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First record of *Sigara assimilis* (Fieber, 1848) (Hemiptera: Heteroptera: Corixidae) in Poland

by

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Abstract

Sigara assimilis (Fieber, 1848) is an aquatic true bug from the family Corixidae. Our paper is the first report on this species from Poland. Numerous males and females of the species were found in a hypohaline coal mine settling pond in southern Poland.

Key words: *Sigara*, boatmen, Nepomorpha, Polish fauna, settling pond, hypohaline waters

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Introduction

Heteroptera are an important component of aquatic ecosystems. Water bugs of the infraorder Nepomorpha, including members of the family Corixidae, comprise benthic and nektonic species (Aukema & Rieger 1995). They are able to colonize nearly all aquatic habitats: rivers, streams, lakes, ponds, temporary waters, pools and brackish coastal waters (Wróblewski 1980; Jansson 1986; 1996; Polhemus & Polhemus 2008; Strauss & Niederinghaus 2014). They occur in waters with salinity up to 100 g l^{-1} (Kay et al. 2001; Rutherford & Kefford 2005; Bröring & Niederinghaus 2008; Strauss & Niederinghaus 2014). Corixidae play an important role in the littoral food webs. Most species are omnivorous. Some species are more specialized phytophages, detritus and algal feeders. Many corixids are carnivorous and feed on protozoans, rotifers, live and dead oligochaetes, planktonic and benthic or nektobenthic crustaceans (copepods, cladocerans, ostracods, anostracans) and aquatic insect larvae, e.g. mayflies, chironomids and mosquitoes. They play an important role as predators in aquatic ecosystems in which there are no fish (Jansson 1986; Papáček 2001; Wollmann & Deneke 2002; Hädicke et al. 2017). In addition, some of the water boatmen may be of economic importance as prey for carnivorous aquatic invertebrates (especially predaceous insects), fish, amphibians and water birds (Papáček 2001; Ghahari 2013).

To date, 66 species of water bugs have been identified in Poland, including 46 Nepomorpha and 20 Gerromorpha (Tończyk & Mielewczyk 2004; Kurzątkowska & Zawal 2011). Corixidae form the largest family of aquatic Heteroptera, with 607 species known from around the world (Polhemus & Polhemus 2008). Thirty five species of water boatmen, including 14 species of the genus *Sigara*, have so far been found in Poland (Tończyk & Mielewczyk 2004; Kurzątkowska & Zawal 2011).

Sigara assimilis (Fieber, 1848) is a Palearctic species (Aukema & Rieger 1995; Fent et al. 2011; Aukema et. al 2013), whose geographical range extends to the west of the Balkan Peninsula (Bulgaria, Croatia, Romania and the European part of Turkey) (Aukema & Rieger 1995; Jansson 1996; Olosutean & Ilie 2010; Stoianova & Simov 2016) and Hungary (Soós 1959; Boda et al. 2015) through Ukraine, Moldova, the South European Territory of Russia, Transcaucasia (Azerbaijan and Georgia), the European part of Kazakhstan, Central Asia (the Asian part of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan), Mongolia, northern China (Jaczewski 1929; Kerzhner & Jaczewski 1964; Jansson 1986; Jorigtoo & Nonnaizab 1996; Derjanschi 2008; Kanyukova 2008; Grandova 2013; 2014) to Japan in the east (Hayashi et al. 2001). In the north, the geographical range extends from Western Siberia (the basin of the Irtysh River) (Aukema & Rieger 1995; Kanyukova 2000) through the Asian parts of Turkey, Iraq, Iran, Afghanistan (Hoberlandt 1952; Kerzhner & Jaczewski 1964; Jansson 1986) to Saudi Arabia and the United Arab Emirates in the south (Aukema & Rieger 1995; Linnavuori et al. 2011) (Fig. 1). So far, it has not been reported from Poland. Therefore, this paper presents the first record of *S. assimilis* from Poland.

Materials and methods

The study was conducted in a settling pond in the mining city of Knurów in Upper Silesia, southern Poland (coordinates: 50°13'09"N, 18°40'11"E, WGS 84) from June to October 2016. The area is characterized by one of the greatest concentrations of settling ponds in the Silesian Upland (Jankowski & Wach 1980). The investigated water body (Fig. 2) was created in 1974 to drain the salt water coming from the "Knurów-Szczygłowice" coal mine (Bielańska-Grajner & Cudak 2014). Therefore, the settling pond is mainly supplied with waters from the mine's dewatering system. The surface area of the settling pond is about 7186 m^2, its length – about 165 m and its width – about 76 m. Both the shoreline and bottom sediments are built of post-mining waste with granulation ranging from 0.2 to 2.0 cm. The studied pond is located at 242 m above sea level.

Samples of Corixidae were collected in the coastal zone of the pond, both from the bottom sediments and the macrophytes, down to a depth of 0.7 m, according to the quantitative method using a 25 × 25 cm quadrat wooden frame that was randomly placed in nine locations. Water parameters such as temperature, conductivity, pH, dissolved oxygen and total dissolved solids (TDS) were also measured in the field using Hanna Instruments portable meters. Samples were transported to the laboratory in plastic containers and preserved in 80% ethanol.

Results and discussion

During the study period, water bugs were represented by 353 individuals (104 imagines, 249 nymphs), all belonging to two corixid species: *Sigara assimilis* and *Cymatia rogenhoferi* (Fieber, 1848). *Sigara assimilis* was found for the first time in Poland. In the collected material (15 samples), the species was represented by 71 males (long winged specimens)

Figure 1

The geographic range limit of *S. assimilis*

Figure 2

The hypohaline settling pond where *S. assimilis* was found

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and 32 females (long winged specimens; identification on the basis of the pattern on hemelytra). The largest number of males (52 individuals) was collected on the 12th of June and the lowest one (8 males) on the 7th of August) (Table 1).

Descriptions of the species were presented by Jaczewski (1929), Jansson (1986), Linnavouri et al. (2011) and Kanyukova (2000, 2006). *Sigara assimilis* is one of the nine boatmen species classified into the nominative subgenus *Sigara* (*Sigara* s. str.). Based on the features provided by Jansson (1986), the males of *S. assmilis* are easy to distinguish from the other species in the subgenus. The analysis of the material that was gathered in Poland indicates that the basis for their identification are features that were also given by other authors (e.g. Jansson 1986; Kanyukova 2000) and include:

1. a unique pattern in semi-compartments of hemelytra – dark brown hemelytra with a clearly bright picture and characteristic shading in the nodal and post-nodal sectors of the pruinose area (Fig. 3A);

2. a system of tooth rows on the pala – the proximal end of the ventral row of the spines goes further than the distal end of the second tooth rows; an arcuate, dorsally situated row of teeth (Fig. 3B);

3. the shape of the right and left paramere: the right paramere – elongated, characteristically arched in the proximal part and terminated by a long hooked processus; the left paramere – long, rounded at the end with numerous small spikes in the outer part (Fig. 3C, D);

4. strigil – clearly visible, large and oval with seven shortened combs (Fig. 3E).

Given that all the collected males of the genus *Sigara* belonged to *S. assimilis*, it is very likely that also all the collected females (32 individuals) and nymphs (249 individuals) belonged to the same species. The morphology of all sampled females matched the description, though not very detailed, provided by Jaczewski (1929). Unfortunately, the available keys to water bugs do not include features enabling the identification of females and nymphs (Jansson 1986; Kanyukowa 2000; Strauss & Niederinghaus 2014). Thus, we cannot completely exclude the presence of females and juveniles of other *Sigara* species in the studied pond.

During the study period, the water was characterized by very high conductivity (mean 30 944 µS cm^{-1}) and was well saturated with oxygen (mean 13.4 mg l^{-1}). Water salinity ranged from 12.9 to 17.1 g l^{-1}, the pH of water was slightly alkaline and the temperature ranged from 13.8°C in autumn to 25.1°C in summer (Table 1). *Sigara assimilis* occurs in a broad range of habitats, both in lentic (Grandova 2013; 2014) and lotic waters (Topkara 2013). Although the species prefers saline and brackish waters, it is also frequently found in freshwater water bodies (Esenbekova et al. 2015). While *S. assimilis* is usually found in mesohaline and polyhaline waters, including rivers (Bening & Medvedeva 1926; Zinchenko & Golovatyuk 2013; Zinovjeva 2013; Golovatyuk & Shitikov 2016), the investigated settling pond was hypohaline. According to Golovatyuk & Shitikov (2016), the optimum water salinity for *S. assimilis* is 30.12 g l^{-1}. These authors studied macrozoobenthos in highly saline small rivers of the Lake Elton basin and calculated the optimum salinity tolerance of *S. assimilis* by using the Gaussian response curve. On the other hand, the authors indicated the presence of *S. assimilis* at sampling sites with water salinity of 17.17 g l^{-1}, similarly as in the settling pond we studied. This confirms that the species has a wide tolerance to salinity (Golovatyuk & Shitikov 2016).

Water bugs are among the few groups of aquatic insects that regularly inhabit brackish waters. Data on species that are found in this type of habitats were presented, among others, by Lindberg (1936, 1948), Poisson (1957) and Strauss & Niederinghaus

Table 1

Parameters of the water and the number of collected *S. assimilis* individuals in each month of the study

Parameter	June	July	August	September	October
Temperature (°C)	24.6	21.0	25.1	25.0	13.8
Conductivity (µS cm^{-1})	34 400.0	30 500.0	26 000.0	30 900.0	33 500.0
pH	7.7	8.5	7.3	7.1	7.5
Total dissolved solids (g l^{-1})	17.1	15.25	12.9	15.4	16.7
Dissolved oxygen (mg O_2 l^{-1})	15.3	14.57	11.48	17.56	10.98
Number of specimens (males)	52	11	8	-	-
Number of specimens (females)	13	6	7	1	5
Number of specimens (nymphs – Corixinae)	175	62	8	4	-

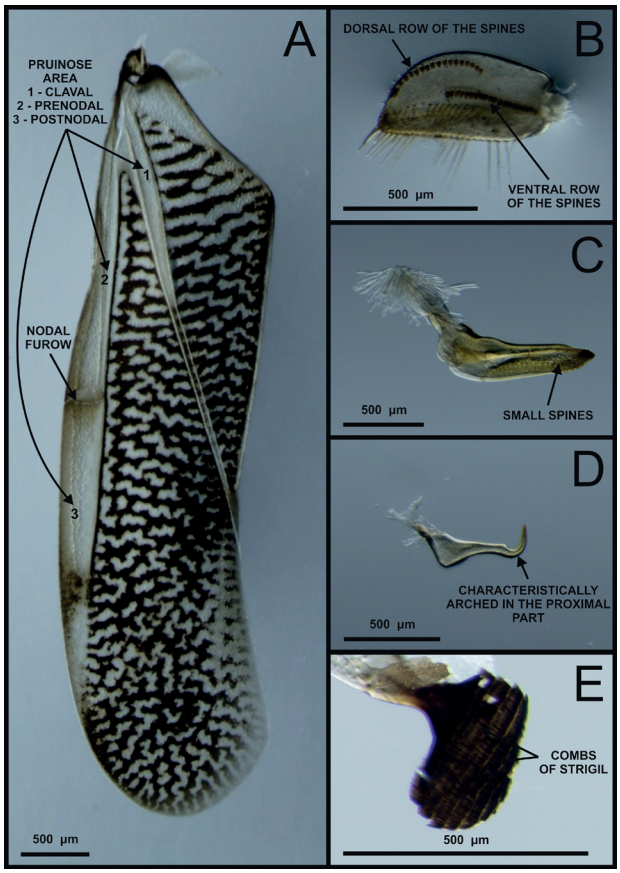

Figure 3

Characteristic features of *S. assimilis* (Fieber, 1848): A – hemelytron, B – pala, C – left paramere, D – right paramere, E – strigil

(2014). In the Polish literature, such data are provided, among others, in the papers by Jaczewski (1935) and Mielewczyk (1970), both concerning the Heteroptera in the coastal waters of the Baltic Sea. According to Tończyk & Mielewczyk (2004), some species of Corixidae that occur in Poland, such as *Corixa panzeri* (Fieber, 1848), *Cymatia rogenhoferi* and *Sigara stagnalis* (Leach, 1817), are halophiles tolerating increased water salinity. Therefore, *S. assimilis* has proven to be another halophilic species in Poland.

The large number of *S. assimilis* individuals collected from the investigated water body indicates that this halophilic species has been a successful colonizer. *S. assimilis* might have been introduced into the coal mine settling pond by migratory waterfowl that are good vectors of the long-distance dispersal of macroinvertebrates (Muñoz et al. 2013; Viana et al. 2016). However, most likely the species got to the water body by the dispersal flight. Such flights of aquatic bugs are the most effective way of dispersal (Fernando & Galbraith 1973; Bilton et al. 2001; Csabai et al. 2006; Boda & Csabai 2009; Boix et al 2011; Boda & Csabai 2013). This may be confirmed by the fact that the nearest known location of *S. assimilis* is located at least 200 km from the area of its first record in Poland. Probably the direction of the species migration was from south to east. Dispersal flights are driven by many of the environmental, ecological and physical factors (Savage 1989; Boda & Csabai 2009; Boix et al 2011; Ruhi et al 2012). We can certainly state that the water salinity is not a key factor in the distribution of *S. assimilis* in Poland, because we did not find it in other settling ponds in the neighboring area with similar or even greater salinity. According to Fernando & Galbraith (1973) and Boda & Csabai (2013), the breeding flight of Heteroptera in Europe occurs in spring and early summer, whereas in autumn most of the species look for a suitable habitat to overwinter. This is consistent with our results as we have observed the largest number of specimens in late spring (Table 1). Finally, it cannot be excluded that the lack of earlier records of this species in Poland may be due to the fact that this type of scattered anthropogenic water bodies with elevated salinity are not frequently studied.

This may mean that the presence of *S. assimilis* in similar saline anthropogenic water bodies can be expected in the future. Therefore, monitoring and studies of such aquatic environments are required. New records are important both for the general assessment of biodiversity but also, specifically, for assessing the spread and distribution of *S. assimilis* in Poland and Europe.

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