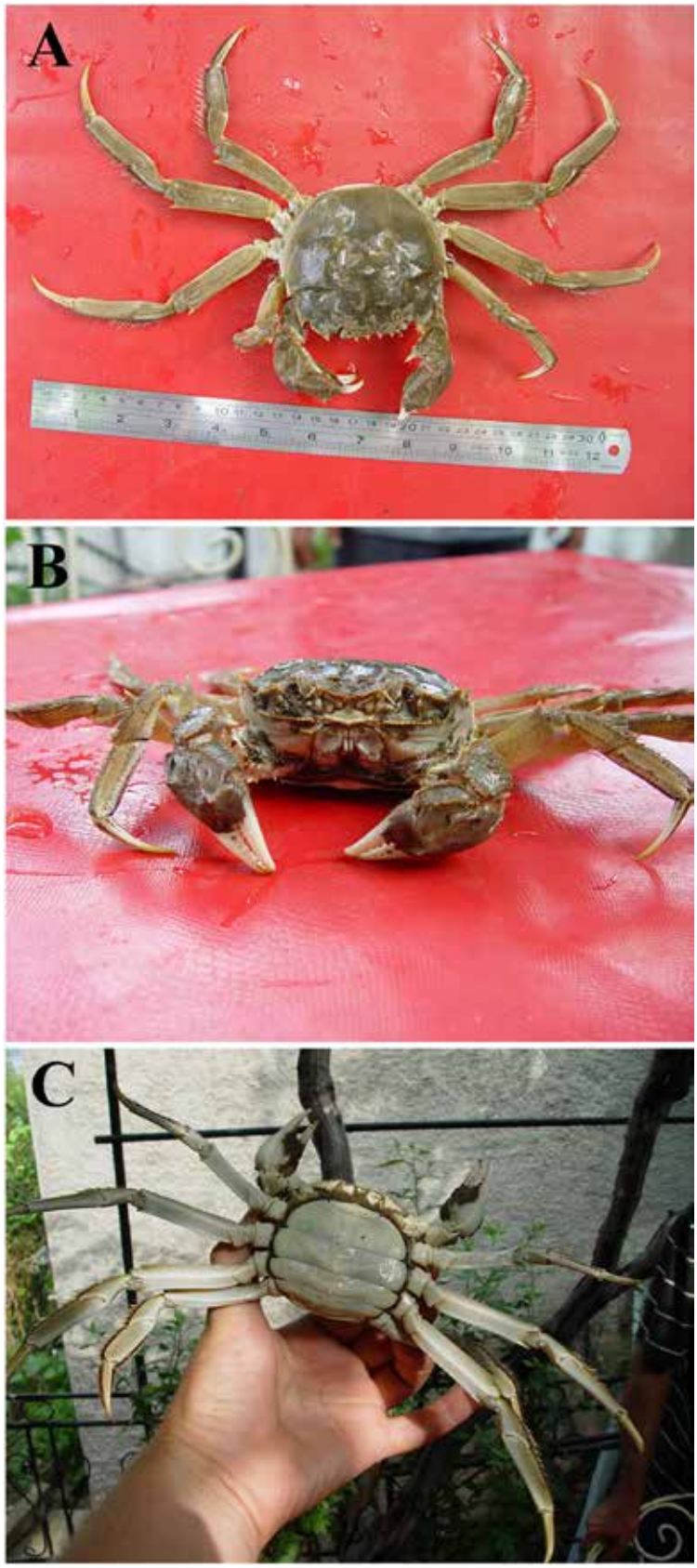

Fig. 1. Chinese mitten crab, *Eriocheir sinensis,* a female specimen, caught in the Danube River, near the town of Tutrakan, Bulgaria (436 rkm): A – dorsal view, showing the general shape of the carapace and the pereopods; B – frontal view, showing the acute spines on the frontal area of the carapace and typical fine hair on the claws; C – ventral view, showing the abdomen (Pictures: Yordan Kutsarov)

Fig. 2. Chinese mitten crab, *Eriocheir sinensis,* an adult specimen, caught in the Danube River, at the village of Botevo (Vidin District), Bulgaria (775 rkm) (Picture: Teodora Trichkova)

its introduction in Europe. According to Welcome (1988, in Karaman & Machino 2004), the species came to Austria, i.e. the Danube River drainage, from Germany in 1927. In 2002, it was discovered again in the Austrian Danube, downstream of Fischamend (1906.2 rkm) (Rabitsch & Schiemer 2003). In Hungary, there was information from fishermen about occasional catches of crab-like animals since the middle of the 1990s, but the first confirmed record was in the main arm of the Danube River, south of Budapest, in 2003 (Puky et al. 2005). The first record from Serbia was in 1973 from the Tisa River at Novi Bečej (Karaman & Machino 2004). Subsequently, *E. sinensis* was reported repeatedly in the Serbian stretch of the Danube River (from 1298 rkm to 972 rkm) in the period 1995-2011 (Karaman & Machino 2004, Paunovic et al. 2004, Škraba et al. 2013). The first finding in Romania (an adult female with eggs) was from 1997, in Musura Bay, near Sulina, the Danube Delta (Skolka 1999). In the period 1997-2004 four more records were reported in the Danube Delta Biosphere Reserve Area (Oţel 2004).

Eriocheir sinensis is a catadromous species and its larval development and survival is temperature and salinity dependent. In other parts of its invasive range, at 4-5 years of age, in late summer, the crabs migrate from the upper reaches of rivers to their mouths and to the seas, and during these migrations the crabs can marsh up to 12 km a day, and in presence of obstacles, come out of water and move on land (Rudnick et al. 2000, 2003, 2005, Veilleux & de Lafontaine 2007). Mating and deposition of eggs usually take place during late autumn in brackish waters, while the embryonic development of eggs takes place in the seas and oceans, for 4-5 months. The larvae develop from the eggs in late winter. They are planktonic and for 1-2 months undergo metamorphosis by passing through a series of stages adapted to different water salinities (Dittel & Epifanio 2009, Veilleux & de Lafontaine 2007). The larval survival is in a range of salinities from 15 to 32 ppt and temperatures from 12 to 25°C (Anger 1991). Optimal survival occurs in salinities of 20-25 ppt and temperatures from 15 to 25°C (Anger 1991, Kim & Hwang 1995).

There are two possible routes of introduction of *E. sinensis* to Bulgaria – by downstream and/ or upstream migration in the Danube River. Oţel (2004) suggested that the most possible way of introduction of the species in the area of the Danube Delta was via the Mediterranean Sea – Black Sea – Danube River. The upstream migration was assumed as the most likely pathway of introduction of the species in the Serbian stretch of the Danube River as well, by either actively migrating juveniles and adults, or by individuals passively introduced through ballast waters of shipping vessels (Karaman & Machino 2004, Škraba et al. 2013). This likelihood is supported by the increased findings of *E. sinensis* in the Black Sea and the Black Sea river estuaries (Romania and Ukraine) after 1997 (Skolka 1999, Makarov 2004, Oţel 2004, Son et al. 2013). In the 2000s the species was also recorded in reservoirs of the Dnieper River (Son et al. 2013). However, there is still no information about the life cycle and migration routes of *E. sinensis* in the Danube River and it is also not clear if the species can reproduce in the Black Sea, because of its comparatively low salinity – from 18.0-18.5 ppt of surface layers in central part to 16-17 ppt in coastal areas, decreasing to 13-15 ppt in north-western coastal part where most of the big rivers flow (Rozhdestvenskiy 1978). Ojaveer et al. (2007) discussed the hypothesis that in the Baltic Sea the species may adopt to the new environment and would be able to reproduce at lower salinities. Otto & Brandis (2011) reported that *E. sinensis* may well reproduce in western Baltic Sea. The authors found several females with eggs, planktonic larvae and juveniles in Kiel Fjord and in the eastern Kiel Canal, where the salinity is 12-30 PSU. A study on the gonad maturity in females of *E. sinensis* in southern Baltic Sea, where the salinity is much lower (≤7 PSU), showed that the low salinity permits mating and fertilisation as well as embryo development in *E. sinensis*, but it is still not clear whether such a salinity level will enable hatching and the complete larval cycle (Wójcik & Normant 2014).

We assume that downstream migration is also possible, especially after the construction of the Rhine – Main – Danube Canal in the early 1990s. As mentioned above, the Rhine was one of the

rivers with the highest abundance of *E. sinensis* in Europe (Gollasch 2011). According to Herborg et al. (2005), within Europe, ballast water discharge may also have been involved as a possible pathway of introductions, and accidental transport with live mussels for aquaculture is suspected as well. In addition, natural dispersal is likely after initial invasion (Brockerhoff & McLay 2011).

The information about the two findings of *E. sinensis* in Bulgaria came accidentally from fishermen in the Danube River. Most probably there were other unreported catches. This shows the necessity of developing a reporting system among fishing associations at regional and national level in collaboration with responsible governmental authorities, in order to receive regular information about catches of *E. sinensis,* as well as other aquatic invasive alien species in the Danube River. Raising public awareness among local people and associations about the invasive alien species of EU concern and their impact is also required. The establishment success and dynamics of *E. sinensis* in the Bulgarian stretch of the Danube River need to be studied, and if necessary, preventive measures against further spread of the species upstream of the Danube River tributaries must be undertaken.

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